WORLD FOOD PRIZE SYMPOSIUM
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Thank you very much, Judith. It's a great honor to be invited to this symposium, and I hope I can do the topic of this session justice. Maybe the only addition that I would give to this introduction is that I started my career about 25 years ago, and it was because of Per Pinstrup-Andersen that I was able to start my career in international agriculture. So I'm doubly honored to be here at this occasion and thank him still for the fact that he gave me my first job.

The title of my presentation here was given to me as, "Can a land sustain needed production?" And this is a production that we've been struggling with over 200 years, as we know that some dire predictions were made, most of which have turned out to be untrue in terms of the time dimension but have not been proven to be untrue in terms of its actual prediction in what may happen in the future.

When we talk about production for the future, we have to take into consideration that the world has an enormous potential to produce. Theoretical calculations put production potential up way beyond the ten metric tons per hectare. And the conditions are changing, both changing in terms of the genetic potential that we bring to bear in this game of producing food for the world. And obviously some of the people that have been honored by World Food Prize have done that bit to change that potential. And on the other hand, there are those in the area of climate change research that are looking at the possibilities of that potential changing as a result of human activity.

But as you can see, the attainable yields are substantially lower, given the natural resource base that we are dealing with. And we are talking about constraints such as water or nutrient deficits but are ... science as well.

And finally we're looking at the actual productivity, which is then again affected by incidents of diseases and pests, which centers like ___ are addressing and many, many researchers around the world. And we heard a great deal about that yesterday.

Now, where do we stand when we look at the second..., the attainable yields? And this will be the subject of my presentation, but it will also be in the next session where we're talking about water constraints.

Now, at the onset I want to point out that I'm going to give a presentation on a subject that we as a scientific community know very little about. We know that land has its inherent limitations, and land here is not just soils – land is climate and all the other goods of a piece of land on which we cultivate.

And as you look at this picture you can see that some of the most potentially productive lands are located in the United States, but also you can find some in South or in East Asia and

parts of Europe. There are a number of particularly temperate regions in the world that are blessed with exceedingly good conditions for production of biomass. But you can also see that large parts of the developing world that are given here in the colors other than green have a greater degree of limitations and constraints imposed on them when it comes to production.

The results of this are that when we look at the relative agricultural productivity, we are seeing that, in terms of what the potential of the land is given its climatic conditions and the water availability and so forth, the agricultural productivity is not anywhere close to what its potential is in many parts of the developing world. And the reasons for those are the fact that we are dealing with inherently poor substrates called soils on which we are trying to do agriculture. And I'm sure that we... the colors here on you, but you can see that in Latin America and Africa, a large part of these continents are in green, which means we are producing far below what that area, that piece of land is capable of doing given its climatic conditions.

Now, if we look at some relatively old data, but it is still the best we have, from FAO, we can see that the shares of the total harvested land in the various parts of the world are quite different in their potential. And we can see, for instance, Latin American is blessed with about 65% of its land being quite high potential, that Sub-Sierra in Africa in contrast only has 36% of its land which is considered high potential. And so inherently these areas are not going to produce the potential yields which we are aiming for and which are necessary in many parts of the world to produce a population.

A population that has been growing steadily and will be growing further, at least for the foreseeable future, we're not particularly sure about which of these curves will be followed, but all of these curves are incremental for the coming decade. So it really doesn't make that much difference which ones of these we're dealing with. The consequences of what we have been seeing in the past decades is that as a result of population increases, the per capita availability of land has been decreasing, particularly in Sub-Sierra in Africa and Latin America. And the consequence of that, one would have suspected, is that we are not producing the amount of food that we should, but in fact we are doing quite well, at least because of the work that some of the laureates here have done.

The agricultural production per capita worldwide has been steadily increasing. However, we must accept the fact that there are huge differentials when it comes to different parts of the world, and particularly Sub-Sierra in Africa, which was addressed many times yesterday. Particularly Sub-Sierra in Africa is lagging far behind in that area. In fact, the per capita food production in that part of the world has been decreasing.

So where does that leave us in the next decades? Well, first of all, when we talk about our natural resource base, the soils, we need to have an idea of what is actually happening with soils. And this is probably the message that I would like to give to the audience. We don't know. We have very limited information about soils, far less than what we know about what happens to our air, and far less than what we know about what happens to our waters. And I would like to bring this out in a number of pieces of information.

Here we have aggregated, and this is really a good friend and colleague that has done this while he was still at I____, Dr. ___. He has aggregated some data that is available in the literature which is more or less experts' information combined with some actual data, given some information about what has happened with our land in various parts of the world over the last four decades. And you can see that in Latin America we are looking at a great deal of deforestation, which is new land being taken into production, which is being offset by some land that is being lost because of degradation and some land being lost because of urban sprawl.

And so when we look at in the various parts of the world over the last four decades, we can gradually get an idea that we are eating up land as we encroach on new land. And that's a real concern. And it is a concern that we cannot substantiate with very good and hard data, but it is based on expert information, the best we can do at this point. I'm happy to say that economies generally don't worry so much how the information is collected, from this point on they're happy to extrapolate and do economic analysis on this data. And so a lot of this is actually worked up by IFPRI.

Now what is the consequence of this. This picture may be a bit more complex, but in each of these regions that we are looking at here, we are looking at the 1960 and 2000 shift in land use. On the lefthand side... The blue colors are the territory that is actually in use, and to the left of that is the land that we left because it was degraded. And to the right of the that is the land that is still available potentially for production in the feature. And what you are seeing is that over the past 40 years we have encroached on our land, moving the blue section of the diagram to the right, and we left behind degraded land on the left there.

And what you're seeing, if we extrapolate with the data that we have collected from the previous diagram and go beyond that to the year 2020, we can see some very disturbing trends. One is that you can see that, for instance, in Southeast Asia, we are likely to run out of any further land disposable to us for further expansion. But even worse, in South Asia, we are well into land that should have never come into cultivation.

So these are very disturbing trends, and it is really disconcerting to me, at least, that in this particular area, the basis of agriculture, the basis of our existence, we have given up on an international institute that's concerned with soils and that we are not giving it the attention that it needs. I talk about soils and soil degradation as our "stealth" problem – it is creeping up on us, we're not keeping track of it, and it hits us when it is generally too late to do much about it or at least at reasonable cost.

Now, we look at the next picture. Again, a little bit complicated, but at the lefthand corner down there you can see what I have drawn there – this is again taken from ___. On the horizontal axis, I'm showing the potential available lands; and on the vertical axis is what is actually being and potentially being produced on that land. And you can see that in the various regions of the world... Let's take Sub-Sierra in Africa. You can see that the potential, both in terms of land being cultivated as well as in terms of the potential yield, is not at all reached. We are only producing in Africa a small fraction of the total potential that is available. This is fine, and we should be able in the next decades to capitalize on that potential.

But look at South Asia. You can see that the yields are not reaching the potential yields, and as a result, the farming communities have expanded well into the areas where they shouldn't be farming at all. And so this is where modern technology should come into play and should bring the farmers back from these marginal lands, back from these lands that are endangering the integrity of our landscapes and do this. But modern technologies, including biotechnology, is necessary.

Now, if we look at the consequence of that, and this is some of the data, and often you will see this data presented to you in the form of a table, often with three significant figures. In fact, this is again the ..., the global assessment of soil degradation, done by I___ in the Netherlands with FAO and UNESC – has done this on an expert evaluation of where our soil stands. And you can see that, particularly in the topical regions, many of our lands are in great danger of degradation. I don't have the courage to put these tables up, because we don't know the extent of degradation, these three significant figures – we only know that approximately. And this gives you an approximate picture of where degradation is a problem. And as you can see, some of our own lands, particularly in Western Europe, are in danger of being degraded to the point of no return.

Now, that was the bad part of the picture. And it really is of great concern to me. But the next part of my presentation will give a little bit more optimistic point of view.

Now, if you'll look at the annual cereal crop yield growth over the last three decades, then you can see that in some areas of the world, particularly Asia, we are seeing a declining change. If we look at Sub-Sierra in Africa, we see a declining trend to a point where annual growth in cereal growth rates are really, really small. But there is another ... area of Latin America where there was a decline trend until about the eighties, and then it went back up.

And I'd like to present a little bit in preparation for the presentation of my friend, Ed Schuh. I'll tell you a little bit about a success story of how you can manage land properly and get some returns on your investment. The Cerrados fifty years ago were considered a wasteland, and on my right here, Pedro Sanchez will confirm that he worked in that area, not that long ago but almost that long ago.

The potential area of production of the Cerrado is somewhere in 127 million hectares, and as you can see in the columns here, currently about 88 million hectares of that land are taken into production. This was only possible after soil scientists identified the major constraints to production in these areas, which was fertility, particularly low pH, phosphorus and sometimes zinc. And the Cerrado, once this was discovered, were given open to settlement, and it took place at a very, very rapid rate.

Now, is this a success story? That is debatable. There are benefits of the development of the Cerrado because of the enormous increase in national grain production and enormous increase in the national beef production; but there have also been ecological consequences. And as you can see in the background of this picture, there has been an enormous loss in biodiversity, there has been quite a loss in soil organic matter and soil fertility, and there have been great problems with soil compaction and severe soil erosion. But this particular little diagram here

shows you what the story has done for soybean production, and you can see this has substantially added to the income of the country.

The organic matter loss has been documented. The large-scale production of maize and soybeans in the Cerrados has caused this kind of erosion problem, caused compaction and therefore water accumulation on the soil. And it has dealt to losses of soil organic matter in the more sandy soils of up to 80% and in the more clay soils of about 41%.

Now, here is another set of data. These are data sets from Brazilian colleagues that have worked with these. Now, the other part of the story is that almost a quarter century ago, the first experiments in the Cerrado were done on minimum tillage. And you can see how the loss of organic matter has taken a turn for the better in this experiment where conventional land use showed substantial losses of organic matter over time, over 22 years, and you can see that in the zero tillage systems there was actually an increase in the organic matter... of organic matter in the soil.

And so it is possible to take these lands, even in intensive agricultural systems, and make something out of it. You can see that the minimum tillage story has been a success story in a relatively short period of time. Between 1980 and 1999 it went to 9 million hectares of land that are now under minimum tillage. And we have just heard from the FAO that a similar story is unfolding in South and Southeast Asia. This does come as a surprise, and we have to be willing to accept that. You can see here in the bottom corner that minimum tillage cannot be done without some form of weed control, and so the use of herbicides has drastically increased in the Cerrado.

The other part of the story is that the Cerrado as a whole – and this is the best calculation that we could do; the data is not really aggregated for the Cerrado as such – but according to our calculations, the input of nutrients exceeds the output of nutrients in terms of export of products. And so an input of about 2.9 million tons of NPNK are only partially offset by an off-farm transportation of about 1.1 million tons per hectare.

The moral of the story is, yes, lands and soils are difficult to manage, but there are possibilities of managing them, and if it's done well, it can be beneficial to the nation, to the farmers.

I would like to finish with three slides that I took from Eric Davidson, a friend of mine who wrote a little booklet that says, "You Cannot Eat GNP." And he shows that the way we look at soils, as ecologists, agricultural scientists, we look at soils as the basis for our existence – it's the place of support for our plant community, which harbor..., and of course wheat eventually then lives.

Now, I work with economists in our center. It was said earlier we are a multi-disciplinary center. The economists' view of soils in their pyramid is quite different. The soils are just one of many production factors, and it is a relatively small part of the way they look at soils. In the end, it's one of the production factors that is a means to an end, and the end is, get a product to market. That's quite different than the way we look at it as ecologists.

And so the proposal of Eric Davidson is that we should probably try to get the economies captured within the ecological framework, and that's the picture shown here. That shows that the economies and their marketing strategies are only one of the users of our soils and that we cannot allow them for their ends to use these resources that should serve many, many generations to come. And we should be very, very much aware of the fact that soils are breaking away from the basis of the experiments and may eventually break away to the point where the economists are anchoring their triangles, their pyramids, upside-down pyramids. And that may then indeed affect the market.

Thank you very much for your attention.