

CONVERSATION: SMALLHOLDER AGRICULTURE AND BIODIVERSITY

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This particular conversation is about the role of small farmers, farm women and men, in the conservation and sustainable use of biodiversity. As Ambassador Quinn said, this year 2010 has been recognized as the International Year of Biodiversity by the UN system, and I think shortly there’s a meeting in Nagoya, in Japan, I think this week, to review what has been done in terms of conservation and sustainable use of biodiversity.

It is particularly appropriate to link this with the Borlaug Dialogue, because I think more than any other plant breeder, agricultural scientist, and world leader, Norman Borlaug recognized the importance of genetic diversity. In fact, all the success of his work was based upon a fundamental principle: genetic homogeneity enhances genetic vulnerability to pests and diseases. Based on this concept, he wanted to have genetic heterogeneity, not homogeneity, in his varieties, so he brought about the pyramiding of genes from diverse sources, whether it was winter wheat or spring wheat, all of them together. And that is one of the reasons why most of the varieties he bred were not only capable of using soil energy, nutrients, and water more efficiently, but also were resistant in the broad spectrum of diseases and pests.

In fact, even last year, one of his last conferences was to fight the Ug99 race of stem rust. He was very concerned of the stem rust; he had seen in his younger days what kind of damage can be caused to crops by rust diseases. Therefore, he decided that he should alert the whole scientific world, [and the] political world, on the dangers of new races of rust, just as Ug99. So I think it’s on this occasion I hope we can again look back and see what we should do to conserve biodiversity and use it sustainably and equitably.

If you look at smallholders and sustainability, sustainable agriculture, one of the very important methods by which the potential sustainability of agriculture was by genetic heterogeneity – bringing a number of varieties, mixed cropping, a large number of varieties grown in what we now call landraces, over one lakh, 50,000 landraces of rice varieties are available. And, of them, more than 100,000 are in the gene bank of the International Rice Research Institute. Farmers have always valued diversity; they are the great conservers. In the broad world of biodiversity, if you take agrobiodiversity, economically important crops and so on, agrodiversity is the product of interaction. Within biodiversity and culture diversity on the one hand, and biodiversity and culinary diversity on the other hand, the way in which we use the grains, a very large number.

If you read the books written by Noel Vietmeyer – who is a biographer of Norman Borlaug – the *Lost Crops of the Incas*, the *Lost Crops of Africa* and so on, you will see what a wide range of crops on which the local food security, as well as the health security, that is, medicinal plants, both were really built on very great biodiversity. Gradually, with the market-oriented agriculture, we have been compressing the full basket. Hardly four or five or six crops today are important. There were several hundred crops in the past. But one good thing, which is happening now with climate change: it is now being recognized that climate-resilient agriculture has to be built on the foundation of biodiversity. There has to be genetic diversity, so that gene banks of a warming planet have once again attracted considerable attention.

Borlaug... Let me also say – even when we were in the late ’60s, we were discussing about underutilized crops, and he encouraged the formation of an International Council for Underutilized Crops where Lazarov was the first director. Unfortunately, he didn’t receive that kind of support, but I want to mention the importance of a wide range – Borlaug was always interested in diversifying the food habits, bringing in a large number of local grains and so on. And the kind of work now is fortunately receiving more attention.

Now, in the case of small farmers, it's largely, mostly women [who] have been the great conservers. From the time over 12,000 years ago [when] the transformation took place from purely food gathering to food growing, you find a very great contribution – the selection of varieties, the selection of species, were all done by women.

Where we work in my own center – which Ambassador Quinn kindly visited, a seminar – but where we work in the interior parts of India, what are called sometimes tribal areas, you may call indigenous people, you find enormous work that is being done by those people, local people, to conserve biodiversity. For example, one group of workers, mainly women, who developed a system of community conservation of biodiversity through gene banks, *in situ* on-farm conservation, in other words, the landraces. Cryogenic is only preservation, but on-farm conservation is evolution plus preservation – and that is the difference. They have constructed gene banks, seed banks, green banks, and water banks, and just received the Equator Initiative Award at Rio de Janeiro and also later on at Buenos Aires. These people were honored.

Similarly, they have always considered biodiversity to be their ally in sustainable agriculture. Whenever there is drought, whenever there are floods, the large number of varieties helps them in order to save something, at least, that they have obtained. And these kind of conservation efforts, we'll have to revitalize now for promoting a climate-resilient agriculture.

But we should also do something to recognize and reward these farmers. There is no use in saying [that] small farmers are the custodians of genetic diversity; they also require some recognition and reward. This is why both the Global Biodiversity Convention as well as the FAO Treaty on Farmers' Rights have specially made suggestions how people should recognize and reward the conservation traditions of local communities of small farmers.

In India we have what we call a Genome Savior Award for those farm families and communities who have been able to conserve landraces of various varieties. These kinds of steps are needed for what the local people themselves have called – in one of the places I work, it is called by botanists and biodiversity experts as a hot spot, as [an] agro-biodiversity hot spot, the area in Orissa, called Koraput. What the women have done there is they decided to form a society. The local name can be converted into English as “Biohappiness Society.” And the purpose of the Biohappiness Society is to ensure the conservation, sustainable use, and equitable sharing of benefits of biodiversity. In other words, they finally say, the Biohappiness Society will convert a hotspot into happy spot.

And today we are now going to hear from our panelists how to convert the biodiversity hotspots into happy spots and thereby ensure sustainable food security forever. I have great pleasure in introducing the very distinguished panelists. The first is Dr. Christian Borgemeister, the director general of International Center for Insect Physiology and Ecology in Nairobi, *icipe*, the very unique institution set up by Thomas Odhiambo, the great African scientist, and followed with great tradition by Dr. Hans Herren, who is a World Food Prize Laureate and who really developed that society, and I'm happy because Christian Borgemeister now is continuing this tradition of taking this institute forward. He was formerly in IITA, International Institute of Tropical Agriculture in Ibadan and worked on integrated control of invasive storage pests. In the previous session there was emphasis on post-harvest technology, of harvesting, storage, processing. But he's one of those who had worked on the control of the storage pests and minimize losses. Earlier he was a faculty member of Justus-Liebig University at Giessen and also worked in Hannover.

Our next speaker is Christopher Flavin. Christopher is the president of the Worldwatch Institute, a very famous institute, [made] famous by Lester Brown. The *State of the World* report of this institute is looked forward to everywhere; every year we watch [for] them. They were the early warning system also. I think Lester Brown and now his successor, Dr. Flavin, have been helping all of us to ensure that we don't go on the wrong path. Sometimes doomsday predictions are also helpful because it will make us determine to make that doomsday not come, should not get realized — that's important. Somebody predicts a doomsday; our duty is

to see that it doesn't come. And that is what the Worldwatch Institute is doing. We are very happy that he is here. He himself is a specialist on energy and climate issues.

Our third speaker is Dr. Dennis Garrity, the very distinguished director general of the World Agroforestry Center, again in Nairobi — the very important institutions are all in Nairobi, I must say, whether it is *icipe* or with ICRAF and UNEP, United Nations Environment Program, they're all there. And Dr. Dennis Garrity, whom I have known from the early '80s onwards and admired him greatly for his work as an agronomist, who mainstreams ecology — what he does is, he mainstreams ecology and technology development and dissemination, and that is what's sustainable. And naturally today he's leading the movement for the Evergreen Agriculture. Evergreen Agriculture means increase in productivity in perpetuity without ecological or social harm. And he will mention to you about the work he is doing on fertilizer, trees, transforming African agriculture in a somewhat different way than what we normally think is the way.

However, we have word also, Dr. Rattan Lal has not been able to come, but we are very fortunate to have two outstanding farmers from Honduras. That is, Guilmer Alfredo Miguel Montufar, a farmer, extension officer, promoted family gardens, family orchards, other methods of conservation. In fact, I must mention at this moment, a very important area named for Vavilov, a horticultural paradise in Soviet Union, in the former Soviet Union, in Russia; it is in somewhat difficulty today, and people are trying to save it. These have been important on conservation, food-for-work program, organic composting, and growing medicinal plants. In other words, this farmer's concern has been, as I said earlier, on food and health security, both of them.

Then we have Suyapa Ucles who is also there, [with a] bachelor degree in social work in Latin America and a masters in social work from the National Autonomous University of Honduras. Rural development, child and women's rights have been particularly her interests, and [she is] program coordinator of the Mennonite Social Action Commission of Honduras.

So, ladies and gentlemen, these five wonderful people are going to tell us more about converting Borlaug's vision of how smallholders can continue to be the custodians of the unique genetic diversity with which we are all blessed. I'll conclude by one word, one quote, from Mahatma Gandhi, who described diversity as the greatest blessing of humankind. He used to say, "Nature provides for everyone's needs" — I now work in the coastal areas. We have 1,500 halophytes; we have a genetic garden of halophytes, which can absorb salt — "Nature provides for everybody's need, but not for everyone's greed." And that is what is important to ensure, that we conserve and do not over-exploit it.

May I first call upon Christian Borgemeister.

Christian Borgemeister – Director General, *icipe*

Good morning, ladies and gentlemen. First of all, I would like to thank the foundation for inviting me, and I would like to thank Dr. Swaminathan for these kind words and kind introduction to *icipe*, to me. And I would like to thank you for linking biodiversity with pests and diseases, which is going to be somewhat the focus of my short talk here.

Yesterday there was a lot of discussion about risk, and applied biodiversity by small-scale farmers in the tropics is basically their strategy to deal with risks. What kind of risks? Primarily risks of crop failure, crop failure due to pests and diseases; due to climate, erratic climate, climate change; but also biodiversity because it reflects the diversity of their food needs, and it also reflects their market approach, following this old saying, "Never put all your eggs in one basket" — diversify, grow many foods, and then the risk of failure of one will be mitigated by others.

Now, contemporary agriculture in the developed world — I hesitate to use the term "modern" here — is more focusing on monocultures. And, evidently, this creates a great deal of economies of scale, but on the

other hand it also increases the risks, the risks, especially, of erratic events, be it outbreaks of pests, be it outbreaks of diseases, be it climatic changes. And one of the reasons for this is loss of genetic diversity. Now, during the last 20 years, there's quite a significant body of evidence emerging that more diverse agroecosystems are less susceptible to these external shocks caused by pathogens, caused by pests, caused by weeds, caused by climate. Yet the underlying mechanisms are still rather poorly understood; basically, the science is not well understood.

About 15 years ago at *icipe*, my colleague, Zeyaur Khan, and his team embarked on a program which tried to use increased biodiversity in a cropping system to address a couple of the major factors affecting small-scale farmers in Africa, especially small-scale cereal farmers, that are: lepidopteran stem borers, which are, like, the number-one field pests in maize and in other crops; weeds and especially parasitic weeds, like *Striga* and *Orobanche*; very poor soil fertility; erosion, which is linked to it; and, in general, low productivity. Can I have the first slide, please?

What we are talking about is basically a system of several crops planted together. We've got maize as the cereal, and we have maize accompanied by two so-called companion plants, both of them perennial — a legume called *Desmodium* and the border is a perennial grass, Napier grass, an indigenous grass in Africa and one of the most important fodder plants. Likewise, *Desmodium* is a very important fodder plant; it's a legume [with] high protein, high protein content. So both of them are very suitable fodder crops for livestock. Now, we included, recently, a fourth plant into the system, beans, mainly because beans provide protein for humans, not only for animals. And intercropping maize with beans and other cereals with beans is a very common practice around the Great Lake Region in Eastern and Central Africa.

Can I have the next slide, please? We call it “push/pull” for a couple of reasons. Let me come back to the Napier grass. The Napier grass is bordering this little plot, and Napier grass is highly attractive to stem borers. The moths are attracted by smell that emanates from the Napier grass, and they prefer to lay their eggs on the Napier grass compared to the cereal in the field. So they're pulled – they're pulled by the Napier grass. So in a way it acts like a trap crop, because the performance of the moths, the stem borers, is much more inferior on the grasses than on the cereals in the field.

The intercrop in the field, *Desmodium*, is not very much liked by the stem borers. On the contrary, they find the smell of the *Desmodium* rather repulsive, so they are pushed away by the odors that emulate from the *Desmodium*. Now, *Desmodium* has some other quite tremendous benefits. It's a legume, so it provides, enriches, the soil with nitrogen. It's a perennial, as I said before, so the soil is covered and you have greatly reduced erosion, you have much better water-holding capacity. And what is most striking, the *Desmodium* kills *Striga*. The simulium plant releases chemicals in its root system that have, if you want, herbicidal effects on *Striga*. So you can completely suppress the *Striga* weed, the parasitic *Striga* weed, when growing maize or other cereals in a push/pull system. That is very important, because you can continue to grow cereals in an area which is heavily *Striga* infested. You would have the same effect if you would simply plant 10 years of beans; you would get rid of the *Striga*, but you wouldn't harvest any cereals.

Now, we call it a platform technology because it doesn't only work with cereals like maize; it works extremely well with rice, it works well with sorghum, it works well with millet. And just to summarize a couple of the advantages of this system: It greatly combats cereal stem borers. It suppresses the *Striga* weed. Because of the availability of, or improved nutrient content of the soil, you have greatly increased yields. On average we see a tripling of the yields; in some cases five to sevenfold higher yields in this context. Better water utilization. The fodder crops I've mentioned, which give a boost to animal husbandry in the area. And you can integrate beans in this system.

And after 15 years we have approximately 30,000 to 35,000 farmers that are using this system in the region of Lake Victoria.

Let me add a couple of other words on the importance of biodiversity for small-scale agriculture, not only, actually, in the tropics. There is very clear evidence between higher flora diversity within fields as well as on a

landscape level and the sustainability and resilience of ecosystems. Some things that we always took for granted, we are realizing, are very fragile: pollination, honey bees, bees and bumblebees, heavily depend on biodiversity, flora biodiversity in an environment, and they can generate enormous increases in yields. We have examples from Tanzania and Kenya, along the coast, where you have cashew plantations in more diverse landscapes produce up to 30% higher yields because of better pollination by bees. The resilience against pests I have mentioned. The bee problem is a particularly pertinent one here in the U.S. with your colony collapse syndrome.

So let me summarize the key arguments for increased biodiversity in an agroecosystem are especially linked to the greater resilience and greater stability of these agroecosystems. They buffer better disruptive elements or disruptive events, like pests, like diseases, and like climate change. Thank you very much.

M.S. Swaminathan

Thank you very much for these very important remarks. The next speaker is Christopher Flavin with Worldwatch Institute.

Christopher Flavin – President, Worldwatch Institute

Thank you. Thank you very much, Dr. Swaminathan, and it's a real pleasure for me and my institute to be a part of this panel, particularly with you as the chair, and also to be a part of this World Food Prize event. You kindly mentioned our annual *State of the World* Report, which we have been producing since 1984. I'm pleased to say that the edition that will appear in January 2011 is the first edition of *State of the World* in its history to ever focus exclusively on agriculture. We're calling it *Nourishing the Planet*. In partnership with the Gates Foundation, our agriculture team headed by Danielle Nierenberg and Brian Halweil has been working over the last year to research and catalog innovative approaches, particularly to small-scale agriculture in Africa. So I hope you will all look for that book when it appears early in the new year. We think it is going to contribute to sparking that next agricultural revolution that Kofi Annan was speaking so eloquently about this morning.

I want to shift gears just slightly, I think, with some of the other panelists in terms of how agriculture and biodiversity relate to each other. Because our research shows that, far and away, the largest threat both to agriculture and to biodiversity in this century is the rapid climate change that is already beginning to unfold. But we've only seen at this point a very small amount of the very drastic change in climate and weather conditions over the next century.

And of course a lot of modeling of this has been done, but suffice it to say that, while there is always going to be uncertainty with that kind of modeling, agriculture is very much at risk in many parts of the world. Particularly, areas closer to the Equator face the prospect of conditions changing so rapidly that, in effect, farmers will be forced to – even those that are tremendously successful today, will be forced not only to invest very heavily but adopt new practices in order to be able to sustain production.

So I think that the question that is front and center when it comes to agriculture these days is, one, of course to anticipate to the degree possible the climate change that's coming, begin making the adaptations in agricultural techniques. And I think many of the innovative, sustainable agricultural techniques that are being discussed in these halls during the current week have the potential to contribute to that.

But secondly, it is going to be very important that agriculture also recognize its responsibility for a portion of the climate change and recognize that there is much that we can do in agricultural systems that will slow the production of the greenhouse gases.

Now, it's estimated that roughly 30% of the greenhouse gases that are being emitted each year actually come from a combination of agriculture and forestry. We're used to thinking of this as mainly being a fossil fuel—related problem. Clearly it is, in majority, but agriculture and forestry and other land-based sources are not an

insignificant contributor. In fact, if you look at the total amount of carbon that is actually held in the forests, in agriculture, in the world's soils, it's actually about three times the amount of carbon that is typically found in the atmosphere. So agriculture and forestry are deeply entwined in the whole climate dilemma that we face.

The good news is that, although today's agriculture of course is contributing to the problem – some of the carbon that we're now breathing in was once found in the prairie soils underneath Iowa – but, on the other hand, there are new agricultural techniques that are being developed that will allow us to actually gradually, over time, sequester some of that carbon in the soils. And we have been working with partners, particularly with ecoagriculture partners to research, understand, spread some of the innovative practices that are being developed that will allow carbon sequestration in soils to become a significant reality and, potentially, for the environmental service performed by that kind of agriculture, to actually be rewarded through the carbon markets that are beginning to develop in many parts of the world.

So that is, I think, a really critical set of new innovations that are coming forward. And I think that that can potentially be coupled with a reduction of the very dangerous level of dependence on fossil fuels that agriculture depends on today. Of course, the fertilizers and pesticides that are used in such great abundance, most of those are derived from fossil fuels. And we've gotten now into dangerous cycles as oil prices have become more volatile and oil supplies are gradually running out now, where agriculture becomes very vulnerable to a very chaotic and dangerous oil market. So reducing that dependence on fossil fuels will both increase food security, will provide more stability for farmers, but it will also contribute again to reducing emissions as we need to do.

I'm going to just leave it there for now. I can get later into some of the details of some of the really exciting, new agricultural techniques that will allow us to capture carbon in the soils. But I think we need to look at this as not only a huge challenge but a huge opportunity for farmers, including very poor farmers throughout the world.

M.S. Swaminathan

Thank you very much. I'm glad you raised the whole question of climate change and its potential impact. As was mentioned, both sub-Saharan Africa and South Asia, which have a large number of undernourished people, are the regions most vulnerable to climate change, particularly warming by which I mean, mean temperature rising by a degree of 2.

And our next speaker will show some way of how agriculture can increase its contribution to mitigation, not talking about adaptation — [for] adaptation, biodiversity is exceedingly important, but mitigation, both through carbon sequestration on the one hand, to photosynthesis on the other, building soil-carbon banks, locking up, also, more carbon in the ocean. Those of you who are coming from Latin America know only too well, the ocean temperature, recently, the Bolivian fisheries – millions of fishes died because the temperature went down from 14 degrees C to about 3 degrees C. So both in terms of fisheries, as well as crop husbandry, we have great implications of climate change, and Dr. Dennis Garrity about how, under those conditions, how do you make agriculture evergreen? Dennis.

Dennis Garrity – Director General, World Agroforestry Center

Well, thank you very, very much, Dr. Swaminathan. Today as we meet here in Des Moines, on the other side of the world, as you mentioned, there is a meeting in progress of the parties to the Global Convention on Biodiversity. It's going on right now. They're assessing the world's progress in meeting the target that was established 10 years ago to stop the precipitous decline of biological diversity around the globe by 2010. I just read the results of that assessment, and it's not an encouraging story.

Biodiversity decline around the world hasn't been halted; rather, in most places it has further accelerated in the past decade. And the majority of those declines have been due to habitat conversion, that is, forest clearing for farming. It has slowly dawned on the conservation community that smallholder farmers have a lot to do with conservation of biodiversity and that local biodiversity is also crucial to smallholders' livelihoods as well.

Now, the map that you see here shows the results of a recent global assessment of tree cover on agricultural lands. The results may be surprising to some of you. Today there is greater than 10% tree cover on half of the agricultural land in the world. And in some regions, such as Southeast Asia and Central America, tree cover on agricultural land actually exceeds 30%. Well, that's a very interesting observation, and it buttresses the good news that although tree cover in forests is still declining rapidly, the number of trees on farms is actually increasing. Unlike in the temperate areas, smallholder farmers in the tropics have always husbanded trees on their farms; they have a year-round growing season. And they continue to culture them for a great variety of purposes.

We call this "evergreen agriculture," a form of more intensive farming that integrates trees with annual crops, maintaining a green cover on the land throughout the year. Evergreen farming systems feature both perennial and annual species that are producing food and income.

Now, imagine for a moment a future where smallholder farmers and large farmers as well practice much of their food-crop production under a full canopy of trees, such as you see in this photo taken of a maize production system in the food breadbasket zone of Tanzania. Imagine that these trees are not competing with the food crops but, rather, quite the opposite — they are dramatically enhancing the yields of these crops due to their striking effects on soil fertility. They are nitrogen-fixing trees acting as fertilizer factories in the field, providing tons of nutrient-rich biomass year after year, decade after decade, since these trees live to be about 100 years old, with no investment costs to the farmer. These trees are fully compatible with the crops because they exhibit a unique physiological trait: reverse phenology. This trait triggers this particular species of trees to go dormant at the beginning of the crop season when the rains occur and drop their biomass as fertilizer to the crops growing in their vicinity.

Imagine that producing food crops like maize, sorghum, millets, and other cereals under these agroforests dramatically increases their drought resilience also in dry years, because of positive soil moisture regimes and a better microclimate. And during the dry season when they are in full leaf, they provide a rich source of livestock fodder through their leaves and pods, greater than the best of what we see in many other systems. Finally, imagine that these systems increase carbon sequestration above and below ground by an order of magnitude greater than what you find in conventional conservation agriculture.

Ladies and gentlemen, this isn't a dream, and it isn't imaginary. It's actually a system of agriculture that is already practiced today by millions of farmers in Africa. The tree is the African acacia, an indigenous species, botanically called *Faidherbia*. It's cultivated by farmers across the African continent throughout the Sahel to East Africa and to Southern Africa as a fertilizer and fodder tree.

For example, I met these hard-working ladies last year out harvesting their maize in Central Malawi where they and a half million of their neighbors have these acacia trees in their maize fields. They told me how they were making barely 10 bags of maize per acre before they began cultivating the trees — that's about 1 ton per hectare. But after they began culturing these trees as an intercrop with their maize plots, their soils improved to such an extent that they've been regularly harvesting triple the yields year after year in a sustainable production system.

Now, trial data from dozens of scientific studies in countries all over Africa bear out what these ladies were telling us. These are the latest results from scores of trials in Zambia alone during the past three years, where a massive scaling-up program for cultivating *Faidherbia* in maize production is currently underway. And what you see is a doubling to tripling of yields, typically, over large numbers of trials.

Now, growing cereal crops in association with these amazing African acacias does typically double or triple crop yields — and this is across a whole series of crops, such as millet, sorghum and others — without the application of inorganic fertilizer. And let us recall that currently less than 20% of African farmers actually use inorganic fertilizer, for one reason or another. But these practices dramatically build soil organic matter and soil fertility and soil biology over the long run, to sustain these high yields, making mineral fertilizer application all of the more attractive and efficient to farmers who practice these intercropped. So it's not an either/or situation; it's a complementary and supplementary approach.

Now, imagine that the positive biodiversity effects that would be achieved if the agricultural landscape were covered by the kinds of trees that farmers find compatible with their food crops, such as *Faidherbia*. You can actually see that vision on over 5 million hectares of millet and sorghum farms in Niger, one of the poorest countries in the world, actually, where there has been an explosion of tree culture, such as you see here, in the past 15 years. Now, the dark green spots in this photo are the millet fields. The white blobs are the canopies of the *Faidherbia* trees, bare and dormant in the wet season, with tree populations anywhere between 30 and 300 trees per hectare. Here is another view in Niger of how smallholder agricultural lands now have dense tree biodiversity over vast landscapes.

Yesterday, Howard Buffett fundamentally challenged us in his brilliant presentation. He said, and I quote, "I've concluded that we really need to approach agricultural development differently. We've got to approach it in ways that are affordable to smallholders." And, Dr. Swaminathan, you have been calling for an evergreen revolution for over 30 years now, an agriculture that produces much more while building on the best ecological principles.

The systems we see portrayed here embody those principles. Farmers have identified and deployed these unique biological tools. The tools are already proven, and they are amenable to much larger deployment on a wide range of farming systems. We can now build on the tree genetic diversity that farmers have identified and nurtured, combined with the best of modern agricultural science and practice. They are not incompatible; they are fully synergistic.

Well, fortunately, more than a dozen countries in Africa are now working on evergreen agriculture scaling-up programs, including the ones that I've mentioned — Malawi, Zambia, Niger, Burkina Faso, and a number of others in East, Southern and West Africa. And many development partners, such as NEPAD, AGRA, IFAD and others, are taking an active interest in supporting this vision. It has been a great pleasure working with you, Dr. Swaminathan, in stimulating also evergreen agriculture visions for India as well. Our opportunity is that, together with the farmers, we are now creating the vibrant partnerships to realize an evergreen Africa and elsewhere in the tropics. Thank you very much.

M.S. Swaminathan

Thank you very much, Dennis. I think he has given a very important message about — incidentally, Norman Borlaug started his career as a forester. He would have been happy to hear [this]; he always used to tell me, "Don't neglect forestry. Agriculture is important, but forestry is more important." So I'm glad that Dennis has brought this enthusiasm. His wonderful tree, *Faidherbia albida*, the whole concept of fertilizer locking up carbon banks in the soil as a mitigation mission. And also in evergreen agriculture, which is the only one which will keep permanently farmers happy. And so thank you for this wonderful note.

We have two great farmers from Honduras, and are you going to translate it? So, first, may I call upon Guilmer Alfredo Miguel Montufar to share his thoughts, and it will be translated in English.

Guilmer Alfredo Miguel Montufar – Farmer, Nueva Frontera, Honduras

Good morning to all. It's a great pleasure to be here, especially with all the representatives of all the countries here. My name is Guilmer Miguel Montufar, Guilmer. I'm from the municipality of Santa Barbara, Honduras,

and the municipality of Nueva Frontera. A very important thing, in what we call the integral farms that we've been learning today about, too, as well – we recognize the importance first is the family involved in the farm. I'm the father of six children, three boys and three girls.

We started this process, what we call the sustainable farm, with the idea to produce without harming the local resources. One thing that is very important for us in farming and education is to say no to the slash-and-burn techniques. Also, we are trained a lot, too, not to use chemicals that can affect the climate as well, the environment. The applications of foliares, which is a natural insecticide and herbicide that we use from the leaves, these are made from natural plants and also animals. Also we can produce it from the manure from cattle.

Another important thing, especially in soil preparation, is the curve or terrace farming. The creation of what we call live barriers and dead barriers, like we said earlier – the live plants that make the barriers and also dead plants that can be the barriers of the farm. And also it's very important to have different types of crops growing at the same time on the same piece of land.

We're producing in a very small area. We're a very small farmer. I have one manzana of land, which is probably less than two acres. I can say I'm one of those small farmers. And on the small parcel of land we can do vegetables. For example, we also do radish and cabbage, banana, beans. We also have papaya trees. We've also learned to plant citrus trees. We've provided vitamins, for example orange and mandarin trees.

Another interesting thing that we've incorporated in our farm is also having rabbits and chicken in our farm. We also have received a cow through "Passing On the Gift" from Heifer and also we appreciate all the support we receive from the local NGO, CASM, which provides all the technical support to us. We also have a horse that helps us to produce organic compost in our small farm. As you saw in the picture, we also have the earthworm farm where we grow our own compost from the earthworms.

On our small farm, too, we have what we've seen earlier this week, a bio-digester. We can produce gas from the manure of small animals and cook with that gas on the stove in the kitchen. And we can use less firewood, because we know that we need to use less firewood, because cutting trees for firewood creates deforestation, and we need to protect our environment and protect the forests as well.

So all of this work on the farm, we always do it together as a family. Today, as I'm here for the first time ever in the United States, my family had to stay back behind on the farm, but I'm glad to be here. They are hopefully still working and sustaining the small farm while I'm here. We don't have any other income or salary. We live off the small farm as a family.

It's been a great pleasure to meet small and also big, big farmers on this visit. It is a priority to grow crops but without harming the soil, without harming Mother Earth and harming the natural resources. I'm very proud to be a small, rural farmer. That's how you begin to grow as a person, without harming the environment, what we think of as Mother Earth, also the water and also the air. Sometimes we don't have to think [about] big pieces of land to produce enough food to feed; we can produce enough on small parcels of land. To learn how to maximize the small-person land to produce more and to do what's good for us, and not what we think is good, is what we need.

I'd like to say it has been a great pleasure to share the few things that we're doing on my small farm. So thank you very much for this opportunity.

M.S. Swaminathan

Thank you very much, Guilmer, for this wonderful exposition of the strengths of biodiverse agriculture from the point of view of a small farmer. Our next, last speaker is Madam Ucles, please.

Suyapa Ucles Salinas

Good morning. It's a great pleasure to be here to share with all of you here. Also I'm very appreciative for the opportunity to share in this panel and to share our experiences. And I'm also very appreciative of the Foods Resource Bank for making this available and the World Food Prize for inviting us here.

I wanted to introduce some elements that we've seen this week here and also that we experienced in our country as well, elements for the small rural farmers. You've seen, observed, what Guilmer has shared with us, and we can see there's some very big differences in what we think of small, rural farmers in Central America and Latin America and what a small farmer might be here in the United States or Europe.

One of those differences is the access to land that our small farmers have, access to be able to produce. And obviously one of those means of production is the earth, land. We could hear what Guilmer shared with us, what he can produce on one manzana of land, less than two acres. The majority of our small farmers have maybe one manzana or less. I would say the majority of the farmers we work with have less than two acres each, and the majority of times the land is not their own land as well. Many times they just rent the land so they can grow basic grains as well – so to say, the majority of small farmers produce to be able just to eat what they produce for them and their family.

Another difference we can see obviously is technology. So I ask myself — is this good or bad? There's actually, in the rural area, there's not much technology. Another thing we can talk about is credit to be able to produce. It is very difficult for small farmers to access any kind of loans to be able to produce as well.

And I think it is very important to discuss also the human development, the dreams that people have, which also are tied to our culture. Generally in our culture we have a very low, low self-esteem in the rural area. So it's very important to work very much in the self-esteem of people to be able to have great success. Also another important thing to discuss too is the level of education that the small farmers have. There's a high rate of illiteracy in the rural area where we work and low levels of access to schools as well. So this makes it difficult to train people to teach new ideas with the rural population.

Another thing that we face in our region that has been discussed here, too, is the vulnerability that we have for natural disasters in Central America. Honduras is the third country, [according to the Climate Change Summit], is the country with the third-highest vulnerability to climate change.

With all those differences, you can see we have many challenges for the national/local NGOs that are helping small farmers. We think it is very important, in these conferences and these events, it's great to talk about different context and different cultures, as well, openly. It is very important to develop processes to be able to improve lives and to improve crops and to improve higher yields as well, too — all the different discussions we're having here.

The responsibility or the role of small farmers in talking about biodiversity: we can say first that it's our responsibility that all the actors, all the stakeholders, share – the state, governments, local municipality governments, and everybody to share – we're all stakeholders in this. It's a shared responsibility with all. And of course small rural farmers have to have a role as well. In our country, and I think also in Central America, the land access that we have in these countries is more for forestry land than for agricultural land. In Honduras any percent of the land is forest area, so we have a great challenge there too.

Our role as local organizations, in this moment, we're working on training people, capacity building, technical building to be able to produce, but to produce jointly with the environment. We have heard a lot how it can be done here, how we can do agriculture and also protect the environment. But it's very important to do advocacy and action as well – to strengthen the capacity of the small farmers and advocacy and action as well, and other local actors, to have in the local agendas, government agendas, and also international agendas, the problems that we're facing, the problems especially of the small rural farmers and also the problems we're facing with climate change and the environment. As we talk about human development, as we're talking

about agriculture and working and training farmers how to work together with a new concept of living together in this world, how to improve the capacities and their self-esteem.

M.S. Swaminathan

Thank you, thank you very much. Again a very powerful message from both of them, [from] Honduras — building a society, please build a bio-happiness society in your area. Now we apparently have only ten minutes left, so brief questions quickly?

Question

I'm Ravichandran, a farmer from India. Actually I took up farming motivated by your great work, sir, Dr. Swaminathan. The high-yielding varieties of Green Revolution changed our history. I feel we haven't yet attained the real potential of the high-yielding varieties of the Green Revolution. There are many biotic and abiotic reasons which reduced our yield potential. And genetic engineering can address these problems — why does it get delayed in our country? This is one question. The Bt brinjal episode — though it got approved from the GEAC, then it was referred to expert committees, then it was rejected. Farmers, we feel rather let down. And other one is — when will we be having the GM crop in our country, and what would be the role of public institutions in general?

M.S. Swaminathan

Thank you. I think we'll take two or three questions and then answer together. Dennis, you can answer this. Next one, please?

Question

Yes. I'm Norman Looney. I'm representing the International Society for Horticultural Science and chaired the board of an advocacy group called the Global Horticulture Initiative. And of course I was very interested in hearing the speakers from Honduras give such a very nice demonstration of how horticulture crops, or garden crops, can contribute to importantly to sustaining biodiversity and utilizing biodiversity through smallholders. And I'm wondering if we could continue to remember that other members of the panel, excellent presentations — thank you very much for those — if we could remember that horticulture crops provide, because of the huge diversity of crops and the genetic potential that is there, we can adapt to climate change much easier, I think, through these crops than some others. And I want you to keep that in mind of your development of these really remarkable systems that you're discussing. Thank you.

M.S. Swaminathan

Thank you very much.

Question

Thank you. Glenn Prickett with the Nature Conservancy. It was a really excellent panel, and each of you really drove home well the importance of focusing on the value of biodiversity to the farmer. And in that respect I was surprised that none of you talked about water and the regulation of fresh water, the recharge of aquifers. That's one of the most valuable functions that biodiversity plays in agricultural landscape.

At the Nature Conservancy we work with farmers and ranchers here in the Midwest, in South America, and in China to preserve natural vegetation and, in some cases, to restore agricultural lands to natural vegetation because of the service it provides in regulating water flows. And as a few of you pointed out, that sort of

ecological service can actually be a source of value to the farmers. The challenge is that it can't be done farm-by-farm [and] needs to be done at the scale of a whole watershed, so I'm wondering if any of you could speak to your experiences either with water in general, or especially with, what are the effective ways to scale up beyond a farm-by-farm approach to really manage the ecological function of water supply at a watershed scale by providing incentives to farmers?

M.S. Swaminathan

Thank you, thank you. One more and then we'll have the panelists. Please go ahead.

Question

I'm Tim Ogborn from Save the Children. I appreciate the comments from the panel. One of the problems about this format is we tend to have panels that agree with each other. So I want to bring a comment from the last panel and get a response from the people in this panel. The representative from Syngenta said something along these lines — I don't have the exact quote: "We cannot allow lifestyle choices for low-productivity organic agriculture to hold back smallholder farmers." And I would like to have a response from this panel to that comment, please.

M.S. Swaminathan

Thank you. I think one more and then we'll stop, because we're already late.

Question

Great work, amazing work, hopeful. But I just have one concern, and probably Dennis can address this. In the last 30 years we have focused on two crops: rice and maize. And we know that these are two crops which require the most important inputs, water and nitrogen. Are there any research work going on that we can look on [for] crops for the future which can be used as staple food, besides these two crops?

M.S. Swaminathan

Thank you, very important. Now we'll start. Christian, you would like to answer? Let each panelist make a few comments in relation to the questions.

Christian Borgemeister

I would like to address the question with reference to the previous panel. The lady from Syngenta made rather sharp remarks about organic agriculture. I got the impression this is very much Europe- or North-, developed-country, focused, trying to create some sort of a dichotomy between organic and nonorganic agriculture. The vast majority of agricultural productivity in the tropics is by definition, by nature, organic. We would classify it as organic — not because of a choice but very often because of lack of inputs. Now, we are feeding this planet to a large extent with organic agriculture. So I don't see the necessity to replicate contemporary, developed-country agriculture in the tropics.

M.S. Swaminathan

Dennis?

Dennis Garrity

Yes, I'd love to address briefly a few of the questions. First of all, on the yield potential [of] modern varieties not being met, I think that one of the main opportunities for building higher-yield potential in those varieties is in fact the biological diversity in the soil, and how we manage that diversity, and how we build soil organic matter in ways like those I described.

On the water, recharge of watersheds — Glenn Prickett — absolutely there are so many ways in which these issues are addressed by these kinds of systems providing higher infiltration rates, raising water tables. And in fact, in the Sahel, where it's right at the edge of the desert, the land is covered by the trees at high densities, 30 to 300 trees per hectare, farmers claim that their wells rise to the surface rather than decline as a result of the trees being present — higher infiltration, greater buffer stripping in the system.

And finally the issue of crops, maize and rice being dominant, looking at other crops. Of course, Dr. Swaminathan has already emphasized the importance of getting more crop diversity into our agricultural systems. And I would only second that sentiment.

M.S. Swaminathan

Christopher?

Christopher Flavin

Just add quickly on the point that Glenn made on watersheds and the really critical role that they play and the need to integrate really sustainable watershed management into agricultural practices, we see that as absolutely key. And in fact there is an entire chapter in the forthcoming *State of the World* entitled, "Getting More Crop Per Drop," authored by Sandra Postel that really provides I think a good framework for thinking about water. It's also important to remember that one of the really critical, and unfortunate, results of unfolding climate change in the decades ahead — that is, among the more certain things that the models tell us is that the dry tropics are going to become even drier. And so I think there's an enormous amount of effort that needs to go in both on the research side but of course, even more importantly, on the implementation side.

Again, I think the agricultural-research community is really not, at this point, doing what it needs to do to address that kind of an interdisciplinary issue in recognizing that an issue like water management is never going to be about a single technology; it's going to be about a systemic approach to agriculture, to doing the variety of things that have already been described. And I think it really is essential that we get the international agricultural community organized around addressing these systemic concerns rather than a sort of a piecemeal, technology-by-technology approach.

M.S. Swaminathan

From Honduras, our farmers?

Suyapa Ucles

I want also to say the question about the watershed. Maybe because of the time we were unable to share, but within the work that we do in supporting the small rural farmers, we work in the protection of the microbasins. Something that affects a lot the microbasins, the water in the microbasins, is that the coffee product, when they use a pulp, they leave the pulp loose, then that goes into the water, all the coffee pulp. So we're doing a lot of training and awareness with small farmers to use the coffee pulp for organic composting with worms; also we do a lot of training on how farmers can protect the water sources and protect the microbasins.

It's true to say that we do have a lot of water, because we have a lot of forests, but we don't take advantage of it, during especially droughts or dry season, so a lot of times there's not technology to have systems of drip irrigation or to bring the water from the microbasins to the rural communities. So we're introducing those systems because that dry season could be a long time in our country.

M.S. Swaminathan

Thank you very much. We have also one of our World Food Prize Laureates, Pedro Sanchez. He was the director general of ICRAF before, he and following, Dennis Garrity, have built up this whole soil fertility program. We're going to ask Pedro to say a remark, or a question. Where is Pedro Sanchez?

Pedro Sanchez

Okay, thank you very much. I'm going to turn the tables, and I'm going to talk in Spanish, and I'm going to ask you to translate to English back there.

I'm also – I was [from] a small rural farm in Cuba, and I believe what you're doing is wonderful. And the idea of the evergreen farms is also very positive. But there's a point of discretion as well. Dennis says, and very correctly, that using the trees also allows you to use better the chemical fertilizers. And I know, as a specialist, that they're not toxic, the fertilizer chemicals, and it's needed when the soil can't support all the necessities. So please learn that chemicals can be used and be good for the small farmer...

M.S. Swaminathan

We should now come to a close, please.

Pedro Sanchez

...if they're used in extremely high quantities, like they're doing it in China – you can use it in high quantities as well. But the idea is the same as drinking milk — it's nutritive, and not toxic. But if you drink two gallons of milk, you could get sick anyways. It's the same with the chemical fertilizers. So don't be allergic to using chemicals together with the organic fertilizers.

M.S. Swaminathan

Thank you, thank you very much. I think it's been a wonderful conclusion to a great conversation. I want to again reemphasize that genetic homogeneity will enhance genetic vulnerability, not only to biotic and abiotic stresses, but will also reduce our capacity to meet the challenges of climate change. If you see the pedigree of any successful variety – for example, Gurdev Khush is here and his rice varieties, which are so popular, because there are over nearly 80 to 90 landraces in the pedigree – if you see the pedigree, it brings together a very large of number landraces. So let us hope the farmers of the world will continue to save us by conserving agrobiodiversity through [the] *in situ*, on-farm conservation tradition. Please give them a big hand.