HARNESSING AGRICULTURAL BIODIVERSITY FOR IMPROVED NUTRITIONAL QUALITY, MORE EFFECTIVE CLIMATE CHANGE ADAPTATION AND BETTER RURAL LIVELIHOODS

M. Ann Tutwiler

Director General Bioversity International
Via dei Tre Denari 472/a, 00057 Maccarese (Fiumicino), Rome, Italy

M. Ann Tutwiler holds a Master degree in Public Policy from Harvard University (USA). Currently, she is Director General of Bioversity International, an international research for development organization that is a member of the CGIAR Consortium. As Director General, she is responsible for leading Bioversity International, a $40M international research for development organization with 345 staff based in 16 countries. She also worked at Food & Agriculture Organization of the United Nations (FAO), at the Department of Agriculture in USA (USDA), and at Agency for International Development, USA (USAID).

ABSTRACTS

In the face of grave and mounting threats to food and nutrition security — land degradation, climate change and economic inequality — the challenge of facilitating pathways to healthy, sustainable livelihoods, communities and diets has never been greater, nor more urgent.

Old approaches are no longer fit for purpose. We need new approaches that harness improved nutritional quality, more effective climate change adaptation and better rural livelihoods.
The calculated formulas that gave us the Green Revolution — simply increasing yields and producing more food and more calories through a limited set of crops — are no longer sufficient. In order to address food security around the world, today's formula requires us to look at food production differently — what we produce, how we produce more and where we produce it, as well as how we market and consume it — all under changing climatic conditions.

Here, a focus on biodiversity is key.

Biodiversity has been recognized in the endorsement of the 2030 international development agenda, The Sustainable Development Goals (SDGs). World leaders have agreed the vital importance biodiversity has for our planet and our lives through Goal 15* of the 17 proposed SDGs. Furthermore, there is increasing recognition that using and safeguarding biodiversity can deliver on multiple sustainable development goals, which demonstrates the vital role of mainstreaming biodiversity into other key targets.

In recent years Bioversity International has been finding that more diverse agricultural ecosystems, with more species or more genetic diversity within species, offer a multiplicity of benefits that work together to support improved nutritional quality, more effective climate change adaptation and better rural livelihoods, all of which are key to the current development agenda.

Our research points to the benefits that can be reaped by revisiting the what, how and where of food production – and in particular by establishing methods for the sustainable use of our most important natural resource: genetic diversity.

When looking at the what we produce, it is interesting to note that there are over 7,000 known edible plant species; yet, currently 50% of the world's calories come from just three crops — rice, wheat and maize. This focus has failed to address the importance of nutritional diversity. Today, more than twice as many people suffer from micronutrient deficiencies as from hunger, while the number of overweight adults in developing countries tripled between 1980 and 2008. Genetic diversity, if used wisely, can help to tackle malnutrition by increasing dietary diversity.

The how we produce highlights the need to produce more food while sustainably using natural resources such as land and water. In recent years research has shown that that more diverse ecosystems, with more species or more genetic diversity within species, often have higher overall productivity than systems based on fewer varieties. They can also be associated with greater stability of yield—higher-diversity plots have been shown to be up to 70% more stable than monocultures. Genetic diversity can also reduce the risk of crop failure in high stress environments.

Finally, we need to look at where we produce more food. As the greater proportion of the expected population increase will take place in the developing countries, we must produce more food in these regions. It happens that most of the world's remaining agricultural biodiversity is found in these developing countries, maintained largely by smallholder farmers: the custodians of biodiversity. For most of these farmers, diversification provides a risk management strategy, offering inbuilt increased resistance to pests and diseases, climate variability and extreme weather phenomena. Our work suggests that supporting their efforts, and investing in more research into crops that can withstand the rigors of climate change and environmental stress, will be critical to development objectives.

There are several examples of how Bioversity International's research demonstrates the gains from increasing biodiversity within agricultural systems.

In Zambia, we are working with local communities to test a diversity of crops and wild foods that have the

potential to contribute to an all-year round healthy diet, and to adapt to local conditions. This research is supported by educational materials about healthy sustainable diets, as well as a seasonal food calendar that shows which foods are available all year round, including the hunger season.

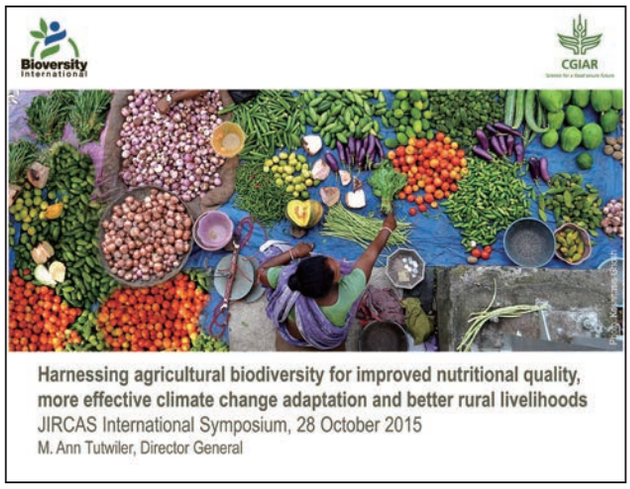
Since 2006 we have been working with national partners in China, Ecuador, Morocco and Uganda to investigate the effects of planting different varieties of the same crop in mixtures. Recent findings from trials with the National Agricultural Research Organization in Uganda show that mixing varieties resistant to certain pests and diseases — many of which are local varieties — with those that are more susceptible, greatly reduces the incidence of that pest or disease. For bananas, for example, farmers reported a 75% reduction in the presence of weevils when they used crop mixtures.

Learning from these lessons requires that we now give greater attention and support to public and private efforts that promote the understanding, development and augmentation of agricultural biodiversity where it is most needed. We need to explore new institutional frameworks and mechanisms for the equitable distribution of benefits at local, national and global level. And we need to push for policies that incentivize enhanced agricultural biodiversity, and that can therefore lead to measurable improvements in the nutritional quality of diets; the yield and resilience of crops in changing conditions, the health of communities; and the security of livelihoods.

* SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

KEYWORDS

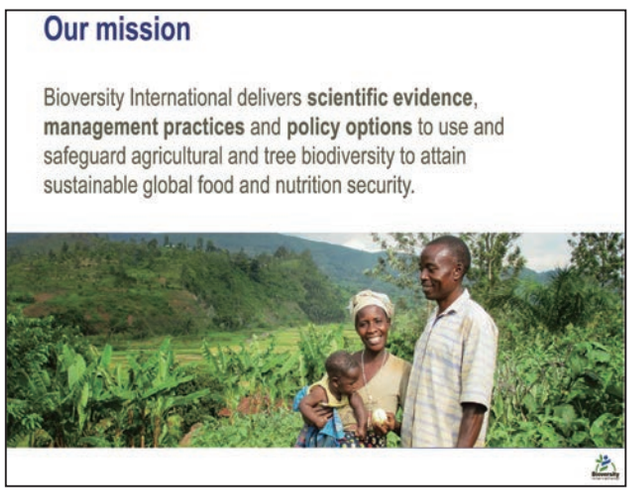
Biodiversity, nutrition, food security, livelihoods, SDGs, climate change adaptation


Bioversity International
CGIAR
Harnessing agricultural biodiversity for improved nutritional quality, more effective climate change adaptation and better rural livelihoods
JIRCAS International Symposium, 28 October 2015
M. Ann Tutwiler, Director General

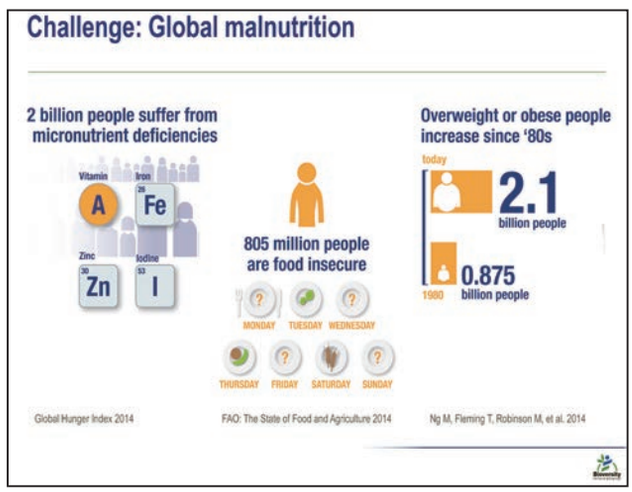
1


Agricultural biodiversity nourishes people and sustains the planet
Photo credit: LI-BIRD/A Subedi

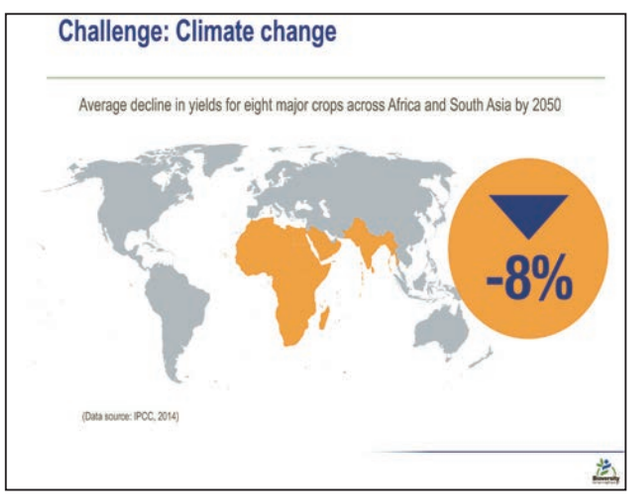
2


Our mission
Bioversity International delivers scientific evidence, management practices and policy options to use and safeguard agricultural and tree biodiversity to attain sustainable global food and nutrition security.

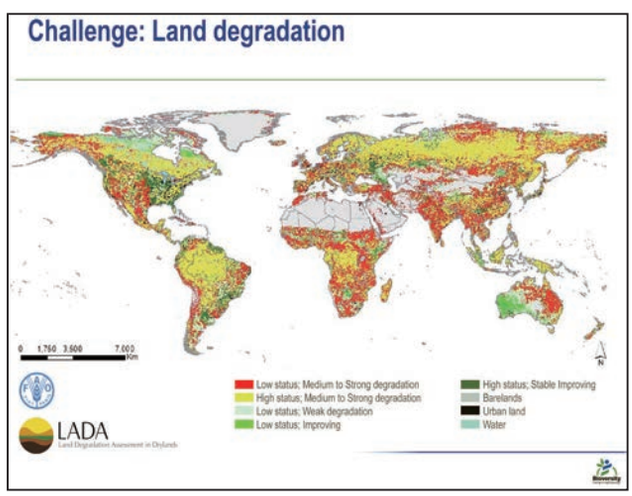
3


Challenge: Global malnutrition
2 billion people suffer from micronutrient deficiencies
Vitamin A
Iron 26 Fe
Zinc 30 Zn
Iodine 53 I
805 million people are food insecure
MONDAY TUESDAY WEDNESDAY
THURSDAY FRIDAY SATURDAY SUNDAY
Overweight or obese people increase since '80s
today
2.1 billion people
1980
0.875 billion people
Global Hunger Index 2014
FAO: The State of Food and Agriculture 2014
Ng M, Fleming T, Robinson M, et al. 2014

4

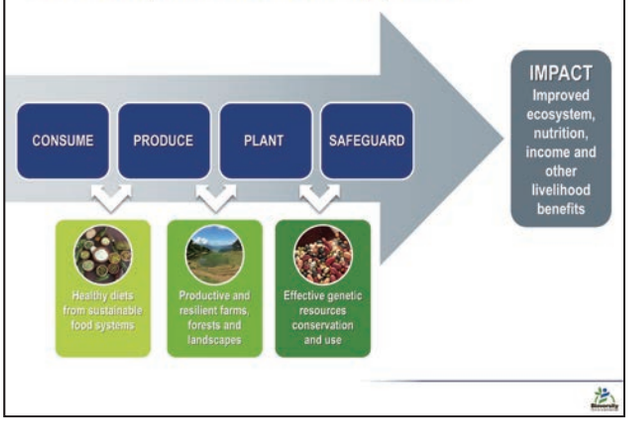

Challenge: Climate change
Average decline in yields for eight major crops across Africa and South Asia by 2050
-8%
(Data source: IPCC, 2014)

5


Challenge: Land degradation
0 1,750 3,500 7,000 Km
LADA
Low status; Medium to Strong degradation
High status; Medium to Strong degradation
Low status; Weak degradation
Low status; Improving
High status; Stable Improving
Barelands
Urban land
Water

6

Bioversity International's approach



7

Healthy diets from sustainable food systems

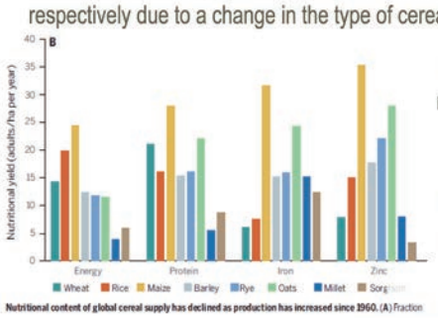
How agricultural and tree biodiversity can contribute to diet diversity and be better used within food production systems through:

- **Rural to urban agri-food value chains**
- **Local agri-food systems**

8

New metric: nutritional yield (DeFries et al.)

From 1961 to 2011, protein, iron and zinc content in the directly consumed cereal supply declined by 4%, 19% and 5% respectively due to a change in the type of cereals consumed



Iron content in millet is twice that of rice

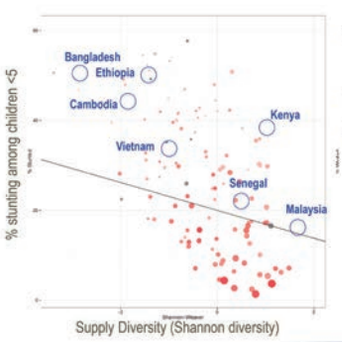
Zinc content in oats is 4 times that of wheat

Nutritional content of global cereal supply has declined as production has increased since 1960. (A) Fraction

9

Stunting decreases with food system diversity

Remans et al. Global Food Security 2014; also adopted by Scaling Up Nutrition Movement 2014



- *Controlling for # socio-economic factors including GNI, trade, infrastructure,..*
- *size of bullet = GNI per capita*
- *Low diet diversity in Ethiopia is also well reported on at individual and household level (e.g. Headey 2014, Hirvonen et al. 2014)*

Coefficient -3.10***
Adj R^2 0.707

10

Productive and resilient farms, forests and landscapes

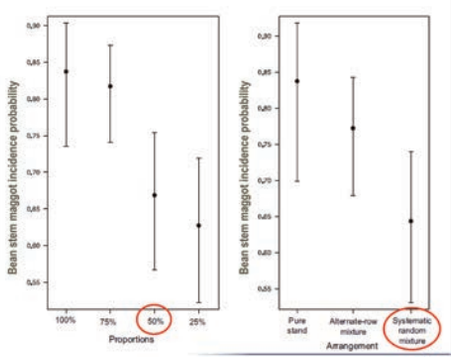
How agricultural and tree biodiversity can be better used to increase productivity and livelihood benefits through:

- **Ecological intensification and diversification**
- **Landscape restoration and management**

11

The use of common bean traditional varieties in mixtures to manage bean fly infestations in Uganda (Ssekandi et al.)

Using 50 % of resistant varieties in mixtures in a systematic random arrangement, reduced bean fly damage on susceptible popular varieties



12

In marginal areas, biodiversity offers options

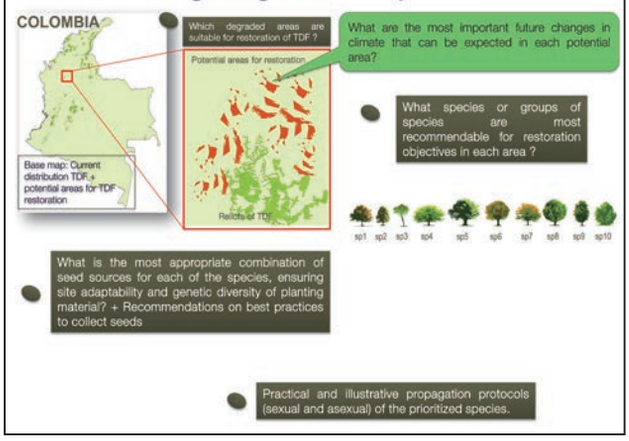
Landraces perform better than improved varieties of Durum wheat in Ethiopia

Trait	Superior (improved)	Superior (landrace)	no‡	Percentage
Days to Maturity*	117	109	57	18.4
Biomass Yield (t/ha)	7.2	10.0	97	31.4
Grain Yield (t/ha)	2.2	3.5	68	23.9

- 18% of farmers varieties are superior to the best improved variety for maturity
- 31% of farmers' varieties are superior than the best improved variety
- A yield advantage of 61% obtained from the best landrace over the best improved variety (Robe) and 24% of the farmers' varieties were showing a yield advantage

13

A model for guiding restoration practice



14

Effective genetic resources conservation and use

How to curb the loss of crop and tree biodiversity and support systems that contribute to more diversity through:

- Strategies, management and trait identification
- Information services and seed supplies
- Policy, institutions and monitoring

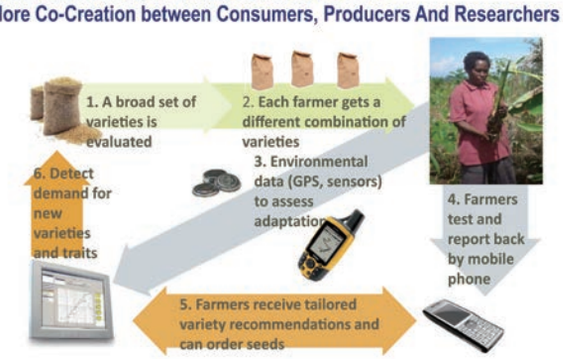
15

Bioversity International's global conservation for use strategies

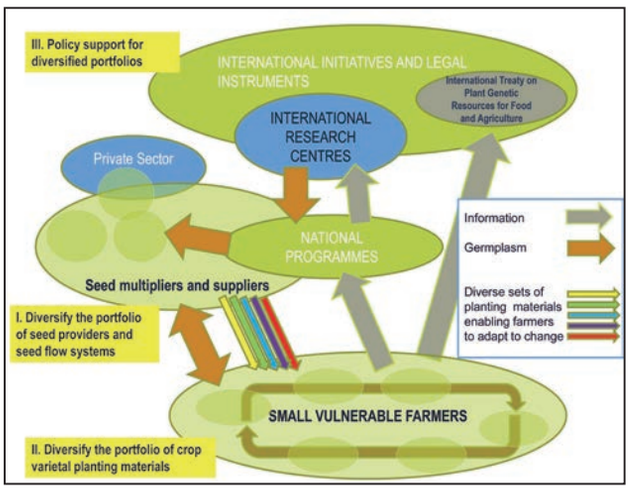
16

New challenges need a new business model:

More Tailored to Specific Needs and Locations
More Co-Creation between Consumers, Producers And Researchers



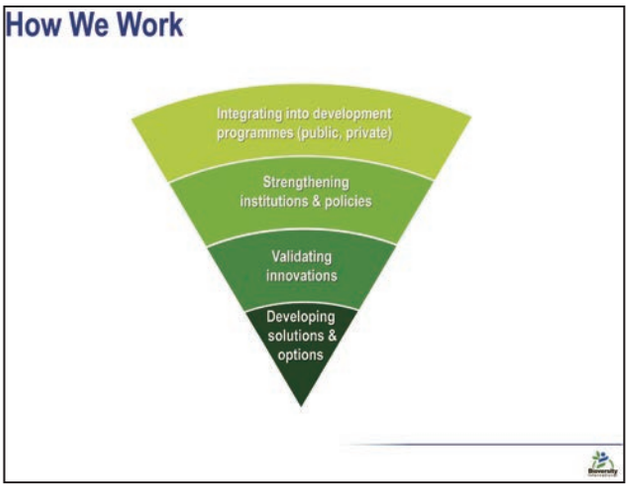
17



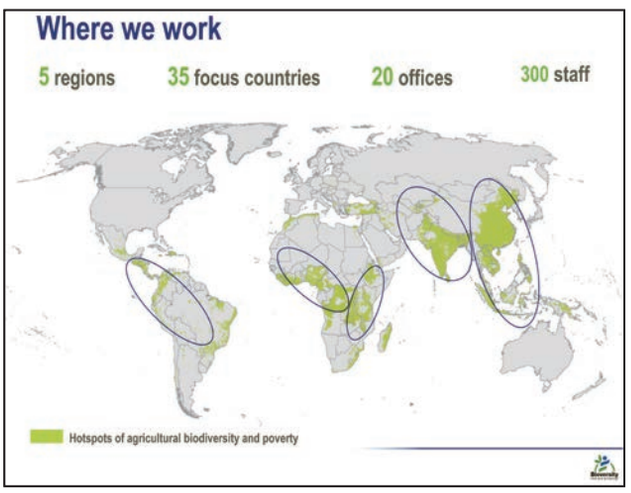
18


Partners
Development organizations
Farmer organizations
Governments
Agri-business sector
UN agencies
Research institutes

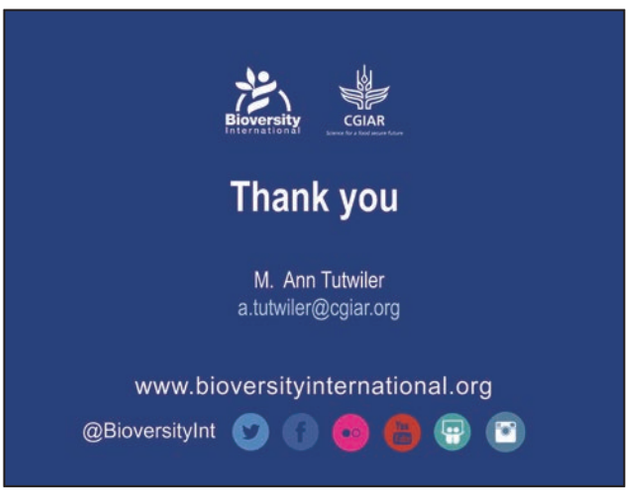
19


How We Work
Integrating into development programmes (public, private)
Strengthening institutions & policies
Validating innovations
Developing solutions & options

20


Where we work
5 regions
35 focus countries
20 offices
300 staff
Hotspots of agricultural biodiversity and poverty

21


Bioversity International
CGIAR
Thank you
M. Ann Tutwiler
a.tutwiler@cgiar.org
www.bioversityinternational.org
@BioversityInt

22

Chairman Doi: Good morning, ladies and gentlemen. I'm Kunihiro Doi, the Director of Research Strategy Office of JIRCAS. It's my pleasure to introduce the keynote speakers today. Before my introductions, I may explain a little bit about the background of the symposium. Our President, Dr. Masa has already said some words, but I will also say some words about the background of this symposium.

Since last century, we have been tackling the important global issues, such as climate change adaptations, food security, and poverty alleviations, which have negatively impacted the lives and livelihoods of people around the globe. However, by and large, these problems have remained unsolved and have become even more complex with the emergence of new concerns such as nutrition security, transborder diseases, and extreme weather events, among others. Until now, I still continue to grope in the dark to find a clear and effective solution to these problems.

Today, we are honored by the presence of two prominent speakers, who are well-known for their expertise in their own fields. We are confident that their presentations would provide profound insight into the importance of quality research in agriculture.

So, I am pleased to introduce our first speaker, Ms. Ann Tutwiler. Ms. Tutwiler is the Director General of Bioversity International, an international research-for-development organization and a member of the CGIAR Consortium. She joined Bioversity International in July of 2013. Before joining this institute, she worked in various governmental and intergovernmental agencies, where she attained outstanding achievement in the field of the international agricultural policy and trade.

So, the title of her presentation is "Harnessing Agricultural Biodiversity for Improved Nutritional Quality, More Climate Change Adaptation and Better Rural Livelihoods." Director General Tutwiler, the floor is yours.

Ms. Ann Tutwiler: Thank you very much. And thank you very much for the invitation to be here. Well, I think we began talking about this, Masa, maybe two years ago almost. So, I'm very thrilled to finally be able to join you.

So, what I would like to do today is to give you a little bit of a flavor of the work that my organization, Bioversity International, is doing to address the issues that have been already put on the table by the previous speakers. Before I start, let me give you a little bit of information about Bioversity International. So, as was mentioned, we are a member of the CGIAR. We are 40 years old. We originally were part of the Food and Agricultural Organization, and one of our original founders was M.S. Swaminathan, who as all of you well know, is one of the fathers of the Green Revolution. Our original mission was very much focused around the conservation of plant genetic resources ex situ. And our original work was primarily around building the capacity of genebanks in developing countries to manage their plant genetic resources. Maybe as some of you do not know, the Global Crop Diversity Trust was a child of Bioversity International and we also played a significant role in providing technical assistance to the negotiators during the formation of the International Treaty on Plant Genetic Resources 10 years ago.

So while our original mission and vision focused very much around the conservation of plant genetic resources, today, to address the new challenges that we are all familiar with Bioversity's vision has moved to be focusing much more on the use of agricultural biodiversity and how it can be deployed or harnessed to improve the quality of agricultural production, the quality of people's lives.

As has been mentioned before this morning, the Sustainable Development Goals that were agreed last month in New York provide a very important foundation for the work that we do at Bioversity. One of the Sustainable Development Goals, Number 15, is specifically focused around the conservation of biodiversity in all its forms and there's specific mention of agricultural biodiversity in that goal. But, when we look at the Sustainable Development Goals, we also see that agricultural biodiversity can help address more than just Goal 15, but also the goals around poverty, around food security, around nutrition, around sustainable management of our natural resources, and more.

In addition, of course, the importance of agricultural biodiversity has been enthroned in the Convention on Biodiversity. And this year, we have been particularly active with this Convention on Biodiversity to mainstream biodiversity into agriculture and into health and nutrition.

So our mission, whereas certainly the provision of scientific evidence—the creation of scientific evidence is an important part of any research organization's mission, our role, we see, is not just to deliver that scientific evidence, but also to turn it into actionable management practices, actionable policy options, and decision tools that farmers and development practitioners, investors in agricultural development—whether they're private or public—and of course farmers themselves can use to improve the quality of production to improve the quality of lives.

So what I'd like to do now is to provide a broad overview of our work and some of the research results that we are generating that I hope will help set the stage for the rest of the day's conversations. So I'm going to list four of the challenges that we all know are facing agriculture, but maybe just to give a particular focus from the perspective of Bioversity International. So these figures are quite well known to us; I think for many years the CGIAR has focused primarily on reducing the number of people who are food insecure. And I have to say that as a world we have been moving in the right direction in terms of reducing the number of people who are food insecure. I think when I started with the FAO, these numbers were estimated to be close to a billion or even over a billion and now the estimates are 805 and I think the most recent numbers were quite a bit... a little bit lower than that even.

But what has... The numbers that have been moving in the wrong direction are the numbers of overweight and obese people which have reached about 2.1 billion people worldwide and the number of people who are suffering from micronutrient deficiencies. And these are the two populations that Bioversity International is focusing on in our work.

So climate change—again, we know in a couple weeks there will be the Conference of the Parties in Paris. For many, the recognition of the impact of climate change on agriculture came far too late. I used to say that sometimes it seemed like it was more important how many people would be losing their beachfront houses than it was how many farmers would be losing their livelihoods as a result of climate change. But now, we are all quite aware of the impact climate change will have. This, of course, has implications for breeding, which is the main work of the CG system, but it also has strong implications for the diversification of the kinds of crops we are planting and in particular, the need to take another look at some of the neglected varieties: neglected crops like sorghum, like millet, which have not received very much research attention in the past, but we know are quite resilient to drought, to heat, and the other kinds of abiotic stresses.

Land degradation—this is something that's not often mentioned in the list of global challenges, but we think at Bioversity it's something quite important for the world and quite important for our mission. In developing countries, a lot of the good land is already taken and around the world a lot of the good land is already taken. Increased food production is going to have to be partially done on marginal and fragile lands. This land degradation affects about 1.5 billion people around the world in 110 countries. And the correlation of marginal lands and poverty is incredible high in many, many countries.

And what's important about this from the perspective of Bioversity and from agricultural biodiversity is that the first Green Revolution focused a great deal of attention on improved varieties for good quality land. That is land with good soils, land with access to either rain-fed irrigation or irrigation infrastructure that was close access to markets. But the land that we are going to have to bring into higher productivity are these marginal lands. And for that, we need different kinds of solutions. We need to look at: Are there landraces? Are there farmers' varieties that are able to perform better in some of these very challenging conditions than some of the improved varieties that we have developed over the past 40 years? Are there microclimates and micro agro-ecological zones that we need to pay more attention to as a result of land degradation that we are seeing around the world? We, as the CG system, and we at Bioversity believe we need to develop more tailored solutions to address these challenges that farmers in these poorest lands are facing.

The other important part about land degradation is the cost of the land degradation to ecosystem services. So it's estimated that land cover changes—land degradation among them—are responsible for 50 to 75 percent of the lost ecosystem services values that are attributed to land around the world. This accounts for about 43,000 to 72,000 dollars per hectare. There's an estimate that about 30 billion dollars of agricultural investments will be needed to reverse these trends in agricultural land degradation around the world.

So based on these challenges, Bioversity has identified four strategic objectives that we would like to address. The first two of these objectives are expanding access for low-income consumers to a diverse, affordable and nutritious diets represented in this diagram by the word "Consume." The second of these strategic objectives

is to increase productivity, ecosystem services, and resilience of farming systems, forests and landscapes for rural communities, presented by the word “Produce.” The third strategic objective is... underpins both the first two and that is that we need to have a diverse supply of planting materials—seeds and other planting materials—for farmers if we are to have diversified production systems and consumption systems. And the fourth objective goes back to Bioversity’s roots in many ways, and that is that we need to continue to safeguard plant genetic resources ex situ and in situ in a way that they can be utilized for current and future generations.

We have three initiatives that we have organized our work around and what I’m going to do now is just to give you a taste of the research that we’ve been doing in each of these three areas. So healthy diets from sustainable food systems. And I think this is perhaps largely what this meeting is about today. We have two components of the research we’re doing here. One is focusing on how we can improve the connection between rural producers and urban consumers through agri-food value chains and with particular focus on nutrition and a particular focus on neglected and underutilized species.

We are also focusing very much on improving local food systems. As we know, in many developing countries, farmers... they have access to a diversity of production but many times they’re selling that production into the market rather than consuming nutritious foods or they are not utilizing the diversity of the production system they have to improve their diets. So we are conducting research into how we can help farmers and consumers use that diversity to improve their livelihoods and their nutritional outcomes.

So as one example of the work that we are doing in this area, this is from an article that was published this summer in Science Magazine authored by two of our scientists, obviously in collaboration with others. And this is basically focusing on the fact that for the past half century, the focus of most of our agricultural research has been on maximizing yields per tons per hectare of agricultural crops and particularly for cereal crops. And increasing the production of these high-yielding cereals—wheat, rice and maize among them—has often replaced more nutrient dense cereals. And this overtime has eroded the nutrient content of the world’s cereal supply. So we believe new approaches are needed to produce healthier foods—more nutrient dense foods that are rich in essential nutrients—and also improve farmers’ productivity. So we think that the standard yield metrics are inadequate to give us a full picture of this issue of nutritional yield. So our scientists have been working to come up with what we call “nutritional yield” of agricultural crops.

Now, if you look at this table, what you can see is that the iron content of millet is, for example, twice the iron content of rice and the zinc content of oats is four times that of wheat. And if you take a look at the amount of cereals that would be required, what this metric does is gives you the amount of cereals you would need to eat in order to provide the equivalent level of nutrition. So how many tons of rice would a person need to eat in a year to give them the equivalent nutrition as the same from the same land that could produce millet or another crop?

So we think this idea of nutritional yield can be very useful for a number of players in the food system. One, it provides a recognition that it’s not just yield—tons-per-hectare—but it’s also nutrients-per-hectare that we need to be worrying about as development practitioners and I would argue not only in developing countries. It could fuel the purchase of more nutritious crops by our development organizations. For example, the World Food Programme has launched its Purchase for Progress program. They could use the idea of nutritional yield to improve the quality of the crops that they are purchasing for their food distribution programs. This can also be used by governments when they're looking at providing support—whether it's research support, whether it’s policy support—for farmers to plant more nutritious crops.

So another piece of work that Bioversity has done that was published, also published last year is looking at the correlation between dietary diversity and stunting. And this diagram is an illustration of the relationship that we’ve discovered between stunting and between dietary diversity. And this analysis did control for some of the important socioeconomic factors including gross national income, trade, infrastructure, etc. and certainly household social conditions. Now what’s important about this is we are often confronted with arguments from some development practitioners that the only solution—or the most efficacious solution—dealing with stunting and other micronutrient deficiencies is to provide a single nutrient solution: so to provide vitamin A fortification or iron fortification. And what we’re trying to demonstrate is that actually through an improved diet through improved diversity of diet, you can achieve a significant impact on the reduction of stunting in developing countries.

So our second initiative is around productive and resilient farms, forests, and landscapes. We have two components here. The first focuses on how we can use biological processes and in particular agricultural diversity to improve productivity and to improve resilience of farming systems. And the second focuses much more on the landscape level, both on the issues of restoration that I mentioned earlier and on improving land management tools and practices.

So this is a fairly complex diagram—although I assume there are a lot of scientists in the audience who can read this one quite easily. This is research that we've done in Uganda on common beans, but I should add that we have done similar research on rice in China, bananas also in East Africa, and are achieving quite similar results. So the bean fly is considered one of the most economically damaging pests in Uganda and despite the use of various pest management approaches, the damage levels from this bean fly are quite high. So what Bioversity has done is evaluated 48 traditional and improved varieties that are being grown in farmers' fields for resistance against this bean fly. We collected the data on the incidence severity and root damage that has been caused by the bean fly maggots. And, through linear modeling, we've revealed that several of the Ugandan traditional varieties are quite resistant to this very damaging pest. So what we've done is selected these traditional resistant traditional varieties and popular, very popular but susceptible, commercial variety from these 48 that were they evaluated. And then we tested the damage from bean flies from using different mixtures and different planting systems by combining the use of the local traditional varieties and these improved varieties. And what we're finding—and again, and I say this is particular results for bean, but we are finding very, very similar results for other crops—is that if we mix 50 percent of resistant varieties in what's called systematic random arrangement which means basically scattering the seeds as farmers do, we end up with a significant 50 percent reduction in the damage of the pest to these crops.

Now what's nice about this approach is, first of all, it relies on biological processes. Secondly, it combines a very popular and high-yielding variety, but that happens to be quite susceptible to bean fly damage with local varieties. We're finding that these local varieties are conferring protection on the commercial variety. This is a very low-tech process for farmers to use and of course, low input levels, low pesticide use levels. And what we're also finding is we've been in conversations with a rather large multinational seed company who's quite interested in using this approach to provide packages of seeds to farmers that are combining their improved variety with some of these local resistant varieties.

And other work that we're doing—back to my earlier comments about focusing on degraded land or land with particular microclimates—we have a project that is active in 11 countries right now we call Seeds for Needs. In this project we are basically working with the national genebanks in these countries where the project is going on and going into their genebank collections with them and screening the collections in their genebanks to identify varieties, usually local landrace varieties but sometimes improved varieties that are more resistant to the abiotic stresses that farmers are experiencing than the improved varieties that they may have access to on the commercial market.

Now, Ethiopia is a particularly interesting case because they are growers of durum wheat. Most of the durum wheat varieties that are grown commercially in the country or grown in the country are from European germplasm. Yet, Ethiopia has one of the world's best collections of Ethiopian wheat durum germplasm. So we've screening that germplasm with the University in Ethiopia and University in Italy to identify higher performing varieties. And what we're finding is that in many cases these farmers' varieties are superior to the improved varieties for the climates and conditions that we're working in. And we are seeing a yield advantage in many, many cases from these landraces.

Now, what this project also does is not just look, as I said before, at the yield per tons per hectare, but we are also looking for other qualities that farmers value, like the amount of straw that's produced or the culinary characteristics of these crops for the consumers which are important in helping farmers determine what varieties they would like to plant.

So let me turn quickly to some research that we are conducting in the area of forest restoration. Many of you will be aware of the Bonn Challenge which has a goal set for reducing the amount of degraded land and for improving reforestation around the world. We have become engaged with an initiative in Latin America called "20 by 20": 20 million hectares to be restored by the year 2020. Now, in many cases in forest restoration projects what we see is a drive to just plant a certain number of trees. If we only can plant 10,000 trees, we will have achieved our objectives. But what we're doing is actually going in and looking at what are the varieties and species of trees that will be needed to create a sustainable living forest for the long-term. And

this involves not just looking at what varieties are needed for wildlife habitats and wildlife that are dispersing seeds in forest systems, but also looking ahead to see what kinds of varieties and species these forests will need in 20, 30, 40 years to deal with climate change. And then identifying where can we find these quality planting material that farmers can... landscape managers can use to replant these forests.

And a couple of interesting points about this work. One is that... What we found is that the risk of failure of these large forest restoration schemes using the wrong varieties is quite high. So an approach that actually helps landscape managers to use the proper varieties has a higher likelihood of a success. What we're also finding is that farmers can earn such a good living from providing the seeds of these trees that they are actually conserving the trees. So the value of the seeds is higher than the value of the timber. And so this is turning out to not only have important outcomes for land restoration but also important outcomes for conservation.

So last, I would like to talk briefly about our third initiative around the effective use and conservation of genetic resources. And here we have three components: one focusing on strategies of the commodity at national level for genetic resource conservation; a second on improving information services and seeds supplies for smallholder farmers; and the third around policies, institutions, and monitoring for genetic resources. So Bioversity is responsible for the world's banana collection. We also have responsibility for cocoa and coconut genetic resources. So these are examples of three genetic resource strategies that Bioversity has helped to shape over the last few years in helping to guide the genebanks and, in some cases in particular in the cacao sector, the private sector, in ensuring that we are not losing our genetic resources in these final crops.

In addition to conducting work on specific commodity strategies, we're also engaged in working with countries to develop strategies for conservation at a national level and regional level. One, I would just mention. In Mesoamerica we worked with 11 or 12 countries in that region to help identify priority species—priority varieties—for all the countries in that region and identifying where those varieties are being grown, particularly in unusual climate situations and how those varieties needed to be protected so that in 30 or 40 years those countries would continue to have access to those resources.

What I mentioned earlier, our Seeds for Needs program. This is an emerging area of work where we are looking at how we can take the learnings that we are gaining from identifying these landraces often to fit very small niches of farmers. How we can turn that into a business model that will enable the private sector to supply seeds to a large number of farmers who may need themselves only a small number of varieties for their own production systems. So we are, as I said, at that early stages of this work, but I think it's very interesting, in a way, to be able to offer an alternative business model to the one that has driven the Green Revolution and driven much of the commercial agriculture in all of our countries where a few large companies are producing a few varieties that are used by large numbers of farmers. So increasingly, we're having a large number of smallholder farmers with very particular needs that are not being met by traditional business models. So we're looking at whether or not we can use technology, whether we can use informational systems to enable more information and more demand to be expressed by these small farmers then to be satisfied by a variety of private and public sector suppliers.

And last, I'm not going to explain this complicated diagram, but I think it's an important one to indicate just how complex the policy environment is for plant genetic resources around the world. And we were discussing this just earlier this morning with the Ministry of Agriculture about the complexity of the policy environment we find ourselves in. So the Seeds for Needs program that I just described is basically the part that you see down here between the smallholder farmers and seed multipliers and suppliers. And that, we worked to provide that link, that connectivity, that exchange of information so that we can improve diversity of planting material that smallholder farmers get.

We're also trying to connect the national genebanks more directly to smallholder farmers, trying to change their mentality from being a safe deposit box to being more like a bank, more like a savings and loan where they have a role or responsibility and a mission to get genetic resources out to their smallholder farmers. But the important part here—not the most part important, but an important part—is that this is all happening in an international context of a Treaty on Plant Genetic Resources which is governing the policy environment and the genetic resource trade environment that we see trickling down even to the level of smallholder farmers. And Bioversity is working at multiple levels throughout this system to ensure that seed policies—national policies—are enabled to promote the smooth transfer of plant genetic resources both at an international level

and but also ensuring that smallholder farmers can get the resources they need and that policies are supportive of smallholder farmers' needs in the agriculture production system.

So, coming to a conclusion, Bioversity works with a number of partners at many different levels throughout the agricultural research and development infrastructure. We are partnering quite closely these days with the international financial institution, in particular, the International Fund for Agricultural Development, trying to begin to link the research that we do into the lending programs so that we are informing the investments that are being made by these large funds by the research that we are doing and we hope ultimately that the rest of the CGIAR can also begin to be much better connected to these large-scale investments.

We've of course worked with other research institutes around the world. I think Bioversity, because of our history, has quite close working relationships with the national agri-research organizations in developing countries. We don't have our own laboratories so we are very reliant on partnering with other research institutes. I mentioned a couple of places in my talk, we are reaching out quite aggressively to members of the private sector, particularly in the seed industry, who are interested in exploring some of these new business models that I talked about. And of course, we work with our colleagues down the street in Rome at the Food and Agriculture Organization.

So this is just an illustration of how Bioversity works with our partners and where we see our most important role. While we certainly are in the business of developing solutions and options for farmers by conducting our own research, we also see ourselves increasingly playing a role of translating research that is done by ourselves but also done by others into innovations that need to be validated at the field level and then scaled up into policies and institutions. So this is perhaps a little more downstream research than some of our colleagues within other parts of the CG system are doing, but we think, back again to one of the comments that was made in the opening remarks, research is not just about delivering research outputs. It's very much about delivering outcomes for farmers, outcomes for consumers, and outcomes for improved policymaking.

So I'll close with a quick survey of the areas where we work. We are focusing on 35 countries, which is very much in line with the CGIAR's new policy of increasing its focus on fewer countries. We have 20 offices around the world, over 300 staff, about 60 percent of whom are in developing countries. In addition to our office in Italy, we also have staff in Leuven, Belgium, where we keep the banana germplasm collection. And we've identified these countries through a very comprehensive exercise looking at where we have strong overlaps between biodiversity hotspots, poverty, micronutrient deficiencies, and climate change impacts.

So with that, I will conclude. I think I'm amazingly a bit early but that's probably a welcome relief. So, thank you all for your attention and again, I appreciate very much the invitation to be here and I hope I've given a flavor of Bioversity's work and how we think agricultural biodiversity can improve outcomes for farmers and consumers. Thank you very much.

Chairman Doi : Thank you, Director General Tutwiler. We are happy to know that Bioversity International has already identified an integrated and sustainable approach for resolving complicated agricultural issues. I am particularly impressed with your institute's approach. It's a normal thing, but you stated that you start from the consumer. We forget it. So it is a very important point. And also regarding your abstract, your institute's highlighting of the overweight adults. I'm personally very much interested in it, but this is not the time to discuss that point so next time, please make a presentation for me. Thank you very much. Again, let's give a round of applause for her excellent presentation.