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# Climate Smart Agriculture, Loss of Biodiversity and the Uncertainties brought by Climate Change

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Recording Link: <https://youtu.be/8VJLwMoWx4U>

## Questions and Answers

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**1) What are the main causes of climate change in agriculture in paddy fields?**

Here you can find some ideas relative to rice and CSA <http://www.fao.org/climate-smart-agriculture-sourcebook/production-resources/module-b1-crops/chapter-b1-3/en/>.

**2) How can we practice Agriculture and realize maximum produce for the population without affecting the environment or climate negatively?**

The recent State of the World's Biodiversity for Food and Agriculture (SoWBFA), prepared by the Secretariat of the FAO Commission on Genetic Resources for Food and Agriculture reported that, to increase the sustainability of agriculture practices, a number of countries implemented several "biodiversity-friendly" practices. These are listed in the Report. These practices are also in line with those identified through the Climate Smart Agriculture approach.

The SoWBFA can be seen here <http://www.fao.org/state-of-biodiversity-for-food-agriculture/en/>

**3) Novel Corona Virus, albeit mutant, has increased biodiversity and its positive impact is seen on the environment, no pollution, cleaner rivers, clearer atmosphere. Should we see a positive impact of this deadly virus?**

There are still no studies that could confirm and even assess such a positive trend, so this response is provided only on the basis of a general speculation. It seems that the lockdown imposed by the pandemics has had some positive impact on the environment and on the reduction of carbon emissions. Clearly, the human loss has been dramatic and there is no way that one can positively consider this pandemic. On the other hand, from this experience we may be able to learn something on the level of commitment is needed to better protect our biodiversity as well as the timing needed to start appreciating some recovery.

**4) Do integrated farming systems help in biodiversity conservation?**

Yes. There has been a number of FAO project in the past years where the co-benefits from integrated approaches can increase the economic returns for farmers and be more biodiversity friendly. A well-documented example is the Kagera project that could be seen here: <http://www.fao.org/in-action/kagera/home/en/>

**5) Is it possible that the loss on biodiversity is not caused by climate change directly but also the combination of pest and plant pathogen also change because the climate change.**

Yes. Climate change, in most cases, is one of the drivers that affect biodiversity. One of the key elements making climate change so difficult to address is the difficulty to foresee what its impact will be. Climate change affects everything, biotic and a-biotic elements, with unexpected outcomes. Just to give you an example, the climate of the next ten years may come out to be more favourable for certain pests, but we cannot predict it with any



level of certainty. So, to keep the same example, losing a species to a pest may be the indirect result of climate change.

As we said, drivers of biodiversity loss are very much interrelated among them.

- 6) As always, we have meagre resources to invest in biodiversity conservation, climate change and CSA, land degradation, desertification control, etc. We therefore thinly distribute the budget. However, if we invest whatever resources we have in increasing the vegetative cover or forest cover of our planet, is it not a better way to address a number of issues in an integrated manner, be it soil erosion, land degradation, biodiversity loss, climate change through carbon sequestration, agricultural productivity, etc?**

Indeed, improving land cover is one way to address biodiversity loss and ecosystem degradation. One of the several ways for which finance is needed.

It is important, however, not to oversimplify the problem as this approach will not necessarily address the issue. Leaving aside the issue that marine and freshwater ecosystem will not be targeted by such measures, there are also several terrestrial areas where such approach would not be sufficient. There are areas where the soil has been polluted, salinized, depleted which should be restored through very specific and knowledge-intensive methods. In addition, without addressing the root causes of biodiversity loss and ecosystem degradation, which are often social and economic, it is normally not guaranteed that any restoration programme is sustainable in the long term.

- 7) How will conservation agriculture help in climate smart agriculture? and which new approach will be integrated with CSA?**

<http://www.fao.org/climate-smart-agriculture/knowledge/practices/crop-production/en/> and <http://www.fao.org/conservation-agriculture/en/>

- 8) What are the effects of modern farming on biodiversity and how can these effects be controlled?**

I believe with “modern farming” you are referring to intensive farming practices. These are normally considered unsustainable from the environment point of view, they are generally non resilient to climate change and have several social and economic drawbacks. I believe, this is not an FAO statement, that the most effective way to control these practices would pass through improved knowledge on their real contribution to food security, their impact on the environment and socio economy. Then awareness needs to be raised and policy improved. Finally, incentives should be identified to move to sustainable practices.

- 9) Is there any sound logical framework that speaks to biodiversity for food and agriculture?**



I believe that this is what the work of the Commission on Genetic Resources for Food and Agriculture is working towards. I would suggest you follow their works to know more.

**10) Small-scale farmers in sub-Saharan Africa are the most hit by climate change. These farmers contribute significantly to food security, but faced with challenges live low adaptive capacity due to poverty, land tenure etc. all these has accelerated the degradation of biodiversity. What measures can be put in place to mitigate these challenges.**

A number of measures can be put in place to address this issue. The Climate Smart Agriculture is an approach that can be adapted on specific situations to support farmers coping with climate change. While on the one hand technology and improved knowledge are essential to support farmers improving their adaptive capacity and the resilience of their practices, on the other hand traditional systems often prove extremely useful as well.

It is important not to believe that all situations are the same, or even similar. Supporting farmers needs a clear understanding of the actual problems, which are normally a set of interrelated social, economic and environmental problems. Every time the “cocktail” of problems, and the consequent approach to be adopted, has a different recipe.

In any case, experience tells us that social, economic and environmental issues go hand-in-hand, they are all hit by climate change and solutions need to be found balancing a mix of measures.

**11) Climate change being mostly felt in the sub-Saharan Africa, smallholder farmer tend to look for new livelihood to sustain their live and these include illegal mining. What do you say on the illegal mining because these has an indirect impact on reducing land for agriculture?**

Illegal mining is an important issue in some region of the world. However, this issue is not just impacting on agricultural land and, in fact, on biodiversity and the ecosystems. I believe that the socio-economic impact of these practices is even most important.

**12) Will rising CO2 levels really boost plant growth?**

I am not informed about this; I think that there are studies you can look at. However, what we do know, is that plant growth adsorbs CO2 and plants represent an important long term storage for huge quantities of carbon.

**13) Which kind of climate change affect the crop yield most. And as an agriculturist which care should be taken by me to avoid such stresses on plants?**

It is extremely difficult to respond. Possibly temperature, seasonal distribution of water, duration and intensity of insolation and number and strength of extreme events, may



be the most important. However, this list can change according to the regions, the production systems, the seasonality of productions and several other variables.

Just to give an example, wind could become a key threat as it could break the fruit from the plants before it is ripe. Also, it is difficult to foresee what would be the impact of climate change to pests and diseases.

#### 14) Do you think that biodiversity could affect postharvest behaviour of fruit and vegetable crops?

We still know very little but possibly yes. There are studies on the importance of pollination highlighting that the more diverse the pollinator species, possibly including wild bees and other species, the better the quality of the fruit.

#### 15) We have been talking about Grow More Food since last couple of centuries. How Climate Smart Agriculture is different from earlier method as under CSA also people are still talking about More Crop/Yield etc. We know that every year we are throwing more than million tonnes of food (waste).

CSA - which is an integrated approach based on increasing resilience throughout the value chain, improving nutrition and mitigating climate change - can lead to reduce food losses in particular by:

- Increasing the **resilience of smallholders** (i.e by adopting technologies which lessen vulnerability to price fluctuations on local markets and maintain the quality of the grains or by improving processing techniques so that the quality of food can be maintained or enhanced).
- This would additionally lead to **improving food availability**. Food systems need to be made more resilient to prevent an erosion of nutrient quality along the supply chain. This in turn would promote and enable more diverse dietary choices, enhancing the resilience of the population as nutrient rich foods are generally in short supply in low income settings (Global Panel, 2015).
- Contributing towards **mitigating climate change and in creating Climate Resilient Food Systems** (extreme weather events could damage both roads and other facilities used throughout the post-harvest and post-production stages of food value chains)
- Contributing towards the promotion of efficient use of resources (e.g. fertilizers, water, and energy)
- Providing the **opportunity for countries to innovate and secure policy environment**, as well as technical and financial conditions necessary to sustainably increase agricultural productivity and incomes.

CSA and the reduction of food loss mutually reinforce a food systems approach and pursue efficiency and resilience in tandem. Resilience without efficiency and improved productivity can in fact pose problems for food security in the long term (Global Panel, 2015).





**16) How does loss of biodiversity contribute to zoonosis diseases like COVID-19?**

Difficult to say how “loss” of biodiversity contributes to spill over of viruses to humans. However, the most recent zoonoses all arose from “bad management practices” of either wildlife or livestock.

**17) Mr. Luchetti, there is a trade off between the need of food sources by introducing hybrid varieties and the conservation of genetic resources. What is your opinion on this matter?**

It is a complex issue. Humans started working on the genetic pool of crops and animal since millennia, and this is what farmers and pastors have continued doing throughout the world. The work of FAO, and especially the Commission on Genetic Resources for Food and Agriculture, has been advancing knowledge on this topic and has supported countries and farmers improving their policy and practices to better capture the benefits of genetic resources and avoid risks.

In general, my opinion is that knowledge on genetic resources is a key element of coping with future challenges, including climate change. You may be interested in reading the publication Coping with climate change – the roles of genetic resources for food and agriculture (<http://www.fao.org/3/a-i3866e.pdf>), which contains interesting information on this topic.

**18) How does indigenous trees improve biodiversity as compared to exotic?**

Indigenous trees are normally better adapted to local conditions and support local biodiversity, including for instance the insects important as pest predators, soil biodiversity, birds etc. Biodiversity should be seen as a sort of web in which every part can be of relevance for the whole system. There are redundancies, i.e. species that could be lost without appreciating an important change to the ecosystem; however, there are species (called keystone species) the loss of which could cause important changes to the whole functionality of the system. Unfortunately, it not easy, if at all possible, to identify a priori what species is keystone and which one is “redundant”.

Using non autochthonous species, allochthonous or “alien”, even if not invasive, normally do not support local biodiversity. Still, allochthonous species are often used as they grow faster or have other characteristics required by the market or by other stakeholders.

**19) Can you explain more the approach of climate smart agriculture?**

Please to see this link with a video <https://www.youtube.com/watch?v=IUdNMsvDIZ0> and this e-learning course <https://elearning.fao.org/course/view.php?id=439>

**20) The use of pesticides and insecticides is one of the main causes of loss of biodiversity. What can we do to stop those powerful people in the world who produce those pesticides and insecticides?**

The problem is not the “use” of these chemical products but the “unsustainable use”. I believe we should put more energy in understanding how chemistry can help agriculture



and biodiversity. For instance, if chemical products could be shaped and managed to support soil biodiversity and, as a consequence, fertility and pest management, this could be an advantage. Agroecology aims at developing sustainable cropping systems that harness biodiversity and biotic interactions with low use of chemical inputs.

**21) Don't you think that the introduction and promotion of GMO crops to developing countries is also one of the factors for the loss of crop genetic diversity/genetic resources?**

Crop genetic resources are lost for several reasons. One of these reasons, as we said during the presentation, is the lack of use of such resources. There are several reasons for which the use of some genetic resources is lost or strongly reduced and GMO is not the only one. I believe that replacement with GMOs is not even the most common reason for the lack of use of other genetic resources. However,, I am not fully updated on this topic.

**22) What is the stand/position of FAO with regards to the cultivation of GMOs in developing countries?**

I believe that countries never developed a FAO position on this.

**23) CSA is not universally applicable?**

Considering soil sustainability, Conservation Agriculture under CSA approach can be, should be applicable universally. It is universally applicable but it is also context specific, so practices must be chosen keeping in mind the local situation.

**24) While adapting climate smart agriculture, the aspect of sustainable water use is important right?**

Sure. See this document for examples: <http://www.fao.org/3/CA1726EN/ca1726en.pdf>

**25) Is there a direct link between indigenous tree and climate change mitigation?**

There is a link between growing trees (indigenous or not) and carbon sequestration. Forests made of indigenous species would last longer, grow more and would support a richer and more stable ecosystem. This, in the long run, would be more beneficial also for carbon sequestration.

However, most natural environment sequester carbon (including the open ocean). This means that improving the health of ecosystems would normally have positive repercussions on climate change mitigation.

**26) I think biodiversity is very important, but most people are not concerned about it, they say that money is important, so they focus on some the specific crop which have good economic value and it induce the loss biodiversity, so what you think about this problem.**

It is a problem that we try to address also by increasing awareness of the importance of biodiversity.



For instance, the CSA approach proposes management measures that increase biodiversity in fields and in rangelands. Croplands containing more diversified genetic plants would be more resilient to a wide variety of stresses. Single variety croplands, on the contrary, could be completely lost in the case such one variety cannot cope with a certain stress.

**27) What is the best methods to measure farmer's knowledge regarding climate smart agriculture practices?**

There are many participatory approaches to be used. again, it depends of the situation.

**28) The panellists discussed about programs and support development on the agricultural activities. You mentioned about climate change as one of the key challenges. Isn't it important that conflict zones be resolved because wars destroys land and soil. isn't it important for this international institution like FAO to work with the United Nations Peace keeping operations and security council of the UN to take serious actions on resolving conflict zones where lands may become useless for farming. would you agree? Lastly, in the context of international relations, transnational corporations such as those Agricultural focused should plays a key role in promoting development and support for farmers. TNCs such as OLAM or AGT have supported the development of agricultural sector and upholding food security. Don't you think TNCs plays a key role in this 21st century where the state has failed in the international arena?**

The overall framework within which FAO, and all the UN, operates is the 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT and of course peace, dialogue and leave no one behind are the fundamental elements of all our work.

**29) I belong to Quechua nation inside plurinational state of Bolivia, we as indigenous peoples of the world, we are preserving biodiversity not only for small farming and survival, but what is really important as well is our ancestral medicine. Inside our cosmovision of health, there is the respect for Mother Earth, so preserving biodiversity is a priority for our cultural survival as well. Ancestral medicine is taking care of our communities during this pandemic crisis. We need forest and biodiversity to heal and survive as indigenous peoples of the world. Is FAO working with this intercultural view?**

This is very interesting and very relevant. Part of our work on biodiversity also include increasing understanding on and awareness of the different services that biodiversity provides to humans. From the more material ones to the cultural and spiritual ones. You may wish to look at the work of FAO on ecosystem services at <http://www.fao.org/ecosystem-services-biodiversity/en/>.

**30) What are the propositions for pastoral livestock systems?**

Difficult to summarize here. I suggest you look at the work on animal genetic resources of the Commission on Genetic Resources. They have done very relevant work on this. You can start from looking at the Pastoralists Knowledge Hub which collects studies and





information and is continuously updated. You can also register and participate in discussions. See it here <http://www.fao.org/pastoralist-knowledge-hub/en/>.

### **31) What is the role IPM on climate smart agriculture?**

Please to read this document <http://www.fao.org/3/BU464EN/bu464en.pdf> and <http://www.fao.org/climate-smart-agriculture-sourcebook/production-resources/module-b1-crops/chapter-b1-2/en/>

### **32) How does CSA distinguishes from Agroecology?**

As far as I know, most of the CSA practices showcased, are also agroecological practices. Agroecology applies ecological concepts and principles to farming systems (HLPE, 2016). Through its focus on the interactions between plants, animals, and the environment, and the integration of the different agricultural sectors, it fosters sustainable agricultural development, which in turn ensures food security and nutrition. Agroecology goes beyond input use efficiency and input substitution. It harnesses key ecological processes, such as natural pest predation and the recycling of biomass and nutrients, to enhance the beneficial biological interactions and synergies among the components of agricultural biodiversity. Agroecological principles, as defined by Nicholls, Altieri and Vazquez (2016), are particularly important for climate change adaptation. Agroecology does not promote a fixed set of farming practices or technologies. It stresses the importance of the specificity of local environmental conditions, and posits that local farming communities are best placed for identifying functional ecological strategies to improve farming systems. Agroecology was initially focused on building knowledge on the use and value of ecosystem services in agriculture, even though the term 'ecosystem services' was not in use at that time. Agroecology is by nature climate-smart, as it contributes to the three objectives of climate-smart agriculture. Many climate smart projects are implementing practices based on agroecological principles.

### **33) What do you think about the production system that integrates crops, livestock and forest?? Here in Brazil it has been showing very good results**

Yes. There has been a number of FAO project in the past years where the co-benefits from integrated approaches can increase the economic returns for farmers and be more biodiversity friendly. A well-documented example is the Kagera project that could be seen here <http://www.fao.org/in-action/kagera/home/en/>.

### **34) Is there a same approach about climate-small Agriculture for every country?**

The approach is the same but it context specific, for example, in some cases mitigation cannot have the same importance of other two, sustainable productivity and adaptation because the country doesn't have a lot of emissions. In any case, it is important when government starts produce and design strategies on CC and agriculture to take also in consideration mitigation approaches.

### **35) Is there a same approach about climate-small Agriculture for every country?**



The approach is the same but it is context specific and interventions are determined through social, economic and environmental conditions where it will be applied. Scaling CSA requires knowledge, an enabling policy environment, and accountability for impact. Putting all these elements in place requires the engagement and commitment of all key stakeholders, including governments, farmers' organizations, national and international civil society organizations, the private sector, research institutions, and international and inter-governmental bodies. In addition, in some cases mitigation cannot have the same importance of other two, sustainable productivity and adaptation because the country doesn't have a lot of emissions. In any case, it is important when government starts produce and design strategies on CC and agriculture to take also in consideration mitigation approaches.

**36) In sub-Saharan African countries like Ethiopia, food insecurity is a challenge so especially in crop production inorganic agricultural inputs are becoming danger and degrading the bio diversity, What are the solutions for this.**

There is no silver bullet that can address such issues. As we said in the presentation, when ecosystem degradation affects agriculture and livelihood, we need to start from restoring the ecosystem health and supporting farmers increasing the sustainability of their practices. There is a need to establish a virtual process that continues in the long term.

**37) Breeding program is still based on to how to generate superior varieties, which narrow the genetic diversity. How to avoid to much losing genetic materials that was abandoned because people tend to cultivate those superior varieties. What kind of strategies to preserve those abandon genetic materials especially on developing countries where the funding on conservation sector quite low.**

FAO does not support the use "super varieties" to address challenges. Use of diversity proved more effective to cope with unforeseen changes of all types, not only on climate. As we said above, using crops or breeds with a diverse genetic pool would help cope with the different unexpected stress that climate change could cause. The so called super varieties could be extremely performant in some cases but since climate change is hardly foreseeable, then using the super variety becomes extremely risky.

*Philippe Lemanceau:* There is a research trend aiming at identifying plant traits mediating plant microbe-interactions that promote plant growth, nutrition and health. It has been hypothesised that some of these traits may have been lost during plant breeding programs mostly targeting yield level. Research is ongoing to test that hypothesis by comparing microbiota associated with ancestral plant genotypes and modern cultivars (e.g. Perez-Jaramillo et al. 2019. DOI: 10.1186/s40168-019-0727-1; Perez-Jaramillo et al. 2016. DOI: 10.1007/s11103-015-0337-7)

**38) I would like to know is climate smart agroforestry concept is being implemented by FAO in other parts of world especially developing countries**

FAO is developing agroforestry in other part of the world, one example in Ecuador.



**39) I would like to know is climate smart agroforestry concept is being implemented by FAO in other parts of world especially developing countries**

FAO is developing agroforestry in other part of the world, one example in Ecuador. The project focuses on cocoa planted in the Amazon chakra which is an agroforestry system (chakra), characterized by the sustainable use of biodiversity and adaptation to adverse productive conditions, it is also essential for culture of the Kichwa people. Below the outcomes:

- Cocoa quality and business capacities strengthened (certification, cadmium traceability, carbon sequestration and market opportunity, financial strategy for farmers)
- Cocoa biodiversity conservation implemented (local cocoa varieties-white cocoa, local gardens-conservation of genetic diversity of cocoa)
- Capacities for CSA implementation and carbon sequestration measurement enhanced (train farmers on CSA, extension services on carbon sequestration and cc-agr, , e-learning course)

**40) Please throw more light on strategies to reduce greenhouse gas emissions from livestock.**

<http://www.fao.org/climate-smart-agriculture-sourcebook/production-resources/module-b2-livestock/b2-overview/en/>

**41) Could you say more about what specific policy frameworks will be most helpful in achieving climate and biodiversity objectives?**

If one could be very specific on this, we would not have the problem. I think that there is still no definitive answer to this question.

**42) When we say improving biodiversity, do we mean soil biodiversity, plant biodiversity, or both? Currently, the focus seems more on plant biodiversity. How can we improve soil biodiversity under climate change?**

The major drivers of soil biodiversity are the soil physic-chemical properties. Having said that, for a given soil type, soil biodiversity is related to plant biodiversity. Soil microbiota multiplication and activities rely on organic compounds provided by plants. Composition of plant residues and rhizodeposits varies among plant genotypes, in such way that a higher plant diversity leads to a higher microbial diversity. This means that all agricultural practices increasing plant diversity (crop associations, agroforestry, crop rotation) promote soil biodiversity.

**43) What about the evidence base side of CSA? This has not been much addressed. Isn't it necessary to program activities based on updated climate data?**

Evidence base is the first step of CSA. you are right with it this we cannot understand the situation



**44) Did you consider including edible insects in any of your solution sets? They are an important part of diets in many countries, and have a very low environmental footprint. From a nutrition standpoint, they are a good source of complete proteins.**

Yes, it depends on the context specific situation. if they are considered by the population and are good for CC and agriculture, it is a good solution

**45) What about the evidence base side of CSA? This has not been much addressed. Isn't it necessary to program activities based on updated climate data?**

Evidence base is the first step of CSA. you are right with it this we cannot understand the situation. Given the importance of growth in the agricultural sector for food security and the major impacts climate change is already having on agricultural growth strategies, the first step in implementing a climate-smart agriculture approach is to develop a robust evidence base. The purpose of this step is to formulate strategies for increasing productivity and agricultural incomes, and estimate their potential mitigation co-benefits. An important part of building the climate-smart agriculture evidence base involves determining the current and projected effects of climate change on specific agricultural production systems and producers in the near and medium term, and pinpointing key vulnerabilities in the agricultural sectors and for food security. Another major component in developing the evidence base is the identification and evaluation of potential climate-smart options for adapting to the expected impacts of climate change while at the same time supporting sustainable agricultural development. These activities need to use economic and social criteria that are in line with national food security and development objectives. In making the initial assessment, consideration needs to be given to the potential synergies and trade-offs for the proposed climate-smart agriculture interventions relative to the baseline activities. The final piece in the construction of a robust evidence base is determining the institutional and financing needs that must be met to implement the priority actions. This includes estimating the costs and barriers to the adoption of different practices, identifying issues related to the sustainability of production systems and preparing the required policy and institutional responses. Both analytical work and stakeholder consultations are needed to build the evidence base. The process also needs to recognize various points of view and take into account uncertainty, as there are still many unknowns about the impacts climate change will have on agriculture, particularly in local settings. (Source CSA sourcebook. <http://www.fao.org/climate-smart-agriculture-sourcebook/concept/module-a1-introducing-csa/chapter-a1-2/en/>)

**46) Did you consider including edible insects in any of your solution sets? They are an important part of diets in many countries, and have a very low environmental footprint. From a nutrition standpoint, they are a good source of complete proteins.**

Yes, it depends on the context specific situation. if they are considered by the population and are good for CC and agriculture, it is a good solution.



**47) How do you address gender inclusion in the 5-action process? If taken into considerations, what are the proposed actions to ensure nobody is left behind or is more vulnerable with the impacts of climate change?**

<http://www.fao.org/3/a-i5546e.pdf> and <http://www.fao.org/climate-smart-agriculture-sourcebook/enabling-frameworks/module-c6-gender/c6-overview/en/>

**48) How will this approach be articulated or aligned in Europe with the strategy published last week "from the farm to the table" within the EU Green Deal? Can Europe take the lead in the CSA and be followed by the rest of the countries?**

[https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/farm-fork\\_en](https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/farm-fork_en)

**49) We all know the effect of use of chemical fertilizers in environment. What can be CSA approach to improve nutrient contents?**

The goal for both CSA and soil fertility is to complete the natural cycle loops especially C and N loops. Reducing emission of N<sub>2</sub>O from soil is beneficial both for climate mitigation and soil fertility (reduction of N losses). However, trade-offs may occur, indeed organic matter mineralisation contributes to plant nutrition but leads to CO<sub>2</sub> emission. Agricultural practices aim at minimising organic matter mineralisation only when plants require nutrients to balance the environmental cost of CO<sub>2</sub> emissions.

**50) What is meta community? What does it include?**

A metacommunity is a set of interacting communities, knowing that a community is a group of microbial populations that share a common living space.

**51) Can we improve soil biodiversity by using beneficial microorganisms?**

Inoculation of microbial strains may provide beneficial effects to the host plant (e.g. Rhizobia on legumes) but does not modify per se microbial diversity. Current studies are assessing the possibility of introducing selected microbial communities which could for a while contribute to the rhizosphere biodiversity of the inoculated plants.

**52) How does soil biodiversity affects food and nutrition?**

There is an increasing literature on how soil microorganisms could contribute to the so-called plant biofortification (i.e. increase nutritional value of plants). During the presentation, example has been given on the impact of bacterial siderophores on plant iron content. For review Singh 2020. DOI: 10.1007/s13593-020-00619-2; Lemanceau et al. 2009. DOI: 10.1016/S0065-2296(09)51012-9 .

**53) In the presentation of Mr. Lemanceau, I had some problems understanding relations between biodiversity and functioning. Can you provide more clarifications?**

The relation between biodiversity and functions relate to the functions expressed by a range of organisms in a given environment. For some functions, it is possible to identify the genetic potential of the organisms to express these functions when the genes





encoding the corresponding activities are known. As an example, *nosZ* gene encoding the enzyme reducing N<sub>2</sub>O in N<sub>2</sub> is distributed in different populations representing thus a functional community. The wider is the distribution of a given functional gene in microbial populations, the higher will be the expression potential of the corresponding function in a large range of environmental situations.

#### **54) What are Rhizodeposits?**

Rhizodeposits are made of all material lost from plant roots, including water-soluble exudates, secretions of insoluble materials, lysates, dead fine roots, and gases (for review see Nguyen. Rhizodeposition of organic C by plants: mechanisms and controls. *Agronomie, EDP Sciences*, 2003, 23 (5-6), pp.375-396. 10.1051/agro:2003011). Rhizodeposits represent a major organic matter release for heterotroph microorganisms in the rhizosphere where their abundance and activities are consequently promoted.

#### **55) Why nitrogen fixation is considered as an agroecology? This is the ancient biological process used as a good agronomic practice through seed inoculation**

You are fully right nitrogen fixation has been known and applied for long. In agroecology, we are developing research to increase the performance of this process by better valuing plant and microbial diversity (cf. slide 7) and to value the corresponding nitrogen input for associated crops (cf. slide 18).

#### **56) I would like to know your views what kind of impact would be on soil biodiversity, if fertilizer efficient plants are developed by biotech ways.**

In the line of your question, it has for example been proposed to select plant genotypes that repress nitrifying microbial communities to avoid potential NO<sub>3</sub>- leaching et N<sub>2</sub>O emission (for review Hallin & Philippot. 2011. <https://doi.org/10.1016/j.tplants.2011.05.007>).

#### **57) Has FAO supported Native Animal Genetic resources conservation for food production anywhere?**

Yes, for instance through the implementation of the Funding Strategy for Animal Genetic Resources for Food and Agriculture. You can learn more here <http://www.fao.org/animal-genetics/global-policy/funding-strategy/en/>.

#### **58) In Indonesia, the loss of biodiversity has reached crisis levels. The main causes of agrarian conflict included recognition and minimal protection of community rights, seizure of arbitrary land, and boundary disputes. How to improve standard of living of small farmers, sustainable agriculture to help biodiversity in this condition?**

It is always very difficult to address these complex and interrelated issues. A recent approach that FAO is developing is that of Integrated Landscape and Territorial



Approach, which addresses social, economic and environmental issues at the same time. You can learn more on this here <http://www.fao.org/3/i8324en/i8324en.pdf>.

The issue of land, in addition, is extremely relevant and sensitive. FAO has developed a very powerful tool on this called Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security that you can find here <http://www.fao.org/policy-support/mechanisms/mechanisms-details/en/c/448858/>.

**59) How to balance need for higher productivity /production vs climate adaptability of local animal genetic resources?**

There is no silver bullet. It always needs to be analysed case-by-case. However, normally, the more sustainable practices, and the use of local breeds, can help matching productivity and adaptability in a balanced way and in the long term.

**60) How do you see pesticides on the effect of ecology and in food security as well as human health?**

Chemicals could in fact be used in a positive way. We need to do more work to understand how to use chemicals in a sustainable way and increase awareness of the risks arising from the unsustainable use of chemicals.

*Philippe Lemanceau:* Although, pesticides are not excluded in agroecology, their use is limited as much as possible to best promote and harness biodiversity and biotic interactions-regulations. However, pesticides may be needed especially for product storage to avoid spoilage.

**61) Most farmers use chemical fertilizers to improve nutrients contents, what can be the climate smart agriculture to improve them and hence avoid the use of chemical ones?**

Chemicals could in fact be used in a positive way. We need to do more work to understand how to use chemicals in a sustainable way and increase awareness of the risks arising from the unsustainable use of chemicals.

**62) What kind of impact do you see on the use of herbicides in agriculture with respect to soil biodiversity?**

There are a series of papers on this topic, you may as an example the following Clémence Thiour-Mauprivez et al. 2019. Science of the Total Environment 684 (2019) 314–325.

**63) Indigenous trees take time to grow and be beneficial to the community, for community to adapt the concept of reforestation of indigenous trees needs alternative economic activities to substitute deforestation. Which concept should be taken into account to take care of that?**

There is no one approach that could address all situations. Alternatives and good practices need to be identified locally and incentives should be provided for their implementation and adoption.



**64) I think FAO must do well to educate smallholder farmers through Extension Officers in developing countries on smart Agriculture because truth be told majority of them have no idea.**

FAO does a lot of work on this. The programme called Farmers Field School, for instance, is active in many countries and works with farmers to identify and adopt improved practices, adapted to their local reality and their socio economic situation.

See this compendium: <http://www.fao.org/3/a-bl361e.pdf>

**65) Minimum tillage is good for drought resilience - any ideas on how to manage the apparent higher nitrous oxide emissions while still benefitting from this resilience?**

There is unfortunately not a generic reply. It depends on the soil properties but also where we place the cursor between the two constraints. So, the question that you raise should probably be addressed locally tacking in consideration the local environment and trade-offs.

**66) Please explain what are biotic and abiotic factor affect the soil microorganism and what kind of microorganisms which influences soil productivity and food quality. How can interact the Fe in soil influence the As in soil solution in paddy field.**

Major abiotic parameter impacting soil biomass and biodiversity is the pH but there are others (see Ranjard et al. 2013. Nature Communications <https://doi.org/10.1038/ncomms2431>; Fierer, N. Nature Reviews Microbiology, 15, 579-590. <https://doi.org/10.1038/nrmic.ro.2017.87>). As indicated, a major biotic driver of soil biodiversity is plant biodiversity and thus the land use. There are all a series of microorganisms influencing soil productivity and food quality, some of them have been presented during the webinar (see review Lemanceau et al. 2015. DOI: 10.1007/s13593-014-0247-0)

**67) People are heard saying Climate smart Agriculture works against conserving biodiversity. Is that true?**

Obviously not.

**68) Mitigating climate change, should we focus on conservation of indigenous biodiversity which have low production but resistant to diseases, or should go for improved exotic breed.**

Generally, the use of exotic organisms is not suggested. However, every case may be worth a separate analysis.

**69) Tillage: the trade-off between pesticide use and greenhouse gas emission is to use mechanical weeding with very limited tillage (only when necessary). Is it correct? What do you mean with necessary?**

In slide 26, the effect of integrated weed management in cropping systems on N<sub>2</sub>O emissions from soils is compared. In system S3, the treatment frequency index is



decreased and tillage allowed when necessary (meaning when weed development does not remain under control). For further information, you may read the corresponding paper Vermue et al. 2016. DOI 10.1007/s13593-016-0381-y.

**70) What is the likelihood effect of COVID-19 pandemic on the biodiversity in the near future?**

I do not know and I think nobody would know.

**71) Phillippe I am interested to understand the relationship between CO2 emissions and N emissions. You said they were negatively correlated. Do you think reducing N emissions could be more important than reducing CO2 emissions in agriculture to mitigating climate gases.**

When pO<sub>2</sub> is low in soils, microorganisms, which have that ability, use nitrogen oxides as electron acceptors for their energetic metabolism rather than O<sub>2</sub> resulting in reduction of nitrogen oxides and thus to N<sub>2</sub>O and/or N<sub>a</sub> emission. N<sub>2</sub> emission is harmless for the environment since it represents the major gas present in the atmosphere, still that emission corresponds to a loss of nitrogen for the soil fertility, whereas N<sub>2</sub>O is a strong glasshouse gaz. CSA should target both an increased of C storage in soils (see 4p1000 initiative) and decrease N<sub>2</sub>O emission by finding the right agricultural practices in a given environment.

**72) Don't you think that climate change also result evolution of new genotype in the nature?**

It is difficult to take a stand on this. I personally think that the time needed to develop new genotypes, at least in more evolved organisms, is much longer than the pace of climate change. However, only time will tell.

**73) The use of pesticides and insecticides is one of the main causes of loss of biodiversity. What can we do before those powerful in the world who produce those pesticides and insecticides**

Chemicals could in fact be used in a positive way. We need to do more work to understand how to use chemicals in a sustainable way and increase awareness of the risks arising from the unsustainable use of chemicals.

**74) Question to Damiano, what would be impact on biodiversity on use of contemporary Agriculture biotechnology, which are playing key role on food security.**

Thank you for the question. There is an extremely vast range of biotechnologies that are key to food security. FAO has done a lot of work on biotechnologies and you may wish to look at this site <http://www.fao.org/biotechnology/en/>

**75) We have just finished a project on practising Conservation Agriculture (CA) relating to climate change on dryland agroecosystem in Indonesia through participatory approach. One of the remaining issues that may be addressed is how**



**CA can improve CSA and may other issues that needed to be fit with CSA.**

<http://www.fao.org/climate-smart-agriculture-sourcebook/production-resources/module-b1-crops/chapter-b1-2/en/>

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