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Implementation Plan for Pillar 3 of the Global Soil Partnership (GSPPA:VI/2018/3 Add.2)

Promote targeted soil research and development focusing on identified gaps, priorities and synergies with related productive, environmental and social development actions

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*** This Implementation Plan is considered a living document which, due to the dynamic nature of research, may be adjusted at any time as considered necessary by the Working Group. ***

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Abbreviations

BonaRes	BMBF funding initiative "Soil as a sustainable resource for the bioeconomy - BonaRes", Germany
CBD	Convention on Biological Diversity
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Center for Tropical Agriculture
EU	European Union
GCF	Green Climate Fund
GEF	Global Environment Facility
GFAR	Global Forum on Agricultural Research
GLOSIS	Global Soil Information System
GLOSOLAN	Global Soil Laboratory Network
GRA	Global Research Alliance
GSP	Global Soil Partnership
JRC	Joint Research Centre
IFAD	International Fund for Agricultural Development
IFDC	International Fertilizer Development Center
INBS	International Network on Black Soils
INSII	International Network of Soil Information Institutions
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
ITPS	Intergovernmental Technical Panel on Soils
IUSS	International Union of Soil Sciences
P3WG	Pillar 3 Working Group
PoA	Plan of Action
R&D	Research and development
RIP	Regional Implementation Plan
RSPs	Regional Soil Partnerships
SDGs	Sustainable Development Goals
SLM	Sustainable Land Management
SSM	Sustainable Soil Management
SWSR	Status of the World's Soil Resources
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
VGSSM	Voluntary Guidelines for Sustainable Soil Management

WB World Bank
WSC World Soil Charter

Executive Summary

This document was developed to provide activities and actions to implement recommendations from the GSP Pillar 3 Plan of Action over a five-year period from 2018 to 2022. Pillar 3 focuses on the promotion of targeted soil research and development (R&D) and enhancing soil research coordination. Specifically, such research should focus on identified gaps, priorities and synergies with related productive, environmental and social development actions, incorporating evidence of return on investment in soil research. Furthermore, soil research should encourage inter- and transdisciplinary R&D, capitalize on existing R&D initiatives and foster synergy and engagement between research and end-user communities and donors.

At the time of development of this document, seven of the nine Regional Soil Partnerships had completed Regional Implementation Plans. Activities in this document aim to provide a global context and enabling environment for the implementation of regional activities, with cognizance of needs and priorities at national level. Soil research and development activities implemented under Pillar 3 will support work under all the other GSP Pillars to ensure that GSP activities are based on up-to-date scientific information. Soil R&D is encouraged in various documents developed under the GSP with the support of its scientific Panel, the Intergovernmental Technical Panel on Soils (ITPS). These include the revised World Soil Charter, the Status of the World's Soil Resources report and the Voluntary Guidelines for Sustainable Soil Management.

Soils are the foundation for food and water security for all regions of the world. This plan focuses on ensuring appropriate R&D to enhance our ability to quantify soils through their description, properties, their potential to fulfill specific soil functions, as well as their current state of fulfilment of those functions. The goal with such R&D is to ultimately contribute to reducing soil degradation and promoting practices that lead to improved soil management and functioning. There is no simple solution that would fit all regions since soils, their properties and functions are region or even site-specific. Therefore, the implementation of research activities will require active and operative RSPs to ensure that research is prioritized and conducted at appropriate scales to gain a collective understanding of the relevant issues by combining our knowledge across all regions.

In order to provide easy access to soil research information, a global soil research internet platform will be developed as a knowledge hub for different users about research partners, facilities, research programmes, research gaps and various research outputs. In order to capitalize on existing R&D initiatives, these initiatives will be identified at national and regional level, followed by the identification of research priorities at national, regional and global levels. The aim is to fill these research gaps through inter- and transdisciplinary research. To achieve this, Regional Soil Research Platforms are proposed to facilitate coordination of regional soil research and policy support and launch targeted regional soil R&D programs. This will include evaluating the return on investment in soil R&D in order to inform decision makers and policies in terms of benefits of soil research for sustainable development. Active collaboration between research bodies, decision makers, extension services, end-user communities and donor agencies to support targeted soil research for development will be fostered by promoting multi-stakeholder discussions for knowledge sharing. This will include training courses for soil research approaches discussion of regional environmental concerns, as well as the organization of global symposiums to link science and policy to address key soil-related topics.

1 Introduction

Pillar 3 of the Global Soil Partnership (GSP) is charged with the promotion of targeted soil research and development (R&D) and enhancing soil research coordination. Specifically, such research should focus on identified gaps, priorities and synergies with related productive, environmental and social development actions, incorporating evidence of return on investment in soil research. Furthermore, research activities should encourage inter- and transdisciplinary R&D, capitalize on existing R&D initiatives and foster synergy and engagement between research and end-user communities and donors. Several documents have been developed to date that inform the implementation of soil R&D activities as developed in this document. These are briefly listed below.

1.1 Pillar 3 Plan of Action and recommendations

A global **Plan of Action**¹ (PoA) for Pillar 3 was endorsed by the GSP Plenary Assembly in June 2015 and proposed to define soils R&D as: “the set of systematic activities that can strategically combine both basic and applied research, with the intention of generating knowledge that can lead to the development and adoption of new or improved technologies and through them, to support development agendas”. The PoA proposed that opportunities to improve the promotion of soil R&D and enhancing soil research coordination can be achieved through the following 4 recommendations:

1. Compile for all partners evidence of the return of investment in soil research, stressing the importance of soil functions (e.g., economic cost of soil degradation and the value of its rehabilitation) for the provision of services by ecosystems and in reaching the UN Sustainable Development Goals.
2. Encourage inter- and transdisciplinary research and development to support the five pillars to enhance the development of appropriate sustainable soil management practices and systems, the applicable use of soil information, the harmonization of methods and determination of best indicators, and the dissemination of research results beyond the scientific community, to globally support economic growth, environmental sustainability and social development.
3. Capitalize on existing R&D research initiatives and outputs through meta-analysis and synthesis reviews for all partners, to identify global, regional and local emerging priorities.
4. Foster synergy and engagement between research and end-user communities, and donor agencies, to facilitate active collaboration in a joint-learning approach that can be effective in broadening the research focus and enhancing its impact

The purpose of this implementation plan is to present global level activities and associated actions to implement these recommendations. The five activities and actions in the present document were developed with consideration of the overall goals of the GSP, priority activities at regional level as developed to date in Regional Implementation Plans (RIPs)², as well as priorities identified by the GSP Plenary Assembly.

1.2 Other GSP documents guiding and supporting Pillar 3

Soil R&D is encouraged in various documents developed under the GSP with the support of its scientific Panel, the Intergovernmental Technical Panel on Soils (ITPS), as briefly elaborated here.

The **revised World Soil Charter** (WSC), which was unanimously endorsed by the FAO Conference at its 39th session in June 2015, encourages governments to: “support research programmes that will

¹ Pillar 3 Plan of Action. Available at <http://www.fao.org/3/a-az920e.pdf>

² At the time of writing, Regional Implementation Plans have been developed for the following Regional Soil Partnerships: [Africa](#), [Asia](#), [Central America, Mexico and the Caribbean](#), [Europe](#), [Eurasia](#), [Near East and North Africa](#), and [South America](#).

provide sound scientific backing for development and implementation of sustainable soil management relevant to end-users”. Furthermore, the WSC established a new definition for sustainable soil management (SSM) as: “a set of activities that maintain or enhance the supporting, provisioning, regulating, and cultural services provided by soil without significantly impairing either the soil functions that enable those services or biodiversity”. Soil related research and development should therefore be guided by this definition as part of developing appropriate solutions to support and improve sustainable soil management (FAO, 2015).

The **Status of the World’s Soil Resources (SWSR)** report of 2015 provides a comprehensive overview of the ten main threats to soil functions that support the delivery of ecosystem services. These soil threats were identified as erosion, organic carbon change, nutrient imbalance, salinization and sodification, sealing and capping, loss of soil biodiversity, contamination, acidification, compaction, and waterlogging. In assessing the status of these threats and the links to science policy, it was stated that contemporary science policy often focuses on impact and public benefit and that soil research is often considered merely a means to an end. It was recommended that, instead, soil research should be included in priority setting exercises and more formal recognition be given to soil resources as a cross-cutting issue in science policy to ensure it receives sufficient support. As such, the SWSR report calls for action by governments to support research programs that will provide sound scientific backing for development and implementation of SSM relevant to end users (FAO and ITPS, 2015).

In 2016 the FAO endorsed the **Voluntary Guidelines for Sustainable Soil Management (VGSSM)** which specifies a set of characteristics that would indicate that SSM is being practiced, along with actions that would create an enabling environment for promoting SSM. The VGSSM specifically calls for fostering and strengthening targeted soil research, indicating that: “It is imperative that investment in soil research is increased to enable national research programs and their partners to work with land users to identify and address the constraints they face in increasing the ecosystem services provided by soils (i.e. soil productivity)” (FAO, 2017).

1.3 Linking Pillar 3 to the other four Pillars of Action

Soil R&D activities implemented under GSP Pillar 3 will support and be supported by work under all the other Pillars to ensure that GSP activities are based on up-to-date scientific information. The main links and interactions are based on the main focus of each Pillar as follows:

Pillar 1: Promote sustainable management of soil resources for soil protection, conservation and sustainable productivity.

- Soil R&D is needed to support the development and implementation of SSM practices by:
 - Optimize available technologies to improve SSM as a whole.
 - Identify the economic and environmental costs of soil degradation, as well as the costs and benefits associated with SSM implementation. This is necessary to overcome some of the barriers to wider adoption of SSM practices.

Pillar 2: Encourage investment, technical cooperation, policy, education, awareness and extension in soil.

- Soil R&D can benefit from the following Pillar 2 activities listed in the Pillar 2 implementation plan:
 - The compilation of a database of donors and potential investors in soil R&D.
 - The compilation of requirements and methodologies to conduct socio-economic and environmental impact assessments.
- Soil R&D should in turn feed into the implementation of Pillar 2 to:
 - Provide evidence of the crucial role of soils for society in terms of soil functions and ecosystem services.
 - Enhance the communication of research results to end-user communities and donors.
 - Increase technical cooperation through inter- and trans-disciplinary research.

- Encourage investment in research by highlighting the return on investment in soil R&D.

Pillar 4: Enhance the quantity and quality of soil data and information: data collection (generation), analysis, validation, reporting, monitoring and integration with other disciplines.

- Soil R&D can contribute to Pillar 4 by:
 - Encouraging the contribution of soil data and information generated through soil R&D to the Global Soil Information System.
 - Developing new or refining existing soil mapping techniques and sensors (such as drones and spectroscopy).
- In turn, Pillar 4 activities would contribute to soil R&D by:
 - Providing increased soil data and information as input data for research activities.

Pillar 5: Harmonization of methods, measurements and indicators for the sustainable management and protection of soil resources.

- Pillar 5 activities support soil R&D through:
 - The selection and definition of indicators which should be applied in soil R&D activities.
 - Improving the availability of harmonized soil data.
- Research and development is needed to:
 - Develop robust prediction models for soil properties over large areas using soil visible near- and mid-infrared reflectance spectroscopy.

1.4 Stakeholders and stakeholder engagement

Implementation under Pillar 3 aims to build on and further develop existing networks, partner involvement and soil-related information globally, while enhancing its relationship and communication with end-user communities. It is considered open-ended in order to consider and adapt to new actions and actors entering the soil research arena and accommodate continuous fluxes of information to support decision making and guide specific actions at global and regional levels.

In order to facilitate global activities, the GSP Secretariat will play a key role in facilitating implementation of activities listed in this document. However, in order to ensure regional participation and impact, implementation of soil research activities is highly encouraged at regional level through the Regional Soil Partnerships (RSPs) and relevant partners. The RSP Secretariats and RSP governance approaches are therefore the next level of support and facilitation. The RSPs are further represented through the regional Pillar 3 Chairs who form part of the Pillar 3 Working Group (P3WG). At national level, the GSP focal points represent a major stakeholder group responsible for national participation in regional and global GSP activities, including those under Pillar 3.

Overall, key stakeholder groups under Pillar 3 are research institutions, universities and soil science societies, in close collaboration with extension services, farmers' associations, government institutions and civil society agents. This is important to ensure two-way communication in terms of research needs and priorities, as well as the sharing of research results. It is envisaged that a more detailed list of research stakeholders will be developed through implementation of this plan and provided on the soil research internet platform as proposed in the Implementation section below.

All GSP partners, especially those involved in soil related R&D activities are invited to participate in the implementation of this plan to ensure optimal collaboration and combined efforts for maximum efficiency of soil research actions to support sustainable development.

1.4.1 Role of the Pillar 3 Working Group

The Pillar 3 Working Group consists of the following members:

- GSP Secretariat Pillar 3 chair,

- ITPS Pillar 3 chair,
- Nine regional Pillar 3 chairs as nominated by the RSPs,
- Representatives of research institutions or organizations that have expressed explicit interest in supporting Pillar 3 implementation:
 - International Union of Soil Sciences
 - BonaRes
 - International Center for Tropical Agriculture (CIAT)

The roles of the P3WG are to:

- Compile regional implementation reports for submission to the annual GSP Plenary Assembly.
- Disseminate global-level documents and program information to national and sub-national groups.
- Identify cross-regional issues and impediments and transmission of these to the GSP, ITPS and WG of other Pillars.

The role of the RSP Pillar 3 Chairs are to:

- Identify regional and national research institutions to be included on the implementation of this plan.
- Establish and chair regional Pillar 3 working groups as part of RSP implementation.
- Facilitate programs (i.e. workshops, training events, assessments of soil research related information).

The role of research institutions and organizations are to:

- Facilitate the participation of the wider research community in Pillar 3 activities.
- Support the development of collaborative actions to ensure inter- and transdisciplinary research and development.
- Facilitate the implementation of programs (i.e. workshops, training events, assessments of soil research related information).

2 Implementation

Soils are the foundation for food and water security for all regions of the world. This plan focuses on ensuring appropriate R&D to enhance our ability to quantify soils through their description, properties, their potential to fulfill specific soil functions, as well as their current state of fulfilment of those functions. The goal with such R&D is to ultimately contribute to reducing soil degradation and promoting practices that lead to improved soil management and functioning. There is no simple solution that would fit all regions since soils, their properties and functions are region or even site-specific. Therefore, the implementation of research activities will require active and operative RSPs to ensure that research is prioritized and conducted at appropriate scales to gain a collective understanding of the relevant issues by combining our knowledge across all regions.

For optimal implementation, it would be ideal if Pillar 3 representatives would be identified for each country under a RSP to ensure implementation of research activities in collaboration with the regional Pillar 3 chairs. This way an extensive network of partners would be available to support the identification of soil research priorities at national and local level. These priorities should be collated to determine regional research priorities through the RSPs, followed by further escalation to determine global priorities.

2.1 Develop a global soil research internet platform

In order to engage all potential actors to develop relevant strategies, invest resources and execute complementary actions towards reaching the R&D objectives (i.e. close gaps in knowledge, generate or improve technologies to solve problems, and support human capital development) globally, within regions and nationally, a global soil research internet platform is foreseen as one of the main tools for information exchange. This activity would include designing the soil research internet platform with potential allocation for region-specific information, presenting information about existing soil research partners, facilities, infrastructures, and soil research programs, as well as research gaps and priorities. In addition, research outcomes will be translated into informative messages to all the stakeholders and the larger public. Such messages are important to enhance the R&D community's relationship with end-user communities, with continuous fluxes of information being essential to support decision making to guide specific actions at global and regional scales.

2.2 Assess existing R&D initiatives and identify global research priorities

The global soil research community is extensive and there are notable differences in soils R&D between different countries and regions based on aspects such as access to funding, capacities, and different goals and needs. Pillar 3 puts special emphasis on consolidating actions within and across regions towards implementing a functional soil R&D system. This necessitates an understanding of who is doing what and where in terms of soil R&D to identify the current research gaps, priorities and potential synergies.

The Pillar 3 PoA calls for the soils R&D community to clearly demonstrate the crucial role of soils for society by linking to the seven soil functions and resulting ecosystem services, as well as to global UN Sustainable Development Goals (SDGs) related to soils. It further states that the programming of new soil R&D activities, or activities to strengthen the outputs and availability of results from existing research, can build on existing reference material from large soil-oriented national and regional research programs.

To implement this, the PoA identified preliminary threats, knowledge gaps, and research questions (provided in Annex 1), suggesting that RSPs prioritize these and add additional priorities unique to each region. Considering the 10 major soil threats identified and subsequent actions suggested in the VGSSM, it can be deduced that sustainably managed soils would have:

1. Minimal rates of soil erosion by water, wind, and tillage;
2. Soil structure that is not degraded (e.g. soil compaction) and provides a stable physical context for movement of air, water, and heat, root growth, as well as an optimised accessibility of water, nutrient or even added heavy metals to pores and particle surfaces including the interactions with plant roots;
3. Sufficient surface cover (e.g. from growing plants, plant residues, etc.) present to protect the soil;
4. Stores of soil organic matter that are stable or increasing and ideally close to the optimal level for the local environment;
5. Availability and flows of nutrients that are appropriate to maintain or improve soil fertility and productivity, and to reduce their losses to the environment;
6. Soil acidification, salinization, sodification and alkalization that are minimal or absent;
7. Water (e.g. from precipitation and supplementary water sources such as irrigation) that is efficiently infiltrated and stored to meet the requirements of plants and ensures the drainage of any excess;
8. Contaminants that are below toxic levels, i.e. those which would cause harm to plants, animals, humans and the environment;
9. Soil biodiversity that provides a full range of biological functions;
10. Soil management systems for producing food, feed, fuel, timber, and fibre in place that rely on optimized and safe use of inputs; and

11. Soil sealing that is minimized through responsible land use planning.

The priority and need for each of these states to be achieved vary based on geographic extent, as well as the diverse and complex interaction between the inherent threats. Therefore, there is an urgent need to prioritize research activities to target specific soil states and to fill specific gaps in the developmental cycle.

In order to achieve these optimal states of soil properties and functions, multiple scientific challenges would need to be addressed, for example:

- The definition of degradation with respect to the main threats defined in the VGSSM, or the sustainable land use management limitations;
- The quantification of soil resilience as boundary condition of the interactions between externally applied chemical, physical or biological stresses and internally affected processes;
- The filtering function of soil, water quality, as well as effects on water regime regulation;
- The fate of nutrients not only in soils, but also in the water and in organisms;
- The optimization of nutrient cycling in agroecosystems;
- The interactions between carbon sequestration approaches, their long-term preservation, and the costs concerning soil biodiversity; and
- The assessment of soil-related ecosystem services from an economic point of view.

Each of the above challenges (and others that can be identified) imply gaps that need to be addressed and filled. For example, for many types of degradation the indicators are not yet established, or existing indicators may not be representative, are incorrect, or difficult and costly to measure. Similar gaps can be identified for all challenges to identify and list relevant gaps. The following preliminary research gaps have been identified to provide examples for expansion:

- Processes underlying soil functions (e.g. soil's role in global CO₂ accounting, the protection of biodiversity, and the hydrologic and nutrient cycles).
- Spatial and temporal changes in soil processes.
- Ecological, economic and social drivers of soil threats.
- Operational procedures and technologies for soil protection and restoration.
- Soil biodiversity as an environmental service.
- Soil as part of our natural and cultural heritage to be properly preserved.
- Soil health and soil health rehabilitation technologies under intensively managed agricultural production systems (such as greenhouse systems).
- Holistic approaches to understand nutrient cycling beyond traditional soil context.
- Connection of the 4/1000 ambition to the GSP's Global Soil Organic Carbon map. This will require the inclusion of process knowledge into soil organic carbon assessment, such as information systems.
- New soil mapping techniques and new sensors might be included (such as drones and spectroscopy, amongst others).
- Understanding and enhancing soil ecosystem services, including factors influencing such services. Demand for precision farming application as one of the main tools for sustainable intensification of agriculture.
- A single, harmonized approach to assess the current state of global soil cover and a methodology for its monitoring.

These and other R&D gaps are evident, but a review of existing advances is also necessary. This should be done by developing an inventory of existing soil research initiatives, facilities, infrastructure and outputs at national and regional level, including metadata on research projects. The major output under this activity will then be to determine the R&D priorities at global and regional levels based on national priorities and needs. Overall, global soil R&D priorities should take into

account the needs and priorities related to the three Rio Conventions³, as well as the needs and priorities identified through existing GSP soil networks and systems such as the International Network of Soil Information Institutions (INSII), Global Soil Laboratory Network (GLOSOLAN), Global Soil Information System (GLOSIS), International Network on Black Soils (INBS), and more.

2.3 Encourage inter- and transdisciplinary research and development

As stated in the Pillar 3 PoA, soil science is intrinsically inter-disciplinary as it involves pedology, geology, biology, chemistry, physics, mathematics, statistics, and social sciences, among others. Soil research should therefore be streamlined to enhance development impacts and human well-being, while enabling sustainable soil protection and use. This requires interaction between multiple actors (including the private sector) with complex and interrelated missions, functions and mechanisms, as well as extended networks to stimulate this interaction (e.g., individual projects embedded in a larger e-infrastructure for an effective sharing of approaches and results). Innovative approaches are needed, supported by enough resources to emphasize joint-learning experiences through real connection between stakeholders and the implementation of research results in practice, which is the ultimate proof of relevance of R&D. Developing strategies to enhance economic growth, environmental sustainability and social development based on tailored soils R&D is therefore important to ensure accountability, maintain credibility and improve governance and decision-making processes. Questions related to future societal trends will challenge soil research in a particular manner. It is clear that the soil research community should strive to work together and in close collaboration with other disciplines to plan and execute effective R&D initiatives.

The soil R&D community should therefore strive to work in close collaboration with other disciplines to plan and execute effective R&D initiatives. To facilitate the coordination of inter- and transdisciplinary soil R&D, regional soil research platforms will be developed or, in the case of existing platforms, these will be enhanced to address regional priority research areas. These research platforms will be developed using the inventory of existing soil research initiatives, facilities, infrastructure and outputs at national and regional level to be developed as mentioned in Section 2.2 and specified in action 2.1 in the Logical Framework Matrix.

Such soil research centres or platforms should be established under the Regional Soil Partnerships with inter-regional collaboration facilitated at the global level. Since the platforms will be targeting regional contexts, the specific regional aims and objectives, modes of operation and organization, roles of the platform and its stakeholders in implementing activities in this implementation, as well as the list of different stakeholders should be developed and defined in the general terms of reference. Targeted R&D programs should be launched by the platforms to address the R&D gaps identified in Section 2.2 and Action 2.3 in the Logical Framework Matrix.

2.4 Highlight the return on investment in soil R&D

According to the Pillar 3 PoA, a pending task for the soils R&D community is to clearly demonstrate the crucial role of soils for society, stressing the importance of soil functions for the provision of ecosystem services. Essentially, this is necessary to ensure changes in attitude and practice at end-user level, and requires scientists and decision makers to: (i) understand the factors that will affect the uptake and impacts of improved technologies by end-users and therefore, to develop suitable options for their promotion; and (ii) identify and address main change agents within the political, economic, environmental and demographic sectors for effectively closing the gap between research and technology adoption. It is necessary to assess the feasibility of implementing strategic research and innovation programs in relation to agendas of end-user communities to effectively embed soil R&D priorities in national, regional and global research programmes and agendas.

Furthermore, positive impacts of investment in soil R&D can only be achieved if adequate communication and dissemination measures are taken to reach the target audience. Isolated national and even regional actions would not have a significant effect on improving soil management to achieve the desired improvements in soil functions and ecosystem services. The strength of GSP Pillar

³ United Nations Convention to Combat Desertification (UNCCD), United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD).

3 lies in the ability/opportunity to replicate the proposed measures and best practices on a large scale, reaching a significant number of territories. Therefore, it is important to invest in the process of disseminating/communicating information to key stakeholders, such as farmers and politicians.

Under the GSP one of the goals is to provide tried and tested SSM practices and transfer these and associated knowledge to farmers and communities to maintain or improve soil functions and associated ecosystem services. To achieve this, the benefits of site and soil specific land use management for sustainable food production (which needs to be increased) and clean ground water should be highlighted. This can be done through a systems approach which considers the ensemble of soil functions that needs to be taken into account, based on which priorities can be determined for different regions. Examples of how this could be achieved are by:

- Defining sites that are best suited for various land uses (i.e. priority areas for construction, farming, filtering and buffering of water, etc.),
- Defining sensitive areas where extensive farming or even fallow should be practiced,
- Keeping groundwater tables high as in former days to stimulated peat growth, and
- Highlighting financial benefits for industry through the reduced risk of further soil or groundwater pollution (by site adjusted soil use management).

In addition, during the 5th GSP Plenary Assembly (held in June 2017) it was highlighted that scientific findings are usually difficult to translate into information that is useful for the general public. The Assembly observed that concrete evidence of the economic benefits derived from adoption SSM practices for farmer and other land users could be more effectively quantified and communicated in many cases. Therefore, providing appropriate SSM practices to improve different soil functions or ecosystem services should be accompanied by information on the related costs and benefits of these practices to promote their implementation and adoption.

Ultimately, investment in soil research should provide an optimal balance between economics and ecology, loading and accumulation of matter/energy in the soil. Unlike systematic passive observations/monitoring, perspective targeted soil studies should provide modelling and testing of optimal land use and agricultural technologies, as well as forecasting the results of their implementation under different soil and climate conditions. This will allow us to move from the current description of the soil condition to effective management of the soil water and nutrient regimes and the reasonable management of carbon uptake.

As stated in the Pillar 3 PoA, addressing all these issues requires: (i) an understanding of SSM and relevant practices in different eco-regions and land uses; (ii) appreciation of the economic, environmental and social consequences of unsustainable management; and (iii) comprehensive analyses of the value of investing in soil protection and rehabilitation. Through implementation under Pillar 1, a global assessment protocol or methodology has been developed to determine whether specific soil management practices are sustainable according to the revised WSC definition. This global protocol will be refined to enable the assessment of SSM practices according to local, national and regional priorities and contexts. Using this assessment protocol, a database of SSM management practices will be compiled, drawing from existing databases, as well as relevant practices not currently catalogued.

Determining the impacts of implementing appropriate SSM practices will be addressed through implementation of Pillar 3. To do this, appropriate indicators should be identified and applied to assess the economic and environmental costs of soil degradation, as well as the economic and environmental costs and potential benefits associated with the implement of specific SSM practices. Once the indicators are available, national and regional capacities should be developed to enable national and regional assessments of the economics of soil degradation and costs-benefits of SSM implementation. These actions should provide relevant information to influence decision making and raise awareness on the wise use and conservation of limited soil and water resources.

In order to understand the nature of investment in soil R&D, an assessment should be conducted at national level to determine the extent of past (last 10 years) and current investment, as well as their return on investment (impact/cost-benefit), should such information be available. It is especially

important to understand to which extent national governments prioritize and invest in national soil R&D.

2.5 Develop active collaboration to support targeted soil research for development

The optimal implementation of R&D activities under the GSP necessitates active collaboration and cooperation between research bodies, decision makers, extension services, end-user communities and donor agencies. This is necessary to increase the speed with which information can be assembled across locations and broader solutions developed that will have an impact across multiple regions. It is further expected that collaboration will provide encouragement for international cooperation at the global and regional levels to look for new solutions to increase productivity and protect the soil, expand the use of modern technologies for land improvement and precision agriculture, remote sensing methods, soil monitoring and other innovative strategies for land use and soil conservation, including for achieving global targets such as land degradation neutrality.

The GSP and its partners should therefore seek active with the following entities:

- Existing international and regional R&D initiatives dealing with current global challenges⁴;
- National governmental research centres and universities;
- Extension services and advisory boards;
- Decision makers;
- Donors;
- Land users, and more

Such collaboration is necessary in order to prevent unnecessary analyses or definition of priority research approaches, to facilitate the sharing of laboratory facilities worldwide, and to enhance and improve our knowledge about soils and the environment. Through such collaboration it is necessary to link the data and information generated through collaborative research and provide more open access to research information.

Relevant key stakeholders and potential donors should be identified at national, regional and global levels to address emerging research priorities and develop a network for the regular exchange of soil R&D results and outcomes. Furthermore, stakeholders should contribute to the development of joint research proposals and subsequent implementation should funding be obtained. Further collaborative actions include the organization of training courses for discussion of region or country specific soil R&D approaches to address specific environmental challenges, the organization of global symposia to link science and policy, the development of various soil and land use management products and guides, and ensuring the diffusion of research outputs at all levels.

⁴ For example: relevant research centres under the Consultative Group on International Agricultural Research (CGIAR), the Global Research Alliance (GRA), the Global Forum for Agricultural Research (GFAR), the Science-Policy Interface of the United Nations Convention to Combat Desertification (UNCCD), the Intergovernmental Panel on Climate Change (IPCC) of the United Nations Framework Convention on Climate Change (UNFCCC), the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), the IUSS, the International Fund for Agricultural Development (IFAD), International Atomic Energy Agency, World Health Organization, the Joint Research Centre, the European Union Horizon 2020 research programme, and sources of soil data (e.g., the International Soil Reference and Information Centre which is also the soil data facility for the GSP)

3 Logical Framework Matrix

Activity	Product description	Actions	Start date	End date	Stakeholders	Budget
1. Develop a global soil research internet platform	<p>A global web-based platform to provide an overview of soil R&D aspects.</p> <p>All products developed from subsequent activities in this document are to be shared on this platform for easy access to all stakeholders.</p>	<p>1.1 Initiate a web-based platform for a structured inventory of global, regional and national:</p> <ul style="list-style-type: none"> • soil research partners, • soil research facilities and infrastructure, • soil research programs; and • soil related research gaps. <p>to provide a soil knowledge hub for different users.</p>	Q3 2018	2020	<p>GSP Secretariat</p> <p>P3WG</p> <p>Identify appropriate host for the web-based platform</p>	<p>In-kind volunteer /contractor</p> <p>USD 400,000</p>
2. Assess existing R&D initiatives and identify global research priorities	<p>Compilation of existing R&D activities with a set of identified priority research gaps at global, regional and national level</p>	<p>2.1 Develop an inventory of existing soil research initiatives, facilities, infrastructure and outputs at national and regional level, including metadata on research projects.</p> <p>This would include the following:</p> <ul style="list-style-type: none"> – Analysis of the capacity of national and international research institutions active in the regions – Conducting a gap analysis and inclusive consultation process – Developing a concept for improved regional soil research advocacy and implementation 	Q4 2018	Q4 2020	<p>National Institutes and Universities,</p> <p>GSP partners</p>	<p>USD 500,000</p> <p>(Budgets for task force meetings: USD40 000 per year)</p>

Activity	Product description	Actions	Start date	End date	Stakeholders	Budget
		<p>2.2 Identify global and regional R&D priorities based on national needs and priorities.</p> <p>Research priorities should be aligned with the following:</p> <ul style="list-style-type: none"> • The SDGs, especially those including aspects on soil (SDGs 2, 6, 13, 15 and 17); • The three Rio Conventions (UNCCD, UNFCCC and CBD); • The needs and priorities identified through existing GSP soil networks and systems such as the INSII, GLOSOLAN, GLOSI, INBS, and more. 	Q4 2018	Q4 2020	Research and academic institutions, focal points, professional communicators	National contributions

Activity	Product description	Actions	Start date	End date	Stakeholders	Budget
<p>3. Encourage inter- and transdisciplinary research and development</p>	<p>Develop new or enhance existing regional soil research platforms to address regional priority research areas through inter- and transdisciplinary collaboration.</p> <p>Develop a global soil research platform to facilitate collaboration between regional platforms.</p>	<p>3.1 Facilitate the coordination of regional soil R&D and policy support through the establishment of integrated regional soil research centers or platforms (subject to availability of financial support). Such platforms will be established drawing from the inventory of existing soil research initiatives as developed under action 2.1.</p> <p>Such soil research centers or platforms should be established under the Regional Soil Partnerships with inter-regional collaboration facilitated at the global level. Where regional research platforms already exist, implementation will facilitate the enhancement of these platforms as needed.</p> <p>The platforms should be responsible for:</p> <ul style="list-style-type: none"> - Collecting and disseminating information from soil research (supported by the global soil research internet platform in Activity 1 above); - Ensuring close collaboration with other disciplines to plan and execute effective R&D initiatives for inter- and transdisciplinary research; - Promoting awareness and training (link to Pillar 2); - Develop project proposals for soil R&D projects of regional and cross-regional interest (link to Pillar 2). Such proposals should target various funding sources and aim to address the research priorities identified through Action 2.2; 	Q12019	Q42021	National Ministries of Agriculture and other relevant Ministries, International Organizations like UNEP, World Bank, IFAD, ADB, SARC, GSP partners	USD 2,000,000

Activity	Product description	Actions	Start date	End date	Stakeholders	Budget
		<p>3.2 Determine aims and objectives, modes of operation and organization, roles of the platforms in implementing activities in this implementation plan, define their terms of reference, and list the different stakeholders of the various platforms.</p>	Q1 2019	Q4 2021	National Ministries of Agriculture and other relevant Ministries, International Organizations like UNDP, UNEP, World Bank, IFAD, ADB, GSP partners	USD 50,000
		<p>3.3. Launch targeted R&D programs aimed at responding to the knowledge gaps identified under Activity 2 and build regional networks of soil research stakeholders.</p> <p>Ensure that the inter- and transdisciplinary aspects are sufficiently included and addressed. Identify key stakeholders and potential donors accordingly at national, regional and global levels.</p> <p>The network should also serve to write joint project proposals and mobilize financial resources.</p>	Q1 2020	Q4 2022	National Institutes and Universities Research and academic institutions, focal points, professional communicators	USD 5,000,000 + Regional and national contributions
<p>4. Highlight the return on investment in soil R&D</p>	<p>Information on the return (impact /cost-benefit) of investment in soil research, stressing the cross-cutting role of soils in grand environmental and societal challenges, and the importance of soil</p>	<p>4.1 Identify indicators to assess the economic cost of soil degradation, as well as the economic and environmental value of its rehabilitation using different SSM practices (including stock taking and gap analysis)</p> <p>Develop region-specific assessment models and convey the results to support decision making and policies on sustainable development.</p> <p>Convey results to support decision making and policies on sustainable development.</p>	Q3 2018	Q4 2021	National Institutes and Universities, interdisciplinary working group for Pillar 3 collaborating with other regions for the achievement of this common goal	USD 200,000

Activity	Product description	Actions	Start date	End date	Stakeholders	Budget
	<p>properties, functions and provision of ecosystem services thereupon.</p> <p>A database with SSM practices including related costs (including investment to dedicated R&D) and benefits. The SSM practices database will be developed under Pillar 1. Information on the costs and benefits of such practices will be added through implementation of Pillar 3.</p>	<p>4.2 Develop national and regional research capacity to assess the economics of soil degradation and benefits of SSM to influence decision making and raise awareness on the wise use and conservation of limited soil and water resources.</p>	Q1 2020	Q4 2022	GSP Secretariat RSPs	USD 250,000
		<p>4.3 Assess the extent of past and current investment in soil R&D per country, as well as their return on investment (impact/cost-benefit), should such information be available. Assessments should include the following:</p> <ul style="list-style-type: none"> • Distinguish between the proportion of international and national funding, as well as between private and public funding of research projects • Past investment can be determined up to the last 10 years <p>Returns can be classified as returns in terms of public (i.e., impacts on soil properties, functions and provision of ecosystem services) or private goods and the economic value of those goods specified to the extent possible.</p>	Q3 2018	Q2 2021	GSP Secretariat RSPs GSP focal points Funding and implementing agencies (i.e., USAID, EU, GEF, WB, FAO, GCF, IFAD, UNDP, etc.), research institutions/organizations (i.e., CGIAR, ICBA, JRC, etc), national Ministries and research institutions, universities, etc.	USD 100,000

Activity	Product description	Actions	Start date	End date	Stakeholders	Budget
<p>5. Develop active collaboration between research bodies, decision makers, extension services, end-user communities and donor agencies to support targeted soil R&D</p>		<p>5.1 Identify key stakeholders and potential donors at national, regional and global levels. Identify key partners and stakeholders for addressing emerging research priorities and establish a network of collaboration linked to the regional soil R&D platforms.</p> <p>The network should also contribute to the development of joint research proposals and mobilize financial resources as listed under Action 3.1.</p>	Q1 2019	Q4 2021	Research and academic institutions, focal points, professional communicators	USD 50,000 + Regional and national contributions
		<p>5.2 Promote multi-stakeholder discussions aimed at sharing knowledge for launching joint projects and initiatives on soil information, functions, conservation and restoration.</p>	Q1 2019	Q4 2020	Research and academic institutions, focal points, professional communicators	USD 250,000 (Budgets for task force meeting: USD50 000 per year)
		<p>5.3 Organize training courses for discussion of region or country specific soil R&D approaches on specific environmental problems, as well as approaches on how to document and quantify them.</p>	Q1 2019	Q4 2022	GSP Secretariat in combination with IUSS Divisions 2 and 3 RSPs	USD 500,000
		<p>5.4 Organize annual Global Symposia linking science and policy to address key soil-related topics.</p> <p>Ensure gender and regionally balanced participation in Global Symposia by supporting participation of relevant active scientists from underrepresented groups and regions.</p> <p>Implement recommendations from Global Symposiums.</p>	Q2 2018	Q2 2022	GSP Secretariat ITPS RSPs GSP Partners	USD 500,000

Activity	Product description	Actions	Start date	End date	Stakeholders	Budget
		5.5 Develop soil and land use management maps and guidebooks for interested scientists, public and politicians (like the IUSS Books: soil matters, etc.)	Q1 2019	Q2 2022	GSP Secretariat together with IUSS Div.4	USD 150,000
		5.6 Ensure diffusion/dissemination of research outputs at all levels and regions. Adapt and translate the scientific message to inform all stakeholders and the larger public	Q3 2018	Q4 2022		USD 50,000
		5.7. Provide policy support to the government and institutions to promote inter-disciplinary participation in soil research.	Q1 2019	Q4 2022	National Ministries of Agriculture and other relevant Ministries, GSP partners	In-kind (also making use of resources mobilized for achieving awareness raising activities under Pillar 2

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5 Total budget

Activity	Budget
1. Develop a global soil research internet platform	USD 400,000
2. Assess existing R&D initiatives and identify global research priorities	USD 500,000
3. Encourage inter- and transdisciplinary research and development	USD 7,050,000
4. Highlight the return on investment in soil R&D	USD 550,000
5. Develop active collaboration between different stakeholders to support targeted soil research for development	USD 1, 500,000
Total Activities	USD 10,000,000

6 References

FAO. 2015. Revised World Soil Charter. Food and Agriculture Organization of the United Nations. Rome, Italy. Available at <http://www.fao.org/3/a-i4965e.pdf>.

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FAO, 2017. Voluntary Guidelines for Sustainable Soil Management. Food and Agriculture Organization of the United Nations. Rome, Italy. Available at <http://www.fao.org/3/a-bl813e.pdf>.

Annex 1. Soil research knowledge gaps, research questions and threats to soils as listed in the Pillar 3 Plan of Action

Any programming of new soil R&D activities, or activities aiming to strengthen the outputs and availability of results from existing research, can build on existing reference material from large soil-oriented national or continental-wide (e.g. Europe) research programmes. To improve the availability of this material, a joint information sharing effort is needed. In addition, in the short-term research priorities can be stated more clearly, partially based on knowledge gaps, research questions and threats to soils resources recently proposed by different sources as priorities within the soils R&D community. The regional soil partnerships should prioritize the knowledge gaps, research questions and threats listed below and add additional priorities unique to that region in order to develop appropriate actions for implementation:

a. Knowledge gaps

In accordance with the “Soil Thematic Strategy” of the commission of the European Communities (European Commission, 2012), the following priority areas for soil research are critical “to close the gaps in knowledge” and “strengthen the foundation for policies”:

- a. Processes underlying soil functions (e.g. soil’s role in global CO₂ accounting, the protection of biodiversity and the hydrologic cycle).
- b. Spatial and temporal changes in soil processes.
- c. Ecological, economic and social drivers of soil threats.
- d. Factors influencing soil related ecosystem services.
- e. Operational procedures and technologies for soil protection and restoration.
- f. Soil biodiversity as an environmental service.
- g. Soil as part of our natural and cultural heritage to be properly preserved.

b. Research questions

Considering the inter- and transdisciplinary and multifunctional nature of soils, key research questions identified by a number of scientists in relationship with ecosystem services include:

- h. Food (Security): How can we increase food production by 60-70% to feed 9 billion people without impacting the environment?
- i. Water: How can we manage soils to contribute to the sustainable use of water resources and enhance water quality?
- j. Nutrients: How do we enhance nutrient use efficiency, nutrient cycling and nutrient balance, through soil management while producing quality food, feed, fiber and fuel?
- k. Energy: How can we produce biomass for biofuels without degrading soils and other natural resources they support?
- l. Climate buffering: How can we manage soils to provide resilience to increased climate variability and regulate climate through reduced greenhouse gas emission while maximizing soil C sequestration?
- m. Biodiversity: How can we improve the understanding, management and conservation of soil biodiversity to enhance ecosystem services?
- n. Recycling (wastes): How can we improve the use of soils as biogeochemical reactors, thereby remediating / avoiding contamination and maintaining soil productivity?
- o. Global equity: How do we balance global needs with local solutions?

Addressing these questions also implies to understand trade-offs between them (e.g. the role of soil biodiversity not only in nutrient cycling but also in soil structure maintenance and its effect on water cycling).

c. Soil threats

Several national research councils and advisory boards have published strategic papers to bring the frontiers and challenges of soil science research to the attention of funding institutions. All reports agree that the state of soils is deteriorating and that there is urgent need to improve soil health. The 10 major threats to soils around the world have been identified in the SWSR (2015) as follows:

1. Erosion
2. Organic carbon change
3. Nutrient imbalance
4. Salinization and sodification
5. Sealing and capping
6. Loss of soil biodiversity
7. Contamination
8. Acidification
9. Compaction
10. Waterlogging

The degree of severity, geographic extent and interaction between these threats are diverse and very complex. Therefore, the prioritization of research activities to target defined threats and hence to serve specific gaps in the developmental cycle is urgently needed.

In general, it is necessary to emphasise how soils R&D could help to better understand soil processes and how they contribute to soil functions, how to efficiently manage (protect and enhance) soils so that they can continue fulfilling these functions (including the rehabilitation of degraded soils), and how to better understand the geographic distributions of soil functioning and the trajectories of future changes in these functions. Complementarily, to ensure changes in attitude and practice at end-user level (from farmers to urban communities, from farming cooperatives to big business, etc.), scientists and decision makers need: (i) to understand the factors that will affect the uptake and impacts of improved technologies by end-users and therefore, to develop suitable options for their promotion; and (ii) to identify and address main change agents within the political, economic, environmental and demographic sectors for effectively closing the gap between research and technology adoption. To this end, research outputs including lessons learnt from previous and current agricultural research and implementation efforts should be intensively documented and incorporated in future R&D strategies.