



FERTILIZER SUBSIDIES IN SUB-SAHARAN AFRICA: SMART POLICY OR POLITICAL TRAP?

AUDIO TRANSCRIPT

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PRESENTERS

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Margaret Spears, USAID (Moderator)

Michael Carter, University of California, Davis

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PRESENTATION

Julie MacCartee:

Well, good morning, welcome. Thank you very much for joining us for our March ag sector council seminar, which has a great title, I think, Fertilizer Subsidies in Sub-Saharan Africa: Smart Policy or Political Trap? So we're very excited to have these two distinguished speakers with us today. But before we get started, just a couple of housekeeping issues. First we always like to remind people to please silence your cell phones, just so that we don't interrupt the speakers, if you've brought those along. Second, this webinar is being recorded and we also have a large webinar audience. Our team in the back of the room is bringing in the webinar group.

And so for both of those reasons, we generally ask that you hold your questions until the end and also that you use one of these microphones that we'll pass around to make sure that we get it recorded and that the webinar audience can hear you. I just wanted to mention this, and this is a product of the ag sector council seminar series, which actually just passed its sixth anniversary.

We've been holding seminars like this for about six years, and doing them in webinar format for almost four years now. Which has been really exciting, we had just a great lineup of speakers, and Tom had actually been part of a Agrilinks seminar in the past, so we're excited to have returned speakers, as well. And it's really grown and changed over the years. It's a product of the USAID Bureau for Food Security but it started with the old office of agriculture, and the Agrilinks platform. So if any of you ever have questions about knowledge sharing for Feed the Future and the Bureau for Food Security, or just the Agrilinks platform in general you are welcome to get in touch with me, Julie MacCartee, I'm a knowledge management specialist with the FF.

And I just wanted to mention that our April event, coming up next month, will be on the role of agricultural insurance in promoting resilience and inclusive growth. That should be a really interesting event and it will be in partnership with our sister site, Microlinks, which is another USAID knowledge sharing platform.

All right, to search introduce our speakers today and to just give a couple of words of introduction, I would like to introduce Margaret Spears, who is the director of the office of market and partnership innovations at the USAID Bureau for food security. So I'll pass the mic briefly over to Margaret.

Margaret Spears:

Well, welcome and thank you for participating in this important discussion about input subsidies today. Increasing use of fertilizer and other improved inputs is important aim of Feed the Future, and is also key to productivity – to increasing productivity to the levels needed to feed a growing population. So, current use of fertilizers in Africa and other – fertilizers and other improved inputs in Africa lags far behind other parts of the world. And increasing that is an important part of reaching agricultural potential for Africa.

In my office, we're particularly interested in how to encourage this in a sustainable way that doesn't distort markets or discourage private sector participation in the input markets. This is very important for implementation of the Feed the Future programs, but also for the policy support in dialogue that we have within the countries where we work.

I'm particularly excited about this session, which will examine evidence across countries as well as within one country on the effectiveness of different policies used to encourage increased fertilizer use. And I'm happy to introduce our speakers today. We have Michael Carter, he's a professor of ag and resource economics at the University of California at Davis, and he also directs the basis – access markets – and market access innovation lab and the I4 index insurance innovation initiative. These are really important – have been very important tools – for our thinking on risk, insurance, and related programs there.

And then also introduced Thomas Jayne, who is a university foundation professor of agriculture, food, and resource economics at Michigan State University. He's also a visiting professor at the University of Pretoria, an adjunct professor at the Indaba Agricultural Policy Research Institute in Lusaka, Zambia. And he's also been an instrumental partner in our thinking about policies on agriculture. They have great set of presentations lined up and are certain to stimulate some lively discussion, so I'll turn it – the microphone back to Julie so we can really get started, and thank you so much for your participation and for your presentations today.

Julie MacCartee: Thank you very much, Margaret. All right, we can turn it over to our speakers.

Michael Carter: Good. Well, it's a great pleasure to be here. This is an issue that is both important and interesting. A couple of you were laughing at the funny picture of me. I was actually adjusting my glasses, so I could see if Tom was coming up behind me to whack me over the head on this one. So this is joint work with Dean Yang is at the University of Michigan and Rachid Laajaj, who is at the Paris School of Economics. The work itself is also collaborative with the International Fertilizer Development Center, in some sense have a dog in this fight, but we will get into that as we go along.

The Margaret already alluded to the stylized fact that I think all of us in this room are aware of, that use of inorganic fertilizers across sub-Saharan Africa is very, very low. When we got interested in – I'd read Tom's work over the years that fertilizer subsidies were often, if – particularly if done poorly were a really bad idea, but we were really interested in seeing if we could actually find an opportunity to really nail down what are the impacts of fertilizer subsidies. And we had an opportunity in Mozambique, which we developed with the IFDC.

And by their kind of farmer field trials, they were saying look, every year farmers are leaving two to three tons per hectare potential production behind that they could receive if they just used in groups these and fertilizers. And yet, in our sample, for example, roughly ten percent of the farmers only had ever used any kind of inorganic fertilizer, and many of those were farmers who had actually worked in Zimbabwe on larger scale farms.

And so it was sort of really good opportunity. So we say, okay, well here's a chance, I like Malawi or some of the countries that have made fertilizer subsidies almost a constitutional rights, we said here's a chance to get in and look at a small-scale program and see how it might be done. So as a starting point here, I just listed a few possible explanations. I mean, why is this a problem? Why might the rate of fertilizer use, why might farmers be leaving two tons per hectare of names on the table every year? That they're not achieving given that the technology is already there?

And what kind of explanation, it's one Tom is going to delve into in more detail later, is I call it here a technological explanation, is that they don't do it because it's not profitable. Basically the soil structures are not there, the actual returns to fertilizer are not there, and there's some implications, but I believe that for Tom to talk about. Let's get down here to the sort of behavioral explanations, as well. There was some work done a few years ago that said, well, actually, it is profitable, but people just have trouble saving money. They think I'm going to do it and then an opportunity for some better use of the money comes up and they never quite get there.

And so it just takes the so-called behavioral nights to get people there. That's another kind of vaccination. What I'd like to focus on here today, I want to call them the sort of core economic explanations. Could be that farmers are simply – they are so poor they are sort of caught stash their liquidity constraints. Another kind of economic problem might be an informational problem. They don't really know what the returns of fertilizers are. So if 90 percent of farmers in the region have never really used as fertilizers, maybe they don't really know. So that's what were going to focus on here, is might you then do subsidies – input subsidy programs, might that actually be a way to get people to learn, maybe to get them a little extra money, because if the inputs are subsidized, they make a lot of money in the first year, and that they can carry that forward in time. There might also be a complementarity with kind of financial interventions, as well.

As some of you know, and as Margaret mentioned, I run something called the I4 index insurance innovation initiative. I have more programs going on on insurance than I care to mention. But again, were finding in those programs that people risk out of the system, farmers may actually find the money that they need to make these kinds of investments, and risk may be the inhibiting factor. So will

come back to some of that in a moment. And finally, again, I'm not going to talk about here, but would be happy to do so, there are actually hybrid explanations. So the drought tolerant maize project, for example, is sort of a hybrid explanation, and saying the technologies that are there are just too risky, so if you could get a technology like drought tolerant maize that pulls risk of the system, then maybe that will relax that constraints and think might move forward.

And then there's more exotic explanations about where to our aspirations, hopes, and preferences come from, and that may be part of this story, as well. Let's jump right in and think a little bit more about these economic explanations, and the first question I want to mention is if we think about this carefully, and we think there might be a case for input subsidies, is that an argument for those subsidies being permanent or an argument for them being temporary? And I want to argue that, at least the thinking that I can come up with, the argument should be that they should be a temporary kind of thing. As Tom will give some figures in a moment, the problem, if it is a problem, the reality is that a number of trees have made fertilizer subsidies a permanent feature of the political economic landscape.

But if we – and as he won't mention, that's a big problem because the opportunity cost of those funds can be quite high. So why are we doing this? Why are we spending so much money on this? I gave a talk in Ghana last year talking about some of this work, mostly macro finance ministry kind of people, and they thought they were going to go to sleep during a session on agricultural topics. And then when I showed them – actually use one of Tom's pictures, the fraction of budgets being spent on fertilizer input subsidies, they all will have they said, oh, you mean we don't have to do that? And so the macro guys suddenly were at least momentarily interested in the topic.

So I would argue that at least in the abstract, the subsidies can potentially be really smart policy. If they break and relax a number of kind of constraints, and I've listed them on slide here. So for example, if they simply relaxed liquidity constraints for farmers that are really poor, it's a sort of jumpstart the system, then that might be a good thing. But again, it's jump start. It's a potentially temporary subsidy. Also, if you have a group of farmers who have never really use these inputs and you're asking them to experiment, and if you asked them to experiment on their own dime, the rate of experimentation maybe much lower than if you share the risk of experimentation.

Finally, any time you have something like experimentation, which really generates a public good, so if Tom experiments with fertilizers, I can see what he does, and he would rather I take a risk and experiment, if we both wait for each other to experiment, then things are much slower changing than they might be. So again, maybe a temporary subsidy might be a way to sort of break that logjam by reducing the cost of experimentation.

So these, to me, are sort of reasonable arguments for why an input subsidy program might make sense. Again, there's a whole literature on how you might do this and let me just mentioned, because I'm not going to say anything more about it here today, that this program is going to look into in Mozambique sat on top of an import market development scheme, I think it's called the AIMS program, which USAID funded. And these are voucher coupons, so they were trying to replace the private sector. It was actually done top of a program meant to expand the supply side of the sector. And there's this voucher program it comes along and sort of hit that the demand side for improved inputs. You can do fertilizer subsidies other ways. The government can just imported it and sell it, and there's another whole set of issues obviously surrounding that.

But I'm going to step aside from that here. So the question that I want to focus, then is – on here is this bottom point on the slides. So if there is, in the abstract of these common argument for temporary subsidies, will they actually work? To examine it, we had the opportunity, then, as a party alluded to, to go to Mozambique with the European Community in collaboration with the FAO and IFDC, launched a temporary voucher subsidy experiment program, and it had enough money overall in the program to give subsidies, I believe, to 25,000 farmers in the whole country. So in a sense, it's massively oversubscribed.

Were going to focus on Manica Province in the central part of Mozambique. It's a maize growing area and were going to look at that, and because it was such a small scale program, there was only money for two years. There was an explicit sunset, we're going to do this for two years and that's it, we leave. We say, well this is actually what we want to do. So it gives us a chance to do a proper, randomized controlled trial, because the amount of resources available for small. And because the program is also small, there was an explicit sunset on the program. So for us, this is an extremely exciting opportunity.

The way the program worked his farmers were – we basically had a lottery of the eligible people in each community. Those that won the lottery got the right for a voucher coupon, which they could take to a local shop, and the voucher coupon would be roughly 3/4 the price of what were considered to be high quality inputs for roughly a half hectare of maize. So the subsidy was worth a little – about \$80 and the overall package was about \$115, something like that. But there was a copayment required.

So that's the basic structure. Let me just jump to this slide. So how do we set this up? The main part of our trial, and what I will largely but not exclusively focus on today is on the left side of this diagram. So we got a number of communities in Manica Province, and we set aside 41 of them where we were just going to do about your only treatment. So we went to these 41 villages and then within those villages, the community along with the extension workers for

those communities identify the eligible population, and then we held the lottery amongst those people with half the people winning – of the eligible people in each village winning the lottery, half not winning the lottery.

And the winners then were given the right to pick up a voucher coupon. Later on, I'll come back very briefly to the things that are slightly grayed out on the right side of the community, in addition to that, we wanted to do some complementary financial interventions. And so we had another set of basically 30 communities where we implemented what we call a basic savings program, I'll say a bit more about that, and another one where we also implemented a match savings program.

And then within each of those communities, we also held the lottery and there were voucher winners and voucher losers. I mentioned this at this time, because notice, winning the voucher is an individual level phenomena. So that means in any community or village, there are going to be some voucher winners in some voucher losers. And were going to see in fact the voucher winners generate information at those over and seems to affect the behavior with a year lag of voucher losers. However, notice by structure here, people that might be subsidized or encouraged say, with a match savings programs to use formal financial instruments is a new kind of technology, they are actually geographically insulated from the people that only got the vouchers, because they were in different communities.

This will be important to interpretation later on, that we had some spillovers from voucher winners to voucher losers, we don't have spillovers from people that got the opportunity to learn about financial technologies. And again, we did that because this was a mobile banking – old-fashioned mobile banking opportunity bank, drove a big armored truck to the villages where the savings were being implemented, and you couldn't sort of exclude anyone from that.

So let me just jump right ahead here to a couple of things. I mean, one thing that is important to reflect on in terms of the effectiveness of this program is we found that just under half the people that won the voucher lottery actually picked up and used the vouchers. Which kind of surprised us, because it seemed like it was a pretty good deal.

A 75 percent subsidy on this. But in the end, that is part of the reality and that is part of what makes it difficult. Now, from impact evaluation perspectives, to use sort of fancy language here, this gives us an opportunity to think about the impacts of those people who were offered the program or the impacts only on those people who chose to use the program. And if you are thinking about how effective is a public policy, the answers to those questions are somewhat different. It's only half the people who are offered the program actually utilized it.

I'm going to focus on the impacts of those who actually participated in the program, or what's called the treatment on the treated, because the big one in here, besides the administrative costs, the big one in here is actually paying for the voucher coupons. So in a sense, that's what were going to focus on here. But if anyone is more interested in the difference, we can sort of talk about that.

So what do we do? There's obviously lots of tortuous academic papers and we are being tortured by nasty referees as we go through this usual peer review process, so let me just focus on the main kind of outcome variables that we look at. And I grouped them here into two types, agronomic variables and also economic variables. So we have a bunch of stuff on both maize-specific outcomes, so we can look at impacts of the vouchers on fertilizer use, on maize productivity, maize yields, the usual kind of stuff. And then also in a sense more interestingly, I think, we look at total agricultural production. Because you might say, well, it do you just – people just substituting from something else into maize, et cetera.

And then finally, and I think to me most interestingly, especially for Feed the Future, we actually put a lot of effort into measuring what I would call kind of core economic outcomes. So if we're interested in food security and food insecurity, we don't really care about kilotons of maize, we actually care about families and their level of well-being. So we used standard living standard measurement survey techniques to actually measure per capita expenditures in these households. And finally, we also look at the accumulation of total household assets over time.

And then the final realm in which we look at stuff will is then we also were able to say something about what the returns of the fertilizer are, and then also how learning operated in the function of this experiment. So let me jump in and use this first picture to explain the overall structure. So the subsidy period was actually in here, the first subsidy year we re-randomized after the first year.

The first subsidy year was actually complete disaster. As I mentioned, I work a lot on agriculture insurance. Yield that first year were 40 percent of normal. I'm sure people without the subsidies regretted the day anybody ever darkened their door and induce them to spend \$30 on something, fertilizer that wasn't going to work. And then we came back and kind of re-randomize the next year. So there going to be one. Where we look at subsidies, and then we continued this study for two years afterwards. And this is what's really interesting is the subsidy goes away, prices go back to the usual market level, and what we're interested in is does this sort of temporary subsidies stick? Does actually look at what happens?

So here's a first picture actually looking at kg per hectare fertilizer. And so you can be initially the baseline treatment group is the dark line, solid line here, and the control group that didn't win the vouchers are this lower line, as and there are very low levels of fertilizer on average in the samples, just over 10 KG per hectare. Very jumps up in the subsidy period, and then what I'd like you to what kind of focus on are these diamonds, which is the average across the two post treatment years. I've shown you both years, because there is some indication here of a downward trend. Certainly if we focus on the diamonds, we can see the subsidies had a huge impact initially, and actually, most of that impact seems to stick.

If we look at maize yields, we see a similar kind of pattern, again with the average here – I forgot the diamond, though, that's my mistake. The average still being substantially above going from under a ton per hectare to over a ton and a half per hectare. So not quite as much maybe as IFDC might have hoped, but that's what we're seeing.

If we look at total agricultural production, and again, I think this is the more interesting metric from a productivity perspective, then what you see is actually I think there's actually some reallocation going on, as farmers – actually, if we look at total fertilizer used, it's actually a much more stable relationship.

The people are using more fertilizer, not just on maize following the subsidy period, but are other crops, as well. So again, we see a pattern, similar pattern here with the impacts of this program sticking and having made a difference into the future. Now, if we look at the more – what I think of as the more stringent test is okay, it looks like we both use of inputs in a way that sustained itself after the subsidy expired. There was no longer a subsidy and people had to pay the full market price of the goods. This actually influenced people's levels of consumption?

So here we have our LS MS per capita expenditures kind of number, and you can see baseline they are pretty much the same, at the first subsidy period, nobody has realized the harvest yet, given the timing of the survey, so the surveys were right before harvest. So there's no difference there. And then you start getting a jump, and again, it's a jump of about – this difference here is about a 10 percent or so, 10 to 15 percent increase in per capita living standards that seems to persist. So for us, that was pretty remarkable that you could come in, do this small thing, the story kind of fits together if you put the dollars and cents together, that we – again, it seems to stick.

And similarly, if you look at assets here, you get a similar kind of perspective. Again, I've written a lot of stuff on asset based approaches to poverty, in some ways, it might be thought to be a more reliable measure, certainly a less noisy measure than expenditures, and you actually get a slightly stronger picture that you begin to get a substantial increase, a substantial difference between the two.

And again, these diamond differences that I'm showing you are all statistically significant in the normal sense.

So the question is what explains this? When my colleague Rashid first presented this work before a particularly cranky academic audience, they said, I refuse to believe this. You're telling me that after the subsidy period, the farmers perspective – prices tripled and they kept doing that? That doesn't make sense to me. And they weren't doing it before? How could that possibly make sense. While the way it could possibly make sense is if farmers actually learn something pretty substantial. So one of the things we did in the study was spend a lot of time trying to elicit before and after, farmers believed in the returns to fertilizer.

And quickly, the way we did it is we let them define bad years, good – normal years in good years, and they gave us the probability they attached to their definitions of those. And then we asked them, what do you think the returns are to your normal technology and what would be the returns you would anticipate to using kind of an improved input package. And from that, we can calculate kind of what they – sort of what farmers perceive is the expected gains to fertilizer. So we go to that kind of exercise, and what we actually find is that the voucher recipients' expectations radically change from the program. So if we compare them after the treatment, they're – compared to the control group, they expect 50 percent higher returns to fertilizer than do non-treated farmers who didn't win the vouchers.

If we actually go back to the baseline, it's a 71 percent increase, and I think the difference arguably is a modified learning that took place for the control group farmers. Software here is that yeah, they did continue to use it because they actually learn something pretty substantial and significant – *[inaudible due to distance from microphone]* so yeah, so in fact, their learning – so we actually use this experiment as a way to estimate the returns to fertilizer. So we have a good statistical set up to do that. And actually farmers increase in expectations, they are still pessimistic. Based on their actual data. So they are about 75 to – their expectations after the treatment is about downwardly biased by roughly 20 percent.

So in a sense, the story fits together. So farmers were sort of conservatively ingesting, if you will, the information from their own experience. So that to us is also interesting. So they were very pessimistic before, they weren't expecting large returns, and the returns we'd get, and this is – helps set up part of what Tom's going to talk about, when we estimate the returns to fertilizers, each kg per hectare gives 20 to 25 kg per hectare of maize. So that sort of 20 to 25 to 1 ratio. Farmers are expecting more like 17, 16, something like that.

So well there's that next slide, so Jerry's question took me right to that point. So in that sense, we think the story sort of fits together. And the final thing I want to talk about then are sort of money matters as I've labeled this on the slide, is what about some complementarities here. So when we started this program off, we said well, farmers are going to transition from voucher subsidized finance to self-finance because there's not credit particularly available for these farmers. They need a mechanism to do that. They need an improved technology. And so that's where the mobile banking came in.

And so when we set it up, we anticipated that maybe only farmers that actually had access to improved savings technologies would be able to carry forward the program. Now, there's another thing that improved saving technologies can allow you to do. So in other words, the savings technology makes it cheaper for you to take money today and move it till tomorrow, and tomorrow could be the moment where you want to buy fertilizer, but tomorrow could also be the moment after the next harvest when things have gone bad. So an improved savings technology may also have – it also cheapens the price of self-insurance, if you will, through savings.

So both of these things could potentially be operative. So let me just – let me skip over in the interest of time the details of what we did, but here's what we see. So if we look at – so we had different groups here. We've got the pure control group, and then here we've got the voucher subsidy group, and that's what we've been looking on. This is sort of the impact of the vouchers by themselves on living standards compared to the total group.

And then if we look at the other combinations which are savings alone plus savings in combinations, we actually find very similar levels, with one exception, across all of them in terms of impacts on living standards, including the households that were just being given the savings groups. The other thing we find which is really interesting, we have a crude measure, this is work in progress, but I'm confident enough in it to share it.

We actually find that if you look at – here's the measure of consumption variability for the control group and here's the people that only got the voucher. Consumption variability goes up. They're taking – they're using riskier technology that doesn't always work out as we've described. And then when you look at the groups that – and look down here at the group that had the subsidy, the voucher subsidy plus match savings, which was a way to really try to encourage them into the financial technology, you find they get both a nine percent increase in living standards, but they do so at no increase, no cost in terms of increased variability. So we find this very, very interesting and it's sort of given us a little pause as a research group to sort of think about.

It seems like the savings treatment is not so much making it possible for people to continue to adopt it, but it makes it possible for them to continue to adopt it without leading to a radical increase in the variability of their production. And so I think that sort of fits together in a very interesting way, so again, we're still working on this just a little bit, but I think as we as a research group are sort of stepping back on this, we were somewhat surprised by this result. We thought we'd see a strong liquidity effect, what we actually seem to be seeing is a much stronger – that what formal savings are doing is actually allowing people to self-insure much better and that by itself, together with the information that's flowing into their systems, because there are spillovers, is actually leaning people into a more aggressive and perhaps a more sustainable investment kind of profile.

So then just to summarize here, so as we look at the results of this, it's a five-year study here, we think we have some pretty strong evidence from this structure that temporary subsidies actually can have sustained impacts. These really are real constraints. It doesn't seem to be necessary in this case to subsidize fertilizer forever, but that initial push, that sort of cheapening the cost of experimentation seems important, and indeed, if you complement those programs with some maybe some financial interventions, in our case we used savings as a way to reduce some of the risk you may actually get much larger effects.

And again, as I mentioned, I do work on insurance, and in a couple of our projects now, we are finding that when you pull risk out of systems with insurance, farmers actually respond, we're getting 25 percent increases in investment rates in Mali and Ghana and a couple of other places like that. That evidence is still fairly thin.

So I think in the end, we've got some interesting evidence here. That doesn't mean the Mozambique program was done in the most intelligent way possible. Certainly was an interesting program, as I mentioned, and it's important to stress everything I showed you here was predicated on the fact that a supply infrastructure had been put out there, and the idea was to get mom and pop stores basically offering improved inputs.

But that doesn't mean we couldn't do it better. So one of the issues I think that really begs for further exploration here is only 50 percent of the farmers who offered – who were offered the vouchers actually used them. They had to be able to co-finance them. Now, the people that actually were declared eligible were people who said they were willing to pay the 30 or so dollars that were necessary to match the voucher subsidy, and yet most of them didn't pick it up, and we asked them why didn't you use the voucher? They said oh, I couldn't get the money together.

So there's some thinking here about what's the right level of subsidy. I mean, if in fact we've cut in half the number of people who might've experimented to save \$30, was that actually smart? We can sort of think about that. It's not an easy – that's not an easy question. So I think there are other issues there. And the other thing then is that I've – what I've shared with you are average effects. There's a lot of heterogeneity here, there's a lot of soil heterogeneity, as all you know. And that's something that Tom is going to jump forward and talk to us about.

And there are a number of us – I run this basis assets and market access innovation lab. We've got a – we've got about three projects right now that are looking very specifically at soil quality and returns to fertilizer and these are really complex issues, as we say. And but that said, in this particular area, which sort of seems like typical low input, low productivity sort of stuck in that – in this particular area of Mozambique, at least, these temporary subsidies seem to work. So that's my favorite picture from the project, the guy taking his fertilizer home on his bicycle. So with that, I'll pass it over to Tom and thank you very much.

Thomas Jayne:

Good morning, everyone. Nice to be here this morning. Thanks Julie and Margaret for the invitation to come here. It's always a pleasure. So let me start in with the title here, this isn't going to be a Floyd Mayweather, Manny Pacquiao sort of boxing, because I agree that there may be a very distinct role for input subsidy programs in some contexts, in some way. But I think we're all in agreement that this is – we have a multifaceted set of problems here that are impeding not only productivity growth in Africa but sustainable agricultural productivity growth in Africa.

It's one thing to get agricultural productivity growth this year or next year, there are well known ways to do that. But to do it in a way that can sustain productivity of the system that farmers operate in over a sustained period of time, that's the challenge, and I think that's what I'd kind of like to talk about. So just by way of introduction, let's talk a little bit about the amount of money that governments are spending on input subsidy programs. The reason why I raise this is because in many cases, it's anywhere from 20 up to 70 percent, in Malawi's case, of their agricultural budgets are spent year in, year out on input subsidy programs over the past 10 years.

That's a huge opportunity cost in terms of millions and millions of dollars each year that have – there's an opportunity cost about how those resources could be spent in other ways. So even if the subsidy programs were producing some benefit, the question is, is that benefit equal to what that money could be achieving if it were used in alternative ways, and how many clinics could've been built in rural areas, how many roads could've been developed, so forth.

So the opportunity cost issue here is one that we should not lose sight of. Our objectives are to – how to move from a situation where many governments realize that they're in a bind. They're importing food, global price of food's very high, they've seen riots and what riots can do in urban areas, so there's big political risks of not getting enough food to feed urban areas. So food production growth is a critical objective. But how do we move from a situation where subsidy programs can constitute 30, 40, 60, 70 percent of the national budget to agriculture to one where there's a more holistic program that takes into account the range of sustainability issues to get productivity growth, and then what would such a holistic program actually look like on the ground.

So the work that I'm going to present right now draws from about three or four papers that we've worked on over the years, and I'm going to try to weave the findings of those three or four papers together. The first conclusion is that rural Africa is still experiencing fairly rapid population growth. It's the only region in the world where rural populations are continuing to rise. So the population of sub-Saharan Africa, rural areas, in 2050 is going to be about 48 percent higher than what it is now.

So sustained rural population growth, and many of the areas of Africa, not all of them, but many of the areas of Africa have reached their land frontier. So area expansion is not possible. So what's happening with population growth is fragmentation and subdivision of land, and the data shows fairly accurate – fairly clearly that over the last 10, 20 years, the farm size of most smallholder farmers has been declining.

Another interesting fact to me is that 1 percent of Africa's rural lands contains 20 percent of its rural people and 20 percent of Africa's rural lands contains about 82 percent of its entire rural population. So rural populations are highly clustered into certain areas. And that has implications for sustainable growth strategy. One of the things we're noticing in these densely populated areas is that fallows have virtually been eliminated. And the whole system of – the farming systems of most of Africa for time immemorial have been one where you're shifting cultivation.

So you utilize this plot of land until it's exhausted its fertility. But land is plentiful and so then you move on to other plots and then cultivate them afterwards. So you can deal with declining soil fertility easily in that system, because you just move to a different plot. But that's becoming increasingly unviable with population growth and reaching the land frontier. So the farming systems have to evolve in a way that not only sustainably plows back in nitrogen, which is – by the way, nitrogen is the primary ingredient in inorganic fertilizer, so the subsidy programs in place are primarily putting more – allowing farmers to put more nitrogen in the ground and a little bit of phosphorus, too.

But the productivity of the system is going to require not just nitrogen, but micronutrients, it's going to have to deal with soil organic carbon and many things that are needed to really get a response out of inorganic fertilizer. So this fallows decline is a really – is a big problem unless the farming system is able to not just replenish in, but many other things, as well. Soil mining is another thing that we're seeing, the agronomists and soil scientists have been raising this red flag for a couple of decades now. So end balance is going way down.

Just to show you how related this is to population growth, here's – we're seeing that phosphorus does seem to be – the soil content of soil and nitrogen is much lower in densely populated areas. The same thing is very true if you looked at nitrogen balances, as well. So this is evidence of some soil mining. The fourth conclusion is massive soil degradation. Maybe some of you have seen this report that came out a few months ago by the Montpellier panel, which reports that about 65 percent of Africa's farmland is degraded, highly weathered, facing declining soil fertility, and that that burden is disproportionately carried by smallholder farmers. So the red flag, I think, is starting to kind of be increasingly understood about the soil fertility dimension of a sustainable productivity growth strategy here.

And the fifth conclusion is evidence of low and declining crop response rates to inorganic fertilizer. Inorganic fertilizer, by the way, is the fertilizer that you put in bags and is the stuff of input subsidy programs. Organic fertilizer is things like compost, manure, there's a lot of soil organic matter in the organic fertilizer.

So evidence of declining response rates and low response rates. This is, I think, at the crux of the issue here about fertilizer and productivity. Survey after survey in recent years shows that the agronomic response rate to inorganic fertilizer is quite low, it can be as high as 20 or so in places in Kenya, but in Nigeria, it's as low as 8 kilograms of maize per kilogram of nitrogen. That's not fertilizer but that's nitrogen, the nitrogen component of the fertilizer. So the response rates to fertilizer would be about three.

That's exceedingly low. In places in Malawi, a review here by Snap et al. shows survey after survey showing maize response to nitrogen around 7 to 12 or so. Exceedingly low. So it's hard for farmers, given the output prices for maize and the input prices for fertilizer, these response rates are generally unprofitable for farmers to turn a profit in fertilizer.

If I calculate it right, Michael, your response rates are going to be about 40 or so, for Mozambique, which is possible in areas where they're new to fertilizer use. Those – these are areas that have been using fertilizer for a long time and it tends to be at – once you've used it in the plot for five, ten years, the response rates tend to go down. So anyway, the point of this is to say that the agronomic responses, and by the way, these are about half as much as what you see in Asia, in Bangladesh, in India, in places, the nitrogen response is in the realm of 30 to

40, that's irrigated, you can do water control. This is dry land. So the dry land part of this is a major – one of the reasons why these numbers are so low.

So highly variable crop response rates, too. This takes the most productive region of Zambia, it's natural region 2A, where the maize – it's kind of the maize breadbasket of Zambia, and it looks at the response that farmers are getting to inorganic fertilizer use. The mean is about 16, 16 kilograms of maize per kilogram of nitrogen. But you can see that some farmers are using fertilizer fairly efficiently. They're getting 30 kilograms of maize per kilogram of nitrogen. But at least a third of that sample are getting unbelievably low response rates.

And what are – some of the reasons for this are not just low soil fertility. Could be floods, could be pests, it could be striga, it could be monkeys coming in at harvest time and taking the crop. There's all manner of these issues, these are some of the risks that Michael talked about that farmers need to take account of when using inorganic fertilizer.

So anyway, so there's multivariate constraints on the profitability of using fertilizer. We've concluded that there's four signs of unsustainable land intensification that are happening in much of the region. One is soil mining, and soil mining is technically defined as the – every time you plant a crop, it's pulling out nutrients and you're not replenishing it the next year at the same rate. So the nutrient content of that soil just increasingly gets lower and lower and lower over time.

And that also constrains the crop response to inorganic fertilizer. The inadequate recycling of organic matter and organic matter is one of the critical complements to nitrogen. So if your soil organic carbon content is too low in the soil, you may apply nitrogen fertilizer, but that soil becomes technically nonresponsive to inorganic fertilizer. So the soil organic content is a major factor that will influence the economics of using inorganic fertilizer.

The demise of fallows, as I've said, and then the limited profitability of using fertilizer at full market price. So partially the explanation for number four is some of these other ones, like two and three. So it's an interrelated system, and the idea of getting farmers to want to use fertilizer at the full market price will require dealing with these measures of – these aspects of the system as well.

So what are the factors that are depressing nitrogen use efficiency? Well, I've talked a little bit about this one. There's a very interesting study from Malawi that's going on that looks at soil samples that were taken in about five districts of Malawi, 20 years ago by the FAO. And so these soil samples record all the kind of plot content, carbon content, and then they went back to those same areas and did 1,000 soil samples in the exact same villages and areas 20 years later, and it's very alarming.

The measures of soil fertility 20 years ago were generally much higher than they are now, and agronomists and soil scientists talk about a threshold level of soil organic carbon. Many of those plots now, soil samples now were below that threshold. So there's something very serious going on here that cannot be addressed simply by increasing nitrogen. This was done by Paswel Marenya and Chris Barrett a few years ago from Kenya. They plot – they put the plot carbon content, this is basically a measure of soil organic matter, on this axis, and then the maize yields on this axis. And as you can see, there's sort of a nonlinear but definitely a relationship between high levels of soil organic matter and yields.

And then they recorded the relationship between the nitrogen response to inorganic fertilizer, and again, plot content and found the same thing, that the – basically the profitability of a small farmer using inorganic fertilizer is very much related to being over this – a certain threshold of plot content. In many areas of sub-Saharan Africa, where soil testing has been done, maybe about half, a third to a half of all of the smallholder farmers are in this range, somewhere below about 1.5 to 2.

And this is the level that's required for profitable use if you use a VCR measure of about two. So a serious issue. Acidification, I haven't even talked about that. This is a big problem in parts of west Africa, northern Zambia, increasingly western Kenya. Acidification is measured by the pH of the soil, and once you get below about 4.8 or so pH level, the phosphorus has trouble being absorbed by the plant. So you can apply the basal fertilizer at planting time, the phosphorus really won't do you much good in acidic soils.

So here is a plot from Mississippi, everything on this plot is exactly the same except for this one received two or three helpings of lime, and lime is what you put to reduce the acidification problem, and you can see pretty dramatic differences. These are the pH levels here. Acidic soil, a little bit ameliorated soil after liming, pretty big difference. And then here's what – this picture is from Zambia, same thing. These two plots are exactly the same in every way, except this one got a big dose of lime the previous year, this one did not. So northern Zambia has a major problem with acidification.

Third one, micronutrient deficiencies. This has been discovered in Ethiopia. I don't know – for those of you that are familiar with kind of the Ethiopian story, there's some interesting work that the ATA is doing, the agricultural transformation authority, and apparently they've done soil mapping in Ethiopia and found that boron and zinc were two of the limiting factors that inhibit the response of inorganic fertilizer. So the – apparently there's been additions of zinc and boron to fertilizer mix in Ethiopia, and boom, there's this big increase in the response rates that farmers are getting nowadays in Ethiopia.

So in some cases, micronutrient deficiencies are pretty important. So everybody agrees – almost everybody agrees that inorganic fertilizer use has to go up. It's exceedingly low. In any kind of sustainable intensification strategy, it's hard to envision how African farmers are going to be internationally competitive or anything close to it, unless massive increases in inorganic fertilizer. So I think we're all agreed here. Why isn't it happening?

There's this sort of cycle that we think is happening that's exacerbated by land pressures and reduced fallows, increased fertilizer use, but increasing fertilizer use on soil that's not going to give farmers a good response. As a result of these deficiencies in the soil, it leads to low crop response rates to nitrogen and then depressed profitability.

So the solution has to be how to get the response rates up enough, dramatically up enough, so that year after year after year farmers are going to be able to use fertilizer in a profitable way. Right now, in Zambia, this is a – maybe not the best way to show it, but it shows that 37 percent of Zambian farmers cannot use top dressing, that's urea, profitably. But about 93 percent of Zambia's farm population doesn't seem to be using basal application profitably right now.

So no wonder use rates are extremely low unless they're subsidized. So I've talked about some of these reasons. I'm going to kind of go through the litany now of various factors that are reducing nitrogen response. Soil moisture – by the way, do you know that in areas where soil organic carbon is quite high, it contains about 2,000 tons more water in that soil than the same hectare of land that doesn't have very much soil organic content? Because that carbon is like a sponge, it holds water. So it allows – it's actually insurance against drought. So the soil organic matter tends to have all these desirable properties that interact well with inorganic fertilizer.

Sig Snap, a colleague of mine at Michigan State, she's an agronomist, she has – some of her work points out that the ability of farmers to use fertilizer efficiently is crucially depending on weeding. Something as mundane as weeding. If you're not weeding and getting those weeds out of there, the weeds tend to compete for the nitrogen with the maize stalk. So weeding is a – and there's many reasons why farmers have problems with weeding intensively.

Crop rotation, I won't go into that because I'm kind of getting short on time. My bottom line is that there seems to be a problem with nitrogen fixation, and I'm not talking about legumes that fix nitrogen in the soil. I'm talking about people who are fixated with one nutrient [*laughter*] when it's a multivariate set of constraints here that need to be addressed to get the sustainable part of this.

So our conclusion is that input subsidy programs need to be a part of a more holistic approach that can make nitrogen use profitable. Okay, I'm limited on time so let me just go to elements of what a holistic strategy would look like. So the first one is R&D, and public sector R&D is in a sorry state in many countries. They're way underfunded. I'm going to show you a picture of what Zambia's soil chemistry lab looks like in a minute.

Extension programs, how to scale up. There's a knowledge issue, there's a – how to scale up in a way that farmers can actually be reached. Many extension programs in Africa are virtually defunct. Extension agents don't have the way to get out there, they have no petrol in their – in motorcycles. There's just not the kind of education programs to reach farmers. And these programs are crucial to complement increased inorganic fertilizer use.

Conservation agriculture, we believe there's great potential in conservation agriculture, but there's also low adoption right now, farmers are not adopting conservation agricultural practices at the rate that we would expect them to. There's problems with those that need to be kind of retrofitted a bit. Physical infrastructure, getting the cost of the inputs to farmers down. Interesting study from Ethiopia shows that over half of the cost that farmers in remote areas of Ethiopia pay for fertilizer are the costs after they enter the country. It's not the cost of production, it's not the cost of international transport, not the clearing it out of the port, it's what happens getting it to the farmers once it's in Ethiopia.

So reducing the costs in these input supply chains. And then lastly, more appropriate fertilizer use recommendations. Many of the recommendations that public sector gives to farmers about how much fertilizer to use are based on trials. They're not based on actual smallholder conditions. So they tend to greatly overestimate, use 400 kilograms of fertilizer per hectare, and that's way too high compared to what smallholder farmers are going to be able to use profitably, given the constraints that they face.

So one of the often asked policy questions is how to be less negative, and this debate about fertilizer subsidy has been going on for a long time. People have asked me, if you're saying this isn't the right way to go, well what is? What's the right way? Concrete guidance to improve their effectiveness. So we have three proposals.

One is try to complement subsidy programs with the other holistic elements that I talked about a moment ago, five or six things that could make input subsidy programs more profitable for farmers. Second issue is to target poor farmers to achieve more equitable outcomes. I'm going to talk about number two real briefly, and then the political will issue. So the first one was get the other complementary parts of the system in place to allow subsidy programs to earn a payoff for farmers.

I've talked a little bit about those, the extension, the R&D, programs to get soil organic carbon more in the system. The second one is reconsidering the targeting guidelines. Here's a case for Zambia, nationally representative survey, this is about 14,000 households, you see that most of the farmers, 41 percent are between 0 and 1 hectare of land. They're certainly the poorest. Between these first 2 categories, about 75 percent of the farmers have less than 2 hectares of land.

But look at how the subsidy programs are allocating fertilizer. The – by far the biggest recipients are the ones that – the 3 percent of farmers down here who are operating 10 to 20 hectares of land. There's a political economy here and when you can control, in an experiment, who the recipients are, you don't have to worry about that. But then when you get into the messy world of actually allocating public funds to recipients, that's where the political economy challenges come in. And many of the benefits do end up getting let's say diverted.

Another issue here is we found that about one third of all of the fertilizer going through the subsidy programs in Malawi and in Zambia end up getting diverted by somebody in the middle. And the way we were – Q&A if you want to know how we established that. But when 1/3 of \$200 million gets diverted in the middle, that's a huge problem that's going to reduce the cost effectiveness of this program from the standpoint of the recipients who are supposed to be the smallholder farmers.

So our third proposal about subsidy programs is can there be greater political will at the top to root out corruption. These programs are vulnerable to corruption. So to make them operate better, we certainly need a little more will at the top to make them operate better. This is a ranking of alternative investments based on kind of a meta study of Asia, seven or eight countries in Asia, and here are the various public sector strategies or investments, and I've ranked them for you.

The Economist comes up with a policy environment, enabling environment as number one. Agricultural R&D, investment, number two and three. Input subsidies is somewhere near the bottom of *The Economist's* list in terms of the contributions to agricultural growth. IFPRE's study is only from India, but there's a very similar ranking there. And then we also ranked it with respect to poverty reduction. So the – if the goal is poverty reduction, once again fertilizer subsidies don't end up looking too good on the list of overall investments. So that harks back to the first graph that I put up showing \$200 million a year going to input subsidy programs and the opportunity costs involved.

So this doesn't say that the results that Michael presented are not right, I believe them totally. But when you get to kind of the messy reality of implementation and trying to integrate these into public sector programs, there's a lot of things that need to be factored in. My main message is that this third one, that spending a large share of the ag budget on input subsidy programs may not be the most effective way to go, given the payoffs to other things. Certainly a demonstrable way to show your constituents that you're doing something. They're very visible, they're very politically desirable.

This is my main message, that subsidy programs would certainly be more effective if more of the budgets were allocated to the complementary public investments that are required to make input subsidy programs more effective for farmers. Those complementary public investments would be extension programs, but in order for extension programs to be effective, they have to be based on good science, so that extension agents are extending the right messages and working with farmers in the right way. That's public R&D, and there's a lot of problems with the public R&D system right now, and that should be one of, I think, our greatest point – entry points in FTF and CATA programs and things like that, to revivify what the messages ought to be, to be going through the extension programs. Thank you very much, ladies and gentlemen.

QUESTIONS AND ANSWERS

Julie MacCartee: We have about 20 minutes for Q&A. I'll pass the microphone around, and please state your name and organization and we'll kind of alternate between the in person and the online audience. I think there'll be a lot of questions, so we'll try and get through as many as we can and then there'll be a bit of time to grab them later as well.

Audience: Great, thank you for those presentations, those were wonderful. I'm Laura Shrike and I'm with USAID and bureau for food security. Michael, you spoke a lot about fertilizer, but always also my understanding was with improved seed varieties. Tom, your main message at the end was that the fertilizer subsidies need to also include other complementary investments, but you never mentioned improved seed varieties. Was that implicit in what you were saying, and if so, I think it needs to be – really needs to come out. And if it wasn't implicit, then why the difference in what you guys are talking about? Thank you.

Thomas Jayne: So yes, public R&D is – seed – improved seed varieties are one of the key things that come out of public R&D systems, so I'll be happy to say it explicitly, I agree that improved seed varieties that are more fertilizer responsive is definitely a key priority.

Julie MacCartee: We'll take it back to our online audience and then come back here.

Audience:

Sure, this first question comes with a bit of context. We have Leslie Gardner who says the voice of smallholders seems to be missing too often in these discussions and due to the remote locations, poor roads and need for seasonal credit, a growing number of middlemen offer agrochemicals on credit in exchange for the right to purchase harvests at very low prices. And these middlemen are not manufacturers but they're distributors whose power comes from access to transport, finance and markets, and there's an alarming change in power relations and problems with distribution channels that will affect the sustainability in the long term. So Sierra asks how do we avoid the danger of benefits being captured by the manufacturers and traders and not the smallholder farmer themselves?

Michael Carter:

I mean, that's a very interesting observation and I think it's a contentious issue, I mean, when you get into kind of a sole source supplier of anything, there's a concern that someone's going to grab up most of the – I used the term of money being left on the table in terms of productivity increases that weren't taking place. And I think we would all agree that if it's a highly monopolistic kind of situation, there's at least that possibility that a lion's share of that will be.

And so again, I – so I don't know that I have anything in general to say about that. I mean, I think we – there are some instances where we see well developed value chains that will actually lend inputs against the standing crop, and there, there's often – there tends to be a little bit more I think of an equitable distribution, just because there's – there are more shared interests. If there's simply a middleman, there's certainly that kind of possibility.

Again, what we see in the Mozambique study I think is interesting, again I want to emphasize, that was built around an effort to create a more competitive supply sector, and I think our per capita expenditure, our living standards results suggests that while surely some people were – other people were making money off the fertilizer sale, there was – there seemed to have been plenty left over to improve the standard of living of the family.

So I would agree that we need to be mindful of what are those market structures out there that might permit the finance of these kinds of things and competition in those circuits are certainly very, very important.

Thomas Jayne:

To add to that, I think in the question, even though I didn't hear the person who asked that question, were they referring to in subsidy programs or were they referring to just normal commercial supply channels? That's a big problem in subsidy programs and in subsidy supply chains it's quite common that actors are trying to grab a – in the middle grab a little bit of the benefits of that before they

actually get out to farmers. I don't see that happening a great deal in competitive commercial systems.

Audience:

Again, want to thank I think everybody here had come and was quite satisfied hearing two of the best agricultural experts in the world talk about one of the most high priority issues, but I had a question really it's mostly directed to Professor Jayne. Your prescription is both very complex and requires a considerable amount of public sector capacity. And I think in many countries, the policy people who'd hear you would say that it's too complex and our public sector is simply incapable of delivering things like that. The statistic that I always like is more than 80 percent of Nigerians don't know where a post office is. The post office has more or less ceased to exist for most Nigerians. So the question is how would you answer that and is part of the answer the kind of experiments people have done about trying to create private sector or mobile phone resident systems, or anyway, something that does an end run around the public sector?

Thomas Jayne:

Yeah, interesting. Wow, well first of all, thank you for your kind words at first, your check will be in the mail later today. Now, about how to do that, there are a couple of schemes that are being set up in Nigeria now to evaluate the mobile – what's it called, the voucher system through the mobile phones. So I think the jury is out right now, but it'll be very interesting in about a year or two from now to see how that program performs. So I think we'll need to wait a little bit longer to find out.

I agree with you that many politicians will – are looking for fairly simple fixes, and that's what the real seductive appeal of input subsidy programs are. In one fell swoop, you can ensure that farmers are going to be using more fertilizer than they were before. So that's why these programs have such staying power. I think that's our job, your job, all of our jobs is to try to make the case for why a holistic strategy, even though it's going to be more complex and require more attention to more different things, why that's still – there's no substitute for getting that in place. I can't imagine how you don't have a public R&D system that's functioning, how you're going to get sustained agricultural productivity growth without it. And I do mean improved seeds when I say that. That's sort of the group that tends to be producing those things.

Michael Carter:

If I could just say a little bit on those issues, as well, and I want to mention a couple of ongoing research efforts that – so part of what a good public sector can do is provide, as Tom gave us some examples of zinc deficiencies. So one of the questions that is an interesting one is how much higher are those fertilizer response rates if small farmers actually get sort of tailored fertilizer blends that would actually work for them. That doesn't take care of the soil organic component itself, but may mean a difference.

So the research group I run, Basis, has a large project in western Kenya right now where we got – we did soil samples on all our farmers' fields and we came up with four distinct fertilizer blends, most of which included a lot of zinc and boron, compared to what's normally available in the market, and now we're actually going to be able to look at that, does that actually make a big difference? So we'll have those – we actually just finished the survey to find out, but we haven't analyzed the data yet.

Related to that, there's another Basis program run by someone named Cheryl Palm at Columbia University where she's using new mobile soil labs, basically it's sort of a soil test in a box sort of thing, it works through the internet – through mobile phones actually, and you get an instantaneous readout of what the fertilizer blend should be.

So again, those are interesting – I mean, that's sort of cheapening what the public sector used to provide. I think in reality, and certainly one of the discussions we've had a lot with Cheryl and her team is okay great, a farmer knows he needs this much zinc in his blend, but how's a two hectare maize farmer, to pick even someone on the larger end, how are they going to buy that? So there's still an issue of the fixed cost of doing that and sharing that information, and secondly, sort of making it actionable. But I think there are some possibilities.

One can start to imagine, I mean, here's where maybe – I've not always been a big fan of the – in the development business, we have love with the ICT kinds of strategies, but here may be a way you get quick information, maybe you can find a way to collate orders and low cost transmission, and if you can get it delivered, there may be ways to do that. So I think there are some new frontiers, and again, that's something that we're sort of pushing out on to see what more can be done that's better.

Julie MacCartee: We'll go back to our online audience and then I'll come over here.

Audience: Sure, this next question comes from Brent Simpson and it's for Michael Carter. What guidance does research give us regarding the level of subsidy required and the length of the subsidy period in order to maximize farmer benefit at a minimum cost?

Michael Carter: That's a great question, as well. And I think what's – that's what we – what we don't know from the study in Mozambique is whether a larger amount of subsidy could've been more effective or whether two years or three years would've been better or this was effectively a one year set of results that we were looking at.

So there probably are ways to do it better. I guess my own kind of gut instinct is that a short time period is probably okay, although again, in this – the first year of this program, I mean, we basically didn't do data collection and didn't implement most of the things because it was just a total disaster. But it seems to us from this that a relatively short period where people have reasonable outcomes provoked fairly strong learnings. And as I indicated before, they weren't naïve learnings, and if anything, they were still somewhat pessimistic and conservative, which is probably a good thing. You don't want people to get sort of wild eyed and crazy and start throwing things on.

I do think the – where did the 30 percent copayment come from, I have no idea. That's just the way the program was set up and that's how we evaluated it. But we do see a relatively low take-up rate, and with a lot of people saying they just couldn't get that 30 percent or they weren't willing, in the end, to put that 30 percent into it. So maybe at that margin, it might be better, but again, I think the political economy issues here are just tremendous in terms of what does a politician want to do, and I want to suggest that there's an asymmetry in the sort of the political staying power here.

I mean, if farmers can really learn something in one or two years from a once-off subsidy program, they're going to be kind of happy about that, right? But the people that really have a lot of political clout are the people that are in the fertilizer business. And Tom's comments on acidification of soils, when we met with our crop – soil science people in Nairobi, they actually showed us, they said look, what your farmers mostly need is lime. And they said, but there's no lime subsidy program because there's not much money in it because lime is relatively cheap. So don't even think about it.

So there's a political economy here that's not just political economy of the farmer. I think that's something we can maybe solve with temporary subsidies. But the sort of more global political economy of people that actually have a lot more money than farmers do to throw around political is at a different level. So the political issue here is not a trivial one, but I think it would be warranted, I believe it would be really interesting if one were impressed by these impacts of short – the impacts of the Mozambique study, to experiment just a little bit more with amounts of subsidies and see if you could get faster take-up and greater amounts of learning with a modest increase in the amount of the subsidy offered to the farmer.

Thomas Jayne:

In some cases where acidification is a problem, subsidizing lime could be a very important thing, both for learning and for – I think we should think about that in terms of maintaining subsidy programs but using commodities or inputs that farmers really don't have any experience with and that the private sector may be

unwilling to provide on its own. A very good case could be made for those things.

Julie MacCartee: Here, I'll pass it to you. Why don't we take just two questions in a row, if that's all right, this time, and then you could answer both.

Audience: I talked with Tom before this, I'm Jerry Wogan, USAID and I talked with Tom a little bit before the session and we agreed that I was one of the more experienced, otherwise older, people around remaining in aid. And one of the things that happens is that you see things over and over again. So when I saw Tom's litany of the problems that people face, it seemed to me that if I had asked that same question in 1979, that litany wouldn't be much different, because the only – the 2 things have changed between 1979 and now. Maybe three. So one is that government policies with respect to ag marketing and exchange rates and the way in which they screwed farmers on the price side has changed in general. Second, Tom's point about the fact that there's been huge population growth and therefore the land margin has decreased substantially, and the possibility for extensive growth is quickly eroding. And I don't remember what the third is, but – oh I guess this fact that there's a growing – growth of an urban class that wants higher quality food products, and there's a growth of that farming to satisfy that demand. But the big problems for smallholder, staple food producers remain the same and, in fact, are probably worse. And so I think it seems to me that there are two major issues that one has to solve, one that's probably impossible which is all these political economy questions, because the governments are what the governments are and the interests are what the interests are. And there are ways of getting around it on the margins, but it's very hard to break it. But the second is something that Michael sort of dismissed and I've never really been a big fan of, but information technology. It seems to me that a lot of these problems, including the problems taking up fertilizer and so on, are information problems. And I can foresee sometime ten years from now when information technology will have become so pervasive and so developed that a lot of the government problems will disappear in terms of how you do extension and research and so on, and the problem of getting very specific information to farmers on their fields will be a lot easier than we – than now, and I just wondered what you thought about that.

Audience: I want to ditto the appreciation for your presentation, thank you so much.

Thomas Jayne: Pleasure.

Audience: And so my question and comment is about sort of we – I find it interesting, so we're mentioning some of the problems with corruption and then farmers having access to the inputs that they might need for inorganic fertilizers access, and what would happen if we took all that funding, and I hear you saying that, and we put

all that money into the R&D and extension side and we focused on soil fertility management, and the brown revolution was where we put all of our money, then would we have all of those problems, like he needs the nitrogen, he needs the lime – the corruption? So I'm a proponent for focusing more so on the soil fertility management side of things and I don't know that we do all agree that we need inorganic fertilizer if we invest ahead of time in some of the more sustainable land care and soil fertility management issues. But I would be curious about what you would think about that.

Thomas Jayne:

Okay. All right, thanks Michael. So Jerry, I agree totally. There's a guy named Marc Andreessen, who was the one who started Netscape. He had a – he predicts that within the next ten years, every human being on the planet will have a smartphone, that they'll come down in price so dramatically that people in rural Ethiopia will be having smartphones. And apparently, according to him, there are hundreds if not thousands of software developers who are right now working on getting apps for this two thirds of the world that currently doesn't have a smartphone but will within a very short amount of time, in order to provide services to them that will – this whole range of services that you're talking about in terms of information technology.

So I can only say that I totally agree, I think it's not a pipe dream. But who knows exactly how that's going to play out. But I do agree that farmers will probably have much more access to technology than they certainly have now. Now, if I understood your question right, it was that in advocating for other kinds of public programs like extension and R&D, there might be corruption issues there, as well, and that – how do we mitigate those things. I don't know the answer to that. I'm sure that that's probably correct.

When you said we're not all agreed that increased nitrogen has to go up, inorganic fertilizer, I guess I am aware of that point of view. I am almost – I can't see how we're going to really triple and quadruple yields right now in Africa without heavy doses of nitrogen, along with increased soil organic carbon and micronutrients and just healthier soils. I can't see how to get that boost in yields without massive increases in nitrogen. So I think –

Audience:

But can that happen with organic managing the soil versus –

Thomas Jayne:

It probably could, but it'll be much more expensive. I think it would cost a lot more to get that kind of nitrogen nutrient from other sources. It's an interesting question, and there are other people out here who might have more information about that than I do. But I'm – from what I've read, it doesn't look likely.

Michael Carter:

And if I could just say very quickly a little bit to Jerry's question, something we haven't talked about but I forgot that I brought with me these wonderfully

colorful handouts if anyone here in the room would be interested in them. But one of them is actually a discussion of what private sector does, too. Because private sector does input subsidies. So one of the things up here is our project in western Kenya with a private seed company, and their whole marketing strategy is that the first year, they give away seeds for free.

And what's up here is actually the learning that takes place from that as well – and kind of comparing it to the learning from a public subsidy. So it's not such a weird idea of a temporary subsidy. They only do it once and in a sense, they think it works. And so it's an interesting issue and I don't want to dismiss IT either, but one thing that comes out in the Kenya study in particular that I think is very specific to African soils is how much can you learn from other people and how much can you learn from yourself, which has something to do with the density of these kinds of programs, the question a moment ago about levels of subsidy is also like how many people need to get seeded with coupons?

And one of the things we found in Kenya where we did all this soil quality measurement is in communities where there's a lot of heterogeneity in soil and we measured it by the cation exchange capacity, which someone told me is the best measure of the likely productivity impacts of fertilizer, in communities where that's highly heterogenous, people actually don't learn from each other. They don't know what the CEC is anything better than I do, but they do know that what happens on their neighbor's does not have a lot to do what happens with themselves.

And that sort of points out, number one, that people actually are learning in an intelligent way, but number two, the ability, however we communicate information, if we are in environments where there's a lot of heterogeneity in underlying soil conditions, it's going to be really hard to make information messages be taken up and kind of stick. So we – those are all things we have to work at. I think IT solutions can be a big part of that in ways we discussed already a little bit, so.

Julie MacCartee:

We're getting close to time. Since our online audience won't be able to ask you all questions afterwards, I thought we'd take one final question there and then that should be a little bit of time to nab the speakers afterwards, so last question from online.

Audience:

Sure. We had one participant who was concerned about farmers who can't afford to participate in a subsidy program, and they made a comment about a policy reform that makes the adoption of best management practices a prerequisite to joining the subsidy program, and he was wondering if you could speak to that. As in they would adopt a best management practice in lieu of a cash contribution to the subsidy program.

Thomas Jayne: Okay, great. There are some programs right now that are testing that. At CIMMYT I'm aware of some researchers who are looking at that, and I think it has great promise. So I'll just leave it at that, but we'll let the results speak for themselves when they come out, but I think it has great promise.

Michael Carter: I mean, that's the idea of sort of a sweat equity match, if you will, instead of a cash match, and that's a good idea. I mean, you see that in a number of kind of programs. I mean, I do think the idea of a self – of a contribution is useful because I think it helps people take it more seriously. I mean, Lena Heron, who manages the Basis program that I direct always tells me you have to get mission buy in, because if they don't put money in it, they aren't going to pay attention.

And it's maybe the same kind of thing, maybe farmers are just like USAID missions, that if they had some of their capital involved, then they pay more attention. And I think that's a really interesting kind of idea. I would say that the – part of what's coming out of this Mozambique study, and let me reference a study in Ghana that was done by Dean Karlan and colleagues, where they explicitly ran a horse race between risk reduction versus cash grants.

So they basically set up a trial where some people got money and they set up – and the other arm is people just got insurance. And the question was which is going to induce greater adoption of new technologies. And what comes out of that study is actually they seem to get the bang for the buck if – from the risk reduction. So if risk is reduced, people seem to have the money. And it's not that they've been sitting on it, the money has been there largely set aside to – as a form of insurance. And if they feel like they have an alternative for insurance, they can reallocate that portfolio.

So I've worked for years on capital constraints and I firmly believe that the – it's a huge, huge problem, but I think the risk side of that is also very, very important and that's what – part of what I think we're seeing in Mozambique is that if you get people better financial instruments that help them manage risk, there may be a little more liquidity in the system than we – that's available for investment purposes once the farmer becomes convinced that they can do that in a prudential manner and not actually threaten the family livelihood security.

Julie MacCartee: Well, I'm sorry we can't get to all questions, I always try and end as close to on time as possible. But I very much would like to express my appreciation to our presenters and to all of you who are repeat customers to the ag sector council seminar series. I see a lot of familiar faces this time around, so we appreciate it and we hope to see you at future seminars.

Michael Carter: Thank you.

Thomas Jayne: Thank you.