**Mainstreaming Biodiversity in Agriculture, Fisheries and Forestry for improved Food Security and better Nutrition**

**Collection of contributions received**

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# Topic note

This online discussion will contribute to define further the objectives and partnerships of the Biodiversity Mainstreaming Platform and to advance the development of its work programme.

In 2017, FAO Members welcomed the FAO’s initiative to act as Biodiversity Mainstreaming Platform and requested the Organization to facilitate, in collaboration with its partners, the integration of actions for the conservation, sustainable use, management and restoration of biological diversity across agricultural sectors at national, regional and international levels[[1]](#footnote-1).

Being global in scope, the Platform aims to improve cross-sectoral coordination of policies and practices to mainstream biodiversity by a wide range of stakeholders. The ultimate goal of the Platform is to promote and facilitate the adoption of good practices across all agricultural sectors that will support the conservation and sustainable use and management of biodiversity and increase the productivity, stability and resilience of production systems in an integrated approach.

|  |
| --- |
| **Biodiversity and mainstreaming** Biodiversity, or biological diversity, stands for the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part. This includes diversity within species, between species and of ecosystems. Biodiversity and ecosystem services are essential in supporting agriculture in multiples ways and at all levels. These interlinkages are increasingly seen as key for livelihoods, welfare, production and development. The Global Environmental Facility Scientific and Advisory Panel has defined mainstreaming biodiversity as “the process of embedding biodiversity considerations into policies, strategies and practices of key public and private actors that impact or rely on biodiversity, so that it is conserved and sustainably and equitably used both locally and globally” . The same document notes that mainstreaming is a long-term process, a social experiment in changing the value structures of institutions and individuals with vital consequences for the natural world and the humans who rely on it. Good governance and strong institutions are key determinants of success. |

The first major activity of the Biodiversity Platform will be the organization, by the FAO and the Convention on Biological Diversity, of the Multi-stakeholder Dialogue on Biodiversity Mainstreaming across Agricultural Sectors (29-31 May 2018 – Rome, Italy).

In the weeks leading up to this meeting, we would like to invite you to help us identify areas of joint action in developing integrated approaches for the conservation and sustainable use of biodiversity.

Such approaches should aim at reducing the ecological footprint of agriculture, fisheries and forestry, and at the same time, they should allow for an increased production to meet the growing demand for nutritious, healthy food.

As we know, while biodiversity and ecosystem services are critical to agricultural sectors, including crop and livestock agriculture, forest, fisheries and aquaculture sectors, these are also major drivers of environmental change with significant impacts on biodiversity and ecosystem services. One main impact on biodiversity loss derives from the conversion of natural or semi-natural land into agricultural land uses, followed by the introduction of invasive alien species, including pests and diseases. At the same time, sustainable agriculture practices can contribute to the conservation of biodiversity, habitats and ecosystem services provision

We would therefore be grateful if you could share your insights and examples on any of the following questions. For your information, please also refer to the instruments, guidelines, tools and technical materials developed by FAO and made available in the background documents section.

1) Biodiversity is an important contributor to food security and improved nutrition. **Could you share examples/activities in your work where**

* **biodiversity is contributing in achieving food security and improved nutrition?**
* **the overuse of biodiversity compromise food security and nutrition?**

2) All agricultural sectors (crop and livestock, forestry, fisheries and aquaculture) rely on biodiversity and on the ecosystem functions and services, they underpin. At the same time, these sectors may affect biodiversity through various direct and indirect drivers. **Could you share examples/activities in your work**

* **where a (sustainable) production system played a key role for the conservation of the biodiversity surrounding it?** Please provide detailed information you may have or know of and identify the agricultural sector.
* **where a(n) (unsustainable) production system played a key role for the degradation of the biodiversity surrounding it?** Please provide detailed information you may have or know of and identify the agricultural sector.

3) Good governance, enabling frameworks, and stewardship initiatives are needed to facilitate mainstreaming of biodiversity within and across agricultural sectors.

* **Do you have any examples of such enabling factors and initiatives or the lack of it?** Examples could include Cross-sectoral land use planning; Macro-economic policy and public investment; Elimination, phasing out and reform of perverse incentives harmful to biodiversity; Product labelling and market certification schemes; Green finance and private investment or others
* **Which partners need to be involved in institutional frameworks, policies and processes for biodiversity mainstreaming to strengthen them?**

4) The importance of biodiversity for improved food security and better nutrition is not always evident to those engaged in agricultural sectors.

* **What needs to be done to increase awareness of farmers, livestock keepers, fisher folks and foresters, their organizations and the industry of the relevance of biodiversity and ecosystem services for the food and agriculture production in their sector?**
* **How can the technical and institutional capacity needed to promote sustainable agriculture and reduce the impact on biodiversity be developed?**

We thank you very much for your inputs and look forward to an engaging exchange.

Yours

Irene Hoffmann
Secretary
Commission on Genetic Resources for Food and Agriculture
FAO

and

Paulo Augusto Lourenco Dias Nunes
Natural Resources Officer
Climate, Biodiversity, Land and Water Department
FAO

# Contributions received

## Kuruppacharil V. Peter, Kerala Agricultural University, India

Biodiversity or biological diversity is wealth of any nation to be conserved, used, exchanged and future crops which are resilient to climate change are to be evolved.

The most unique feature of earth is the existence of life is its diversity. Approximately 9 million types of plants, animals and fungi inhabit the earth along with 9 billions of people.

In 1992, at the first Earth Summit in Rio de Janeiro Brazil, the vast majority of the world's nations declared that human actions are dismantling the Earth's ecosystems, eliminating genes, species and biological traits at an alarming rate. Increasing concern about dwindling biological resources led to the establishment of the Convention on Biological Diversity (CBD) in 1992.

In India measures for conservation and sustainable uses of biodiversity did not start with CBD. India has a long history of conservation and sustainable use of natural resources. The Biological Diversity Act-2002 was enacted to adopt the objectives enshrined in the United Nations Convention on Biological Diversity. The National Biodiversity Authority (NBA) was established in 2003 to implement India’s Biodiversity Act. India has a very rich reservoir of horticultural crops-fruits, vegetables, spices, medicinal and aromatic plants, plantation crops, tubers, bamboos and mushrooms.

A series BIODIVERSITY OF HORTICULTURAL CROPS now in Vol.VII was edited and published ([www.astralint.com](http://www.astralint.com)).The ICAR-NBPGR has the mandate to collect, document, describe, conserve and make available to users the genetic resources of plants.

Likewise ICAR National Bureau of Fish Genetic Resources and ICAT National Bureau of Animal Genetic Resources are established.

## John Ede, Ohaha Family Foundation, Nigeria

Most rural farmers in Nigeria are not even aware of the practice of Biodiversity, or biological diversity, primarily because the farmers practice inherited agricultural practice that seem to follow tradition, some practices that they have held unto over generations, these practices.

Trust in Biodiversity and biological diversity is a major concern among farmers, as they still believe that biodiversity or biological diversity has cultural implications from traditional belief, due to modification of the seeds and Agricultural produce.

To have them engaged in the practice of Biodiversity, or biological diversity, we need to educate them, train the, teach them, let them understand the innovation, how it has helped to increase agricultural yields in a shorter time.

## Thatchinamoorthy C, Annamalai University, India

Biodiversity is crucial to human well-being, sustainable development, and poverty reduction. Agro-biodiversity has always formed the basis for human food production systems and has provided cultural, spiritual, religious, and aesthetic value for human societies. Agro-biodiversity refers to all crops and animals, their wild relatives, and the species that interact with and support these species. It includes the variety and variability of living organisms that contribute to food and agriculture in the broadest sense. As such, these species would usually be considered under the term agro-biodiversity. The importance of various components of agricultural biodiversity and the contribution they make to sustainable production, livelihoods, and ecosystem health are now widely appreciated. Improved management and use of diversity for production necessary, fortunately, awareness of the need for sustainable agricultural production has increased, in response to the unprecedented population growth, food demand, and regionally high per capita use of natural resources and global environmental change that is now occurring. The focus is shifting to a greater reliance on ecological goods and services, which is especially important for modern intensive agriculture since there will be less-damaging effects on environmental quality and on the biodiversity of wildlands. Conservation of existing biodiversity in agricultural landscapes and the adoption of biodiversity-based practices have been proposed as ways to increase the sustainability of agricultural production.

Biodiversity is key to food security and nutrition. It is needed to sustainably produce enough nutritious food in the face of challenges, such as climate change and growing populations with changing diets. Production should address not only the quantity of food or calories but high nutrient values such as vitamins, minerals, and other micronutrients as well. In agricultural ecosystems, maintenance of biological diversity is important both for food production and to conserve the ecological foundations necessary to sustain life and rural livelihoods. Agriculture is a major user of biodiversity but also has the potential to contribute to the protection of biodiversity. Occupying more than one-third of the land in most countries of the world, if managed sustainably, agriculture can contribute to important ecosystem functions. These include maintenance of water quality, erosion control, biological pest control and pollination.

 Both native and exotic plants sp. are valuable in biodiversity conservation but native plants sp. Due to modernization all, our natural and agricultural resources have been depleted rapidly. Concrete extension efforts are needed to conserve biodiversity especially in agriculture and other fields. Agriculture extension personnel need to be trained in this field is the need of the hour. We can conserve our biodiversity through planting more plants or by conserving the existing plant through, community seed bank, educating women about the importance of biodiversity conservation, strict enforcement of various laws related to biodiversity.

## Samantha Farquhar, University of Washington, United States of America

***In response to:***

**Could you share examples/activities in your work where biodiversity is contributing in achieving food security and improved nutrition? And the overuse of biodiversity compromise food security and nutrition?**

One of the most popular tools for marine biodiversity has been marine protected areas (MPAs). However, much debate surrounds MPAs and their impacts on social issues such as food security. I recently read a paper that discusses this issue at length. Kamat and Kinshella (2018) investigated the effects of MPAs on food security by highlighting various cases. They showed that in some cases food security improved but in others decreased. Then the authors introduced their own case from Tanzania. They concluded that food security is such a multifaceted issue and varies from location to location. Thus, MPAs should be considered on a case by case basis when trying to both conserve biodiversity and increase food security. (<https://www.ncbi.nlm.nih.gov/pubmed/29601211>)

***In response to:***

**Could you share examples/activities in your work where a (sustainable) production system played a key role for the conservation of the biodiversity surrounding it? Please provide detailed information you may have or know of and identify the agricultural sector.**

I think a great example of a sustainable production system advocating for the conservation of its surrounding biodiversity could be  pearl farming. Pearl farming is a practice dependent on pristine environmental conditions. Thus, many pearl farms work very hard to protect their surrounding waters through green energy initiatives, zero pollutant discharge, and strong enforcement.  There is some evidence to suggest that pearl farms have actually increased fish abundance in French Polynesia. (<https://www.pubfacts.com/detail/24341945/The-influence-of-pearl-oyster-farming-on-reef-fish-abundance-and-diversity-in-Ahe-French-Polynesia>)

(<https://vimeo.com/59023816>)

Additionally, another example that comes to mind is the culture of rare species for both economic and conservation purposes. For example, the sahar (Tor putitora) is a valuable indigenous fish of Nepal that is now on the endangered species list. Currently, experiments are occurring to breed sahar in ponds with some successes reported. With more research, hatcheries could be established for sahar which would promote a new industry in Nepal as well as restore local populations. (<http://aquafishcrsp.oregonstate.edu/sites/aquafishcrsp.oregonstate.edu/files/13qsd02um_fir_tr1.pdf>)

***In response to:***

**Good governance, enabling frameworks, and stewardship initiatives are needed to facilitate mainstreaming of biodiversity within and across agricultural sectors. Do you have any examples of such enabling factors and initiatives or the lack of it?**

An excellent example of good governance for mainstreaming  biodiversity is the system used to organize Locally Managed Marine Areas (LMMAs) in Madagascar. This system involves a local set of laws known as dina being determined by various villages that are party to the LMMA. Then, an elected body made up of community members are responsible for the enforcement of the dina. All permanent residents of villages within the LMMA are "de jure" members, with the right to participate in the association and benefit from its actions. Additionally, each village elects representatives that will sit on an assembly which meets frequently to stay up-to-date with the dina and discuss other happenings in the LMMA. This political set-up has allowed for consistent management and communication and consequently led to a successful LMMA with multiple uses such as: the banning of destructive fishing methods, no-take zones, mangrove and seagrass protected areas, aquaculture zones, and tourism areas.

([https://tropicalconservationscience.mongabay.com/content/v3/10-12-20\_447-472\_Andriamalala\_&\_Gardner.pdf](https://tropicalconservationscience.mongabay.com/content/v3/10-12-20_447-472_Andriamalala_%26_Gardner.pdf))

## P.C. Abhilash, Institute of Environment & Sustainable Development, Banaras Hindu University, India

Exploration and sustainable utilization of agrobiodiversity is essential for the dietary diversification and sustainable agriculture. Especially, the utilization of neglected and underutilized crops offers huge promise in fulfilling the food and nutritional requirement of the resource-poor peoples in developing world as the traditional or local varieties have better climate tolerance and adaption potential than the modern crop varieties. Moreover, they are rich in essential nutrients and can be considered as promising crops for dietary diversification (Singh et al., 2018)

<https://link.springer.com/article/10.1007/s40974-018-0091-1>

## FAO Publications

**FAO resources on biodiversity**

Here is a selection of titles proposed by FAO Publications for forum participants who would like to read more on biodiversity.

Corporate brochures

**SUSTAINABLE AGRICULTURE FOR BIODIVERSITY**

BIODIVERSITY FOR SUSTAINABLE AGRICULTURE

This booklet presents FAO’s work on mainstreaming biodiversity as a cross-cutting theme in the agriculture, fisheries and forestry sectors. It provides examples of on-the-ground activities and highlights relevant international mechanisms.
<http://www.fao.org/3/a-i6602e.pdf>

**CORPORATE BROCHURE: GLOBALLY IMPORTANT AGRICULTURAL HERITAGE SITES − GIAHS**Including a selection of photos and text, this book brings the reader on a journey through the most breath-taking agricultural landscapes around the world. These Globally Important Agricultural Heritage Systems (GIAHS) provide services to family farmers, smallholders and local communities and are home to considerable biodiversity.
<http://www.fao.org/3/I9187EN/i9187en.pdf>

Flagships

**STATE OF THE WORLD’S FORESTS 2016**
This report covers the status of forests, policy and institutional developments and other key issues concerning the forest sector. It shares current, reliable and relevant information to facilitate informed discussion and decision-making.
<http://www.fao.org/3/a-i5588e.pdf>

**THE STATE OF WORLD FISHERIES AND AQUACULTURE 2016**
This publication gives a global analysis of trends in fish stocks, production, processing, utilization, trade and consumption. It reports on the status of the world’s fishing fleets and analyses human engagement in the sector.
<http://www.fao.org/3/a-i5555e.pdf>

Major reports

**THE SECOND REPORT ON THE STATE OF THE WORLD’S ANIMAL GENETIC RESOURCES FOR FOOD AND AGRICULTURE**
This publication provides a comprehensive and timely assessment of livestock biodiversity and trends in animal genetic resources management and identifies the knowledge gaps that will have to be filled in order to tackle current challenges.
<http://www.fao.org/3/a-i4787e.pdf>

**THE STATE OF THE WORLD’S FOREST GENETIC RESOURCES**

Biodiversity in forest genetic resources is essential to improving species’ productivity and the nutritional value of the foods they produce – including leafy vegetables, honey, fruits, seeds, nuts, roots, tubers and mushrooms. This report makes recommendations to address threats to biodiversity and analyses the drivers of change and relevant emerging technologies.
<http://www.fao.org/3/a-i3825e.pdf>

**THE SECOND REPORT ON THE STATE OF THE WORLD’S PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE**

Based on information gathered from country reports and a wealth of other documents, this publication tracks developments in the field of plant genetic resources between 1996 and 2010.
<http://www.fao.org/docrep/013/i1500e/i1500e.pdf>

**GLOBAL FOREST RESOURCES ASSESSMENT 2015**
FRA provides five-yearly updates on the status of the world’s forests. This edition shows that over the past 25 years the rate of net global deforestation has slowed by more than 50 percent.

<http://www.fao.org/3/a-i4793e.pdf>

**CODE OF CONDUCT FOR RESPONSIBLE FISHERIES**This Code provides a framework for national and international efforts to ensure sustainable exploitation of aquatic living resources in harmony with the environment. It establishes principles and standards applicable to the conservation, management and development of all fisheries in a non-mandatory manner.

<http://www.fao.org/docrep/005/v9878e/v9878e00.htm>

Other key titles

**INTERNATIONAL CODE OF CONDUCT ON PESTICIDE MANAGEMENT**

GUIDELINES FOR THE REGISTRATION OF MICROBIAL, BOTANICAL AND SEMIOCHEMICAL PEST CONTROL AGENTS FOR PLANT PROTECTION AND PUBLIC HEALTH USES

This publication guides pesticide regulatory authorities in registering microbial, botanical, and semiochemical pest control agents for plant protection and public health uses. It updates and replaces the 1988 publication on The Registration of Biological Pest Control Agents.
<http://www.fao.org/3/a-i8091e.pdf>

**THE ECOSYSTEM APPROACH TO FISHERIES**This document reviews the evolution of the terminology and underlying paradigms; some selected ecosystem characteristics; the impact of fisheries and of other activities with which fisheries compete; the institutional foundations of the approach and the conceptual objectives and principles of relevance for EAF.
<http://www.fao.org/3/a-y4773e.pdf>

**VOLUNTARY GUIDELINES FOR THE CONSERVATION AND SUSTAINABLE USE OF CROP WILD RELATIVES AND WILD FOOD PLANTS**This overview of crop wild relatives andwild food plants describes their human andenvironmental benefits and the threats theyface (e.g. natural disasters). It providesrecommendations for implementing anational conservation plan, ranging from target species inventories to threatassessments.
<http://www.fao.org/3/I7788EN/i7788en.pdf>

**VOLUNTARY GUIDELINES FOR MAINSTREAMING BIODIVERSITY INTO POLICIES, PROGRAMMES AND NATIONAL AND REGIONAL PLANS OF ACTION ON NUTRITION**Appropriate use ofbiodiversity for foodand agriculture innutrition and agricultureprogrammes is a keymeans of addressingmalnutrition in all itsforms. The Commissionon Genetic Resourcesfor Food and Agricultureendorsed these VoluntaryGuidelines, with the aimof assisting countriesto make the best useof biodiversity in theirnutrition programmes.
<http://www.fao.org/3/a-i5248e.pdf>

**BIODIVERSITY FOR FOOD AND AGRICULTURE**

CONTRIBUTING TO FOOD SECURITY AND SUSTAINABILITY IN A CHANGING WORLD

This publication summarizes the major challenges expected over the next 40 years and offers a perspective on the fundamental changes needed to ensure that biodiversity contributes to sustainable and productive systems.
<http://www.fao.org/3/a-i1980e.pdf>

**GUIDELINES ON ASSESSING BIODIVERSE FOODS IN DIETARY INTAKE SURVEYS**These guidelineshighlight how FAOcollaborates with stakeholders tointegrate biodiversity into foodconsumption surveys as a priority.
<http://www.fao.org/3/a-i6717e.pdf>

**SUSTAINABLE DIETS AND BIODIVERSITY**

DIRECTIONS AND SOLUTIONS FOR POLICY, RESEARCH AND ACTION
The book presents the current state of thought on the common path of sustainable diets and biodiversity.
<http://www.fao.org/docrep/016/i3004e/i3004e.pdf>

**GARDENS OF BIODIVERSITY**

CONSERVATION OF GENETIC RESOURCES AND THEIR USE IN TRADITIONAL FOOD PRODUCTION SYSTEMS BY

SMALL FARMERS OF THE SOUTHERN CAUCASUS
This book contains studies on the food habits of the people of the Southern Caucasus, who contribute to maintaining sustainable agricultural systems.
<http://www.fao.org/3/a-i1687e.pdf>

**PRINCIPLES FOR THE ASSESSMENT OF LIVESTOCK IMPACTS ON BIODIVERSITY**This publication identifiesbroad principles intendedto assist stakeholders in theassessment of livestock impactson biodiversity.
<http://www.fao.org/3/a-i6492e.pdf>

**TREES, FORESTS AND LAND USE IN DRYLANDS – THE FIRST GLOBAL DRYLANDS ASSESSMENT: PRELIMINARY FINDINGS**

Drylands cover 40% of the land area of the world and are also important in terms of biodiversity conservation; of the 25 global biodiversity hotspots, 8 are in the drylands. This publication provides a comprehensive overview of the forest and tree resources as well as land use in the drylands of the world.
<http://www.fao.org/3/a-i5905e.pdf>

**MAINSTREAMING OF BIODIVERSITY AND ECOSYSTEM SERVICES WITH A FOCUS ON POLLINATION**
For this publication,researchers and policy-makersconsidered a range of actionsto address pollination deficitsand develop an indicativeset of policy responses.
<http://www.fao.org/3/a-i4242e.pdf>

**COMMON PLANTS OF MALDIVES**The book covers 270 species ofvascular plants, both native and non-native,found on more than 50 islandsof the Maldives. It will be a usefulfield guide for both specialists andnon-specialists.
[**http://www.fao.org/3/a-i5777e.pdf**](http://www.fao.org/3/a-i5777e.pdf)

**MAINSTREAMING ECOSYSTEM SERVICES AND BIODIVERSITY INTO AGRICULTURAL PRODUCTION AND MANAGEMENT IN THE PACIFIC ISLANDS**This guidance document details thelinks between ecosystem services andbiodiversity in agriculture, and analysescurrent policies and best practices acrossthe Pacific Islands.
<http://www.fao.org/3/a-i6505e.pdf>

**MAINSTREAMING ECOSYSTEM SERVICES AND BIODIVERSITY INTO AGRICULTURAL PRODUCTION AND MANAGEMENT IN EAST AFRICA**This guidance document details thelinks between ecosystem services andbiodiversity in agriculture, and analysescurrent policies and best practices in Africa.

[**http://www.fao.org/3/a-i5603e.pdf**](http://www.fao.org/3/a-i5603e.pdf)

**CONSERVATION OF GENETIC RESOURCES AND THEIR USE IN TRADITIONAL FOOD PRODUCTION SYSTEMS BY SMALL FARMERS OF THE SOUTHERN CAUCASUS**
This book contains studies on the food habits of the people of the Southern Caucasus, who contribute to maintaining sustainable agricultural systems.
<http://www.fao.org/3/a-i1687e.pdf>

**VOLUNTARY GUIDELINES FOR AGRO-ENVIRONMENTAL POLICIES IN LATIN AMERICA AND THE CARIBBEAN**
This publication provides policy-makers with sustainable methods to tackle food insecurity and poverty through stronger governance systems and social participation.
<http://www.fao.org/3/a-i5462e.pdf>

**INVENTAIRE FLORISTIQUE ET FAUNIQUE DES ÉCOSYSTÈMES DE MANGROVES ET DES ZONES HUMIDES CÔTIÈRES DU BÉNIN**This report provides an inventory of flora and fauna species in Benin’s mangrove ecosystems, including distribution, conservation and space−time dynamics. It calls for conservation actions for endangered species in partnership with research institutions.
<http://www.fao.org/3/I8402FR/i8402fr.pdf>

**REVIEW AND ANALYSIS OF INTERNATIONAL LEGAL AND POLICY INSTRUMENTS RELATED TO DEEPSEA FISHERIES AND BIODIVERSITY CONSERVATION IN THE ABJN**Recognizing the need to control fishing activity, this publication reviews international treaties relevant to deep-seas fisheries management and discusses which provisions require national-level implementation.

[**http://www.fao.org/3/a-i7009e.pdf**](http://www.fao.org/3/a-i7009e.pdf)

More on biodiversity

[VOLUNTARY GUIDELINES FOR SUSTAINABLE SOIL MANAGEMENT](http://www.fao.org/3/a-i6874e.pdf)

[AGROFORESTRY FOR LANDSCAPE RESTORATION](http://www.fao.org/3/b-i7374e.pdf)

[SAVE AND GROW IN PRACTICE: MAIZE, RICE AND WHEAT. A GUIDE TO SUSTAINABLE CEREAL PRODUCTION](http://www.fao.org/3/a-i4009e.pdf)

[SALUD, SABERES Y SABORES](http://www.fao.org/3/I8269ES/i8269es.pdf)

[PULSES: NUTRITIOUS SEEDS FOR A SUSTAINABLE FUTURE](http://www.fao.org/3/a-i5528e.pdf)

[BIODIVERSITY CHALLENGE BADGE](http://www.fao.org/3/a-i1885e.pdf)

[YOUTH GUIDE TO FORESTS](http://www.fao.org/3/a-i3856e.pdf)

[WATERSHED MANAGEMENT IN ACTION](http://www.fao.org/3/a-i8087e.pdf)
Also forthcoming

**THE STATE OF THE WORLD’S BIODIVERSITY FOR FOOD AND AGRICULTURE**

In addressing all biodiversity relevant to food and agriculture, the publication presents a broad perspective on the contributions made by biodiversity for food and agriculture to food security and nutrition, sustainable and resilient production, and the provision of ecosystem services.
[**http://www.fao.org/nr/cgrfa/biodiversity/sowbfa/en/**](http://www.fao.org/nr/cgrfa/biodiversity/sowbfa/en/)

THE STATE OF THE WORLD’S AQUATIC GENETIC RESOURCES FOR FOOD AND AGRICULTURE
<http://www.fao.org/aquatic-genetic-resources/background/sow/en/>

REVIEW OF THE STATE OF THE WORLD’S FISHERY RESOURCES: INLAND FISHERIES

This new update aims to improve global understanding of the contribution of inland fisheries to food security and human nutrition, ecosystems services and biodiversity resources and livelihoods.

## Chinasa Ikelu, Institute de Mathematique et des Sciences Physiques, Benin

1. Biodiversity is contributing in achieving food security and improved nutrition through the World Bank's Assisted Project of Transforming Irrigation Management in Nigeria (TRIMING). In our seminal paper on Growth and Poverty Dynamics in Nigeria: Evidence from two-wave panel survey, My co-author and I concluded that this good agricultural sector intervention (TRIMING) was important so as to improve access to irrigation and drainage services and strengthen institutional arrangements for integrated water resources management and agriculture service delivery in selected large scale public schemes in Northern Nigeria.

3. Mainstreaming biodiversity requires good governance. Examples of such policies from the Nigerian government could be the Green Bond for Environment and recently introduced Sukuk Bond. These kinds of innovative ways of financing through the capital market should be encouraged in all sectors especially the agricultural sector - that is a driver of growth. To effectively monitor the progress of this bond require free market system because good exchange rate system boost confidence of potential investors.

In addition, partners needed to be involved in institutional frameworks, policies and processes for biodiversity mainstreaming include key public and private actors in the Ministries of Environment, Water Resources, Agriculture, Livestock and Animal Production. Also members of the civil society organisations (CSOs) are not left out.

4. To increase awareness of farmers, livestock keepers, fisher folks and foresters, their organizations and the industry on the relevance of biodiversity and ecosystem services for the food and agriculture production in their sectors, proper education on the importance of biodiversity - through advertisement on radios and the best means of communication to farmers (like electronic short messages for those in the rural areas) - and involving them in all stakeholders meeting that leads to the design and planning process on biodiversity should be priority.

Furthermore, technical and institutional capacity can be developed through enabling friendly environmental practices within and across Agricultural sectors thereby protecting them against bacteria, fungi and other harmful living organisms. This institutional capacity can be in the form of preservation of the environment - naturally endowed ones rich in Agriculture should be priority instead of the rent that comes from it.

Thank you.

Sincerely,

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Chinasa IKELU

Doctoral Researcher,

Institut de Mathematiques et des Sciences Physiques (IMSP), Porto Novo, Benin Republic

## Jorge Granados, FAO, Colombia

English translation below

Pregunta 2.

a) dónde un sistema de producción (sostenible) ha jugado un papel clave para la conservación de la biodiversidad que lo rodea?

El trabajo que comparto se presenta tuvo como propósito acercarse, en una primera visita, a las relaciones que se establecen entre los sistemas de producción agrícola ecológica (en adelante P.A.E. <http://www.fao.org/fsnforum/sites/default/files/discussions/contributions/agricultura%20ecol%C3%B3gica%20en%20los%20andes%20colombianos%20%20y%20biodiversidad.pdf> ) y la conservación y uso sostenible de la diversidad biológica y de ello derivar nuevas noticias sobre la agricultura ecológica y su desempeño como instrumento(s) de manejo y conservación del paisaje y de la diversidad biológica.

Se buscaba comprobar la hipótesis de trabajo según la cual, las practicas y formas de organización y lógica inherente de los sistemas P.A.E, contribuyen a contener o por lo menos aminorar los procesos, explicados por los modelos de desarrollo, en particular de los sistemas agrarios vigentes y predominantes en el país y el mundo, y sus efectos en términos de deterioro y pérdida de la diversidad biológica.

Los resultados sugieren, de manera no concluyente, ni definitiva, y con criterio heurístico, que existen evidencias (derivadas de la revisión de literatura y de los resultados empíricos del trabajo) acerca de una positiva contribución en los sistemas P.A.E a la conservación de la diversidad biológica y un aprovechamiento funcional de la oferta ambiental, de los servicios y funciones que esta y la diversidad biológica contenida, sirve a las unidades productivas y agroecosistemas.

También se percibió cómo las practicas, tecnologías y formas de organización de los espacios, de los tiempos y los ciclos, así como el desempeño agroambiental al interior de los predios, conforman un base cultural- productiva, decisiva para reversar las tendencias de degradación de los recursos y de la diversidad biológica misma y avanzar hacia condiciones de sosteniblidad en los sistemas agrarios.

Se halló que los sistemas P.A.E contribuyen notablemente a enriquecer la estructura y complejidad de los agroecosistemas mediante la gestión planificada de sus componentes y como resultado de la gestión ambiental de los sistemas productivos.

También es remarcable el grado de diversidad asociada presente, tanto en los bordes de los agroecosistemas, como en los bosques y ecosistemas circunvecinos. En particular se evidenció que la biodiversidad asociada es relativamente rica en comunidades de aves, invertebrados, insectos

Se concluyó que la agricultura ecológica y los sistemas de producción agrícola ecológica conforman una base técnica, de organización social y de gestión agroambiental que contribuyen positivamente al enriquecimiento, conservación y uso sostenible de la diversidad biológica y que estos pueden servir como eficaz instrumento de manejo del paisaje rural para los objetivos de mantenimiento de la diversidad biológica .

Question 2.

a) where a (sustainable) production system played a key role for the conservation of the biodiversity surrounding it?

The work I am sharing aimed to explore, in first instance, the relationships between the ecological agricultural production (hereinafter referred to as EAP) systems and the conservation and sustainable use of biodiversity, and to bring new findings on ecological agriculture and its role as a tool to manage and preserve landscape and biodiversity.

The aim was to ascertain the working hypothesis whereby the practices, organisational structure and inherent logic of the EAP systems contribute to restrain or at least slow down the development processes, particularly of the current predominant agricultural systems -at country and global level-, and their impact on the deterioration and loss of biodiversity.

The results suggest -in an inconclusive, tentative and heuristic way-, there is evidence (derived from the literature review and empirical findings of the work carried out) of the positive contribution of the EAP systems to the conservation of biodiversity, and the functional utilisation of the environmental resources, services and functions and the related biodiversity for the productive units and agroecosystems.

It was also noted that the practices, technologies and ways of organising land, timing and cycles -as well as the agro-environmental performance within the plots-, provide a crucial cultural-productive basis for reverting the resource and biodiversity degradation trends and making progress towards the sustainability of the agricultural systems.

The existing diversity is also remarkable, both at the boundaries of the agroecosystems, and at the surrounding forests and ecosystems. In particular, it was clear that birds, invertebrates and insects have a relatively rich biodiversity.

The work concluded that ecological agriculture and the related production systems provide a technical, social organization and agro-environmental management basis for a positive contribution to the enrichment, conservation and sustainable use of biodiversity, capable of effectively managing the rural landscape for this purpose.

## Mostafa Jafari, RIFR/ IPCC/ TPS for LFCCs, Iran

Dear Moderator and colleagues

Few important points need to be kept in mind in all discussion:

Biodiversity in forestry and fishery are mainly laid on natural species;

But in Agriculture, even though natural base origin species are playing very important role, but they are mainly modified by different means.

Attention should be made to the natural and modified species with clear distinctions.

Also the impact of climate change on biodiversity and its vulnerabilities should be considered sufficiently.

Finally the role of invertebrates in related to the food web chain are very crucial.

Hope all discussion have very practical out come to eliminate or eradicate poverty in all over the world.

## Joseph George Ray, Mahatma Gandhi University, Kottayam, Kerala, India

**Where a (sustainable) production system played a key role for the conservation of the biodiversity surrounding it?**

Definitely, a sustainable produyction system such as organic farming system always conserve a lot of biodiversity in the agroecosystem, which include not only diversity of crops but also soil biodiversity.

In the organic farming system, soil is rich in algae, fungi (mycorrhiza) and bacteria. In addition to the same such soil systems, especially in the tropics different varieties of earthworms, millipedes, centipedes and molluscana, all of which are very important partners in organic degradation and conservation of nutrients in the soil.

For example, in the traditional domestic farm yards of Kerala, one can see diversity of crops, vegetables, fruit crops along with cash crops and serials, where soil fertility remain quite sustainable as well

**Where a(n) (unsustainable) production system played a key role for the degradation of the biodiversity surrounding it?**

Definitely, in the chemicalized farms one can see poor soil without any form of living organisms. The microbial flora also remain poor in such systems. Most of the chemicalized farms are monocultures without the sign of life and hence are called ecological cemetries

**Do you have any examples of such enabling factors and initiatives or the lack of it?**

Awareness of unhealthy and poisoned food from chemicalized farms prompt people to cultivate themselves and generate food stuff organically. In Kerala, such an awarness is causing people to do so and there is an 'organic cultivation boom' now visible in the society.

Biodiversity rich conservation agriculture is possible only when individuals are interested in the cultivation of healthy foods and domesting farm yards come up everywhere. Because industrial farming has limitations in the conservation of biodiversity. Productivity, marketting and cost effectiveness are issues that prevent organic farming at industrial level. But there is no such constrains when individuals cultivate for own use.

**Which partners need to be involved in institutional frameworks, policies and processes for biodiversity mainstreaming to strengthen them?**

Institutions such as Local governments, residence associations and farmer clubs need to be included in the mainstreaming of biodiversity farming. The state should formulate proper policies to promote individual farming for own use.

**What needs to be done to increase awareness of farmers, livestock keepers, fisher folks and foresters, their organizations and the industry of the relevance of biodiversity and ecosystem services for the food and agriculture production in their sector?**

One of the most important form of awareness is health impact of the chemicalized farm products. Naturally, the health consciousness cause individuals and groups to engage in time consuming and labour intensive organic farming which naturally protect biodiversity and soil fertility.

In addition to the health related awareness campaigns, there should be strengthening of ecological education in the schools which will enable the young generation to understand the interrelatedness in nature and the problems of temporary gain oriented agriculture activities that have deleterious environmental impacts

**How can the technical and institutional capacity needed to promote sustainable agriculture and reduce the impact on biodiversity be developed?**

Agriculture need to become people involving and people oriented

Agriculture shuold beocme a culture and not business.

In ancient times agriculture was really a village culture.

In modern times the state need to support individual involvement of every one - the lowest to the highest educated or the low income to the highest income groups - to get involved in some kind of agriculture activities.

There should be tax excemption to personal income tax for those who involve in organic agriculture production to promote sustainable agriculture - at least the non-cultivators should be encouraged to get involved in farmer's clubs to support them financially and morally so that they eat healthy food and conserve biodiversity

Leaving cultivation as an activity of few farmers cause them to cultivate intensively and carelessly which is the major reason for unsustainable agriculture

Agriculture has to become a collective effort of all to eat healthy food

## Emile Houngbo, National University of Agriculture, Benin (UNA), Benin

English translation below

Dans le texte introductif de cette discussion, je lis: "L'importance de la biodiversité pour l'amélioration de la sécurité alimentaire et de la nutrition n'est pas toujours évidente pour ceux qui interviennent dans les secteurs agricoles." Je voudrais bien croire que les agriculteurs familiaux ne sont pas concernés par cette déclaration. Car, c'est presque naturel pour les agriculteurs africains (à dominance familiale) de sauvegarder la biodiversité agricole. La sauvegarde de l'agrobiodiversité fait partie de la pratique paysanne; elle est intégrée à l'agriculture familiale. Les producteurs sont souvent conscients de ce qu'il faut conserver les diverses espèces et variétés végétales et animales selon leurs utilités. C'est ainsi, que la recherche de rendement élevé n'est jamais le seul critère de choix des cultivars par les producteurs familiaux. Même parmi la diversité de critères qu'ils adoptent souvent, le rendement élevé n'est pas toujours le critère principal. Les critères des exploitants familiaux sont diversifiés en fonction des catégories de besoins du producteur, des consommateurs et de la communauté: sécurité alimentaire, souveraineté alimentaire, remèdes sanitaires, amélioration de la reproduction humaine, besoins financiers, lutte biologique contre les parasites, ... J'ai publié à ce sujet un article intitulé "Diversité et critères d'adoption des cultivars de maïs (Zea mays) dans le village Zounnou, centre Bénin". Cet article est disponible en ligne: https://www.ajol.info/index.php/jab/article/view/129189. Un autre article est en cours sur le manioc, une autre culture de base au Bénin et dans nombre de pays africains.

Cette réalité décrite sur l'agrobiodiversité n'est pas toujours présente dans l'agrobusiness, dans l'agriculture industrielle et l'agriculture commerciale. Car, le développement de ces types d'agriculture conduitle plus souvent à la réduction (drastique) de l'agrobiodiversité, en mettant l'accent sur quelques cultivars de grande valeur commerciale.

La véritable préoccupation aujourd'hui devrait être d'accompagner les producteurs familiaux dans leur réflexe habituel de préserver l'agrobiodiversité. Comment accompagner les producteurs agricoles familiaux dans cette attitude intelligente et salvatrice pour l'humanité ? C'est plutôt là le défi à relever à mon avis.  A cet effet, je sais que déjà, les Nations Unies ont déclaré l'année 2014, année internationale de l'agriculture familiale. C'est un signe de reconnaissance. Mais, il faudra aller plus loin avec des appuis significatifs à la recherche-développement dans ce cadre.

In the introductory text of this discussion I read: “The importance of biodiversity for improved food security and better nutrition is not always evident to those engaged in agricultural sectors.” I hope that family farmers are not included in this declaration, because it is almost natural for African farmers (predominantly family farmers) to safeguard agricultural biodiversity. Safeguarding agro-biodiversity is part of the small farmer’s practice; it is bound up with family farming. Producers are often aware that there is a need to conserve the different species and varieties of vegetables and animals according to their uses. That is why the search for high yields is never the only criterion for choosing crops for the family farmers. Even among the various criteria often adopted, high yielding is not always the main criterion. The criteria for family farmers are diverse in accordance with the type of need of the producer, consumers and community: food security, food sovereignty, sanitary solutions, improvements in human reproduction, financial needs, biological fight against parasites … I have published an article on this subject called: “Diversity and Adoption Criteria of Cultivars of Maize (Zea mays L.) in Zounnou Village, Centre Benin” this article is available on line: <https://www.ajol.info/index.php/jab/article/view/129189> Another article in preparation relates to cassava, another basic crop in Benin and numerous other African countries.

This reality as described on agro-diversity is not always present in agro-business, in industrial or commercial agriculture because the development of these types of farming often leads to the (drastic) reduction of agro-biodiversity by putting the accent on some high commercial value crops.

The real concern today should be to support family farmers in their typical forms of preserving agro-biodiversity. How to accompany family farmers in this smart and life-saving attitude for humanity? In my view, this is really the challenge to be met. To this effect, I know that the United Nations have already declared 2014 the International Year of family farming. It is a sign of recognition, but it will be necessary to go further with significant support for research and development in this framework.

## Paul Sommers, California State University, Fresno, United States of America

Mainstreaming Biodiversity for Improved Food Security and Better Nutrition.

As someone who began addressing this same challenge in 1976, I have mostly seen over the decades an increase in the simplification of agricultural landscapes. The reasons for simplification are due to a complex web of factors but the challenge remains at farm level: how to encourage households who at one time had resilient, climate-smart, nutritionally rich, biodiverse farming systems to once again rebuild their biodiverse structure to meet their daily food and income needs. It may be doable if the will is there at all levels in the decision making process.

On a practical note, FAO's 1990 publication, "Improving nutrition through home gardening - A training package for preparing field workers" remains one of the top field guides on how to close dietary gaps, improve nutrition and food security through biodiversity, especially in the home lot.

## Oamenii Padurii, Romania

The first step to take is investment in education. People need to understand the need to preserve this diverse world and to link it directly to our existence as a species. If we are not aware of this interdependence, nothing will be done.

The next step is to present the benefits for each, possibly bonuses for best practice.

## Samuel Agele, Federal University of Technology, Akure, Nigeria

Agriculture plays a key role in the provision of food and nutrition security outcomes. Large population of sub-Saharan Africa are malnourished. Productivity of agriculture should improve to provide nutrient-rich food, enhance on-farm incomes and human and environmental health. Technological and social innovation may enhance the sustainability of agriculture, food and nutrition outcomes and resilient environment along rural-urban sprawl. Potentials of resilient, neglected and underutilized genetic resources should be harnessed to attain food and nutrition security in sub-Saharan Africa. The resilient (endemic), neglected and underutilized crop genetic resources of the sub-Saharan Africa have diverse uses and genetic traits and constraints to productivity. The diverse dietary preparations and ability to meet up with or supplement the calory (energy) and protein requirements of many families are useful for ameliorating malnutrition, hidden hunger and resilience to environmental challenges among resource-poor and rural communities (vulnerable groups).

The endemic (resilient), neglected and underutilized crop genetic resources of the sub-Saharan Africa have diverse uses and genetic potential for ameliorating malnutrition, hidden hunger and resilience to environmental challenges among resource-poor and rural communities (vulnerable groups).

The success of efforts focusing on enhancing resilience of agriculture, seed system, food and nutrition security to climate-induced stresses in sub-Saharan Africa: use and conservation of resilient seeds would be premised on examining the contribution of agricultural biodiversity to stable and sustainable agricultural production, system resilience and ecosystem services)

The conservation and use of adapted plant varieties would lead to increased productivity, on-farm incomes, and nutrient-rich food, as well as enhanced resilience to production shocks and reduced

Increasing necessity to safeguard biodiversity for food security and climate change adaptation, and manage and sustainably deploying plant genetic diversity is one of the key options available to vulnerable farmers in their efforts to achieve food and nutrition security and make their farming systems resilient.

Other pathways would involve increased r4d for sustainable use and conservation of resilient crops for enhanced production, food and nutrition security, resistance to stresses, commercialization and end user perspectives

Conducting more ethnobotanical survey on plant genetic resources and diverse’ genetic traits, determine their uses and phenotypic variability in physical and chemical properties and identify constraints (production risks, conservation and utilization ) and use; develop and scale out best-fit conservation, production and utilization practices.

Examine variability in agronomic and nutritive characteristics: nutritional value (Organoleptic and nutritional; caloric, mineral and protein profiles), examine array of menus produced and used strategies to promote interest by younger generation for foods from resilient crops.

Conclusions

Resilient, neglected and underutilized genetic resources of sub-Saharan Africa are characterized by diverse uses and genetic traits (variability in physical and chemical properties constraints (production risks, conservation and utilization). Large variability exists in their agronomic and nutritive characteristics (organoleptic and nutritional; caloric, mineral and protein profiles) characterization. Wide array of menus are prepared and used from various dietary preparations with potential to meet and supplement the caloric (energy) and protein requirements of many families.

There are strong and intertwined associations among people, endemic biodiversity and survival and hence resilient, neglected and underutilized leguminous and cereal genetic resources are utilized for food, traditional medicine and diversity of other uses.

Effort should be geared to harness their potentials to attain food and nutrition (alleviation of nutrient (micro-nutrient) deficiencies) security in sub-Saharan Africa.

Effort should be geared to harness their potentials to attain food and nutrition (alleviation of nutrient (micro-nutrient) deficiencies) security in sub-Saharan Africa. It is important to improve knowledge on ethnobotany and constraints to production systems, and use, and develop and scale out best-fit conservation, production and utilization practices for enhanced productivity, food and nutrition security and livelihoods, and reduce climatic risks.

## Rony Trujillo, Universidad de San Carlos de Guatemala (Associated Researcher) & Global Soil Biodiversity Initiative (Associated), Guatemala

Biodiversity is contributing in achieving food security and improved nutrition?

The overuse of biodiversity compromise food security and nutrition?

According to the last Human Development Report (UNDP 2016), 49.8% of all the children below the age of five are suffering from chronic malnutrition in Guatemala. To the present day, child malnutrition remains an issue of serious concern in the country, although this does not mean that the problem is being addressed properly by government authorities.

Even though there is no much information regarding the link between biodiversity and food security and nutrition in Guatemala, there are two possible scenarios. One scenario is that, if Guatemalan rural people would not have access to some forest products (food plants and bush meat) that enables to supplement their basic corn and beans diet, the percentage of malnourished children in the country would be even worse. The second scenario is much related to the first one, because the chronic malnutrition epidemic in Guatemala might be being exacerbated by deforestation and land use change. According to the last forest cover analysis, Guatemala has an annual gross loss of 132,137 hectares of forest, which means that an area of 150,000 square meters of forest is lost every hour.

## Jaishanker Nair, IIITM-Kerala, India

Habitat Protection the Precursor of Biodiversity conservation

Our inability to handle biodiversity partially stems from the inherent vagueness embodied therein. We are yet to find a means to represent the 'variability among living organisms from all sources.' None of the indices of biodiversity that we are familiar with does justice. A poorly defined problem statement is central to the inertia in acknowledging the importance of biodiversity.

An objective representation of biodiversity is pivotal to arrive at measurable policies and strategies. This gap is widely seen in the inability to identify Tier I or II indicators of Aichi biodiversity targets of Sustainable Development Goals (SDGs).

We have moved from the Anthropocene to Diktyocene. The networked era wants innovative approaches to conserving biodiversity. It is important to realize that our goal should be to conserve life forms in their natural habitats.

The Nair's Measure of Biodiversity (NMB) and the holistic representation of biodiversity put forward by a team of researchers at the C V Raman Laboratory of Ecological Informatics is noteworthy.

We are currently involved in understanding the importance of physical attributes (of soil) in maintaining a healthy resource pool of diverse microorganisms. In short, our efforts are towards "Vibrant habitats for healthy diversity."

## Irene Hoffmann and Paulo Augusto Lourenco Dias Nunes, facilitators of the discussion

Dear Members of the Forum,

Thank you for your contributions. You raise very important points in relation to mainstreaming of biodiversity in agriculture, fisheries and forestry for improved food security and better nutrition. Also, thank you for pointing to specific examples from India, Nigeria, French Polynesia, Tanzania, Nepal, USA, Benin, Iran, Colombia and others.

Thank you also for pointing out that the mainstreaming of biodiversity across agricultural sectors will be only possible if the adoption of good practices across all agricultural sectors will support biodiversity conservation as well as increasing the productivity, stability and resilience of production systems. It is therefore fundamental to take advantage from lessons learned in raising awareness at the institutional level as well as involving all relevant stakeholders, including farming communities, to ensure effective practices in mainstreaming biodiversity.

Some contributions mention that biodiversity mainstreaming takes place in landscapes and seascapes and targets two groups of biodiversity, the ‘wild’ one that is used by fisheries and forestry, and the ‘domesticated’ that is used in crop and livestock agriculture”, and that management approaches and stakeholders differ between those groups. Others mention the importance of traditional knowledge of farming communities, but also the need for new knowledge and capacity development, in order to make practices more sustainable. Legislation and favourable market conditions are mentioned as supporting mechanisms.

The link between mainstreaming of biodiversity in agricultural sectors for food security and better nutrition is key. Here, we invite you to further reflect on what change/ type of coordination is needed to connect biodiversity with policies and legislation from different sectors (Education, Health, Agriculture, Gender) to enhance food security and nutrition. Also, how can food value chains prioritize biodiversity in different areas to diversified supply of domestic and exportable products contributing to food security and nutrition?

Ultimately, success will be associated with joining forces with other sectors (e.g. public health, education) and partners (e.g. UN agencies, NGOs etc.) with the ultimate objective of developing an alternative, transformational change towards sustainable food systems, including further guidance on the concept of “sustainability” in food and agriculture with regard to biodiversity.

I look forward to reading more of your contributions during the next week of this discussion.

Paulo Augusto and Irene

## Adele Muscolo, Mediterranea University, Reggio Calabria, Italy

We evaluated as different forest management practices influenced the quality of soil in terms of ecosystem functioning, individuating the sustainable practice for the improvement or the conservation of soil quality. investigated, in a Pinus laricio forest of south Italy, how systematic thinning of different intensities (intense thinning, T45; moderate thinning, T25; clear cut, CC; and no thinning, T0) affected soil biological properties, organic matter trend and carbon (C) storage in soil and plants.

The results showed that soil carbon content and carbon/nitrogen (C/N) ratio were significantly higher in the T45 than in control, T25 and CC. Under T45, the soils had also the highest enzymatic activities, microbial biomass carbon (MBC) and colonies of fungi and bacteria. The humification parameters (humification ratio, HR; the degree of humification, DH; humification index, HI) indicated T45 as the best silvicultural practice-approach method to manage Pinus laricio forest for increasing soil carbon storage (Settineri et al., EJFR 2018 <https://link.springer.com/content/pdf/10.1007/s10342-017-1077-9.pdf>). We are also working on the effects of different thinning on soil biodiversity evaluating EMI index, species richness Shannon Wiener index and species Evenness index, to identify what is the best practice that increase the soil biodiversity. We evaluated also the influence of selective and traditional thinning on soil biodiversity in fagus sylvatica plantation in protected area. The results individuated the traditional thinning as the best forest practice able to maintain soil ecosystem functioning and at the same time able to increase forest natural regeneration and growth.

The results are submitted to Forestry and Applied Soil Ecology. We are also working on the effects of different compost addition on biodiversity of agricultural soil to individuate a compost able to maintain soil biodiversity in respect to specific soil properties, with the aim of finding a specificity between the chemical-physical properties of compost, soil properties and biodiversity.

## Rajasekaran Murugan, University of Kassel, Germany

The basic strategy of my research is to integrate research on microbial ecology and functional role of soil biodiversity in biogeochemical cycles across climate, land use and environment. The aim is to investigate response of soil biodiversity and their ecosystem services to climate change across temperate (Alps, Himalayas), Andean (Chile, Peru) and tropical (Western Ghats) mountain soils.

My research projects are focused on the effects of land use and climate change on soil biodiversity, and subsequently on the effects of changes in soil biodiversity on ecosystem processes. I am particularly interested in how plants and soil microbial communities interact under these changing circumstances, and how this influences ecosystem processes like nutrient and carbon cycling.

Specific current projects are:

1. Impact of climate change on Alpine soil biodiversity and greenhouse gas emission

2. Role of invasive plant species on below ground diversity and ecosystem services in tropical forests

3. Influence of precipitation gradient and clay type on microbial community structure of Andean soils

4. Land use intensification effects on matter flows in rural-urban cropping systems

5. Enabling farmers to assess the soil quality implications of agricultural management options, Farmer citizen science in Madhya Pradesh, India.

6. Impact of traffic induced pollution on soil microbes and ecosystem processes across India.

7. Identifying main drivers of soil microbial stoichiometry in Andean range lands

Overall, it is important to Integrate of research on the functional role of soil biodiversity in biogeochemical cycles not only across climate and environments but at regional and farm level.

## Lal Manavado, University of Oslo, Norway

Even though some knowledge-gaps still exist in the area, a vast amount of useful information is already available on the current status of bio-diversity in agriculture, fisheries and forestry. Further, there is a general agreement on its direct and indirect importance for human well-being in general and adequate nutrition and food security in particular. In spite of this, it is beyond dispute that global bio-diversity continues to diminish.

My contribution to the present effort to incorporate ensuring an adequate and sustainable bio-diversity into agricultural pursuits, fishing and forestry will be to suggest a pragmatic action template to achieve our objective, into which the relevant and appropriate information, technologies and procedures could seamlessly fit. Such a framework would be holistic by definition, and it will consists of two logically inseparable parts.

The first might be called the overall mechanism designed to achieve our purpose. It contains the familiar pathways of action like policy design, deciding on strategies needed to implement it, and finally the tactical methods one may use to implement those strategies. At this point, let me emphasise that while policy and strategy may have certain elements in common among the members of some group of countries, their tactical implementation may often require methods appropriate for a limited geographic area.

Before we take up the second part of our framework, I would like to underline the importance of coordinated action in achieving our aim. Sometimes, praiseworthy enthusiasm may drive groups to undertake independent local projects whose success is expected to inspire and motivate similar action elsewhere. However, it is uncertain whether the enhanced bio-diversity of an area could remain sustainable when surrounded by places where it remains threatened. Let us call such differences in bio-diversity in contiguous areas their diversity deficits.

It will be agreed that enhanced and sustainable bio-diversity in our target areas implies that there would be minimal bio-diversity deficits among them and their contiguous surroundings. As far as I know, no research has been yet undertaken to ascertain the interaction between an area of adequate bio-diversity and its contiguous surroundings with a diversity deficit as far as its effect on the overall bio-diversity of the whole area. Indeed, this is a complex task, nevertheless, its importance ought not to be under-estimated.

Let us now look at what is necessary to design the first part of our framework, and make it appropriate and relevant. Stating the obvious, a comprehensive description of the bio-diversity depletion of an area, its causes, optimal means of its prevention and regeneration are essential technical information here. However, there are two entirely different considerations which alone imparts to the first part of our framework and this information their high value, viz., their necessity for sustainable food security and adequate nutrition.

After this value justification of the pressing need to undertake a significant restoration of bio-diversity in our three target areas, we are now ready to put together the second part of our framework. In its turn, it consists of three parts:

Surveys to establish the qualitative (types of species) and the quantitative status of current bio-diversity in the target areas.

Ascertaining to the best of our ability the previous status of bio-diversity in those areas. Even though it may not be possible to gather precise data here, at least an informed approximation is necessary to restore any loss bio-diversity and to prevent its further reduction. It is vital to understand that unless this data is available, we cannot justifiably evaluate our success in restoring bio-diversity, and it is not sufficient only to prevent its further loss. Here, a sound understanding of the local food culture would be indispensable. This may often serve as the only scientifically justifiable benchmark in restoring the biodiversity of our three target areas.

Compilation of the known optimal methods of restoring bio-diversity and prevention of its reduction, and the design of more appropriate and relevant ways of achieving those objectives. It will be noticed that it is this aspect of our task that has received the greatest attention in the invitation to the present discussion. While these may be collected and/or developed in vitro so to speak, their successful use in the field depends on the appropriateness of the first part of our framework, for that depends on among other things, on a coordinated field work across the board.

Let me inject a sense of proportion to our discussion by underlining some often overlooked facts. Even in an area where volunteer or supported projects may have achieved a remarkable success in restoring biodiversity in all three areas, viz., crops, fisheries/animal husbandry and forestry, authorities may initiate there mining, factory construction, large-scale road building, or even re-introduction of a monoculture for export on the advice of some expert economist. Recent history of nearly all country teems with examples of this. Moreover, for economic reasons, authorities are still supporting activities we have long known to threaten biodiversity.

As sustainable food security and adequate nutrition depend on a sustained and adequate ecosystem services, the vital importance of biodiversity hardly needs justification, for the possibility of having such services entirely depends on the balance between its qualitative and quantitative dimensions. All too often, this qualitative aspect of biodiversity i.e., number of diverse species receives all the attention while the quantitative, i.e., size of each species population seems to remain neglected.

After these preliminaries, let us look at the requirements a potentially successful policy to achieve our objective ought to meet. As no policy at any level exists in isolation, no policy could succeed however appropriate it is for its purpose unless the other policies in its operating ambience are in harmony with it as far as its objective is concerned. An example of lacking this inter-policy harmony would be economic and development policies that advocate monoculture with a view to export. Perhaps, the greatest threat to biodiversity and the future quality of human life is our consistent failure to acknowledge the untenability of our population growth.

Our next obstacle to success at the highest level is the internal lack of harmony in food and agriculture policy with respect to our goal. Unfortunately, examples of this lack of intra-policy harmony are legion. A non-exhaustive list of these disruptors of internal harmony are given below:

1. Strategies to increase food production based on introduction of ‘enhanced’ non-endemic crops cannot be sustained by locally available ecosystem services, hence call for intensive supplementation of them. This supplementation may include intensive use of fertilisers, biocides and irrigation whose adverse effects on bio-diversity are well-established.
2. Allowing extensive monoculture in agricultutre and animal husbandry either for economic gain by export, or for manufacture of industrial food by commercial food monopolies.
3. Permitting the use of compounds now known to be endocrine disruptors and the introduction of genetically modified species the effect of whose interaction with the environment are unknown.

I have already implied that intra-policy disharmony with its own objectives results from the use of unsuitable strategies to implement it. Obviously, such usage becomes the norm when policy and strategy decisions are made on a reductive basis while professing to promote a holistic approach. In the example used here, all it would have required is to define as the goal of food and agriculture policy as increased production of diverse, appropriate food stuffs in a way that entail no environmental degradation.

This brings us back to the issue of coordination I have mentioned earlier. Inter-policy harmony for our purpose calls for inter-departmental coordination which seems to be easier said than done. However, we have no choice but to keep on trying even though this may sometimes seem hopeless to some of us. This requirement applies with even greater force when it comes to achieving intra policy harmony.

For instance, where one is trained and in what, combined with eagerness to embrace the latest technology have driven many designers of policy implementation strategies which are not only inappropriate for practical reasons, but are also in conflict with an area’s own food culture. The latter is often enough to guarantee an inevitable loss of local biodiversity while in extreme cases, it would lead to irredeemable eco-disasters like that in Aral Sea basin.

Therefore, it is crucial that strategy planners receive some suitable training to acquire a sense of proportion vis a vis the local reality as a whole by talking to the local people involved in our target areas, and by a thorough visual inspection of them. This cannot be achieved by any other means however high-sounding or colourful they might be. I cannot envisage any other effective way to encourage any open-minded strategist to adapt his approach to real life as it obtains in fields, fisheries, animal husbandry and in forests.

Once we have achieved a real willingness and ability to coordinate their efforts among the policy makers and strategy planners, we will be in a good position to undertake the next step, i.e., the second part of the action package as it were. It is concerned with defining the range and scope of actions required to prevent any further loss of biodiversity from our target areas, and to restore them as much as possible.

I have already refered to the importance of local food culture as the key benchmark in crops, animal husbandry and fisheries. Local folklore is often useful to ascertain the composition of flora and fauna in forests. Many older people still remember a larger number of local species and their approximate density while unhappily, younger local people are not as familiar with those as their elders. This is especially true in areas where there is large forest degtradation. No botanist or a zoologist however qualified can possess this locally valid empirical knowledge.

I do not suggest that policy and strategy formulation should wait until we have established locality-specific benchmarks of biodiversity restoration. The design of requisite policies and strategies can begin on the basis of what we already know of lost biodiversity by aiming to prevent its aggravation and restoration. However, part of its strategy should include simultaneous surveys to ascertain the following in order to revise those policies and strategies and to expand unified research on its prevention and restoration methods.

1. Expanded surveys to establish relevant local benchmarks.
2. Research into locally relevant prevention and restoration methods that would result in least possible deficits in biodiversity in contiguous areas. For instance, introduction of non-endemic species to re-forest a locale often reduces the real local biodiversity and may indeed adversely affect the flora and fauna (eg. pollinators) of contiguous areas.

Now, the results of the above two undertakings should be the basis of local actions to prevent the loss of local biodiversity and its restoration. In other words, how the strategies to implement the policy involved are implemented locally. Thus, a continued dialogue between policy and strategy planners and the local authorities and the people is a necessary condition for our success.

Here, one may complain that I have not even touched upon how to secure the finances needed for such an endeavor, nor yet the legal instruments needed to enforce preventive measures. Being a realist, I can only make an oblique reply; there is an increasing tendency to seek funds for efforts like this from trade and industry motivated by gain. But ensuring gain entails reduction of costs, which inevitably requires mechanized food production, monoculture to increase yield …. I cannot see how entities embodying gain as their principal motive could really promote biodiversity regardless of their green guise.

As for the legal tools, it is not the lack of them that cripples us, rather the problem of their impartial and efficient enforcement. A carpenter may have world’s ‘cutting edge’ tools and finest seasoned wood. But if the man does not have the skill to use them well, or is not willing to do so, his mere possession of such splendid tools does not result in Chesterfield furniture.

With best wishes!

Lal Manavado.

## Galfato Gabiso Gada, Hawassa University, Ethiopia

Dear FSN Form members,

Please see the research result of home garden agrobiodiversity for food security.

<https://www.scitechnol.com/peer-review/the-niche-of-tree-and-crop-in-traditional-home-garden-agroforestry-system-in-case-of-agrobiodiversity-conservation-at-farm-level-i-u1JS.php?article_id=7078>

Galfato Gabiso

## Noel Templer, Go Organic East Africa, Kenya

Where a (sustainable) production system played a key role for the conservation of the biodiversity surrounding it?

At Go Organic East Africa, the focus has been on training for both farmers and under/postgraduate students on sustainable organic production with constant reflections on food systems in transition. Knowledge dissemination from multiple stakeholders has helped us pass the broader message of biodiversity conservation for agroecosystem health.

In our subsequent studies and analysis on certified organic agriculture and potential increase on agroecosystem health, we had interesting findings. Our hypothesis was that practicing certified organic agriculture would increase and balance agroecosystem health, including the ecological domain. Taking into account that the indicators in the ecological domain were mostly referring to agricultural practices rather than ecological preconditions, our findings did not support the hypothesis. This, however, does not explain why farms differed significantly in all domains of ecological health across the study sites. Rather, we attribute the difference to the fact that only farms in the ecology-driven cluster were applying key strategies of organic agroforestry: shading and mulching in an integrated cropping system.

## Samuel James, Maharishi University, United States of America

There is a fundamental conflict between maintaining soil macrofaunal biodiversity normally extant in naturally-functioning ecosystems, and implementing any type of agriculture requiring a wholesale replacement of the vegetation. I work with earthworms, and the general rule is that habitat conversion wipes out the indigenous species. There are exceptions. For example recent sampling in Terra Preta (aka Amazon Dark Earths) shows plenty of earthworms, most of which we believe to be local or regional species, rather than widely-distributed invasive and/or anthropochorous species. However those sites sample are mostly under secondary forest and we may be seeing a long to medium term recovery of local diversity after site abandonment. The sites are also embedded in larger areas of agriculturally-converted land, so it is difficult to judge. what the earthworm diversity would have been prior to the relatively recent (last 50 to 100 years) deforestation.

Soil genesis is strongly affected by ecosystem engineer soil fauna, earthworms among them. The use of soils thus developed typically entails a dramatic reduction in the species richness and functional trait spectrum originally present in that soil. So while we benefit from the legacy of soil bio-engineers, we do not presently have a good way to maintain those engineers in the soil. The primary replacements are the widely distributed or invasive species mentioned above; these will be different in different climate regions. There is a well-characterized tropical set of common replacment species, of which Pontoscolex corethrurus is the best known, and others for temperate zones including higher elevation tropical locations.

It is easy to find cases of degradation of earthworm biodiversity, even including our best attempts at sustainable agricultural systems. The longer term question is how soils can be maintained under the new, simplified biotic regime characteristic of all agriculture.

## Kanna Siripurapu, Watershed Support Services and Activity Network (WASSAN), India

*Special Programme for Promotion of Millets in Tribal Areas - "Reviving Millets in Farms and on Plates"*

"The nutritious millets traditionally occupied substantial part of the diets and crop systems in tribal areas of Odisha. Millets require less water and are more resilient to climate vulnerability. They can also be cultivated on the undulating and change and be cultivated even in undulating terrain. Reduction in millets resulted in nutrition deficiency. It led to unsustainable cropping systems increasing demand on water. In order to address growing crop failures and nutritional issues, millets need to be revived. To revive the millets, a flagship programme called "Special Programme for Promotion of Millets in Tribal Areas"has been launched by Department of Agriculture & Farmers Empowerment, Odisha. Programme intends to revive millets in rainfed farming systems and household consumption."

For more details please check: <http://www.milletsodisha.com>

*Strengthening of Backyard poultry (BYP) for livelihood and nutritional security of women in Tribal Areas of Andhra Pradesh in India.*

For more details: <http://www.wassan.org/desipoultry.htm>

*Community Managed Livestock Insurance as an integral drought adaptation strategy for rainfed agriculture regions of Andhra Pradesh state in India.*

For more details please check: <https://www.wassan.org/assets/uploaded/publications/pdf/community_managed_livestock_insurance.pdf_09_15_56am_ocwzo8rnm4lwmaxoykv1.pdf>

*Reviving community managed tank-based fisheries in the rainfed regions of Andhra Pradesh, India.*

For more details please click: <http://www.wassan.org/assets/uploaded/publications/pdf/Reviving%20Communicity%20Managed%20Tank%20Based%20Fisheries.pdf_08_53_13am_a6r575datdo4a5sbrybe.pdf%C2%A0>

*Mainstreaming Community Managed Seed Systems - An experiment of People and Public Partnership for local production and supply of seeds in Ananthapuram District of Andhra Pradesh, India.*

For more details please click: <http://www.wassan.org/about_wassan/document/CMSS_WASSAN_Anantapur.pdf>

*Participatory groundwater management in rainfed areas - ground water sharing between farmers with borewells and farmers without borewells to ensure critical irrigation during dry spells in rainfed areas.*

Please watch the youtube video for more information: <https://www.youtube.com/watch?v=Aw5BoRKYHRE>

## Aklilu Nigussie, Ethiopian Institutes of Agricultural Research, Ethiopia

1) Biodiversity is an important contributor to food security and improved nutrition. Could you share examples?

I am going to state my sweet nation of Ethiopia with its smallholder farmer production system. Ethiopian farmers use diversified production system with application of biodiversity with in the subsector of crop production itself with rotation production system to maintain fertility, nutritional contribution to the household consumption and food security; furthermore they diversify with horizontal integration with livestock system especially cattle and small ruminants (sheep, goat, poultry, bee); yet with an increasing of chemical application and range land declines especially on the highlands of Ethiopia because of diversified reasons like population pressure; the so called industries are conquering the fertile land than marginal land; housing of urbanization use the fertile land than marginal land; and other factors pressurized the range or grazing land for highlanders to increase production system of livestock. These hamper the production system. But still the smallholder tries to diversify at homestead production.

## Michael Commons, Earth Net Foundation, Thailand

*Biodiversity is contributing in achieving food security and improved nutrition?*

While I think this is obvious, from many years working with small-scale farmers in SE Asia on "rice-based farming systems" helping them convert to "organic" (agroecological) methods which support ecological health and abstain from chemical use. It is clear this shift brings a quick and impressive return of the diverse flora and fauna that live in healthy rice ecosystems. Fish are usually the most valued resource that returns, but also shrimp, crabs, good tasting snails and diverse wild vegetables (edible weeds). All of this is natural biodiversity that is oppressed in a chemical intensive system but which returns with agroecological management and provides valued secondary - highly nutritional yields. Beyond this these farming systems promote increased integration, (and thus increased agricultural biodiversity). Bunds are not sprayed with herbicide but often widened and used to plant small fruit trees, herbs, and vegetables- providing additional healthy food. While perhaps not a key point here, our project also identified many factors from these more diversified ecological "Rice-based Farming Systems" promoting increase resilience - specifically climate change resilence. Diversity of yields is one of these factors.

*In terms of Mainstreaming Biodiversity in Agriculture (and more)*

As part of a collaborative effort of the Agricultural Biodiversity Community with Ileia / Farming Matters magazine we develop the March 2014 issue "Cultivating Diversity" I think all of this issue (attached below) is relevant to your topic.

The article I submitted on pages 24-25, looks at what has been limiting the expansion of biodiversity-friendly agricultural practices.

Now 4 years later, while I still feel what I have written is valid, I see much more of a deteriorization of the (traditional) knowledge on how to use the diverse resources in diverse agroecological / forest garden systems. (Such as bamboo varieties for building, for cooking with, for weaving, for making ties, for eating, etc) or the many dye plants, many traditional herbs, many wild/ perennial vegetables. This links strongly with aging farmers whose children and grandchildren are not involved in farming. And then with how biodiverse farming can provide a good livelihood for capable young people.

While we have many good examples that are working well, I am aware of some limitations and needs. Such as a greater availability of small-scale appropriate technology / machinery for working in biodiverse farming systems such as forest gardens that could help with increase labor constraints everywhere.

<http://www.fao.org/fsnforum/sites/default/files/discussions/contributions/30_1_Agrobiodiversity_0.pdf>

*Where a (sustainable) production system played a key role for the conservation of the biodiversity surrounding it?*

From my experience what is known as "Forest Gardening" or "Organic Agroforestry" has perhaps the most impressive role in conservation of biodiversity for land-based systems. In our network it is normal to have more than 100 intentionally grown "crops" in these systems. However for scaling up (and which is the case with our gardens and most in our network) one or more "key economic crops" is within the forest system (along with a high diversity of food crops, herbs, spices, hardwood trees, etc.)

Well-documented are the Forest Gardens of Sri Lanka. In terms of watershed/ forest restoration on a larger scale, the success of the Organic Forest Coffee Project initiated by Earth Net Foundation in Chiang Rai province, led to the signing of an MOU with Khuechae National Park and Lam Nam Kok National Park in 2016 to revitalize and restore the degraded forest of the National Park- an area of 3,200 hectares over 10 years together (2016- 2025) through the practice of Organic Agroforestry. Coffee is the key (understory) economic crop.

An article I wrote (link below) describes the forest gardening system of farmer colleague Ms. Kanya Duchita in Chantaburi with key economic crops of Para rubber and tropcial fruits (Durian +) that co-exist with wild elephants (and many other wildlife).

<http://regenerationinternational.org/2018/01/15/forest-gardening-space-place-wild-elephants>

## Joseph Ahenda, FAO, Somalia

Below ground biodiversity is very important for maintaining the resilience of soil ecosystem for sustainable agricultural production. Besides this, soil flora and fauna play a vital role in sustaining the above ground biodiversity and terrestrial ecosystems in general. Despite these, many modern agricultural development interventions pay little attention to these subterranean resources.

The well-being of the soil biodiversity is always being ignored in most agricultural development interventions which emphasise on intensification, large scale monoculture and some time in unstable (erosion prone) landscapes. This leads to decline in soil biodiversity which in turn disrupts agro-ecosystem by reducing plant diversity, organic matter decomposition, nutrient retention and cycling. Many soils become ‘’lifeless’’ and can only support crop production through application of fertilizers.

Many agricultural systems have adopted intensive use of inorganic fertilizers and soil conditioners to compensate for the reduced soil regeneration capacity. However, these inputs further change soil physical and chemical environments, complicating the matters by irreversibly impacting negatively on the soil organisms. This makes farmers increasingly rely on inorganic fertilizers which is not sustainable in the long run in terms of production cost and environment. However, many farmers in Africa can ill afford the inputs leading to steady decline in productivity and production levels in regions.

It is therefore important that agricultural development interventions deploy appropriate strategies to safeguard the below ground biodiversity to ensure soil resilience and sustainable agro-ecosystem.

## Laura Aldrich-Wolfe, North Dakota State University, United States of America

My laboratory is currently comparing fungal community composition and diversity in root systems of coffee grown along the continuum from conventional to organic management at 25 sites in Costa Rica. We find that coffee farmed under shade and without large inputs of inorganic nitrogen fertilizer hosts a more diverse fungal community with more fungi (hyperparasites) that have the potential to serve as biological controls for diseases on coffee. Our work is still in its preliminary stages but suggests that these hyperparasites may be depauperate in conventionally-managed coffee, reinforcing reliance on fungicides to achieve disease control and may need to be restored in order for farmers to successfully transition from conventional to organic management. Despite growing recognition that fungi play critical roles in nutrient cycling and disease control, many researchers and farmers continue to view fungi as playing exclusively negative roles in crop production. There is an urgent need to shift this paradigm by providing farmers with concrete examples of ways in which intact fungal communities can minimize the need for external inputs for nutrient supply and disease control in agriculture.

## Maria J.I. Briones, Universidad de Vigo, Spain

*Could you share examples/activities in your work where a(n) (unsustainable) production system played a key role for the degradation of the biodiversity surrounding it?*

Earthworms improve the structure and fertility of soil by accelerating decomposition processes, enhancing nutrient cycling and facilitating water percolation. Conventionally plowed soils reduce earthworm populations drastically. The most vulnerable species to tillage are the larger ‘anecic’ earthworms that create permanent vertical burrows and feed on soil surface residues. However, they can bounce back if conventional plowing is replaced with less disruptive methods.

The findings published in the scientific journal Global Change Biology show a systematic decline in earthworm populations in soils that are ploughed every year. The deeper the soil is turned, the more harmful it is for the earthworms.

Please also visit our post at the Global Soil Biodiversity Blog "Ploughshares are swords… if you are an earthworm": <http://blog.globalsoilbiodiversity.org/article/2017/06/07/ploughshares-are-swords%E2%80%A6-if-you-are-earthworm>

## Kanna Siripurapu, Watershed Support Services and Activity Network (WASSAN), India

Decentralized Seed Systems for Climate Resilient Agriculture in Rainfed Areas - Designing an Appropriate Seed System for Climate Resilience and Growth of Rainfed Agriculture.

**Background**

Rainfed farming systems in India are diverse, complex and risk prone. Diversity of crops and varietal choices, local adaptability to suit different soils, topography and rainfall patterns (early or late rains for instance), and buffer seeds to meet contingencies; need to be factored into developing an appropriate seed system for climate resilient rainfed agriculture. A community managed, decentralize seed system in public-people-partnership with adequate budget allocation and legal provisions can best address the seed requirements of rainfed areas.

The Crippling Seed Economy of Rainfed Agriculture

* Served mostly by the informal seed sector without much public investment in research and development,
* Unavailability of quality seeds of diverse and locally adapted crops in time,
* Ne seed buffers for climate contingencies, high susceptibility to climate variability, contingency plans remain a rhetoric,
* High seed costs – particularly high volume seeds like groundnut,
* Seed constraints of inter-crops, compelling farmers to resort to mono-cropping,
* Loss of locally adapted landraces and (indigenous) agro-biodiversity,
* Poor public investment and non-availability of subsidies and access to state supported schemes.

**The Seed Systems of India**

**Formal Seed Sector**: Seed market of India worth US$ 2.7 billion and the sixth largest seed market in the world (ISF, 2013). The private and public sectors are the only players in the formal seed system. Much of the seed sales in India have been confined to supply and sale of only a handful of seed varieties of high yielding varieties (HYVs) and cash crops. Only 30-35 per cent of the seed requirement is met by the formal sector, and the rest 65-70 per cent is met from the farm saved, informal seed system.[1],[2],[3]

**Public Seed Sector**: Promotes HYVs, focuses on seed replacement ratio. Supplies only handful varieties of high-volume, low-value seeds. Highly centralized with poor outreach and caters to subsidized seed distribution. Confined to Seed Village Programme, promotion of certified seeds, QC, market regulation and research, and Small-scale farmers may not have access to certified seeds.

**Private Seed Sector**: Supplies cross-pollinated, high-value and low-volume seeds. Do not supply low-volumes of diverse low-value crops seeds and Low penetration in the rainfed regions.

**Seed Village Programme**: Meant for replacement of farmer saved seeds, the seed village programme (SVP) is ad-hoc and do not have any mechanism for procurement and supply of locally produced seeds to ensure a seed supply chain.

**Protection of Plant Varieties and Farmers Act 2001**: There is a lack of mechanism for multiplication and integration of locally adapted landraces and the registered famers’ varieties into the formal seed supply chains.

**Informal Seed Sector**: Predominantly farm produced, caters to 65-70 % (upto 90% in few Indian states) of seed requirement of the country with high potential for production of diverse crops. Self-pollinated, diverse indigenous land races and varietal choices adapted to local weather and soil conditions. Maintains buffer seeds to meet contingencies. Conserves indigenous agro-biodiversity and indigenous knowledge and practices. Retains farmers’ sovereignty over seeds and food production, and Minimizes investment on seeds, promotes local enterprises and economy.

**Public-People-Partnership**

* Location specificity, diversity and contingency are core to an appropriate seed system for rainfed agriculture; the present seed systems cannot meet these requirements,
* Public investment on an appropriate seed system for rainfed agriculture can stimulate growth, provide security against vagaries of climate change, and
* Government partnership with farmers’ organizations can best serve the purpose of rainfed areas.

In the above context, a National Workshop was organized by WASSAN (<http://www.wassan.org>) on designing an appropriate decentralized seed system for rainfed agriculture in India and we are in the process of finalizing the proceedings, which will be shared soon.

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## Siosiua Halavatau, Pacific Community (SPC), Fiji

Food availability from agricultural production (food per capita) in the Pacific Islands is either stagnating or declining over the last few decades and the causes are agro ecological including declining productivity of the production environment as caused by downward spiral of soil productivity, increased pests and diseases and genetic erosions. And socio-economic factors like changing dietary habits, land tenure systems and decreasing labour force as youths are not interested too much in farming. As consequence of our dietary change and lifestyle becoming more static – we as a region is the most prone to NCDs and of the 10 most NCD severe countries in the world at least 5 are from our region.

For this discussion the issue of biodiversity is the theme. For the sake of development the approach has been to go for a few varieties of major staples and promote for food and marketing. As a consequence this has resulted in narrowing down of the genetic base and in some instances because crops become more prone to pests and diseases – crops almost disappear from countries like taro leaf blight almost wiped out taro from Samoa in the mid-late 1990s. This has become a real issue in the Pacific Islands and hence strategy now is to widen the genetic base by introducing more crop accessions and developing local varieties. The Pacific Community (SPC) in Fiji then established the Centre for Pacific Crops and Trees (CePaCT) to conserve, clean up materials and promote use in the Islands. We also now promoting participatory selection where varieties and accessions are given to farmers to evaluate and select those they want and this has started to widen genetic base. This approach has revitalise taro in Samoa. The same approach is also taken for trees where traditional trees are lost and CePaCT is also set up to address this. This means we need to be seed smart by continuously evaluating our crop varieties against stressors – climate change and non-climate change. Water management is also very vital for this since many of our countries have been having droughts in the last decade.

The Pacific Islands also are the most vulnerable to climate change and we have adopted climate smart agriculture as an approach and in an integrated manner we are starting to promote smart technologies like nutrient and Carbon smart where we try to improve nutrient cycling and soil organic carbon in the soil so that below ground biodiversity is improved. To improve resilience, we are starting to promote reintroduction of traditional and multi-purpose trees to the systems which are long-term sinks. And by doing these smartly we improve resilience and adapt to climate change as well as attaining food and nutrition security.

In Pacific Islands, we now regularly getting category 5 cyclones so our food supplies are regularly disrupted by these natural hazards – cyclones, flash floods, and droughts. So for disaster risk reduction strategy genetic resources become vital for these . Countries must have ex situ sources of planting materials to quickly respond to these.

In a nutshell the Pacific Islands are vulnerable to not only climate variability but like atolls inherent soil and water availability are issues and these must be taken into consideration as prerequisite to promoting biodiversity for food security and better nutrition. But for biodiversity to work its promotion must be coupled with promoting lifestyle changes to counter the incidence of NCDs

Thanks

Siua

Siosiua Halavatau
Crop Production and Extension Coordinator
SPC Land Resources Division
Suva
FIJI ISLANDS

## Dineshkumar Singh, Tata Consultancy Services, India

**1) Biodiversity is an important contributor to food security and improved nutrition.**

**1.1) Biodiversity is contributing in achieving food security and improved nutrition?**

**Fisherfolk is taking up mangroves conservation through lucrative mud crab farming: A case study from Maharashtra (India)**

*Source:* [*https://scroll.in/article/865136/maharashtra-is-encouraging-fisherfolk-to-conserve-mangroves-by-introducing-lucrative-crab-farming*](https://scroll.in/article/865136/maharashtra-is-encouraging-fisherfolk-to-conserve-mangroves-by-introducing-lucrative-crab-farming)

Mangroves are trees or shrubs which grows in tidal, chiefly tropical, coastal swamps, having numerous tangled roots that grow above ground and form dense thickets. They are also the breeding grounds and habitat for a variety of marine organisms. They have developed unique adaptations to the harsh conditions of coastal environments and also act as shoreline protectors from nature’s fury like Tsunami.

Maharashtra, a west coast province of India, has a mangrove area of 186 sq km. This too is being threatened due to chance in climate and various developmental activities like urbanization. But they are important nursery and feeding habitats for many marine and coastal species.

A crab species called mud crab is found in estuaries, backwaters and coastal areas. It is also known as mangrove crab and is a good source of protein and is especially in demand during the summer season, when the fish catch drops. Small fisher folk would wade through the mangroves and mud flats searching for crab holes to hunt them using long iron hooks.

During 2011, UNDP Global Environmental Finance initiated a four-year-long mangrove crab farming in 17 villages of Sindhudurg district in Maharashtra. Sindhudurg has a unique coastal and marine biodiversity. The program facilitated the fisher folk from these villages to go on aquaculture related institutional tours, get financial grants, form of self-help groups and set up pens, besides providing them with baby crabs, also known as crablets, for a mere $0.03 (Rs 2) per piece, which will fetch farmers $16 (Rs 1000) per crab after nine months of harvesting. The season for crab farming in the mangrove region is from September to May and there is huge demand for mud crab in international markets.

Instead of digging artificial ponds for growing crabs, fisher folk create pens in existing waters, leaving the tidal water flowing to the mangroves undisturbed. They source the crablets from a hatchery and not from the wild; as such precautions ensure optimal growth of crabs in a healthy mangrove ecosystem. This not only creates a livelihood for the local community but helps in enabling the mangrove conservation as this habitat is an important factor in this livelihood. As the crab farmers utilise the space between the mangrove shrubs, the community no longer cuts the branches for fuel wood or other purposes. The crabs are grown in the pens for six and eight months and fattened with remains of marine creatures like squid and eel to increases their sizes, guaranteeing the fisher folk a good price.

Women Self Help Groups (SHGs) have earned over 600$USD to 1200 $USD per year from this venture. One of the major challenges faced by them is about the availability of the mud crablets. Maharashtra government has allocated 3.5m USD to its Mangrove and Marine Biodiversity Conservation Foundation (MMBCF) part of which will be used to set up a crab hatchery in Sindhudurg, with the potential of producing one million crablets a year which will also ensure extending the UNDP Project to all coastal districts of Maharashtra.

**1.2) the overuse of biodiversity compromise food security and nutrition?**

**Loosing livelihood: Overfishing cuts Maharashtra's catch by over the years – a case study**

Source: <https://timesofindia.indiatimes.com/city/mumbai/Vasai-turns-into-a-one-fish-town-as-overfishing-cuts-Maharashtras-catch-by-23/articleshow/55532520.cms> and <https://www.researchgate.net/publication/255635078_Trawling_and_by-catch_Implications_on_marine_ecosystem> [accessed May 21 2018].

A few decades ago, Maharshtra fisherfolk used to catch a variety of fish with their traditional fishing gears like dol or bag nets. Now that’s changing. Experts blame the crisis mainly on overfishing caused by the explosion of trawlers and the introduction of purse-seine nets in the late 1990s. Together they accounted for almost 75% of state fish catch during 2105. While fish catch can fluctuate from year to year, a 2013 CMFRI analysis of long-term trends found that the many fish stocks are in decline. Study found that CAGR had declined from 3.2% in 1961-90 to 0.41% in 1990-2000 to -4.7% in 2000-2010. Apart from trawlers, traditional boats have also increased in size and number too.

**Curse of purse seines**

But the spread of purse seines, which are much larger than traditional nets, is seen as the most immediate threat. A purse seine is a large wall of net dropped into the ocean, with a string looping the bottom edge like a drawstring purse. It can corral 1-2 lakh tonnes of fish at one go, including vast quantities of commercially useless baby fish.

**Bottom Trawl – Greed to destroy**

Trawling is a controversial method of fishing due to the perceived lack of selectivity of the trawl net and the resultant capture of a huge quantity and diversity of non-target species, bottom flora and fauna including endangered species such as sea turtles, coupled with its effect on the marine ecosystem. The impacts of trawling on the physical, chemical and biological environment of the marine ecosystem and the diversity and quantity of by-catch and discards remain poorly documented for the tropical waters. In India, the by-catch landed at fishing harbours are utilized mainly for the production of manure and animal feed. Further, by-catch reduction devices have not been implemented in the field.

**Wasting the future - juvenile bycatch**

This juvenile bycatch results in fewer fish growing up to reproduce. A report by the V S Somvanshi expert committee last year warned against the use of purse-seine nets in near-shore waters (shallow waters), especially during breeding season. No new purse-seine licences are being issued, and mesh sizes have been restricted to reduce the catch of smaller fish. Sustainable fishing is the need of the hour. A 61-day ban on monsoon fishing already exists. Also, traditional fishermen voluntarily close their dol nets earlier than usual in the pre-monsoon months. This has resulted in good catch in subsequent months, but much of the Bombay duck catch has been the normal adult size.

**Pollution**

Still, other challenges remain. Pollution flows down the Vasai creek into the estuary, choking breeding grounds. Plastic has become part of the catch. And the proliferation of oil wells off Thane has shrunk traditional fishing grounds.

**2) All agricultural sectors (crop and livestock, forestry, fisheries and aquaculture) rely on biodiversity and on the ecosystem functions and services, they underpin. At the same time, these sectors may affect biodiversity through various direct and indirect drivers.**

**2.1) where a (sustainable) production system played a key role for the conservation of the biodiversity surrounding it?**

**Saguna Rice Technique (SRT) – A case study on bio-diversity conservation using Zero till, More yield & Better soil fertility method.**

Source: [https://sagunarice.wordpress.com/srt-an-introduction](https://sagunarice.wordpress.com/srt-an-introduction/)

Saguna Rice Technique is a unique new method of cultivation of rice and related rotation crops without ploughing, puddling and transplanting (rice) on permanent raised beds. This is a zerotill, Conservation Agriculture (CA) type of cultivation method evolved at Saguna Baug, Neral, Dist. Raigad, Maharashtra. This method combines multiple best practices of the cultivations such as Systematic Intensification of Rice (SRI), raised bed cultivation, green manure, etc. The permanent raised beds used in this method facilitates ample of oxygen supply to root zone area while maintaining optimum moisture condition there. The SRT iron forma (the tool will be better soon) facilitates planting of crop in predetermined distances enabling precise plant population per unit area.

**Multiple advantages of SRT**

For not having to do puddling, transplanting and hand hoeing, saves 30% to 40% cost of production & not requiring transplanting saves 50% treacherous labour.

Loss of valuable silt (about 20%) during puddling can be prevented thus more fertile land can be handed over to next generation.

Leaves of rice plants on SRT beds seem to be broader and head more upwards to sunlight than their counterparts in conventional method. They are likely to produce more biomass, means higher yield.

SRT has ability to bring “Vigorous Uniformity” and higher yields in all soil types even in degraded soils and socio-economic groups. For example a very new farmer and well established awarded farmer and agricultural universities will attain about the same higher yield per unit area.

Hand hoeing is strictly avoided in SRT. Once again this reduces hard-work and loosening of top soil making it vulnerable for washing away.

Today’s recommend dose of fertilizer can be brought down considerably.

**A good number of earthworms are noticed on SRT beds during high rainfall days attracting unusual birds to SRT plots. This magic is due to suppressing all green growth with glayphoset, which decays and becomes instant food for the worms. Also ‘No-Till’ prevents destruction of E’worms life. Thus SRT proves to be Eco-friendly Farming. This is big positive gain**.

SRT insists keeping of roots of previous crop in the raised bed. The root network prevents soil from cracking and makes it more spongy. The same roots become valuable source of organic carbon which is uniformly distributed and oxygen pathways to root zone of next crop.

Avoiding of puddling will drastically reduce diesel consumption, emission of CO2 over thousands of acres of paddy cultivation. Also SRT being aerobic method it will prevent methane generation. Both CO2 and methane are responsible for global warming.

The traumatic shock caused to the rice seedlings during transplanting is avoided in SRT. This reduces possibility of pest & disease problem.

Rice crop gets ready 8–10 days earlier. Also it saves time required for soil tilling between two crops. This leaves valuable 10–15 days of crop season for the farmer enabling him to take more than one crop in the same plot in a year.

Due to excessive water in low-lying plots removing of harvested paddy from the plot for drying can be avoided with SRT raised beds.

During milling of paddy, SRT will yield higher percentage recovery of grains.

Non-use of heavy agricultural machinery for tilling in field will prevent compaction & formation of hard pan of lower strata of soil enabling better percolation of water into dipper soil & permanent establishment of earthworms.

It is possible to get high returns (more than ₹ 5,00,000 per hector per annum) with crop rotation such as Basamati Rice (PS-5) in Kharif, leafy vegetables in Rabbi, Bold Groundnut (W-66) in Summer, while improving health of the soil.

Damaged soils can be recovered by SRT, which is caused by lashing, scrubbing & natural calamities, in quickest possible time.

**2.2) where a(n) (unsustainable) production system played a key role for the degradation of the biodiversity surrounding it?**

**National Human Rights Commission (NHRC) issues notice to Punjab govt (India) over excessive use of pesticides**

Source: <https://timesofindia.indiatimes.com/home/environment/nhrc-issues-notice-to-punjab-govt-over-excessive-use-of-pesticides/articleshow/62726755.cms>

A study in 2011 found that the disease of cancer among farmers of the Malwa region of Punjab is caused due to excessive use of pesticides on the crops and that due to non-availability of the cheap treatment of cancer, about 70-100 cancer patients travel to Bikaner in Rajasthan for free treatment and cheap medicine at the Acharya Tulsi Regional Cancer Trust. The commission had closed the case the same year after a prompt and affirmative action was promised by the state government.

The Punjab government, at that time, had said that the farmers were being trained on the judicious use of pesticides even as some dangerous pesticides had been banned or their use was restricted.

"A study, reportedly conducted by the Baba Farid Centre for Special Children, an NGO suggests that heavy metals may be responsible for a steady decline in sperm count, disturbed ovulation cycles, increasing menstrual disorders, sterility, spontaneous abortions, premature births and birth defects," says NHRC.

"It is further stated that Punjab, especially the Malwa region is reeling under the 'cocktail effect' of heavy metals. The green revolution of the 60s' and 70s' resulted in the dumping of dangerous chemicals such as endosulfan and these pesticides are still in use in Punjab, long after they were banned," it said.

NEW DELHI: The National Human Rights Commission has issued notices to Punjab government and Union ministry of health and family welfare over a report that excessive use of pesticides and insecticides have left a residue of heavy metals in soil and groundwater causing various serious diseases to many people in the Malwa region of Punjab.

"The negligence by the state authorities has caused a grave violation of human rights of these people. Due to these diseases, poor victims are not able to lead a normal life with dignity. The insensitive approach of the administration is apparent. The state cannot leave its citizens, affected by various diseases due to soil and drinking water poisoning, to live in undignified and traumatized conditions," said NHRC in a statement.

**According to reports, heavy metals are reaching the environment in dangerous amounts from reckless human activities due to their use in products like pesticides, herbicides, medicines, paints and cosmetics.**

**3) Good governance, enabling frameworks, and stewardship initiatives are needed to facilitate mainstreaming of biodiversity within and across agricultural sectors.**

**3.1) Do you have any examples of such enabling factors and initiatives or the lack of it?**

**<to be developed>**

*Examples could include Cross-sectoral land use planning;*

*Macro-economic policy and public investment;*

*Elimination, phasing out and reform of perverse incentives harmful to biodiversity;*

*Product labelling and market certification schemes;*

*Green finance and private investment or others*

**3.2) Which partners need to be involved in institutional frameworks, policies and processes for biodiversity mainstreaming to strengthen them?**

We must involve the local NGOs, farmers community and government. We should look at incentivizing the farmers for their contribution.

**4) The importance of biodiversity for improved food security and better nutrition is not always evident to those engaged in agricultural sectors.**

**4.1) What needs to be done to increase awareness of farmers, livestock keepers, fisher folks and foresters, their organizations and the industry of the relevance of biodiversity and ecosystem services for the food and agriculture production in their sector?**

We must use the technological platforms like mKRISHI® to create awareness and create an open and transparent communication channel – between all relevant stakeholders

mKRISHI® CCA - An ICT strategy to enhance Adaptive Capacity to Climate Change in vulnerable regions

Source: <http://www.iimahd.ernet.in/egov/ifip/july2015/dineshkumar-singh.html>

## Salomeyesudas Buduru, Researcher, India

Mainstreaming Biodiversity for improved Food security and better Nutrition is the need of the hour. The reality is there are many regions which are rich in Biodiversity in Agriculture and Forestry but highly poor in nutrition.

The biggest challenge is look at the successful case studies where these too are linked for mutual benefit.

I have sited few such studies below

[www.fao.org/tempref/docrep/fao/012/i0370e/i0370e10.pdf](http://www.fao.org/tempref/docrep/fao/012/i0370e/i0370e10.pdf)

<https://www.ncbi.nlm.nih.gov/pubmed/17215184>

[http://agrobiodiversityplatform.org/par/2014/10/21/forests-as-food-producing-habitats](http://agrobiodiversityplatform.org/par/2014/10/21/forests-as-food-producing-habitats/)

Governments should make nutrition as their priority over industry ,mono cropping systems and chemical input agriculture. Safety and diversity in diets are key to nutrition.

Sincerely,

Salome Yesudas

## Adam Brent, Cocoa Corporation, United States of America

Hello,

I would like to submit the following work for consideration:

Cocoa Corporation is participating in 3-year study that merges drainage management authority objectives with conservation services that follow circular economy principles. The project aims to improve water quality, rebuild soil health and increase crop resiliency, while benefiting farm economics and creating new business opportunities throughout the region.

Specifically, the team will focus on reducing phosphorus, nitrogen and sediment loads to the Great Lakes Basin, and on increasing the ability of soils to hold water. The team projects that even a moderate level of uptake a few years beyond the project would greatly reduce agriculturally-derived nutrient loading to the Great Lakes.

Agricultural landowners in legal drainage districts must pay assessments to maintain and improve the public drainage systems that serve them. These assessments are generally based purely on acreage and/or linear extent of the adjacent drainage. This project will test new methods for calculating drain assessments that reward farmers who implement land management practices that improve soil and water quality. This adaptive drain fee assessment model presents the opportunity to test market-based approaches that work in support of the model.

Three treatment approaches will be tested in this project with pilot locations in Van Buren County, Michigan, Milwaukee River watershed, Wisconsin and a to-be-finalized location in Indiana. These pilots will yield information on both water quality benefits and economic opportunities associated with phosphorus capture. The project will create and propel a community of practice that includes drainage district authorities, conservation managers, agricultural retailers, commodity buyers, farmers, and food waste generators that will extend this work beyond the initial Great Lakes pilot locations.

Cocoa’s role in this study will be to produce a high quality humus compost from organic waste residuals, apply the compost in variable application rates, and then measure the effects of the compost on nutrient and water use efficiency as well as crop yields. The diverse microorganisms contained in our compost will help rejuvenate nutrient cycling and suppress soil diseases.

Best wishes,

Adam

## Gabriel Luna, cam-plants.com, Mexico

Climate change is already talking its toll on biodiversity and the path humanity has taken of extensive mono crop production with no regard to biodiversity has put enormous strain in ecosystems around the globe,

Plants are key players in any healthy biota. Atmospheric carbon is transformed in to and organic carbon that is then incorporated to the food web. Humanity's food security ,dependent on mono crops like soya, corn,wheat and rice is threatened by climate change and the availability of water sources for irrigation. The crops mention above follow a C3 and C4 photosynthetic pathway which needs regular water availability. The norm with climate change are irregular rain patterns and an increase of global temperatures. We need to plan ahead.

Crassulacean Acid Metabolism plants follow a different photosynthetic pathway one that evolved to be successful in the type of environment we are facing. Their stomata, tiny openings that allow the exchange of gases open an night when the temperatures are cooler, sequester the atmospheric carbon and store it as malic acid, during the day when temperatures rise, they close the stomata minimizing water lose through perspiration and complete their photosynthetic cycle.

Mexico holds the most diverse concentration on cam-plants in the planet and humans here for millennia have been successful in incorporating them as food sources and in many other useful applications that need to be shared .

Permaculture design that incorporates the holistic management of grassland and cam-plants can help restore food security in conflict ridden arid regions around the globe. Same regions that are now triggering mass migrations to northern latitudes caused by the underlying consequence of loss of livelihood.

The agave and cactus is are an important part of the xeric grasslands and scrublands ecosystems, they give nourishment and shelter to a myriad of organisms, help water retention and can be used as anchors to slow erosion, help soil formation and sequester carbon in environments that by nature have slow carbon cycles.

Governing sectors, nonprofits in hand with international agencies can coordinate affords to propagate and educate local farmers to incorporatee indigenous species of cam plants that con be used for sustainable fodder and human consumption in times of drought.

At the Federal and State level, Mexico has implemented programs to propagate cam-plants with a varied rate of success and the experience can be used as a precursor template to implement propagation programs around the globe, in fact many useful species of cam-plants can readily be micro-propagated at relatively low cost.

Below we added some links that can be useful to illustrate some State sponsored efforts to propagate agaves in Mexico.

<http://www.sederec.cdmx.gob.mx/comunicacion/nota/sederec-apoya-proyectos-para-produccion-y-preservacion-del-maguey-cultivo-nativo-de-la-cdmx>

<http://biblioteca.inifap.gob.mx:8080/jspui/bitstream/handle/123456789/1372/794.pdf?sequence=1q>

cam-plants.com is an effort from the civil to bring awareness and incorporate Crassulacean Acid Metabolism plants to our food cycles to face our global warming paradigm. Link academics, farmers and the general public to generate effective propagation strategies.

## Penelope Greenslade, Federation University, Australia

**Mainstreaming biodiversity in Agriculture, Fisheries and Forestry for improved Food Security and better Nutrition.**

**2. an unsustainable? Production system plays a key role in degradation of the biodiversity surrounding it.**

Broad acre arable agriculture in south eastern Australia. The system studied was a low tillage/direct drilled system growing wheat/canola/lupins in a rotation and a separate system with continuous cotton. The surrounding native vegetation is each case supports a native soil fauna (Collembola) comprising upwards of 20 species with few if any exotic species. The arable systems carry mostly exotics with few natives. In long term trials the native species disappear.

The conclusion is that broad acre arable agriculture of a range of crops in south east Australia contribute nothing to native biodiversity and only promote exotic invasive species.

**3. Mainstreaming of native biodiversity**

Conservation farming which includes broad strips of native plantings around cropping and pasture fields which is adopted by a few farmers in western Victoria, Australia, provides habitats for native species, particular predators. Examples of these conservation farms will be surveyed shortly.

The partners that need to promote this conservation farming are the Catchment Management Agencies, Land Care Groups, Farming Cooperatives, local councils and State governments.

**4. Education of management and other authorities of the contribution of biodiversity.**

Raising awareness in all those persons managing land must be via media that is used by these practitioners. I suggest they all use meteorological services and regional agricultural information sources. Methods could be via information sheets but better interactive online games that allow different options such as different levels of pesticides, tillage, native vegetation plantings, seed treatments and density etc and models showing the different outcomes of each option separately and in combination to pesticide levels in crops, value of ecosystem services, production and economic and social benefits.

Increased knowledge of the benefits and otherwise in the options can only be advanced by increased research. The answer, as always, to solve this is financial support for increased research including university places in agricultural faculties and Tafes.

## Dheeraj Singh, CAZRI, India

**Small biodiversified farm for perennial food and nutritional security in arid zone: A case study from Rajasthan, India**

**Dheeraj Singh,Chandan Kumar,M K Chaudhary and M L Meena**

The case study presents a precise review of Mr. Madan Lal Deora, a progressive farmer of Pali, district of Rajasthan in India who had established himself as a successful farmer adopting diversified farming system.  He had adopted multiple cropping and farming system on his farm which is 2.5 hectare in area by growing legumes, cereals, oilseeds, pulses, medicinal plants and forest plants alongwith horticultural crops including fruits and vegetables.

The case study is an excellent example where one can find more than 100 cultivated and natural species of plants growing in close harmony supplementing each other.

The crops include wheat (Triticum aestivum), maize (Zea mays), barley (Hordeum vulgare), oats (Avena spp.), jowar (Sorghum bicolor), bajra (Pennisetum americanum), mustard (Brassica nigra) and til (Sesamum indicum). In spices one can find cumin, fennel, fenugreek and dill in fruits the major plants are Drumstick (Moringa olerifera), Ber (Zizyphus maurtiana), Mulbery (Ficus alba), Jamun (Sygigium cumuni), Aonla (Emblica officinalis), Custard apple (Annona squmosa), Gonada (Cardia myxa) and Fig (ficus carica). In vegetables the farmer is growing mint (Mentha Arvensis), spinach (Basella alba), okra (Hibiscus esculenta), tomato (Lycopersicon  esculentum), ginger (Asarum canadense), red and green chillies (Capsicum annum),carrot (Daucus carota), coriander leaves (Coriandrum sativum) and fenugreek (Trigonella).

The farm structure contributes to biodiversity, a diverse and esthetically pleasing rural landscape, and open space.

In wild plants we can find Phog (Calligonum polygonoides), Angreji babool (Prosopis juliflora), Bordi (Ziziphus nummularia), Lana (Haloxylon salicorniourn),Bawli (Acaacia jacquernontii), Gugal (Cornrniphora wighti), Henna (Lawsonia inermis), Anwal (Cassia ouriculate),  Kair (Capperis decidua), Ber (Ziziphus nummularia) and Kheep growing on the farm boundary.

In general we can see an entire biosphere of the arid zone vegetation with cultivated plants in a small farm. The farm embodies a diversity of cropping systems, of farming systems, of landscapes, of biological organization, culture and traditions. The forested areas from which wild foods, and leaf litter are extracted, the wood lot, the farm itself with intercropping, agroforestry, and large and small livestock, the fish pond, the backyard garden, allow for the preservation of hundreds if not thousands of wild and cultivated species.

Proper management of the natural resources of soil and, water, produces significant environmental benefits for society. The benefits of farms extend beyond the economic sphere. To begin with, Mr Madan utilizes a broad array of resources and has a vested interest in their sustainability. At the same time, his farming system is diverse, incorporating and preserving significant functional biodiversity within the farm. By preserving biodiversity, open space and trees, and by reducing land degradation, the farm provides valuable ecosystem services to the larger society. Along with agriculture the farmer is having livestock which yields milk and the dung is converted into valuable vermicompost. He had also turned himself into an entrepreneur by processing and value addition to his farm produce through a tunnel drier.  The solar tunnel dryer is a poly house framed structure with UV-stabilized polythene sheet, where products on large scale could be dried under controlled environment. The enterprise consists of different value added products of typical Indian fruits and vegetables including juice, squash, candy, powder, pickle, dry aonla, churan tablets, preserve and ladoos. All the products are purely organic have high demand in the local and regional market. Thus this model of multifunctional small farm which integrate crops, horticulture,

## Elie Padonou, Global Soil Biodiversity Initiative, Benin

Could you share examples/activities in your work where a(n) (unsustainable) production system played a key role for the degradation of the biodiversity surrounding it?

Impact of farming on bowalization in Benin, West Africa

Bowal (plural bowé) is a particular form of degraded land that occurs in tropical regions and leads to the exposure of ferricretes, which are unsuitable for farming. Bowé are more common on farmland and degraded savanna. Changes in land use/land cover were used to map a region of 6.7 million ha in northern Benin, West Africa in 1975, 1990 and 2010. The changes observed during these periods (1975-1990, 1990-2010 and 1975-2010) were used to predict the occurrence of bowé in the period up to 2050 using Markovian chain analysis.

The findings publsihed in Land Use Policy (Padonou et al 2017) showed a considerable change in land use/land cover during the three periods. The types of land on which bowé occur (farmland and degraded savanna) increased in northern Benin by 5.4% per year during the period 1975-1990 and 9.5% per year during the periods 1990-2010, while the natural vegetation (forest, woodland and tree savanna) decreased by the same amount. The future scenarios also predicted the same trend. In the period 1975-1990, 1.28 million ha (26%) of natural vegetation was converted to degraded savanna and farmland while 2.23 million ha (53%) of natural vegetation was converted to degraded savanna and farmland in the period 1990-2010. Based on the dynamics recorded during the period 1975-1990 and 1990-2010 respectively, a total of 1.28 million ha (26% of the natural vegetation that was present in 1975) and 1.29 million ha (31% of the natural vegetation that was present in 1990) will be converted to farmland and degraded savanna in the study area by 2050.

## Jodean Remengesau, FAO, Italy

**4) What needs to be done to increase awareness of farmers, livestock keepers, fisher folks and foresters, their organizations and the industry of the relevance of biodiversity and ecosystem services for the food and agriculture production in their sector? How can the technical and institutional capacity needed to promote sustainable agriculture and reduce the impact on biodiversity be developed?**

Good governance and enabling framework—Lessons from the Pacific SIDS

Mainstreaming biodiversity requires a coordinated effort of high-level engagement with the national government, traditional leaders and international organizations. In the SIDS country of Palau, traditional leaders sit as special advisory council to Office of the President. Recognizing the needs and trends of the people and the effects on the environment and national resources the Council of Chiefs work closely with the President to ensure laws and regulations are aligned with traditional wisdom and grassroots needs. The [Micronesia Challenge](http://themicronesiachallenge.blogspot.it/p/about.html) ,[Palau National Shark Sanctuary](http://news.nationalgeographic.com/news/2009/09/090925-sharks-sanctuary-palau.html), [Protected Areas Network](http://www.un.org/depts/los/consultative_process/documents/7abstract_idechong.pdf) and [Palau National Marine Sanctuary](http://www.huffingtonpost.com/president-tommy-remengesau-jr-/palau-chiefs-offer-wisdom-in-bul_b_8168200.html) are based on the traditional conservation practice called bul whereby village chiefs in observance of depleting fish stocks enforce a temporary ban on specific species ensuring the natural processes of spawning and feeding enable the replenishment of fish stocks and securing the long-term livelihoods of fisherfolk and the tourism industry. The [Green Fee](http://www.palaupanfund.org/) is an environmental use fee paid by visitors to fund enforcement at the local level. In many SIDS countries tourism is the breadbasket of the economy and exploitation of natural resources leads to the permanent loss of biodiversity. In mainstreaming best practices toward conservation of biodiversity Palau introduced an innovative law in December 2017 requiring tourists to pledge not to harm the environment. Immigration and education policies were altered to promote and enforce the discouragement of irresponsible tourism for the benefit of the future generation of Palau ([The Palau Pledge](http://www.theguardian.com/world/2017/dec/15/explore-lightly-palau-makes-all-visitors-sign-pledge-to-respect-environment)).

## Maria Tsiafouli, Aristotle University, Greece

**2) All agricultural sectors (crop and livestock, forestry, fisheries and aquaculture) rely on biodiversity and on the ecosystem functions and services, they underpin. At the same time, these sectors may affect biodiversity through various direct and indirect drivers.**

Biodiversity plays a decisive role in ecosystem functioning. The most neglected part of biodiversity, namely soil biodiversity, provides significant ecosystem services, including processes related to nutrient cycling, but is affected by land use type. Specifically, extensive studies in agricultural areas across Europe with variable climatic conditions ([de Vries et al. 2013](http://www.pnas.org/content/110/35/14296), [Tsiafouli et al. 2015)](https://onlinelibrary.wiley.com/doi/abs/10.1111/gcb.12752) have shown that land use systems, such as intensive wheat rotations including annual tillage, consistently reduce biomass and diversity of several groups of soil organisms irrespective of soil abiotic properties.

**3) Good governance, enabling frameworks, and stewardship initiatives are needed to facilitate mainstreaming of biodiversity within and across agricultural sectors.**

Our study ([Tsiafouli et al. 2013](https://link.springer.com/article/10.1007/s00267-013-0036-6)) has shown that agricultural activities, regarding crops, livestock and forestry, are present in 86% of sites belonging to the Natura 2000 network (European network of areas for nature conservation). Taking into consideration that agriculture relies on biodiversity but also affects biodiversity, there is a need for a closer cooperation between initiatives of both the agricultural as well as the conservation sector. A common goal would be to both conserve biodiversity but also optimize the delivery of multiple ecosystem services. A Frontiers research topic ([Tsiafouli et al. 2017](https://www.frontiersin.org/research-topics/3651/optimizing-the-delivery-of-multiple-ecosystem-goods-and-services-in-agricultural-systems)) shows how biodiversity/ecosystem based management regimes can enhance both agricultural production and the provision of multiple ecosystem services.

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## Stefan Geisen, NIOO-KNAW, Netherlands

1.Biodiversity is an important contributor to food security and improved nutrition with biodiversity contributing in achieving food security and improved nutrition?

Soil biodiversity might provide the solution for sustainable agriculture. That means, to reduce conventional pesticides and fertilizers through application of biocontrol agents and as biofertilizers. We know, however, too little about the taxonomic and functional diversity of soil life for targeted applications. I am trying to expand this knowledge together with the Global Soil Biodiversity Initiative (GSBI) and at the same time try to manipulate soil biodiversity for enhanced crop production. Small companies in the Netherlands have now started to also realize the potential of sustainably promote plant growth by the addition of specific, novel biofertilizers and I am collaborating with them (e.g. [www.ecostyle.nl/groensector/protoplusr](http://www.ecostyle.nl/groensector/protoplusr) and [www.soiltech.nl/pages/en/home.php?lang=EN](http://www.soiltech.nl/pages/en/home.php?lang=EN) )

3. As mentioned above, the GSBI provides an international framework to bridge experts on all aspects of soil biodiversity around the globe. In line, I have started the soil protist initiative (<https://soilprotists.wordpress.com> ) in which the aim is increase the understanding of a little, yet important group of soil life: protists. Furthermore, UniEUK (<https://unieuk.org>) is another global effort to increase the (taxonomic) understanding of little known eukaryotes, which brings together the entire scientific community working on mostly single celled eukaryotes.

In Wageningen, the Center for soil ecology (<https://www.soilecology.eu>) was initiated that helps linking soil scientists working on all aspects of soil biodiversity with the public and private sectors to spread the importance of soil biodiversity.

All these initiatives are key to promote soil biodiversity as we are well aware that soil biodiversity forms the base for our well-being (Bardgett and van der Putten, 2014; Wall et al., 2015; Wall and Six, 2015).

Yet, more attention, a better connection between soil biodiversity science and e.g. politics, and diverse business sectors including agriculture need to be achieved, which will help to better study soil biodiversity before some members might go extinct. This will in the end result in a mutual benefit by all partners involved.

4.Diverse steps have to be taken and these have to start from all partners. Scientists have to become more aware of ongoing problems and need to engage in outreach outside their scientific community. At the same time, governmental (or FAO) supported platforms would help to bring different parties together and start these interactions. These would be beneficial both on a national but also international level to find a common ground for more efficient methods to promote sustainable agriculture and (soil) biodiversity at the same time.

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## Tobias Ludes, Global Nature Fund, Germany

Dear Sir or Madam,

I would like to make a contribution to your discussion round on “Mainstreaming Biodiversity in Agriculture, Fisheries and Forestry for improved Food Security and better Nutrition”

EU-LIFE Project “Biodiversity in Standards and Labels for the Food Sector” aims at improving criteria from food standards and procurement guidelines in order to enhance biodiversity in agricultural production. Both, food standards and food companies from all across EU participate in this initiative. After a first analysis of 54 regional, national and international food standards and guidelines a baseline report on how far the schemes address biodiversity was published. Based on this paper and on further interactions with stakeholders and experiences from pilot farms a set of recommendations for the food sector was elaborated. This paper includes biodiversity measures for agricultural production which food standards and food companies should respect in their procurement guidelines and criteria catalogues. A great number of stakeholder will implement these measures in their standard review. To complete the mainstreaming of biodiversity, a monitoring system based on an online tool for potentials for biodiversity on the field is under development and will soon be available for testing. Additionally, a roundtable on the subject of Biodiversity in the Food Sector is about to be created were any interested stakeholder can contribute to the future role of this important topic.

For more information on the project, please visit: food-biodiversity.eu

Links:

Recommandations: <http://www.business-biodiversity.eu/en/recommendations-biodiversity-in-standards>

Baseline Report: <http://www.business-biodiversity.eu/en/baseline-report>

In case, more information on the project is needed and wanted, I am at your disposal.

With kind regards

Tobias Ludes

## Jean Marius D'Alexandris, Lyseconcept, France

A biotechnology to revalorize wastewater producing a fertilizing liquid from organic farming land.

The problem of drinking water in the world is intimately linked to the problem of wastewater treatment, its main source of pollution.

Land earth, soil and the sub-soils, the environment, natural hydraulic environment, the aquifers serve as a –trash- disposal for wastewater treatment.

Waste water with a biological characteristic contains gold-ganie, a natural enrichment of the topsoil.

This liquid, which comes out of the "Fosse Biologique" process, contains water, fine particles of suspended organic matter, active bacterial flora, biochemical components (nitrogen, nitrate, potassium phosphate, ammonia, urea) a natural fertilizer.

This biotechnology is implemented in the form of a biological purification concept that is of interest to every place that consumes water daily for domestic purposes.

This biotechnology is established in all areas of the globe, anywhere, in any configuration, adapted to the production of wastewater: hotel, catering, industry, school, community, individual.

Regardless of the location of the biotechnology installation, the discharge of the liquid at the outlet from the device is dispersed on a vegetated outlet in addition to purification of the process. This biodiversity can serve as a food support for the habitat but also for the community of the disadvantaged.

The biotechnological concept of excreta treatment preserves the healthiness of areas with high habitat densities.

Biotechnology, which immediately recycles liquid from the process, provides a reduction in the abstraction of drinking water from underground reserves while preserving groundwater from pollution.

I would like to thank you for your interest in our Bio-technology for the biological purification of wastewater effluents.

Good reception

Cordially

Jean Marius D’Alexandris

<http://www.fao.org/fsnforum/sites/default/files/discussions/contributions/Biotechnolgy_0.pdf>

## Andrea Polo Galante, FAO, Italy

Dear Moderator and colleagues,

I would like to add some thoughts to contribute with this rich discussion:

We are convinced that diversifying and improving diets are essential to human health and nutrition. We also know that the world is facing hunger, undernutrition, stunting, obesity, heart problems, diabetes, high blood pressure and all these issues are connected in some ways with the malnutrition. On the other hand, diets are becoming more and more monotonous, less diversified, based on a limited number of crops such as rice, maize, sugar, oil, wheat, soya and other. An important issue to be discussed is how consumers and farmers in general and especially those poorly educated understand food diversification.

The food industries are using these few crops to create different food products /ultra processed food with the same ingredients , different appearance and different taste with a lot of added artificial colors and additives. These products have very attractive taste as well and can give consumers the idea that they have a diversified diet, that they are not eating the same thing. Consumers still need to be educated and convinced that these industrialized food products (ultra processed foods) do not necessarily contribute to their diet diversification. Furthermore, these ultra processed foods have very low cost and compete with local products and diversified crops.

Biodiversity brings us the possibility to review the food production and consumption, to reshape the local food systems with crops and crop varieties, thus to improve the diets. Nonetheless it is also necessary to transform crops to semi processed and processed foods that the ordinary population desire and feel prepared to include them in their daily consumption, Biodiversity is a window of opportunity to create a new diet culture and contribute to food security and better nutrition.

## Takele Teshome, Association for Sustainable Development Alternatives (ASDA), Ethiopia

Mainstreaming biodiversity in agriculture, fisheries and forestry for improved food security and better nutrition.

Agriculture is the science or practice of farming, including the growing of crops and the rearing of animals to provide food, wool, and other products while biodiversity is the variety of different types of life found on the Earth etc. It is a measure of the variety of organisms present in different ecosystems. In this context Ethiopian agriculture is exemplary to this biological diversity. Ethiopian small holders grow cereals, pulses, oil crops, fruits and vegetable. They also rear cattle, small ruminant, poultry etc. They also multi purpose trees (fodder, tree seedlings. This mixed farm system (crop-livestock and forestry ) contributes to the biodiversity. In Ethiopia, the institute of biodiversity promotes gene bank to prevent genetic erosion. International Livestock research Institute’s Fodder bank also preserves fodder. This is also being promoted at community level to maintain biodiversity. This indeed requires further integration between Academic/research with extension service delivery and farmers as end users and feed back providers. Farmers’ training centers and rural school farms can serve as demonstration centers for enhancing scaling up and achieving wider impact.

I believe that National and International NGOs can play a significant role in the dissemination process. For example the national NGO I represent made little contribution in this regard by promoting nutrition sensitive agriculture, initiating seedling production women groups, vegetable production, poultry keeping, small ruminant rearing, cattle fattening, fuel efficient stove production and agroforestry all of which attempts to reduce pressure on environment. Diversification of crop livestock production and their integration will contribute to mainstreaming of biodiversity into agriculture and producing nutrient rich food (protein, vitamin, carbohydrates etc).

## César Marín, Global Soil Biodiversity Initiative; South American Mycorrhizal Research Network, Chile

1) Biodiversity is an important contributor to food security and improved nutrition. Could you share examples/activities in your work where biodiversity is contributing in achieving food security and improved nutrition?

Some of my colleagues in Chile which with whom I collaborate, are working in several topics regarding this issue. The overall goal of some of these projects is to use crop and wild biodiversity to achieve food security.

- For example, the program 'Wine, Climate Change & Biodiversity', over the last years has focused on the biodiversity and ecosystem services proveded by vineyards and their surrounding natural habitats: <http://www.vccb.cl/english/index.html>

Several scientific publications by Prof. Olga Barbosa have appeared in this regard: <https://scholar.google.com/citations?hl=es&user=McN2nPIAAAAJ&view_op=list_works&sortby=pubdate>

- Also, in our laboratory we are starting to use arbuscular mycorrhizal fungi inocula from pristine Patagonian forest to inoculate cereals, resulting in their higher production and higher tolerance to stressful conditions as high Aluminium and low phosphorus:

<http://dx.doi.org/10.4067/S0718-95162016005000065>

<http://dx.doi.org/10.4067/S0718-95162017000400010>

<https://doi.org/10.1016/j.agee.2017.05.031>

2) All agricultural sectors (crop and livestock, forestry, fisheries and aquaculture) rely on biodiversity and on the ecosystem functions and services, they underpin. At the same time, these sectors may affect biodiversity through various direct and indirect drivers. Could you share examples/activities in your work where a (sustainable) production system played a key role for the conservation of the biodiversity surrounding it? Please provide detailed information you may have or know of and identify the agricultural sector.

The same program 'Wine, Climate Change & Biodiversity', has proved to change agricultural practices, and has had a positive effect on mediterranean Chilean biodiversity (birds; microbiological diversity). <http://www.vccb.cl/english/index.html>

3) Good governance, enabling frameworks, and stewardship initiatives are needed to facilitate mainstreaming of biodiversity within and across agricultural sectors.

Which partners need to be involved in institutional frameworks, policies and processes for biodiversity mainstreaming to strengthen them?

All partners imaginable: producers, academia, consumers, goverment, ONGs.

4) The importance of biodiversity for improved food security and better nutrition is not always evident to those engaged in agricultural sectors.

What needs to be done to increase awareness of farmers, livestock keepers, fisher folks and foresters, their organizations and the industry of the relevance of biodiversity and ecosystem services for the food and agriculture production in their sector?

A well-thought education in ecology and basic concepts of biodiversity and its economic and intrisic values. The overall message that sustainable production often ends in bigger economic inputs (economic ecology). A basic understanding on how and ecosystem works, and a basic phylosophy that their productive systems also constitute ecosystems.

## Christiaan Duijst, Food and Agriculture Organization of the United Nations, Italy

A key enabling factor (Question 3) for biodiversity is supporting investments – both public and private - that conserve biodiversity, use biological resources sustainably and share benefits equitably.

In 2014, the Committee on World Food Security adopted the Principles for Responsible Investments in Agriculture and Food Systems (CFS-RAI) that aim to guide governments, civil society and the private sector to support responsible investments. One of the ten principles is dedicated to the conservation and management of natural resources and calls for investments ‘supporting and conserving biodiversity’ and ‘contributing to the restoration of ecosystem functions and services’.

To support the operationalization of the CFS-RAI and responsible investments that take into account biodiversity, FAO has developed a multiyear Umbrella Programme Supporting Responsible Investments in Agriculture and Food Systems. For example, under this programme, the Organization for Economic Co-operation and Development (OECD), together with FAO, has launched a pilot project with thirty leading enterprises to implement the OECD-FAO Guidance for Responsible Agricultural Supply Chains. This guidance, specifically designed for enterprises, builds on the CFS-RAI and calls for supporting the conversation of biodiversity. Through the pilot project, the OECD and FAO are strengthening the ability of enterprises to build responsible supply chains, including by taking into account natural resource management and biodiversity.

As the activities under the Umbrella Programme are developing, further awareness raising and capacity development activities are foreseen that support key actors such as parliamentarians, government officials and farmers organizations with enhancing responsible investment; including those investments that improve and conserve biodiversity.

Those that are interested in the Umbrella Programme can send their queries to responsible.investment@fao.org .

## Prabas Bhandari, Nepal

Biodiversity means variety of lives in a certain environment, in an ecosystem one is made for another and it is important for sustainability.

There is always a problem in everywhere but there is also the solution. In the agriculture there are many problematic pests but there are also natural enemies, antagonistic lives. These things helps in the sustainable agricultural production. If the biodiversity is disturbed than the problems starts to arise, it means we have to use the foreign tools to manage the problems than the chemical used in the production increases the cost of production and poisoned foods.

Likewise, biodiversity is also have big role in water animals like fishes. When I was child I and my friend used to go for fishing nearby the ditches and wetlands. We used to catch many fishes but now due to the human activities like disturbing the water source by making roads, converted to the farm land and use of chemicals to catch the fish, now there is difficult to see the frogs too. Instantly we are not suffering from any kind of problems but I think the problem may arises in future. It clear impact is on those ethnic group who used to go for fishing for their livelihood and I think the impact also hits in the commercial ponds soon because they are nearby the farmland where many chemicals are used as agriculture inputs.

Forest ecosystem greatly impacts on farm. Nowadays the predator animals like tiger, lion are killed for their body part and the number of animals like deer, boar, porcupine etc. which destroy the crops are increasing. It’s difficult to control those animals by the farmers. Every years the wild animals destroy the tons of food.

Biodiversity should maintain for the food security and better nutrition.

Thanks

## Davorka Hackenberger, University of Osijek, Department of Biology, Croatia

Soil biodiversity is mainly completely ignored in a conventional agriculture. However, its benefits to soil structure, fertility, nutrient cycling and water percolation has been observed and proven in many experiments and described in many papers. However, the conventional tillage and removal of surface residues (and other "routines") have a detrimental effect on, for instance, earthworm populations with a particular impact on deep burrowing (anecic) species. The balance between methods used in agriculture (tillage, pesticides and fertilizer usage, residue removal) to maintain high productivity and keeping the soil biodiversity in order to gain the best from it and save soils should be our goal.

## Roy Neilson, The James Hutton Institute, United Kingdom

**The Nation that destroys its soil destroys itself – Franklin D Roosevelt (1937)**

These are insightful words that until recently have largely remained unheeded.

Soil is a key asset of natural capital, providing goods and services that sustain life through the support of food production, but with impacts beyond agricultural systems such as provision and promotion of biodiversity, carbon sequestration and greenhouse gas mitigation. It is therefore perplexing that soils have been significantly undervalued as an asset (Panagos et al., 2016).

Compounded with an ever-burgeoning global population, the area of soil usable for cultivation declined from 0.32 to 0.25 ha per capita between 1975 and 2000. The maintenance of food security delivered by a sustainable intensification of agriculture (Tilman et al., 2010) is arguably the greatest global challenge (Godfray et al., 2010). However, due to agricultural intensification, degradation threats to soils are numerous (Banwart, 2011; Powlson et al. 2011) with degradation estimated to extend to between 1-6 billion ha globally (Gibbs and Salmon, 2015).

Soils are a complex system delivered by a nexus of biology, chemistry and physics. The biodiversity of the soil system is the engine that drives the numerous processes that deliver the numerous ecosystem services including food production. The technological advances in recent decades has provided the opportunity for initial understanding of the interactions and couplings of the tripartite nexus. However, there is so much more to learn and with a plethora of anthropogenic derived impacts such as a changing climate there is a clear imperative for soil biodiversity in an agricultural context to have a core research focus to underpin and improve food security.

**1) Biodiversity is an important contributor to food security and improved nutrition and 2) All agricultural sectors (crop and livestock, forestry, fisheries and aquaculture) rely on biodiversity and on the ecosystem functions and services, they underpin. At the same time, these sectors may affect biodiversity through various direct and indirect drivers.**

Forward thinking policymakers have recognised this need. For example, in Scotland, the devolved government has funded a 5 year (2016-2021) strategic research programme which amongst a diverse research portfolio on soils includes a research deliverable “Soil and its Ecosystem Function”, that seeks to characterise soil biodiversity identifying its key roles in ecosystem processes in particular carbon and nutrient cycling; the contribution of soil physical and chemical properties and processes to ecosystem functions and the role and importance of soil in sustaining above-ground biodiversity in different systems and habitats including fragile ecosystems (e.g. Paterson et al., 2011; Ghee et al., 2013; Chen et al., 2014; Vink et al., 2014; O’Callaghan et al., 2018).

**4) The importance of biodiversity for improved food security and better nutrition is not always evident to those engaged in agricultural sectors.**

B4[hkMy personal research aligns with the overarching aims of The Global Soil Biodiversity Initiative, which I am a member, seeks to promote the translation of expert knowledge on soil biodiversity into environmental policy and sustainable land management for the protection and enhancement of ecosystem services. A current example of this is a national scale project (SoilBio, funded by Innovate UK) which seeks to develop with industry partners a tool that can be deployed on-farm to assess soil health and thereby inform farmers of potential positive management interventions to sustainably maximise yield. By project end, we will have characterised approximately 30 parameters encompassing the nexus of soil biology (soil nematode communities), chemistry and physics for c. 6000 soil samples across the UK in the context of management strategies and resource inputs. In the specific context of this project, to raise awareness of soil biodiversity related issues we engage directly with farmers and national associations through delivery of workshops and meetings. Furthermore, organisations such as the Sustainable Soils Alliance (https://sustainablesoils.org/) directly engage with policymakers, and is working to bring together all stakeholders in soil health to create a forum to influence positive change, identify beneficial policy principles and create the frameworks that will support the development of healthy soil for future generations.

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## Maria Minor, Massey University, New Zealand

I am a soil ecologist and also am associated with the Global Soil Biodiversity Initiative. In New Zealand, we have conducted studies of links between pastoral agriculture (sheep and dairy), soil biodiversity, and soil ecosystem services such as nutrient and water supply. Soil invertebrates make important contributions to nutrient supply and water movement in the soil, as they feed on the soil organic matter and burrow through the soil. Soils and soil fauna of New Zealand pastures are coming under increasing pressures, as farmers increase fertiliser application and stocking rates to increase productivity. We have found that soil invertebrates with similar characteristics were consistent in their response to pasture management practices, particularly to changes in soil porosity due to livestock treading. We also found that the invertebrate contributions to nutrient supply in pastures remained important even in fertilised soils where nutrients were not limiting. Below are some examples of these studies.

**1) Biodiversity is an important contributor to food security and improved nutrition. Could you share examples/activities in your work where biodiversity is contributing in achieving food security and improved nutrition?**

Soil invertebrates contribute to a wide range of soil services vital in agricultural soils, such as nutrient recycling through feeding, excretion, burrowing, casting, and litter incorporation. We investigated the influence of invertebrates on N cycling in a low-N and high-N environment in constructed ryegrass–white clover soil mesocosms (Schon et al. 2011a). We found that invertebrates improved N availability and N uptake by plants. At high bulk density and low N, the N made available by invertebrates resulted in higher plant growth, without any increases in N losses to the environment. The influence of invertebrates was dependent on bulk density, suggesting that invertebrates in compacted soils improved soil structure and N availability. In the high bulk density mesocosms, soil invertebrates stimulated the mineralisation of organic N and the uptake of N by plants at both low and high N fertility, but their contribution to N mineralisation was also more likely to be lost via leachate and gaseous emissions. This study highlights the importance of invertebrates in N supply and nutrient cycling in compacted and high fertility soils.

We also sampled invertebrates (macrofauna, mesofauna and microfauna) from four paired commercial organically and conventionally managed dairy farms on different soil types in New Zealand (Schon et al. 2012), and calculated rates of invertebrate-mediated N mineralisation. The organic dairy operations used fewer nutrient inputs and had lower cow stocking rates than conventional farms, which meant lower calculated pasture production and less available plant litter entering the soil food web. Despite lower plant litter inputs, earthworm biomass was higher under organic management. Nitrogen mineralisation was higher in organic systems, with earthworms contributing the most (24–98 kg N/ha/year). As the cow stocking rate increased under conventional management, physical loading on the soil increased, and the ability of the soil to provide ecosystem services (i.e. N mineralisation and litter decomposition) became compromised. We concluded that organic management on four soil types stimulated soil biological activity and provision of ecosystem services such as N mineralisation. The higher stock treading pressure under conventional management reduced soil invertebrate activity and their influence on N mineralisation, which was not compensated by higher food supply.

**2) All agricultural sectors (crop and livestock, forestry, fisheries and aquaculture) rely on biodiversity and on the ecosystem functions and services, they underpin. At the same time, these sectors may affect biodiversity through various direct and indirect drivers. Could you share examples/activities in your work**

**where a (sustainable) production system played a key role for the conservation of the biodiversity surrounding it? Please provide detailed information you may have or know of and identify the agricultural sector.**

In another study (Schon et al. 2008), the low-intensity pasture system with higher soil C:N ratio and lower sheep stocking rate supported lower earthworm numbers, but higher density and diversity of soil mesofauna and oribatid mites, which are considered indicators of soil disturbance. By comparison, the intensive pasture system had higher densities of introduced earthworms, but the native species Octochaetus multiporus had declined.

 **where a(n) (unsustainable) production system played a key role for the degradation of the biodiversity surrounding it? Please provide detailed information you may have or know of and identify the agricultural sector.**

Earthworms play an important role as primary decomposers in agricultural systems; they incorporate plant litter into the soil and mix soil layers. In Schon et al (2011b) we explored the response of earthworms to increasing fertiliser inputs, pasture production and livestock numbers in 21 sheep- and dairy-grazed pastures in a variety of soils and management regimes in New Zealand. Native earthworms were only found in some low-fertility pastures. Introduced earthworms (when present) dominated pasture soils. Anecic earthworms showed a positive response to the increasing pasture intensification (higher potential dry matter inputs and livestock loading), while epigeic earthworms declined. We suggest that due to their lower susceptibility to livestock treading pressure, anecic species may be a suitable substitute for incorporation of surface litter into the soil in pasture systems where livestock treading limits epigeic earthworm populations.

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## Kanna Siripurapu, Watershed Support Services and Activity Network (WASSAN), India

Government of the Indian state of Odisha is Making History by Bringing Indigenous Landraces in to Seed Supply Chain - It had been an interesting case with farmers of Odisha in relation to acceptannce of high yielding varieties (HYVs) of paddy developed by Agriculture universities and ICAR institutes.

These state supported institutes regularly develops new improved varieties, and release them into the market. however, acceptability of these HYVs had been very poor among farmers of the state. Only 4-5 paddy varieties such as "Swarna" have been accepted by farmers on a large scale. The situation had been worse in case of pulses, millets and oil seeds. No improved pulse variety had been accepted by farmers for the past 20 years.

 For more details: <https://www.facebook.com/Watershed-Support-Services-and-Activities-Network-Wassan-767706903348145/>

## Simoneta Negrete-Yankelevich, INECOL, Mexico

Dear moderators and colleagues, I am a researcher in Mexico and also part of the Global Soil Biodiversity Initiative. I will summarize in the following paragraphs the examples from our work where: 1) a sustainable production system plays a key role for the conservation of the native crop and belowground biodiversity, 2) the historical transformation of such a system is playing a key role for the degradation of the such a biodiversity and their vital functioning, and 3) what we are doing to increase awareness of farmers, their organizations and decision-makers to raise awareness of the relevance of biodiversity and ecosystem services provided by soils for the food and agriculture production in small scale agriculture.

Land use intensification of naturally thin and nutrient poor soils has often been invoked as the prime explanation for reductions in food production and food security in tropical mountains. Little is considered the relative importance of cumulative land use legacies and current practices (like agrodiversity reduction) on soil functioning. For tropical mountains in Mexico where we have studied Milpas (the ancient Mexican maize-based polyculture that feeds the nation) the legacy of cropping years explains 8 to 22% of the variability in soil fertility and 5 to 22% of belowground taxa richness. The capacity of soils to establish mycorrhizal symbiosis diminishes with decreasing diversity of cultivated plants, while available P (Bray) increases with the diversity of crops. Compared to an introduced hybrid, some native maize landraces and their symbionts are much more efficient in obtaining P from very deficient soils. Many bacterial isolates from nitrogen fixing nodules correspond to bradyrhizobia closely related to native bradyrhizobia from the forest. The interactions of land use legacies with modernized current agricultural practices (monocultures with chemical fertilization) may be hampering the natural mechanisms that native diverse polycultures have to cope with naturally thin and nutrient poor soils and maize production has steadily decreased in the last 30 years, since homogenizing technological packages were introduced. The immense variety of locally developed crops benefits from symbiotic relationships with an equally diverse array of coevolved soil microorganisms. Understanding such a network is allowing us now to develop locally tailored technologies aimed at improving food security and conserving an invaluable indigenous below-above ground heritage.

The obstacles of sustainable agricultural production greatly stem from ignorance and the lack of a common language. It is urgent to innovate in communication strategies in order to create reciprocative links between farmers, scientists, consumers, and decision makers. We have created Soils! The underworld, a puppet show that is part of DeMano, our project for rural food security (<http://www.fao.org/agroecology/database/detail/en/c/1043363>). Soils! focuses on taking care of the living organisms of the soil so it can produce nourishment for entire families. It reflects upon the complexity of the food security problems. All the actors in the problem go on stage. We show the great potential of integrating science and tradition in order to collectively face large-scale challenges such as soil deterioration, male migration, chronic malnourishment, and market inequity. We have found that puppet shows have a great power to sensitize everyone involved in the sustainable food security challenge; scientists, farmers, consumers, and authorities. It particularly appeals to audiences with low literacy levels and great empirical knowledge, a profile found in rural Mexico and several other places around the globe. We have experienced the vast convening power of the theater and puppet shows, much greater than any conference, workshop, or lecture. Farmers come to the show thinking it will be great for their kids, and leave the show as enriched and filled with ideas as their children.

I hope our experiences are useful inputs for this important forum, if details are required I will gladly provide corresponding scientific papers or other evidences available.

Best wishes,

Simoneta

## Omar Ulises Luna Rubio, cam-plants.com, Mexico

En la actualidad, sabemos que estamos ante una retroalimentación negativa del ciclo del carbono con grandes emisiones de CO2 a la atmósfera y una reducción en el carbono orgánico en los suelos. La conversión de ecosistemas naturales como bosques y matorrales a zonas agrícolas reduce de manera dramática el carbono en los primeros cm del suelo, por lo que, secuestrar y almacenar el CO2 en forma de carbono orgánico en el subsuelo es una de las medidas más importantes para reducir los impactos del cambio climático. Las plantas CAM son eficientes en esta tarea y no implican una gran perturbación de los horizontes del suelo con lo que zonas que consideramos poco productivas por su lento ciclo de carbono se podrían incorporar al a estrategia de sumideros de carbono con consecuencias positivas a la biodiversidad a la seguridad alimentaria.

## Joseph Bagyaraj, Centre for Natural Biological Resources and Community Development (CNBRCD), India

1. Biodiversity is contributing in achieving food security and improved nutrition?

Through our research we have screened several arbuscular mycorrhizal fungi (AMF) and plant growth promoting rhizomicroorganisms (PGPR), studied their compatibility and using such microbial consortia (MC) we have inoculated crops important in agriculture, horticulture and forestry and have shown that 25 - 50% of NPK fertilizer can be saved through inoculation with MC. These have been proved under field conditions. Inoculation not only saved chemical fertilizer input but also crop yield up to 10% with no adverse effect on nutrients. This has been shown in crops like french bean, chilly, capsicum, tomato, finger millet and many medicinal plants like Ocimum sanctum, Coleus forskohlii, Withania somnifera, etc.  Another interesting observation in medicinal plants is that inoculation also increased secondary metabolite concentration which is of industrial/medicinal importance.

2. Where a (sustainable) production system played a key role for the conservation of the biodiversity surrounding it?

We have screened and developed the best AMF for inoculating several forest tree species in the nursery. Inoculation resulted in healthy vigourously growing seedlings which established better when planted in the field site. These seedlings were planted in wasteland and monitored periodically. The inoculated trees were nearly twice the size of the uninoculated trees when monitored 60 months after planting. This was studied in tree species like Tectona grandis, Dalbergia sissoo and Acacia auriculiformis.

3. Do you have any examples of such enabling factors and initiatives or the lack of it?

a) There is one place called Palamaner in Chittoor district of Andhra Pradesh, India. One of the crops raised in this region is peanut. The yield of peanut in this region is low. We felt that it may be due to lack of effective Rhizobium in soil. In our experiment for 3 years we treated the seeds with an effective strain of Rhizobium and raised the crop. The growth and yield of peanut was nearly 25% more as compared to uninoculated crop.

b) In South India tomato is affected by a disease called wilt disease complex. It is caused by a fungus (Fusarium udum), a bacterium (Ralstonia solanacearum) and a nematode (Meloidogyne incognita). We have developed a MC consisting of Glomus bagyarajii, Pseudomonas fluorescens and Paecilomyces lilacinus which effectively protected tomato against the wilt disease complex.

4. What needs to be done to increase awareness of farmers, livestock keepers, fisher folks and foresters, their organizations and the industry of the relevance of biodiversity and ecosystem services for the food and agriculture production in their sector?

There is a need to strengthen popularization of biofertilizers and biocontrol organisms for the benefit of farmers through media, training programmes and demonstration trials.

## Kumar N G, University of Agricultural Sciences, India

Dear Members of the Forum,

I am associated with the Global Soil Biodiversity initiative. I am working on the soil biology aspects since 1984. Soil biodiversity play an important role in decomposition of organic litter to available form of nutrients to plants. As we know well that the organic litter pass through primary consumers, secondary and tertiary consumer to form humus in nature (natural forest ecosystem). In this process, mycophytic feeders, primary and secondary decomposers, reducers also play important role in the ecosystem. A balance of all organisms and microbes takes place in nature. No outbreak of any pest and diseases in the natural forest ecosystem. With this background my work initiated to enhance biodiversity in the agro ecosystem especially in the dry land agro-ecosystem.

1) I worked on the impact of the subterranean termite Odontotermes horni foraging effects on the soil nutrient status. This is a dominant species in South Indian states especially in the red soil .The results indicated this species extensively consume organic matter (crop residue) from October to February months (post cropping season) under rain fed situation. Significant reduction in soil organic carbon, available nitrogen, phosphorus, potassium and total nitrogen content in termite replaced soil was observed. Soil meso -faunal abundance greatly reduced due to non-availability of organic matter. This fungus growing termite never leaves a single pellet of excreta also. Even though, the soil physical properties altered it is mainly in the non-cropping season.So, termite activity is not favorable for conserving soil organic matter and faunal biodiversity.

2) Second project on “Soil management for increased fertility: role of soil meso and macro fauna”- Sponsored by the Indian Council of Agricultural Research –National Agricultural Technology Project

This project was operated in the alfisols under rain fed cropping situation.

Highlights:

The mesofaunal activity was peak at the end of rainy season (October –November Month) both in the natural (undisturbed grass land) and agro ecosystem.

Soil meso faunal abundance and diversity was > 60 per cent less in the adjacent agro ecosystem compared to natural undisturbed grass land.

Recommended fertilizer and other practices reduced soil mesofaunal population .However, slight increase in mesofaunal population was observed when farm yard manure @ 10tonnes /ha applied along with other cultivation practices recommended for the crop,

Intercropping, multiple cropping and crop rotation enhanced soil mesofaunal diversity and abundance than monocropping.

One fixed treatment experiment was initiated in the year 2001 and continued till 2016.The treatments included soil application of 5,10,12.5,15,17.5 and 20 t of FYM /ha at the beginning of the cropping season and compared with only recommended package of practices for soybean cultivation. Fertilizer dose was reduced to 25, 50 and 75 per cent in 12.5,15 and 17.5 t of FYM/ha applied treatments. Consortium of native mesofauna rich soil (1 kg /21 sq.m) was introduced to each treatment after germination of the soybean crop.

Significant increase in soil mesofaunal diversity and abundance was noticed after fourth year of experiment especially in 17.5 t of FYM +25% of Fertilizer and 20 t of FYM alone/ha applied plots. Apart from this, the soil Organic carbon content increased to 0.75 to 0.8 per cent from 0.3 per cent in the beginning of the experiment or compared to fertilizer alone treated plot. Significant increase in available N, P.K, ex.Ca, Mg, Na, soil microbial biomass carbon and soil enzyme content was observed in 20 t of FYM alone + native mesofauna introduced treatment. Soybean grain yield was high compared to recommended package of practices and fertilizer treatment with introduced native mesofauna treatments. Even application of 5 tonnes of FYM was on par in grain yield with recommended fertilizer alone treatment. Addition of partially decomposed organic matter also supported more soil mesofaunal abundance.

Conclusion: The soil mesofauna can be re-established in the agro ecosystem by introducing from the mesofauna rich native ecosystems of the local conditions and supplying sufficient quantity of mesofauna and microbe food ( farm yard manure & crop residue) to the field. Growing of suitable multiple crops, crop rotation etc enhance soil biodiversity .Deep ploughing operation should be avoided. It is easy to reestablish mesofauna in the protective irrigated conditions.

Drawback: Source of mesofauna rich soil is limited. So, it takes long time to cover vast agro ecosystem.

3) I was also involved as co-investigator (soil fauna) of the TSBF –CIAT/GEF project – Conservation and management of below ground biodiversity at Western ghat biosphere. Highlights of the project – Natural forest ecosystem had significantly high soil biodiversity and abundance compared to cardamom, coffee, natural grass land (shallow depth soil), paddy and afforested land with Acacia sp. alone.

With these experiences I am working on the ICAR project “Sustainable management of soil fertility through enhancing native soil fauna

1) Biodiversity is an important contributor to food security and improved nutrition.

Biodiversity is contributing in achieving food security and improved nutrition?

Yes , it helps in maintaining sustainable ecosystem for better crop growth with self regulating mechanism of pest and diseases.

The overuse of biodiversity compromise food security and nutrition?

It helps in food security by avoiding use of fertilizers, pesticides etc and reduce pollution.

2) All agricultural sectors (crop and livestock, forestry, fisheries and aquaculture) rely on biodiversity and on the ecosystem functions and services, they underpin. At the same time, these sectors may affect biodiversity through various direct and indirect drivers.

Explained above as per the results of various projects operated by me

Where a (sustainable) production system played a key role for the conservation of the biodiversity surrounding it?

Yes, sustainable production system can be achieved with the above results within 4-5 years.

Where a(n) (unsustainable) production system played a key role for the degradation of the biodiversity surrounding it?

I evaluated different doses of fertilizer, various insecticides, acaricides, herbicides, fungicides and neemcake in the natural undisturbed grass land where soil mesofaunal abundance is more. All agrochemicals showed negative impact on the abundance and diversity of soil meso and macro faunal activity.

3) Good governance, enabling frameworks, and stewardship initiatives are needed to facilitate mainstreaming of biodiversity within and across agricultural sectors.

Yes, good governance and stewardship initiatives are needed along with demonstrations to facilitate mainstreaming of biodiversity within and across agricultural sectors.

Do you have any examples of such enabling factors and initiatives or the lack of it?

I explained the same above

Which partners need to be involved in institutional frameworks, policies and processes for biodiversity mainstreaming to strengthen them?

Agricultural university (where Farmers training Centre exist) , State agriculture departments, NGO’s can take up this activity.

4) The importance of biodiversity for improved food security and better nutrition is not always evident to those engaged in agricultural sectors.

What needs to be done to increase awareness of farmers, livestock keepers, fisher folks and foresters, their organizations and the industry of the relevance of biodiversity and ecosystem services for the food and agriculture production in their sector?

Agricultural university (where Farmers training Centre exist) , State agriculture departments, NGO’s can take up this activity

How can the technical and institutional capacity needed to promote sustainable agriculture and reduce the impact on biodiversity be developed?

A course on sustainable agriculture with good coverage of soil, fauna, plant and microbes are needed for undergraduate and post graduate degree programme level especially in the agriculture, horticulture, forestry and fisheries degree programmes.

## Brandon Eisler, Nutritional Diversity, Panama

The mainstreaming of better food security and better nutrition today, comes down to inspiring individual importance on health, and [new biodiversity education](https://www.patreon.com/educationinpermaculture) with the [correct information on proper diet](https://nutritionaldiversity.com/). As this specific information is learned by more individuals, they will be motivated to support new farming methods that benefit our food security and nutrition greatly. This gradual process of learning and changing will be the next step in not only security for food and the best nutrition but also in improving world poverty conditions, and sustaining fruitful population growth.

The new diet will motivate [Permaculture Farming](https://nutritionaldiversity.com/permaculture/) (2nd best man made food source), which is the old answer to everything eloquently disguised as new alternative gardening. After a while of this planting and new way of eating; [Bio-Dynamic Agriculture](https://nutritionaldiversity.com/bio-dynamic-agriculture/) (best man made food source) written by Rudolph Steiner, and [wild plant foraging](https://nutritionaldiversity.com/application-of-nutritional-diversity/stomach-nutrition/plants/wild-plant-foraging/) will take the forefront of importance as this type of farming once did – when there was great food security and the best nutrition in human culture.

NEW DIET

Talking about [better nutrition](https://nutritionaldiversity.com/) is very simply talking about a more correct, natural and [optimal diet](https://nutritionaldiversity.com/).

Today we eat three to ten mostly cooked things, on three plates daily (with slight individual variation). Here in Panama where the [Nutritional Diversity](https://nutritionaldiversity.com/) study continues, the local culture eats mostly [chicken](https://nutritionaldiversity.com/chicken/) and mostly fried, fried green [plantains](https://nutritionaldiversity.com/bananas-plantains/), fried [yucca cassava](https://nutritionaldiversity.com/cassava-cancer-cure/) (a great crop for food security, and excellent nutrition when the whole plant is used and prepared properly); all using hydrogenate vegetable oil (which is gut destruction if a real tribe found out just how harmful it is would likely kill those who introduced it).

Vegetables are interestingly rare on plates here in this Panamanian and Latin American culture as a whole today, even among the indigenous. Just like across the English speaking world, here now packaged, processed foods are added to the arsenal of mistakes. Insanely misguided and harmful modern agriculture and modern nutritional practices dominate this country as they do every single country on the globe.

These cultural and educational norms have shorted us incredibly on the scopes of proper or even sufficient nutrition. Every diet typed up on the web today, taught in schools, by mom, grandma or by your nutritionist, is insufficient nutrition.

[Nutritional Diversity Diet](https://nutritionaldiversity.com/), is the practice of eating at least 30-60 different species and working thy way towards 100 and more, per day /week. While modern diets argue the small points and do the regurgitated “exclude this, add this, research paper this, study on rats that” simply learning from nature we can obtain the idea from the monkeys, the cows, the bees, and the trees that a large diversity of nutrition is what makes optimal health. The Nutritional Diversity concept is a concept from nature, and it is based on all natural practice.

I must apologize in my last entry before realizing the potential of this particular forum, I made reference to monkeys as a specie that lacked imagination, this was a serious error on my part. Monkeys are one of the natural specie who I learned this concept from, and they don’t require the doctor or the dentist and so far as I can tell still have all their teeth; a feature I myself cannot boast. They look at me on my Panama farm, curiously as if they think “what are these other crazy primates doing?” I wonder if they say “he does all the work to make plants grow, something they do on their own, and something there are plenty of.” They look at me as if I am crazy and they love so free, and so happy, and they do try to to defend the forest from us forest clearing primates with their howls (The Island of Colon Bocas del Toro, Panama a principle study site, is largely populated with the howler monkey).

Nutritional Diversity Diet study over the last five years fell almost immediately into the study of eating wild plants, and the great uncontaminated nutrition that they offer. Along the way we have taken a good hard look at the way plants benefit from healthy positive human and animal interaction, Bio-Dynamic Farming principles and more to get the most of our farm and our nutrition. It is a science, a Nutritional Diversity Science.

“Poison is in everything, and no thing is without poison. The dosage makes it either a poison or a remedy.” – Paracelsus

While the “their stomachs versus ours,” arguments throughout the various primate specie can be debated, all mammal stomachs in nature seem to be filled full of plants to the point that the waist in half digested, green fibrous and healthy shaped (refer to Bio-Dynamic Agriculture: Vortex). The healthiest human states in my experience come from the mimicking of this practice (in the ND study) and I have worked with a lot of people, a lot of ailments and challenges at this point who have all (100%) benefited “most remarkably” (their words) from this very practice versus other practices they have tried to include modern medical practices. Shove them down ladies and gentlemen, a diverse spectrum of plants.

WARNING: You cannot just go and start eating wild unknown things some of it in the smallest dose will kill you. Some will make you very sick, you must work with an expert in plants, and plant edibility testing, a food testing education which my group can also provide.

The regular human waste is a foul smelling dark colored waste most normally seen in nature from rodents and more carnivorous beings. So this being said, meats have something to do with that waste form and nutritionally meats are healthy, if the animal was loved, and their endocrine systems were left unmolested. I do not at all disqualify any meats, in fact I think that a diversity of meat eating is also essential to health.I also think with enough reforestation, and what I call living in harmony with nature like the other biological things do the Vegan concerns become smaller Optimal nutrition is a complex science and we have written as a doctrinal factor 5x times as much raw or cooked natural plant fiber (10% raw minimum) as any other food state and a diversity of 30 specie minimum for newbie diet revolutionaries. Individual assessments of lifestyle and bowel health can be quickly made from waist examination. The answer still remains the same, and this is adding in the diverse plant ratio above.

Realizing the centrally distributed modern agriculture / mono culture food supply is full of glyphosate and other harmful chemicals linked to cancers and other sickness, and the harmfulness of eating these foods and processed foods alone makes food security conversation even more nervous. It kills the nutrition conversation completely just like the soils these mono culture grown foods are  farmed on. For both nutrition and security we must seek other food sources (permaculture / wild culture, etc.).

The Nutritional Diversity diet is the best most advanced, routed in nature; miraculous diet that has ever been described on the modern diet scene. It’s effective and quickly gaining popularity among athletes. We are developing a Nutritional Diversity food supplement to help people in the every day hustle and bustle get it together right for themselves away. This is the optimal nutritional formula. It mandates a different food supply within it’s doctrine one of two primary changes to be made. The second is to eat a more full spectrum nutrition, in the starting range (according to our study thusfar) of 30-60 species per day. This requires a bit of a mechanism building for most modern humans. Gradually an optimal nutrition will be gained eating a spectrum closer to 100 different species. Mainstream this diet, and mainstream food security and better nutrition.

This diet on a regular through our testing with a pretty significant  test pool so far, means the healthiest looking waist product, better sleep, better mood, physical healing, weight-loss, and lean muscle core improvements,  joint and skeletal improvements, better stamina, and better brain function. It is my friends, the better nutrition we seek.

NEW INFORMATION

Could it really be a little bit of new information on how to eat better, and sufficiently, can help me twice the man (or woman) I am today? Can just this new information provide for and also motivate, bio-diversity in my life and in the lives of other individuals?

This Nutritional Diversity miracle concept is new information for most ears. It does ring that bell that rings when things make sense, and the brain bulb turn on right when hearing it.

New information today in the modern age of confusion has it’s challenges, especially concerning modern diet. Health is not understood, by today’s human culture. Medicinal practices today are some of the most intrusive, unnecessary harmful and misguided practices human culture has ever faced. Misguided guidelines and health guru’s, their business models, insurance companies , pharmaceutical companies, hospitals and I am sorry to say but people with PHD’s in biology, have been so polluted by ill research and insane science that new pure natural information, as accurate as this is even has it’s human opponents, corporate or government opponents and this is an important mention in discussing nutrition and food security. Monsanto is a perfect and most recent example of this and of new information that is harmful to the food supply, bio-diversity on this planet, and nutrition most immediately.

Having opponents today is interesting. If their is big governments and corporations who threaten the food supplies or even start wars of killing and destruction, where are those formidable opponents at all? Community is such a big part of this because, it’s communities of paycheck receiving good people that push these dangerous mistakes and interests of the rather malnourished few who design control models. It will be the Permaculture Farming and Nutritional Diversity Eating cultures that will be our guides to freedom, health and happiness moving forward. These interests will be heavy hands in securing and advancing bio-diversity. Nutritional Diversity Science doctrine is heavily rooted in the importance of referring to nature and restoring some balance opposite of technological industry to individual human life and the life of all biology in which we come from.

There is a lot of green stuff out there, we don’t know it, and what we do know we use inappropriately. We still know quite a bit and herbalogists have made some texts that have survived through time also. Food testing can be done, and modern catalogues can be made, and we do a lot of study in wild foods for security.

Loggers can take out the jungle, our bio-diversity, a billion times faster than we can reforest it.

Humans today are going to care the most when they are educated that today’s harmful agriculture and industrial culture effects them as individuals the most. Again this individual motivation will start with Nutritional Diversity Education.

This new information will upset huge industry, tons of businesses, thousands of FDA and PHD and health industry recommends. Huge agricultural chemical supply dealers to the modern agriculture mono culture system, and they will no doubt spend large budgets to protect their industry. Are challenges in food security and nutrition are great. But Let’s be very clear on what those challenges are. If you have taken a train a plane a car or a bus, around any country you know there is plenty of green stuff out there. It may not be as sweet and pretty as the other stuff but educate yourself, about how those sweet pretty foods are produced and what the original paleolithic gathered species were more like. Cooking may require more brain power, imagination and ingredients in the future. Why not?

Dis-information and mis-information, themselves are significant enemies of nutrition and food security today. Everything from salt and fat recommends are inaccurate and have been for a long time. Regardless of arguments from numerous nutritionists and people in the fitness channels who test optimal nutrition closely, certain guidelines remain unchanged and even interestingly re-enforced in opposition, something very apparent in developing countries sadly.

NEW EDUCATION

A new education and also a cultural pimplanted reminder module development is so important.

It is surprising to me how many students of this Nutritional Diversity way of living, do it heal from it, and then when I check in later with tehm later on, tell me they have trouble keeping there range of diversity above 30 (the minimum biodiverse diet standard). I myself will never go back to eating the insufficient nutrition that modern education examples for us. We need new education for how to eat, where to get our food from, and regarding the biology and life cycle in which we come from and depend on. This education just like the incorrect diet education of old had been, should be oriented for the young learning mind. We have developed an [online biodiversity education for young people](https://www.patreon.com/educationinpermaculture).

[New education about biodiverse diet](https://nutritionaldiversity.com/), and the individual impact it has on each of us will no doubt be the mainstreaming of biodiversity for food supplies. When people realize the benefits of this way of eating, and healing, the market for diverse agriculture practices will be in high demand. As a response to this demand, we will have man bio-diverse motives across the globe to learn and benefit from.

Our new education model will include reforestation education, food forest development, an initial basics “movie” followed by several learning episodes with the bold creative missions needed in this bio-revolution of the way we know nature and benefit from nature.

Cities from space photography mirror almost exactly microscopic images of cancer, to much man made stuff and we have a crisis of young aged cancer patients. We need new systems for living in many ways, renewable energies are here, solar systems are top of the line, and affordable. We sit on the fence of change as if afraid to go into the new era, of health freedom and happiness.

Here are a few simple ways you can pass on the knowledge.

The first is nutritionaldiversity.com where we even develop a learning show for kids and the whole family all about permaculture, nature, bio-diversity, loving animals and good food.

Most simply eat what you eat now and start adding as many different and bio-diverse fresh green non-toxic organic plants from the wild (you must be educated here, and know what you are doing) or from organic permaculture farms. Cram them in, until your waist cannot wait to leave, and you start producing shiny green waist, with undigested fiber that leaves your body in a regular two to three times a day optimal health fashion. Simply learn about a permaculture farm near you and help your friends and family, buying for them all at much better prices and way better values, to start to cleanse the toxins that all U.S. citizens blood test very high for right now. You should be able to buy your entire starting  Nutritional Diversity Diet from one permaculture farm.

New education must be simple, many contributions to this subject only other PHD’s can understand. The everyday poor person with no education understands a seed thrown in the dirst can grow, a PHD in biology thanks to modern education, will want to confuse and see papers on the process there. this direction of direction is curious and wrong if one seeks to understand biology.

Albert Einstein — ‘If you can’t explain it to a six year old, you don’t understand it yourself.’

“The art of healing comes from nature, not from the physician. Therefore the physician must start from nature, with an open mind.” – Paracelsus

[Nutritional Diversity is the Mainstreaming of Bio-Diversity in Diet](https://nutritionaldiversity.com/).

With all of our challenges please support our [Nutritional Diversity Diet & Permaculture Education effort here](https://www.patreon.com/educationinpermaculture).

Here is the [New Education Model](https://www.patreon.com/educationinpermaculture)!

Support the [Permaculture and Biodiversity Education Movie & TV Show for Kids & Family](https://www.patreon.com/educationinpermaculture) Project [here](https://www.patreon.com/educationinpermaculture)!

Paper Written For Submission to : fao.org : Mainstreaming Biodiversity in Agriculture, Fisheries and Forestry for improved Food Security and better Nutrition

It is recommended to download this in [pdf format](https://nutritionaldiversity.com/wp-content/uploads/2018/05/nutritional-diversity-introduction-to-better-food-security-optimal-nutrition.pdf).

Continued Points:

Water is Everything.

We discuss food security, and imagine the idea in relation to the impoverished. Most who discuss the subject have not lived in poverty, how can they know it like a poor person does? Interestingly, the modern city water supply taps in the English speaking world is terrible across the board, even to contain pharmaceuticals, plastic micro fibers and some of it was even flammable..

Water pollution is drastically prevalent – most important resource is water. All biology is over 70% water, and it is a much more complex element that any of modern science realizes. Please see this information and very solid science on biology and water, and some home water solutions that you can use right away to clean it up for your family.

It’s Not When Are They Going To Stop But Who is Going To Stop Them!

Corporate, business and government interests are the greatest threats to our quality of life, ability to survive, freedom, independence and food security and nutrition.

Biodiversity itself is under serious threat and there are a few places on the earth measured to have the most bio-diversity left in them. We need to realize with our individual diet and nutritional realizations that, these zones need not only protection but expansion. Permaculture reforestation efforts and food supplies should be developed on the outskirts of these areas and others, on land not owned, or land shared in diverse ownership of individuals who did the work, and not corporations of people who buy and sell things that don’t care so much about the life their for sustained food security and better nutrition for all.

Quite frankly small groups with the right expertise, research orientation and funding can establish incredible food security and nutrition across the globe that will also inherently provide for freedom, increased quality of life, better air, less global warming issues, less discussion about population control  and optimal health for soil, plants, animals, fish in the sea, birds in the sky us everything. Fund a few Permaculture groups to go out and do this full time year round, it’s one of the smartest actions

The Native American of North America lived in a story where crossing the Mississippi river one could not help but be pelted with 100 fish and a squirrel did not ever touch the ground from that river to the Atlantic Ocean.

Food Security and Nutrition become a crisis because of a series of mistakes, which we must as a human culture take responsibility for and fix. Should we continue this road or error we will multiply the results of these errors and fall to immensely low quality of life, violence and terrible nutrition.

Who is going to turn us around? Who will save us from the corporate destruction? I think of the James Cameron Avatar production and the “Toru Macdow,” charter who decides his life mission and calling is to be a savior. I think of this reference because it’s a movie my and beloved daughter saw in 3-D together, some of the best memories I have. It is these real things I value most, and too many products of industry disgust my other cousins in nature, and I recognize that. It was Nature and Nutritional Diversity diet who healed me from the hardcore loss of my princess, a depression that actually killed me twice, and had me completely non functional for years.

Thank you for you interest in Better Nutrition, Food Security and Mainstreaming Nutritional Diversity. You can become more involved in our small humble, leading research effort in the game by contacting here. As cocky as I can be sometimes, the aim is to leave you with a smile, and say that our ecosystem and our fraction of the important research too definitely needs your help.

Most importantly now that you have read this, get yourself some good nutrition, get nice and brainy and productive and improve your own quality of life through nature. To be Nutritionally Diverse does also require that you go into nature, not just the concrete jungle whose space shuttle taken imagery resembles cancer through a microscope.

Sincerely Your Friend & Fellow Child of God,

I love you,

Brandon Eisler

## Richard Bardgett, the University of Manchester, United Kingdom

1. Biodiversity is an important contributor to food security and improved nutrition.

There are numerous examples of soil organisms playing crucial roles in regulating key soil functions that sustain crop growth. Some examples from our work include:

(a) Working in grasslands we have shown that management practices that enhance the abundance of fungi relative to bacteria in soil are associated with more efficient nutrient cycling and reduced nutrient loss from soil (Bardgett et al. 2003), especially following perturbations (e.g. dry/wet cycles) (Gordon et al. 2008; De Vries et al. 2012a).

(b) As part of a large pan-European study, we shown that intensive agriculture universally reduces soil food web diversity and the abundance of most functional groups, and that soil food web properties strongly and consistently predicted processes of carbon and nitrogen cycling across a wide range of contrasting geographic locations and land uses. Not only did this study provide the first quantification of relationships between soil food web complexity and ecosystem processes at larger spatial scales, but also it demonstrated the need to include soil food web parameters in biogeochemical models (De Vries et al. 2013).

(c) In a related study, we showed that reductions in soil food web complexity and diversity caused by intensive land use, especially a reduction in the ‘slow’ fungal relative to the ‘fast’ bacterial energy channel, strongly impairs their ability to resist and recover from extreme climatic events, in this case drought. This then causes increased loss of carbon and nitrogen from soil to the atmosphere and in drainage waters (De Vries et al. 2012b). These findings have implications for sustainable land management, because they provide evidence that extensive agricultural management can promote more resistant, and adaptable, fungal-based soil food webs, thereby contributing to ecosystem services such as soil nitrogen retention, which is of central importance to sustainable food production and pollution mitigation.

2. Where a (sustainable) production system played a key role for the conservation of the biodiversity surrounding it and where a(n) (unsustainable) production system played a key role for the degradation of the biodiversity surrounding it?

In a paper by De Vries and Bardgett (2012) we proposed various ways by which the he promotion of plant–microbial linkages in agricultural systems has the potential to enhance N retention and reduce N loss. Although trade‐offs with agricultural yield are inevitable, we suggest that promoting plant–microbial linkages will reap benefits in terms of plant crop resistance to climate change as well as to pests and diseases. As an example of declines in biodiversity associated with intensive management,

Tsiafouli et al. (2015) examined biodiversity in soil food webs from grasslands, extensive, and intensive rotations in four agricultural regions across Europe, and found that land‐use intensification reduced the complexity in the soil food webs, as well as the community‐weighted mean body mass of soil fauna. In all regions across Europe, species richness of earthworms, Collembolans, and oribatid mites was negatively affected by increased land‐use intensity. The taxonomic distinctness, which is a measure of taxonomic relatedness of species in a community that is independent of species richness, was also reduced by land‐use intensification. We concluded that intensive agriculture reduces soil biodiversity, making soil food webs less diverse and composed of smaller bodied organisms.

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## Esperanza Huerta Lwanga, Wageningen University and El Colegio de la Frontera Sur, Netherlands

It is important and urgent to have biodiversity above and below ground. Overall in agricultural areas where the accumulation of pesticides are present, it’s important to take actions, in order to diminish the use of pesticides, and then to increase diversity. The food health depends on how health is the soil. A healthy soil is reach in different kind of organisms, soils under biological crops are so different so alive in comparison to those soils under the use of agrochemicals.... pesticides. We cannot close the eyes anymore, and think only in economic matters, it’s important to support those farmers who are willing to change into more healthy ways of production. It’s important to think really in the future generations, our actions determine their present and future.

A soil rich in soil species, it’s a soil rich in health.

## Qi Li, Institute of Applied Ecology, Chinese Academy of Sciences, China

I am a soil ecologist from Chinese Academy of Sciences and associated with the Global Soil Biodiversity Initiative. In a 10-year experimental field, we found that long-term conservation tillage (no-tillage and ridge-tillage) can maintain more C in soil by having positive effects on soil microbial and nematode communities within different aggregate size fractions. Special functional groups of soil biota, such as AMF, and gram-positive bacteria cultivated in conservation tillage system can conserve more C in biomass and ultimately increase C stock. Our study indicated that different functional groups of soil organisms and their connections provide different pathways to C sequestration at the spatial dimension of soil physical structure under different tillage systems. The abundance and richness of most microflora and microfauna are positively influenced by the conservation tillage. The stability and trophic links of bacterial and predator–prey pathways were strengthened in no-tillage and ridge-tillage compared to conventional tillage. Our study suggests that a more functionally stable food web can be built through the bottom–up effects after 10 years of conservation tillage.

## Blaise Kuemlangan, FAO, Italy

**Comments and observations from the Development Law Service (LEGN), Legal Office, FAO**

3) Good governance, enabling frameworks, and stewardship initiatives are needed to facilitate mainstreaming of biodiversity within and across agricultural sectors.

**GENERAL COMMENTS**

The thoughts and observations stated here are expressed from the perspective of those who work in FAO on development law i.e legislation, regulations etc, as enabling frameworks for food and agriculture and natural resources (land, forestry, water, fisheries etc.) for access and use and related management. It is vital to underscore the importance of explicit reference to legislation or legal frameworks in the context of mainstreaming biodiversity because when the question is asked of what “biodiversity mainstreaming” means, the working definition often cited is the one set out below, which omits the term “legislation” and “legal frameworks”:

“*Biodiversity mainstreaming is the process of embedding biodiversity considerations into* ***policies, strategies and practices*** *of key public and private actors that impact or rely on biodiversity, so that biodiversity is conserved, and sustainably used, both locally and globally*.” *(emphasis added*)

It may be argued by some that specific reference to legislation or legal frameworks in the definition cited above is not necessary as the term “policy frameworks” is inclusive and covers legal frameworks. However, while carefully thought-out global analyses or guidance documents (e.g. *STAP Advisory Document on mainstreaming biodiversity in practice* (Huntley, B.J. and Redford, K.H., 2014)) underscore the need for legislation as an enabling mechanism for biodiversity mainstreaming, most discussion on and development of strategies and initiatives, including through programmes and projects, only mention policy and rarely focus on legislation. An example of the lack of reference to law as a mechanism for mainstreaming biodiversity is observed in the text of the *Voluntary Guidelines for Mainstreaming Biodiversity into Policies, Programmes and National and Regional Plans of Action on Nutrition* (FAO 2016). Another written account of an initiative on biodiversity for food and agriculture[[2]](#footnote-2) mentioned legislation once and referred to regulations five times. If law or legislation is mentioned at all, it is normally done in the context of law being a complementary or as a secondary consideration.

LEGN believes that legislation or legal and regulatory frameworks are vital and are often core to efforts in mainstreaming biodiversity. Legal frameworks give legal force to policy in terms of creating legal obligations and enforceability of requirements. Legislation can drive change in approach, planning, decision making, management and behavior. It can secure the participation of stakeholders including gender participation and the input of the often marginalized peoples. Legislation can also establish appropriate institutions and mechanisms for these changes to occur. An important aspect of legislation is that it enables designated or interested parties to enforce the law or seek protection of or realization of rights that are accorded and violated.

Reviewing legal frameworks, enhancing existing laws and developing new legal frameworks must therefore be core of strategies or established programmes or projects for mainstreaming biodiversity or at least be a vital component of such programmes or projects. Appropriate resources should be allocated for these as well as implementing related capacity building, information and further research activities to plug gaps in knowledge or the understanding of the role that law can play in mainstreaming biodiversity. The need for legislation, in the context of mainstream biodiversity should “take center stage” rather than legislation being a secondary complement, a peripheral consideration or an after-thought - to be dealt with or pursued as an activity only if there is time or other resources are available.

**Do you have any examples of such enabling factors and initiatives or the lack of it?** Examples could include Cross-sectoral land use planning; Macro-economic policy and public investment; Elimination, phasing out and reform of perverse incentives harmful to biodiversity; Product labelling and market certification schemes; Green finance and private investment or others

Currently, the main area of work of LEGN is in assisting Members of FAO (countries) at their request to review existing legal frameworks (i.e. identify gaps and legislative measures to address such gaps) or assisting countries in drafting legislation for food and agriculture and natural resources (e.g. forestry, land, fisheries) in the context of food and nutrition security. Most of the legislative review and drafting work is sector driven but biodiversity mainstreaming is embedded in drafts of these sectoral legislation as principles and management guidelines or as measures in operative provisions/texts. Examples of biodiversity mainstreaming can be seen in legislating for the ecosystem approach to fisheries (EAF) or the implementation of the VGGT and the Small Scale Fisheries Guidelines or measures to reduce or report by catch or catches of non-target and associated species in fishing operations in fisheries legal frameworks. REDD+ principles and best practices being embedded in forestry legislation is another example of biodiversity mainstreaming. The work on reviewing and developing such legislation is done in a multidisciplinary manner and in a participatory approach.

What is lacking however is the programmes and projects that targets biodiversity (conservation and management) as the core subject to be realized across sectors with a focus on enhanced legal frameworks as the driver for change. A few countries (examples to be provided on request) have experimented in overarching or framework biodiversity or environment legislation but whether this approach could be studied as best practice and replicated are activities that would require a programme or project which commits adequate resources to undertake the activities.

**Which partners need to be involved in institutional frameworks, policies and processes for biodiversity mainstreaming to strengthen them?**

As many interested stakeholders or their representatives as possible should be involved in the review and development of legal frameworks for biodiversity mainstreaming whether through a sectoral opr multi-sectoral programme. After all, ensuring sound legislation is not only a matter of ensuring that its contents are comprehensive – it is also a matter of process – of ensuring that interested stakeholders and communities are consulted and contribute input into the drafting of legislation. These ensures buy-in and ownership of the process and product but also legitimacy of the law. This in turn might help in implementation and compliance with the law.

**LEGN contacts:**

Blaise Kuemlangan, Chief, LEGN

Valerie Johnston, Legal Officer, LEGN

## Anne Theo Seinen, European Commission

Dear Sir, Madam,

Please find attached a contribution from the European Commission to the online discussion prior to next week's multi-stakeholder dialogue. Various colleagues in several Directorate-Generals of the Commission contributed to this submission.

<http://www.fao.org/fsnforum/sites/default/files/discussions/contributions/180525%20-%20COM%20reply%20to%20online%20consultation%20prior%20to%20mainstreaming%20dialogue%20final.pdf>

I am looking forward to the dialogue!

Kind regards

Anne Theo

ANNE THEO SEINEN

Policy Officer

## Karin Jacobs, Stellenbosch University, South Africa

Dear Members of the forum,

My group are working on restoration ecology, and my interest is in particular the microbial communities. In South Africa, only 12% of soils are suitable for crop production, and of that only 3% are considered fertile. Thus, we need to find ways in which crop production can be intensified on marginal soils. Conservation Agriculture had a significant impact on farming in South Africa, and many farmers changed their practices. Our research group are involved in studies on a number of aspects.

Biodiversity is an important contributor to food security and improved nutrition.

From a number of studies we have seen that a reduction in the above ground diversity had a significant impact on the below ground diversity, resulting in a decrease in ecosystem function. One of the most important questions that we are currently investigating is the effect of farming practices on the microbial community diversity and function.

Measuring microbial diversity for research has in recent years become easier and more affordable, however, it is still difficult for the farmer and agricultural consultant to measure diversity and interpret the meaning against the backdrop of other soil health indications. To this effect we developed a fingerprint profile method to characterise soil diversity to be used in conjunction with other soil health indicators. This has shown to be effective in providing the agricultural community with a method to measure changes in biodiversity.

Our group has also developed a soil microbial consortium which has been successful in field trials. The microbial mix allow farmers to reduce chemical input, and the organisms are native to the region. This is particularly important in this region as much of our biodiversity are endemic and invasion is a real threat to our native biodiversity.

Good governance, enabling frameworks, and stewardship initiatives are needed to facilitate mainstreaming of biodiversity within and across agricultural sectors.

Currently, the government are working on draft legislation to promote CA in South Africa. There are also many champions, on national as well as regional scale who actively show and promote the value of these practices in enhancing diversity in the ecosystem. This has been very clear during the last drought, where CA farms showed more resilience, and maintained yields.

It is important for academia to foster relationships with farmers, industry and government to address the road forward.

## Lijbert Brussaard, Wageningen University & Research, Netherlands

Rather than answering all questions separately, I refer to the uploaded publication, which gives many examples of the kind you request for.

<https://www.sciencedirect.com/science/article/pii/S0959378012000568>

Kind regards,

Lijbert Brussaard
Professor emeritus, Soil Biology
Wageningen University & Research
Wageningen, The Netherlands

## Peter Bolo, International Center for Tropical Agriculture, CIAT, Kenya

1) Biodiversity is an important contributor to food security and improved nutrition.

Agricultural (cop) productivity and quality of the agricultural (crop) products greatly define food security and nutrition. Biodiversity (belowground and aboveground diversity) greatly influence the crop productivity and quality of products in a myriad of ways.

Nutrients (macro-and micro-nutrients) like nitrogen and phosphorus are necessary for increased crop productivity. Some of the nutrients are available in limited concentrations in the soil (thus, limiting crop productivity and nutrient balance). However, below-ground biodiversity (macrofauna, mesofauna, and microfauna) often assume active roles in nutrient transformations, involving mineralization, solubilization of recalcitrant nutrients and cycling, thereby increasing their concentrations for crop uptake (leading to increased food production and nutrient balance).

Certain bacteria and fungi in the soil are beneficial nitrogen fixers, nitrogen mineralizers, and soil stabilizers. in addition, phosphorus, being one of the most limiting nutrients, is often mineralized, solubilized and mobilized by fungi (specifically arbuscular mycorrhizal fungi (AMF)), contributing to increased nutrient availability for plant use. Besides, AMF also helps alleviate drought stress, pests and disease control, BNF, and detoxification of soil pollutants among others, therefore enabling for increased food productivity and nutritive balance in crops. In our study, we noted that the activities of phosphorus mineralizing organisms (enzyme phosphomonoesterases) increased where there was an inadequacy of available phosphorus; and where the soil was more acidic. This implies increased mineralization/solubilization of phosphorus to meet the crop demands (and contribute to improved food nutrition) in such systems, an aspect facilitated by the biodiversity.

However, it is important to note that a number of agricultural practices (poor agricultural management practices) can greatly threaten the biodiversity structure and composition; abundance and functions. For instance, removal of residues from the farm after harvesting, sole application of inorganic fertilizers without any soil amendments, and practicing conventional tillage, greatly impaired microbial proliferation and activities.  However, practicing conservation agriculture was associated with increased microbial abundance, diversity, functions, and enzyme activities, increased soil aggregate stability and improved crop yields...aspects that were directly positively correlated with the microbial abundance.

These collectively point towards the connection existent between biodiversity, food security and improved nutrition.

## Vanessa Pino, the University Of Sydney, Australia

Dear moderators and colleagues,

I am a Postdoctoral Research Associate in Soil Spatial Ecology from The Sydney Institute of Agriculture at The University of Sydney in Australia.

1. Our team here value that soil biodiversity is a critical contributor to food security and nutrition. There is no way how to replace its biochemical performance behind soil health conditions (nutrients availability and soil structure, for instance) on which relies agricultural productivity. Unfortunately, carrying out a large scale study across the main agricultural zone (so-called Wheatbelt region) across the state of New South Wales (> 800,000 km2), we found how soil biodiversity is lower in cropping areas and that the extent of this reality varies across different soil types - even beyond other environmental variables and land uses. To assess the real impacts on food security we are now profiling these relationships since a proper measure and a reference is needed for those different scenarios. As indicated by other studies, a decrease in soil biodiversity brings down the soil functionality that would compromise food security if an overuse of biodiversity occurs. A  baseline to estimates those critical points compromising food production should be established for the different soil environments – something that we are developing for this study area.
2. In our study, the paired soil ecosystems under more sustainable uses (but not productive ones) such as natural grasslands, forests and woodlands were also assessed in the same sampling points. In these environments, a higher microbial diversity showed up indicating how soil biodiversity is higher under natural ecosystems that any conservation measures would be a contribution to avoid biodiversity degradation.
3. I know about the local initiative looking after soil biodiversity in New South Wales. The NSW government has defined The Draft New South Wales Biodiversity Strategy 2010–15 which aims to improve and maintain soil biodiversity by promoting and educating in the use of sustainable land practices to keep soils healthy. Globally, my main understanding is on the activities organised by the Global Soil Biodiversity Initiative. All of those sectors involved somehow either in the exploitation or protection/conservation of soil ecosystems should be partners for promoting soil biodiversity mainstreaming strength. Producers, landowners, representatives from agricultural industry and experts from multidisciplinary areas to provide scientific support and tool for guiding a sustainable and resilient agriculture.
4. Declines of biodiversity should be stopped and avoided but there are no ‘values’ to show and tell the extent of this damage. The same lack of references does not allow an economic valuation of this damage to promote protective regulations. There are not standardized references showing, for example, what would be the best biodiversity level to promote nutrients availability or at which level certain pathogens can become a problem affecting soil productivity, etc. Landholders require guidelines on which rely how good o bad or far away are for sustaining biodiversity. Certainly, these references are variable by specific agroecological conditions. This requires investigation and observations encompassing different environments and the development of tools and collaborative guidelines from the different agricultural sectors. This information requires a technical and institutional capacity for its development. This is a developing knowledge that needs to be captured and then organised to reflect the extent of its economic and social impacts that will support the urgency for policies and regulations on behalf of its protection.

## Van Kien Nguyen, the Australian National University, Australia

I am evaluating the impacts of HYV rice intensification on biodiversity and nutritional supplies in the Mekong Delta. I found that intensification of rice has contributed to reducing in wild food catch: fish and other aquatic animals which used to apply rich nutrition for rural poor households

On the other hand, preserving the traditional floating rice based farming systems which provide habitats for fish and aquatic animals, which supply rich and diversity of nutritional sources for community.

## Mithare Prasad, SHUATS, UP, India

*Mainstreaming biodiversity in agriculture, fisheries and forestry for improved food security and better nutrition*

*Mithare Prasad*

*Assistant Professor (Agronomy), Department of ILFC, KVAFSU, Bidar-Karnataka, India*

* Biodiversity is a broad term in which origin of different species of plants (Crops), Animals (Livestock) and Microorganism are involved in it and also its genera and variety. When the biodiversity is related to agriculture sector it is called as Agro-Ecosystem which include Agriculture and Non-Agriculture aspects in which the aquaculture, soil ecosystem are also part of it. The major field of agro-ecosystem is Agro-Pastoral system, Aquaculture system, Different Cropping Systems and all together called as Integrated farming system or mixed farming system.
* Integrated Farming System approach: It play a vital role in minimizing the risk of crop failure due to aberrant weather conditions. Cultivation of crops along with different components like Agro-Forestry, Dairy Farming, Goat/Sheep Farming, Poultry Farming, Aquaculture, Duck Farming, Sericulture and Honey Bee Farming will be a great source of generating continuous income per unit area without effecting the eco-system and Organic Farming & Sustainable agriculture is a way of protecting the ecosystem.
* Farmer should give more scope towards organic farming for getting higher income with by minimizing the input cost. It also have many advantages over conventional farming like; Maintain soil fertility, Soil health, Increase organic matter content of soil, reduce compaction, Increase soil flora & fauna, Increase soil microbial activity, Increase nutrient use efficiency, Increase water holding capacity, Increase ground water table, Prevent soil pollution, Produce Pesticides residue free food, Environmental safe, maintain eco-System and diversity, Ultimately all these reduces the cost of production and increase the Net income of the farmers without disturbing the ecosystem.
* Farmers should practice LEISA (Low External Input Sustainable Agriculture) to minimize the input cost by reducing the chemical inputs such as Fertilizers, pesticides, herbicides, plant growth hormones etc which are harming the ecosystem rapidly.
* Sustainable forming is not just a matter of reducing certain inputs like chemical pesticides  and fertilizers, but rather instituting farming methods that emphasize soil building practices (e.g.: crop residues, animal and green manures), natural pest control ,crop and livestock diversity and crop rotation. Regularly adding to crop organic residues and manures is another central feature of sustainable farming.
* Biodiversity is an important contribution to food security and improved nutrition, many extra ordinary examples of soil microorganism which play a vital role in soil functions that sustain crop growth. Grassland eco system have abundance amount of micro flora of beneficial organism like bacteria, fungi, actinomycetes and algae, which are involved in decomposition and of higher C: N ratio and recycling of nutrients, which are essential for plant growth and food production.
* The ecosystem has many stages of food and nutrient recycling as in which Primary Producer - Secondary Producer – Primary Consumer - Secondary Consumer - Decomposers. In this process, mycophytic reducers also play important role in the ecosystem.
* Biodiversification of food and nutritional security: India is the agriculture based country in which 60 % of population is involved in Agricultural activates in which various agro-climatic conditions and zones are involved, comprising for Tropical, Semi-Tropical and Temperate eco-system is present. India is one of the leading producers of various agriculture crops like; Cereals, pulses, oilseeds, fruits, vegetables, spices, medicinal and aromatic crops.
* Family Farming Approach will be the prominent concept in maintaining the biodiversity and eco-system. Family Farming: It is very old concept but very effective approach in agriculture. Adopting this approach a farmer is capable of self sustainable & self sufficient to feed his family for year round, by which ultimately the poverty is prevented to major extent. Examples:- Growing of (Cereals + Pulses + Oilseeds + Fruits + Vegetables + Fibre + Fodder)
* Shelterbelts are effective approach in Mainstreaming biodiversity in agriculture forestry for improved food security and better nutrition: Shelterbelts are linear plantings combining trees, shrubs and plants designed to alter the flow of wind or snow, thereby altering the microclimate in an immediate area to make it more habitable for crops, wildlife, livestock and dwellings. Shelterbelts are also called windbreaks, hedgerows, timber belts, living fences or conservation buffers. Few important Advantages of Shelter Belts are moderating effect on temperature & it can increase or decrease the temperature. It retards the evaporation & increases the soil moisture. It reduces the wind velocity and wind erosion of soil. It increases the fruit production by minimizing wind damage.

**Benefits of Shelter Belt**

1. Reduced soil erosion by wind: A field shelterbelt modifies the microclimate, mostly in its downwind vicinity. This modified microclimate includes reduced wind speed and, therefore, reduced soil erosion.
2. Reduced wind damage to crops: Crops benefit from the reduced wind speeds in the protected zone. The plants are less likely to be twisted by the wind or sandblasted by eroding particles.
3. Increased moisture for crop growth: Shelterbelts reduce evaporation and provide more moisture for crop growth. Field shelterbelts use moisture and nutrients from a greater depth than most annual crops.
4. Potential for increased crop yields: Most of the research conducted around the world reports yield increases due to field shelterbelts. In drought-prone prairie regions that receive snow in winter, about half the yield increase is attributed to extra moisture from snow trapping by shelterbelts.

**Factors affecting ecological balance:**

1. Deforestation and overgrazing of range lands.
2. Accelerated soil erosion, Irrigation related problems.
3. Over exploitation of ground water.
4. Indiscriminate use of agrochemicals like chemical fertilizers and pesticides.

**Deforestation and overgrazing of range lands**: Perennial vegetation such as trees and grasses successfully prevent soil erosion and runoff from fallows. Forests influence climate of a region due to their effect on wind direction and hence the rainfall. Deforestation and overgrazing modifies the climate and the biodiversity besides loss of valuable genetic resources used in breeding programme for developing high yielding cultivars.

**Accelerated soil erosion, Irrigation related problems**: Accelerated soil erosion is currently a major environmental problem in tropical and sub tropical areas of the world as a consequence of population growth and demand for food. When once the vegetative cover is lost, the bare soil is exposed to the vagaries of wind and intensive rains leading to accelerated soil erosion. The productive soil is lost, making the soil unsuitable for crop production. Runoff from arable land contributes to nutrient enrichment (Eutrophication) of the water into which it drains.

**Over exploitation of ground water**: Poor quality water is one of the main factors turning good soils into saline or sodic soils. Provision of irrigation, without adequate drainage leads to the same problems as that with poor quality water. Many canal irrigated lands have become unproductive due to salt problems and ground water table. Total area is suffering from water logging ranges between 6 and 8.5 mha while that affected by salinity is around 9 mha.

**Indiscriminate use of agrochemicals like chemical fertilizers and pesticides**: Surplus soluble inorganic fertilizers, particularly nitrogen which have not taken up by the plants are leached out of the system. Others such as phosphorus and potassium are not so susceptible to loss by leaching as is nitrogen, except under abnormal condition. Overuse and abuse of chemical fertilizers harm the biological power of the soil.  Use of pesticides to control animal pests (insecticides), Plant diseases (fungicides) and weeds (herbicides) to cope up with crop protection opened the doors for several problems. Exclusive reliance on chemical pesticides has resulted in problems such as pesticide resistance, resurgence, residues and environmental pollution.

## Gabor Figeczky, IFOAM - Organics International, Germany

Biodiversity is key for rural livelihoods.

Biodiversity plays an important role in the functioning of ecosystems (i.e. the activities, processes or properties of ecosystems, such as decomposition of organic matter, soil nutrient cycling and water retention), and consequently in the provisioning of ecosystem services. Preserving biodiversity and ecosystem services contributes directly to human well-being and development priorities, creating great synergies between the 20 Global Biodiversity Targets and the Global Sustainable Development Goals.

Rural people depend on natural resources for their livelihoods, relying on a range of natural assets from their ecosystems and biodiversity for food, fuel and much else. Productive and sustainable agricultural systems need clean water, healthy soil, and a variety of genetic resources and ecological processes. Biodiversity is also important for enhancing the resilience of poor farmers and indigenous peoples to climate change, pests, diseases and other threats.

Unsustainable agriculture is a major cause of biodiversity loss.

Agricultural production, as currently pursued, is a source of 24% of greenhouse-gas emissions, 33% of soil degradation, and 60% of terrestrial biodiversity loss. Unsustainable farming practices, such as deforestation, the destruction of wetlands and aquatic environments, and overfishing are key threats to biodiversity. Farming is a major driver of agrobiodiversity loss, too, as the intensification of food production is narrowing the genetic diversity of the plants and animals on which we rely for food and nutrition. Agriculture is clearly associated with all the five primary threats to biodiversity, i.e. climate change, habitat change, invasive alien species, nutrient loading and pollution, and unsustainable overexploitation of natural resources, as identified by the Convention on Biological Diversity (CBD).

We need innovative solutions!

Are farming and biodiversity then inevitably incompatible? The simple answer is, no. But solutions rely on major shifts in policy, practice, behaviours, attitudes, and knowledge to explore how we can do farming for biodiversity. Although the world is far from achieving the Aichi Biodiversity Targets, there are various approaches to direct food systems onto a sustainable path. One of these are voluntary certification schemes, most of which are rooted in organic certification.

Organic agriculture maintains biological diversity.

Organic agriculture is based on a holistic approach and sustains ecosystems by:

* providing food and shelter for wild species and thus increasing them in number and variety,
* supporting agro-biodiversity,
* maintaining healthy soils and soil fauna,
* reducing the risk of water pollution,
* cutting the demand for synthetic inputs, thereby reducing land-use pressure on natural habitats by the energy industry, and
* nourishing ecosystems and ensuring that they are not cleared to further extend the agricultural frontier.

Participators Guarantee Systems deliver on all fronts of sustainability and social inclusion.

Consumers’ trust in an organic label rewards farmers for their good practices enhancing biodiversity. Besides third party organic certification, needed for international trade in organic, there are locally focused quality assurance systems, such as Participatory Guarantee Systems which can only be used for domestic sales. Producers are certified based on active participation of stakeholders and are built on a foundation of trust, social networks and knowledge exchange. They contribute to establishing sustainable and fair food systems by

* ensuring that the smallest farmers can have access to organic markets,
* ensuring the integrity of organic products in a cost effective, transparent way and
* facilitating local production and consumption of organic food.

Biodiversity friendly organic agriculture needs to be promoted by policies.

As organic agriculture is a system which has biodiversity protection as its core element, it should be promoted by a conducive policy environment. This can be done in various ways, such as:

* favouring agricultural research and extension on organic methods, agro-forestry, etc.,
* supporting the development and use of organic inputs (e.g. on-farm plant preparations, vermicompost, etc.),
* subsidizing certification to biodiversity-friendly standards,
* area payment subsidies for organic production,
* subsidies for agri-environmental practices, such as preserving extensively managed grasslands hedges, woodlands, ponds, etc. on the farm, agroforestry, non-use of chemical pesticides, no/low-use of chemical fertilizers, permanent ground cover under perennial crops etc.,
* organic management in public areas and publicly-owned land, and
* prohibition of agro-chemical use in biodiverse sensitive areas.

Another testament to a growing global movement for positive change in behaviours is the depth and breadth of response to the Farming for Biodiversity Solution Search is a testament to this. Through this contest, over 300 innovative and replicable ideas have been identified that connect agriculture, livelihood and the environment.

These game-changing solutions are bringing farming into harmony with the natural environment to protect and increase the biodiversity of surrounding plants, animals, and microbes on the agricultural land itself. They highlight sustainable land use management practices that promote the natural balance and benefits of biodiversity. They promote alternative pest control, fertilization, and waste management to protect water sources and ecosystems. They address human/wildlife conflicts and put in place livestock control measures to protect both flora and fauna. They bring new-found economic benefits and recognition for traditional varieties, knowledge, and practices. They celebrate the potential of youth and women farmers to drive change.

Following the overwhelming success of the contest, we are dedicated the next two years to bringing these solutions to scale – both through behaviour change and technical training for our local champions in-country and through engaging in international policy processes.

Some inspiring solutions that Farming for Biodiversity surfaced and that I would like to share with you include:

* Our contest Audience Prize Winner, Apis Agriculture from Ethiopia, has used certified organic wild honey to create employment opportunities and provide training for hundreds of landless, unemployed youth in his area. This tackles youth out-migration and deforestation simultaneously, as young people find new income sources and also have incentives to protect local forests.
* In Nepal, Local Initiatives for Biodiversity, Research, and Development, has developed a “landscape label” that markets local agricultural products based on the tourism appeal of the local area, Begnas and Rupa Lakes, introducing buyers to niche products to create new demand
* The community-based Kenya Organic Oil Farmer’s Association – which has a mixed membership that includes women and youth – has a contractual agreement with Earth Oil Extracts to produce Organic and “Fair for Life” (a Fair-Trade standard and certification system) tea trees for essential oil extraction.  Currently, they have trees covering about 500 acres, and each member has between 1-3 acres of land on which they grow a mix of food crops and essential oil crops.

Because land degradation and fragmentation are at the heart of the habitat loss that threatens biodiversity, most of the projects address technical aspects associated with protecting or restoring land, water, or forest systems, often in combination. Innovators employ numerous methods, with an emphasis on organic farming, integrated farming, and conservation agriculture to replace the overuse of chemical fertilizers and pesticides, and restore ecosystems. They take a better control of waste and crop residues, including turning them into compost, animal feed, or biofuel. They plant trees planting and apply agroforestry, with incentives (e.g., more food production, nutrition, income generation, skills) for local communities to benefit from the sustainable use and preservation of forest systems.

Explore some of these ground-breaking innovations at the recently launched ‘[Agriculture and biodiversity solutions](https://panorama.solutions/en/portal/agriculture-and-biodiversity)’ site of the Panorama platform – and share your own solutions with the world.

Recommendations to donors and policy makers

Based on the above, our recommendations to donors and policy makers are the following:

* Create enabling environments through policies, social structures, and financial incentives that support biodiversity stewardship with agricultural production such as organic farming.
* Foster community solutions to farming for biodiversity with enabling policies and funding to support tested initiatives, proof of concept, and new technologies and innovations for community-based and community-driven programs.
* Invest in indigenous communities, youth, and women as agents of change in biodiversity conservation and agricultural/economic development. Design programs targeting women and older generations who are key in the valuation of traditional ways and the intergenerational transfer of indigenous seeds, breeds, and knowledge.
* Work with policy actors from local and regional levels to inform and align with national and international strategies for conservation, agricultural development, and economic development.
* Beware of and eliminate the subsidizing of policies (e.g., support for monoculture, overproduction, high use of chemical fertilizers/ pesticides) that harm biodiversity and its linkages with food production in the name of increased productivity. Introduce the polluter-pays-principle for agriculture.
* Set up agricultural advisory services and establish farmer-to-farmer learning programmes to scale up and scale out sustainable innovations and to demonstrate that biodiversity and increased food production can, and must, be compatible.
* Donors, governments should work in partnership with business to fund incentives (e.g., direct payments, academic certification, prizes, other recognitions) that reward environmentally and economically sustainable farming, so that it becomes an occupation of choice.
* Establish participatory research programmes and human-centered design models, putting leaders and communities at the center of problem solving and change, so that they truly become transformational.
* Highlight solutions through rewards, scholarships, networks, mentoring programs, social marketing campaigns, and events to encourage young people to engage in farming for biodiversity through strategies that integrate business development, financial inclusion, new technologies, communications, and innovative linkages.
* Take a cross-sectoral approach in planning and use the ‘Guidance on agriculture, crop and livestock’ of the Cancun declaration on mainstreaming the conservation and sustainable use of biodiversity for well-being when addressing biodiversity and food systems. Consider how broader social, political, economic, ecological, and physical dimensions (e.g., urbanization, farmland, forests, water sources) fit together and affect natural resource use and management.

## Seth Cook, IIED, United Kingdom

I want to share some points that are relevant to this discussion from a new paper by Hivos and IIED entitled The spice of life: the fundamental role of diversity on the farm and on the plate (<http://pubs.iied.org/G04305/>), which focuses on agricultural biodiversity and diverse, high quality diets.

Maintaining agricultural biodiversity is vital in order to meet food and nutrition security and to cope with the challenge of climate change. Improving and diversifying diets is essential to human health and to limiting the spread of non-communicable diseases. Reviving and maintaining diversity on the farm and on the plate requires action on multiple fronts and at multiple scales. At a macro level, promoting diversity entails a shift from industrial agriculture – which relies on monocultures and a small number of crops, crop varieties and animal breeds – to diversified sustainable farming systems. At a national and local scale, it entails raising awareness and stimulating demand for diverse and healthy foods, as markets for diverse crops and animal products need to be supported and expanded. Meanwhile, policies, subsidies, research and extension programmes need to be aligned to support diverse food production and consumption. Finally, the cultural underpinnings of diverse food systems – which are also under threat worldwide – need to be protected and strengthened.

Markets have an important role to play in fostering greater diversity of production and consumption. In developing countries, informal markets are particularly important, and often do a better job than formal markets of linking diverse, affordable foods with consumers. Such markets should be nurtured, to support and improve their operation, rather than trying to stamp them out, as governments often unsuccessfully attempt to do. Barter markets can also provide an important mechanism for poor groups to access diverse nutrients and sustain agrobiodiversity. For instance, a barter market controlled by indigenous women in the Lares area of Cusco province in Peru enables highland and lowland products to be exchanged, enhancing the nutritional security and agrobiodiversity of both regions.

Gastronomic movements around the world have played an increasingly important role in promoting the revival and maintenance of traditional crops and ingredients. For instance, in Bolivia, this has created a small but significant demand for traditional products by chefs, who are working directly with local producers to ensure sustainable processes for the production of local Andean crops. One of the key organisations involved in the Bolivian gastronomic movement is MIGA (Movement of Gastronomic and Food Integration of Bolivia). Since 2012, MIGA has brought together different key actors in the gastronomic food system to enhance the value of Bolivian culinary heritage and promote sustainable economic, social, cultural and environmental processes. MIGA seeks to promote the value of biodiversity represented in local and native products, preserving traditional knowledge, seasonality, as well as traditional ways of consumption.

Carefully targeted procurement programmes (e.g. in schools, university, hospital kitchens and prisons) can be another powerful lever to improve diets and create demand for a more diverse array of crops. In fact, procurement is one of the few mechanisms that can stimulate demand and supply for more diverse, healthy foods in a direct way and at scale. School feeding programmes with the aim of improving children’s nutrition are a good illustration of public procurement. Depending on how such programmes are designed, they can also promote local sourcing and a diversity of foods, thereby creating demand for local crop varieties.

India has the largest school lunch programme in the world, serving 120 million of the country’s poorest children. Biodiversity International, the M.S. Swaminathan Foundation and other organisations have promoted the conservation and use of millets, including in school lunch programmes. The substitution of millets for white rice in school lunches in 12 districts of Central and South India led to a 37% increase in haemoglobin levels in children over a three-month period.

## Thomas Bandoli, College of Southern Idah, United States of America

I truly appreciate this forum and the opportunity to share ideas, goals and implementation strategies.  I feel that for global food security to become a reality, a truly global approach to local problems in turn leading to global solutions is absolutely essential.  We must promote all attempts to implement multiple agricultural schemes and solutions to produce food and other natural resource products while insisting that biodiversity is an equal variable in the equation.

Multi-disciplined teams must operate together to understand and integrate very complicated local situations to solve and divert a potential and in some places a pending food and natural resources crisis.  The difficulties presented by Climate Change effects can only be solved at all levels from UN Forums to small local and family farms.  Examples of agriculture practices that consider and implement techniques that ensure high levels of biodiversity must occur on every continent and in every country for it to have a positive and significant effect on the essential food security issue.

## Patrick Kalas, Food and Agriculture Organization of the United Nations (FAO), Italy

**Moving from “Small is beautiful” to a “Sea of Transformative Change”: Applying a system-wide, country-owned and empowering capacity development approach to mainstream biodiversity across agriculture sector**

Addressing FSN Forum Question: *How can the technical and institutional capacity needed to promote sustainable agriculture and reduce the impact on biodiversity be developed?*

Mainstreaming biodiversity within and between agriculture sectors requires addressing complexities across biophysical, technical and socio-economic levels and multiple actors.

Who will own, drive and be accountable for this mainstreaming process and results, particularly at country level? How can the process become country-owned, sustainable and reach scale? What are the national and subnational capacities across people, organizations, institutions, networks and policies that need to be enhanced?

In line with development effectiveness principles, the proposal is to take a system-wide, country-owned and empowering capacity development approach to enable transformative, country-driven and impactful mainstreaming results to conserve and more sustainably use biodiversity resources.

System-wide capacity development means to interdependently strengthen:

* individual capacities (e.g. knowledge, skills and competencies),
* organizational and institutional capacities (e.g. performance of organizations, cross-sectoral multi-stakeholder coordination mechanisms) as well as
* the systemic capacities (e.g. the enabling environment such as sound regulatory and policy frameworks, effective governance, institutional linkages, institutional political economy, networks, political commitment and will).

Practically and during the capacity development process, this means to jointly with all stakeholders and across all capacity development levels to:

(a) assess capacity strengths, needs and priorities

(b) define and design contextualized capacity development interventions and

(c) define meaningful results and track progress

Practical tools, methods, approaches and experiences are available by a variety of development actors, including the United Nations Food and Agriculture Organization (FAO. These can be contextualized for biodiversity such as:

* Enhancing Capacities for a Country-Owned Transition towards Climate Smart Agriculture. FAO. 2017. <http://www.fao.org/climate-smart-agriculture-sourcebook/enabling-frameworks/module-c1-capacity-development/c1-overview/en/>
* Institutional Capacity Development Assessment Approach for National Adaptation Planning in the Agriculture Sectors. FAO. 2018. <http://www.fao.org/3/I8900EN/i8900en.pdf>
* Capacity Development at Multiple Levels for Effective Implementation of Sustainable Land Management. FAO. 2017. page 82 in Sustainable Land Management (SLM) in Practice in the Kagera Basin. <http://www.fao.org/3/a-i6085e.pdf>
* Measuring Capacity Development Results- What and How. FAO. 2015. <http://www.fao.org/3/a-i5243e.pdf>

In sum, mainstreaming biodiversity across agriculture sectors will need to address complexities across biophysical, technical and socio-economic spheres. It will require involvement, meaningful inclusion of and facilitated dialogue with trust building among all actors across sectors and administrative levels. Above all, the process needs to foster joint-ownership, joint-commitment and mutual accountability to achieve biodiversity improvements the planet so urgently requires.

A system-wide, needs-based and empowering capacity development approach across people, organizations, institutions and the enabling policy environment can make a tangible and meaningful contribution towards this aim.

**Disclaimer**: This is a contribution to the Global Forum on Food Security and Nutrition on “Mainstreaming Biodiversity in agriculture, fisheries and forestry for improved food security and better nutrition”. It is a personal opinion with reference to institutional approaches on effective capacity development of the Food and Agriculture Organization of the United Nations (FAO).

## Rob Blakemore, VermEcology, Japan

Critical decline of earthworms by >80% in intensive agriculture.

Blakemore, R.J. (2018). Critical Decline of Earthworms from Organic Origins under Intensive, Humic SOM-Depleting Agriculture. Soil Systems. 2(2): 33. [<http://www.mdpi.com/2571-8789/2/2/33>; PDF Version:  <http://www.mdpi.com/2571-8789/2/2/33/pdf>. DOI: https://doi.org/10.3390/soilsystems2020033]. Blog: [https://vermecology.wordpress.com/2018/05/27/wormageddon-destruction-in-our-soils/](https://vermecology.wordpress.com/2018/05/27/wormageddon-destruction-in-our-soils/%C2%A0).

## Mylene Rodríguez Leyton, Universidad Metropolitana de Barranquilla, Colombia

**BIODIVERSITY AND FOOD SECURITY AND NUTRITION**

Below are two strategies implemented in Colombia to protect biodiversity, the first are the basic guidelines for sustainable cocoa and the second is the signing of the biodiversity pact.

**Basic Guidelines for Sustainable Cocoa - LBCS**

The Swisscontact Colombia team has advanced the project "Promotion of the Production and Exportation of Fine Cocoa and Aroma of Colombia - Coexca", and the "Trade for Sustainable Development" program of the International Trade Center-ITC, they developed the protocol of BASIC GUIDELINES OF SUSTAINABLE COCOA - LBCS-, which offers cocoa farmers a tool that allows them to evaluate and permanently their agricultural and organizational practices, against criteria that guide their activity towards social, environmental and economic sustainability; developed with the support of the Swiss government, through the Secretariat of State for Economic Affairs - SECO.

Basic guidelines for sustainable cocoa - LBCS, is a set of evaluation criteria applicable to organizations and their associated producers, which allow to know their progress in the implementation of sustainable practices and the gaps to be resolved in a program of productive improvement and organizational maturity, before arriving at more complex certification processes or as an alternative to clients that do not request them, but want to know the dynamics of the organization.

With the participation of ITC's Trade for Sustainable Development -T4SD program, LBCS has become part of the global platform <www.sustainabilitymap.org>, where producers and their organizations can access their different modules, presenting their advances in the implementation of LBCS and communicate with different actors at a global level.

This initiative has been integrated into the National Cacao Association of Colombia-Red Cacaotera, which has incorporated LBCS as a strategic element for its internal development, so that the basic sustainability criteria are incorporated into the process of organizational maturity of its associations in Colombia.

<https://www.swisscontact.org/fileadmin/user_upload/COUNTRIES/Colombia/Documents/Content/Lineamientos_Basicos_de_Cacao_Sostenible_V.2.pdf>

**Pact of Biodiversity**

In Colombia, the initiative has been implemented to raise awareness among the population about how daily actions affect some of the most threatened species in the country and the measures that can be taken to contribute to the non-affectation of forests; this is why the Pact of Biodiversity was signed in 2017, an initiative that arises from the partnership between the Franco-Colombian Forest Conservation Association, National Natural Parks of Colombia, the Alexander Von Humboldt Institute and Sustainable Week.

This strategy invites people to understand the connection between their habits and species and thus they can commit themselves through the signing of the Pact to change their habits permanently. In addition, they will have the option of staying informed about good practices that will allow them to fulfill their long-term commitments.

To advance this initiative, we have the platform <www.pactobiodiversidad.org>, where Colombians can also learn about the habitat and customs of the condor, the Andean bear or the spectacled bear, the golden frog, the marmoset and the turtle.

In agreement, with Daisy Tarrier, promoter of the project "Colombian biodiversity is exceptional, it is essential to protect this nature, not only for its beauty but for the services it provides. With the Biodiversity Pact we want to show that we can all participate. "

The agreement will be available to the public as of May 22, 2017, the day of the World Day of Biological Diversity.

**Does overexploitation of biodiversity compromise food security and nutrition?**

With respect to the relationship of biodiversity with food safety and nutrition, I share some evidence from other authors and their own.

Both in the past and in the present, biodiversity is closely related to the food and survival of human beings, so it has been considered that the protection of native plants and animals against environmental and ecosystem changes ensures livelihoods of populations living in environmental conditions and in unfavorable soils for food production. (Rodríguez -Leyton, 2010).

According to Hollingsworth (2015), human beings who inhabit the Earth, use the soil to obtain food, to feed themselves and to conserve life, because there is no other option at the moment; the soils and the biodiversity associated with these are resources that today act as a buffer against climate change, both in ecosystems and in agroecosystems. However, what is taken from these resources to meet the demands of society, through agriculture, goes against the sustainability of the system.

The reasons that lead people not to have a respectful treatment with nature and with resources such as the soil, are mainly Western culture that considers nature and culture as separate.

With respect to the cultural dimension, we must introduce changes in the behavior patterns of people that lead to respect for the soil, its components and in general the life that inhabits it (Feller, 2015).

A study by the Conservation Monitoring Center of the United Nations Environment Program (UNEP) and the Cambridge Conservation Initiative found that the rapid expansion of cropland is the main cause of biodiversity loss in tropical countries, corn and soybeans stand out as the most expansive crops and as the main causes of the loss of biodiversity in tropical regions. Other crops that pose a significant threat to habitats and wildlife are beans, cassava, cowpeas, peanuts, millet, palm oil, rice, sorghum, sugar cane and wheat, the study says.

Another aspect analyzed by several authors is the scarce biodiversity of concern in the last decades of the last century for FAO, because "only between 150 and 200 plant species and 40 domesticated species of mammals and birds, constitute the supply of food in the last century.

It was estimated that 60% of the calories and proteins consumed by the population come from rice, corn and wheat and that 35 food crops and 29 forages guarantee 80% of the caloric supply in the world's population. "

It was evident that many traditional species of plants and animals are displaced by other improved varieties or have been replaced by more productive crops, with which not only the variety but also the traditional knowledge associated with their production is lost. There are forgotten species used in their centers of rural origin and others that have fallen into underutilization or have stopped being used for cultural, economic or agronomic reasons. In view of this concern, from 1992 onwards, the need to conserve biodiversity was raised, promoting "the protection of traditional knowledge, participation in policy decisions and fair and equitable participation in the distribution of the benefits derived from the use of genetic resources for agriculture and food "De Loma E (2008).

Until a few years ago, it was stated that world food production was sufficient to meet the needs of the population, as Reichmann puts it, there are plenty of food to meet the food needs of the world population, for which it is essential to generate changes in food production. The basic political-economic structures. However, the rapid growth of the population, calls into question not only the possibility of satisfying the food needs of the population, but also increases the concern for the loss of biodiversity.

The decrease in biodiversity leads to risks in food production by reducing future options, due to the loss of genetic information and genetic material; "An increasing susceptibility to diseases and parasites because few varieties and species grow over extensive areas, which can lead to dependence on pesticides, fertilizers and destabilization of ecosystem processes, with interruptions in soil formation and in their cycles"

In 1989 the World Wildlife Fund defined biodiversity as: "the richness of life on Earth". With this wealth, it refers to the millions of species of animals, plants and microorganisms, as well as the genes of all of them and the ecosystems in which they live, and which therefore make up the natural environment.

To date, an enormous amount of species has been described, around 1,750,000, but it is estimated that there are still many millions more to be cataloged.

Biodiversity contemplates the biological richness of all the ecosystems, species and genes that surround us, and represents a crucial factor in the natural heritage whose ecosystem services guarantee our well-being. Thus, the various ecosystem components, their interactions and functions favor an optimum quality of life, both individually and collectively, ensuring basic services of first necessity (drinking water, natural foods). Therefore, ecosystem goods and services are a fundamental pillar of local economies, since they have a high potential for generating employment and social welfare.

Consequently, biodiversity protection and management policies must be approached from an integrated management perspective, focused on the biophysical processes that determine the ecological integrity of ecosystems, both inside and outside the protected areas, and in the enhancement of value. Of biodiversity as a key element for the promotion of models of sustainable development.

Biodiversity is one of the fundamental bases of human nutrition. The genetic resources of animals and plants are the basis for the development and improvement of cultivated plants and animal breeds, to cope with new pests and diseases, and to safeguard their potential for adaptation to changes in the environment and in the ecosystems The biodiversity of native plant varieties and animal breeds adapted to local conditions ensures the livelihoods of populations in unfavorable environmental and soil conditions.

The different forums held since 1992 to promote conservation and use of biodiversity, have faced the problem of erosion of these resources in the framework of respect and protection of the rights of farmers and fishermen. This right implies the protection of traditional knowledge, participation in policy decisions and fair and equitable participation in the distribution of benefits derived from the use of genetic resources for agriculture and food.

The following are the main agreements for the protection of biodiversity:

The Convention on Biological Biodiversity (CBD), which enters into force in 1993, is the broadest international instrument for all matters related to biological diversity and establishes a binding legal framework for its conservation and sustainable use.

The Cartagena Protocol on Biosafety was adopted in Montreal in the year 2000; The purpose of this Protocol is to help ensure an adequate level of protection in the area of safe transfer, handling and use of living modified organisms resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of diversity biological, also taking into account the risks to human health, and focusing specifically on transboundary movements.

1. C 2017/33 [↑](#footnote-ref-1)
2. Biodiversity for Food and Agriculture, Comtributing to food security and sustainability in a changing world, FAO 2011. [↑](#footnote-ref-2)