Food and Agriculture Organization of the United Nations

GLOBAL SOIL PARTNERSHIP

Plan of Action for Pillar One of the Global Soil Partnership

Adopted by the GSP Plenary Assembly

Promote sustainable management of soil resources for soil protection, conservation and sustainable productivity

Pillar One Working Group:

- **Chair:** Liesl Wiese
- **Africa:** Jeroen Huising
- **Asia:** Joseph Bagyaraj and Prem Kandel
- **Europe:** Violette Geissen, Patrick Heffer, Peter Kuikman, Konrad Meyer, Peter Weisskopf and Pandi Zdruli
- **Latin America:** Arnulfo Encina Rojas, Rafael Fuentes, Maria Beatriz Giraudo and Olegario Muniz
- **Middle East and North Africa:** Hedi Hamrouni and Feras Ziadat
- **North America:** Archis Ambulkar
- **Secretary:** Ronald Vargas and Sally Bunning

Table of Contents

Acronyms

CAADP	Comprehensive Africa Agriculture Development Programme
CBD	Convention on Biological Diversity
CST	Committee on Science and Technology
CGIAR	Consortium of International Agricultural Research Centers
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
ELD	Economics of Land Degradation
ENSA	European Network Soil Awareness
EVS	European Voluntary Service
FAO	Food and Agriculture Organization of the United Nations
GEOSS	Global Earth Observation System of Systems
GDP	Gross Domestic Product
GHG	Greenhouse gas
GSIF	Global Soil Information Facilities
GSP	Global Soil Partnership
GWP	Global Water Partnership
HWSD	Harmonized World Soil Database
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFA	International Fertilizer Industry Association
IIASA	International Institution for Applied Systems Analysis
IITA	International Institute of Tropical Agriculture
INM	Integrated Nutrient Management
INSII	International Network of Soil Information Institutes
IPCC	Intergovernmental Platform for Climate Change
IPR	Intellectual Property Rights management
IRRI	International Rice Research Institute
ISFM	Integrated Soil Fertility Management
ISO	International Standard Organization
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
ISFM	Integrated Soil Fertility Management
ITPS	Intergovernmental Technical Panel on Soils
IUSS	International Union of Soil Sciences
IYS	International Year of Soils

LADA	Land Degradation Assessment in Drylands
MDG	Millennium Development Goal
NGO	Non-governmental Organization
OGC	Open Geospatial Consortium
PTF	Pedo-transfer Functions
PTR	Pedo-transfer Rules
QA/QC	Quality Assurance and Quality Control
RSP	Regional Soil Partnership
RSPO	Roundtable on Sustainable Palm Oil
R&D	Research and Development
SCAPE	Soil Conservation and Protection in Europe
SOTER	Soil and Terrain Database
SDG	Sustainable Development Goal
SLM	Sustainable land management
SSSA	Soil Science Society of America
SSM	Sustainable Soil Management
SSS	Soil sampling, Sample preparation and Sample storage
SOC	Soil Organic Carbon
SPI	Science Policy Interface
SSSA	Soil Science Society of America
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USDA	United States Department of Agriculture
WGSIS	Working Group on Soil Information Standards
WOCAT	World Overview of Conservation Approaches and Technologies
WSC	World Soil Charter
WSD	World Soil Day
WRB	World Reference Base for Soil Resources
WWOOF	World Wide Opportunities on Organic Farms

Glossary

Agriculturally productive soil refers to soil with the suitability to produce certain yield of an agricultural crop or crops due to its inherent physical, chemical and biological properties.

Agronomic biofortification refers to the application of soil and foliar mineral fertilizers and/or improving solubility of mineral nutrients in the soil to promote nutrient accumulation in edible parts of food crops.

Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food.[1]

Integrated Nutrient Management refers to the maintenance of soil fertility and plant nutrient supply at an optimum level for sustaining the desired productivity by optimizing the benefits from all possible sources of organic, inorganic, biological and sustainable recyclable waste components in an integrated manner, to prevent environmental impacts from nutrient outflows.

Integrated Soil Fertility Management refers to a set of soil fertility management practices that necessarily include the use of fertilizer, organic inputs, and improved germplasm combined with the knowledge on how to adapt these practices to local conditions, aiming at maximizing agronomic use efficiency of the applied nutrients and improving crop productivity.[2]

Nutrient Use Efficiency refers to getting the maximum amount of nutrients applied to soils and crops into the harvested portion of a crop. This implies the recovery of nutrients supply through fertilizer application by the crop, through uptake of nutrients by the plant and depends on plant characteristics (transport, storage, mobilization and usage within the plant) and on the environment.

Nutrition security means access to the adequate utilization and absorption of nutrients in food, in order to be able to live a healthy and active life.1

Potentially agriculturally productive soil refers to soil that is not agriculturally productive, but can be transformed into agriculturally productive soil through the implementation and application of appropriate amendments and management practices.

Region indicates a Regional Soil Partnership (RSP) established under the GSP among interested and active stakeholders. The RSPs will work in close coordination with FAO Regional Offices to establish interactive consultative processes with national soils entities, regional soil science societies and relevant regional mechanisms under the related conventions. The following seven regions have been identified:

---

[1] FAO. 2009. *The State of Food Insecurity in the World 2009*. Food and Agriculture Organization of the United Nations.

[2] Van Lauwe B. 2013. Integrated Soil Fertility Management – a concept that could boost soil productivity. *Rural 21*. 3:34-37.

- Asia
- Africa
- Europe and Eurasia
- Middle East and North Africa
- North America
- Latin America
- Southwest Pacific

Soil conservation indicates the (i) preventing soil degradation processes such as physical soil loss by erosion or biological, chemical and physical deterioration; including, excessive loss of fertility by either natural or artificial means; (ii) a combination of all management and land use methods that safeguard the soil against depletion or deterioration by natural or by human-induced factors; and (iii) the branch of soil science that deals with soil and water conservation in (i) and (ii).[3]

Soil contamination implies that the concentration of a substance (e.g. nutrient, pesticide, organic chemical, acidic or saline compound, or trace elements) in soil is higher than would naturally occur (See also *soil pollution*).

Soil functions refer to the seven key functions of soil in the global ecosystem as:

1. Biomass production, including in agriculture and forestry;
2. Storing, filtering and transforming nutrients, substances, and water;
3. Biodiversity pool, such as habitats, species and genes;
4. Physical and cultural environment for humans and human activities;
5. Source of raw materials;
6. Acting as carbon pool;
7. Archive of geological and archaeological heritage.

Soil pollution refers to the presence of substances at concentrations above threshold levels where they become harmful to living organisms (See also *soil contamination*).

Sustainable Land Management (SLM) means the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while ensuring the long term productive potential of these resources and the maintenance of their environmental functions.[4]

Sustainable productivity means the ability to maintain productivity, at field, farm or territorial scale, where productivity is the output of valued products per unit of natural resource input.

Sustainable soil management refers to the definition for sustainable soil management developed in the World Soil Charter.

[3] SSSA. 2008. Glossary of Soil Science Terms. Madison, WI, USA.

[4] UNCED. 1992. *The RIO Declaration on Environment and Development.* United Nations Conference on Environment and Development (UNCED), Rio de Janeiro, 3-14 June 1992.

Executive Summary

Background

Soil is considered a finite, non-renewable natural resource on the human time-scale since it does not regenerate at a significant rate within this time, and needs to be managed accordingly.

Soil has various key functions that are important for agricultural, environmental, nature protection, landscape architecture and urban applications. As such, it serves as the basis for food, feed, fuel and fiber production, provision of clean water, nutrient cycling, serves as a sink for organic carbon, provides for one quarter of global biodiversity, provides construction material and serves as a platform for construction. Soil is therefore at the heart of concerns about food security, biodiversity, climate change, land degradation, desertification, and the provision of ecosystem services. However, inappropriate soil management practices, increasing population demand and inadequate governance, amongst others, have resulted in the degradation and loss of available soil resources in various parts of the world, reducing their capacity to perform essential ecosystem services. The protection and conservation of soil is therefore critical to the maintenance of a wide range of ecosystem services and compels land users to ensure its long term sustainability as natural resource.

Development process

The development of the Pillar 1 plan of action was initiated during the "Managing Living Soils" workshop held in Rome, Italy during December 2012. This workshop focused on the regional and national status, as well as challenges and priorities for sustainable soil management. This was followed by a Pillar 1 discussion session during the 2nd Global Soil Week held in Berlin, October 2013. The aim of the discussion was to decide on the structure of the plan of action and its main content. A formal Working Group of 26 members was formed according to the GSP Rules of Procedure, tasked with developing a draft plan of action for Pillar 1 from November 2013 to March 2014. The draft plan of action was submitted to the Intergovernmental Technical Panel on Soils (ITPS) for its review and endorsement. Following a very dynamic process during which ITPS recommendations were included, the draft was endorsed by ITPS during its second working session in April 2014 and submitted to the Second Plenary Assembly of the GSP. The Plenary Assembly consolidated the original 11 recommendations endorsed by the ITPS into five concrete recommendations. Additional comments and suggestions from GSP members were incorporated and this final version of the Pillar One Plan of Action was endorsed by the Plenary Assembly of the GSP on 23 July, 2014.

Approach

Sustainable soil management (SSM), as defined in the World Soil Charter, should be promoted and implemented in all land uses. To this end, the challenges associated with SSM implementation should be assessed and addressed, including economic, technical, social political, investment and partnership challenges. The GSP can bring together partners and existing initiatives to improve global and regional solutions towards improving and increasing sustainable soil management for soil protection, conservation and sustainable productivity. To

promote and increase sustainable soil management implementation, this plan of action proposes 5 recommendations.

Summary of Recommendations

Recommendation 1: Appropriate sustainable soil management practices and systems should be identified for all land uses at regional and national levels using existing knowledge, adapted according to site characteristics and land user needs, considering cost-benefit analyses and social impacts. These practices and systems should be implemented at appropriate scales to restore and maintain soil functions and ecosystem services.

Recommendation 2: In light of the primary importance of food security, sustainable agricultural production should be supported by balanced soil fertility management using a range of available nutrients and appropriate physical management practices without causing negative environmental impacts.

Recommendation 3: All barriers preventing the implementation or adoption of sustainable soil management practices and systems should be assessed and policy and technical solutions proposed to create an enabling environment for sustainable soil management.

Recommendation 4: A monitoring system should be developed to measure the progress of implementation of sustainable soil management practices and systems.

Recommendation 5: The GSP should facilitate the development of a capacity building strategy amongst all stakeholders to promote the adoption of sustainable soil management.

1 Introduction

The Global Soil Partnership (GSP) was formally established by members of the Food and Agriculture Organization of the United Nations (FAO) during its Council in December 2012. The Council recognized soil as an essential natural resource, which is often overlooked and has not received adequate attention in recent years, despite the fact that production of food, fiber, fodder, and fuel critically depends on healthy soils. The Mandate of the GSP is to improve governance of the limited soil resources of the planet in order to guarantee agriculturally productive soils for a food secure world, and support other essential ecosystem services, in accordance with the sovereign right of each State over its natural resources.

In order to achieve its mandate, the GSP addresses the following five pillars of action to be implemented in collaboration with its regional soil partnerships:

1. Promote sustainable management of soil resources for soil protection, conservation and sustainable productivity;
2. Encourage investment, technical cooperation, policy, education, awareness and extension in soil;
3. Promote targeted soil research and development focusing on identified gaps, priorities, and synergies with related productive, environmental, and social development actions;
4. Enhance the quantity and quality of soil data and information: data collection (generation), analysis, validation, reporting, monitoring and integration with other disciplines;
5. Harmonisation of methods, measurements and indicators for the sustainable management and protection of soil resources.

The Plans of Action for each pillar were formulated in an open and participatory format, strictly following the Guidelines for the development of Plans of Action of the GSP Pillars as presented in the Rules of Procedure.

This document presents a plan of action for Pillar 1. Pillar 1 is strongly linked with Pillars 2 and 5 regarding activities for its implementation, and strongly relies on Pillars 3 and 4 for the generation of technical information that will be used in its activities. Pillar 1 is therefore the overarching Pillar upon which the other four Pillars will contribute in order to provide the context and activities for sustainable soil management implementation and promotion.

The development of Pillar 1 was initiated during the "Managing Living Soils" workshop held in Rome, Italy during December 2012. This workshop focused on the global and regional status, as well as challenges and priorities for sustainable soil management. This was followed by a Pillar 1 discussion session during the 2nd Global Soil Week held in Berlin, October 2013. The aim of the discussion was to decide on the structure of the plan of action and its main content. A formal Working Group of 26 members was formed, tasked with developing a plan of action for Pillar 1 addressing the following priorities:

- Develop a consistent plan of action covering sustainable soil management practices, knowledge and adoption, ecosystem services provision, as well as required policy and institutional support.
- Identify the main areas for action towards sustainable soil management through a process that takes into account the main challenges and priorities in countries and regions.
- Allow Regional Soil Partnerships to establish the main action areas in accordance with the 5 pillars and to decide on the expected outcomes through the development of regional implementation plans.
- Promote better coordination of existing work on sustainable soil management and initiates new activities through the mobilisation of resources and effective partnerships.
- Consider the different ground level user needs in terms of sustainable soil management at all scales, including support to address major soil management problems; as well as puts the land users first, taking into account all scales and genre of farming, and puts mechanisms in place for farmer-driven participatory action research.
- Address all land uses;
- Consider socio-cultural aspects of sustainable soil management, including gender balance and youth participation;
- Establish an enabling environment to ensure that land users have access to appropriate inputs, knowledge, research, finance and planning capacity.
- Promote the conservation of soil resources and the restoration/rehabilitation of soil functions in degraded soils.

The draft plan of action was submitted to the Intergovernmental Technical Panel on Soils (ITPS) for its review and endorsement. Following a very dynamic process during which ITPS recommendations were included, the draft was endorsed by ITPS during its second working session in April 2014 and submitted to the Second Plenary Assembly of the GSP. The Plenary Assembly consolidated the original 11 recommendations endorsed by the ITPS into five concrete recommendations. Additional comments and suggestions from GSP members were incorporated and this final version of the Pillar One Plan of Action was endorsed by the Plenary Assembly of the GSP on 23 July, 2014.

2 Why do we need to promote sustainable soil management globally?

Soil is considered a finite, non-renewable natural resource on the human time-scale since it does not regenerate at a significant rate within this time. Therefore, soil needs to be managed accordingly. Soil has various key functions that are important for agricultural, environmental, nature protection, landscape architecture and urban applications.

Soil serves as the basis for food, feed, fuel, and fiber production, provision of clean water, nutrient cycling, is a sink for organic carbon, provides one quarter of global biodiversity, provides construction material, and serves as a platform for construction. Soil is therefore at the heart of concerns about food security, biodiversity, climate change, land degradation, desertification, the provision of ecosystem services, and it provides the foundation of agricultural development and ecological sustainability (Imeson *et al.*, 2011). However, inappropriate soil management practices, increasing population demand, and inadequate governance have resulted in the degradation and loss of available soil resources in various parts of the world. Thus reducing its capacity to perform its essential ecosystem functions. The protection and conservation of soil is therefore critical to the maintenance of a wide range of ecosystem functions, and compels land users to ensure its long term sustainability as a natural resource.

The area of fertile soil is limited and increasingly under pressure by competing land uses. In addition, soil as a natural resource is threatened by the increasing degree and extent of soil degradation processes due to mismanagement and land use changes. Urgent action is needed to reverse this trend. This will ensure the necessary food production for future generations, the mitigation of climate change, the provision of ecosystem services, and the preservation of biodiversity. Therefore, the promotion of sustainable soil management for soil protection, conservation and sustainability, is essential in the contribution to the four global requirements

Requirement 1: Maintaining soil functions and ecosystem services

Soils have critical functions within the global ecosystem which deliver provisional, regulating, cultural and supporting services such as the production of food, energy supply, suppression of pathogens, water cycling and purification, nutrient cycling, soil formation, material for building and a platform for settlement, and recreational services. Most of these services have a direct impact on human well-being, as well as maintaining the biodiversity-ecosystem relationship.

Requirement 2: Sustaining long term food security

At the current population growth rate, it is estimated that the world will need to produce 60 % more food by 2050, which prioritizes the preservation of sufficient soils for a food secure world (Alexandratos & Bruinsma, 2012). Soil is an essential resource for ensuring food security in the world, providing 99% of the global food needs. However, the area of fertile and agriculturally

productive soils is decreasing as a result of mismanagement and unsustainable agricultural use, as well as the use of agriculturally productive soils for non-agricultural uses. For a food secure world, soil management practices need to be sustainable and aimed at restoring the maximum potential productivity of soils in agriculture. In addition, development plans for urban growth, infrastructure and other non-agricultural land uses need to take into account soil types, and preserve the agriculturally productive and potentially agriculturally productive soils for agricultural use as much as possible.

Requirement 3: Climate Change mitigation and adaptation

Soil use and management practices should be adapted to the changing climate conditions and should aim to increase the efficiency of input use and levels of soil productivity. In the agricultural sector, it is imperative to promote adaptive management strategies to increase productivity, reduce greenhouse gas (GHG) emissions, contribute to adaptation goals, and provide resilience to environmental shocks. Sustainable soil management systems should also include non-agricultural land uses, which will increase soil protection against climatic extremes and protect soil organic matter.

Requirement 4: Maintaining soil biodiversity

Soils and soil organisms provide a multitude of ecosystem services, including waste breakdown, release of nutrients, enhancing soil structure, biodegradation of pesticides and other chemicals, being a sink for greenhouse gas emissions, fighting pests and soil-borne plant pathogens, and benefiting human and animal health including digestion and immunity. It is therefore important to maintain the genetic and species diversity of soil organisms for the continued provision of these functions in soil.

Soil resources therefore need to be a **top priority** in the global natural resource arena. The GSP is the international body that specifically advocates for and coordinates initiatives to ensure that knowledge and recognition of the importance of soils, and their functions. The GSP will ensure that protection and sustainable management are appropriately represented in global change dialogues and decision making processes.

3 Implementing sustainable soil management to address soil degradation and improve soil protection, conservation and sustainable use through the GSP

In order for soil to optimally perform its key functions and to contribute to the global requirements listed above, soil degradation needs to be prevented and reversed, and the long-term sustainability of soils should be ensured. Soil degradation largely occurs due to the soil's mismanagement and land use changes driven by population growth and urbanization. Therefore, sustainable soil management should balance soil functions and ecosystem services

with human production and environmental protection needs over the short- and long-term. This requires reversing degradation processes such as erosion, nutrient mining, compaction, acidification, loss of organic matter, salinization, pollution, and loss of soil biodiversity. Sustainable soil management is the tool needed to achieve those goals and preserve or improve soil functioning. Although the implementation of sustainable soil management has steadily increased at national and regional levels, there is a critical need for its expansion and increased uptake. Effective sustainable soil management implementation is needed over the long-term at a global scale and long-term investment is needed to sustain such implementation.

Although the concept of sustainable soil management has previously not been clearly defined, much effort has been put into developing soil management approaches and to improve the production potential of soils, and to simultaneously protect them from degradation and maintaining soil functions. However, relatively little attention has been given to incorporating non-agricultural land uses into sustainable soil management systems for their associated soil benefits. Moreover, there is still a big global yield gap, despite extensive progress in the availability of high-yield and pest-resistant varieties of major crops, the level of success achieved through on-station research, and technological developments. In order to successfully understand the context of sustainable soil management and to increase its implementation in all relevant land uses, the following key aspects should be considered.

3.1 Increasing sustainable soil management Implementation

Sustainable soil management should be promoted and increased in all land uses to improve soil functions. A range of relevant best practice systems for global, regional and national sustainable soil management need to be identified. For this purpose, existing databases should be consulted.

The identification of most appropriate practices should consider their ability to address the following key soil principles:

- Maintaining and restoring the multiple functions of soil.
- Improving and retaining soil organic matter content for soil carbon sequestration and soil structural improvement.
- Improving soil water storage.
- Maintaining buffering capacity of soils.
- Controlling soil erosion.
- Retaining and protecting the most agriculturally productive soils.
- Maintaining soil biodiversity.
- Protecting or restoring extensively managed or unmanaged organic soils.
- Restoring degraded soils.

Increasing sustainable soil management is especially important in existing agricultural areas to achieve sustainable increases in crop production. To date, global increases in food production resulting from changes in land use practices were due to combined expansion of cropped areas and increased productivity per unit area (Ittersum *et al.*, 2013). However, many world regions

have limited scope for the spatial expansion of agriculture, while sustainable increases in current production is essential. The potential of global regions to support higher yields differs as a function of climate, soil condition, access to water resources, and the capacity of land users to implement soil management practices to increase current production rates.

In non-agricultural land uses, sustainable soil management is needed to increase the protection of soils against degradation, increase their water holding capacity, maintain and improve soil cover and organic matter, increase the nutritional value of grazing, improve soil aeration, provide erosion control, and enhance nutrient cycling.

In order to account for landscape and climate heterogeneity, sustainable soil management systems and practices should be identified and adapted for implementation in different biomes, landscapes, watersheds, land uses, land cover types, and farm types or scales (i.e. large and small scale, industrial and agro-ecological, subsistence and commercial, intensive and extensive systems). Additional factors to consider are the, site characteristics, management systems, traditions in soil management, determining socio-economic factors, and determining institutional, economic and political factors. Suitable sustainable soil management practices should be identified from a range of activities. Those activities would contribute to addressing the key soil principles, namely:

- Activities restoring soil functions and ecosystem services.
- Activities restoring and enhancing soil chemical and physical fertility.
- Soil conservation techniques.
- Management systems which increase and maintain soil cover.
- No-till, minimum-till and ecological farming combined with integrated and responsible weed, pest, and disease management.
- Crop rotations and intercropping to ensure soil organic matter is increased and soil physical and biological conditions are protected and/or restored.
- Efficient plant nutrition and responsible input management to replenish nutrients and address nutrient mining and pollution, including intercropping with legumes.
- Irrigation according to sound technical parameters including water use efficiency and drainage.
- Activities restoring soil water regimes at watershed level and restoring ecosystem services.
- Control of flooding and landslides through land use planning and disaster risk management.
- Identification and targeted implementation of effective and affordable technologies.
- Activities that reduce risk and enhance capacity to cope with salinization, drought and desertification.
- Sustainable intensification of cropping and grazing systems through rotations and diversified/integrated systems.

3.2 Costs and Benefits from Sustainable Soil Management Practices

The analysis of cost-benefit scenarios in terms of implementing sustainable soil management technologies and approaches are needed to determine the cost effectiveness of local innovations and modern scientific advances. Such data is especially important for promoting sustainable soil management at land user and policy levels. Assessing the costs of inaction versus the costs and benefits of sustainable soil management is equally important. Any findings should be communicated to land users and policy makers in order to support decision making regarding changes in soil management, as well as sustainable soil management investments. Such information will be generated under Pillar 3. Pillar 3 focuses on researching gaps within the sustainable soil management environment and obtaining evidence-based information, which can then be translated and packaged into a cost effectiveness implications analysis.

Recommendation 1: Appropriate sustainable soil management practices and systems should be identified for all land uses at regional and national levels using existing knowledge, adapted according to site characteristics and land user needs, considering cost-benefits analyses and social impacts. These practices and systems should be implemented at appropriate scales to restore and maintain soil functions and ecosystem services.

3.3 Sustainable soil management and soil fertility

Nutrient management in soils is a major management component to reduce soil degradation (e.g. nutrient mining and soil contamination), enhance plant growth and root development for soil stabilization (physical protection against erosion) and achieve sustainable production intensification.

The International Fertilizer Industry Association (IFA) promotes best management practices and in particular the 4R nutrient stewardship, which calls for fertilizer application with the Right nutrient source, at the Right rate, at the Right time, in the Right place.

Land user goals for soil fertility management include providing sufficient nutrients for crop growth and subsequent animal and human consumption, sustaining and improving soil condition and functions, and minimizing soil degradation. Fertilizer sources are mainly grouped as organic, inorganic, or typically manufactured fertilizers commonly used for agricultural purposes (FAO, 2014). Steps that promote optimal and efficient plant nutrition are required on a large scale to achieve food security (getting enough calories) and nutrition security (ensuring a sufficient intake of all nutrients for optimal health) (Bruulsema *et al*., 2012), while being the least detrimental to the environment. IFA has already adopted a new paradigm encompassing human health, yield and soil fertility improvement, profitability, and the reduction of environmental impacts. A balanced diet of all required nutrients, including micronutrients, is the difference between achieving food security and nutrition security. Soil fertility further includes ensuring good physical soil condition, which is essential for plant growth to prevent soil sealing, water

runoff, and erosion processes, and to ensure sufficient aeration, water availability, and mechanical anchorage for plant roots.

A judicious combination of manufactured fertilizers with organic nutrient sources and the use of biological amendments is promoted to balance both over- and under-fertilization. This can best be achieved through integrated nutrient management (INM) or integrated soil fertility management (ISFM). Such integrated nutrient management should also be aimed at avoiding detrimental environmental impacts of soil contamination through over fertilization (e.g. contamination by heavy metals, nitrogen and phosphorous outflows to water sources, as well as the release of nitrogen into the atmosphere). Sustainable soil and nutrient management are further necessary to improve the buffer capacity of soils against soil contamination by other sources such as organic pollutants, toxins, and pathogens. Sources of such soil contaminants include forestry, mining, transport, waste disposal, industrialization, and urbanization in densely populated areas. Certain agricultural practices further cause diffuse soil contamination by direct application of pesticides, as well as contaminated sewage sludge, compost, and manure.

As demands on agricultural production increase, plant nutrients will continue to be the most important input into such production systems, and the demand for manufactured and complimentary fertilizers will increase. Increased fertilizer use efficiency (the increase in crop yield per unit fertilizer applied) of farming systems is therefore recommended to prevent excessive increases in fertilizer demands. Fertilizer demand should be further reduced by the sustainable recycling of nutrients from both on-site and off-site sources of waste materials from, amongst others, energy, urban and agricultural processing sectors.

Global attention needs to be consistently focused on the need for large-scale adoption of integrated nutrient, soil fertility management, and fertilizer use efficiency. Promotion of these concepts and their practical applications at the farm level requires that the scientific community, extension workers, decision-makers, private sector, and other stakeholders concerned with agricultural development have a clear understanding of the subject. This necessitates the involvement of the GSP in any activities aimed at stimulating fertilizer use in order to encourage such initiatives to promote balanced nutrient applications and not simply an increase or decrease in application as may be required. For example, the implementation of the Abuja Declaration is aimed at increasing fertilizer use in Sub-Saharan Africa to 50kg ha^{-1} by 2015.

Recommendation 2: In light of the primary importance of food security, sustainable agricultural production should be supported by balanced soil fertility management using a range of available nutrients and appropriate physical management practices without causing negative environmental impacts.

3.4 Challenges and priorities for sustainable soil management implementation

Despite the level of development of sustainable soil management technologies over the last few decades and their documented success in reducing soil degradation and improving soil

functions, the rate of adoption by land users and impact on soil improvement globally is low. Therefore, a clear understanding of the challenges hindering the implementation of sustainable soil management is needed to effectively promote and implement sustainable soil use.

The successful implementation of sustainable soil management practices is heavily dependent on factors directly affecting the soil management. Examples of this are: the specific land management practices applied, lack of infrastructure, inadequate technology or knowledge to implement it, lack of adequate equipment, overgrazing which leads to soil exposure and the use of crop residues for livestock feed, or inadequate access to support services. Similarly, indirect causes at play include the political and institutional setup related to the intensity of land use, cultural factors, land tenure systems, access to knowledge and information, time, and human resources (FAO, 2014). The 6 overarching challenges which need to be addressed to improve sustainable soil management implementation are:

Economic challenges	Low economic efficiency of agriculture exists due to cost of inputs, lack of versatility, adaptability of tools and technologies in different regions, management conditions, instability of crop production, and poor ability of the soil to perform ecosystem functions. (Linked to Pillars 2 and 3).
Technical challenges	Technical challenges are experienced in numerous areas of soil management, such as improving and maintaining vegetation cover, protecting soil from water run-off, quality seed-bed preparation, pest and weed control (including responsible use of phytosanitary treatments), field transport operations for fertilizer spreading and crop harvesting, maintaining soil organic matter, and improving of sustainable soil management practices as a whole. Such technical challenges exist as a result of either insufficient technologies available to land users, or insufficient knowledge and support to optimally use the available technologies. (Linked to Pillar 3).
Social challenges	Land users' needs are often not considered during the planning of sustainable soil management activities. Since implementation of sustainable soil management for the preservation of soil functions depends on land user uptake, all scales and genre of land users

	behavior with regard to farmer implementation. Land use systems vary greatly in terms of social, political, economic, and natural settings. The interrelations between these factors should be effectively understood, addressed and managed. (Linked to Pillar 2).
Policy challenges	Insufficient awareness of political will exists to address soil degradation, its impacts. It is therefore difficult to allocate resources to reverse soil degradation, protect soils and enhance its ecosystem functions. National level policies need to focus on protecting agriculturally productive and potentially agriculturally productive soils for agricultural use, to increase sustainable soil management, to improve and maintain the functions of soils in non-agricultural land uses, to combat desertification, and finally to provide a global and legal framework to achieve land and soil degradation neutrality, and minimize the loss of fertile soil. Although the GSP does not have the mandate to enforce such issues, it should address the effective communication of scientific facts and recommendations to appropriate policy platforms. (Linked to Pillars 2 and 3).
Investment challenges	A lack of sustained public and private investment is experienced in the development, testing and implementation of sustainable soil management, conservation, and restoration technologies to translate the GSP Pillars into action. Additionally, in order to improve soil functions and reap the associated secondary benefits, appropriate incentives are needed to encourage land users to adopt sustainable soil management practices. (Linked to Pillar 2).
Partnership challenges	Coordination and partnerships are needed to create a unified and recognized voice for soils, avoid the fragmentation of efforts and the waste of resources. Streamlined efforts are required across the countries, regions, and the international level to make spatial datasets and knowledge systems on soils more widely available and usable. (Linked to Pillars 4 and 5).

Recommendation 3: All barriers preventing the implementation or adoption of sustainable soil management practices and systems should be assessed and policy and technical solutions proposed to create an enabling environment for sustainable soil management.

3.5 Sustainable soil management coordination and monitoring

The GSP should coordinate the promotion, implementation, adoption, and monitor the progress of sustainable soil management systems at global and regional levels. A monitoring

system with suitable indicators to measure sustainable soil management implementation and its impact on soil functions and social impacts needs to be developed for this purpose.

Pillar 4 addresses the concept of soil condition indicators for the establishment of a global system for monitoring and forecasting soil condition, including the return on investment from various sources of evidence. Pillar 5 further addresses the need for the harmonization of such indicators. Pillar 1 is therefore linked with both Pillars 4 and 5 for the development and use of soil indicators in the monitoring of sustainable soil management implementation.

Different scales of indicators are necessary for monitoring at national, regional and global levels, with higher detail indicators used at national scale. Imposing a "one-size-fits-all" or standard set of indicators for monitoring purposes consistently poses a challenge based on the concern that it would lead to inadequate or inaccurate assessment of soil status. A recommended alternative is to use indicators based on landscapes, soil properties and soil uses. This would allow for analyzing indicators developed for different situations, make indicators and best practice descriptions really comparable, and allow for making suggestions adapted to different situations.

Recommendation 4: A monitoring system should be developed to measure the progress of implementation of sustainable soil management practices and systems.

4 Sustainable Soil Management Education, Awareness and Extension

GSP Pillar 2 focuses, on *encouraging education, awareness and extension in soil.* These topics are therefore fully addressed in Pillar 2. However, within the context of promoting sustainable soil management (Pillar 1), it is necessary to reiterate the vital importance of education (or knowledge), awareness, extension, and the need for active partnerships as vehicles to promote sustainable soil management from global to local levels.

Sustainable soil management deals with soil structure and texture, soil organic matter, soil tilth, soil cover, soil biota, soil functions and productivity, chemical fertilizers and pesticides, cropping systems, crop rotation, organic manures and fertilizers, and phytosanitary treatments and microbial inoculants. Much research has been conducted on different aspects of sustainable soil management. This will continue under Pillar 3. However, there is a gap in the knowledge, skills and technology transfer to various stakeholders. In addition, extension, education, and awareness based services should consider gender sensitivity in order to make such initiatives more effective in tackling soil degradation. The target groups for such activities include:

a) Land users, land users' organizations and other land uses including herders;
b) Non-agricultural land users
c) Community leaders and local authorities;
d) Extension services (Government, NGOs, private sector) and technical sectors;
e) Various educational services;
f) Technical advisors;
g) Various industries (i.e. food, mining, commodity traders, retailers and others);

h) Business sectors;
i) Agricultural consumers;
j) Research and Academia;
k) Primary and Secondary Schools (students and teachers);
l) Civil society (including consumers);
m) Policy makers and planners;
n) International Union of Soil Sciences (IUSS);
o) Non agrarian sectors – through leveraging the service benefits of soil of interest to the various groups including urban populations.

In addition to these priorities, the establishment of solid partnerships is encouraged under Pillar 1. Efficient partnerships are needed to improve the sharing of soil expertise, skills, data, advice and technologies to work towards sustainable soil management. This should include GSP partnerships with public, private, civil, development agencies, business sectors, research institutions, and government departments. Identifying and establishing linkages with key related stakeholders and sectors is required including all land uses, water, cities, youth, women, and consumers, with partnerships and information to be tailored to specific sectors and actors.

The GSP can play a critical role in bringing together active partners working on sustainable soil management at country, regional and global level. Such partnerships should be maintained and expanded at the respective levels.

Recommendation 5: The GSP should facilitate the development of a capacity building strategy amongst all stakeholders to promote the adoption of sustainable soil management.

5 Global Policies and Actions

The issue of soil management and policy interface is included in Pillar 2, as it addresses policies with regards to soil issues. However, within the context of promoting sustainable soil management, the role of policies that influence land use and soil management is crucial. Therefore, the GSP has an advocacy role in promoting the importance of sustainable soil management in policies. In addition, the GSP has a role in enabling GSP regions and partners to engage in constructive dialogue with policy makers and business sectors (e.g. fertilizer manufacturers, agricultural machinery developers, and suppliers of irrigation technologies) to promote, motivate, and develop relevant but not prescriptive commercial solutions.

To this end, the way that soils are viewed within political and policy discussions should be considered to determine how soil policy can be influenced by the GSP. There are many political hierarchies across GSP regions and countries, but there is a common view of the importance of informing and educating governments (i.e. ministers, advisors, and the business sectors) about the importance of soils, their ecosystem functions, and the policy frameworks necessary to remove barriers to sustainable soil management implementation and adoption. They should also be encouraged to put the required policies in place to address issues of soil contamination,

regulate sustainable soil management implementation in all land uses, as well as provide investment strategies to ensure their sustainable management. This includes reserving agriculturally productive and potentially agriculturally productive soils for agricultural purposes.

Policies should further contribute to creating an enabling environment for sustainable soil management implementation, and assist in removing barriers associated with its adoption. This includes addressing aspects of land tenure systems within the context of sustainable soil management to clarify the roles and responsibilities of land users in soil management and protection.

With regards to sustainable soil management within the policy environment, the ultimate goal is to achieve a clear commitment from national and regional authorities to sustainable multi-purpose soil management. This commitment should not be reduced to an industrial producer of commodities, but should also manage the environment, remove institutional and political barriers to sustainable soil management implementation, and ensure a sustained generation of ecosystem services.

6 Linking GSP with existing initiatives

There are numerous national, regional and global initiatives or platforms which directly or indirectly promote improved soil management through a range of interventions or monitoring systems. Some of these platforms, such as the three Rio Conventions, require country ratification, which increase the responsibility of the member countries to adhere to certain standards and guidelines, as well as report on progress of implementation. Such initiatives include (not an exhaustive list) the:

a) Rio Conventions and their relevant panels
    i. CBD - Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)
    ii. UNCCD - Committee on Science and Technology (CST) and Science Policy Interface (SPI)
    iii. UNFCCC - Intergovernmental Panel on Climate Change (IPCC)
b) Millennium Development Goals (MDGs)
c) Post-2015 Development Agenda
d) Sustainable Development Goals (SDGs)
e) Global Water Partnership
f) Global Partnership on Nutrient Management
g) Consortium of International Agricultural Research Centers (CGIAR)
h) Abuja Declaration on Fertilizer for and African Green Revolution
i) Comprehensive Africa Agriculture Development Programme (CAADP)
j) International Union of Soil Sciences
k) Others to be identified

In addition the GSP should broaden its scope of interaction to initiatives that are indirectly linked to soil management as a result of the processes they address. For example the Roundtable on Sustainable Palm Oil (RSPO) monitors the environmental impacts of the uptake of sustainable palm oil in the market. Where appropriate, the GSP could initiate additional and specific initiatives among market players, NGOs, consumer organizations and businesses that all have a vested interest in sustainable soil management

At an international level the GSP should collaborate or partner with these and similar initiatives and conventions to place greater emphasis on soils and their protection within each platform. A list of such initiatives and platforms is needed in order for the GSP to create such partnerships and promote the inclusion of sustainable soil management issues. This should include the assessment of how the GSP would benefit from existing processes by joining efforts and benefitting from synergies to improve and expand efforts and make sustainable soil management (and SLM) adoption more effective from local to global levels, on the ground and through policies. Such an assessment should also differentiate between practical and strategic approaches, target audiences and levels of intervention, in order to identify gaps and implementation needs from local to global levels, as well as from land user to decision maker levels.

The GSP should act as a source of positive expert advice to related global initiatives. It will be a challenge for the GSP to deliver a common strategy for sustainable soil management that would address all the issues within conventions including Millennium Development Goals (MDG) and Sustainable Development Goals (SDG) at the widest extent. Instead, the GSP should demonstrate and reinforce the synergies within sustainable soil management and these global goals. To date, conventions have not placed a focus on soils. It is up to soil scientists to convince the international community that sustainable soil management must be addressed in order for these conventions to be successful. There is a need to place soils high on the agenda of food and agriculture and environmental processes not only the GSP Intergovernmental Technical Panel on Soils (ITPS) and FAO, but also IPBES and the CBD, the CST and the recently formed SPI of the UNCCD which aims to identify policy makers' needs for scientific knowledge and mechanisms for addressing them, as well as the Intergovernmental Panel on Climate Change of UNFCCC. In addition, the GSP should be integral in the review and update of the World Soil Charter to ensure that the priority of soils in the global ecosystem is recognized and addressed sufficiently.

7 References

Alexandratos, N & Bruinsma, J : *World Agriculture Towards 2030/205: The 2012 Revision*. ESA Working Paper No. 12-03, Food and Agriculture Organization of the United Nations, Rome, Italy, 2012.

Bruulsema TW, Heffer P, Welch RM, Cakmak I, and Moran K. 2012. *Fertilizing Crops to Improve Human Health: A Scientific Review. Executive Summary*. First Edition, IPNI, USA.

FAO Sustainable Agriculture Platform: pilot website. www.fao.org/tc/exact/sustainable-agriculture-platform-pilot-website/nutrients-and-soil-fertility-management/organic-fertilizers-including-manure-and-compost/en/ [Accessed: 24-04-2014. 14:45].

LADA. http://www.fao.org/nr/lada/ [Accessed: 24-04-2014. 14:42].

SSSA. 2008. Glossary of Soil Science Terms. Madison, WI, USA.

Imeson, A., Arnalds, O., Montanarella, L., Arnoldussen, A., van Asselen, S., Curfs, M. & Rosa, D. de la (eds.) 2011. Soil conservation and protection in Europe: The way ahead. Publication European Union. 159 pp [online]. Available from: http://eusoils.jrc.ec.europa.eu/esdb_archive/eusoils_docs/other/Scape.pdf.[Accessed: 24-04-2014. 14:40].

TerrAfrica. 2005. *Launch Of New Alliance To Combat Land Degradation In Africa*. The World Bank.

UNCED. 1992. *The RIO Declaration on Environment and Development.* United Nations Conference on Environment and Development (UNCED), Rio de Janeiro, Brazil, 3-14 June 1992.

World Bank. 2006. *Sustainable Land Management: Challenges, Opportunities and Trade-Offs.* Washington DC, USA.

Van Ittersum, M.K., Cassman, K.G., Grassini, P., Wolf, J., Tittonell, P. and Hochman, Z. 2013. Yield gap analysis with local to global relevance – A review. *Field Crops Research*. 143:4-17.