

**2012 THE "BORLAUG DIALOGUE"**

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Panel Moderator: Margaret Catley-Carlson

**CONVERSATION:**

**DROUGHTS AND DRYLANDS:**

**AGRICULTURE'S ROLE IN CONFRONTING GLOBAL WATER CHALLENGES**

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*Panel moderator:*

**Margaret Catley-Carlson**

Chair, World Economic Forum Advisory Council on Water

*Panel members:*

<b>Igal Aisenberg</b>	President & CEO, Netafim
<b>J. Carl Ganter</b>	Co-Founder & Director, Circle of Blue
<b>Roberto Lenton</b>	Executive Director, Robert B. Daugherty Water for Food Institute - University of Nebraska
<b>Aditi Mukherji</b>	Senior Researcher, International Water Management Institute

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*Introduction by:*

**Ambassador Kenneth M. Quinn**

President - World Food Prize Foundation

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Good morning. Welcome, everybody. So it's Thursday morning - it's a little hard getting everybody up. They were out reveling last night at our reception and then networking dinners and then dialogueNEXT. So into another full day of the Borlaug Dialogue Symposium.

And yesterday you met our laureate, Dr. Hillel, work in water. Last night we honored Dr. Aditi Mukherji for her work in water. So it's only appropriate that we start the panel today, "Droughts and Drylands: Agriculture's Role in Confronting Global Water Challenges." So let me invite the panel and our moderator to come to the stage. I was tempted to ask Margaret Catley-Carlson if she was coming up. She had water in her cup.

I know water's important, but I'm far, far from an expert about it. In fact, the World Food Prize has realized that water is important for a long time. And it was in 2002, the third year that I was president that we were honored to have a whole session on water, from the Middle East to the Middle West, managing freshwater shortages and regional water security. We had two special guests from Israel at that time: Saul Arlosoroff - he was chairman of the Israeli Water Engineers; and Erez Meltzer, president and CEO of Netafim at the time. And we also had from the West Bank, Jad Isaac, Palestinian water experts, as well as experts from Egypt and Syria. So today is a follow-on to that.

But the one constant is that back then the person who was at the forefront of coordinating the entire symposium told me – Here’s who to invite. It was our Council of Advisors member, Margaret Catley-Carlson, herself a distinguished international expert in water issues. I have been so privileged to know her and to have her advising me. To the extent that anything goes very well at the World Food Prize, it’s usually because of the advisors pointing me in the right direction. So, Maggie, over to you.

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**CONVERSATION:**

**DROUGHTS AND DRYLANDS:**

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**Margaret Catley-Carlson**

Chair, World Economic Forum Advisory Council on Water

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Thank you very much, Ken. And thank you all for being here. It’s pretty awful to be here at this hour of the morning, but it would be much worse if you weren’t here. So we’re enormously grateful that we can see some heads out there, and we’re very glad to have you here.

I’m joined this morning by a number of people who are going to take you to interesting dimensions of the drought and drylands question. Just moving along from my left hand, we have Igal Aisenberg, and he’s from Netafim, which is the company that Ken Quinn just talked about, a real leader in drip irrigation and new forms of irrigation – because it isn’t just drip irrigation. You’re going to hear some about that.

The next is Roberto Lenton – he’s just taken over, I guess it’s within the last year now, at the University of Nebraska, setting up a whole water and agriculture unit, which is going to be global in scope but also very much grounded in the Midwest here. So he’s got some very interesting things to talk about.

Aditi Mukherji, I hope none of you need an introduction to, because she was last night’s first winner of the research on the ground prize – the Norman Borlaug commemorative prize offered by Rockefeller really to get in and reward researchers under 40 who have actually got in, got their hands dirty, and started to do the kind of field research that Norm said was necessary to feed the world.

And Carl Ganter at the other end, publicist, researcher, photographer, assembler extraordinaire, and recent winner also of the Rockefeller Centennial Innovation Grant, which honors the fact that we need much better communicators in the world.

So that’s what we’re going to do. And we’re going to try and keep this in a conventional mode with a couple of longer presentations. And we’re really going to try to use the first hour of your day and some of our days by exploring the whole drought and dryland issue. These are pretty scary words – drylands. We think of them almost as being the same thing, that a dryland is just

something that's ready to turn into a desert, and desert is something that's about to turn into a drought. And of course that's one of the things we're going to be exploring - is that inevitable?

And I would like to start off by saying - well, you know, some of the productive and wealthy zones in the world are drylands. Southern California, Australia, Southern Alberta, Morocco, Tunisia - these are drylands by any standard, even the South of France, parts of Spain.

And so, clearly, being a dryland area is not the same thing as being a drought area. But there are movements. When people want to be scary about the world, they talk about the fact that there's two children born per second and that there's an acre comes out of production into nonagricultural uses. And then they talk about the number of acres per day per week that do turn into desertified areas. So there's obviously some bad forces going on, and I hope the panel this morning is going to talk about some of the forces that we can use to make sure that not every dryland becomes desertified, in fact, less and less of them. And, in fact, can we turn this process around. So that's generally a little bit the menu.

So we're going to start with - what is the real challenge of droughts and drylands? And Carl Ganter is going to take us on a flying picture, a flying overpicture of what drylands look like in many parts of the world at the moment and always with that drought and the desert just on the side. Carl?

### **J. Carl Ganter**

Co-Founder and Director, Circle of Blue

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Thanks, Maggie. It's great to be here bright and early in the morning. I also run Circle of Blue, which is a group of journalists and scientists reporting on water, food and energy issues around the world. So I'm going to take you on a quick, four-minute travel log. I have the remote, so I have full control of the television. But we're going to start in the Tehuacan Valley.

So in Tehuacan what you see here is a community once known for vibrancy and water, even known for its bottled water. And it's drying up in many ways. It's a drylands that's changing; its aquifers are dropping - very significant changes in this region of Tehuacan.

We find farmers who are at the frontline here in Tehuacan who the very first time in their lives, in memory, are actually having to buy water. Their wells were dry when we visited. How did they water their maize? How did they water their corn? So again big changes occurring in how people manage agriculture and manage their lives.

And also when we look at drylands and shifts in water and precipitation, we also have to look at shifts of people. So we talk about environmental immigrants. Well, we found Francisco Rosa Valencia, and when we listened to her story, she started to tear up. And she reached for a picture, a picture of her children, her nephew and her son, who she hadn't heard from in more than a year after they left to move to the U.S. So she didn't know if they'd made it. They left because their wells were dry.

So other places that we're looking around the world, of course, is Iowa, right here in our backyard. So in Tuesday I went out into the field, quite literally, and learned a lot about the corn

crop, learned a lot about the issues – what is drought? What is, in a sense, a dry area now and at least this it looked like. And corn yields were down, sometimes 25% of what they normally are. And so I visited this farm. This is Jeff Hanfer, and it's about an hour west of here, and it looks like a lush farm, because it just rained, and the grass is green. But yet his ponds are going dry. His well he can only run for so many hours a day before it goes dry. And now what he said is, the images that we saw on television last summer of really dry, cracked land, he said, what he's really concerned about is winter and spring when calving season and he doesn't have enough water for his cattle. So again big changes. Is this a new normal?

So on our little travelogue too, I visited this family. This is Wu Yun in inner Mongolia. And when we talk drylands, we have to talk about this nexus of water, food and energy. So I wanted to take a look at – how is this water/energy challenge playing out? So in inner Mongolia, here's Wu Yun standing in the grasslands. This is in December, so of course it's not green, but it's also incredibly dry. Their wells have gone dry because of the demands of the coal mines in the background that you see there. She's standing outside the front door of their small, little home, their winter home. They normally live in a yurt, or a ger, out in the grasslands. But they now have a dry well; they have to drive 15 kilometers to get water for their sheep. That's the tractor in the background with the tank that they have to drive to get the water.

So then also looking at this water/energy challenge, we wanted to back up and look a little deeper into China's challenge specifically. Because what China does the world...when China talks, the world listens. And this water/energy challenge and food, of course, because it's all connected – the water/food/energy challenge in China is playing out most heavily right now in the energy demand world. So we have three trends converging. We have a country that's growing so fast it's increasing its use of coal. Coal uses huge amounts of water for processing and also for cooling power plants.

So what happens when the energy sector needs lots of water? Well, we've already seen a change. We've already seen in Ningxia Province that farmers and co-producers are at odds, that the water accessible for farmers has dropped 30%, at least in 2008. So this is a struggle. This is a really interesting challenge that's unfolding in China and other parts of the world. This is one of their responses. China is responding by policy; they're also responding by massive infrastructure projects. This is the largest industrial infrastructure project on the planet right now – a hundred billion dollar pipeline from the south to the north.

Also in China we're seeing all sorts of innovation. Innovation means, one hopes optimism, one hopes change. China is testing all sorts of interesting things. They're testing water rights trading where industry and municipalities are investing in agriculture in efficient use of irrigation. So we're seeing that the cities are finding that investment in making agriculture much more efficient in water use brings them more water downstream – so really interesting changes there too.

In the U.S. now of course we can't talk about water without talking about the U.S. and drylands and the Colorado River. This is the Arizona project. This brings water from the Colorado River to Tucson and to Phoenix. So a week ago I did an early-morning flight down to Colorado. And this is the lifeblood for Tucson and Phoenix. Now, also keep on your radar a new report on the Colorado River and climate change coming up in December, and I understand it's going to be very, very stunning. It will be a new, it will probably be fodder for a drama, a television series called "The Real Water World."

The next step, too, is around the world, looking at Australia, another drylands, a food bowl that was faced with severe drought. This is a rice paddy in the middle of practically the desert here. So we hit the GPS, landed, went and asked the farmer, "Why are you still growing rice?" He said, "Well, because I'm getting a great price." And his complaint was, he had to drill his well deeper every year. That was his complaint to us.

Australia is responding. They're responding with some new carbon and CO<sub>2</sub> emission standards and also new ways of managing their water in the Murray-Darling Basin.

So you remember Wu Yun, but very quickly three weeks ago I was out on the grasslands, a two-hour motorcycle ride, out to the edge of desertification. This is in the backyard of her sister's in-laws' home, a little ger on the grasslands there. And these are the deserts. This is the actual dunes marching across the grasslands. And so Astronaut Jerry Linenger, when he was in Mir in the Soviet space station for five months, he said he would look down, and the real connective tissue of the world that he saw, one was of course water, and he could see these dust storms emanating from Wu Yun's backyard, blowing all the way to Beijing and all the way to Los Angeles. So the drylands, these changes, it connects us all. And then as far as managing them, it's one of our greatest challenges but of course our greatest opportunities to rethink how we get our food in the water context.

### **Margaret Catley-Carlson**

Thank you very much indeed. That was quite a birds-eye view of things. And we're going to be talking a lot now about how you try and cope with this. But I want to spend just a few minutes on the overall perspective of what we're seeing here. Is this sufficiently person-made, that we can actually try and think about turning around some of the root causes? How much of this is climate change? Do we know the difference? Are people studying the difference between manmade and climate change? Are there differences in prescriptions here?

Roberto, do you want to lead us off, and just let's exchange some view on the overall picture of what we saw there.

### **Roberto Lenton**

Executive Director, Robert D. Daugherty Water for Food Institute - University of Nebraska

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Maggie, well, thanks a lot. It's a pleasure to be here this morning. And, Carl, that was a fantastic way to start the proceedings, I think. It really showed how the issues of drought and drylands play themselves out in different parts of the world and the human drama that comes behind that and that unfolds in different ways in different places.

I think what I'd like to say is a little bit about the drought in this part of the world. Carl started out with a couple of slides on Iowa, and that certainly brought home to me, having just recently moved to the Midwest of the U.S., the issues of drought and water management are absolutely central to this part of the world.

And part of what we're doing at our institute is trying to learn lessons from the drought in terms of - well, what is it that you can do? And one of the clear lessons is of course the importance of irrigation. If you take the state of Nebraska, from a climatological, climatological point of view, was the hardest hit of all the states. But if you look at it from a production point

of view, it was not. So that something was happening in Nebraska that explained that difference. And clearly irrigation is one part of it, the fact that Nebraska has the highest amount of irrigation of all states in the U.S. – it has around four million hectares of irrigated land. And if you took Nebraska as a country, it would be about 13<sup>th</sup> or 14<sup>th</sup> ranked in the world in terms of irrigated area. So certainly irrigation had a huge role in terms of coping with the drought.

But I think the lessons go beyond that, because my sense is that those farmers who were already, whether they were rainfed or irrigated, were already practicing techniques to conserve water, those were the ones that fed the best in this drought. Those farmers who were rainfed who were practicing no-tillage ways of conserving water in the soil, moisture in the soil, they did better. Those farmers who were irrigated but trying to irrigate with the least amount of water, either through planting drought-tolerant crops or through installing soil moisture sensors so they were minimizing the amount of water, those were the farmers that did the best.

### **Margaret Catley-Carlson**

Okay, and we've got one of our big experts on that, so I'm going to come to him in a second. He's going to talk about that.

Aditi, is there drought awareness in India? That sounds like such a banal question, but I mean, does awareness of drought actually change behavior in India, in the places that you work?

### **Aditi Mukherji**

Senior Researcher, International Water Management Institute

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Yes. I mean, what I was hoping to talk about is exactly that. I mean, drought, desperation and water irrigation, especially groundwater irrigation plays in that. So again like Nebraska I have what I call "Tale of Two States." Let me talk about Punjab where Dr. Norman Borlaug did his pioneering work and contrasted the state of Bihar. So both 2009 as well as 2012 were drought years in India with rainfall deficits of up to 40 to 50% below normal rainfall.

And I was just looking up the statistics for 2009, and what I found very, very interesting was – both Punjab, as well Punjab is in Northern India. Try imagine a map of India in your head and Punjab is in the northwest and Bihar is in the eastern side of India. And both these states had exactly the same amount of rainfall deficit, around 41 to 42% of rainfall below the normal. But in Punjab there was hardly any reduction in cropped area. The reduction in cropped area was like .8%, why on the other hand in Bihar the reduction in cropped area during the monsoon season was as high as 48%.

So why is it that states which have similar rainfall deficits react so differently to the rainfall deficit? And the answer lies again, just as Dr. Lenton pointed out so well, the answer lies in access to irrigation. It's just that farmers in Punjab have access to irrigation, both canal irrigation but even more importantly groundwater irrigation that gives them reliable and timely access to it. And then there's such a paradox involved in it, because in Punjab farmers actually pump water from depths of a hundred feet or more, while in the state of Bihar groundwater is available at a shallow depth of 10 to 30 feet.

**Margaret Catley-Carlson**

So we've got a tale of two places, both of them reacting very differently, the real point being irrigation. Do you know something about this subject of irrigation?

**Igal Aisenberg**

President and CEO, Netafim

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I hope I do. First, I'm honored to be here, and I am more than glad to hear the word "irrigation" at least three times.

**Margaret Catley-Carlson**

Yeah, positively, too.

**Igal Aisenberg**

Well, positively or negatively, something that sometimes puzzles me – I do not attend very often in national venues like this one, but I do a couple of times a year. And it always intrigues me how much time people can talk about water issues without even spelling the word "irrigation."

Now, it is especially intriguing if we agree that it's been widely accepted that irrigation is responsible for, and now I don't know how much science is behind the numbers, but you can take any number between 60 to 85%, depending on the way people talk about water withdrawals or water consumption, etc., etc. But in one way or the other it is widely accepted that irrigation is actually responsible for the way people manage water on this planet.

And again there is no way to talk about water without talking about irrigation. And I still wonder how little irrigation per se is the top of the agenda of the international institutions, political, financing, etc., etc.

So let me just say a couple of words about the presentation. I had the pleasure to hear yesterday Dr. Conway's presentation, I believe, and the big question was – Can we feed the world? And his answer was – Yes, if... I would add to that, that if we could run producing food as one business unit, the answer to that question would be an unconditional yes. But this is not going to be the case in the foreseeable future. And then we have to deal with the normal imbalances that are always part of a suboptimal system. And I look at that from a business perspective. We are actually facing a suboptimal system that is here to stay. In other words, the water and food issues are and will be local, but they can benefit or suffer from global developments.

And now I want to touch on the water and irrigation one. We started predicating to the water issue since actually we came into being in the mid-sixties. And by the way, I joined Netafim only 23 years ago, and I must tell you that I am one of the few Israelis I know that did not invent drip – guaranteed – had nothing to do with that and actually joined a vibrant industry that was already peaking.

But it was only in the last five years that we in our business realized that looking for the real critical finite resources in this planet, the number one finite resource is arable land. And we still have plenty of room to deal and improve the way we use water. I don't want to go into that. But our oceans, runoff, storage, municipal waste, and many other factors can really improve the amount of available water even in a short time.

Arable land, unless we find a way to farm in the moon, is actually the most critical and diminishing resource that, combined with water, actually presents the full scope of the challenge. And from a business perspective, once we realize that, we can only say that we believe... And now let me just in the next few seconds, let me take you through an imaginary journey.

Imagine. Imagine there is a way to improve yields between 20 to 200%, and that depends on the crop and different conditions. And imagine that water can be saved in the range of 20 to 50%. And imagine that we can use much less fertilizers and pesticides. And imagine that we can just reduce dramatically pollution and land/soil degradation by many different ways - runoff, low or no-till, salinization of the soil, etc., etc.

And now imagine that all those nice things can be done at once. And the fact is that a system that can do all of that, not to 100% of whatever we want to grow but probably to a good 20 to 25% of what we can grow on this planet - that exists. And the factors that limit the introduction of drip and microirrigation today, besides the fact that this is an innovation for most farmers - look at Nebraska... And by the way, there is a very rapid introduction of drip small-scale in Nebraska since the past three to five years.

And the real limiting factor is the fact that people need to adopt something they don't know, and they need the support of probably governments and rural institutions because irrigation (and I am, just as my finishing remark), irrigation not as fertilizers, seeds and pesticides, is capital... that requires significant initiative investment.

So from a pure business perspective, many or most other inputs are OPEX, operating costs. Irrigation is invariably CAPEX that requires significant investment. Private-public corporation can do much of that.

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Catley-Carlson            Thank you. So you've painted a really optimistic picture about what could be possible in a better and more adaptive world.

Aditi, take us back to your two states in India. Why, what makes the difference in uptake between one and the other, given the picture that is painted here of really a much better outcome in crop. Those two states have different wealth, but is the different wealth factor the major reason that causes the differential uptake of new ideas, such in particular as the ones that Igal is talking about?

Mukherji    No. I think what really the reason for the different outcomes is the policies that the government, that this, water is a state subject in India, so every state government has different policies, vis-à-vis, how water is to be used or how irrigation is done.



So basically in Punjab what happens is, even though Punjab has absolutely overexploited its groundwater resources, the government policies actually provide free electricity to farmers that allows them to - the good thing is that gives them a hedge against drought. So whenever there is less rainfall, they can continue extracting groundwater, but that obviously is not such a good thing. They continue to do that even in good rainfall years.

While in contrast in Bihar, even though groundwater is available at very shallow levels, what is happening is that the state doesn't have any electricity, so farmers depend on diesel-driven pump. And if the economics of it does not make sense to continue pumping.

So I would think that much of the reaction is actually policy-driven. And also in Punjab what's happening is that it's not as if the farmers are not reacting to scarcity. I mean, it's true that they get free electricity, it's true that they grow crops that are totally unsustainable given the water endowments. They grow wheat and paddy and paddy is a very water-intensive crop.

But what is happening over the time is that there is another set of policies, like electricity policies. So number of hours of electricity that farmers get have been whittled down to such a bare minimum, like six to eight hours in the peak summer season, that farmers are by default forced to economize on that water.

Catley-Carlson        You're saying that the policy is really the absolutely central part.

Mukherji    Absolutely.

Catley-Carlson        Roberto, you ran the International Water Management Institute, which before that was the International Irrigation Institute. So you've run an organization that was looking nonstop at irrigation decisions. Do you agree with that assessment? Is it policy? Is it having an enlightened government? Is it farmer push? What makes the difference between the two states or the two parts of the world that start adopting change and those that don't?

Lenton        Well, policy is absolutely fundamental, and I'm not surprised with Aditi's conclusions in terms of Bihar and Punjab. In the end it's policies that make farmers adopt better technologies or better approaches to conserve water. So if you don't have the policies in place, you're not going to have the incentives.

And the slide that Carl was showing of the farmer in the Murray-Darling continuing to grow rice despite falling groundwater tables, it seems to me it's a failure of policy. There wasn't an incentive in place for the farmer to act differently.

Catley-Carlson        Igal, is it policy, or do you get farmer push? In wealthier areas do you get farmer push to make these kinds of changes?

Aisenberg    Well, it is both, but policy plays a major role, and I think I need to say that bad policies can abuse everything good we have created. Dr. Aditi was mentioning the way people can abuse the use of electricity, but does that mean that electricity is a

bad thing to be giving to people? And I think that in the area of irrigation, we can see the same thing. We should not associate the water politics and water policy with the technology that can allow people to do things in a better way.

In the Murray-Darling people may be using drip to irrigate rice – imagine that – and that may be the wrong thing to do. Is drip to blame because of that? So policy is key.

Catley-Carlson        Okay. Well, you said technology, and technology relates to research, relates to science. I'm going to take us back to Aditi for a moment and talk about one of the management elements of looking at the base case of drylands, and that is the existence of groundwater. And India is famous for exactly what she's been setting out – our image is of an overall country that is overpumping, using free electricity, free water. But there has to be better futures for groundwater management, and the first thing you need is some better knowledge about what's actually going on in different places.

So, Aditi, what's the future for groundwater management in India, recognizing that India is rather a large place?

Mukherji    I think also relating it to drought, what is absolutely imperative is the conjunctive use of groundwater and surface water. There is no denying of that. So suppose it's a drought year and farmers would very legitimately, and surface water supplies, they're not sufficient. In that case farmers very legitimately depend on groundwater. But it does not mean that on years of normal rainfall or excess rainfall they should still be as dependent on groundwater.

But the policies, some of the policies are so misconstrued, mis... how do I say? Some of the policies are so bad that even in good rainfall years farmers fall back on groundwater. So how can we provide incentives to farmers to make sure that they make use of both available surface water as well as groundwater? I think that would be the future for managing India's groundwater resources is to convince farmers and our policymakers to set up those kind of policies that actually help farmers, wean them away from use of groundwater in years when rainfall is normal and in that way build up groundwater reserves, put them to use in years like 20012 when rainfall was deficit...

Catley-Carlson        Is that an unrealistic dream, or has that been done in some places?

Mukherji    I would now like to cite the example of West Bengal, but I think West Bengal is also like a water-abundant state, so it may not be exactly comparable with Punjab. But I think what the government of West Bengal has done is, by metering electricity – because groundwater is accessed using electric pumps and they have metered electricity, which means that farmers pay a full cost for using that groundwater. And that means that we found that after metering, our study shows that farmers almost do not use groundwater in the monsoon season. Earlier they would use groundwater because they had to pay a flat price for electricity, so they would like use water, groundwater anytime. But after metering, we find that they do not use groundwater unless they absolutely need to do it.

So I think putting those policies can help. And I think even Punjab has certain good policies in place. For example, rationing – it doesn't sound like a very good policy, but then because metering is not possible because the farmers really resist to any kind of metering and measurement of their water use, so the governments basically have fallen back to what is the second-best, and I think workable, solution. That is, if you can price it, you ration it. And once you ration it and you create a scarcity, you send those scarcity signals to farmers, then they're also trying to make as efficient use of water as possible.

So we find in the last five years massive adoption of laser leveling, so that could improve water efficiency. We find evidence of adoption of microirrigation on quite a major scale in many parts of Southern India and Gujarat. So just sending those scarcity signals to farmers, either through pricing or rationing or some such way, would help.

Catley-Carlson        Meter, manage, measure. But send signals and try and change the political climate.

Carl, how do you create the kind of climate that will move suspicious farmers, irrigators who have learned over time they may not have as much reason to trust their public authorities as we would wish? How do you get them to accept? How do you get the general public to accept that difficult changes may be necessary both to get groundwater and to cut down on the switch to new irrigation methods that are less water intensive.

Ganter                I think there's one word, too, is "risk." And another word that goes with that is "investment." So identifying the bit risks that we face. And China is seeing this right now. So you have this really interesting interplay between the provinces and the local governments and back in Beijing. So a lot of the local governments, their license plates say, "I heart GDP." And so anything that's going to stop, block their way in GDP growth is a huge challenge.

And so near the border of Kazakhstan in Urumqi, China, it's very, very dry, and they have glacial melt. They're building massive, massive industrial plants there, and they also have large, irrigated agriculture. The farmers really don't have a voice in that right now, because there's so much money coming in. But back in Beijing they're starting to do the risk assessments. And they're starting to see that they need to do that investment in the agriculture and in their stability in their food security. So that becomes a communications tool.

So you say – Here is a massive risk, here is what's coming, here's a huge opportunity. And now if you want your water for your industry or your city, you need to invest in our irrigation and in our efficiency, and we'll share the water. And therefore we'll have a little bit better climate in order to manage our water, our food and our energy security.

Catley-Carlson        Well, you're a publicist extraordinaire. That's why Rockefeller reached out and found you. Do you know of an instance where a public authority or a coalition has got together and really done an excellent public sensitization exercise to

create the basis so that political action could be taken and ultimately economic action could be taken?

Ganter Yeah, I mean there really is no... We talk more in general terms, but there really is no better opportunity than an inflection point, like we said, a crisis.

Catley-Carlson You're saying what ought to happen. I'm asking what has happened. Do you know of any really good campaigns?

Ganter As far as actual campaigns, no. I think we need – back to “ought to happen.” I think we really need to tell better stories, and we need to listen better. So that when Australia... It took Australia 12 years. It took the world to wake up to Australia for 12 years in the Murray-Darling...

Catley-Carlson And yet the water people singing, there is simply nothing like a drought. So they actually did manage to provoke some changes.

Ganter Right.

Catley-Carlson Do you know of any changes where public policy has really created the better knowledge base to get people to change what they're doing.

Aisenberg Believe it or not, my answer is absolutely.

Catley-Carlson Good.

Aisenberg And this is a sensitive time to talk about the role of government, but ignoring the fact that we are ten days away from some elections around here.

Catley-Carlson Really?

Aisenberg That is a rumor. Yeah, absolutely, and let me give you a few examples. Central government in India and state government in India, the state of Gujarat where actually we operate one of our plants in India, is doing a fantastic job of actually making the use of water, and by doing that they actually optimize or at least improve the use of electricity in ways that are changing the face of agriculture in the state of Gujarat. It's not the only state in India, but it's probably the one at the forefront of doing that.

The government of China is just doing probably large improvements in that area, a ways to go. And I would mention a third country which is not always mentioned when we talk about irrigation, and that is Turkey. So good, positive, progressive programs that governments can manage.

Catley-Carlson Preceded by public campaigns, so that people understand them? This is what I'm really pushing about is the need to get people onsite so that they're not resentful and that they're welcoming of these changes, inasmuch as people can ever be welcoming of change.

Aisenberg There's no better public campaign than subsidies, so giving people money is probably a good way to campaign.

Catley-Carlson That's probably what the government of India said to itself 50 years ago when they put on the electricity subsidy. We've got to create some grand coalitions here, and I'm going to turn to Roberto. What's the percent, what's the possibility that working with institutes such as yours, or emanating from institutes such as yours, we can really form a coalition of the good things that we're hearing a this morning and start moving the changes out into the larger universe, you know, that wonderful phrase – learning the lessons from the bad parts. What are the potentials. What are you thinking of doing for the next couple of years to try and make that a reality?

Lenton I think the word “grand coalitions” is absolutely the right word to use in this instance. But I can have your permission to give one additional example to the question that you were asking earlier, because I think there's a wonderful example right next door in terms of institutions that work in managing water effectively. And that's the natural resource districts that were established in the state of Nebraska 40 years ago. They were established before Nebraska embarked on a massive increase of its irrigation. And they were local bodies where local farmers had the ability to elect public officials to essentially regulate groundwater within their watershed.

The impact of that has been that, despite this massive increase in irrigated land, the amount of water withdrawal or downturn in the aquifer has only been about 3%, no 1% in those 40 years as compared to other parts of the Ogallala aquifer that have seen very great increases in drawdown. So I think we have really very, very good examples of institutions that work that can make a difference over the long term.

Now, on the question of the grand coalition, the reason why I say it's exactly the right word, because this is a multifaceted issue that we're talking about in droughts and drylands and the better management of water. It's multifaceted, and if we're not going to recognize those different facets, we're not going to make a dent in the issue.

So we're going to have to get public and private institutions involved, the public sector in terms of providing the right policies, the right institutions, the right incentives, but the private sector to come in with the technologies, the better seeds, the better varieties, the drought-tolerant crops, to be able to make this work.

We're going to have to have work on both technologies and policies to feed that. We're going to have, particularly having to get the science connected with the practice – and that's really what we're trying to do in the institute that we have just established in Nebraska, connecting the science of better managing water for agriculture with the practice in a number of different ways.

Catley-Carlson But there's 600 million very poor farmers or very poor farming units out there, probably very close to a billion. How do they get access to what you're talking about? Because what you're talking about sounds expensive to me, and the capital resources are one of the things that these poorest, and particularly the rainfed farmers, really have difficulty with. How do they get access?

Lenton The solutions obviously have to be context-specific, and what works in one place is going to be very different from one that works in another place. And when you have very strong incentives and very expensive water and high productivity, you're going to be in a very different situation in terms of technologies than when you're in a different situation.

But part of this grand coalition is that you do have to work, both in addressing the problems faced by largeholders and smallholders. It's a global world that we live in, and this drought I think has sent a very strong message that if there is a deficit in water in the United States, it affects not only farmers in this part of the world but it has implications for consumers in poor villages in China, in India and elsewhere. So we do have to think about how to be able to tackle the issues, both of largeholders and smallholders.

That said, clearly the ones in most need, that have the greatest difficulty in access to better ways of doing things are the ones that deserve the greatest attention.

Catley-Carlson Igal, can you get what the miracles you're talking about to very poor farmers and how?

Aisenberg If I touch on the smallholder problem, I would say to decode the smallholder issue probably is the greatest challenge that people face; and this is being done over the past 25 years, and billions have been spent, and the result are very disappointing.

Now, an engineer will just give a simple answer to the problem, how to deal with smallholders – make them bigholders, largeholders. If you think about that – and I'm not referring to any type of social engineering, this is not a stupid thing to do. And here is where private/public enterprises can come together and maybe make a difference.

So we've heard Peter Brabeck from Nestlé. Peter Brabeck, by the way, is doing a tremendous job promoting irrigation, efficient irrigation. And believe it or not, more than once he can spell the word "drip" and talk to the benefits of drip.

Now, look at the inputs manufacturers' industries. We have bigger and smaller. The whole irrigation business, all of us together, micro and mechanized, all over the world, this is a small industry. If you take them all together, maybe six billion U.S. That is 5% the size of Nestlé. That is one and a half percent the size of Walmart. Now, if these entities, big food corporations and big retailers, being Walmart, Reliance in India, Carrefour Tesco, if we can come together, input manufacturers, and actually these food corporations have the ability to group smallholders. Again, it's not about social engineering. It's about creating buying groups, it's about creating cooperatives, without changing the basic way of life of the smallholders. That can be – and I am very cautious about that, because I think there are plenty of failures and probably no successes in that area. That may be one of the ways to try to decode the smallholder problem.

Catley-Carlson Aditi, will that get to your smallholders? I mean, West Bengal is not the richest area of the world. How are your farmers going to afford change?

Mukherji I think there is a lot about farmers that is absolutely innovative. The only two key ingredients that farmers need are access to input and fair price for their crops. Once they have these, they, they find out, you know, amazingly they're making the best use of all the resources that they have. And in my experience, farmers are always trying to maximize what is scarce.

For example, in Gujarat what is scarce is water, so in Gujarat you see such rapid adoption of water-saving technologies. In West Bengal what is scarce is really the arable land. You have very high population density, very little land; and there farmers are trying to maximize productivity from land, and they're trying to crop three times in a year, three or four times in a year. And they need access to irrigation. So just providing them with the inputs and not necessarily subsidizing foods at all time, provided that your output prices then are not depressed.

The problem with India and for most other places is that, because of the overall goal of keeping food prices low, our output prices are also suppressed artificially, therefore, the need to provide input subsidy. But I talked to farmers in Punjab, and I raised the issue of free electricity, and they said – "Look, we really don't need free electricity. We are not beggars or anything. Just give us fair market price for our produce, and we are ready to pay all the input prices."

So I come back to my two key points – easy and affordable access to inputs and a fair price for the outputs – and farmers can do amazing things.

Catley-Carlson ...interesting to run an election in India on trying to change that particular see-saw – free input, or at least freeing up the input prices in return for freeing up the output prices, very interesting.

We're going to go to the audience and ask you if you have questions. But while you're moving up behind the microphones (I take it the microphones are out there. We can't see anything from up here. We just have this sea of people.), so while you're moving behind the microphones, I want to ask the panel – Is there something that any one of you would really like to bring up in response to what others have said or in the general subject of drought and dryland before we start answering. Carl?

Ganter Yeah, I just wanted to add to, and we talk about campaigns, to come back to the earlier question. We usually talk about short-term, beginning, middle and end. There is no beginning – or there may have been a beginning, but there is no end to these situations that we face. And in Las Vegas – interesting place to look at water issues – and it's fascinating, because when they first experienced drought more than ten years ago, very serious drought, they brought the whole community together and said, "We have to do something about this. We have to change how we're using water." They spent \$200 million buying grass, and that's not laying grass. That means buying people's front yards and removing it, so finding ways to put water back into the Colorado River. And they now will claim that they have almost a hundred percent recharge rate back to the Colorado from their buildings and from general Las Vegas operations, not including evaporation and other use.

Catley-Carlson Ask me about the Las Vegas laundry if you want a good question. Okay, we've got somebody up there. Would you like to identify yourself, please?

Q Yes, Norman Uphoff from Cornell University.

Catley-Carlson Hello, Norman.

Q Hello, and a question for Aditi. You were going to start to make a comparison between Punjab and Bihar 2009 and 2012 but didn't have time to talk about 2012. I think in 2012 in fact Bihar had like a 50% increase in its rice crop in the kharif season. Punjab continued to have these water stress problems of the lowering water table. In Bihar they started changing their management practices, as you probably knew, to the system of rice intensification. And about 10% of the area of Bihar now is under this management system, and it produced about 40 to 45% of that increase, because the average yields were, according to the Department of Agriculture, 8.08 tons per hectare versus usual 2½ to 3 tons.

So the question is... I mean, I'm not against irrigation improvement - Roberto knows I've worked on irrigation not quite as long as he but almost. But I think there's a lot of scope for management improvements, especially using management to get those roots in the plant down deep and be able to tap the groundwater at lower levels. So if you could say about the 2012 experience if you follow it in this comparison?

Catley-Carlson Okay, thank you.

Mukherji That's interesting because I was recently doing some fieldwork in Bihar villages, and every village told us that the government has a new subsidy scheme on system of rice intensification, and farmers seemed quite keen to adopt it, not because... I mean, most farmers in my experience adopt it when they face some kind of water scarcity, and Bihar farmers actually face very high cost of irrigation. So they took to SRI quite well.

But again my experience from the field was that although I wouldn't believe all the government numbers that are coming out, because what the farmers tell me is that to take the subsidy they actually plant, like they take the subsidy for, say, one hectare of the land but in the end they plant it for only half the hectare; and once the inspector comes, they fix it. So I mean I know that there has been adoption of SRI but may not be as rosy a picture as the government of Bihar is painting it.

But impact of drought in 2012 in Bihar was quite severe in spite of adoption of SRI.

Catley-Carlson Thank you. Yes, please.

Q Yes. I didn't hear really anyone on the panel discuss the question of the pricing of water. Could there be some comment about technologies to have more cost-effective ways of measuring, monitoring and pricing of the cost of water in order to drive the adoption of drip irrigation and lots of other techniques that would save the use of water.



Catley-Carlson Thank you. Would you like to identify yourself, please?

Q Patrick Benz, Westbrook Associates.

Catley-Carlson Okay. Who'd like to take that on?

Aisenberg That's not a good one for me, but I'll tell you why. I spent eight years in the Central Valley living in the Central Valley of California. And I remember going to meet with some of the water coalition groups, etc., etc., and people that supposedly care for the good use of water, and when we tried to touch the price issue, the response was - "You do not understand what our role is, do you?" And I don't want to add to that because probably this has to do with the politics of water.

Now, pricing water is certainly a factor, and let me say only that. We see response to the price of water or to the cost of water when the difference is extreme. And I am not telling you anything you don't know. People respond to extreme changes quite rapidly, and they are very slow to respond to slow changes. Just look at what happens at the pump when you have to pay more for a gallon of gas. When is it that people try to change their habits?

In other words, only drastic things can change the way people use water or this drastic change in order, I would rather refrain to that. I think it's a very - as you had said before - context specific. I don't know that in India that would be the most advisable and the first thing the government has to do. Probably the U.S. and Australia and South Africa and other countries will just provide different examples to that.

Catley-Carlson Carl, you've been working with Google and others on big datasets. Do they include who's charging what for water?

Ganter We've been doing a survey on municipal water prices around the country, which actually was covered in *USA Today* a few weeks ago, looking at price rates.

One thing I'd like to... you know, pricing, it's a hot button issue. Maybe something, a place to start with that, is valuing water. You know, what value? It comes back to understanding the role of water, understanding, like you said, the farmers downstream. They said, "You don't understand our role here." And so I think what we need to do is also do a better job talking about the value of water. I live in the Great Lakes, and yet our lakes are down, but nobody believes that we're in a drought situation, and yet we actually shipped our honey bees out of the state because there weren't enough flowers this year because it was so dry.

Catley-Carlson You kind of deflected my question, though, about whether anybody's tracking agricultural prices for water, which was...

Ganter I don't know about agricultural prices. I know we're watching the municipalities.

Catley-Carlson It's really a big issue, because I can remember the Bangladeshis saying, "It isn't fair - we sit and grow... We do agriculture next door to India, and they've got

subsidized inputs, and we don't have subsidized inputs. And we pay for water, and they don't pay for water." So I'm just wondering if any institute in the world is actually tracking agricultural water prices and whether this wouldn't be a useful kind of reference point to have. Aditi?

Mukherji Water markets in Australia actually allocates water to higher-value use and by default and prices water. So in drought years I suspect you wouldn't any longer finding farmers growing patty in Murray-Darling Basin because they might be just selling off their water share to farmers to grow, I don't know, flowers or even to cities and industries. So as far as I know, that might be one of the...

? [inaudible]

Mukherji Yeah, but then that's something that I don't think can be imported to a country like India, because again as the girl was saying that her water pricing, to be successful, it would have to be priced at such a high level that farming itself might then become an uneconomic affair, and that would not be politically acceptable.

So if not pricing, I was thinking that there could be second best but equally smart solution. And the one that readily comes into my mind are, like second-best solutions were better in the developing country context. And I find that what does pricing do? Pricing sends a scarcity signal to farmers. And there are other ways of sending those scarcity signals, and that's the way that the Punjab is doing, for example, or Gujarat is doing, for example, is just by giving lesser and lesser number of electricity supply, which means that farmers can pump less groundwater so they have to get their groundwater to work harder for them, and therefore they adopt all kind of water-efficient technologies.

So if you can price it, ration it - so that's what India has been trying to do.

Catley-Carlson You're sort of contradicting yourself, because pricing doesn't have to be full cost pricing. It would be ideal. But as you said later, pricing sends a signal about scarcity, and so therefore we shouldn't let the best be the enemy of the good and actually starting to send some signals about the value of water - which, we go back to what Roberto and Carl were saying.

I think we've got somebody else out there. Yes, please.

Q My name is Dean Kleckner. I'm a farmer and former chairman of Truth About Trade and Technology. My Dean is that my mother's name she gave to me - I got it honestly. I'm not a dean of a university, and it took forever. And anyhow, but I am a farmer from Northern Iowa. And on my farm I had a lot of wetlands, so I tiled. I mean, they were called swamps, marshes and bogs, and they're bad; when the wetlands are good - I mean, I should have called it a wetland, and I wouldn't have had to tile it. But it was very good land, and I wanted to make it productive, so I put in tile.

I've always thought that if you subsidize something, you get more of it; when you tax something, you get less of it. And I've always thought also, my question was,

and it's been answered, was on pricing. Isn't it crazy to have nice, green lawns growing in Phoenix and Tucson in the desert, but those people that have those houses are willing to pay for it. And are we wrong to tell them that it's bad, if they're willing to pay for it?

That farmer in Australia that was growing rice, he was growing rice because the price was high, and he could afford to do it. Now, whether he should be doing it or not, from a water standpoint, I don't know. But he's willing to do it. And are you all willing to say he shouldn't be – he should be forbid from doing it?

I think the solution here to a lot of this stuff is simple – simply have the government pass laws to forbid a drought, and then we won't have anymore.

Catley-Carlson Here, minister, here's your – “Drought is forbidden” paper – all you have to do is sign it. Good questions, heartfelt. Roberto.

Lenton Well, it's a provocative question, and I'm sure that everybody has a view on this. But I think the issue that we have to frame this question in, which hasn't really been mentioned sufficiently, is the question of sustainability. And the reason why the farmer in the Murray-Darling should be somehow induced to stop doing what he's doing is that over the long term this isn't viable. And it's particularly important when you're talking about groundwater. You certainly want to make sure that farmers have access to irrigation, but you at the same time have to make sure that they're going to have access to irrigation over the long haul for generations to come.

And so the whole question of preventing drylands going to droughts means in the end conserving the results over the long term. So you have to put in place policies that provide the scarcity signal, as Aditi was saying, that induce those changes in behavior. Sometimes it's going to be outright prohibition, and you can do that by regulating at least new permits and so on. Sometimes it's going to be by putting in the right price signals.

Catley-Carlson Or repiping the system so that they're using gray water much more efficiently and saying – If you want to water your lawns, you've got to have a gray water pipe system within your house.

Aisenberg I think that question has a very interesting facet that has nothing to do with irrigation. And I've been a member of the irrigation association in the U.S. a number of years, and I can remember having a discussion about whether or not it is good to promote irrigation in Phoenix, of all places.

And I think one point was raised at that time, which in my view is very worth taking into account. And this sounds like a domestic issue of the U.S. – it is not. Is it okay to expect, by ways of prohibiting, is it okay to expect from people that live in the sun belt to not have lawns and greens, etc., etc.? So would you, like most people, move up to Boston or to Chicago or to Manhattan and just say that, if you want to live in Phoenix, you need to put up with the fact that there's no water for watering your garden?

In other words, I think that regulation will have to look at that question from a much broader perspective than managing water. And that's all I wanted to say.

Catley-Carlson I'd be willing to say yes to all those questions. You don't get to shovel snow, you don't get a lawn, so anyway. That's probably why I'm not running the place. Yes, you have the next question. Please identify yourself.

Q Yes, thank you, ma'am. I'm Larry Driley and I'm a senior editor with *High Plains Journal*, which is a farm and ranching magazine based in Kansas, but we serve 11 states in what America politely calls "fly-over country." But it's the bread basket of the world, and we also feed... If you eat beef or pork, it's where it all comes from.

I'd like to ask Dr. Lenton, who I've never met, and I often go up to Lincoln for extension things and the like, but we've never met. I'd like to ask him, because it's a fascinating subject. We've been talking about drip irrigation in my neck of the woods for 25 years or more, in trying to use it at larger scale. And you mentioned NRCS, and this is what triggered it in my mind, is that about 20 years ago in four locations across the high plains, they tried doing drip irrigation on large scale for corn areas. And it was very successful, but it was just so expensive to try to lay down the strip.

Is it time now, 20 years hence of that original NRCS pilot project, that we ought to go back and revisit it and try to do some sort of incentivization program for people to move away from the center pivot irrigation systems and on to the drip irrigation systems that have been touted here today?

Catley-Carlson Thank you very much. You said you thought subsidy could be very useful in these circumstances, Igal - are you talking about that kind of circumstance?

Aisenberg ...answer that question, let me make one remark. The system economics of corn didn't work for drip ten years ago -with \$2 a bushel, it won't work; \$4 a bushel, it does work, \$6, great, \$8, unbelievable - and this is what we see today.

Catley-Carlson We don't want those fixes, but, yes, you're right.

Aisenberg We do not dictate those prices.

Lenton It's a great question, and I should say I'm not an expert on drip irrigation. Mr. Aisenberg is, and so I'm glad that you addressed that question. You might want to go further into it.

What I see as being very interesting happening in this area of Nebraska, which I'm new to, so I should emphasize that - most of my experience has been in the developing world. But what is fascinating is there's been a two-stage adoption of technologies.

The first stage was adoption of the center pivot irrigation that is the characteristic of this part of the world, these large center pivots. The second stage has been more adoption of information technology, which is soil moisture sensors connected with

mobile phones that are now the center pivots to be able to distribute the water more precisely in relation to the needs of the crops.

And so you have, I think, an evolution of technologies that I would say at this point is much better to allow that second-stage evolution of technologies then to start advocating a whole new approach. And it seems to me it's a more practical solution in terms of what is already in place and the investments that are already there.

But again, on the drip irrigation system, I would beg to offer my colleague here a chance to comment.

Catley-Carlson       And he did. He said they're highly price sensitive, which is I think is a very good answer. Our last question from the floor, because I want to do a little bit more just with the panel. You have the floor, please.

Q                   Thank you. My name is Chris Johansen. I'm a professor emeritus from Purdue University. One of the things that I think we're overlooking is that the family farm exists completely different today in the U.S. It's a family business. They've incorporated. They all have accountants, they have lawyers.

And I own a farm in Nebraska - it's a little over 300 acres. Our tenants started out 22 years ago when we first signed up with them, with about 500 acres. They now own somewhere over 8,000 acres, and this is all because of our tax laws. They take the money that they receive and invest it back into the business. They buy new equipment, they buy grain storage so that they can hold the grain until the market is up at the right price. I mean, this is, we're talking co-operations here among the farms.

And so the whole farming complex to me has really changed, and a lot of it's just around tax laws. I wonder if you'd comment on that.

Catley-Carlson       I think we could all say yes. Anybody want to make particular comment? I think it's the case, yeah. Thank you. I mean, you made a good comment, and I think there's nobody that would dispute this.

We've got five minutes left, and I want to come back to the panel. We've talked about dryland situations and how to ameliorate them, particularly through irrigation but also through different farming methods, in effect, so that we don't have economic disasters but also so that that land does not move into desertification. I want to spend the last five minutes really talking about how we forestall the creation of drylands? How do we forestall decertification coming from drylands? How do we forestall drylands coming from what were previously much better watered and more resource-endowed places and where the rainfall has not particularly changed?

You must have all seen this in your life, and we've talked about ameliorating and living with the situation that's there in terms of agriculture, but what do we do to try and hold back the creeping desert and hold back the spread of drylands where these are increasing in size and scope? Carl, you look like you want to start off.

Ganter Well, actually, I grew up on a farm in Northwest Michigan, and there's nobody more resilient than farmers. And at least in the U.S. we used to make huge investments, and we still do, but not to the scale – and we talked about this last night – the scale of research and the scale of commitment.

And so we live in a very exciting time where the world is a click away and where it isn't a click away. We have these great technologies for monitoring soil, we have some incredible policy research going on. I think we need to do a better job communicating against and with ourselves, but communicating with Washington, with policymakers around the world that these are big risks and there are huge opportunities for investment, and that we're resilient and we know how to forestall this or actually how to respond and be much more productive and fix some of these problems.

Catley-Carlson Roberto, you've given a lot of your life to thinking about this.

Lenton I think a lot of it has been – in a sense part of the reflections over the last hour have got at this – but in my view this is in the end a combination of technologies, policies and institutions.

On the technology front, in the end we've got to find ways that farmers can do more with less, and that in the end means more efficient use of water. Coming from the water side, it also means doing better on the plant side with more drought-tolerant crops and so on. So you need to have the technologies available to farmers.

You need the policies to be able to send the right signals for the reasons that Aditi and others were mentioning earlier, to provide the incentives for the farmers to adopt appropriate approaches. But you need the institutions, and particularly you need the local institutions, because if you're going to think about long-term sustainability, in the end you've got to provide for a mechanism where those that live on a common watershed can recognize that their common future is at stake and put in place the measures that are going to allow the sustainability of the resource over the longer term.

Catley-Carlson And we're leaving out a lot of very problematic areas – the whole Sahel turning into the Sahara is a balance between the pasturealists and between the sedentarized farmers. The conflict that goes on, the impact of herds that are using land that they'd never used before, that this is having in many cases a devastating effect on the ability of the soil to then hold water, to be trampled down on the water use. There's some very complex things out there.

We've been talking about the world as if agriculture was really a question of growing crops in the ground. There's other kinds of agriculture. There's the whole biofuel issue and where this is pushing into lands that shouldn't be being used at all, and that is also promoting dryland and possibly desertification. So we have covered one area very well, but we've certainly left out some very complex areas around the world that are indeed pushing towards both the drylands and in some cases to desertification.

Give you each three-quarters of a minute for a closing thought. Igal?

Aisenberg Okay. Let me connect the desertification issue with producing food. I'm no soil scientist, but I think that it will be very difficult to bring unproductive land into productivity again. And here we are trying to figure out how to increase food production by 50% within 30 to 40 years.

I think yesterday we had the opportunity to see a great, in my opinion, a great tagline for that project. That is "sustainable intensification." By the way, we call it "sustainable productivity." We will not be able to bring into production much more arable land. What we can certainly do is make each piece of land and each unit of water more productive.

Lenton I think just in three or four words – doing more with less, which is the point that Gordon was making yesterday – is absolutely equally valid for today's session. That's what we do.

Mukherji I think I'm certainly... recognizing that this is a serious problem, then the political will and absolutely important role of governance that no right political will and the governance can play in solving it. That's how I'll sum it up.

Catley-Carlson Okay, Carl?

Ganter And to build on the policy, the institutions and the technology, also listening better, because our indigenous peoples and our farmers around the world, that they know what the challenges are and oftentimes they have experienced or know how to help solve them.

Catley-Carlson Well, I've pulled four lessons out of this, out of the many, many rich contributions that were made. That it is possible to have drought without catastrophe, but it isn't possible if we do things the same way that we're doing them in all the places in the world. So what we're trying to remove is catastrophe, not necessarily drought. We also need to work on drought, however.

Another message came from something Igal said. Only drastic things promote change, because policies change as a result of emotional change, and it takes very real pressure, very real stress to actually drive the climate to make change possible.

The word "subsidy" is not always a dirty word. We had two people who thought that subsidy was really going to be necessary to take some of the measures to use less water, i.e., to get more out of irrigation systems and put in new ones.

And the final thought, that farmers are a very innovative lot. If you help them with inputs, they'll probably increase outputs on their own with a little input, as long as that input includes knowledge, capital, etc.

So I think we've had a rich and very interesting morning, and I'd like you to thank very warmly our panel for giving us that morning.