GLOBAL SOIL PARTNERSHIP

International Technical Workshop

“Managing Living Soils”

5-7 December 2012

FAO Headquarters

Rome, Italy

Workshop Report

Foreword

This workshop report presents the proceedings of the Global Soil Partnership (GSP) technical workshop "Managing Living Soils" held at FAO headquarters in Rome from 5 to 7 December 2012. The workshop objective was to provide guidance for the development of a comprehensive Plan of Action for Pillar 1 of the GSP on promoting the sustainable management of soil resources. The presentations made in the workshop focused on the status, challenges and priorities for Sustainable Soil Management and were discussed globally and by region for:

- Sub Saharan Africa
- the Middle East,
- the Mediterranean and North Africa
- Asia and the Pacific
- Latin America and the Caribbean
- North America
- Europe and Eurasia

Keynote speakers set the stage by discussing international processes and trends of relevance for sustainable soil management. Working groups developed strategies and action plans for the GSP based on the potential to increase adoption of sustainable soil management practices through technical, policy and capacity-building support. Key Questions addressed in each working group included:

- What priority issues need to be addressed to bring about a transformation towards the sustainable management and protection of soils?

- What are the constraints and barriers (policy/governance, institutional capacity, technical expertise/knowledge) to achieve sustainable soil management in your country/region and what international support is required?

- What are existing opportunities (partnerships, funding, expertise, case studies/ experiences etc.) on which we can build?

The workshop agenda is provided in Annex 1 and the List of Participants in Annex 2.

Acknowledgements

This report was prepared by the Global Soil Partnership (GSP) Secretariat in FAO, under the guidance of an ad hoc working group whose members were selected to represent the regions and whose support is hereby gratefully acknowledged notably: Liesl Wiese (ARC, Republic of South Africa) for Eastern and Southern Africa; Bernard Van Lauwe (IITA, Nigeria) for West and Central Africa; Charles Rice (American Soil Science Society, USA) for North America; Kazuyuki Yagi (NIAS, Japan) for Asia; Pandi Zdruli (CIHEAM, Italy) for the Mediterranean region; Feras Ziadat (ICARDA, Jordan) for the Near/Middle East & North Africa; and Rafael Fuentes (IAPAR, Brazil) for Latin America and the Caribbean. The report was compiled by Sally Bunning and Frank Davis (intern) with support of Christian Nolte, Manuel Ravina and Freddy Nachtergaele who contributed substantively to the technical editing.

The content comes, in part, directly from the presentations that were made by participants from each region and by partner institutions - each of the presenters are warmly thanked for their valuable contributions. The discussions in plenary sessions and in working groups are also reflected and the recommendations emanating from these deliberations are provided. Each workshop participant is warmly acknowledged for his/her active contribution representing their country, region and institution/organization. This report should provide a rich and valuable information and suggestions to feed into and guide the development of the Plan of Action for Pillar 1 “Promoting sustainable soil management” of the Global Soil Partnership.

The European Commission and ISPRA (Institute for Environmental Protection and Research), Italy, are gratefully acknowledged as co-organizers of this workshop. Finally, special recognition to Maryse Finka and Ronald Vargas for organizing the workshop and to Luca Montanarella and Carlo Jacomini for co-organizing this workshop.

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List of Acronyms

AAPRESID	Argentinean No-Till farmers Association
AGRA	Alliance for a Green Revolution in Africa
ATA	Agricultural Transformation Agency (Ethiopia)
CAADP	Comprehensive Africa Agriculture Development Program
CBO	Community Based Organization
CDERA	Caribbean Disaster Emergency Response Agency
CIAT	International Centre for Tropical Agriculture
EU	European Union
FAO	Food and Agriculture Organization of the UN
GEO	Global Environmental Outlook
GHG	Greenhouse Gas
GIS	Geographic Information System
GPNM	Global Partnership on Nutrient Management
GSBI	Global Soil Biodiversity Initiative
GSP	Global Soil Partnership
IAPAR	Agronomic Institute of Parana (Brazil)
ICARDA	International Centre for Agricultural Research in Dryland Areas
ICBA	International Centre for Biosaline Agriculture
ICRAF	World Agroforestry Centre
IFA	International Fertilizer Organization
IISB	International Initiative for the conservation & sustainable use of soil biodiversity.
ITPS	Inter-governmental Technical Panel on Soils of the GSP
IIRR	International Institute of Rural Reconstruction
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
ISFM	Integrated soil fertility management
ISPRA	Institute for Environmental Protection and Research (Italy)
IUSS	International Union of Soil Scientists
IYS	International Year on Soils (proposed 2015)
JRC/EC	Joint Research Centre of the European Commission
KARI	Kenya Agricultural Research Institute
LADA	Land Degradation Assessment in Drylands
MDG	Millennium Development Goals
MENA	Middle East and North Africa
MoA	Ministry of Agriculture
NGO	Non-governmental Organization
NLRC	National Land Resource Centre (New Zealand)
SDG	Sustainable Development Goals
SLM	Sustainable Land Management
SOM	Soil Organic Matter
SSM	Sustainable Soil Management
SWAT	Soil and Water Assessment Toolkit
Vi-AFP	Agroforestry program of Vi (Sweden)
WSD	World Soil Day (5 December)

1. Welcoming Remarks and Opening Statements

Alexander Müller, Assistant Director General, FAO Natural Resources and Environment Department, welcomed participants and highlighted the need for international recognition of the importance of soil management. The consideration and ratification of the GSP Terms of Reference by the ongoing 145th session of the FAO Council and its endorsement of the 5th of December as "World Soil Day", are major steps forward for the GSP programme. The support to the GSP by the European Commission and ISPRA (Institute for Environmental Protection and Research), Italy, is highly welcomed.

Mr. Müller outlined five key messages for the public and policy makers concerning soil management:

1. Soil is a vital and a non-renewable natural resource (on a human time scale).
2. Soil provides an essential interface between water, nutrient and atmospheric cycles including nitrogen and carbon, and living organisms and is vital for maintaining the health of the ecosystem.
3. Soil is essential for food, feed, fibre and fuel production and it deserves to be at the top of the international agenda for its role in ensuring food security.
4. Soil provides many other goods and ecosystem services, making it invaluable for the spectrum of benefits it provides to humankind.
5. Biodiversity is an essential component of soil. Soil as a living system is both a habitat for and is maintained by the living organisms that inhabit it.

Mr. Müller stressed that agricultural systems could not be sustained unless the soil resources were managed in a sustainable way . Development plans for urban growth and infrastructure need to include soil conservation measures and preserve productive soils for use by agricultural systems. By 2050 the world will need to produce 60% more food to be able to feed the growing world population, it is therefore very important to preserve healthy and productive soils for a food secure world. The importance of the Global Soil Partnership (GSP) programme in supporting efforts for sustainable soil management worldwide is vital in this respect.

Mr. Müller also noted that the Voluntary Guidelines on the Responsible Governance of Land Tenure, Fisheries and Forests represent the first set of globally acknowledged principles to manage land tenure issues. The GSP should likewise aim to create a global movement by developing a set of principles for soil protection and sustainable soil management.

Mr. Müller wished the workshop participants successful deliberations and welcomed their guidance and concrete outputs for developing an outline plan of action for Pillar 1 of the

GSP. He also invited participants to attend the celebration of World Soil Day being held as a side event to the FAO Council.

Jae Yang, President of the International Union of Soil Scientists (IUSS), stressed that a World Soil Day is an effective way to raise awareness and promotion for sustainable soil management. But it is also the responsibility of global organizations, such as the IUSS (that represents some 60,000 soil scientists) and the GSP (that is endorsed by most countries in the world)to generate and disseminate soil knowledge and information and to create synergy for the promotion of sustainable soil management worldwide.

Maria Dalla Costa, International Relations office, ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale), Italy, confirmed the need for streamlined efforts across the regions, nations and the globe to make spatial datasets more usable. She drew attention to the lack of agreement reached in Europe over the Soil Protection Directive and suggested the need to start with the creation of a coherent strategic framework through technical committees and guidelines. The scientific community should also help build a consensus among productive and private sectors and the public for sustainable soil management.

Ms Dalla Costa also noted ISPRA's long term work on soil conservation, biodiversity, and soil overexploitation. Currently, a national law is being discussed in the Italian Parliament as a first step to protect agricultural land from urban expansion in order to slow the rate of soil consumption. Soil erosion remains a concern in the country due to poor uptake of conservation measures. Land degradation and biodiversity are being monitored in field plots across Italy under the 2010 national strategy on biodiversity, which is supported by the EC. Furthermore, the SIAS Project (Sviluppo Indicatori Ambientali per il Suolo) for the development of soil indicators on erosion and organic matter content is involved in soil carbon monitoring through the Joint Research Centre (JRC/EC). Sustainable land management (SLM) is also being assessed. Italy recognizes the need for a common platform for spatial information on soils.

Luca Montanarella, Secretary, European Soil Bureau Network, Joint Research Council, European Commission, noted the important ongoing decisions in the FAO Council, to support World Soil Day and endorse the terms of reference of the Global Soil Partnership. He welcomed the new legal instrument in Italy to protect agricultural soils recognising them as a non-renewable resource. He noted that this workshop follows and should build on a series of important meetings in 2012 that helped to show the importance of soils including during the Rio+20 global conference and the 1st Global Soil Week in Berlin.

2. Keynote Presentations

David Coates, Secretariat, Convention on Biological Diversity (CBD), recalled the International Initiative for the Conservation and Sustainable Use of Soil Biodiversity, adopted as a cross-cutting initiative within the Programme of Work on Agricultural Biodiversity by the 8th session of the CBD Conference of the Parties. FAO and other relevant organizations were invited to facilitate and coordinate the Initiative. During Rio+20 the importance of soils and its sustainable management was barely highlighted except for limited reference to soil and water security, soil health and biodiversity. The management of soils and the knowledge of its limitations and challenges at national and regional levels deserve concrete actions as a core part of the sustainable development agenda for agricultural production and environmental conservation.

Luca Montanarella, JRC/EC, presented on behalf of Diana Wall the Global Soil Biodiversity Initiative (GSBI), which was established in 2006 by the research community. This initiative aims to foster soil biological knowledge and its applications. It supports the CBD International Initiative for the conservation and sustainable use of soil biodiversity (IISB). With regard to awareness raising, 2010 was the International Year of Biodiversity in the UN system and a major success worth mentioning is the publication of the European Atlas of Soil Biodiversity. The GSBI recognizes that soils are alive and represent a massive and critical biodiversity reservoir (Figure 1).

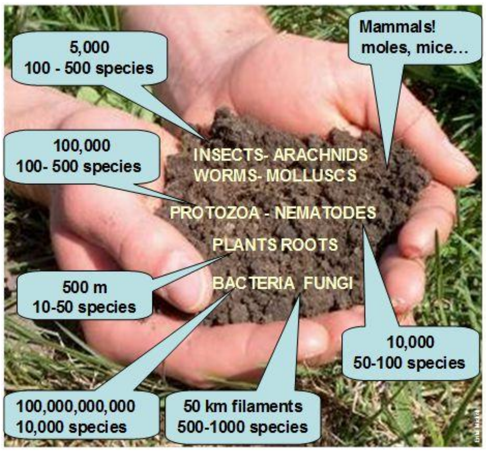

Figure 1: Soil as a biodiversity reservoir (Photo courtesy of Luca Montanarella)

Soil conservation and sustainable soil management contribute to economic, ecological, and ethical benefits. Soil organisms provide a multitude of agricultural ecosystem services, including waste breakdown and release of nutrients, enhancing soil structure, biodegradation of pesticides and other chemicals, providing a sink for greenhouse gas emissions, fighting pests, and benefiting human and animal health including digestion and immunity. Globally, nitrogen fixation is estimated to be worth about 70 billion Euro annually and pollination 150 billion Euro annually. Soil micro-organisms are also valuable to the pharmaceutical industry. For example, Rapamycin in the soils of Easter Island, an immunosuppressant drug used to prevent rejection in organ transplantation, is produced by the soil bacterium *Streptomyces hygroscopicus*.

The GSBI is expected to contribute to the GSP as a member of the Intergovernmental Technical Panel on Soils. One of the priorities of the GSBI is to promote synergy between scientific and technical panels dealing with food security, climate change, desertification, and biodiversity (Figure 2).

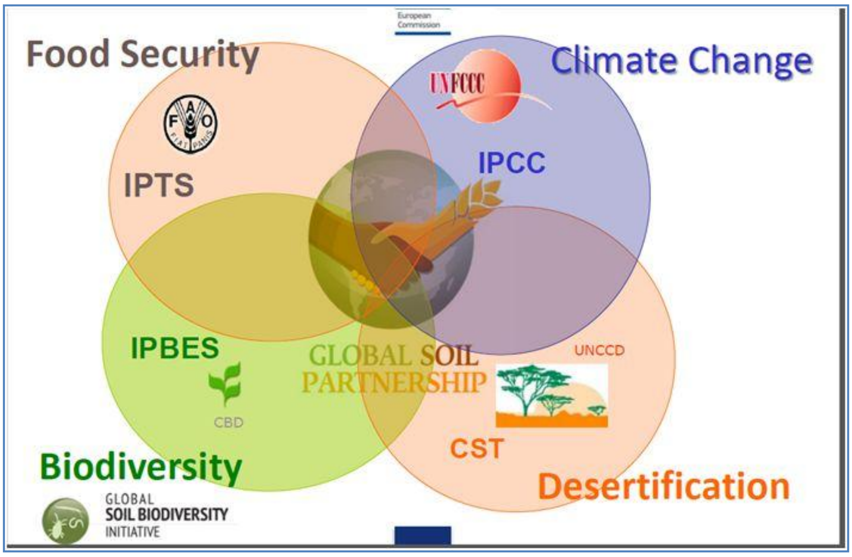

Figure 2: The interrelationships between the international commitments and processes that address biodiversity, food security, climate change and desertification

Sally Bunning, Senior Land/Soils officer, FAO Land and Water Division, presented the background and purpose of the Global Soil Partnership (GSP) and the process for its development. This workshop was jointly organized by FAO Natural Resources & Environment and Agricultural Departments supported by the Joint Research Council of the European Commission and ISPRA, to initiate the process of developing Pillar 1 of the GSP on promoting sustainable soil management worldwide. Sustainable soil management (SSM) must be comprehensively defined in relation to the wider sustainable land management (SLM) context. The GSP needs to develop a consistent action plan on SSM practices, knowledge and adoption, ecosystem services provision, as well as required policy and institutional support. The workshop should recommend next steps to further develop an SSM action plan with all concerned stakeholders.

Ms. Bunning recalled the definitions of “soil health” which denotes the soil intrinsic function as a living system and “soil quality” which includes its capacity to sustain productive services as well as socio-cultural and ecological services (Box 1). SSM should balance soil health and ecosystem services against human production purposes. Both are reduced through degradation processes including erosion, nutrient mining, compaction, acidification, salinity and pollution. The main function of healthy living soils lies in providing a medium for plant establishment and growth for vegetative and livestock production. Soils provide invaluable ecosystem services such as the regulation of water, nutrients and atmospheric gases (Figure 3).

Text box 1: Definitions of soil health and soil quality

Soil health *is the capacity of the soil to function as a vital living system within ecosystem and land use boundaries to sustain plant and animal productivity and health and maintain or enhance water and air quality (Doran, 1996)*

Soil quality *is the capacity of a specific kind of soil to function within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human healthy and habitation. (SSS of America, Karlen et al. 1997)*

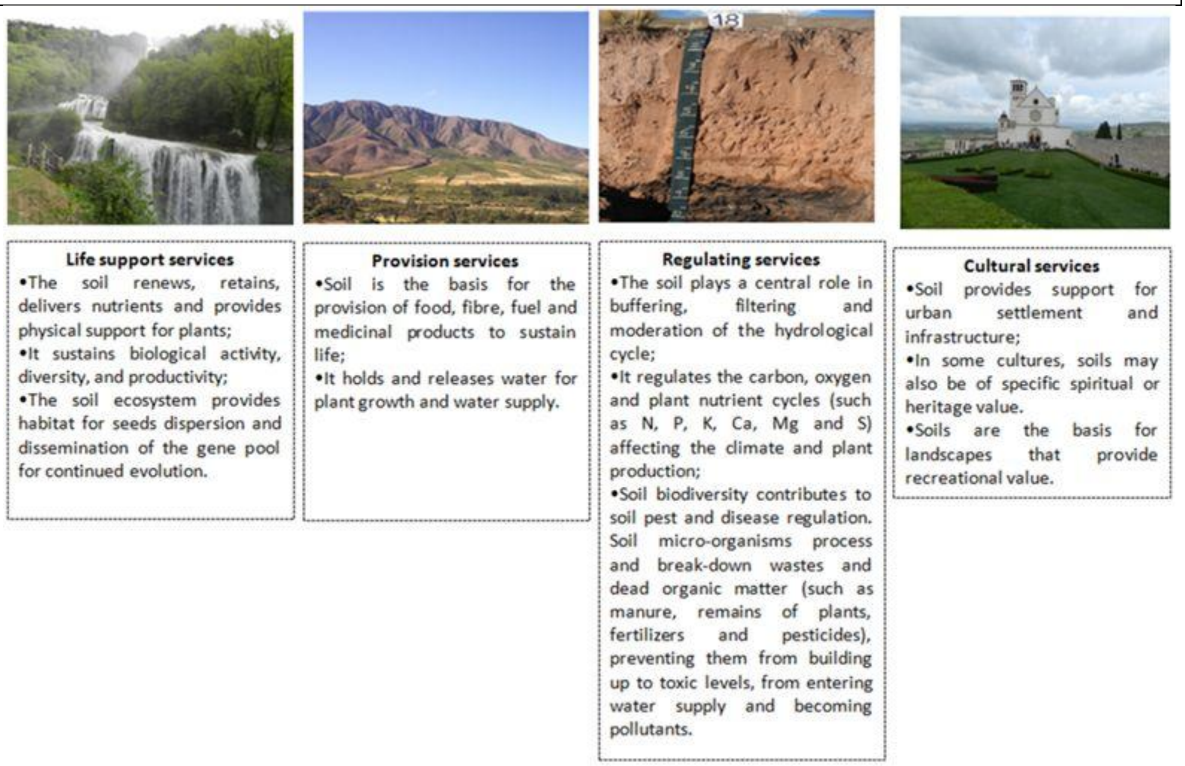

Figure 3: Human and Ecosystem Services of Soil (Vargas, 2012)

Soils vary greatly geographically due to the environmental factors of geology, topography, climate, organisms and time. Furthermore, their productivity and resilience are affected by local land use and management practices which influence its physical, chemical and biological properties. Soils provide the basis for food, fibre, fuel, environmental regulation, and socio-cultural services. Healthy soils are therefore required to feed the growing population and meet their needs. The decrease of productive soils occurs as a result of population and economic growth, leading to competition and overuse of this limited natural resource. Soil is affected by environmental degradation including water pollution and scarcity, point and non-point source pollution, climate change as well as soil sealing through population growth and urbanization.

The potential of the soils to sequester carbon is estimated globally at about 2,200 gigatons. Most of it (2/3) is found in the soil organic matter. For this reason the impacts of land degradation in wetlands, peat soils and permafrost areas, which contain high amounts of fresh soil organic matter, are of great concern as they will accelerate global warming through emissions to the atmosphere of carbon dioxide and other greenhouse gases.

The GSP mandate is the improvement of global governance of the limited soil resources of the planet through leadership coordination in order to ensure food security and sustain other ecosystem services. The main issues for the GSP to address are:

- Soil technical expertise is dispersed, not shared and not harmonized.
- Information and knowledge is not readily accessible and is inadequately disseminated to key stakeholders: land users (farmers, livestock holders, foresters) and policy makers/planners.
- Soil management capacities vary between countries and are inadequately used in interdisciplinary, ecosystem approaches.
- Soil scientists are disappearing as a result of lack of attention and support for soils.

The main priorities for the GSP are therefore to:

- Raise awareness of policy makers to improve soil governance;
- Promote adaptive management strategies for climate smart agriculture;
- Find win-win synergies between climate change, food security, nutrient overloading and mining, and urbanization;
- Identify all key stakeholders and develop a plan of action for GSP pillar 1 on SSM;
- Strengthen training capacity and education for future generations.
- Extend soil management policies from national level to regional and international levels.

Christian Nolte, Senior Soil fertility officer, FAO Agriculture Production and Protection Division, highlighted the interlinked challenges of food and water security, climate change, and nutrient management. He mentioned the importance of sound soil organic matter (SOM) management and the use of organic material in combination with the judicious use of mineral fertilizers. The combined use of organic and inorganic fertilizers has proven additional benefits. The need for fertilizers is especially pronounced in nutrient-depleted soils in Sub-Saharan Africa to kick-start biomass production. A high return of biomass will enhance soil biodiversity and beneficial organisms, such as mycorrhiza, which are essential for many crops on nutrient-poor soils. There are also important interactions between crop pests and nutrient deficiencies, for example maize stem borer attacks increase with K-deficiency. Regarding institutional and policy issues, enhancement of capacity building for farmers and soil scientists is needed. Soil work is fragmented and although national soil policies exist in some countries, these are missing at regional and international level. For instance, soil degradation is not part of the Millennium Development Goal on Environmental Sustainability.

3. Global Status, Challenges and Priorities for Sustainable Soil Management

3.1 Global Status and Challenges of Fertilizer Use. *Patrick Heffer, Director Agriculture Service, International Fertilizer Industry Association (IFA)*

Global fertilizer (N; P2O5; K2O) consumption increased strongly since 1961 from about 35 to 140 million tonnes. This increase was driven by developed and developing economies until the mid 1970s, when consumption in developed countries reached a plateau and leveled off. In developing countries demand increased until 1989. Between 1989 and 1993, the global demand decreased by 17%, primarily in transition countries, due to the collapse of the former Soviet Union. After 1993, global demand increased by another 36%, but that increase only happened in developing countries, driven by the strong economic development of mainly Asian countries. The demand in transition and developed countries stagnated. Over the 48-year period from 1961 to 2009 the composition of fertilizer demand changed considerably. Nitrogen saw a large 8.7-fold increase, compared to a 3.4-fold increase in phosphorus and a 2.7 fold increase in potassium. That means the nutrient ratio changed to the detriment of phosphorus and potassium, which is not sustainable. A preferred price differential for N as well as subsidies in some countries, biased towards nitrogen, are responsible for this development.

The recent economic downturn between 2008 and 2011 had different effects on world regions. Relative increases in fertilizer consumption were noted in South Asia and India (highest) as well as in Eastern Europe, Central Asia, North America and Africa. Meanwhile in other regions (West and Central Europe, Latin America and East Asia) the use decreased slightly. Globally during this period, potassium use decreased while nitrogen and phosphorus use increased, further deteriorating the nutrient ratio. The medium-term outlook until 2016-17 forecasts an annual 2.1% growth in fertilizer consumption, with 75% of that increase taking place in Eastern (30%) and Southern Asia (24%) and in the Latin American / Caribbean region (21%).

Food security is a great challenge and the demands of another 2.5 billion people will have to be met by 2050. To achieve food security, a 60% increase in agricultural production is needed by 2050 according to FAO, 90% of which must occur through increased yields and cropping intensity. There are also growing demands on land productivity for livestock feeds and biofuel. New capacity is being established by the fertilizer industry through a global investment of some $90 billion so that by 2016 there will be approximately 250 new fertilizer processing units and 30 to 35 new phosphate rock mining operations worldwide.

IFA has adopted a new paradigm that encompasses human health in addition to yield and soil fertility improvement, profitability and the reduction of environmental impact. It means to consider nutrition security with all essential elements, besides pure food security, which focuses on enough availability of calories. Success stories so far include the use of zinc in Turkey and of selenium in Finland and New Zealand, but there is a need for scaling up.

In order to reduce the footprint of agriculture on the environment it is necessary to increase land productivity, because it minimizes further conversion from forests to arable land, which releases large amounts of GHG. Less conversion also preserves biodiversity. At the same time the nutrient use efficiency must be improved. This can be achieved first through good agricultural practices, because erosion and nutrient leaching are major processes that lead to nutrient loss of mainly phosphorus and nitrogen. Experiments in research plots have shown that the use efficiency of nitrogen can be increased to 60-80%, compared to an estimated 40% in farmer fields. The use efficiency has been raised in the last 3 decades in developed countries and now there are first signs that they are also increasing in countries like China. Phosphorus use efficiency in temperate soils is much higher and can reach up to 90% in the long-term, although in the first year of application it is usually low with 10-25%.

The fertilizer industry works on innovations in fertilizer types, and techniques, including slow release, stabilized, soluble and liquid fertilizers. However, at present there are only used on high value crops, because their high price prevents more widespread application. IFA promotes best management practices and in particular the 4R nutrient stewardship, which calls for fertilizer application with the Right product, at the Right rate and the Right time in the Right place. This requires improved knowledge transfer, notably in developing countries, which now account for two thirds of the worlds' fertilizer consumption. Inefficient government extension services call for new approaches to develop locally adapted management practices, so that farmers do not need to rely on blanket recommendations. Mobile phones are being used effectively in some areas for targeted agronomic advice.

There is an urgent need to restore soil fertility in Africa and to focus on nutrient depleted soils. It is estimated that about 40% of the 220 million ha of farmland lose on average 30kg of nutrients per ha and year (Figure 4). This amounts to a total loss of some 4 billion USD annually. For more information on IFA visit webpage www.fertilizer.org.

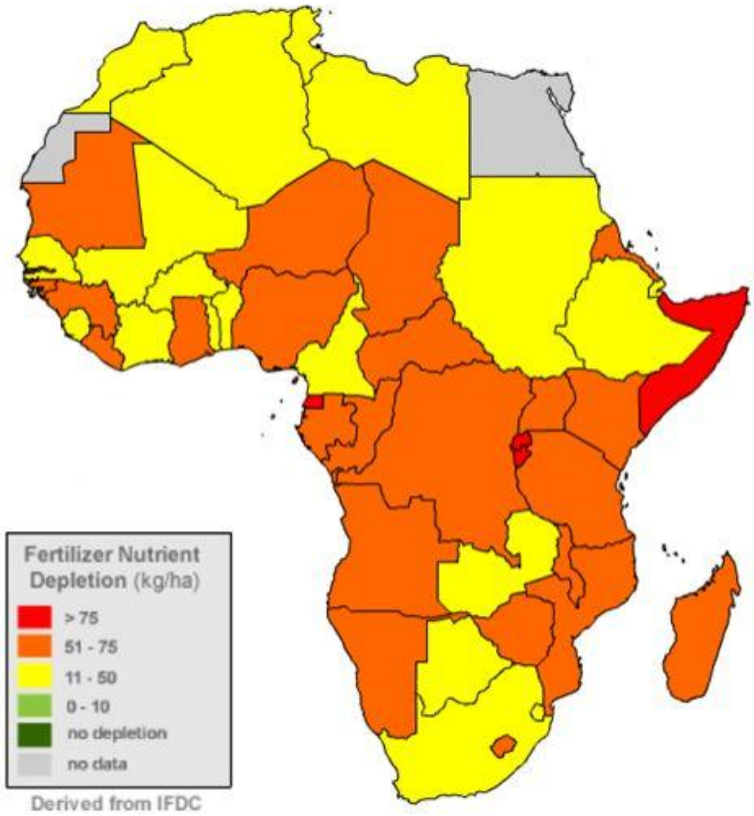

Figure 4: Global Fertilizer nutrient depletion at a Regional Scale in Africa (Source: IFDC)

3.2. Global Partnership on Nutrient Management (GPNM). *Anjan Datta, UNEP.*

The GPNM is a UN initiative with the goal to embrace governments, scientists, policy makers, private sector, NGOs and International Organizations to position nutrient issues on the International Development Agenda. Since the Green Revolution of the 1960s the use of inorganic fertilizes increased by nine fold for nitrogen and three fold for phosphorous. However, a large part of it is lost to the environment due to overuse, wrong application techniques, and inadequate crop management. As shown in Figure 5, global fertilizer use outpaced in relation to global yields by more than two fold during the period 1961-2009 (Save and Grow, FAO 2011). Nitrous oxide (N_2O) has 296 times the global warming potential of carbon dioxide and yet by the year 2030, N_2O emissions from fertilizer and manure are expected to increase from 35 to 60 percent. The distribution of nutrient loads is not uniform across the globe. Too much nutrients per ha of land exist in the Netherlands and Vietnam, Japan and the UK as opposed to too little in many African countries. According to a report by Johan Rockström et al (2009), the safe operating boundaries for the Earth have already been exceeded for three factors: biodiversity loss, climate change and human interference with the nitrogen cycle.

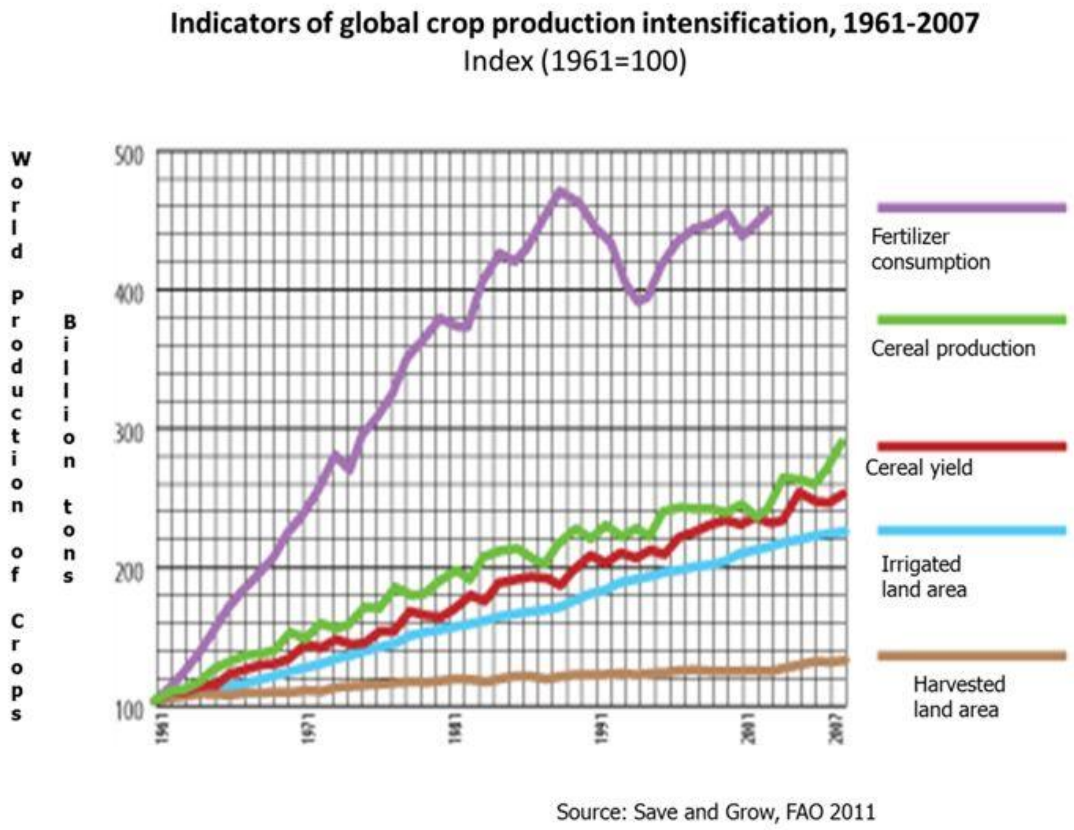

Figure 5: Global Fertilizer Use Efficiency (FAO, 2011)

The European Nitrogen Assessment in 2011 identified five key threats from excess nutrients, captured by the acronym WAGES; Water quality, Air quality, Greenhouse gas balance, Ecosystems and Soil quality. The economic cost of the global loss for ecosystem services is estimated to be equivalent to about $200 billion per year.

The GPNM publication "Building the Foundations for Sustainable Nutrient Management" (2010) expresses ''the nutrient challenge'' with respect to balancing societal needs for food and energy and a complex web of adverse environmental impacts. The greatest challenge is to achieve four wins concurrently: High crop yield, high efficiency of resource use, improved soil fertility, and enhancement of environmental quality. The GPNM aims to address this challenge by creating partnerships and advocacy among the stakeholders striving towards the goals of a global sustainable nutrient management. It will enable cooperation at global and regional levels, build consensus in promoting nutrient use efficiency and develop with stakeholders guidance, strategies or policies on sustainable nutrient management. The importance of the management of nutrients in the ecosystem on the global agenda has been emphasized in several international and governmental documents and outputs (UN SG's Oceans Compact, Rio+20 Outcome document, Manila Declaration, CBD Aichi Target 8). Indeed, there are many positive signals of governmental commitments. GPNM looks forward to collaborating with GSP for the development of appropriate public policies.

3.3. Challenges of Agro-ecological Soil Management and the Opportunity for Advanced SOM through Microbial Composting. *Tobias Bandel, Co-founder, Soils and More.*

The cost per ton to produce wheat in Egypt is expected to increase 65% by the year 2020 with conventional agricultural practices, according to the Sustainable Food Lab and Cool Farm Institute[1]. However agriculture is often associated with loss of soil structure and as a result high nutrient losses as well as increased energy costs and increased GHG emissions. Greater attention is needed to restoring soil quality as an important win-win.

The capacity of farmers should be built to analyze: i) What resources are being underused on- farm (C:N ratio, manure, residues, etc.) and ii) How to make more efficient use of all biomass produced on the farm (e.g. compost which also has important benefits in terms of pest and disease control, etc.).

Small scale controlled microbial composting can produce stabilized humus in 10 to 12 weeks with crop residue, manure and straw and it closes the nutrient cycle by returning nutrients to the soil. Micro-organisms are a major part of the process and contribute nitrogen and other nutrients by consuming and releasing nutrients stored in residues. Trials with compost tea in Egypt, India and Kenya have shown that after 15 days of microbial decomposition of organic residues, available nutrients increased five times and harmful nematodes decreased by 90%.

Footprinting of systems in terms of soil quality, GHG emissions, water availability, and sustainability can be very effective in developing niche markets for environmentally friendly products, e.g. Fair Trade, Rainforest Alliance, Marks and Spencers, (see www.soilandmore.com or contact info@soilandmore.com). Extension officers can also be trained in monitoring key parameters. Companies such as Unilever, Kraft, Heinz have agreed on a joint tool for farm level monitoring of agro-environmental impacts.

3.4. Need to Assess Societal Impacts of Environmental Policies. *Thorunn Petursdottir, researcher at the Joint Research Centre of the European Commission.*

Ms Petursdottir argued for the assessment of societal impacts of environmental policies when analyzing their effectiveness. Her research suggests a paradigm shift towards assessing the social outcomes of proposed management strategies as well as the economic and ecological outcomes. Possible indicators should address attitudes towards soil management strategies and behavior in regard to farmer implementation. Agricultural systems vary highly according to social, political and economic settings as well as in terms of natural sciences, so we need to consider how to effectively manage these interrelated dimensions.

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[1] The Sustainable Food Lab is a consortium of business, non-profit and public organizations working together to accelerate the shift toward sustainability; its' Cool Farm Institute provides a quantified, standardized decision support tool initially focusing on GHGs to enable millions of growers globally to make more informed on-farm decisions that reduce their environmental impact.

Sustainable development requires an alliance between people, governments, civil society, and private sectors (Figure 6). People must have the opportunity to influence their own lives and futures by participating in decision making and voicing their concerns. The socio-ecological approach integrates related social, economic and political systems.

Priorities for assessing the social impacts of environmental policies are: (i) Understanding the effects of social structure on agricultural sustainability; and (ii) Assessing attitudes of stakeholders and the efficiency of SSM implementation to determine sustainability of the system.

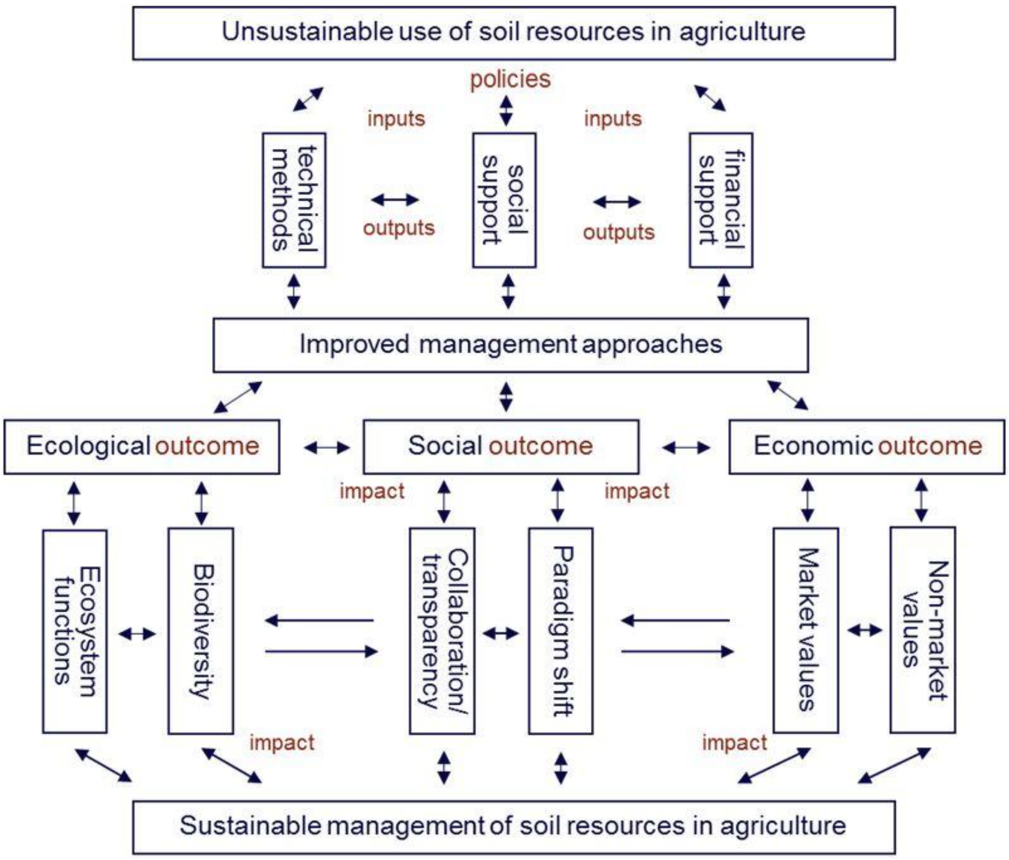


Figure 6: Evaluating Effectiveness of Agricultural Policy (Petursdottir et al. unpublished)

3.5. Issues raised in the plenary discussion

The foregoing presentations on the global status, challenges and priorities for sustainable soil management raised a number of comments and suggestions:

1. The need for governments and civil society to support the development of national soil policies (Nigeria).

2. The need to provide support to farmers regarding the high costs of fertilizers and to improve their access to agricultural inputs, by developing efficient input markets (IFA).

3. The need to improve nutrient use efficiency and carbon and nutrient cycling through the establishment of integrated agro-ecosystems / mixed crop systems. (Honduras)

4. To consider adding appropriate fertilizer use to the three principles of CA /no till systems (Brazil).

5. Linking soil vulnerability to climate change and to phase out subsidies which encourage imbalanced nutrient use.

6. The need to address trade-offs and regional differences e.g., climate change and C sequestration are more important for industrial countries than for developing countries that have other priorities such as land reform, yield increases, soil biodiversity management, etc. (ICRAF).

7. The need to carefully consider Nitrogen use efficiency. There is a need to raise Nitrogen to the same level of attention in policy as Carbon, because the two issues are so closely interlinked (UNEP).

8. The challenge today is to meet societal needs through improved nutrient use efficiency for enhanced agricultural productivity, while at the same time reducing environmental pollution.

4. Current Status, Trends and Priorities of Soil Management in Sub-Saharan Africa

4.1. Overview of the Status and Challenges of Sustainable Soil Management in Africa. *Bernard Vanlauwe, International Institute of Tropical Agriculture (IITA).*

Mr. Vanlauwe discussed the so-called "Coca-cola paradox": In 2010/2011, urea cost between 200-500 USD per ton on the world market, but 900-1,400 USD in Bukavu (DRC). Yet a bottle of Coca-cola costs between 1.5-2 USD in Europe, whereas in Bukavu it costs only 0.5 USD. How do we explain this disparity when the in country transport system is the same?

The main limitation to yield increases in Africa is nutrient availability. Many farms have nutrient depleted out-fields, which are too far away in terms of farmers' transport capacities to recycle crop residues and manure. Over time this has led to a high variability in natural soil fertility on the same farm. These outfields have been so depleted that they have become non-responsive to fertilizer application. Non-responsive soils mostly occur in densely populated, resource-scarce areas.

The importance of policy and good governance for agriculture is apparent in recent examples from Malawi, Rwanda and Kenya. The Comprehensive Africa Agriculture Development Program (CAADP) set a benchmark for agricultural spending by governments at 10% of the national total. Countries which have obtained this target include Burkina Faso (highest), followed by Niger, Guinea, Senegal, Ethiopia, Malawi, Mali and Ghana.

Attempts to resolve the soil fertility problem in Africa have changed over time. In the 1970s emphasis was put on purchased inputs (Sanchez, 1976). Then in the 1980s the focus shifted to biological management of soil fertility by introducing cover crops, such as herbaceous legumes and trees, as in alley cropping systems. Conservation Agriculture was developed in Brazil in the early 1970 and the first signs of no-till farming in Africa occurred in the 1980s. Large-scale adoption of CA has taken off in Brazil since 1990. Conservation agriculture integrates three main principles of crop and soil management: no tillage, maintaining soil cover greater than or equal to 30%, and cropping system diversification and crop rotation. The implementation of CA in Africa on a larger scale has faced important constraints. There are niches for full implementation of CA principles, but frequently crop yields and thus amounts of crop residues are too low to reach the minimum requirement of 30% soil coverage. Without sufficient coverage, no tillage can be more harmful than tillage, because it can result in soil crusting. The use of fertilizer to increase biomass production should therefore be a 4^{th} principle of CA in Africa.

The strategy in the 1990s in Africa was to overcome soil constraints by relying on biological processes and enhanced soil biological activity. Germplasm had to be adapted to adverse soil conditions. The optimization of nutrient cycling was to minimize external inputs and to maximize their use efficiency (Sanchez, 1994).

Recent thinking is oriented along principles of Integrated Soil Fertility Management (ISFM). ISFM is a step-wise approach that increasingly combines improved germplasm, mineral fertilizer, and organic resource management with local adaptation to fertilizer-responsive and less responsive soils, in conjunction with soil and water conservation practices to minimize erosion, improve rainwater harvesting and reduce evaporation losses. That will lead to optimization of fertilizer and organic resource use efficiency and crop productivity. ISFM can be seen as an entry point for a longer-term full implementation of all CA principles.

More understanding on farmers' strategies to cope with limited financial resources and access to fertilizers is needed. Yield and income are farmers priorities and should thereby be addressed first, through improved access to seed and fertilizers and SWC practices. Because income is a prerequisite to implement ISFM, it is of utmost importance for farmers to have access to reliable input and output markets to achieve effective and sustainable soil management in Africa.

A new approach, called "eco-efficient agriculture" (Keating 2012), is being developed by CSIRO in Australia for high-input systems. The desired outputs are weighed against undesired outputs, such as GHG emissions and nutrient loss. Consideration of both will shift the biological optimum for yield and the economic optimum downwards towards a risk-adjusted optimum.

4.2 Links between Soil Management and Food Security in West Africa. *Victor Chude, President of the Soil Society of Nigeria*

According to the African Union Commission (2005), the annual growth rate of food production in the continent is lower than the population growth rate. Food production must be increased by at least 4-6% annually in order to make up for this deficit and meet food needs of the growing African population. Indeed the African population is expected to increase from about 900 million today to 1.3 billion by year 2020.

Stocking (2003) reported that declining crop yields are exponentially related to loss of soil quality and soil management should take into account the variability of African soils. About 16% of Africa's land is considered to be of high quality, 13% of medium quality, and 16% of low quality. The remaining 55% is not suitable for cropping, but may support nomadic grazing. In West Africa, 48% of soils have low productivity and soil management issues include: soil erosion; salinization; flooding; organic matter decline; degradation of soil structure; loss of soil chemical quality; acidification; deforestation/ overgrazing and poor management. Nutrient loss rates (Stoorvogel and Smalling, 1990) were shown to be highest in Ghana, Nigeria and Ivory Coast.

Positive success stories on soil management for enhanced productivity and food security can be found in Nigeria, Mali, Ghana, Burkina Faso, Niger, and Chad. It has been shown that with good policy governance on environmental issues coupled with appropriate support to farmers with fertilizers, it is possible to turn a country from a net importer of maize to a major exporter.

Sustainable soil management strategies include: (i) Water productivity improvement; (ii) Soil fertility and micro-nutrient availability enhancement; (iii) No-till farming and CA; (iv) Adapting to climate change through use of drought resilient crops; (v) Use of innovative technology: Remote sensing to identify plant nutrient stress; the use of zeolites and nano-enhanced fertilizers; biological nitrogen fixation (BNF) and mycorrhizal inoculation; water saving and recycling technologies (drip irrigation, waste water use) and so forth.

Mr. Chude echoed Lal (2009) and concluded that if the soils in West Africa were judiciously managed and properly restored, there would be the capacity to grow adequate and nutritious food for present and future populations.

4.3. Status and priorities of soil management in Zambia. *Fredrick Kunda, Department of Land Reclamation.*

There are three main agro-ecological zones in Zambia (Figure 7).

- In Region I, Luangwa and Zambezi rift valley areas (14% of the land area), temperatures are high and rainfall is unpredictable <800mm, droughts and floods are common and there are highly erodible soils (Haplic Luvisols and Haplic Solonetz);
- Region II, includes a) the Central and Eastern plateaus of Zambia (28% of the land area), rainfall is moderate 800 – 1000mm, the climate more temperate and soils more

productive (Haplic Lixisols) and b) the semi-arid plains of Western Province (12% of the land area) are characterised by infertile coarse sands and alluvial soils (Ferralic Arenosols).

- Region III, North (46% of the land area) is prone to intense tropical rains (>1200mm/year) and high temperatures and soils are leached, acidic and with low fertility (mostly Haplic Acrisols).

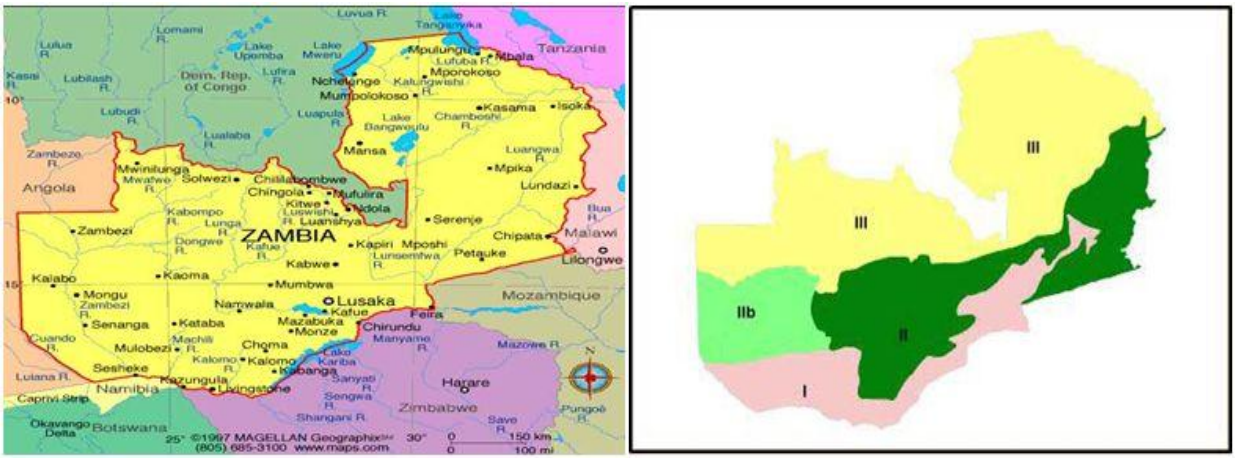


Figure 7: Agro-ecosystem zones of Zambia. Sources: Geography of Zambia and CFA, Zambia Branch Homepage

Shifting cultivation/slash and burn agriculture (*Chitemene* system) is the main agricultural system in Zambia with the main crops maize, cassava, millet and groundnuts. Provided that there is a long enough period of fallow, the slash and burn method would not be harmful to the soil. However, since the management of fallow is declining there is no re-establishment of nutrient and SOM levels. Instead the use of mineral fertilizers has increased, which is included in the Farmer Input Support Program through which about 20% of smallholder farmers access fertilizers. However, the use of Ammonium nitrate is causing an increase in soil acidity.

The current status of the soils in Zambia shows a need for soil fertility improvement. Soil moisture stress in the soils and drought are also causing low crop yields. In addition, poor agricultural practices also influence the productivity and quality of the soils. These include mono cropping systems, of maize in particular, continuous use of inorganic fertilizers without liming, and burning of crop residues. During land preparation, current ploughing practices lead to capping/hardpan formations with the initial rains. This causes runoff and interferes with emergence of the crops. The practice of soil ridging if not well managed along the contour can contribute to rill and gully erosion.

To respond to these challenges a number of institutions have collaborated with national partners and farmers to adapt integrated soil fertility management technologies. The best bet options being promoted include: (i) The use of green manure (Mucuna, Crotalaria, Sesbania, Tephrosia) and dual purpose legumes (such as cowpea) for soil fertility improvement, cover crop and human nutrition; (ii) The use of animal manures and compost for soil structure improvement and hence improved water retention and aeration; (iii) the use of improved fallows with Nitrogen fixing trees and shrubs, *such as Sesbania sesban, Tephrosia vogeli, Gliricidia sepium* and pigeon peas for 1-2 years to replenish soil fertility; (iv) Tree-crop intercropping e.g. maize and *Faidherbia albida* in high population areas with small land holdings. The greening of the Sahel across thousands of hectares (starting in Niger) is attributed largely to widespread farmer regeneration using such practices on their smallholdings.

Due to variations in weather and annual rainfall pattern, the effectiveness of conservation agriculture varies across regions and agricultural systems and over time. Summarizing, there are four key elements to adapt conservation agriculture in Zambia:

1. Cereal - legume rotations: the legumes (soybeans, groundnuts and common beans) improve N-input through nitrogen fixation and nutrient recycling
2. Targeted application of farm inputs placed closer to the crop, in restricted fixed locations, e.g. planting pits;
3. Leaving crop residues on fields after harvest (not burning them) hence improving water infiltration and preventing soil erosion;
4. Use of minimum tillage systems during the dry season enabling earlier planting for farmers.

A range of training materials, notably for conservation farming, are available. Information dissemination and promotion approaches are used including demonstration plots, farmer field schools, study circles, farmer exchange, training of trainers and media development.

4.4. Status of soil management in Nigeria. *Olatunji Ojuola, Department of Agricultural Land Resources*

Over 60% of Nigerian soils are characterised by sandy textured soils that are low in SOM and cation exchange capacity (CEC) and 46% of the soils have low productivity with low potassium and organic matter content ranging from 1% to 2.5%.

Poor soil management practices lead to soil and land degradation including soil erosion, salinization, flooding, desert encroachment and nutrient depletion. The use of fertilizers is often not adapted to the different soil and crop types and as a result is not efficient. However, through “improved” farming systems, with high quality seed/germplasm, correct applications of fertilizers and improved soil, water and biological resources management the area of highly productive soils could potentially be increased from 5% today to some 46% of the land.

The discovery of oil in Nigeria led to a major paradigm shift. The country was the largest exporter of oil palm in 1960s but this agro-industry collapsed over time. The need was recognised to jump start the agriculture strategy from subsistence farming to agribusiness: value chains were developed for 7 main crops: maize, cassava, rice, cocoa, oil palm, groundnut, soybean and cotton to decrease bottlenecks and provide inputs. Today Nigeria is the largest producer of soybean in Africa and has overtaken Brazil for cassava.

Meanwhile the agribusiness faces some challenges in moving forward. The farming population is ageing; the extension system collapsed and efforts are needed to link research institutions with farmers. In the 1990's, the Government together with FAO supported the Soil Fertility Initiative which conducted a stocktaking of soil information and maps, soil management issues, and soil productivity data and constraints and opportunities for promoting enhanced soil management. More recently Nigeria joined The African Soil Information Systems project (AfSIS) funded by the Bill & Melinda Gates Foundation for soil information systems development in order to target extension service delivery and address farmers' soil constraints.

4.5. Status and Priorities of soil management in South Africa. *Liesl Wiese, Agricultural Research Council.*

In South Africa various government departments are involved in soil protection through the legislation under the various mandates. These include the National Departments of Agriculture, Forestry and Fisheries (which holds the agricultural mandate); Environmental Affairs, Water Affairs, Rural Development and Land Reform, and Mineral Resources. Various parastatal institutions, NGOs, tertiary institutions and research institutions are also involved in efforts relating to soil protection in varying degrees. Although this extensive institutional setup is in place in South Africa, improved coordination of soil protection efforts and communication are needed.

South Africa is essentially a dryland country with only 10% of the country being classified as humid, which increases the importance of efficient water management and soil water protection in the country. South Africa has a dual agrarian system with a large number of small scale farmers and a much lower number of commercial producers. The challenge in terms of agricultural production is to strike a productive balance between the two systems. Most of the soils are slightly weathered (81%) and 30% are sandy. The majority of agricultural land use is used for grazing, with only 13.7% of the area being potentially arable, and 10% is actually cultivated.

Three major initiatives were undertaken recently (2009-2011) to assess the level of soil degradation in the country and respond. The first, the Land Degradation Assessment in Drylands (LADA) project (funded by the Global Environmental Facility (GEF) and executed by FAO during 2008-2011) supported the assessment and mapping of the status and trends of land degradation (types, extent, severity) and SLM (types, extent, effectiveness) at national and sub-national level, as well as their drivers, pressures, impacts and responses. This was followed by the development of a Soil Protection Strategy and an extensive Erosion Modelling project at national level. The results of these projects are well suited to inform decision making in terms of priority areas for improved soil management.

The challenges for soil management in South Africa are linked to unsustainable practices and lack of support and extension for small-scale farmers. The high cost of fertilizer and the limited livestock to produce manure aggravates the problem. The land tenure issue also strongly affects the management and the capability of improving these lands, leading to the degradation of soil physical, chemical and biological properties including: (i) Physical soil disturbances such as sealing, crusting and compaction increasing water run-off and decreasing water holding capacity of the soils; (ii) Soil nutrient imbalances through low application of fertilizers and low SOM content in arid areas and historical overuse of fertilizers leading to soil acidity. Also, acidity is a natural soil limitation in areas with high rainfall (Kwa-Zulu Natal), but liming is used to treat these acid soils.

The most important vehicle used in South Africa to address the soil degradation issues is the use of conservation agriculture. The main issues are:

- How to build and improve farmer-led experiments and demonstration trials using farmers' inherent capacity so that they take ownership of the process?
- How to strengthen quantitative and qualitative measurements to show success first hand on the ground? There is a need for statistically designed trials in small scale farming communities.

4.6. Soil management in Kenya. *Hamisi Mzoba, African Conservation Tillage Network (ACT), East Africa HQ, Kenya, www.act-africa.org.*

The ACT Network is a pan-African non-profit organization aiming to bring together stakeholders who are dedicated to improve agricultural productivity, through the sustainable management of natural resources in Africa's farming systems. The network is committed to mutual collaboration, partnership and sharing of information/knowledge. The headquarters are situated in Nairobi with offices in Ougadougou, Dar-es-salaam, and Harare.

The soils of Kenya are often characterized by low fertility. The productive lands are found in the highlands, coastal plains and the lake region and consist only of 1/3 of the total land with alluvial swampy and black cotton soils (river valleys and low lying lands) and volcanic fertile soils (highlands). The other two thirds are characterized as arid and semi-arid lands with low rainfall and are mostly used for grazing and livestock production.

To address low soil productivity of arable lands, soil management strategies and investments include:

- Integrated soil fertility management (ISFM) supported by AGRA Soil Health Program that is gaining momentum to promote use of organic manures and inorganic fertilizers with support of Kenya Agricultural Research Institute (KARI), Ministry of Agriculture, and TSBF-CIAT.

- Crop diversification
- Soil and water management measures: Contour farming and Conservation Agriculture – combining minimum soil disturbance, permanent soil cover, crop and cover crop rotations/associations (Figure 9)
- Rainwater harvesting and supplementary irrigation
- Greenhouse farming
- Agroforestry (Vi-AFP and ICRAF) mainly in Western Kenya.

CA is not adopted by many Kenyan farmers although it has the ability to improve soil fertility (increase in OM, soil biodiversity, water retention), decrease soil compaction, enhance drought resilience and sequester carbon. Under CA the C sequestration rate is low (0.05 – 0.2 tons/ha/yr), but if it were practiced by millions of farmers there is the potential to result in huge benefits.

There is a need to create coordination mechanisms among the dispersed partners in the country working towards sustainable management. This concerns MAFF, KARI, Kenya Soil Survey (KSS) alongside initiatives of FAO, UNEP, CGIAR centres, NGOs and the private sector. There is also a need to improve the difficult access of soil information in the country. Meanwhile, policies on agriculture and natural resources are many but not specifically focused on soils. Low soil fertility is a major factor endangering the food security of smallholder farmers in Kenya. A fertilizer and soil fertility policy is currently under development with a draft bill for the regulation of fertilizers and soil conditioners; and development of the Sessional Paper for Soil Fertility being discussed. The aim is to regulate the import, export, manufacture and sales of fertilizers and soil conditioners. The ACT Network sees the opportunity to make a difference through collaboration with GSP.

4.7. Overview of the Agricultural Transformation Agency (ATA) and Priorities in the Soils Program. *Sam Gameda, ATA, Ethiopia.*

ATA involves a set of complex partnerships with public, private, civil, development agencies, and the Ministry of Agriculture of Ethiopia which is the primary partner. The activities and role of ATA are aimed to: (i) Strengthen the capacity of the Ministry and other partners;(ii) Align objectives with national targets; (iii) Act as a high performance agent of change with strong analytical capacity and stakeholder engagement; (iv) Produce scalable solutions with tangible productivity and livelihood improvements; (v) Develop an approach that integrates gender and the environment in agriculture.

Ethiopia, with support from the Gates Foundation, undertook a diagnostic of its extension system, which was found not to be as effective as wanted. This exercise led to further analysis of soils and fertilizer use and suggested to integrate value chains with agricultural system approaches and policy initiatives to improve soil health and quality. The challenge to improve soil fertility and soil quality through this approach involve two types of bottlenecks:

(1) Soil level bottlenecks include the physical, chemical and biological limitations where organic matter depletion and physical degradation are the greatest (Figure 8). For instance, the Ethiopian Highlands with areas of high rainfall are characterised by the presence of acid soils (40%) and serious land degradation.

(2) Systemic bottlenecks include lack of soil information management inadequate technology development and distribution (e.g. inefficient fertilizer use), lack of value chain analysis and weak regulatory framework and management systems.

Figure 8: Soil level bottlenecks for transforming agriculture in Ethiopia (source ATA, expert input)

The current priorities in addressing systemic bottleneck involve investment in soil information and technology management. Presently AFSIS is investing in digital soil mapping combining soil survey and remote sensing in order to provide information on the distribution of soil properties and characteristics.

The investment in fertilizers has not yet paid off. The current average yield in Ethiopia is of 1,6 T/ha. While the use of fertilizers has increased by 10%, the yields have only increased by 5% between2003-2011 (Figure 9). Currently DAP and Urea are used according to the blanket application resulting in the less efficient use of fertilizers by crops. The government has responded to this challenge through the building of fertilizer blending plants to be able to cater for the specific properties of Ethiopian soils in terms of fertilizers. Shifting to row planting could be another major step forward.

To address the collaboration and organizational/management bottlenecks, a transition from current regional and national uncoordinated research institutes, soil laboratories with no data exchange and segregated extension services, will be made to a central soil research institute ensuring coordination between researchers. Some farmer training centres and on-farm demonstrations where farmers participate will also be planned.

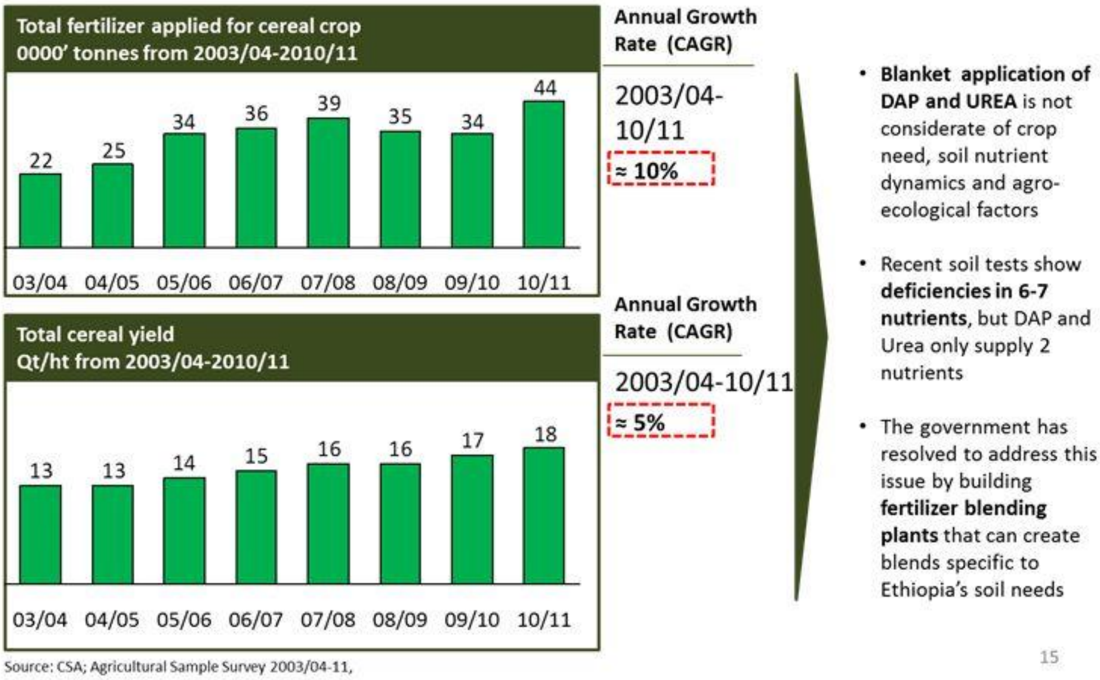


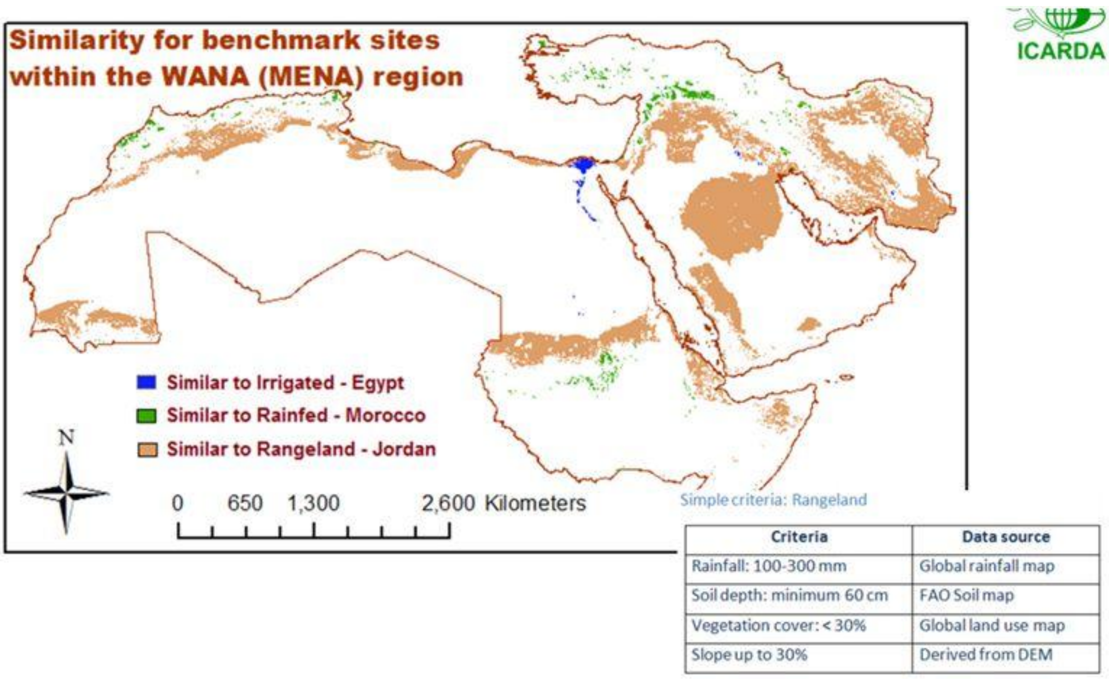
Figure 9: Fertilizer Usage and Yield response in Ethiopia (2003-2010)

5. Current status, trends and priorities of soil management in the Middle East and North Africa and Mediterranean Regions

5.1. Overview of the Status and Challenges of soil management in the Middle East and North Africa region (MENA).*Feras Ziadat, ICARDA (International Center for Agricultural Research in Dryland Areas).*

ICARDA is one of the 15 CGIAR (Consultative Group on International Agricultural Research) centres with the vision to improve livelihoods of the resource-poor in the dry areas of the world. It involves several partners: national agricultural research systems, advanced research institutes, development organizations and rural communities.

The challenges to achieve sustainable soil management in the dryland areas include limited availability of soil data, the need to improve mapping units and to achieve a more site specific management. There is a need to address the temporal and spatial changes, to empower institutional capabilities as well as facilitate collaboration among the countries. ICARDA is creating benchmark sites that represent dominant agro-ecosystems. Consequently the packages for improved agricultural and environmental management can be applied across areas with similar conditions (Figure 10). Benchmark sites are currently established in rain-fed agriculture (Morocco), irrigated agriculture (Egypt) and rangeland management in the driest areas (Jordan).



Criteria	Data source
Rainfall: 100-300 mm	Global rainfall map
Soil depth: minimum 60 cm	FAO Soil map
Vegetation cover: < 30%	Global land use map
Slope up to 30%	Derived from DEM

Figure 10: Transferring technology from Benchmark Sites to similar AEZ (Image courtesy Feras Ziadat)

The use of digital sol mapping (DSM) has improved the accuracy of predicted soil characteristics (chemical, physical and soil fertility related attributes for the surface and sub-surface soils) and has been demonstrated to be better than those derived from traditional soil maps. ICARDA has also designed a user-friendly toolkit (SWAT) to predict soil attributes to investigate the impacts of various Sustainable Land Management (SLM) options while also modeling runoff, sediment loss and soil nutrient loss at field and watershed levels.

The conclusion is that the similarity and suitability analysis, and the soil-landscape and environmental modeling are promising tools to cope with soil management challenges. They provide means to facilitate within and among countries collaboration and to provide regional coverage of data and information needed for sustainable soil management.

5.2. The State of Soil Management in the Mediterranean region. *Pandi Zdruli, CIHEAM (International Centre for Mediterranean Agronomic Studies), Bari, Italy.*

CIHEAM activities focus on training, research, cooperation and knowledge management embracing a number of member countries located in the Mediterranean: Albania, Algeria, Egypt, France, Greece, Italy, Lebanon, Malta, Morocco, Portugal, Spain, Tunisia and Turkey.

The Mediterranean landscape is strongly influenced by topography and results in topo-sequences of soils (catenas). A typical ''catena'' ranges from bare rock in the upper mountains, turning to Leptosols, Regosols, Luvisols, Vertisols in the upper and mid-slopes, and to Cambisols, Fluvisols and Gleysols in the lowlands. Gully erosion, rill and sheet erosion, nutrient mining, soil sealing, river bank erosion and forest fires all occur at different points along a catena. However, these same processes through deposition processes can also contribute to soil formation (Figure 11).

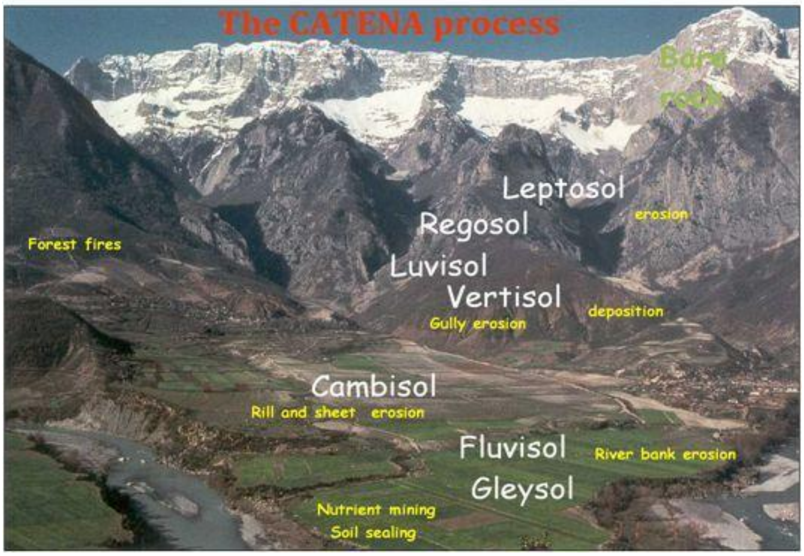


Figure 11: Typical Mediterranean CATENA (Photo courtesy Pandi Zdruli)

The major challenges for soil management in the Mediterranean region include soil sealing, soil erosion, salinization/alkalinisation and loss of soil organic matter and fertility decline. Due to higher population density the expansion of urban areas has increased and led to an expansion of “Technosols” and soil sealing, particularly in coastal areas. This phenomenon has drastically reduced the availability of arable land. Currently, around 14% of the land in the Mediterranean region is arable and 40% of the soils are already sealed. It is expected that sealing will have affected 50% of the soil by 2050 soils, if no actions are taken. The decrease of arable land due to soil sealing is estimated at equivalent to 275 ha per day in Europe. For instance, in Italy for the period 2000-2010 more than 300,000 ha of soils were sealed, in Lebanon 30,000 ha, and in Turkey 827,000 ha.

Human-made Anthrosols are also common where natural pastures have been modified and converted to agriculture. For example, in the Apulia region of Italy special equipment is used to break up stones and boulders in the fields and use the resulting “man-made” soil for intensive grape production.

Management techniques to address soil problems in the region include:

- Halophytic (salt resilient) crops such as Atriplex for saline soils;
- Strip contour farming and/ or terracing for water conservation and erosion control;
- Conservation agriculture including cover crops and no-till for efficient use of soil and water resources and sustainable productivity;
- Also indigenous technologies; such as “Zocos” in the Canary Islands, which are funnel-shaped hollows with horseshoe shaped walls to protect vines from strong winds and conserve moisture during the night.

Water scarcity in the Mediterranean region is widespread and 60% of the population benefits from less than 1,000m^3/person/year (Plan Blue 2008). Desalinisation of sea water in Malta, covers already 56% of the needs and the same trend is found in Cyprus and Israel. The occurrence of groundwater over-pumping in the coastal zone is causing salinization and soil salinity has become a common problem covering a total of more than 10,000,000 ha in the region (1 M ha. in each of Egypt, Algeria and Italy; 1.5 M ha. in Turkey and 3.4 M ha in Spain). Salinity problems occur especially along the coasts of Italy, Spain, Greece, Albania, Egypt, Turkey (Zdruli, 2012).

Sustainable land management practices to address these specific issues in the Mediterranean are can be multiple win-win as the adapted techniques can increase productivity, improve water use efficiency, optimize nutrient cycles, increase SOM, mitigate climate change, enhance protective vegetation cover and increase food security.

6. Current status, trends and priorities of soil management in the Asia and Pacific Region (including C. Asia)

6.1. Challenges and priorities of soil management in Uzbekistan and Central Asia. *Kristina Toderich, International Centre for Biosaline Agriculture (ICBA)*

Climate change has become the major threat to agriculture in Central Asia and the Caucuses region that concern eight arid, landlocked countries. The impacts of increasing temperature and unreliable rainfall patterns have led to an increased risk of drought and salinity. Moreover, the expansion of irrigated agriculture has led to an increase in saline soils in the region.

The major soil problems in this region include saline soils (36 million ha), shallow ground water (64 M ha), soil erosion (19 M ha), widespread low soil fertility, sodification and alkalinisation on carbonate bedrock, and low soil organic matter and nutrients.

The investments in the region have mainly been focused on Transboundary Water Resources Management rather than on soil conservation. An important example is the Aral Sea Basin (150 million hectares) which is exposed to extremes of heat and cold and faces challenges of desertification and climate change. This basin is the largest irrigated area in the world, but the lack of adequate water distribution planning has led to salinity and waterlogging in 90% of the basin. 40-60% of all soils are salt affected and 30% exhibit strong to moderate salinity (Qadir et al, 2009). The economic loss due to salinity is estimated to be about 2 billion US$/year.

The impacts on soil management are also related to the socio-economic context, notably: (i) Land reform has led to a generation of farmers with limited knowledge on soil management as well as to outmigration. (ii) Ageing irrigation infrastructure has increased soil salinization; and (iii) inadequate land use planning.

Ongoing research in bio-saline management involves the domestication of native wild halophytes for use in agro-pastoral systems. This has shown to increase soil carbon stocks, be of use on marginal lands, and provide renewable energy and feedstock. An example is salt tolerant sweet sorghum genotypes, which are inedible for humans but can be used for renewable bio-energy (biogas) and livestock feed. However, more social networks are needed to promote these bio-saline products. Other useful halophytic crops that can be industrially produced and marketed include liquorice and asparagus.

For restoration of saline land within agricultural systems, methods such as afforestation with deep rooting trees, and the use of salt-tolerant crops such as Alfalfa and Artemesia can be promoted. These techniques not only decrease the amount of salt in the soil, but also provide a source of income and food security for the local population. For the rehabilitation and protection of wetlands, riparian trees and shrubs can also be useful. In the marginal lands, the use of waste water is a good option to decrease the extraction from surface /ground water resources.

Conclusions for promoting sustainable soil management in the Region include:

- Participatory approach for bioremediation technologies integrated with aquaculture and use of marginal water resources.
- Integrated approach for soil health.
- Raise awareness of policy makers, develop environmental policy.
- Capacity building and knowledge sharing.

6.2. Status and priorities of soil management in Thailand. *Pitayakon Limtong, Land Development Department*

In Thailand the agricultural area is of about 27 million ha of which 11 M.ha is used for paddy fields, 5 M.ha for field crops (cassava, sugar cane and maize), 4.5 M.ha for perennial crops (para rubber, oil palm and eucalyptus) and 1.5 M.ha for orchards. Thailand has two major climate regimes: the Savannah and the Tropical monsoon climates, which divide the country in two agro-ecological regions that differ widely in socio-economic conditions and agricultural management. The edaphic soil conditions vary between the regions, and mainly include Ultisols (42%), Entisols (33%), Inceptisols (9%) and Alfisols (9%). Only about 16% of the land is suitable for agriculture, while 51% of the land is characterised by degraded and unfertile soils and 29% are located on steep areas.

The major soil management problems in the country are the low organic matter on 60% of the land, soil erosion and salinity. The challenges for soil management vary according to the different soil conditions:

- Sandy loam soils: deforestation and shifting cultivation
- Sandy soils: low fertility and soil organic matter and vulnerability to erosion.
- Clay soils: high fertility (rice paddy) but also high acidity
- Shallow soils: high risk of erosion and loss of productive lands

To face these challenges a large number of conservation measures are promoted, these include: (i) Re-establishment of organic matter and nutrient management through the use of inorganic and organic fertilizers, microbial activators, green manure, intercropping, agroforestry, mulching and minimum tillage; (ii) Prevention of soil erosion through conservation practices as strip cropping, use of cover crops, Vetiver grass, and perennial crops as well as hillside ditches, terracing and farm ponds for dry season water storage; (iii) Control of salinization in affected soils through leaching of salts and use of salt tolerant crops: *Eucalyptus, Sesbania, Acacia* and Dixie grass; (iv) Management of acid-sulphate soils in coastal lowlands through organic farming, application of dolomite or lime (6t/ha), organic matter application (rice straw incorporation, green manure) and fertilizers, water management and use of Fe and Al tolerant crops, (v) Management of sandy soils to improve water retention through the application of organic matter (rice straw and compost) and in shallow soils through hole/pit planting with organic matter, mulch and in some cases tree planting.

Currently there are many extension activities and technology transfer by the Land Development Department (LDD), Ministry of Agriculture and Cooperatives for the promotion of sustainable agricultural management. These include:

- Land use planning, soil analysis, soil improvement and conservation, land use management and socio-economic survey
- Analysis of soils, water and plant at laboratories and in the field (mobile units), including soil improvement materials
- Construction of farm ponds for soil and water conservation (cost sharing)
- Supporting soil improvement and soil and water conservation (Vetiver grass, microbial activators, green manure seeds and so on)
- Establishment of "soil doctors" as volunteers in all villages throughout the country to assist LDD staff

6.3. Status, trends and priorities in soil management in New Zealand. *Alison Collins, National Land Resource Centre (NLRC)*.

In New Zealand, about 55% of the land use system consists of agriculture, forest and horticulture. Agriculture contributes 25% of the gross domestic product. The agriculture production is regulated but not subsidized in the country. The landforms in the country are geologically young and show a high variability of soils, the most common ones are brown and pumice soils (NZ soil order).

There is increased awareness on environmental pressures on the water quality and the need to mitigate GHG emissions. In addition, there is also a high concern that productive and fertile soils are being currently sealed through urban expansion. New Zealand soil management challenges include: (i) Erosion rates average 10 times the global average; (ii) Over-irrigation in soils that are not suitable for irrigation i.e. stony, thin soils; (iii) "Tar sealing" by which process arable land is lost through urbanization

Solutions to these challenges include the need for:

- Precision technology (getting more from less) in irrigation, fertilizer use and effluent management.

- Creating multifunctional landscapes - diversification for increased resilience to threats (natural and economic)
- Using waste as a resource – e.g. metal waste to fortify crops
- New socio-economic collaborative management systems with high value activities on productive soils. There should be fragmented among multiple enterprises; Also 'terroir' approaches with shared capital infrastructure and co-governance.

The New Zealand Government created the National Land Resource Centre (see http://www.nlrc.org.nz/home) and also established the Land and Water forum with science, business and governmental collaboration to guide sustainable land use among multiple sectors. In addition, the National Science Challenge is an initiative which uses investment to build the evidence base for sustainable land management.

Priorities for sustainable soil management in New Zealand include:

- Managing soil for both economic growth and environmental protection e.g. viewing waste as resource;
- Embed soil protection into business/primary industry best practice: requires socio-economic collaboration and Infrastructure creation;
- Capacity development: preventing erosion of knowledge, codifying knowledge and training personnel;
- Build evidence base through investment in science
- Increasing soil literacy through public engagement;
- Harmonizing with international initiatives;
- Development of a national policy statement on soil /land (needed).

6.4. Status and priorities of soil management in Japan. *Kazuyuki Yagi, National Institute for Agro-environmental Sciences.*

Japan consists of more than 6,800 islands along the Pacific Coast of East Asia. The climate varies from Pacific summer monsoon to Siberian winter monsoon. The land use in Japan covers about 60% forests and 12% of agriculture systems. The major soils include Fluvisols (30%), Andosols (24%), Brown Forest Soil (8%) and Peats.

The priorities in soil management in Japan include:

- Soil fertility management: soil organic matter and manure
- Environmental assessment for soil contamination (heavy metals, organic pollutants, phosphorus, radionuclides) and for soil carbon sequestration.

- Soil information for food security : soil surveys for improved fertilizer application through long term experiments on typical soils in each prefecture (T. Ota, NARO 2011) and 20,000 soil environmental monitoring sites and producing maps of soil erodibility, soil C, radioactivity etc.
- Capacity building: networking at national and regional levels, for example, among research institutes (national agricultural and forest institutes, experimental stations, extension stations), policy bodies (MAFF, prefectural government) and land users (Associations of producers, etc.).

The challenges for soil management in Japan include:

- The development of measures to reduce environmental risk (climate change, nutrient imbalance, radioactivity and heavy metal contamination);
- Sustaining soil fertility through environmentally sound agriculture;
- Improving soil information for food security and raise awareness about soil knowledge and management for future generations.

7. Current status, trends and priorities of soil management in the Latin America and the Caribbean region

7.1. Soil management in Argentina. *Maria Beatriz (Pilu) Giraudo, Vice-President of the Argentinean No-Till farmers Association (AAPRESID).*

Founded in 1989, AAPRESID focuses on: (1) The promotion of No-Till systems in order to achieve economic, environmental and socially sustainable agricultural activities; (2) Technological, organizational, and institutional innovation; (3) Commitment to interacting with diverse public and private organizations; and (4) Achieving integral development of the nation.

In Argentina there are currently more than 27 million hectares under conservation agriculture, equivalent to 78.5% of the total cropland. This area is under No-Till but it requires urgently the adoption of all the Good Agronomic Practices (GAPs) in order to reach sustainability (no tillage and cover crops, crop rotation, nutrition, integrated pest and responsible agrochemical management, good livestock practices). The benefits of conservation agriculture include:

- Soil organic matter increased doubled, improving soil structure and porosity,
- Soil erosion reduced by 90%,
- Water evaporation reduced by 70%,
- Use of fossil fuel reduced by 40%

- Yields and efficient water consumption doubled under a proper fertilization level (balanced NPK applications) compared to the control without fertilizer (a 2 year crop rotation of maize/wheat/soy bean (3 crops) produced on average 10 t/ha/year over the last 5 years).

The amount of crop residues that soils should receive is determined using simulation models. For example it is estimated that 4.3 t.C/ha/year (about 11,000 kg of crop residues) will be needed to maintain an average value of 2.5% of SOM under continuous no till system.

Conservation Agriculture systems allow improved use of water, air and nutrients through: (i) Root growth (type and quality of exudates); (ii) Increased OM quantity and quality (microbial biomass –mineralization rate and C, N and P cycling) and (iii) No till (enhanced soil structure porosity, soil aggregates and rooting -biopores for improved air and water flow)

CA is a gradual process that restores and optimises soil functions over time:

- Initial phase: 0-5 years: Low OM and residues, soil structure regeneration, microbial activity increases, more need for nitrogen.
- Transition phase: 6-10 years: Organic matter accumulation, more residues > soil aggregates and microbial activity, N immobilization > mineralization and P accumulation
- Consolidation phase: 11-20 years: Increase of residues lead to C accumulation in the soil; > available water in the soil; N mineralization > immobilization; Increase CEC > nutrient cycling
- Maintenance phase: 20 years +: Continuous flow of N and C; High residues > available water in the soil; High nutrient cycling > N and P availability

7.2. Status and needs of soil management in Central America. *Carlos Gauggel, Soil scientist at Zamorano University, Honduras.*

In Central America, national and foreign investors acquire ownership of fertile and high productive areas that are used for commercial plantations, while the remaining marginal lands are left for subsistence farming. This situation is due to the lax government policies on land use and results in the fact that the whole region is obliged to import food. The most important crops produced commercially for export are: coffee, sugar cane, vegetables, bananas, bio-fuels and oil-palm. Another concern lies in the massive migrations from rural to urban areas or to very marginal lands/soils which are in need of soil conservation and intensive inputs (fertilizers, irrigation, etc.) and technical support. Currently NGOs, cooperatives, international institutions and foreign governments are providing support for sustainable soil management.

Challenges to soil management include:

- Government policies on land use, ownership and agrarian reform;

- Demand for agriculture land ;
- Lack of soil resource information and technical assistance;
- Inadequate local policies and lack of compliance with local laws;
- Few economic resources available to farmers.

In Central America, Costa Rica has the most advanced legislations and working programs in land use management. There is also a developed extension service where research institutes transfer technology to the farmers. In Honduras, on the contrary, soil management has the lowest government support, and private institutions and companies play a key role to provide soil research and generate information. However, in most cases, this knowledge does not reach the individual farmer. In Guatemala and El Salvador some government and private efforts have been made towards the improvement of soil productivity and sustainability. In Guatemala soil mapping has been undertaken at detailed level which will be useful for soil management and agricultural development.

Soil management needs and priorities include:

- More information on soil resources.
- Zoning of lands for their proper use.
- Compliance with the land use laws.
- Technical assistance in soil management quality, and as a source of carbon storage.
- Make economic resources available to farmers and users.

7.3. Status and challenges of soil management in Peru. *Julio Alegre, President of the Latin American Soil Science Society*

In Peru the topography varies drastically from the highlands to the coast and the rainforest. Soil limitations are found in the coastal areas where exposure to drought and salinity is common and in upland Ultisols that show a high risk of physical and chemical degradation.

Challenges for soil management in Peru include:

- Lack of appropriate land for crop productivity expansion;
- Unsustainable agricultural practices such as deforestation and land conversion of rainforest to agricultural land, through slash and burn system (150,000 ha/year deforested) and for use of fences (500 trees/year);
- Coca plant production is a very valuable crop and hard to compete with (passion fruit is the only crop that is more valuable).

Conservation measures employed in Peru include:

- Terracing - an ancient and widespread system (Figure 12)
- Agroforestry is widespread (Eucalyptus species are very popular)
- Alley cropping decreasing soil erosion by around 93% (erosion can reach 69 tons per hectare) (Alegre 1996).

Figure 12: Terrace Building in Peru (Photo courtesy of Julio Alegre)

7.4. Status and priorities of soil management in Brazil. *Rafael Fuentes and Ademir Calegari, Agronomic Institute of Parana.*

Brazil has seen an agricultural transformation from low production and yields, rural poverty and no food security before the 1970s to a modern system based on scientific innovation (Figure 21). Today, Brazil is an agricultural powerhouse and 1st in the production of orange juice, sugar, coffee; 2nd in the production of beef and soybeans, and 2nd in the production and use of ethanol as a fuel. According to FAO, Brazil has the largest ratio of available agricultural area to occupied area (USA is 2nd) .

In the 1970s, soil degradation, rill, sheet and gully erosion, and sediment pollution were common. As of 2006, 48.8% of agricultural land in Brazil is under no till farming. Yield has increased 151% with only a 31% increase in area across Brazil. Conservation agriculture can be achieved without herbicides, but needs large quantities of biomass.

Brazil's commitments toward the Kyoto Protocol and Copenhagen negotiations (COP-15 UNFCCC) include:

- Degraded pasture recovery
- Integration of crop/livestock/forest
- Increase in no tillage system
- Biological nitrogen fixation
- Forest planting and
- Animal residue treatment.

Priorities and commitments for soil management in Brazil 2010-2020 (UNFCCC):

- Less expansion of agricultural areas
- Less deforestation
- No-till quality improvement (8 M ha 10-20 M t.CO_2 equiv.)
- Recover degraded pastures (15 M ha – 83-104 M t.CO^2 equiv.)
- Integrated crop/livestock/forestry systems (4M ha. – 18-22 M t.CO_2 equiv.)
- Increase forest planting (3 M ha)
- Increase biologic nitrogen fixation (5.5M ha – 10 M t.CO_2 equiv.)
- Adequate destination of manures – treatment (4.4 m ha – 0.9 M t.CO2 equiv.) expansion of irrigation.

7.5. Status and Challenges of soil management in Haiti. *Donald Joseph, Ministry of Agriculture, Natural Resources and Rural Development.*

In Haiti agriculture is the leading economic activity, employing 46% of the current labour force, sustaining 70% of the population and contributing to 28% of the gross domestic product. The forest cover is extremely low at 1.5% to 2%. The limiting factors for agriculture include the topography classified as rough terrain with steep slopes exposing the soils to erosion and runoff risks. The soil distribution shows a great variety due to the geomorphology and climate. However, calcareous soils from sedimentary rock predominate as well as materials of volcanic origin.

The challenges facing soil management in the country include: demographic pressure; soil degradation (Figure 13); deforestation; and decline in productivity leading to expanded area under cultivation. In addition, the consequences to productivity loss result in a decrease in water availability reduced domestic energy production and increased costs.

Soil erosion is a major challenge for the soils in Haiti. A World Bank study (1990) on the management of natural resources in the country estimated soil losses for some watersheds ranging from 7.5 M to 750 M t/ha/year with common losses of 12 to 150 M t/ha/year in many parts of the country. Consequences of these include: loss of productivity in rainfed systems; lower productivity and profitability of investments in irrigated systems; decrease in quantity and quality of water for domestic and industrial use; Reduction in domestic energy production and increased cost; also increased risk of damage to infrastructure, and reduced potential for coastal areas.

Watershed management is promoted with 3 main objectives: (1) to reduce the vulnerability of river basins both upstream and downstream (education and equipment); (2) to protect infrastructure for economic production; and (3) to protect property and lives. The priorities for soil management in Haiti include: (1) Investment in infrastructure and equipment for farmers; (2) Provision of materials/ inputs-planting material; (3) Applied research; (4) Market research; (5) Pest control techniques and quality control; (6) Legal framework to provide incentives for investment; and (7) Access to credit for processing.

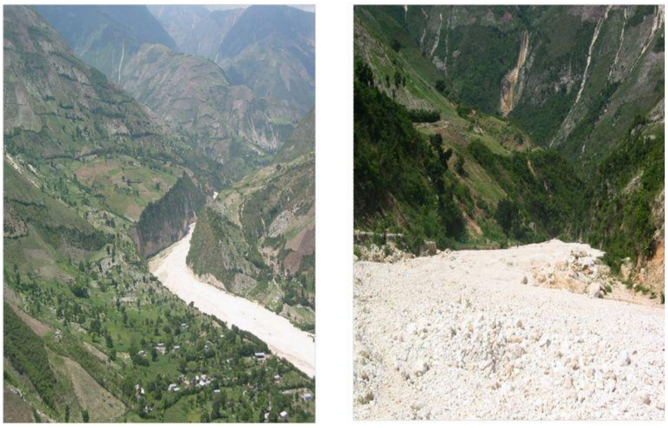


Figure 13: Soil Erosion Processes in Haiti (Photo courtesy of Donald Joseph)

8. Current status, trends and priorities of soil management in North America

8.1 Status Challenges and priorities in soil management in the United States. Charles Rice, President American Soil Science Society

Soil scientists in the US are working to actively engage politicians through a "Soils Caucus" where scientists meet with lawmakers to inform them about soil management.

The challenges for soil management in the USA include:

- Food and energy Security: site specific solutions to optimise ecosystem services;
- Climate change: identify processes and management practices to reduce GHG emissions

- Waste treatment and water quality, including urban and rural storm water and industrial water;
- Generating soil benefits to human and ecosystem health including deactivating pathogens and preventing water contamination;

Drivers of change include: (i) Grain, fuel and land prices are at an all-time high (20% increase); (ii) Decreased political and financial support for the Conservation Reserve Program land maintained in conservation under grasslands through government incentives is being taken out of the scheme (iii) Climate change is a reality and is causing a deepening drought in Central USA and a serious risk of return to 1930's Dust Bowl conditions: even under conservation agriculture farmers are facing exposed soil and wind erosion (Figure 14).

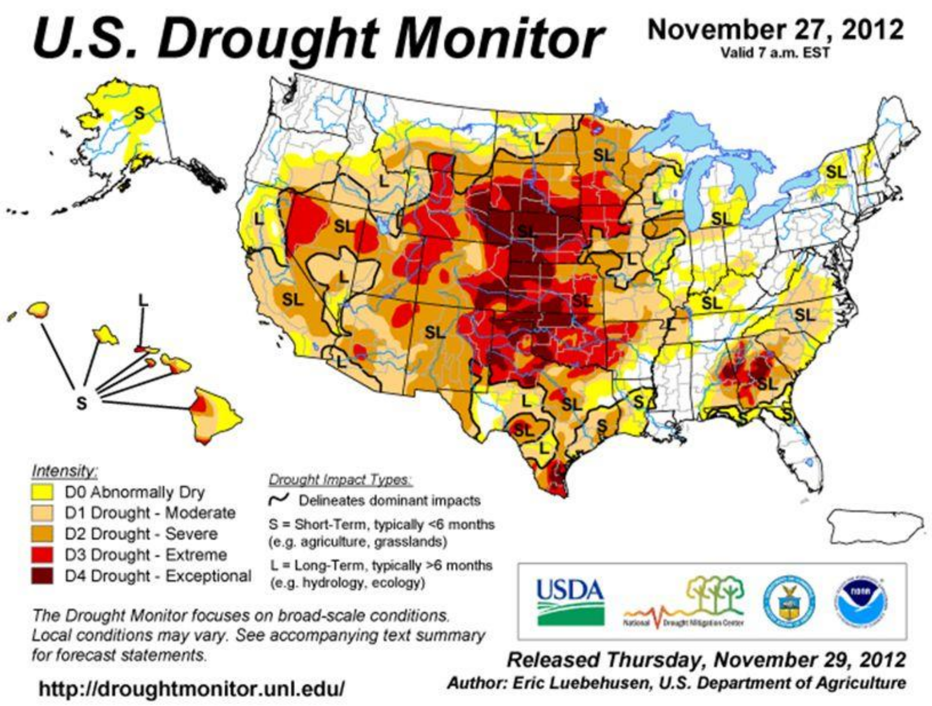


Figure 14: Current US drought conditions. USDA

The practices to mitigate and adapt to climate change include:

- Erosion prevention, irrigation, infrastructure efficiency
- Diverse cropping systems to adapt to climate and pest and diseases
- The use of drought tolerant crop varieties
- Synchronization of planting and harvesting operations with the water cycle or increased water use efficiency (WUE)
- Valuing agricultural commodities for low water and environmental footprint/traits

- Soil C sequestration to improve ecosystem functions
- Increase N-use efficiencies for cropping systems

Sustainable soil management requires: (i) Advocacy and teaching the importance of soil, in particular the value of soil carbon; (ii) Communication to link science and land managers; (iii) Development of long term records and programs; (iv) Training and mentoring of personnel to build capacity; (v) Investment in research - pays dividends in the long term.

9. Current status, trends and priorities of soil management in Europe and Eurasia

9.1 Status and priorities of soil management in Russia. *Pavel Krasilnikov, Eurasian Centre for Food Security.*

Since 1990 the system of land tenure changed radically from large farms of common use to a complex system of state, collective and private tenures of different sizes and status. The major problem lies in that the soils in Russia are considered to be real estate only, rather than a natural resource. The current state of agriculture includes market freedom, weak producer and social protection, loss of scientific background and a dependence on imported technology. The greatest challenges which vary from one area to another include water erosion and scarcity, salinity and low organic carbon content. A National Soil Atlas of Russia was produced in 2011 with mapping from 1:2,500,000 to 1:60,000,000 scale (Figure 15). The priorities for soil management in the future include placing an emphasis on Conservation Agriculture and Biological soil management.

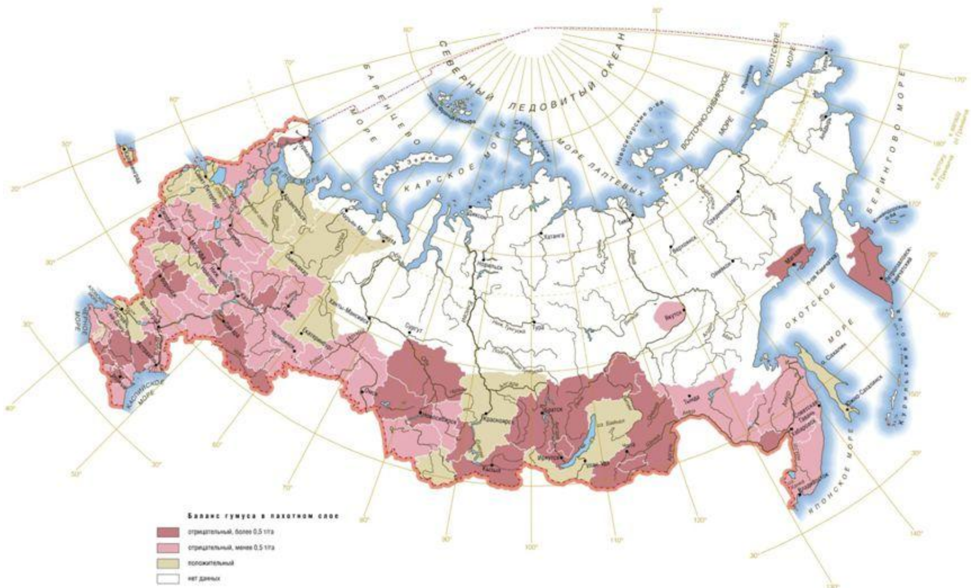


Figure 15: Low Organic Matter in the Russian Federation (High OM-pink to low OM –white) Adapted by Krasilnikov from National Soil Atlas of Russia

9.2. Status and priorities of soil management in the United Kingdom (UK). *Helaina Black, President of the British Society of Soil Science (BSSS) / soil ecologist, James Hutton Institute, Aberdeen.*

The land use system in the UK consists of 20% arable land, 50% grassland, 20% forest and 10% natural land. The policies involving soil management in the region are complex since soil governance is fragmented countrywide by region and institution: (1) *England*: Natural Environment White Paper, DEFRA soil policy team, ADAS commercial agricultural development and advisory service; (2) *Scotland*: Scottish Soil Framework and Land Use Strategy; (3) *Wales*: Natural Resources of Wales; (4) *Northern Ireland*: Agrifood and Bioscience Institute.

Legislation such as the Good Agricultural and Environmental Conditions, the Water Framework Directive, the International Plant Protection Convention (IPCC) on pollution prevention, and laws on Biodiversity Conservation tend to work towards the same goals and overlap with each other. Policy governance monitoring includes the sustainable use of soils, forestry standards, organic soil protection and reducing GHG emissions.

Soil management policies are low on the UK agenda, while air, climate and biodiversity issues are more accessible to the public and policy makers. Research is mostly privately driven and country-funded (not for UK as a whole). Since the 1980's the Government stopped funding for soil surveys. Over time there has been a change of priorities, from agricultural production and food security in the 1940's to environmental quality, such as water, pollution and biodiversity issues today. Towards 2020 the emerging priority will lie on ecosystem services and the food, water and energy nexus.

There are 4 main categories of Technical issues, threats and opportunities in the UK:

1. The excess of nutrients in agricultural soils, in particular N and P, has been raised as an important matter. Several areas have reached critical limits of nitrogen levels resulting in poor water quality, higher GHG emissions (N_20) and limitations to the soil use and management. This in turn affects the state of the soils and its productivity. Improvements in nutrient management will provide benefits through cost savings of fertilizers, contribution to climate change mitigation through reduced NO_3 and reduced costs of water purification.

2. Deficiency in soil organic matter (SOM) is a problem in agricultural soils because it leads to degraded soil structure, especially in peat soils. However, there are opportunities emerging for the re-establishment of soil organic matter and carbon restoration. These involve developing maps of C-poor and C-rich soils and planning tools and incentive mechanisms for carbon sequestration and reduced emissions. Risks for drought and waterlogging in agricultural soils have increased, affecting the costs of production through loss of yields, sedimentation, the need for irrigation systems and threats to biodiversity conservation. Opportunities for soil moisture management lay in target

irrigation, crop selection and offsite benefits of flood mitigation through payments for ecosystem services.

3. Threats involving soil physical properties include compaction, erosion and landslides within agricultural systems. The consequences of these lead to water quality issues, waterlogging, mechanical impedance, build-up of sediment and result in a loss of productive area. Opportunities to these challenges lie in investment in soil restoration, increase in productive area and off-site benefits of water quality and flood mitigation.

4. The agricultural soils have currently very low concentrations of living organisms and these need to be increased through ecological farming methods. Efforts are also ongoing to improve soil biology properties. The opportunities regarding enhancement in soil biology will lead to an enhancement of soil quality, mitigation of GHG emissions and decrease of biodiversity losses.

The ecosystem services can be presented as a trade-off system which seems similar to the analysis done by GLADIS for land degradation (FAO 2011) using multiple indicators for areas where economic, social and environmental costs can be compared (Figure 16)

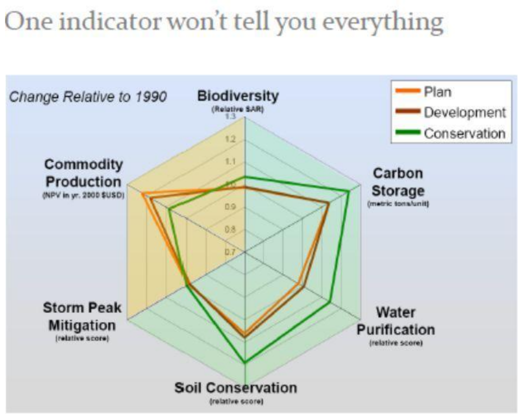


Figure 16: Ecosystem services analysis and trade-offs (Source WCMC)

9.3. Soil Issues in Italy, Maria Dalla Costa (ISPRA)

Soil related problems in Italy include:

- Soil sealing has increased from 2.7% in 1950 to 6.6% in 2010.
- Moderate to severe erosion is present across 30% of Italy's land surface.

The largest contributing factors to soil degradation are steep slopes, overgrazing and poor management practices.

10. Prioritization and Preparation of a Joint Plan of Action

10.1 Working group Discussion Process

The process of developing a GSP joint plan of action for this Pillar on sustainable soil management (SSM) requires first an agreement on the definition of sustainable soil management in order to set the scope for the pillar and to develop a set of guiding principles for it. The process should identify and take into account the main challenges and priorities in countries and regions as laid out in the preceding regional and national presentations and discussions.

Text box 1: *Definitions of sustainable land management*

UNCED, 1992: The use of land resources, including soils, water, animal 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 **World Bank, 2006**: A knowledge based process that helps integrate land, water, biodiversity and environmental management (including externalities) to meet rising demands while sustaining ecosystem services and livelihoods.

Participants were divided into three working groups with representatives from each main region, to focus on the three main topics, each group received a set of questions and issues to guide their discussion. The working groups dealt with the following issues:

WG 1. Knowledge and information for promoting sustainable soil management (SSM) practices (Implementation);

WG 2. Participatory research for adaptation and wider adoption of SSM (Evidence base);

WG 3. Policy and institutions for SSM (Enabling Environment).

The aim was to initiate the development of a comprehensive strategy for the Global Soil partnership (GSP) to promote the sustainable management of soils worldwide.

10.2. Knowledge, Information and Capacity Development for Promoting SSM (Implementation)

<u>Working Group 1</u>

- Pandi Zdruli, CIHEAM (chair)
- Carlo Ponzio, Italy (rapporteur)
- Pilu Giraudo, AAPRESID Argentina
- Feras Ziadat, ICARDA, Syria
- Fredrik Kunda, Zambia
- Hamisi Mzoba, ACT Kenya
- Satira Udomsri, Thailand
- Pitayakon Limtong, Thailand

- Alexander Schoning, GIZ, Germany - Sally Bunning, FAO Land and Water Division

The working group identified (i) the required improvements needed in existing SSM documentation and tools (ii) the main stakeholders for whom these tools should be adapted and (iii) a stepwise approach to promote and implement the SSM process.

1) **Documentation and Tools are required:**
   (a) To assess and document systematically the cost-benefit of SSM technologies and approaches including local innovations and modern scientific advances.
   (b) To comprehensively review and identify suitable practices for different agro-ecological zones (e.g. using WOCAT tools, impact assessment)
   (c) To build and share common information and tools for agro-environmental monitoring with stakeholders at various levels- international, national, project and private sector.
   (d) To develop a curriculum and training for assessment and long-term monitoring:
      - in the use of systemic approaches (farming system, ecosystem services),
      - in technical advances such as conservation agriculture,
      - in land use zoning and accurate digital soil mapping and information for accurate and targeted advice
2) **Stakeholders/Target Groups** for whom capacity development and information packages for SSM need to be addressed/ tailored include (a) Farmers and farmers organizations; (b) Decision/policy makers and community leaders; (c) Extension system (Government, NGOs, private sector) and technical sectors; (d) Research and academia; (e) Primary and secondary schools and (f) Civil society (including consumers).

3) A Participatory stepwise process to promote the effective uptake of sustainable soil management practices:
   (a) Make an inventory of local practices: through farmers leaders, identify and prepare an inventory of the “best” practices and innovations introduced and used by farmers to cope with existing soil limitations.
   (b) Characterize the land users (e.g. small holders, medium and large commercial farmers) and understanding the particular needs of each group. Understand the constraints to adoption of SSM practices and examine the reasons why some farmers do not adopt sustainable practices whereas others do: there may be technical, social, economic reasons. Tools are needed to help assess and understand lack of adoption
   (c) Identify in each group willing farmers to test and validate specific and integrated management practices and provide packages of SLM options to suit different land users and site conditions.
   (d) Establish mechanisms for farmer to farmer learning and dissemination of effective, economically-viable, practices (e.g. Farmer field schools, exchange visits etc.).

(e) Mobilize youth in modern agriculture: Involve young people and demonstrate that agriculture can be a viable business option as well as providing food security and a reliable livelihood.

(f) Assess and explain multiple benefits and highlight economic returns. It is necessary to develop and promote the use of tools to assess the multiple benefits of a certain practice. It is also important to highlight actual and potential (i.e. in the short and longer term) economic return from the application of best soil management practices.

(g) Develop a systemic /ecosystem approach to design SSM from individual farm to landscape level that addresses social, economic and environmental dimensions through assessing the provisioning, socio-cultural and regulating services generated (rather than just a commodity / market driven process).

(h) Ensure public support for adoption and scaling up: ensuring that the land users receive appropriate assistance by local governments/municipalities to adopt the SSM innovations and that incentives are established for scaling up across agro-ecological zones and at national scale. This requires a public level of support at various levels for promoting SSM; for example a tax discount is offered to farmers in Argentina when implementing SSM. Opportunities can also be identified for cost sharing by farmers or private sector of the required support, as in Thailand.

(i) Ensure the support of agribusiness that might be interested in certifying a SSM quality standard, to be adopted by the farmers willing to be part of the commercial network (example of Global Good Agricultural Practices (GAP) requested by European supermarket chains or the example of Thai farmers that grow organic products according to good practice standards while the government provides control and certification which supports trade of the products.

(j) Assessment and monitoring: In depth assessment, documentation and monitoring are valuable tools to demonstrate and share SSM practices and to demonstrate quantitative results and impacts of wider use of SSM/SLM practices over time. The wider benefits of SSM on the economy, for nutrition, and on the standard of living for those segments of the population not directly involved in agriculture should be documented.

10.3. Participatory Research for adaptation and wider adoption (creating the evidence base)

<u>Working Group 2</u>

- Christian Nolte, FAO Agriculture Production and Protection Division

- Edmundo Barrios, World Agroforestry Centre (ICRAF), Kenya

- Bernard Vanlauwe, International Institute of Tropical Agriculture (IITA), Nigeria

- Rafael Fuentes, IAPAR, Brazil

- Liesl Wiese, Agricultural Research Council, Republic of South Africa

- Julio Cesar Alegre, University of La Molina, Peru

- Kristina Toderich, International Centre for Biosaline Agriculture/ ICARDA

- Carlos Gauggel, University El Zamorano, Honduras

- Victor Chude, Soil Science Society of Nigeria, Nigeria

There is quite some overlap with the proposals from working group 1. The group discussed the required strategy for promoting participatory research for the adaptation and wider adoption of sustainable soil management practices and proposed the following steps:

(1) Develop a participatory research and extension processes aimed at developing locally adapted solutions: transformation of agriculture will require a movement away from "best bet" and "blanket" applications towards local and country specific solutions. Participatory processes have shown good results even in extreme environments. The social and cultural value of indigenous knowledge and new SSM practices should be assessed in addition to economic and yield concerns. These values should include gender equity.

(2) A soil management system should be studied, observed and understood before trying to modify it. Bottlenecks and constraints to adoption of soil management technologies must first be identified, understood and addressed. Furthermore, any changes must be processed with continuous feedback from local land users as it is their role to implement the practices through their daily work.

    Such "benchmarking" is used by ICARDA and can provide valuable insight into specific farming contexts that can subsequently be scaled up. FAO also developed valuable local level diagnostic tools (biophysical and socio-economic) that use the DPSIR framework to analyse and understand land degradation and SLM status and trends, the drivers and causes behind specific practices, the impacts on livelihoods and ecosystem services and the actual and potential responses in a specific study area. This "LADA–Local" toolbox could be usefully tested and peer reviewed and updated with support of the soil management –research community. The AKT toolkit (Fergus Sinclair; ICRAF) allows to analyse and graphically present farmer knowledge and hypotheses and information discussed with farmers. Ethiopia's agricultural transformation model through diagnosis, analysis of bottlenecks and theory of change, also helped inform a shift from subsistence to agribusiness.

(3) Bring together fragmented soil management research and datasets, for example on soil degradation, fertility, soil carbon, soil biodiversity, etc.) and strengthen analysis spatially (across land use systems) and over time (long term). This lack of knowledge is currently reducing the capacity to influence land management and policies. Actions are needed to actively promote innovation for sustainable and

productive soil management and to move away from surveys and research strategies which do not offer practical and proven solutions to the farmer's problems.

(4) Extension services should be adapted to the farmer's needs: Farmer Field Schools may be effective on a small scale, but they are often costly and difficult to organize and require well trained and motivated facilitators. Many farmers do not have a lot of free time to invest in education and research. As well as farmer innovation and experimentation it is important to efficiently provide evidence to farmers on what has been achieved and accepted by science and technology. Farmers should be supported to choose among best solutions according to an objective and constructive cost/benefit analysis.

(5) For on-farm demonstration and research it is important to share knowledge between scientists and farmers and to jointly identify and demonstrate the effect of alternative or competing management techniques. In-field demonstrations including comparisons of soil pits and identification of early-warning bio-indicators of degradation have shown good results for illustrating the importance of sustainable soil management. On-farm applied research needs to address farm-scale implications of technologies (e.g. impact on labour) and should be made available and published more widely in scientific journals. Local language is important for participatory research tools and processes.

(6) Multi-stakeholder and integrated approaches are required to harmonize the needs and solutions of different levels of society, including policy-makers, farmers and consumers. For example, farmers and consumers are both interested in maximizing benefits while minimizing costs. Policy makers are responsible to both groups and are required to provide solutions which are equitable to all parties. To accomplish this, it is necessary to create and maintain markets for inputs and outputs which are reliable, efficient and affordable.

(7) In many cases small farmers are difficult to connect to appropriate innovation programs for sustainable soil management. In contrast, big landowners can pay for scientific research to aid management decisions. Equity in law as well as in practice is necessary for widespread adoption of SSM and requires attention to tenure, access and empowerment of marginal groups.

(8) Science-policy interface: The best science should be integrated with national capacity-building programs. Farmers and scientists should jointly engage and link with policy makers. An effective sound land use policy framework is needed that addresses issues of ownership and access over resources and management of fragile as well as high potential ecosystems and territories (watersheds, grazing lands, etc.)

(9) Decentralized territorial approaches are necessary to provide long-term support for local actors. Investments backed up by technical experts that can be consulted and local intermediates are needed to support farmers during the process of

implementation. Risk-insurance policies must be adapted to individual situations to compensate for any short term yield loss involved with adoption of SSM practices.

Long-term investments*: Short term projects need to be replaced by long-term investments to address specific problems through territorial repartition of initiatives and donors and capacity development of local service providers. Resource mobilization is needed to support on-farm research and technology transfer*

(10) Disseminating success stories: Documentation of success stories should include illustrating strategies for up- and down-scaling solutions in different countries, situations, fields and soils. A successful approach is applied on-farm research projects that disseminate their results to the wider public. This requires a change in paradigm from the research community, who seldom publish on-site research in scientific papers.

Communication strategy*: Communication and scaling up mechanisms also need to be investigated in terms of effectiveness. Smart messages should be derived from media campaigns employed by local and regional agencies and institutions. These messages could be disseminated on radio broadcasting programs in areas to reinforce other dissemination mechanisms. Social media such as blogs, twitter, etc can provide important communication tools for the young. Also tape-recording local farmer interviews can provide useful information which they might be reluctant to convey to an external surveyor/auditor. Positive messages are needed of SSM success and benefits rather than continued focus on negative trends in land degradation, etc.*

10.4 Policy and Institutions (Enabling Environment)

Working Group 3

- Samuel Gameda, ATA, Ethiopia
- Olatunhi Ojuola, Agric Land Resources, Nigeria
- Charles Rice, Kansas State Uni. USA
- Patrick Heffer, IFA
- Helaina Black, BSSS, UK
- Alison Collins, NLRC, New Zealand,
- Jean Luc Chotte, CIRAD-INRA, France
- Ivonne Lobos, IASS, Germany
- Saoussen Khalifa, Ministère des Affaires Etrangères, France
- Thorunn Petursdottir, JRC Soil, European Commission

The group addressed policy and institutional issues affecting sustainable soil management and highlighted strategies for the GSP to develop an enabling political environment for sustainable soil management.

There is a need to review the impact of agricultural and environmental strategies and mobilise development of soil policy and legislation and move towards more harmonised agro-environmental policy.

Rather than negative messages on degradation and food insecurity we should communicate positive messages and means for scaling up SSM successes, investments and approaches.

(1) **Mobilising the development of soil policy and legislation**:

Strategies for policy development: the importance of soils for agriculture and for other ecosystem/ environmental services, and the development goals that soils contribute to should be highlighted. It must be emphasized and communicated that soils need to be protected in their own right. For example, soils are important in spatial planning and infrastructure development which place emphasis on soil resources as a platform. However, in this process the other values of soils are often ignored. This implies that the GSP should devise two groups of strategies for integrating soil management into global policy:

SSM for its intrinsic value (direct): First it is important to assess, account for and demonstrate the intrinsic values of soils for food production and life support. Also soils as a major source of medicinal products (antibiotics and anticancer drugs etc.) should be stressed. In considering soils for their productive purposes there is a need to address both urban and rural perceptions of soil value.

SSM for other benefits beyond production (indirect) which are seen both off-site as well as on-site. Linking soils directly with the health, water and climate change agenda is important for prioritizing soils on the international agenda. This requires involvement of the multiple sectors and stakeholders benefitting from and impacted by soil functions and services. Soils are already addressed in some countries as a major component of payments for ecosystem services for example: (i) in Kenya by the Nairobi Water Supply company; (ii) in Tanzania through the Uluguru highlands-Dar-es-Salaam water quality program; (iii) in Scotland, through Land Use Strategy woodland expansion trade-offs; (iv) in the US Department of Agriculture soil conservation programme.

(2) **Guidance to policy makers should be policy-relevant** but not policy-prescriptive and should include solutions as well as drawing attention to problems. Evidence for policy making needs to be in a suitable language with a clear presentation of the impacts including environmental, social as well as economic costs and benefits.

Governments need to be pressured by civil society and scientists to take action and invest in SSM for enhanced productivity in cropping, livestock and forest based systems because of the major threats and challenges for global food security of population growth, land degradation and climate change.

(3) **Harmonising agro-environmental policies:** Policy for soil protection and management should be an integral part of land use policy and planning framework and should address issues of ownership, land use zoning (e.g. management of fragile and high potential ecosystems, watersheds, cropping, forest and grazing lands) and legislation.

(4) **Environmental and development goals**: Sustainable soil management should be related to international initiatives and commitments (i.e. environmental conventions) by forming direct or indirect relationships with the objectives of these initiatives. Also, SSM goals should go above and beyond the conventions and be linked to other sustainable development goals that already have country-level indicators in place. Through this dual approach, awareness of the importance of soils will be raised and decision making can be influenced at country and regional level.

(5) **Country and regional strategies and governance**: Country level strategies should be reviewed to identify where they can be enhanced by incorporating the value of soils and the diverse services they support and the need to protect them through SSM. There is a need for integrating strategies to manage soils effectively at all levels of governance. Policy dialogues should have a regional and country level relevance reinforced by attention to global issues and perspectives to add weight to and prioritize local and provincial issues for SSM.

(6) **Comprehensive strategies for SSM**: These should be wider than the implementation of specific practices and should reflect/address one or more of the GSP Pillars. For example, the lack of soil information is identified as a limiting constraint in several countries such as Ethiopia and Nigeria. The GSP could provide information to local and regional partners which will provide the evidence necessary to engage with local governments and to satisfy local needs as well as contributing to the GSP mandate.

(7) **GSP-IPBES linkages**: The GSP could provide expert advice on soils for consideration by IPBES (International Panel for Biodiversity and Ecosystem Services) with a view to raise attention to the importance of soil conservation and management for the implementation by countries of the various conventions.

(8) **Link science and action:** There should be a clear link between soil scientific knowledge and the practical and operational actions at local, national or global level in support of the development of land management policies. Harmonized soil information could be made available to address regional or **transboundary issues,** for example through the Observatory of the Sahara and Sahel (OSS) and SSM investment through the Great Green Wall Initiative.

(9) **Assess the costs of inaction versus the costs and benefits of SSM** and communicate the findings to policy makers to support decision making for investing in SSM and provide different options or scenarios that provide positive outcomes (economic, social and environmental) e.g. longer term costs of intensive agriculture systems on

water supply compared to short term productivity benefits. The GSP could promote a common approach for such assessments and collate case studies, for example, for consideration as part of the ongoing process under the UNCCD on the Economics of Land Degradation (ELD).

(10) **Learning from successes**: It is important to use cases where SSM policy has become operational at country and regional level and review their major accomplishments. The GSP could play a role in analyzing regional and national cases from technical and systemic perspectives to illustrate how impediments to soil management have been resolved and how related strategies have been used to this effect. Such a process is based on the assumption that step-by-step changes, as demonstrated in Ethiopia and Nigeria, are needed for land management to integrate SSM. This will involve linkages across all GSP pillars, as SSM may not be the limiting factor, as highlighted above.

(11) **Positive message of SSM successes**: The GSP should act as a source of expert advice to related global initiatives. It will be a challenge for the GSP to deliver a common strategy for SSM 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 SSM and these global goals. To date, conventions have not placed a focus on soils and it is up to soil scientists to convince the international community that SSM 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 Convention on Biological Diversity (CBD), the Committee on Science and Technology (CST) and relevant science policy mechanisms of the UNCCD and the Intergovernmental Panel on Climate Change (IPCC) of UNFCCC.

11. Regional and Thematic considerations in developing the GSP Plan of Action for Achieving Sustainable Soil Management

11.1 Latin America and Caribbean region and North America

Participants from the Latin American and Caribbean region (RLAC) and North America first discussed the wide disparity among countries in extension mechanisms and operations for soil conservation and management:

Text Box 2 Ranking of extension mechanisms for soil conservation and management

Country	Level	Mode of operation
Argentina	High	Most farmers have access to agricultural extension

Brazil- South - North	High Medium	- Well distributed through visit to farms - Depends on the state, somewhat frequent
Costa Rica	High	Across the country and for most crops
Nicaragua	Very limited	Rarely visits to the field
Peru	Medium-Low	Participatory approaches with farmers

It was agreed that Pillar 1 of the GSP on promoting sustainable soil management is the primary or foundation pillar that should be supported by all the other pillars.

(1) The GSP should help identify strategies and develop materials to promote Sustainable Soil Management by addressing the following main issues for all land uses within the appropriate global, national and local context: (1) Food insecurity; (2) Soil degradation; (3) Carbon sequestration; (4) Climate change; (5) Water quantity and quality; (6) Biodiversity (soil and otherwise) (7) Urbanization; (8) Soil health for plant health for healthy food and healthy people. ***To catch initial interest a one page brief on each of these issues should be developed for advocacy with politicians and decision-makers.***

(2) Sustainable soil management technologies which should be given priority include among others:(1) All activities that can help soil restoration; (2) No-till farming where appropriate; (3) Crop rotations to make sure soil organic matter is protected and restored (4) Efficient plant nutrition and responsible inputs management to address nutrient mining and pollution; (5) Irrigation according to technical parameters; (6) Integrated soil and water management at watershed level and restoration of ecosystem services; (7) Control of flooding as consequence of inadequate watershed management;(8) Implementation of effective and affordable technologies; (9) Salinization, drought and desertification

(3) Awareness raising is vital and could include (1) Development of a communication plan for schools and the public; (2) Support the implementation and extension /scaling out of practices and knowledge; (3) Compile case studies for guidance and training workshops; (4) Develop a common understanding of SSM and SLM, including social and ethical dimensions.

(4) The production and sharing of research, information and databases is very important and can be accomplished by using the GSP as a platform for groups with different interests in soil information.

(5) Managing and finding funding for information development (Pillar 2) is a crucial role of the partnership.

(6) Identifying and establishing linkages with key related stakeholders and sectors is required including forest, agriculture, water, cities, youth, women, and consumers. Messages and information should be tailored to specific sectors and actors.

11.2. Suggestions from the African group

(1) **The GSP should develop and make policy recommendations to governments**. The GSP should partner with the CAADP in order to ensure that sustainable soil management is high on the development agenda. Regular meetings of ministers should be organized to discuss soil management with support of the World Bank and other actors.

(2) **Fertilizer use must be increased in Africa** in order to “kick-start“ biomass production and thereby initiate the process of restoring degraded soils and enhancing productivity.

(3) **The GSP should launch the remaining regional partnerships** in the first half of 2013. The African Partnership will be developed through sub-regional consultations (W. and C. Africa; E. and S. Africa and N. Africa, which is currently part of the Near East and N. Africa group) that will aim to build on existing political structures and kick start the awareness raising and prioritization process.

(4) **The GSP should help the African region to develop a road map** to achieve their SSM goals: food security is a major driver for SSM in Africa, and the GSP has an important role in raising awareness of this vital linkage. Also, African Governments must spend 10% on agriculture according to the CAADP benchmark, and this can be used as leverage for fund raising. Regional ministers must agree to focus on holistic farming systems and productivity increases should be the top priority of sustainable soil management.

Another group that represented “Asia and the rest of the world” informed the plenary that the issues they had raised had already been covered by the previous working groups. In addition they highlighted the importance of identifying trans-regional common issues and shared approaches.

12. Recommendations for the development of the GSP Plan of action for promoting Sustainable Soil Management

Some clarifications were made in the workshop plenary regarding the GSP Establishment.
The GSP website (www.fao.org/nr/globalsoilpartnership) provides all the official documents and illustrates the process and opportunity for interaction.

Sustainable Soil Management Definition

The GSP should first support the development of a common understanding of what sustainable soil management means, taking into account the definition on the glossary of the Soil Science Society of America, as well as cultural and ethical considerations. Also, a very easy to understand message should be formulated to communicate to other sectors and stakeholders.

Scope of the Action Plan of Pillar 1

It is important to agree on the scope of the action plan on SSM and to develop a set of principles for sustainable soil management. The process for developing the main areas for action for the SSM plan of action should identify and take into account the main challenges and priorities in countries and regions (as referred in the global, regional and national presentations and discussions). The Regional Soil Partnerships should establish the main action areas in accordance with the 5 pillars and decide what the expected outcomes are. Some priority areas identified by this workshop are: (1) Soil carbon /soil organic matter; (2) Education in soil science; (3) Creating a platform for information exchange; (4) Increasing the voice of soil scientists at policy level.

Recalling the vision and mission of the GSP (see text box 3), it is important to promote a better coordination of existing work on sustainable soil management but also to initiate new activities through mobilizing resources and effective partnerships.

Moreover, it is essential to put the farmer first, taking into account all scales and genre, from family farmers to large farmers, male or female, and to put in place mechanisms for farmer-driven participatory research-action through farmer field school and similar approaches. As noted by Rafael Fuentes "If a farmer does not feel that suggested practices are going to solve his/her problems and constraints, he/she will not adopt them". Development and adoption of locally-adapted and sustainable soil management practices requires also an enabling environment to ensure that farmers have access to appropriate inputs, knowledge, research and finance, and that they have the capacity to plan together for soil and water conservation measures at wider watershed/landscape/community territory level.

Text box 3: ***The vision and mission of the Global Soil Partnership programme***

Vision: Improve governance of the limited soil resources of the planet in order to guarantee healthy and productive soils for a food secure world, as well as support other essential ecosystem services, in accordance with the sovereign right of each State over its natural resources. The GSP should become an interactive and responsive partnership.

Mission: Develop awareness and contribute to the development of capacities, build on best available science, and facilitate/contribute to the exchange of knowledge and technologies among stakeholders for the sustainable management and use of soil resources.

Policy and Governance for Sustainable Soil Management

At international level, the GSP should have an advocacy role in promoting the importance of Sustainable Soil Management (SSM) in inter-governmental initiatives and conventions. Specifically, it would be useful to partner with the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) and to advocate for IPBES to place great emphasis on soils as key providers of ecosystem services (Figure 17).

In addition to the agreed international governance objectives, the GSP should also pay attention to regional and national level initiatives. The GSP should have a role in enabling regional GSP partnerships to engage and have dialogue with policy makers so as to promote options or solutions which are relevant but not prescriptive.

The GSP could set up a working group to look at entry points within existing sustainable development goals for SSM in regional and global initiatives. The International Union of Soil Sciences (IUSS) and associated national soil science societies could collaborate to provide inputs.

> First, there must be a consideration on how soils are viewed within political and policy discussions and how soil policy can be influenced by the GSP. There are many different political hierarchies across GSP countries but it is a common view of the importance of informing and educating governments, including ministers and advisors, about the importance of soils.
>
> Second, the GSP should have a role in identifying where harmonised information on soil resources is needed to tackle regional issues. As an example, the GSP could provide coordinated soil science information in support of the Observatory of the Sahara and Sahel (OSS) to address trans-Saharan issues.
>
> Third, the GSP should have a role in supporting and delivering diagnostic assessments with a specific focus on soils and their sustainable management. This would involve scientific analysis of soil-related issues in order to identify and develop recommendations and required actions and to develop targets and initiatives for achieving agreed objectives according to a set timeline e.g. 2 to 5 years.

A starting place could be a Global Environmental Outlook (GEO) report on land degradation to review progress in addressing /reversing land degradation in the context of SSM with country level participation to review how various initiatives were implemented.

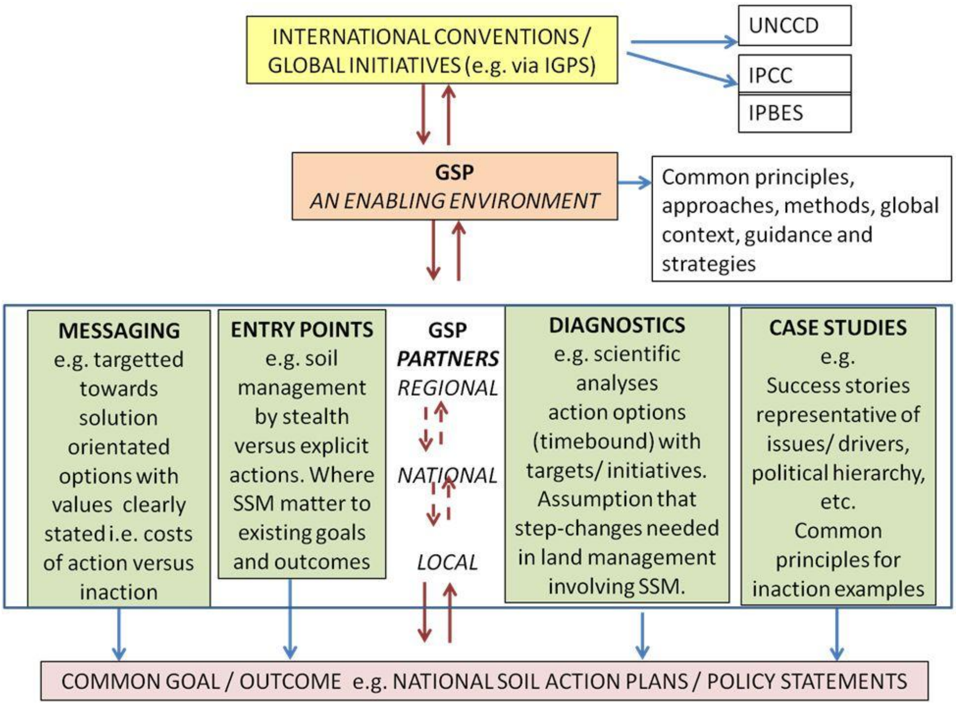


Figure 17: Flowchart for enabling political environment for sustainable soil management

Science – Policy interface

Soil scientists need to develop and make available better targeted information on the importance of soils for facing today's major and interlinked challenges of food insecurity, climate change, land degradation, biodiversity loss and water shortage.

Soil scientists also need to help make the case for convincing the various stakeholders – the general public, land users, policy makers, donors, technical agencies and the private sector - on the need for substantially increasing investments in SSM across the various land use systems of the world. They need to demonstrate that enhancing productivity of our soils will impact on sustainable livelihoods and poverty alleviation and will contribute effectively to the Rio+20 goals for sustainable development notably the zero net hunger and the zero net land degradation goals.

Soil scientists need to prioritize actions for 1) soil and water conservation and 2) soil organic matter/carbon management as two key areas of action for maintaining the area of productive soils/lands and for sustaining agricultural intensification and thereby generating multiple social, economic and environmental benefits.

The best science should be drawn on in developing and implementing national capacity-building programs for SSM. Farmers and scientists should jointly engage and link with policy makers.

A communication strategy is needed to develop clear messages from soil scientists to policy makers. Also fora are needed to bring together soil scientists and policy makers for discussion and awareness raising e.g. the 2nd Global Soil Week organized by IASS (Potsdam, Germany) could provide a useful venue and process. Also the proposed celebration of World Soil Day on 5 December and the International Year on Soils in 2015 once approved by the UN General Assembly should provide important awareness raising platforms for advocacy and awareness raising activities worldwide.

Participatory Research for SSM

Through the GSP, country level applied participatory research based on farmer expertise should be encouraged and to the extent possible as well as a farmer-to-farmer learning approach. Scientists and decision makers should be accessible to and provide support to farmers and land users and other local actors.

The GSP should provide a platform for sharing assessment –diagnostic tools among others. The GSP website could be a useful platform for sharing and discussing the effectiveness in different contexts of such tools. The GSP should also use all available resources, including social media for raising awareness and encouraging the involvement of young scientists.

GSP must make available all the tools at its disposal and partners should apply them and assess their functionality so that the tools can be continuously improved. This can be done through peer review process and sharing findings and criticisms through discussion fora. A roster of experts could be developed and shared for review and capacity development for their wider application. The tools must be accessible, especially to farmers, and should be translated into different languages. However, this is difficult because there are dozens of languages in African countries.

The GSP should adopt the research approach of working on benchmark sites and concepts and up-scaling of results for wider application in similar contexts. The AKT toolkit (software) could be more widely used by partners for uploading and analysis of hypotheses and results/findings generated from local farmer knowledge and for the presentation of graphics.

Methods for scaling up have been much talked about but not seriously investigated. The social dynamics of adoption are also, in general, an unknown factor which must be taken into account. Issues of scaling up and adoption should be an important research topic involving students and aiming at interesting young scientists in promoting SSM.

There is little knowledge of the effectiveness of media campaigns and therefore these must also be researched.

Awareness Raising and Capacity building

The GSP should work to raise awareness of the importance of SSM by developing a communication plan targeted at schools and the general public. Supporting extension of practices and implementation of knowledge is a priority, as well as influencing policy-making, capacity building at different levels. The GSP could develop a guideline on SSM supported by case studies and the key implementation approaches that were presented in this workshop on Managing Living Soils.

The following target groups should be addressed by the Plan of Action for capacity development concerning implementation of sustainable soil management (SSM) practices:

> (1) Farmers and Farmers' organizations; (2) Decision/policy makers, community leaders; (3) Extension system (Government, NGOs, private sector) and technical sectors; (4) Research and Academia; (5) Primary and Secondary Schools (students and teachers); (6)Civil society (including consumers); (7) Non agrarian sectors – through leveraging the service benefits of soil of interest to the various groups including urban populations.

Young people should be actively included: this will involve the GSP identifying and targeting young people in communities with a positive message of "going back to land" and developing agriculture as a business. (It is noted that farming is not considered a proper job in much of SSA but a means for subsistence).

A first step is to know how the local farming system functions. The SSM practices must be then duly targeted to local communities and families through a farmer level approach. Good scientists are important, but equally important is asking the right questions and integrating various disciplines to address the most salient issues. Soil scientists must be conversant in other disciplines especially social sciences and should not be too specialized. Cost effectiveness must be placed ahead of cost benefits analysis to take into account social benefits.

The GSP plan of action should identify ways to promote sustainable soil management (SSM) implementation through an iterative process:

(1) First, through farmers leaders, identify the local best practices introduced by farmers to cope with soil limitations. Take an inventory of currently implemented farmer innovations. Site and community specific packages have a better chance of being implemented.
(2) Examine reasons /constraints - technical, social, and economic - for some farmers not to adopt best practices. Tools are needed for understanding lack of adoption.
(3) Emphasize the potential and actual economic return from best practice application. Modelling and monitoring the impact of SLM practices can be used to display results quantitatively. Tools are also needed to assess the multiple benefits of SSM practices including yield, effect on water quality and similar human and ecosystem services. These tools, once developed can be used to promote SSM.

(4) Support farmer to farmer dissemination of effective, economically-viable practices. Technology specifically tailored to farmers' needs has higher probability of being adopted by them. Land use zoning, long term data collection, and regional reporting are all mechanisms to illustrate impact of these practices on a larger scale.

(5) Farmers and other land owners and users are not solely responsible for ecosystem management, and therefore need to be supported for the transition from unsustainable to more sustainable practices and land use systems.
Investigate avenues for agro-business actors to certify a SSM quality standard that can be adopted by farmers willing to participate in a commercial network similar to the Global GAP requested by European supermarket chains and the Organic Farming standards. For example, Thai farmers who grow organically and according to good practice standards are provided government certification that increases the market value of these goods. Identify how local governments can invest in agricultural development and integrate SSM should be integrated into territorial issues which impact all stakeholders.

(6) Monitor and assess progress: It is useful to use mapping tools to illustrate application of SSM practices worldwide, for example using the WOCAT tools for assessment and documentation.

GSP Ad hoc Working Group on Sustainable Soil Management

Finally, an ad hoc working group with a member from each region was set up to support the finalization of the workshop report and the further development of a draft framework for the Plan of Action on sustainable soil management to be fed into the regional Soil Partnership for consideration and further development based on needs and priorities. This working group is composed of:

- Sally Bunning on behalf of FAO, GSP Secretariat
- Liesl Wiese for E. & S. Africa
- Bernard Vanlauwe for W. & C. Africa;
- Charles Rice for North America;
- Kazuyuki Yagi for Asia.
- Pandi Zdruli for the Mediterranean region;
- Feras Ziadat for Near/Middle East & North Africa;
- Rafael Fuentes for Latin America and the Caribbean;

Closing Session

During the closing session, the participants expressed their appreciation of the workshop process and expertise of the participants and support of the organizers. Many participants expressed their interest in being further involved in the development of the Plan of action for promoting SSM.

Annexes

Annex 1: Agenda of the Workshop

TIME	TOPIC	PRESENTER	CHAIR
Day 1: Wednesday 5 December **Session 1: Global Status, Challenges and Priorities of Soil Management**			
08:45-09:20	Welcome and opening: Aims and objectives of the GSP and the workshop Opening statements:	Mr Alexander Müller, ADG FAO, Natural Resources Management & Environment Department - Ms Pia Bucella, DG Environment EC - Prof Jae Yang, President IUSS	
09:20-09:40	Keynote speakers What is sustainable soil management	FAO	Ms Sally Bunning, Senior Land/Soils Officer, FAO
09:40-10:00	Farmers' perspectives on soil management	Mr Marco Marzano, World Farmers' Organization	
10:00-10:20	Global status and challenges of fertilizer use	Mr Patrick Heffer, International Fertilizer Industry Association	
10:20-10:40	Global Soil Biodiversity Initiative	Mr Luca Montanarella, JRC/EC	
Session 2: Global and Regional Status, Challenges and Priorities of Soil Management			
11:15-11:30	Global status and challenges of soil nutrient management	Dr Anjan Datta, UNEP	Mr Christian Nolte, Senior Soil Fertility Officer
11:30-11:45	Status and challenges of soil management in the Middle East	Dr Feras Ziadat, ICARDA	
11:45-12:00	Status and challenges of soil management in Africa	Dr Bernard Vanlauwe, IITA	
12:00-12:15	Challenges of agro-ecological soil management	Mr Tobias Bandel, Soils&More	
12:15-12:30	How to evaluate the effectiveness of agri-environmental policies on sustainable management of soil resources	Ms Thorunn Petursdottir, JRC	
12:30-13:00	Discussion		
13:00-14:30: Side Event – Sheikh Zayed Centre, Atrium **Securing Healthy Soils for a Food Secure World: A Day dedicated to Soils**			
Session 3: Current Status, Trends and Priorities of National Soil Management			
14:40-14:55	Status and priorities of Soil Management in Thailand	Mr Pitayakon Limtong, Land Development Department	Mr Samuel Gameda, Ethiopia
14:55-15:10	Status and priorities of soil management in Japan	Mr Kazuyuki Yagi, National Institute for Agro-environmental sciences	

TIME	TOPIC	PRESENTER	CHAIR
15:10-15:25	Status and priorities of soil management in India	Mr D.K. Sharma, Central Soil Salinity Research Institute	
15:25-15:40	Status and priorities of soil management in New Zealand	Ms Alison Collins, National Land Resource Centre	
15:40-16:00	Discussion and sum up Asia and Pacific (coffee)		
16:00-16:15	Status and priorities of soil management in Russia	Mr Pavel Krasilnikov, Eurasian Food Security Centre	Mr Carlo Jacomini, ISPRA, Italy
16:15-16:30	Status and priorities of soil management in Uzbekistan	Ms Kristina Toderich, International Centre for Biosaline Agriculture and ICARDA	
16:30-16:45	Status and priorities of soil management in the United Kingdom	Ms Helaina Black, British Society of Soil Science	
16:45-17:00	Status and priorities of soil management in the USA	Mr Charles Rice, Kansas State University	
17:00-17:45	Discussion and sum up – Central Asia, Europe and N. America		
Day 2: Thursday 6 December **Session 4: Current Status, Trends and Priorities of National Soil Management**			
08:30-08:45	Status and priorities of soil management in South Africa	Ms Liesl Weise, Agricultural Research Council	Mr Bernard Vanlauwe
08:45-09:00	Status and priorities of soil management in Zambia	Mr Fredick Kunda, Department of Resettlement	
09:00-09:15	Status and priorities of soil management in Ethiopia	Mr Samuel Gameda, Ethiopian Agricultural Transformation Agency	
09:15-09:30	Status and priorities of soil management in Kenya	Mr Hamisi Mzoba, African Conservation Tillage Network	
09:30-09:45	Status and priorities of soil management in Nigeria	Mr Olatunji Ojuola, Department of Agricultural Land Resources	
09:45-10:00	Links between soil management and food security in West Africa	Mr Victor Chude, Nigerian Soil Science Society	
10:00-10:15	Discussion and sum up Africa		
10:15-11:30	Coffee break		
11:30-11:45	Status and priorities of Soil Management in Honduras	Mr Carlos Gauggel, Universidad el Zamorano	Ms Ivonne Lobos Alva, Research Fellow, IASS
11:45-12:00	Status and priorities of soil management in Haiti	Mr Donald Joseph, Ministère de l'Agriculture, des Ressources Naturelles et du Développement Rural	
12:00-12:15	Status and priorities of soil management in Argentina	Ms Maria Beatriz Giraudo, Associación de productores de siembra directa	

TIME	TOPIC	PRESENTER	CHAIR
12:15-12:30 12:30-12:45 12:45:13:00	Status and priorities of soil management in Brazil Status and priorities of soil management in Peru Discussion and sum up Latin America and Caribbean	Mr Rafael Fuentes, IAPAR Mr Julio Cesar Alegre, Universidad La Molina	
13:00-14:00	Lunch		
14:00-14:45	Status and priorities of soil management in the Mediterranean region	Mr Pandi Zdruli, CIHEAM	Mr Pandi Zdruli, CIHEAM
14:45-17:30	How can institutions operate cohesively and effectively to provide the political and technical support and capacity development necessary to sustainably manage soils nationally and globally?	Divide into three working groups on thematic areas	Facilitators: Mr Ronald Vargas, Ms Sally Bunning, Mr Christian Nolte, FAO
Day 3: Friday7 December **Session 5: THE WAY FORWARD, PRIORITIZATION & PREPARATION OF JOINT PLAN OF ACTION**			
08:30-10:30	Plenary session – report back and discussion	WG rapporteurs	Ms Sally Bunning, FAO
10:30-13:00	Identifying priorities for sustainable soil management at global, national and national levels (draft outline plan of action for development in WGs)	Divide into regional working groups to discuss process of development of the plan of action Asia, C. Asia and Pacific region, Africa and Near East regions, Americas and Europe	Facilitators
13:30-14:30	Lunch		
14:30-15:30	Report back from working groups and questions for clarification		WG rapporteurs
15:30-17:00	Discussion on regional and thematic content of a consolidated plan of action for promoting sustainable soil management		Mr Luca Montanarella, NRC/EC
17:00-18:00	Final discussion and way forward establishing an effective partnership for GSP pillar 1 on sustainable soil management: designate ad hoc working group to further develop the Plan of Action		

Annex 2 List of Participants

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Annex 3: Conceptual frameworks for the development of sustainable soil management strategies

1.1 The innovation process for the development of an effective, actionable plan on soil management is showed on a series of interactions between researcher and farmers and other supporting stakeholders (Douthwaite et al.,2002). This process will take a period of 5 years or more and include 4 phases of development; development phase, start-up phase, adaptation and expansion (Figure 18).

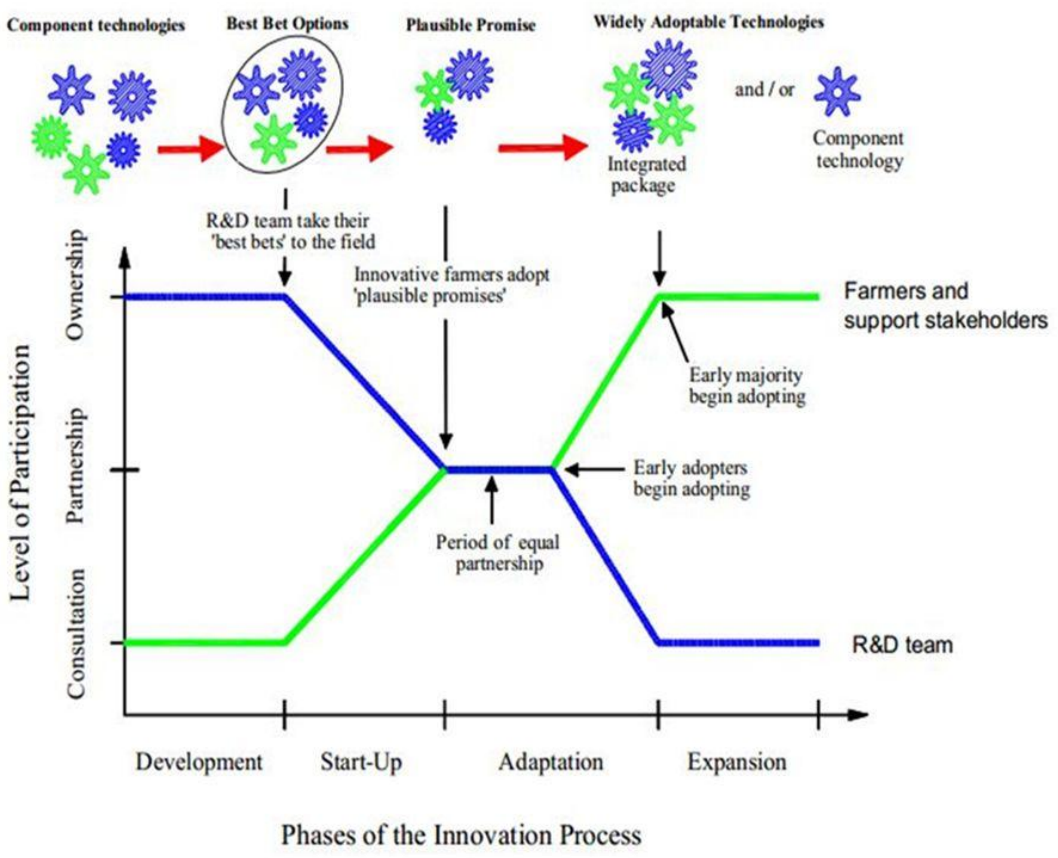

Figure 18: Conceptual map of the innovation process adopted in case studies (Douthwaite, 2002)

Development phase: Component technologies are selected according to expected field conditions and anticipated problems. Identified technologies are used to develop general best bet options for a sustainable soil management plan that is taken to the field by researchers. During this initial phase, ownership of the process is in the hands of the researchers, while farmers have a consultative level of participation.

Start-up phase: In the field, the best bet options are fine tuned in coordination with the needs, limitations and resources of innovative farmers. During this start-up phase, farmer participation increases and researcher participation decreases to a partnership level of participation for both parties. Researchers present the best bet options and discuss how they could be implemented and the expected costs and benefits, and farmers decide which options are feasible for their fields.

Adaptation period: Initially a small group of innovative farmers will adopt the fine tuned best bets as plausible promises that are implemented on a trial basis in their fields. There is continuation of the equal partnership between farmers and researchers. After innovative farmers have shown successful results from the adaptation of the plausible promises into their farming system, other farmers, the early adopter group begins adopting the same practices in their fields, which become a feature of their established farming system. As this process occurs, level of participation increases for farmers to an ownership level and participation by researchers decreases to a consultation level.

Expansion phase: After a majority of farmers have adopted the practices, they form an integrated package of widely adopted technologies, and so begins the expansion phase, where the accepted package is taken up by all the farmers in a community. This final phase is not time limited and includes the adaptation of new component technology as it becomes available.

1.2 **The Sustainable Livelihoods Framework** is a conceptual methodology for assessing the influence of transforming structures (levels of governance and private sector) and processes (laws, policies, cultures and institutions) on livelihood assets (human, national, financial, social, and physical capital) (Figure 19).

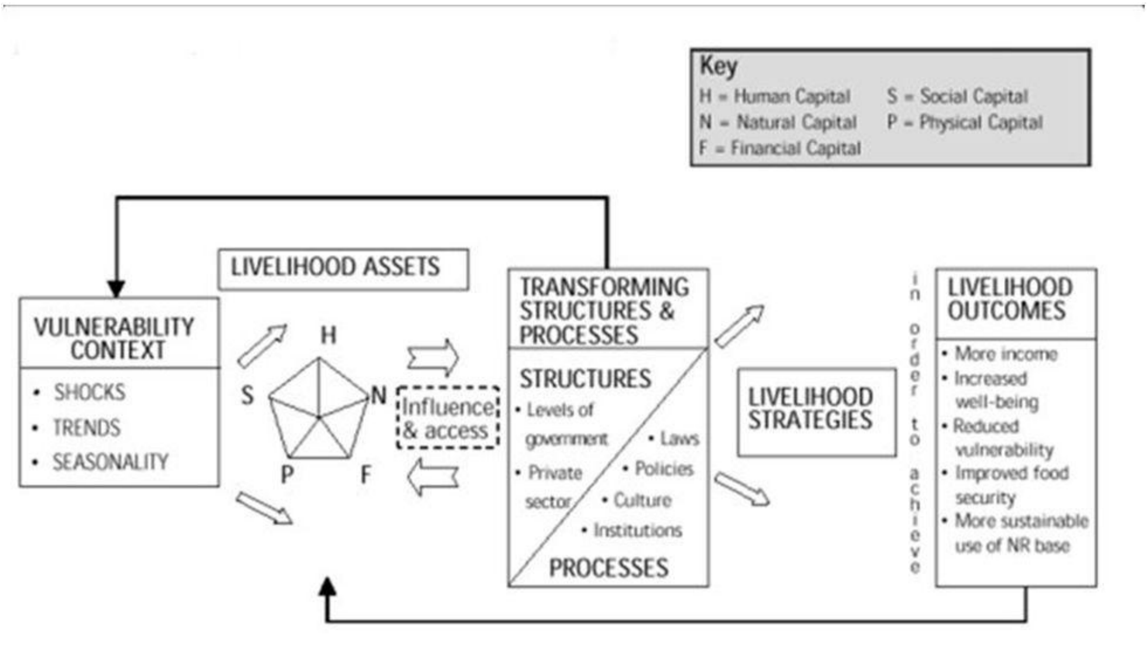

Figure 19: Sustainable Livelihoods Framework (Adapted from Adato, 2002)

Transforming structures and processes will influence livelihood outcomes (more income, increased wellbeing, reduced vulnerability, improved food security, and sustainable use of NR base) which in turn has an influence on livelihood assets. Transforming also has a multidirectional relationship with livelihood assets by impacting on access to these assets. Finally, transforming can change the vulnerability context (shocks, trends, and seasonality) which also affect livelihood assets.

1.3 **Local Agricultural Research Committee (CIAL) and process**

The CIAL is a research service which belongs to and is managed by a rural community (Braun et al., 2000) (Figure 20). The CIAL process is an iterative process where the community is engaged to provide this service. The process includes motivation to develop a CIAL and meeting with the entire community to discuss the purpose of the CIAL and selection of local farmers to become members. Through elections, local farmers who have experience with on farm experimentation and a willingness to serve the community are elected to the CIAL.

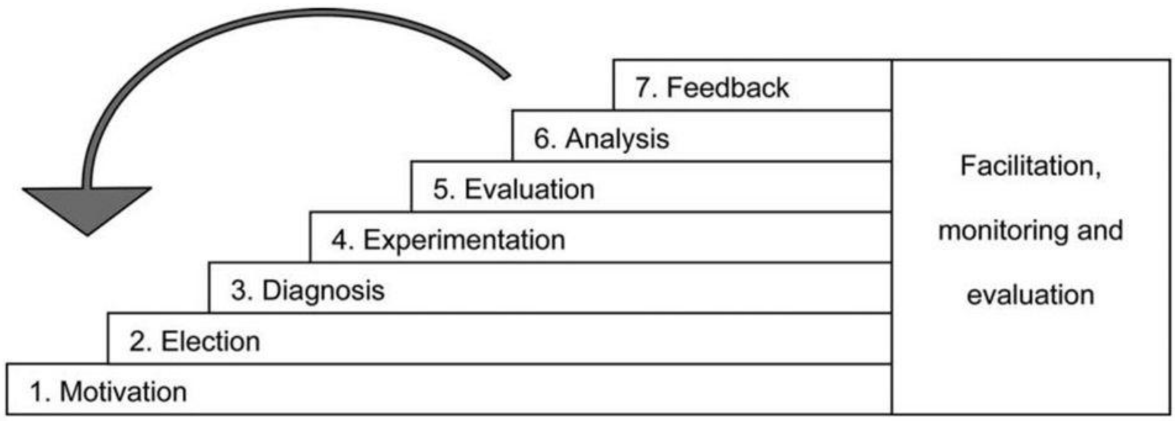

Figure 20: The CIAL process (Source Braun et al., 2000)

The diagnosis phase involves identifying significant agricultural problems in the community including productivity, pests, water management, and soil conservation and the development of research plans to investigate these issues.

Next the research phase involves planning, establishment and management of the experimentation, evaluation of treatments and control, analysis of data and feedback to draw conclusions and present them to the community.

This process is repeated through three or four successive experiments, including preliminary trial, exploratory trial, production scale trial, and commercial production trials if desired.

1.4 **The Learning Alliance Process**

The learning alliances process is used for developing, testing and implementing new management strategies (Figure 21). Learning alliances established by the Rural Agro-enterprise Development Project at CIAT seeks to establish an innovation system that matches the supply of new ideas with demand at the field and policy level.

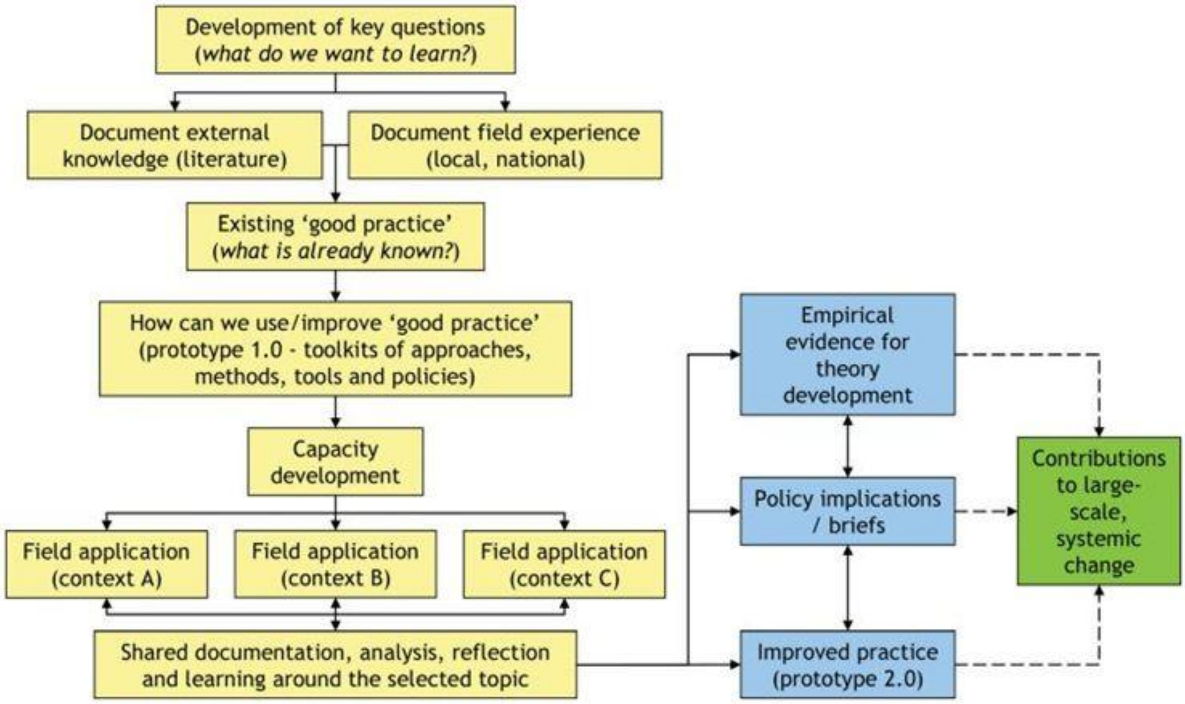

Figure 21: The Learning alliance process (Lundy, 2004).

This methodology begins by asking key questions, such as, "what do we hope to accomplish?" Next, external knowledge such as literature as well as field experiences at the local and national levels are documented, to assess existing good practices. Then, the user must determine if good practices may be improved. Next, the existing capacities for implementing change in the field are assessed and alternative scenarios for field application must be developed based on existing capacity. Finally, all documentation, analysis, reflection, and learning are collected around the selected topic. Empirical evidence, policy implications and improved practices are collected and assessed for contributions to large scale systemic change.

1.5 Conceptual framework for scaling up sustainable agricultural practices

The International Institute of Rural Rehabilitation (IIRR) provides a conceptual framework for scaling up sustainable agricultural practices (Figure 22). The goal of IIRR is to enable communities to develop innovative and practical solutions to poverty through participatory, people-centered sustainable development. According to Douthwaite et al. (2003) scaling out is the spread of innovation from farmer to farmer, community to community, within the same stakeholder group; while Scaling up is the institutional expansion from the grassroots level to policy makers, donors, development institutions, and other key stakeholders.

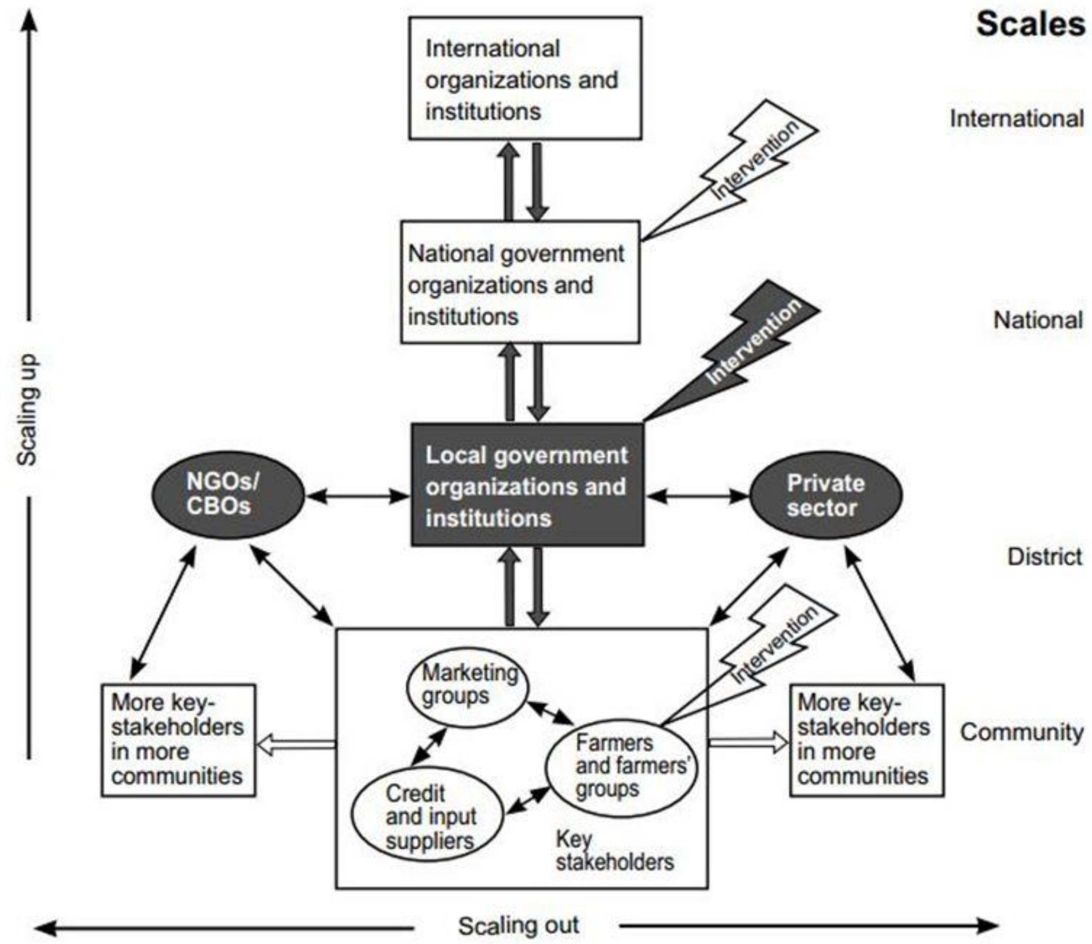

Figure 22: Concepts of vertical and horizontal scaling-up (CBO=community-based organization). Source Douthwaite et al. (2003), adapted from IIRR (2000).

For instance, *Striga hermonthica* is a parasitic weed and a major constraint to cereal production in SSA. Figure 23 illustrates the assessment pathway which was used to develop locally adapted integrated *Striga* control (ISC) approaches (Douthwaite et al., 2003). On-farm research was essential for adapting and validating the pest control options. Researchers used an approach similar to the processes above. First, two villages with severe *Striga* problems were identified for trial experimentations. Then, community meetings were held which generated a problem consensus which ranked *Striga* as the most severe problem in the village. Finally, experiments were conducted to evaluate the best options for control of the parasitic weed along with the participation of local farmers. However, the most crucial stage of this process is improved knowledge of farmers followed by adoption of technologies.

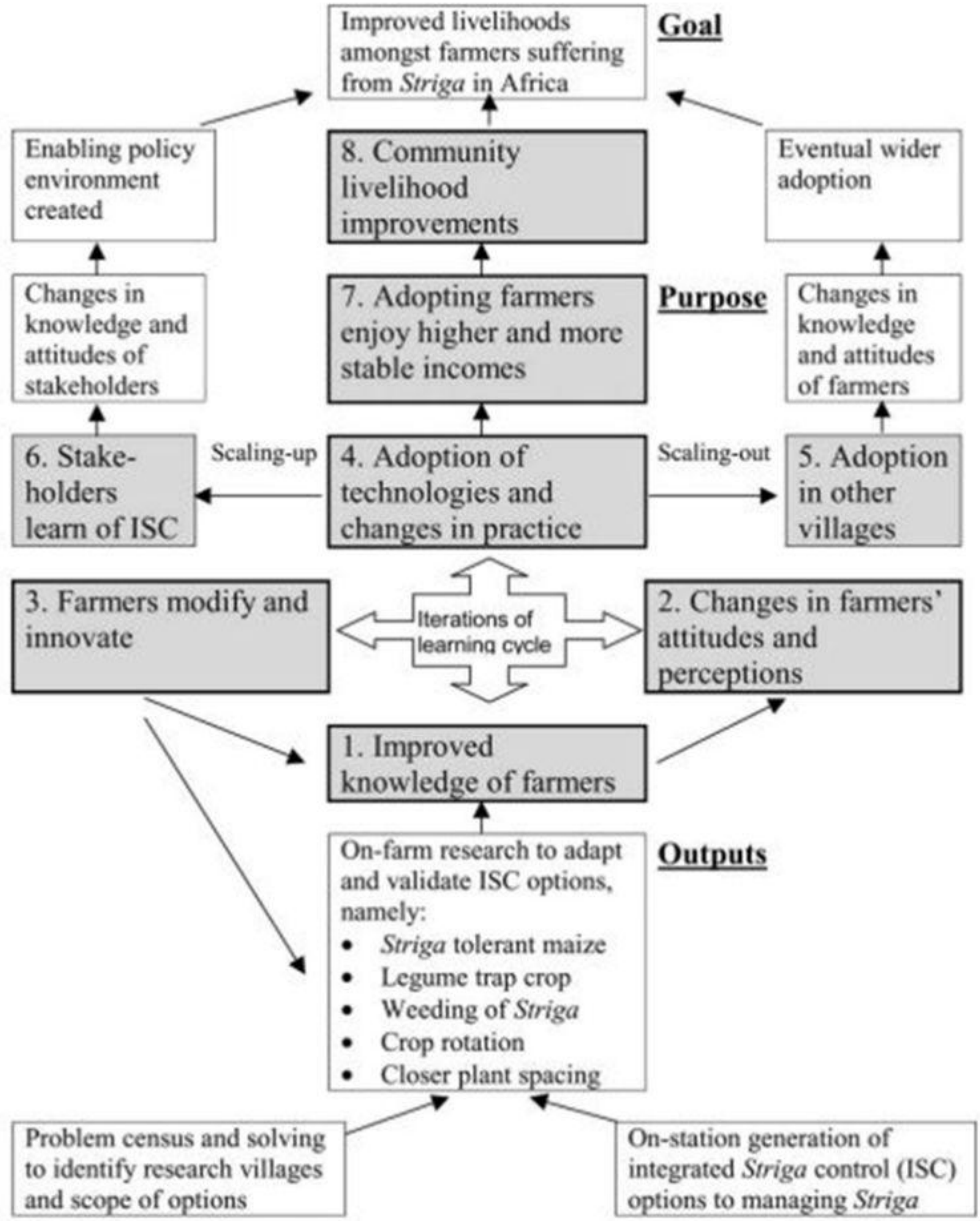

Figure 23: Impact pathway for an integrated Striga control Project in Northern Nigeria (Source Douthwaite et al., 2003)

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