# Launch of the Global Soil Partnership in Eastern and Southern Africa

25th-27th of March, 2013

Jacaranda Hotel

Nairobi, Kenya

## Acknowledgement

The launch of the Global Soil Partnership in Eastern and Southern Africa was organized and funded by FAO and implemented by CIAT through a Letter of Agreement. Mr. Saidou Koala and his colleagues in CIAT - Kenya are greatly acknowledged for their efforts. We thank all participants from the region are thanked for their active participation during the workshop and for their commitment towards the implementation of future GSP activities through the sub-Regional/Regional Soil Partnership .

This report was compiled by Peter Okoth, Saidou Koala, Ronald Vargas, Sally Bunning, Christian Nolte, Manuela Ravina Da Silva, Freddy Nachtergaele and Silvia Pioli. 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 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 Plans of Action for Global Soil Partnership Pillars of Action.

Participants in the workshop and contributors to this report honour Dr. David Dhliwayo, a meritorious soil scientist from Zimbabwe who was fully committed to promoting sustainable soil management in Africa and who passed away during the launch of the GSP in the region.

# Table of Contents

## List of Tables

## List of figures

## List of Acronyms

| | |
|---|---|
| AEZ | Agro-ecological Zoning system |
| AFAP | Africa Fertilizer and Agro Business Partnership |
| AfNET | African Network for Soil Biology and Fertility |
| AfSIS | Africa Soil Information Service |
| AFO | African Fertilizer Organization |
| ATA | Agriculture Transformation Agenda |
| AGRA | Alliance for a Green Revolution in Africa |
| ASARECA | Association for Strengthening Agricultural Research in Eastern and Central Africa |
| ASDP | Agricultural Sector Development Programme |
| a.s.l. | Above sea level |
| ASARECA | Agricultural Research in Eastern and Central Africa |
| CA | Conservation Agriculture |
| CAADP | Comprehensive Agricultural Accelerated Development Programme |
| CEC | Cation Exchange Capacity |
| CGIAR | Consultative Group on International Agricultural Research |
| CIAT | International Center for Tropical Agriculture |
| CRP WLE | CGIARs Research Program on Water Land and Ecosystem |
| EAC | East African Community |
| EASSC | East African Soil Science |
| ECA | East and Central Africa |
| ENR | Environment and Natural Resource Management |
| ES | Ecosystem Services |
| FAD | Fonds Africain de Développement (African Development Fund) |
| FAO | Food and Agriculture Organization of the United Nations |
| FARA | Forum for Agricultural Research in Africa |
| FFS | Farmer Field School |
| GEF | Global Environmental Facility |
| GIAHS | Globally Important Agricultural Heritage Systems |
| GIS | Geographic Information System |
| GPNM | Global Partnership on Nutrient Management |
| GSP | Global Soil Partnership |
| ICT | Information and Communication Technologies |
| IGAD | Intergovernmental Authority on Development |
| IITA | International Institute of Tropical Agriculture |
| IFDC | International Fertilizer Development Centre |
| ISRIC | International Soil Reference and Information Centre |
| ISABU | Institut des Sciences Agronomiques du Burundi |

| | |
|---|---|
| ISFM | Integrated Soil Fertility Management |
| IP | Innovation Platforms |
| IWM | Integrated Watershed Management |
| JRC | Joint Research Centre |
| KSS | Kenya Soil Survey |
| MoARD | Ministry of Agriculture And Rural Development |
| MT | Metric Tonnes |
| NAADS | National Agricultural Advisory Services |
| NARS | National Agricultural Research System |
| NEPAD | New Partnership for Africa's Development |
| NGO | Non Governmental Organization |
| NUE | Nutrient Use Efficiency |
| NRM | Natural Resource Management |
| PPP | Public Private Partnership |
| REC | Regional Economic Communities |
| SSA | Sub Saharan Africa |
| SLMP | Sustainable Land Management Program |
| SOLAW | State of the World Land and Water Resources |
| SOFRAIP/PADEP | Soil Fertility Recapitalisation and Agriculture Recapitalisation Project / Participatory Agricultural Development and Empowerment Program |
| SPS | Soil Protection Strategy |
| TFRA | The Tanzania Fertilizers Regulatory Authority |
| UNCCD | United Nations Convention to Combat Desertification |
| UNDP | United Nations Development Programme |
| UNEP | United Nations Environment Programme |
| VBA | Village Based Advisor |
| WAW | World Agriculture Watch |
| WB | World Bank |
| WFP | World Food Programme |
| WOCAT | World Overview of Conservation Approaches and Technologies |

## Preamble

This document summarizes the proceedings of the launch of the Global Soil Partnership (GSP) for the Eastern and Southern Africa region, held in Nairobi from 25th to 27th March 2013. The objective of the meeting was to present the status, needs and priorities for soil inventories and sustainable soil management in the 21 participant countries in order to develop the priorities of actions to be undertaken by the Regional GSP. The discussions and presentations were sub-divided into the following sessions:

1. Introduction to the GSP and regional soil management initiatives.
2. National presentations on the status of the soil and land resources in each country, as well as needs and identified priorities for sustainable soil management.
3. Plenary and working group discussions on the main needs and prioritized actions that will ensure sustainable soil management in Eastern and Southern Africa.
4. Establishment of the Eastern and Southern Regional Soil Partnership and preparation of a communiqué.
5. The suggested way forward for Global Soil Partnership in Eastern and Southern Africa.

## Resume- Soil status and trends and needs and priorities in the Eastern and Southern Africa region

Sub-Saharan Africa (SSA) comprises 0.8 % of the global population. Comparing poverty trends, between 1981-2005, poor people (living on less than 1.25 USD a day) declined by 60% in East Asia whereas in SSA it only declined by 2% (World Bank, 2009). The importance of investing in sustainable and productive agriculture was highlighted as it constitutes the backbone of economy in Africa, whereby 75-80% of its population are rural and relying on rainfed, smallholder farming systems for food production and livelihoods. Yet, the average grain yield in Africa remains among the lowest in the world, with an average on farm yield in SSA of under 1 tonne ha-1 compared to a global average of 3 T ha-1 which highlights the need to invest in particular in sustainable soil management.

Deforestation, slash and burn practices, and overgrazing are commonly cited in the region as main causes of land degradation as well as practices such as conventional tillage and increasing use of monocultures that negatively impact soil health and function through loss of soil organic matter and compaction. Lack of capacity for improved soil, nutrient and water management is a key driving forces towards declining soil productivity impoverishment and accelerating soil degradation trends. However successes are cited in reversing this trend through agroforestry, soil and water conservation and watershed management, and conservation agriculture systems that combine zero tillage with cover crops and rotations and improved rainwater and nutrient management.

Soil degradation and fertility decline are related to the increased yield gaps observed in many countries of SSA leading to massive food imports of some 50 million tons per annum to meet food needs in the region. FARA calls for an annual growth rate of 6% in agricultural productivity by 2020 to meet needs of the growing population. Moreover, Sanchez (2009) showed that improving agricultural management through fertilizer input and improved seed varieties lead to increases in maize yields by one additional tonne/ha and such investments would cost six times less than importing food from other regions of the world (135 USD compared to 812 USD).

There are common challenges across the countries in the region regarding the status and trends of soil resources and their implications for agricultural productivity, food security and resilience to climate change. Soils vary depending on the agro-ecological zones, parent material, age and topography Over large parts of Africa the soils are inherently poor in soil organic matter and nutrients, derived from sandy or highly weathered parent material with low productive potential. These include the moderately leached savanna soils in drier areas (Arenosols, Cambisols, Lixisols, etc.), highly weathered forest soils in higher rainfall areas (Ferralsols, Acrisols and Gleysols, etc.), and weakly developed soils on sloping land in highlands (Cambisols, Regosols). Also in some areas soils are limited by alkaline or saline materials (Calcisols, Gypsisols, etc.). Nonetheless, there are also large areas of soils with high fertility or nutrient holding capacity, such as black cracking clays (Vertisols), which are inherently fertile but suffer from poor drainage and workability problems, and the slightly acid but deep Luvisols and the well developed Nitosols. Reference is made to the newly published Soil Atlas of Africa (European Union 2013) for more in depth information.

Whatever the soil type sustainable soil management is essential to maintain fertility. Intensive cultivation and increased exposure to the elements leads to progressive degradation in biological properties (loss of SOM, soil biota and associated functions), chemical properties (acidification and in specific situations sodicity and salinisation) and physical properties (compaction, sealing, crusting, reducing infiltration and water holding capacity and increased run-off), resulting in reduced productivity and increased risk of erosion and drought. Climate risks through erratic rainfall and increased frequency of storms, floods and drought periods affect crop production and soil management in the region, with implications on food security, as reported in Botswana, Eritrea, South Sudan, Namibia, Lesotho and Zambia.

Soil erosion is cited as the major common challenge in sub-Saharan Africa including erosion by wind, in particular in drylands, and erosion by water notably on sloping lands, and both leading to depletion of soil organic matter and nutrients. Depletion of soil organic matter is also a result of a shift from diversified systems towards monocultures and inappropriate cultivation practices resulting in reduced nutrient cycling and soil moisture retention and increased soil acidity in areas with high rainfall. These trends have been triggered by increasing population density associated with land fragmentation especially in highlands and other areas of high potential and encroachment of agriculture into more marginal lands, especially drylands previously used predominantly for livestock production. Major soil erosion and acidity challenges are reported in Ethiopia, Rwanda, Somalia, Madagascar, Lesotho and South Africa due to sheet and rill erosion which compromise productivity as well as gully erosion which take valuable land out of production and causes damage to infrastructure. Ethiopia has a high population density and reports highest degradation rates in SSA with a mean of 137 t ha-1 per year of topsoil loss due to erosion and 40% of its arable lands facing soil acidity. Rwanda has the highest population density in Africa, and 50% of land managed by rural households is reported to suffer from moderate to severe soil erosion with a mean loss of 2.6 tonnes ha-1 and problems of soil acidity and high nutrient depletion.

Soils in SSA suffer from several decades of nutrient mining due to low fertilizer input and limited availability of organic amendments calls for an increased use of fertilizers in order to kick start biomass production and progressively enhance soil health. Soil fertility depletion has been estimated at an average of 660 kg N ha-1, 75 kg P ha-1 and 450 kg K ha-1 over some 200 million ha of cropland in SSA. In South Sudan, nutrient mining from maize production has been estimated to range from 30-60 kg ha-1 per year. However, access to inputs, in particular fertilizer and improved seed, is hindered by lack of knowledge, high cost due to poor infrastructure and high transport and import taxes, and corruption. Currently, the average fertilizer use is only 8 kg ha-1 and costs of inputs are often five times higher than the price in the world market. So increasing fertilizer use by farmers is a challenge. The use of animal manure, compost and vermin-compost and production of N fixing legumes is also low and need to be promoted as part of integrated soil fertility management practices (ISFM). More recently, micronutrient deficiencies, such as Sulphur (S), Zinc (Zn), Boron (Bo), Copper (Cu), Iron (Fe) and Manganese (Mn), have been observed in several countries of the region which may be the key limiting factor to increase crop production and ensure positive response to NPK inputs. Research in Mozambique has demonstrated that using blended fertilizer input (i.e. targeted to specific soil nutrient deficiencies ) can boost agricultural production by 40% while reducing manufacturing costs. Several blending plants are being established in Mozambique, Kenya and Tanzania.

All of these challenges of soil degradation due to inappropriate uptake of practices for soil and water conservation and nutrient replenishment are triggered due to socio-economic bottlenecks, such as: inadequate policies and regulations on sustainable soil management, lack of investment and governmental support to implement guidelines, limited technical capacity and knowledge on sustainable soil management, and labour shortage due to the aging and increasingly feminized population in rural areas, fuelled by out migration of youth especially male. Also many countries through governmental efforts and support from development agencies have compiled valuable soil maps and data in the past, but often through localized surveys and these are seriously in need of updating and digitalization. In Sudan, it was noted that limited attention to soil research and information requires generic deductions on soil status for food security and climate change predictions and modeling and investment in soil survey and mapping using modern techniques are urgently needed.

The need of strengthening capacity development for digital soil mapping was emphasized by many participants to facilitate monitoring and implementation of national programmes and projects regarding land/soil restoration and conservation. Other urgent needs include strengthening soil research and extension services through reinforcement of soil laboratories and trained staff and targeted strategies to address soil degradation and increase adoption of sustainable soil management practices such as Integrated Soil Fertility Management (ISFM), micro-dosing to increase nutrient use efficiency (NUE) and Conservation Agriculture (CA). Further, soil knowledge and information needs to be harmonized and made available to build capacity in rural areas and farmers need to be involved developing and implementing innovative technical strategies to facilitate their wider uptake. Governmental efforts are on-going in several countries in implementing programmes for soil conservation and nutrient efficiency as in Rwanda, Malawi, Tanzania, Ethiopia and Uganda among others.

Several regional initiatives and bodies in SSA promote improvements in the agricultural sector including: Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), work of the East African Community (EAC), the Alliance for Green Revolution in Africa (AGRA) program, the International Center for Tropical Agriculture (CIAT), the African Network of Soil Scientists (AfNET), and the New Partnership for Africa's Development (NEPAD), Global Partnership on Nutrient Management (GPNM). These are promoting improved farming systems through a range of interventions, in particular: promoting the adoption of Integrated Soil Fertility Management (ISFM); capacity building and development on soil research, extension services, farmers associations and civil society; creating public- private partnerships; advocacy and training support for policy development and harmonization, regulations for increased accessibility to farm inputs, among others.

In order to generate greater engagement among policymakers towards the vision of sustainable soil management there is the need to gather all these actors and initiatives together to work towards a common goal of creating a pathway towards sustainable production intensification that enhances production while sustaining livelihoods, resources and ecosystems. Moreover, it was highlighted the need to make better use of the substantial research and knowledge generation over many years in Africa. Priority setting should be drawn from lessons learned and most important of all, the farmers should always be involved in deciding what is best for them.

Finally, emphasis was placed on the enormous potential the Africa region has to feed itself due to the high natural resources potential in many countries which need to be managed in a sustainable manner to maintain or restore their productivity. Moreover, Burundi harbours substantial natural rock phosphate reserves, sufficient to address its nationwide soil acidity challenge, thus investment is needed to increase its extraction and the building of fertilizer blending plants. Madagascar also has high potential for extraction of natural lime resources. In South Sudan, there are vast water reservoirs that are not being used, which could be developed through irrigation and flood management systems .

# 1. Introduction to the GSP and Regional Soil Management Initiatives.

## 1.1 Opening Session

**Christian Nolte, Senior Officer, Soil Health and Plant Nutrition Management, FAO, Rome.** Christian welcomed the soil scientists and representatives and thanked them for the commitment shown to the GSP agenda through their participation. The DVD ‘’Soils, your Silent Ally’’ was presented. The upcoming Global Soil Week 2013 event was announced - to be held in Berlin from 27 to 31 October 2013.

**Sally Bunning, Senior Soil/Land Officer, FAO, Rome** drew attention to the main aims of FAOs Land and Water Division. Emphasis was placed on the importance of prioritizing the promotion of sustainable land and water management practices for improved agricultural productivity, sustainability and resilience to climate change. Three core areas were highlighted:

- **Productive systems and practices**: ensuring a production system capable of producing more with less use of resources, through improved and efficient use of land and water.
- **Sustainable systems and practices:** ensuring long-term efforts directed towards prevention of overexploitation and degradation of land resources and sustainable livelihoods of the human societies that depend on those resources.
- **Equitable access**: ensuring the rights of access and use of land and water for all users.

The **links between land and water, ecosystem services and climate change resilience** are essential concepts to be included in the GSP agenda. Processes such as **urbanization, degradation and pollution** should also be linked with the status and trends of the soils and its potential to secure global food production.

In its new strategic framework, Two of FAO‘s strategic objectives (SO) are of particular relevance:

- “***Increase and improve provision of goods and services from agriculture, forestry and fisheries in a sustainable manner” (***SO2) which requires efforts to enhance agricultural and forest productivity as well as climate change mitigation and adaptation, through sustainable management and use of natural resources (land, water, air, climate and genetic resources) for the benefit of present and future generations; and
- ***“Increase the resilience of livelihoods to threats and crises” (***SO5) which aims to reduce vulnerability to natural disasters, extreme climatic events and human conflicts through risk/crisis management and emergency response and rehabilitation.

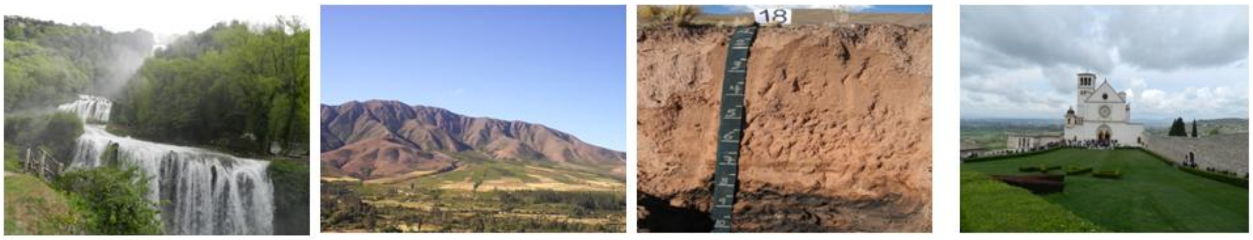
Programmes and activities under these two objectives will also contribute indirectly to 2 further objectives and wider goals of the organization:

- "***Enhance food security and nutrition***" (SO1).
- "***Reduce rural poverty***" (and enhance socio-economic progress for all, through food production, rural development and sustainable livelihoods) (SO3)

The FAO Land and Water Division is engaged in a range of normative activities and field projects on land and water management that are implemented with countries and partners including:

- Assessment and mapping of Land Degradation (LD) and Sustainable land management (SLM) and promotion of SLM technologies and approaches at farm and watershed levels (in collaboration WOCAT and UNCCD).
- Setting up and implementation of the Global Soil Partnership through Plans of Action for the 5 Pillars, to be developed with Regional Soil Partnerships.
- Development of geospatial tools and information systems.
- Participatory land use planning and negotiated territorial development.
- Water resources management and development including efficient use of water, modernization of irrigation systems and water governance.

**Ronald Vargas, Officer Land and Water Division FAO, Rome,** gave an overview of the activities of the Global Soil Partnership. The importance of healthy soils, in view of their contributions to multiple ecosystem services and global food and agricultural production was illustrated (Figure 1). By 2050 the world's food production needs to be increased by 60% due to the high population growth rate and increased demand from urban populations, however, soils are already under pressure and at risk of overexploitation in many areas. It was emphasized that "Because soils are everywhere, we tend to overlook the fact that soil is a limited natural resource" in the context of a human lifespan.



**Life support services**
- The soil renews, retains, delivers nutrients and provides physical support for plants;
- It sustains biological activity, diversity, and productivity;
- The soil ecosystem provides habitat for seeds dispersion and dissemination of the gene pool for continued evolution.

**Provision services**
- Soil is the basis for the provision of food, fibre, fuel and medicinal products to sustain life;
- It holds and releases water for plant growth and water supply.

**Regulating services**
- The soil plays a central role in buffering, filtering and moderation of the hydrological cycle;
- It regulates the carbon, oxygen and plant nutrient cycles (such as N, P, K, Ca, Mg and S) affecting the climate and plant production;
- Soil biodiversity contributes to soil pest and disease regulation. Soil micro-organisms process and break-down wastes and dead organic matter (such as manure, remains of plants, fertilizers and pesticides), preventing them from building up to toxic levels, from entering water supply and becoming pollutants.

**Cultural services**
- Soil provides support for urban settlement and infrastructure;
- In some cultures, soils may also be of specific spiritual or heritage value.
- Soils are the basis for landscapes that provide recreational value.

**Figure 1**. Soils support interaction with four main key ecosystems; life support services, provision services, regulating services and cultural services (Vargas, 2012).

The links of the GSP activities with global development agendas were illustrated, notably the outcomes of the Rio+20 process as outlined in the document “The Future We Want” and the “Zero Hunger Challenge” proposed by the United Nations. The GSP Initiative is aligned closely in support of the two key concepts “a land degradation neutral world” and “the zero hunger challenge”. Moreover, a much greater emphasis on sustainable soil management and its preservation for future generations is needed at decision making levels and its prioritization in the global agenda for sustainable development. The following issues and areas of focus should be addressed:

- Increased knowledge of the importance of soils among civil society and decision makers is a prerequisite.
- Current levels of investment in soils, in different parts of the world are minimal compared with the needs.
- Soil degradation is increasing in terms of area affected, yet efforts to halt or reverse this trend and investments are inadequate since soils are generally regarded as an

inexhaustible resource. There is a need to inventory, quantify and properly account for soils and the multiple services they provide in order to mobilize adequate financing.

- Capacity development and encouraging youth to embark in soil science is needed and strengthening of national soil institutions both in technical capacity and in numbers of those involved.
- An interdisciplinary perspective is needed in view of the multiple interactions and benefits to society and the crosscutting issue of soils should be placed at the center of agricultural and environmental development processes.
- Updated and increased soil data and information is required and efforts to enhance its use and availability for evidence-based decision making at all levels.

Particular attention was drawn to the issue of scarce available global and regional soil information and limited capacity of soil science communities to provide accurate and updated information to different soil users. Researchers and institutions should respond to the needs for improved, up-to-date, quantitative and applied soil data and information. In an era of increasingly limited financial resources it is of prime importance that the soil science community speaks with a common voice in order to request donors to support an integrated plan of action in terms of soil data and information.

The goal of the Global Soil Partnership is to provide a platform that fills the gaps for consensus building and, with support from actors on the ground, achieves a real active partnership in each region. The upcoming GSP activities are:

- Establishment of Regional soil partnerships and development of the different Plans of action for the 5 pillars of the GSP.
- Organization of technical workshops to provide inputs into the plans of actions.
- Awareness raising on the importance of soils: including celebration of World Soil Day on 5$^{th}$ December, the International Year of Soils in 2015, as well as events such as the Summer of Soils in Sweden in July, 2013 and Global Soils Week in Berlin in October 2013.
- Organization of the 1$^{st}$ GSP Plenary Assembly with countries and other partners and establishment of the Intergovernmental Technical Panel on Soils.

## 1.2. Regional Initiatives

### 1.2.1. Status and Priorities of Soil Resources in Eastern Africa.
*Anthony Esilaba, Chair of East African Soil Science (EASS)*

The East African Community (EAC) depends largely on agriculture. The new "Vision for African Agricultural Research" developed by the Forum for Agricultural Research in Africa (FARA) and its member organizations calls for an annual growth rate of 6% in agricultural productivity by the year 2020 in order to achieve sustainable development (FARA, 2003). The aggravated impact of land degradation and soil erosion was stressed. Land degradation is to a large extent caused by high population densities located in the fragile highlands of the Eastern and Southern African region. Soil fertility decline was emphasized as the major constraint to food security in the region. The use of fertilizers is among the lowest in the world with extremely low average doses being applied in Uganda of about 9 kg $ha^{-1}$. Nutrient mining is caused by continuous cultivation with low replenishment of fertilizers, organic amendments and low soil organic matter. N, P, K balances for 13 countries in SSA showed a negative trend with about 200 million ha of cropland having lost 660 kg N $ha^{-1}$, 75 kg P $ha^{-1}$ and 450 kg K $ha^{-1}$ in the last 30 years. A major soil type in many countries in the region include Vertisols, which are inherently fertile but they are characterized by poor drainage and workability problems that hampers increased productivity. Extensive areas of salt-affected soils are also found in Sudan, Ethiopia, Tanzania and Kenya, especially associated with irrigation projects.

Efforts are needed to reverse soil degradation and to restore soil fertility through: i) integrated and sustainable practices for managing soil, water and nutrients; ii) enhancing adoption of best-bet integrated soil fertility management technologies; iii) building the capacities of researchers, extension officers, farmers and other stakeholders to package and disseminate Integrated Soil Fertility Management (ISFM) techniques, information and technologies, among others.

Regional bodies that cooperate with national partners include: the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA); and the East African Community (EAC) with participation of its 11 member countries and their agricultural development institutes. These have supported actions to enhance knowledge, technology and resource mobilization within the agricultural sector in Eastern and Central Africa. Thematic interventions in managing productive soils cover three main areas: i) promotion of Integrated Soil Fertility Management technologies for major food and staple crops; ii) managing problematic soils to increase agricultural production; and iii) management of cropping and conservation tillage systems.

### 1.2. 2. Incorporating Secondary and Micronutrients into Fertilizers.
*John Wendt of the International Fertilizer Development Centre (IFDC).*

The question was raised that " If the use of fertilizers leads to profit, why are they not being adopted by African smallholders and rural communities?" Apart from non-responsive soils to NPK there are other deficiencies in micro-nutrients which are often neglected. Low amounts of Sulphur (S), Zinc (Zn) and Boron (Bo) have been detected in large parts of SSA as well as Copper (Cu), Iron (Fe) and Manganese (Mn), which are not included in the commercial fertilizers. With appropriate blended fertilizers, it has been estimated that the potential increase of crop yields could be up to 40 %. Soil and/or plant analysis and on-farm trials are essential to target key nutrient compounds for specific crop and soil conditions. In Uganda, ongoing activities include identifying soil and plant nutrient requirements which provide the basis to develop adapted blended fertilizers. Several blending fabrics are now available in Mozambique, Kenya and Tanzania. Since organic resources are limited in the soils, fertilizers are essential in order to kick-start the cycle for soil health enhancement and crop development. Furthermore, the cost of micronutrients is low at about 10 USD $ha^{-1}$ per nutrient. The need for training and raising awareness among policy makers, suppliers of fertilizers and farmers was stressed, since there is lack of general recognition of other nutrient deficiencies apart from macronutrients.

### 1.2.3. Status and Challenges of Soil Health Management in Africa.

***Rebbie Harawa, The Alliance for a Green revolution in Africa (AGRA).***

The comparison of poverty trends between Africa and other continents from 1981 to 2005 showed that in 2005 the percentage of East Asian population living under USD 1.25/day had decreased by 17 %, while in sub-Saharan Africa it only decreased by 2%. The growing population has put a severe strain on the soils leading to annually food import of about 43 million tons costing Africa about 7.5 billion US$ (World Bank, 2009). In addition, Sub-Saharan Africa faces soil nutrient depletion of over 60 kg $ha^{-1}$ due to the effect of burning land which leads to poor soil structure and productivity losses. Climate change tends also to increase the extent of unproductive soils and untamed waters. The changing weathering conditions and unpredictable rains are shifting agro-ecological zones and are decreasing the area of productive land.

Regarding the increase of food import, Sanchez (2009) showed the economic benefit to support farmers with fertilizer and seed distribution supplemented with training to improve maize yields. Indeed in this way production of an extra Ton of maize costs 135 USD, while buying 1 Ton of maize locally and distributing it costs 320 USD and buying, shipping and distributing a ton of US maize in Africa costs some 812 USD. AGRA was formed by the Rockefeller and the Bill and Melinda Gates Foundations with the aims to reduce food insecurity with 50% in 20 countries, to double the incomes of 20 million smallholders and put 15 countries on track for sustaining an African Green Revolution by 2020. The Soil Health Program was launched in 2009 to combat hunger through implementing the following strategies: i) efficient and economically sustainable supply of fertilizers to farmers in Africa; ii) uptake of appropriate Integrated Soil Fertility

Management (ISFM) technology packages by smallholder farmers; iii) creating an enabling environment upon which other organizations can build and engage in Sub-Saharan Africa. Currently 16 countries from SSA are involved in this program.

The micro-dose technology has shown great potential for increasing yields in smallholder farms in Africa. In addition, there is a great potential of increasing yields through Integrated Soil Fertility Management (ISFM) where yields of staple crops as maize and legumes have more than doubled in several countries. Other major constraints to tackle regarding farmer needs is education, access to improved seed varieties and fertilizers as well as the need for innovative micro-financing and the need to invite private sectors to facilitate the adoption of improved technologies.

#### 1.2.4. Better Soil, Water, and Land Management- Essential for Sustainable Agricultural Growth.

*Saidou Koala, African Network of Soil Scientists (AfNET), International Centre for Tropical Agriculture (CIAT).*

The need to increase annual growth of agricultural production with 6% by 2030 was stressed. This means in other words to increase the production value from 280 billion US$ to 880 billion US$ (Roxburgh *et al.*, 2010). However, there are some challenges that sub-Saharan Africa must overcome including: i) limited resources potential over large areas and high input prices (i.e., 1 kg of NPK in East DR Congo costs 1.7 USD); ii) recycling of organic residues (limited availability); iii) limited labour availability due to migration to the cities by youth; iv) land fragmentation (division among siblings) leading to the existence of many small farms often on poor/marginal soils; v) lack of an enabling environment (i.e., lack of harmonized policies, adequate infrastructure, support services, market organization as well as civil strife, etc.); and vi) natural hazards and risks of climate change.

The current production statistics in Sub-Saharan Africa show that: i) the average fertilizer use of 8 kg $ha^{-1}$ (mainly concentrated on cash crops); ii) SSA comprise over 10% of the global population but uses less than 0.8% fertilizer; iii) fertilizer demand SSA: 1.3 million MT nutrients; iv) yield gaps observed on farm in several countries of the region whereby average on farm yield lies under 1 Tonne $ha^{-1}$. Through country studies the loss of macronutrients can be some 4,4 M Tons NPK per year while replenishment is only around 0,8 Mt per year. These challenges prioritize the import of food rather than enhanced production, estimated at 50 million MT of food import annually. The continent has however been observed to recently move towards attaining higher crop yields mainly attributed to increased use of modern seeds (supplied through the formal seed sector).

CIAT has come up with two programs to support agricultural improvement in Sub-Saharan Africa; i.e., Integrated Soil Fertility Management (ISFM) (livelihood perspective) and Sustainable Land Management (landscape perspective). Specifically CIAT emphasizes the following key components for high yields and sustainable production systems: i) building the capacity of various stakeholders in soil fertility management; ii) moving from diagnosis of soil constraints to evidence-based, site-specific soil management recommendations; iii) the restoration of non-responsive soils; iv) creating Public Private Partnership and providing qualified extension specialists including 140 from NARs and 110 from universities working with CIAT's AfNET programme; and v) promoting nitrogen fixation for smallholder farmers in Africa.

CIAT also sees opportunities for collaboration with the GSP through:

- Scaling up of successful agronomic practices to improve nutrient use efficiency to reduce the yield gap.
- Target use of fertilizer for a two-to-three fold increase in crop yields.
- Strengthening the capacity of African researchers, extension specialists, NGOs and other stakeholders to improve soil productivity.
- Landscape analysis for policy decisions.
- Building a road map on the GSP and a consortium of stakeholders to move it forward.

### 1.2. 5. Selected thoughts on the Status and Challenges of ISFM in Africa.

***Bernard Vanlauwe, the International Institute for Tropical Agriculture (IITA).***

There are many organizations working for agricultural development in Sub-Saharan Africa through implementation of specific programs. The status and challenges for ISFM in Africa are:

1.*"We have understood important principles for improved and sustainable soil management"* :
i) soil management is important but is only one of the several factors affecting productivity; ii) In order to ensure returns on their investment, farmers need immediate gains from their harvest; iii) there is a need to value multiple benefits of good soil and crop, livestock management; and iv) the variability across fields, farms and landscape should be better appreciated.

2. *" We have effective technologies to deal with low soil productivity and nutrient mining" :* i) technologies exist to address low productivity in the major crops in Africa (maize, cassava, banana, and sorghum/millet) but Where do we deploy them? ii) crop- and soil-specific formulations are needed- Where do we start? iii) diagnosis and management of non-responsive soils; and iv) diagnosis of soil constraints in production systems such as AfSIS tools, local indicators, test kits, lab tests etc.

*3."We need a 'unifying theory' of sustainable soil management"* to combine the various existing technologies which are often framed as specific ''paradigms'' (Conservation agriculture (CA), evergreen agriculture, ISFM, organic agriculture, etc.)  so as to avoid creating a silo mentality. There is a need to create a pathway to sustainable intensification identifying which principles are important and where to apply them? In addition, there is need to create effective engagement among policymakers on sustainable soil management.

4.*"We need to engage with value chains to make investments in soil management profitable".*
The investments on soil ecosystem services and fertility management need to be increased. The costs of inputs are often 5 times higher than the World market price. Maximal use efficiency- (i.e. to maximize value : cost ratio or benefit-cost ratio) should be stressed. Innovative analytical models exist in this respect. Small packs of inputs (for initial micro-dosing) and private sector interest in producing specific blends packed in relatively small packs have been shown to be efficient.  The challenges to uptake the engagement with value chains include the need to sensitize and engage all actors in one place (fertilizer, seed, credit and markets, etc.) so that small producers can be effectively linked to markets, and thereby improve their returns. (Value chain analysis looks at the sequence of steps and relations between producers and other actors involved in the process of production to market delivery of a product to identify methods for increasing efficiency, and ways to enable businesses to increase productivity and add value.

5. *"We have experienced bottlenecks with engaging a large number of farmers"*
The wheel should not be re-invented but one should rather make use of the knowledge generated from many years of research in Africa to draw lessons learned and use them to create the desired change. For example:  i) Learn from the performance of best practices, tested with farmers under their management; ii) appreciate that larger farmers can take greater risks iii) understand the limitations of extension methods Farmer Field Schools, radio, video, demonstration plots, etc.; iii) recognize that ICT tools can be effective for 'simple' knowledge transfer (e.g., Nutrient  Manager tools); iv) analyse how to deal with complexity ('blanket recommendations' vs. 'site-specific soil fertility management'); v) Which dissemination approaches are relevant for which levels of complexity targeted? and vi) How to engage poorer farming families (typologies)?

The role of GSP Pillars for African rural development could be through: i) linking national soil initiatives to regional or global soil communities for advice and support; ii) functioning as a direct voice to policy makers at national, regional, and even local level; and iii) ensuring that Africa's voice is heard at politically important events (e.g., the World Soil Day).

The GSP could focus its specific agenda on: i) the identification of gaps at either continental or regional scale and ii) be an honest broker of best soil management practices ("Let the farmer decide!"). Table 1 shows ongoing initiatives and relationships with the five GSP Pillars involving and building on existing actors/programs.

**Table 1.** Ongoing activities related to the five main pillars of action of the GSP.

| GSP Pillars | On-going activities |
|---|---|
| **1. Promote sustainable management of soil resources** | Various ( CGIAR, NARS, etc.) |
| **2. Encourage investment, technical cooperation, policy, education awareness and extension in soils** | AGRA (Soil Health Consortia), etc. |
| **3. Promote targeted soil research and development focusing on identified gaps and priorities.** | NSF-Bread (non-responsive soils), etc. |
| **4. Enhance the quantity and quality of soil data and information.** | AsSIS, ATA, etc. |
| **5. Support harmonization of methods, measurements and indicators for sustainable soil management** | WLE CRP, Vital Signs etc. |

### 1.2.6. Status of the New Partnership for Africa's Development (NEPAD) Fertilizer Program in Africa.

***Maria Wanzala, NEPAD.***

The NEPAD Agency's Fertilizer Support Program was developed to monitor and promote the implementation of the Abuja Declaration "Fertilizers for an African Green Revolution" at national and regional levels. The program provides technical assistance and advocacy support to countries and to Regional Economic Communities (RECs) in regard to harmonization of policy and regulations, removal of taxes and tariffs, increasing access to seeds, fertilizers etc. Other activities include:

1. Conduct studies on fertilizer policy and marketing issues to inform agriculture development planning and decision-making (one study completed and two studies planned in 2013).
2. Convene regional dialogues to promote regional policy harmonization (regional policy platforms on fertilizer subsidies and on innovative financing for fertilizer interventions are planned for 2013).

3. Conduct policy advocacy training for key stakeholders (training on advocacy skills to promote fertilizer policy and regulatory issues as delineated in the Abuja Declaration, also a workshop will be held in Mozambique in 2013).
4. Mainstream ISFM into the Comprehensive Agricultural Accelerated Development Programme (CAADP) - blueprint for revitalization of the Agricultural sector in Africa (aiming to increase agricultural production by 6% and increase national budgets by 10%).

NEPAD activities are challenged by the following constraints: i) inadequate human resources at the agency; ii) lack of financial resources for the NEPAD fertilizer program; iii) monitoring and reporting on implementation of the Abuja Declaration is a core program activity but there is low response rate at country level; and iv) insufficient commitment at country level to prioritize on the fertilizer agenda. Progress was also mentioned through activities of the African Fertilizer and Agro-business Partnership (AFAP) that was set up to increase participation and investment by the private sector and closer collaboration with AFO (African Fertilizer Organization).

### 1.2. 7. Global Partnership on Nutrient Management (GPNM) to promote sustainable nutrient management for ecosystems' health.

***Anjan Datta. United Nations Evironment Programme (UNEP).***

Paradoxically while there are problems of access to fertilizers in some regions, there is an overuse of fertilizers and mismanagement in other regions, which is resulting in serious emissions of greenhouse gases and substantial contributions to climate change. The published report ''Our Nutrient World'' reveals that in some areas too much fertilizers are used, particularly in peri- and urban agriculture, leading to pollution of water resources and soil degradation. Nearly 75% of the applied nutrients are lost in the environment due to over-application or mismanagement Sutton, Bleeker *et.al.*, 2013). By 2030, FAO predicts that the global $N_2O$ emissions from manure and fertilizer application will increase from 35% to 60% (SOLAW, 2011). In recent years the use of nitrogen and phosphorous has been respectively 9 and 3 times greater than before. According to Rockstrom (2009) human interference has caused the nitrogen cycle to exceed the "planetary boundaries", which are appropriate global limits. Indeed, it is important to recognize that the global warming potential for $N_2O$ is 296 times greater than a unit of $CO_2$ .

The ''nutrient challenge'' strives to strike a balance between the needs for food and energy and a complex web of adverse environmental impacts. Currently, the nutrient input is imbalanced with overuse in intensive industrial agriculture and underuse in small-scale farming systems (in particular in Africa). In the context of population growth, there are aggravating threats of climate change and urbanization The greatest challenge is how to reach nutrient use efficiency and to achieve both 1) enhanced crop yields, as well as 2) efficiency of resource use, improved soil fertility and improved environment.

The Global Partnership on Nutrient Management (GPNM) was launched to address this challenge and consists of a global partnership of governments, scientists, civil society, industry, NGOs and international organizations. This UN initiative is guided by a steering committee with UNEP as secretariat in order to: i) implement strategic advocacy and cooperation at global and regional level for the promotion of nutrient use efficiency and, together with stakeholders, develop guidance, strategies or policies on sustainable use of nutrients; ii) enhance the capacity of various stakeholders to design and implement effective management policies; iii) create a knowledge platform to support science policy interaction and translate science for policy makers; iv) positioning of nutrient issues as part of the international sustainable development agenda; and v) innovate and regenerate knowledge to reduce nutrient losses and promote overall Nutrient Use Efficiency.

According to GPNM-UNEP (2010) a 20% improvement in Nutrient Use Efficiency by 2020 would lead to annual savings of 20 million tons of Nitrogen. This would result in improvements in human health, climate and biodiversity worth around 100 billion USD per year. Several targets addressing environmental impacts caused by nutrients can be found in the Global Agenda, notably in the Convention on Biological Diversity - Aichi Biodiversity Targets, in the Rio+20 Outcome document and UN SG's Oceans Compact and in the Manila Declaration adopted at the Third Intergovernmental Review Meeting (IGR-3) to strengthen Implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA).

# 2. National presentations on status of soil and land resources, and needs and priorities for sustainable soil management.

## 2.1. Status and challenges in Burundi.

*Prosper Dodiko. Soil Fertilization Department, Ministry of Agriculture and Livestock.*

| Background Box | |
|---|---|
| **Total land area** | 27,834 $km^2$ |
| **Population** | 8,1 million |
| **No. of provinces** | 16 |
| **No. of communes** | 129 |
| **Arable land** | 3 million ha |

Country facts about Burundi are summarized in the background box. A major problem in the country is widespread soil acidity leading to unproductive soils for crop development An estimated 1 million of the 3 million ha of arable land have a pH lower than 5. Other soil challenges are exacerbated by lack of investment and governmental cooperation. Specific problems include: i) soil degradation through burning and soil erosion; ii) low capacity and expertise in soil management; iii) underuse of mineral fertilizers and animal manure; iv) lack of sustainable soil management methods; vi) lack of studies performed on the feasibility of making available mineral fertilizers (e.g. natural phosphate reserve of Matongo); vii) importation of fertilizers through the government on a tendering process, leading to small quantities available and used (Table 2); and viii) abundant natural lime reserves but lack of investment for its extraction.

**Table 2.** Imported fertilizers used on type of cash crops

| Fertilizer | Crop |
|---|---|
| DAP 18-46-0 | Beans, corn , wheat, potatoes |
| UREA 46% | Rice, coffee |
| KCL 60% $P_2O_5$ | Potatoes, palm |
| NPK | Tea, cotton, tobacco |
| TSP 45% $P_2O_5$ | Sugar cane |

Burundi has a great potential to extract its own raw materials for liming. The studies performed by the Institute of Agronomic Sciences of Burundi (ISABU) evaluated reserves at 850 million tons derived from four separate geological units: i) dolomitic rocks of Moso, ii) dolomitic marbles of Bubanza and Gasenyi, iv) travertine of Imbo North + Busiga and v) carbonatites of Matongo. In 2010-2011 some 3,600 metric Tonnes of limestone was produced which is insufficient for improving soil productivity. There is a serious need for Burundi to develop fertilizer manufacturing industries to make lime and phosphate fertilizers available at affordable prices and enable farmers to increase soil pH and hence crop productivity. Currently there is a need to produce 1 million Tons of food per year to meet food security needs in the country.

## 2.2. Soil Resources status and its priority for sustainable management in Eritrea.

***Kiflemariam Abraha. NARI-ERITREA.***

Country facts of Eritrea are summarized in the background box. The landscapes in Eritrea are dominated by arid to semi-arid conditions leading to the formation of shallow soils with low availability to hold moisture for crop development. According to the FAO soil classification system the dominant soil types include Cambisols, Regosols, Leptisols, Fluvisols, Solonchacks and Vertisols. Soils in the Western plains include Vertisols and Fluvisols which, with adequate rains or under irrigation, are highly suitable for agricultural development. The major land use systems are divided in 9 classes (Table 3).

| Background Box | |
|---|---|
| **Total land Area** | 124,000 $km^2$ |
| **Topography** | From very steep to flat plains with a central highland dividing the country between its Eastern and Western lowlands. Altitudes from 3,000m - 130m a.s.l. |
| **Rainfall pattern** | Erratic with high variation per year |
| **Annual rainfall** | 200 -800mm (North-South) |
| **Climate** | Hot and arid (Coastal Plain) to Temperate Sub-humid (Eastern Highland Escarpment) |
| **Mean temperature** | 16 -30° C (Highlands-Red Sea Coast) |

**Table 3.** Land use systems in Eritrea showing extent and percentage cover of each in the country

| Land use system description | Hectares | % |
|---|---|---|
| Cultivated rainfed land | 562,280 | 4.62 |
| Irrigated land | 22,000 | 0.18 |
| Disturbed forests | 53,000 | 0.43 |
| Forest plantations | 10,000 | 0.08 |
| Woodland and shrubland | 673,000 | 5.52 |
| Browsing and grazing land | 6,821,320 | 55.96 |
| Barren land | 4,047,000 | 33.21 |
| Potential irrigable land | 600,000 | 4.92 |
| Potential rainfed land | 904,320 | 7.42 |
| **Total** | 12,189,000 | 100 |

### The Status and Challenges of the Soil and Land Resources in Eritrea

Nutrient and soil organic matter depletion and hence low soil fertility is a major challenge for food production caused by a combination of biophysical factors such as: i) wind and water erosion due to poor vegetation cover and intense rains; and ii) shallow soils overlying bedrock hence low moisture-holding ability; and socioeconomic factors , including:  iii) poor agricultural practices adopted by rural communities; iv) the lack of soil data to inform farmers and enable correct use of the soils according to suitability/ potential; v) limited coverage of exploratory and reconnaissance soil surveys - not conducted country-wide; vi)) limited use of satellite images/ aerial photos/ GIS to support soil surveys.

According to results from soil analysis, nitrogen and phosphorous deficiencies are widespread, while potassium is found in medium to high levels. Challenges regarding soil health enhancement include the lack of capacity by smallholders and rural communities to apply proper fertilizer applications due to lack of time, labour, knowledge (type, quantity and timing of application) and lack of financial resources. Climatic risks, such as the frequency of drought also affect soil management and productivity. To mitigate these challenge the promotion of wide adoption of soil and water conservation and water harvesting practices would be useful. However, low labour capacity of smallholders is an additional challenge. Several mitigation practices which could be implemented to address soil degradation and some practical obstacles that need to be addressed for their effective implementation are given in Table 4.

**Table 4.** Mitigation practices for soil health enhancement and challenges for implementation in Eritrea

| Mitigation practice | Challenges |
|---|---|
| Fallow | High population density with high demand on land for food production.<br>Lack of fencing and free grazing (common property). |
| Animal manure | Low livestock ownership.<br>Free grazing leading to low collection of manure.<br>Priority use as a fuel for cooking and plastering. |
| Compost | Used in areas where no animal manure is present.<br>High labour demand.<br>Lack of capacity for preparation of quality compost. |
| Crop residues left on fields | Generally, crop residues are used for communal grazing<br>Lack of fencing to keep out livestock.<br>Used for other priorities fodder, construction, fuel, sale.. |
| Conservation Tillage | Lack of capacity and equipment<br>Lack of suitable herbicides |
| Live barriers to wind erosion or runoff | Are used to control runoff (water management).<br>Lack of suitable tree species.<br>Competition with crops (light, nutrients, moisture).<br>High labour demand for maintenance. |

**Soil Survey**

The development of soil mapping in Eritrea could be a useful tool to reverse soil degradation and enhance soil health. Soil survey provides information on various soil attributes that can be mapped and used for guidance on suitable land use systems or areas of priority for restoration. There is a need for capacity building in soil survey in Eritrea as the country suffers from a lack of trained staff and scarcity of up-to-date soil data and studies, which are essential investments for soil health enhancement and conservation. To date exploratory and reconnaissance soil surveys were carried out to quantify and characterize specific areas for potential irrigation schemes. In 1998, a sector study on soils for irrigation and water resources planning was initiated at national level but not finalized. Proxy indicators are used to evaluate soil status such as crop yields backed up by results of soil laboratory analysis when available.

**Soil restoration**

A range of priority interventions to improve soil restoration in the country are proposed and include: i) the need for soil analysis, especially of pH, to evaluate potential fertility; ii) soil and water conservation measures; iii) introduction and promotion of conservation agriculture; iv) replenishment of soil nutrient reserves; v) soil description according to common properties and characteristics; vi) strengthened national soil laboratories for periodical soil analysis; vii) establishment of satellite soil laboratory services at zonal levels; and viii) increased research for the establishment of appropriate practices for soil restoration.

## 2. 3. Status of soil resources in Ethiopia and priorities for sustainable management.

*Samuel Gameda. Ethiopian Agricultural Transformation Agency (ATA).*

Current challenges threatening food security in Ethiopia are the notably high population density increasing rapidly and coupled with an increasing deficit in crop production. About 85-90% of the population (68-70 million or around 12 million households) depend on agriculture. At least one million metric tons in grain equivalent is needed to meet national food security demands. Actual harvests show maximum cereal yields of 2 T $ha^{-1}$ and pulse crops 0.8 T $ha^{-1}$. The total cultivated land is around 12 million ha mainly as semi-commercial or subsistence farming systems. Land shortage and migration to more marginal lands and protected areas are contributing to serious impacts on land productivity due to land degradation.

**Factors affecting soil productivity**

Soils in Ethiopia are inherently poor and considered among the oldest on the continent. They are vulnerable to soil erosion by water and wind and soil erosion rates average 137 t $ha^{-1}year^{-1}$. Nutrient mining in cultivated crops is common due to lack of adequate fertilizer application. Soil nutrient depletion has caused severe deficiencies in N, P, K, S and Zn levels as well as Bo and Cu in parts of the country. Unsustainable farming practices such as removal of crop residues from the fields, low application of farmyard manure and insufficient fertilizer inputs cause soil degradation and nutrient depletion. Other challenges include waterlogging, soil acidity affecting 40% of the soils, and alkalinity in specific areas (Figure 2).

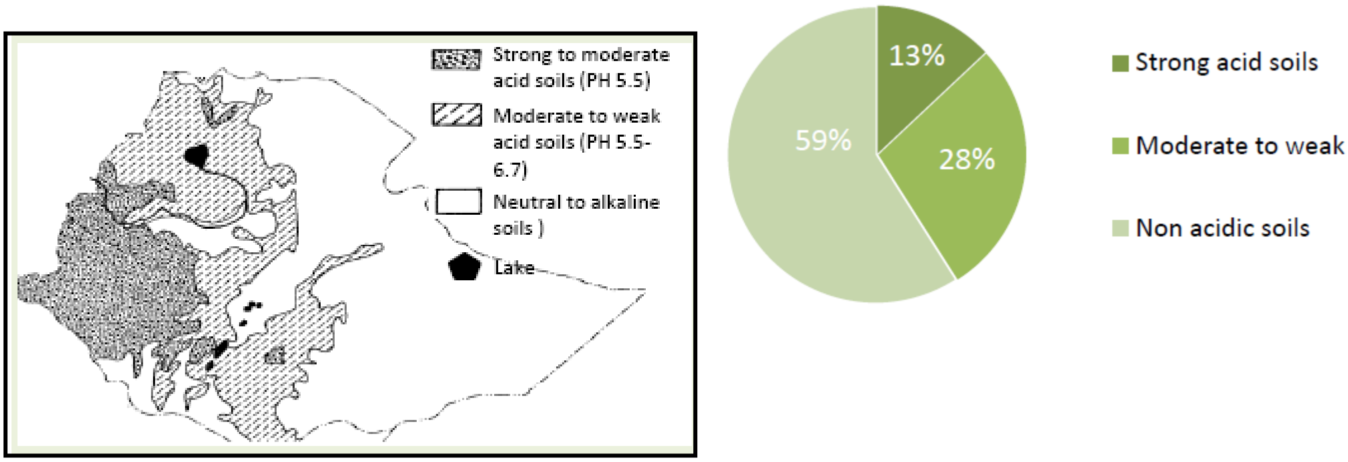



**Figure 2.** Ethiopia's soil acidity situation.

## Soil bottlenecks

The lack of capacity for sustainable soil management, weak policy support and outdated soil data are major constraints that need to be addressed to attain resilience in soil health and conservation. The bottlenecks can be presented and grouped into five main categories, from information management to organization and management systems (Figure 3).

| Bottlenecks | |
|---|---|
| **1. Soil Information management**<br>• Lack of up-to-date information on soil fertility<br>• No shared soil information database | **5. Organization and Management systems**<br><br>**Absence of an independent national soil research institute**<br><br>**Lack of coordination among research institutions**<br><br>**Limited coordination among soil laboratories** |
| **2. Technology generation and dissemination, and linkage**<br>• Lack of soil test-based fertilizer recommendations<br>• Lack of soil fertility and health management technology registry and release mechanism<br>• Low emphasis on soil fertility focused extension system<br>• Limited research emphasis on soil health and fertility<br>• Limited lab capabilities and capacity<br>• Inadequate use of, and inappropriate management for, irrigation<br>• Limited coordination between research, extension, and academia | |
| **3. Input value chain**<br>• Limited accessibility/affordability to inputs (e.g. fertilizer, soil amendments)<br>• Inefficiency in distribution and marketing of fertilizers<br>• Other inefficiencies in value chain<br>• Limited financial support to farmers' adoption of practices | |
| **4. Strategic and regulatory framework**<br>• Limited quality control mechanisms and regulatory systems for inputs<br>• Lack of proper agricultural land use management and strategy implementation | |

**Figure 3.** The bottlenecks constraining the sustainable management of the Ethiopian soils.

## Interventions and Priorities

There are recent Governmental initiatives that address the soil challenges including massive land rehabilitation in the highlands and national Sustainable land management programme (SLMP). Implemented efforts include: i) scaling up best soil management practices as in Vertisols; ii) increase liming of acidic soils; iii) promotion of compost use among rural communities; iv) blended fertilizer program to introduce and test new blended fertilizers; iv) promotion of Integrated Soil Fertility Management (ISFM); v) mapping of soil fertility in agricultural lands; and vi) through EthioSIS, a joint effort between the Ethiopian government and the Africa Soil Information Service (AfSIS), geospatial projections are made using remote sensing to study soil characteristics and nutrients in space and time (Figure 4).

Soil fertility maps showing changes over time, including 150 Woredas (6-7 main nutrient requirements) was prepared. The use of fertilizers increased by 10% however the yield response was lower than expected, due to micronutrient deficiencies (S, Zn and Bo). In the future four new fertilizer blending plants will be established at cooperative unions with a capacity of blending over 250,000 tons per year. Demonstration plots at 48,000 sites in 2013 show efficient new blended fertilizers for agricultural purposes. The dry blending facilities create fertilizers with a mixture of up to six nutrients and have the flexibility to alter formulas based on soil data. The setting of local fabrics will contribute to reducing costs of import and facilitate access to the farmers.

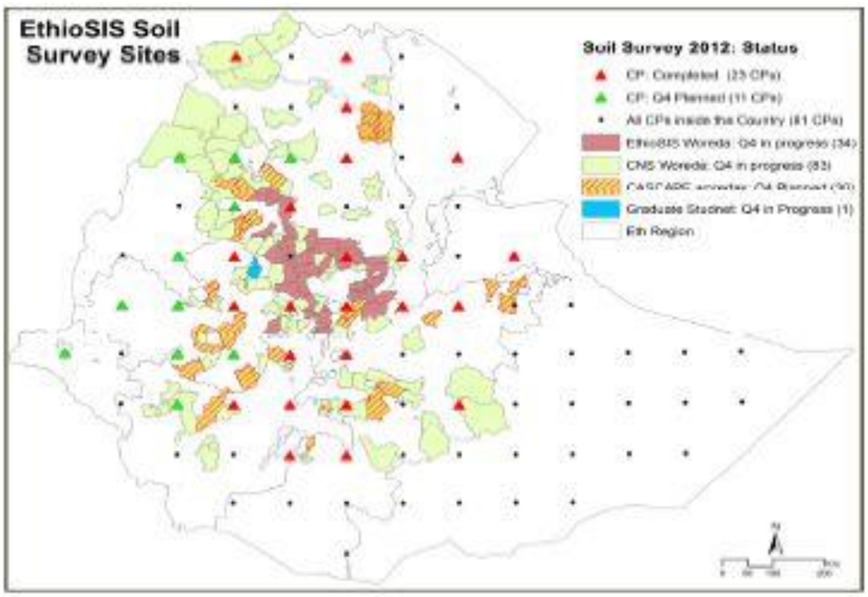



**Figure 4.** EthioSIS survey sites and sampling plan in Ethiopia.

**Sustainable Land Management Programme (SLMP)**

Massive land rehabilitation and soil conservation efforts have been implemented since the mid-1970s by the Ethiopian government and its partners. UN programs and funds (WFP, UNDP, UNEP) have partnered with MoARD for the past 45 years in soil and water conservation practices. More recently the SLMP was launched in 2008, designed to address 500,000 watersheds and reaching so far 250,000 households. The SLMP framework (now run by MoA) operates with a total budget of 103 M Euros from multiple donors and operates in 6 regional states (Amhara, Tigray, SNNPR, Tigray and Gambella) . The project includes strategies for watershed management and focuses on farmland and homestead development. The program strives to enhance promotion of Integrated Soil Fertility Management (ISFM) where the adoption of improved, sustainable farming practices are encouraged among the rural communities through field trials.

## 2.4. The status of soil resources, needs and priorities towards sustainable soil management in Kenya. Peter Macharia. Kenya Agricultural Research Institute.

The Kenya Soil Survey (KSS) has compiled national soil maps at a scale of 1:1 Million (Figure 5).

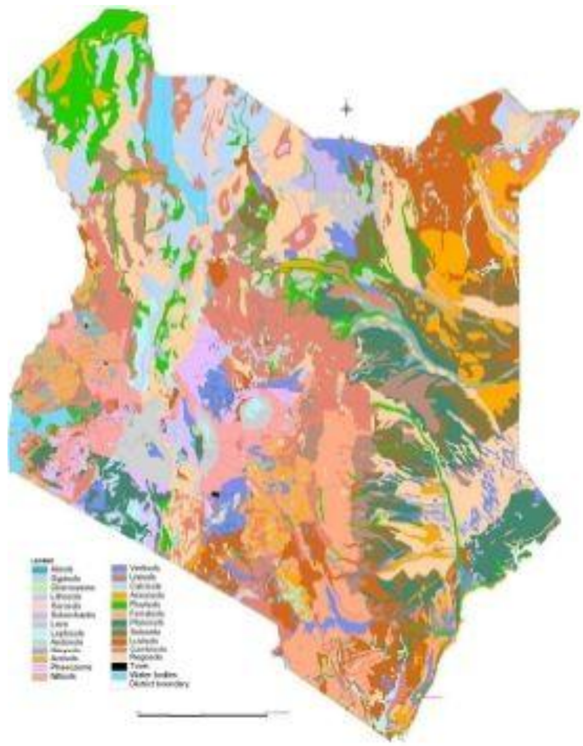


**Figure 5.** The exploratory soil map of Kenya-scale 1:1,000,000.

These are available in both analogue and digital formats and are currently used for national land use planning and management. Other compiled maps include semi-detailed and detailed soil maps covering different parts of the country. In total, about 40% of the country is already mapped at a scale of 1:100,000 and 1:250,000. Kenya has 25 major soil types with 10 dominant soil types distributed over the country including Regosols, Cambisols, Luvisols and Solonetz.

**Soil status and its challenges in Kenya**

Attention was drawn to the major national challenges that trigger soil degradation: i) In particular pressure from rapid population growth leads to low soil fertility; ii) Also migration to marginal lands is often followed by a land use change that in turn leads to soil and biodiversity degradation; iii) continuous cultivation and low inputs of soil organic matter and inorganic fertilizers have led to large areas of nutrient depleted soils; iv) deforestation and overgrazing of rangelands leads to soil erosion mainly on steep slopes (Figure 6a); v) the large areas of bare soils due to loss of protective cover leading to high runoff and erosion rates (more blue than green water, Figure 6b). A case study on soil fertility status in the Western and Rift Valley illustrated high deficiencies of Soil Organic Carbon, Total N, available P, Calcium, and Zinc.

**Figure 6 and 6.a:** Deforestation and land degradation on steep slopes in Kenya (left). 6.b. Lack of soil protective cover leading to high erosion and run-off rates in Kenya.

Challenges include: i) high costs and maintenance of improved technology including geospatial tools e.g. ArcGIS mapping software and specialized laboratory equipment for soil and plant analysis, ii) high cost of soil inventories, iii) lack of technical capacity; declining number of soil scientists and freeze of new staff employments, iv) few collaborative/partnership activities; and v) the aggravating impacts of climate change on soils and land productivity.

**Interventions and Priorities towards Sustainable Soil Management in Kenya**

Targeted efforts to address soil degradation in Kenya show the need for: i) implementing technical strategies such as Integrated Soil Fertility Management whereby the efficiency of knowledge transfer on soil fertility decline between scientists and rural communities is important; ii) to establish policy strategies as a major research area on how to plan and use more efficiently soil resources and what incentives exist for sustainable soil management practices; iii) involvement of all stakeholders along the value chain, the role of soil scientists to claim their niche and involvement of non-agricultural disciplines; and iv) the Institutional collaborative research for share of knowledge and technologies, facilities, build scientific capacity and scaling up of regional projects.

## 2.5. Rwandan soil health status for Sustainable Food Security and Economic Growth.

*N.L.Nabahungu. RAB-Rwanda.*

The agriculture sector strategic orientation of the country emphasized the vision of 2020 for shifting towards agriculture growth led by private sector. This will target and increase GDP by 1,200 USD per capita, creating 2.3 million off-farm jobs and increasing food production and food security. Rwanda has the highest population density in Africa and over 80% of its GDP emanates from agriculture. Agricultural activities are practiced mainly on marginal lands, hillside slopes covering 80% and wetlands. Soil erosion is a major challenge for agricultural production in Rwanda where half of the households suffer from the effects of moderate to severe soil erosion. The poor adoption of conservation measures causes loss of topsoil about 2.6 tonnes $ha^{-1}year^{-1}$. Other total annual losses of soil components including N, P, K and soil organic matter are illustrated in Table 5.

**Table 5.** Total annual losses of soil variables in Rwanda in T per year.

| Variable | T $yr^{-1}$ |
|---|---|
| **Soil organic matter** | 945,200 |
| **Nitrogen** | 41,210 |
| **Phosphorous** | 280 |
| **Potassium** | 3,06 |

Citing from FAO Bulletin (70) " Soil constraints to Food production and Agriculture Development" nitrogen deficiencies are caused by erosion, nutrient mining and its quick mineralization with poor replenishment. In Rwanda, over half the soils are Ferralitic and are in general very acidic (pH 3.5-4.4) deficient in P and N and to a lesser extent K and poor in bases such as Ca and Mg. These hillside soils retain very little water or nutrients. There are problems of P adsorption, in addition, the soils suffer from Al toxicity. The lime requirement is high, over 2 Tonnes $ha^{-1}$ and often liming can not be increased because of the high cost of transport.

The existing national policies include improved soil fertility management by privatizing and liberalizing the market, the regionalization of the agriculture and supporting production-oriented agriculture. Currently a Land Consolidation programme and a Crop Intensification programme are ongoing targeting some 700,000 ha of arable land and progressive increase in fertilizer use from 6 kg $ha^{-1}$ in 2006 to 29 kg $ha^{-1}$ in 2012 and a projected increase up to 45 kg $ha^{-1}$ in 2017. Other efforts towards enhancement of soil health involves the promotion of soil conservation measures such as building bench terraces, which was initiated as a public investment and the offering of one cow per poor family to increase food security.

**Priorities and Needs for integrated soil fertility management (ISFM) in Rwanda**

The challenges and opportunities in ISFM in Rwanda are illustrated in Table 6.

**Table 6.** Challenges and opportunities in ISFM in Rwanda

| Issues | Technology | Target Areas | Current adoption | Constraints |
|---|---|---|---|---|
| Need for Increasing major nutrient elements in the soil according to soil fertility status | Location specific fertilizer recommendations. | All cropping systems | Land consolidated areas | Financial capacity Low responses of soils to fertilizers and need for research need |
| Soil acidity management | Use of local limestone | Acidic areas (High land) | Southern Region | Bulky (high transport costs |
| Increase biological fixation and recycling of nutrients. | N fixation of common legumes (Soyabeans, Beans) Mycorrhiza (Banana). | Banana based farming systems | Beans and Banana cultivated everywhere | Limited knowledge of environment - rhizobia - genetic interactions , low P in soils |
| Soil organic carbon amendments. | Composting (Vermicompost, Bacteria and Mycorrhiza). | All cropping systems | FYM widely adopted | Quantity and Quality |
| Increase Nutrient efficiency in Agriculture | Minor and oligo-elements, microdosing | All cropping systems | Oligo and micro dosing not used | Research gap |

An assessment of soil degradation levels and the need for improved soil conservation practices was conducted in 2012 which showed that: i) more than 1,100,000 ha of arable land are in need of progressive terraces; ii) more than 245,00 ha require bench terraces; ii) rainfall erosivity is significant (250 to 500 R-USA units); and iv) dry mechanical erosion, deep-ploughing the land twice and hoeing twice in each cropping season causes 30 to 60 tonnes/ha of soil loss. Conservation Agriculture can make a major impact if adopted widely. From the Soil conservation baseline report soil erosion was estimated to occur on 73% of the cropland and efficient soil conservation measures extent to only 53% of the crop areas. Further, only 19% of required bench terraces have been completed.

Issues related to approaches for extension services and research for development were brought up and summarized in Table, 7.

**Table 7.** Involvement of the Rwandan government to address soil and land degradation impacts.

| Issues | Approaches | Pilot phases - lessons learned | Issues related to scaling up |
|---|---|---|---|
| Relation between downstream water users and upstream land users and nature of soil and water problems | Integrated watershed management (IWM) | Needs 5 years demonstration to create a faster spill over | Key public investment are needed as entry point |
| Thematic issues related to soil fertility | Farm Field school (FFS) | Understand the extension challenges is not obvious . Need to adhere the capacity building protocol of Farmer Field schools through empowerment of early adopters | Alternative funding mechanism to sustain results/achievements so far.<br>Linkage with market oriented approach is needed such as Innovation Platforms (IPs) |
| Link Natural resource management (NRM) and markets | Innovation platforms (IP) in areas where erosion is ranked as the first problem | SWOT analysis to be conducted to identify most suitable crops to promote soil conservation (e.g.: Potatoes are readily marketed and can motivate farmers to adopt contour ridging) | IPs can facilitated, and create a conducive environment for FFS and IWM |
| Capitalize social networks for NRM | Local to National level through Landcare | Need to discuss with donors and policy makers how to create sustainable social infrastructure for NRM e.g. a catalytic seed fund. | |

## 2.6. Status, needs and priorities for Sustainable Soil Management in Somalia.

*Ali Ismail. FAO SWALIM Liaison Office Manager.*

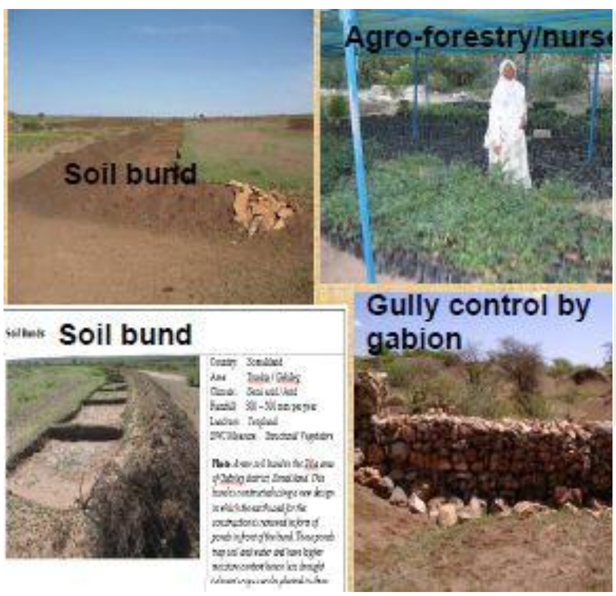
Some country facts are summarized in the background box. Soils vary between regions: In the North, soils are shallow, sandy and/or stony with deeper calcareous horizons. In the Centre, sandy soils occur along the coast and there are moderately deep loamy soils with a high content of calcium carbonate and/or gypsum further inland. In the south, soils are formed in low-lying alluvial plains (Juba and Shabelle rivers) they are clayey with poor drainage and/or high salinity. Some riverine areas in the low-lying alluvial plains are also liable to flooding. The low-lying plains consist of shallow soils interspaced with deep loamy soils with a high clay content.

**Status of Land degradation in Somalia**

Soil nutrient depletion occurs in most of the agricultural lands in Somalia. Soil degradation is estimated to cover about 30% of the arable land characterized by a loss of vegetation cover, topsoil losses and gully erosion. The main causes aggravating soil degradation: are i) increased aridity; ii) anthropogenic disturbances such as land use change through deforestation for timber, charcoal production and mining of construction materials; iii) continuous mono-cropping; iv) over-grazing; v) expansion of settlements and water points; vi) underuse of fertilizers and nutrient replenishment; vii) increased use of enclosures and encroachment of crop cultivation into marginal rangelands. All of these will progressively contribute to soil degradation and desertification if inadequate measures are taken in time.

**Responses to land degradation in Somalia**

Several efforts have been initiated in Somalia to reverse soil and land degradation including the application of soil conservation techniques such as contour bunds, gully control gabions, water harvesting and cut-off drains (Figure 7).




| Background Box | |
|---|---|
| **Total land Area** | 637,657 km$^2$ |
| **Population density** | 10,085,638 |
| **Land Use Systems** | Pastoralism as major system<br>Rainfed system (Northwest)<br>Irrigation along Rivers Juba and Shabelle and seasonal streams and springs in the North for fruits and vegetable growing. |

**Figure 7.** Soil and water conservation in Somalia.

**Needs and Priorities for Sustainable Soil and Land Management in Somalia**

There is also an urgent need to introduce Integrated Soil Fertility Management techniques for soil health improvement in the country. There are a number of constraints that hamper the implementation of sustainable soil management techniques in the country: 1) Scarce and outdated soil maps - requiring investment in soil surveys and mapping throughout the country. 2) There is a need to strengthen the capacity of national institutions (technical, and financial) to monitor and promote the adoption of Sustainable Land Management practices; 3) The current low support for agricultural/soil research institutions and extension services – this would need to be increased substantially.

## 2.7. Status, priorities and needs for sustainable soil management in Sudan.

*Abdel MagidAli ElMobarak. Land and Water Research Centre ARC*

Sudan is one of the largest countries in the continent that covers a wide range of climatic zones from dry monsoon to bare deserts, with a high variability of soil types. The major soils are found to be alkaline, free of salts, poorly drained and vulnerable to soil erosion: Aridisols, Entisols, Vertisols, among others. Table 8 shows the proportion of soil surveys conducted until now.

**Table 8.** Proportion of surveyed areas in Sudan.

| Level of Soil Survey | Total Surveyed Areas | % of Sudan Area Covered |
|---|---|---|
| Detailed Survey | 1% | 0.28 |
| Semi-detailed | 5% | 2 |
| Reconnaissance | 6% | 2.7 |
| Exploratory | 88% | 36.4 |
| **Total** | **100** | **41.3** |

**Needs and priorities for sustainable land and soil resources management in Sudan**

The main limitations leading to unproductive and degraded soil conditions include the topography, salinity, sodicity, erosion; and nutrient depletion. Urgent needs to achieve sustainable management of soil resources would require i) the development of the Soil Map of Sudan at 1:250,000 scale as a base for soil research and data harmonization and capacity building in soil digital mapping ii) climate change assessment in relation to soil properties and management iii) education on the value of the land and bridging gaps in knowledge management and coordination iv) unifying land resources planning and an investment body integrating soil needs and priorities in different parts of the country and v) creating awareness on the importance of regulating use of soil and water resources.

## 2.8. Status, priorities and needs for sustainable soil management in South Sudan.

*Pio Kowr. Research Unit of the Ministry of Agriculture, Forestry, Cooperatives and Rural Development.*

Southern Sudan has a total land size of 640,000 km$^{2.}$ It can be divided into six Agro-ecological zones (AEZ) (Figure 8.) according to the rainfall pattern, temperature and growing season. In the

Arid Zone rainfall can be as low as 300 mm per year while the Green Belt ranges from 800 to 2,000 mm per year. Temperatures in the country vary between 25 and 40°C and the growing season between 100-200 days depending on the AEZ. There are mainly two cropping seasons in April-June and in July-December. The climate is characterized by intermittent periods of drought and floods, which results in a loss of yields, death of livestock, human migration, famine and diseases. There are many water reservoirs such as rivers and streams and potential groundwater reserves, which have not yet been utilized to develop irrigation and flood management systems. The main crops grown are not sufficient to meet demands  for food security in the country.

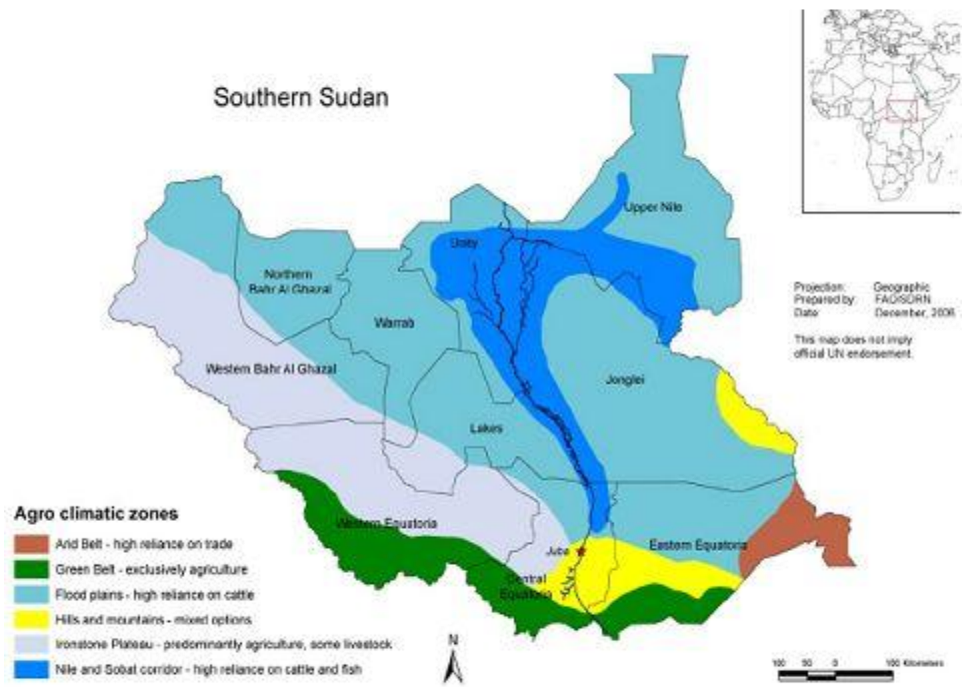



**Figure 8.** The six Agro-ecological zones found in South Sudan.

**Status of the soil heath in South Sudan and constraints**

The rapid increase of rural population and limited arable land resources leads to a chain effect of land shortage, poverty increase, poor agricultural practices and land degradation.  The soils have a high variability in soil properties and need adapted practices according to their characteristics. Overall soils are moderately fertile but in the absence of good agricultural practices and soil amendments, nutrient level are expected to decrease rapidly. The main nutrient deficiencies are phosphorus, calcium and potassium. Soil organic matter content is inherently low in many areas of the country (arable land, even virgin lands). Nutrient mining is a common challenge since adoption of fertilizer is barely used reaching a mean input of 4kg $ha^{-1}$ in agricultural soils. Nutrient mining from maize production has been estimated to range from 30-60 kg $ha^{-1}$ per year. The natural process of soil nutrient replenishment is slow in comparison to the need to produce food. For two years of continuous cropping a fallow period of 3-5 years is required. .

**Priorities and needs for soil health enhancement.**

To improve crop production and address the challenges of soil degradation and nutrient depletion there is an urgent need for capacity building among the rural communities in Integrated Soil Fertility Management and a supply of blended fertilizers (organic and inorganic). Currently, little knowledge in the use of fertilizers is available for the producers, since extension services are inadequate to assure knowledge transfer. Hence, the need to organize awareness campaigns and establish on-farm demonstration plots for ISFM, soil conservation and water harvesting. Soil surveys and soil mapping are crucial to serve as basis for soil rehabilitation. Updating of soil data and information through investing in collection, analysis, validation, reporting and monitoring is urgently required. There is also need to establish well-equipped and operational soil laboratories and to increase the training of national technicians and researchers. The research budget would need to be substantially increased.

## 2.9. Overview of the status of soil resource in Uganda, and the needs and priorities for its sustainable management.

*Onesmus Semalulu and Kayuki C. Kaizzi. NARO-Kawanda.*

**Status of soils in Uganda**

Information for Uganda is summarized in the background box. There is a high variability in inherent soil fertility and hence levels of productivity in Uganda. The potential productivity rating has been established with a grading system based on soil memoirs from 1960 (Figure 9). Efforts to convert hard copy soil memoirs into digital format are ongoing. In addition, soils database development is ongoing to integrate the newly generated analytical data with existing soils data. The soils laboratory analyzed over 12,000 soil samples in 2012.

| Background Box | |
|---|---|
| **Total land Area** | 241, 548 km$^2$ of which 15% is covered by water bodies |
| **Mean annual temperature** | 15$^o$ -30$^o$C |
| **Mean annual rainfall** | 750 -1500 mm |
| **Topography** | 1000 – 2500 a.s.l. |
| **Population density** | 32 million |
| **Population growth rate** | 3.2% per year |

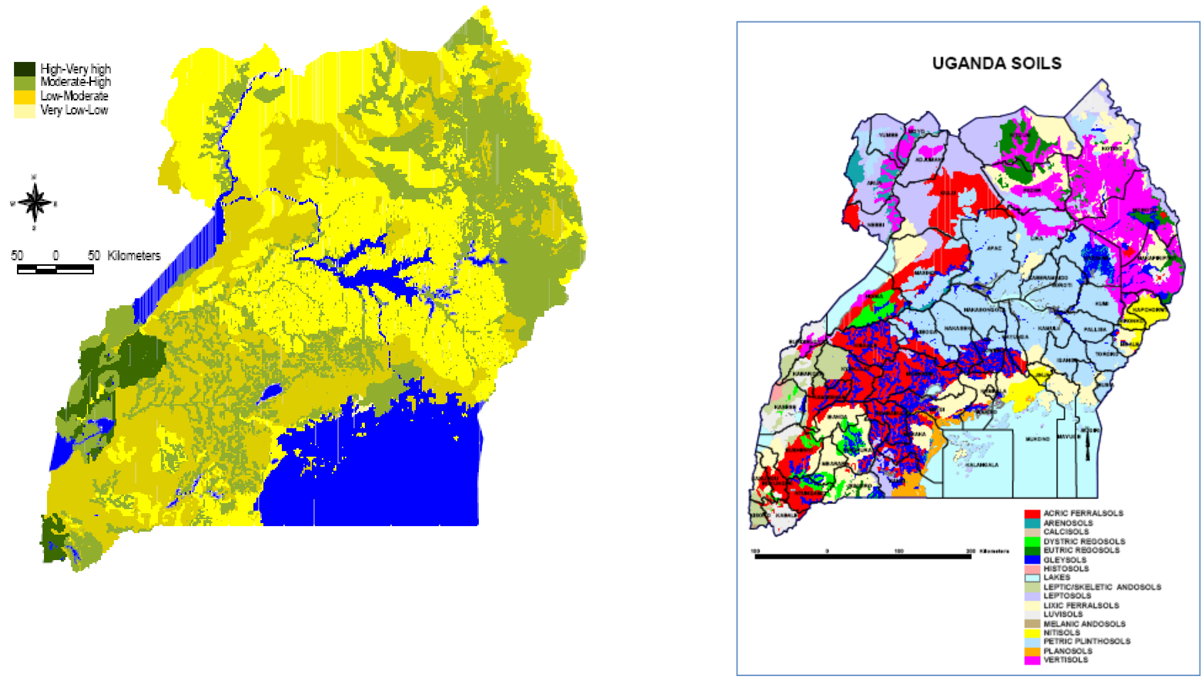



**Figure 9.** Productivity rating of the soils and the soil map of Uganda

**Soil related Challenges**

The challenges on soil resource are due to effects of growing population pressure leading to expanding area and severity of land degradation, in particular: i) soil erosion in hilly and mountainous areas but also in other topographic conditions; ii) deforestation and soil fertility decline; iii) poor agricultural practices due to lack of capacity and lack of economic resources to invest in sustainable soil management; iv) outdated soil maps; v) the lack of government support for enforcement of environmental and NRM policies and regulations; vi) poor waste disposal; vii) high cost to update the soil database and to undertake required soil analysis for farmers (11.5 USD for a routine test: pH, OM, N, P, K, Ca, Mg, texture).

**Priorities and Needs to address soil challenges in Uganda**

There are on-going efforts in the country to address challenges for soil and land degradation and to promote ISFM interventions through a range of implemented Sustainable Land Management (SLM) practices, such as Conservation Agriculture (CA) and linking ISFM to profitable enterprises. Other initiatives include the updating of fertilizer recommendation for cash crops, updating of soil information, public-private partnerships in information dissemination, providing a soil testing service to farmers and the private sector as well as policy interventions (e.g. developing a fertilizer strategy, government support to fertilizer use through National agriculture advisory development services (NAADS).

In addition to these on-going efforts to address soil challenges for soil rehabilitation in Uganda there a number of priority issues to be tackled in order to strive for sustainable soil management. To adopt sustainable soil management practices one should invest in: i) Sensitizing grass-root communities on matters of SLM, ii) Finding innovative ways of disseminating soil management information and improving information management and dissemination systems, iii) Improving networking and information/data sharing among institutions/departments, iv) investing in soil research, v) updating of soils inventory / soil survey and land use planning and vi) policy interventions (e.g. enforcement of policies and legislation, formulation of a land use policy, increase budgetary support to agriculture and environment and natural resources programs).

## 2. 10. Status, priorities and needs for sustainable soil management in Madagascar.

*Lala Razafinjara.FOFIFA, Ministry of Agriculture.*

Salient facts about Madagascar are summarized in the background box.

| Background Box | |
|---|---|
| **Total Land Area** | 587,040 km² (99%) |
| **Water Mass** | 5,500 km² (1%) |
| **Shoreline** | 5,000 km |
| **Climate** | Tropical (Coast), Temperate (Central High Plateaus), Aridic (South) |

The major soil types are divided into 4 sub-groups according to their geological characteristics: 1) Red Ferralitic soils (on crystalline terrains), 2) Yellow Ferralitic soils, Red Ferruginous soil, Calcareous soil (on sedimentary terrains), 3) Andosols and Ferralitic soils (on volcanic terrains) and Fluvisols, Hydromorphic soil, Podzols and Ferralitic soil on alluvial and colluvial terrains (Figure 10).

The main soil characteristics include high acidity ($4.5<pH<5.5$), high Fe content (iron toxicity in rice cultivation), high Al content (Al toxicity in upland crops, such as maize), very low available P (high P-fixation due to high amount of Al and Fe oxides, deficiency in nutrients such as nitrogen and potassium and sulphur in some areas, with a probability of other micronutrient deficiencies and low soil organic matter. In addition, soils are compacted and vulnerable to soil erosion.

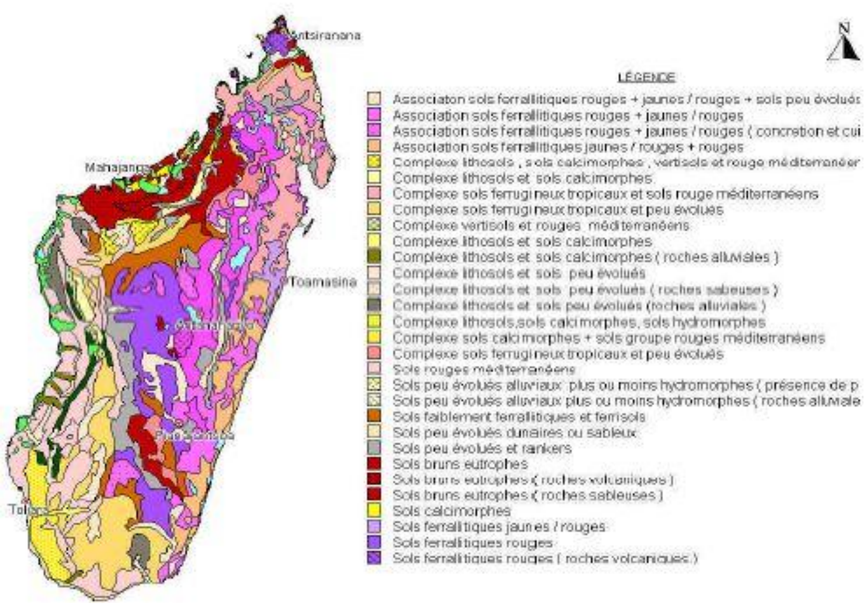



**Figure 10.** Map of soil types in Madagascar

**Major issues and challenges causing land degradation**

The main challenges driving land and soil degradation in Madagascar include the growing population density combined with poor agricultural practices such as slash and burn agriculture on steep slopes, deforestation, over-grazing and low adoption of improved techniques. The frequency of heavy rains results in soil erosion in particular with the formation of gullies in the Central High Plateaus (Ferralitic soils) leading to huge losses of top soil of 5-20 Mg $ha^{-1}$ $yr^{-1}$, soil nutrient depletion and siltation in paddy fields, lakes, rivers and irrigation networks.

To emphasize the aggravating effects of soil erosion and the importance of conservation measures, attention was drawn to two case studies performed in different regions of Madagascar to grade the level of stability of gullies known locally as “lavakas” (Figure 11).

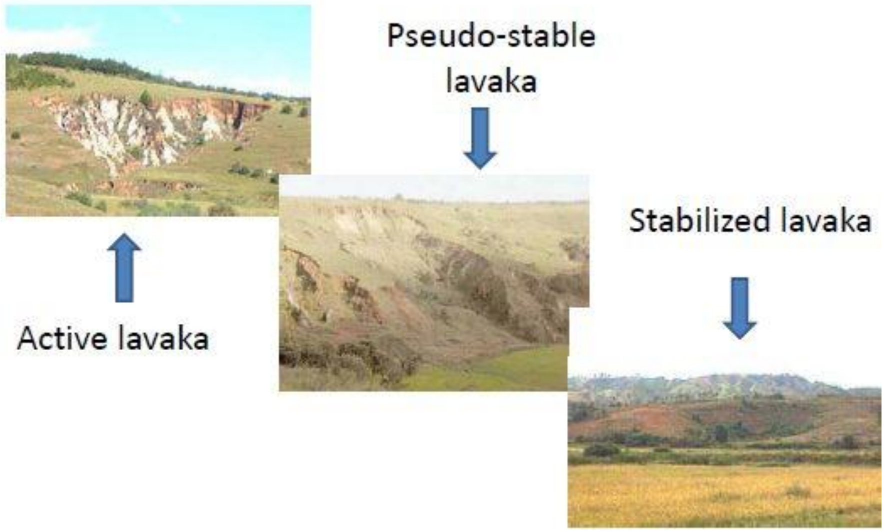



**Figure 11.** Lavaka (gully) evolution within watershed in Madagascar.

In short, with help of Landsat Imagery the total amount of soil lost was predicted depending on the level of stabilization. In two different regions the number and size (from 3 ha to 15.5 ha) of gullies/ lavakas and their stability differed largely: of the 5000 gullies in the Aoltra basin some 13% were stable; while only 2% of the 400 gullies in the region of Itasy were stable leading to higher rates of soil erosion. Regarding the amount of soil loss, compared to blanket/sheet erosion, gullying can cause higher amounts of degradation if not stable. Data computed from satellite imagery has given estimations of massive soil volume lost to erosion, some 20 billion $m^3$. Including gully erosion, which cover 40% of degrdad lands in the country and from blanket soil erosion from the remaining 60% of degraded lands.. The total soil loss in Madagascar has been thereby estimated to be massive

**Priorities and needs for sustainable soil and land management in Madagascar**

Ongoing practices to enhance soil fertility and soil conservation in the country are: 1) promotion of local available products such as animal manure, liming materials, ammonia sulphate and identifying areas where they can be used; 2) implementation of national programs for watershed and protection of irrigated areas by government and external agents (WB, IFAD, GEF); 3) promotion of ISFM and fertilizer recommendations through a national strategy on fertilizer use; and, 4) promotion of agro-ecological techniques and Conservation Agriculture (mulching, legumes cover crop and minimum tillage).

The immediate needs required to fully address the sustainable soil and land management issues in Madagascar are: i) the updating of soil inventories and soil maps with digital/geospatial tools; ii) strengthening of capacity development of young soil scientists; iii) making accurate and sound fertilizer recommendations; iv) capacity building and strengthening soil, plant and fertilizer testing and analytical laboratories for research and public service; and v) establishing fertilizer blending plants.

## 2. 11. Status of soil resources in Botswana and the needs and priorities for its sustainable management.

*Kabelo Mate.Department of Agricultural Research*

The country facts for Botswana are summarized in the background box. Agriculture constitutes the backbone of the activity of the population in Botswana, with more than 80% involved in subsistence farming. The population is concentrated in the East of the country where soil and climatic conditions are more favorable for arable farming. Even though agriculture is an important activity, it supplies barely 50% of food needs and accounts for only 3% of the national GDP. Drought is one of the factors threatening food security in the country and most rivers are seasonal making water a scarce resource.

| Background Box | |
|---|---|
| **Total Land Area** | 582,000 km² |
| **Climate** | Semi-arid |
| **Rainfall pattern** | Low and unreliable, variable from year to year |
| **Population density** | 2 million |
| **Vegetation** | grassland, natural woodland, savanna, bushland, wetlands and plantations. |

**Soil resource status in Botswana**

About two thirds of the soils consist of deep, poor, sandy soils and red and grey desert soils in the Kalahari sands. Water is obtained by drilling boreholes to a depth of around 200m, where it is found in fossil, subterranean aquifers. In some areas in the extreme West, boreholes go as deep as 500m. Eastern areas of the country consist of a hilly topography with drainage depressions which feed the Limpopo River. The soils are mainly sandy loams to sandy clay loams, with shallow skeletal soils where heavy, sporadic rainfall washes newly formed soil materials into low lying areas and down drainage lines. The soils are thus mainly alluvial and /or colluvial in form and structure. The soils of the Okavango Delta and surrounding areas are predominantly characterized by silty sands with some organic/humic content. As the rivers flow out of the Okavango Delta dispersing into the Makgadikgadi Pans areas, the soils become fine sands with high sodicity on the seasonally flooded flats and fine silt sands on the dry ancient lacustrine shoreline areas.

**Soil health and land husbandry**

For promotion of soil health and good land husbandry in Botswana the division of land resources in the Ministry of Agriculture is responsible for conducting soil surveys and mapping, gives advice on land husbandry, applies agricultural land use planning, does cartography, and includes geographical Information systems (GIS) and remote sensing sections. The Ministry employs a corresponding broad range of professionals and specialists e.g. agricultural engineers, soil surveyors, land use planners, GIS and Remote Sensing specialists, cartographers and conservation specialists. The division also develops land resources baseline data, required for sustainable land resource management, and the development of surface and sub-surface water resources for livestock and irrigation.

**Challenges encountered towards obtaining sustainable land and soil resources management**

The critical challenges to be addressed that are hindering sustainable soil and land resources management are: i) the majority of the soils covered by Kalahari desert sands which are inherently poor; ii) the climatic impact of recurrent droughts and drying out of seasonal rivers; iii) land degradation (soil erosion, overgrazing); and iv) the lack of locally sourced fodder to meet immediate needs.

## 2.12. Status and management of land resources in Malawi.

*John Mussa. Land Resources Conservation, Ministry of Agriculture and Food Security.*

The country facts are summarized in the background box. Agriculture contributes up to 90% of Malawi's export earnings and 38% of the GDP.

| Background Box | |
|---|---|
| **Total Land Area** | 118,480 km² |
| **Total Water Area** | 24,400 km² |
| **Population Density** | 13.1 million, 51% women 49% men(2008) |
| **Population growth rate** | 2,8% per year |

The major soil types in Malawi are: i) Eutric Leptisols (Lithosols) that are shallow and stony soils found on steep slopes; ii) Chromic Luvisols that are red-yellowish, deep and well drained; and iii) Haplic Lixisols. Other soil types include Acrisols - strongly leached with low pH; Cambisols - rich in organic matter content and dark brown in colour; Gleysols - high clay content and prone to waterlogging; and Vertisols - dark cracking clays that develop the ''gilgai'' micro-relief due to alternating wet and dry conditions.

**The status of the soils and measures for control**

The degraded state of the soils in Malawi is due to unsustainable agricultural practices, cultivation on marginal/fragile areas, deforestation and overgrazing. The challenges of soil degradation involve: i) soil erosion in stream and river banks forming gullies due to poor agricultural practices; ii) cultivation of marginal/fragile areas; iii) deforestation; iv) overgrazing; and v) soil compaction preventing deep rooting of the crops.

Several studies were made to estimate the amount of soil loss caused by erosion, the most recent study by World Bank (1992) estimated the amount of soil loss as 20 T $ha^{-1}$. Soil conservation practices have been adopted to mitigate soil and water erosion impacts including: i) contour ridging, building of check-dams, swales, box ridging, vegetative hedgerows (Vetiver grass); ii) agro-forestry techniques such as improved fallows and interplanting *Faidherbia albida* with crops (annual or perennial); and iii) use of animal manure, compost and conservation agriculture (e.g. inter- cropping/crop rotation, minimum tillage, soil cover) (Figure 12).

**Figure 12.** Soil and water conservation measures in Malawi: a) contour ridging (left) and b) intercropping maize and cowpea (right).

**Priorities and needs for sustainable soil and land resources management**

The Land Resources and Evaluation Project implemented in 1991 through FAO and the Government of Malawi provided updated field data on soil resources. Outputs of the program have led to increased inventory of soil properties, a land unit and land resource database, present land use and vegetation, land suitability for various crops and soil mapping of 1:250,000 scale for eight agricultural divisions across the country. However, the data has not been updated since. The lack of capacity to use of the data is also a challenge and the mapping scale is not appropriate for planning at farm level. There is an urgent need to revise land resources and appraisal data. There is also need to implement environment and NRM policies and increase capacity building on appropriate agronomic practices in the country. A range of coordinated programs on promoting soil and water conservation exists with the agricultural sector, research institutions, steering committees and university diplomas. The National land management policy and strategy 2002 and forestry policy need to be developed into an operational Action Plan.

## 2. 13. The Status of soil resources in Mozambique.

*Jacinto Mirione Mafalacusser. Platform for Agricultural Research and innovation*

The country facts for Mozambique are summarized in the background box.

| Background Box | |
|---|---|
| **Total Land Area** | 799,380 $km^2$ |
| **Temperature** | 13 to 31 $^oC$ |
| **Climate** | Tropical with dry season (Apr-Sep) and wet season (Oct-March) with common cyclones and flooding |
| **Mean Rainfall** | 800 mm |
| **Rainfall pattern** | Heavy (Coast and Highland);Low (South) |
| **Population density** | 23 million (2012) |
| **Population growth rate** | 2,5% per year |
| **Population living in rural areas** | Over 70% |

There is a long history of soil surveys in Mozambique summarized in Table 9.

**Table 9**. History of soil surveys in Mozambique.

| Type of Survey and Purpose | Map Scale | General Method | Coverage | Published |
|---|---|---|---|---|
| **Exploratory:** Establish major soil regions for agricultural planning | 1:2,000,000 | Deduction from natural resources maps ex. geological maps, study of satellite imagery, aerial photo interpretation, soil observations at selected sites and laboratory analysis of selected soil profiles. | All Country | Early 60's |
| | 1:1,000,000 | | All Country | 1995 |
| **Reconnaissance:** Systematic inventory of land resources with multipurpose land evaluation for regional planning and project location. | 1:250,000<br>1:250,000 | | Maputo, Gaza<br>All country | 1990<br>*To be Completed in 2014* |
| **Semi detailed:** General purpose: High potential areas; Special purpose: Project feasibility studies | 1:50,000 | Photo interpretation, intensive field observations (limited field testing), lab. analysis of selected profile and composite samples | Maputo, Gaza | 1990 |
| **Detailed** : Special purpose: Farm estate and project development, characterization of trial sites, irrigation layout and planning | 1:10,000<br>1:5,000 | Intensive field observations, aerial photo interpretation; field testing, laboratory analysis of soil profiles and composite samples | Scattered | |

Currently, the national reconnaissance land resources survey at a scale of 1: 250,000 from 1990, is being updated and expected to be completed in 2013. Soil mapping and land evaluations linking land use systems with soil productivity and crop requirements has had a high priority in Mozambique. The major soil types in Mozambique are: Aridisols, Lixisols, Acrisols and Leptosols (Figure 13). Most of the soils are deep, well drained, with low soil organic matter content and moderate water holding capacity. In addition, there is low risk of soil salinization in Mozambique.

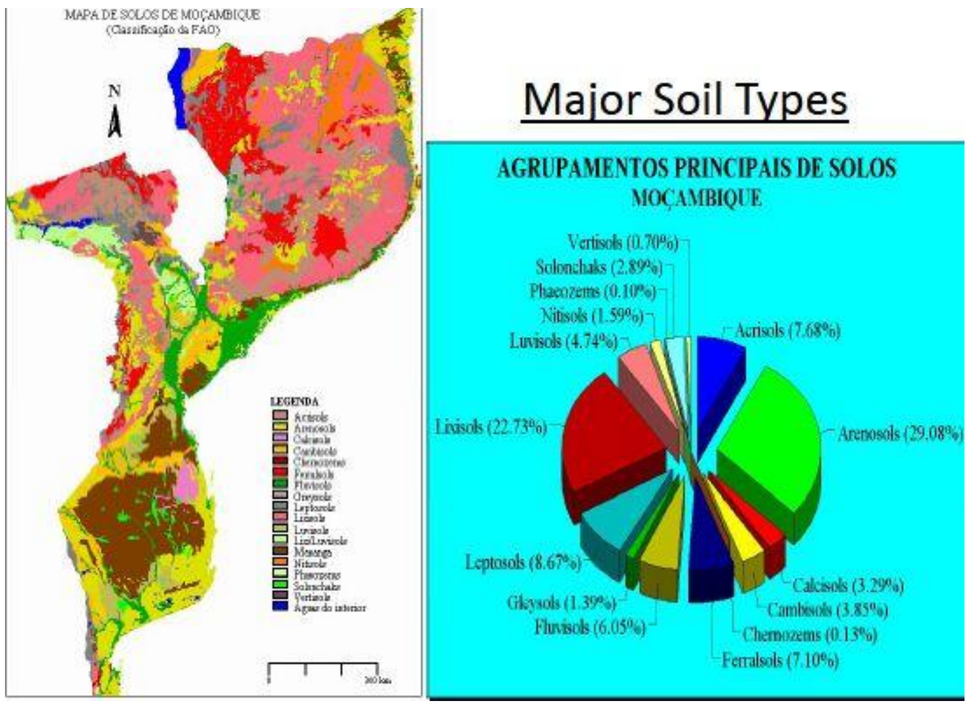



**Figure 13.** Major soil types in Mozambique.

By matching land use with soil productivity all potential areas have been determined for rainfed agriculture, afforestation (i.e., fast growing species), irrigated agriculture (i.e., paddy rice, surface, subsurface and sprinkler) and extensive grazing. With the help of soil mapping the limiting factors for different land use systems are recognized. The limiting factors for rainfed agriculture system, afforestation and extensive grazing systems are low annual precipitation, effective soil depth, erosion risk and low water holding capacity.

## 2. 14. Status, priorities and needs for Sustainable Soil Management in Namibia.

*Magdalena Hangula. Ministry of Agriculture, Water and Forestry.*

| Background Box | |
|---|---|
| **Total Land Area** | 823,290 $km^2$ |
| **Total agricultural land** | 388,200 $km^2$ |
| **Total Population** | 2,2 million |
| **Main rainfall** | 300-750mm |

The country facts are summarized in the background box. About 65% of the population depend either directly or indirectly on agriculture contributing 6.4% of the GDP. Whereas the livestock subsector contributes with 72% of the total agricultural output, the crop sub sector is only 15% and the remaining 13% is contributed by forestry. The soils are mainly sandy and rocky in desert and flood plain areas.

### Challenges for sustainable soil and land resources

There are various challenges hindering sustainable soil and land resources such as nutrient depletion, low soil organic matter content that are due to unsuitable farming practices such as mono-cropping. The high cost of fertilizer import is a problem leading to their underuse. However, even organic fertilizer such as manure is not commonly used due to labour shortage and traditional beliefs (e.g. manure could bring weeds into the fields). There is a limitation in accessing improved seed varieties and agrochemicals to combat pests and diseases and there is limited knowledge on fertilizer input among rural communities. Moreover, there is lack of capacity of soil scientists, low collaboration/partnerships for programs to enhance soil health and conservation resulting in trained staff leaving to private sector. Soil maps are outdated and technical capacity is low. There is also a weak supporting laboratory to cater for national needs (but it is outdated and ill-equipped with frequent breakages). Furthermore, the aggravating threats of climate change is causing impact on soil health and crop productivity due to high frequency of erratic rainfall, droughts and flooding.

### Priorities and Needs

Major priorities and needs in Namibia to achieve sustainable management of soil and land resources are: i) Integrated Soil Fertility Management; ii) improved cropping systems - crop rotation/Intercropping; iii) adoption of Conservation Agriculture; iv) the use of decentralized laboratories/ soil testing mobile kit; v) updating of soil fertility maps (soil digital mapping) and strengthening capacity development; vi) implementation of policies supporting best use of soil resources; and vii) strengthening support to soil research programs.

## 2. 15. Status, needs and priorities for sustainable management of soil resources in Tanzania.

*Shabani Hamisi. National Soil Service Milingano.*

Agriculture employs 85% of the population in Tanzania. Soil fertility decline has been one of the major constraints hampering rural development and resulting in deficiencies in nitrogen, phosphorus, sulphur and low soil organic matter content in the soils.

**Status of Soil Research Activities in Tanzania**

Current on-going research activities are conducted under three areas/disciplines namely: i) soil and land resources, ii) soil fertility and management iii) soil analytical services. Activities in soil and land resources include GIS applications for the inventory of land resources, land suitability assessment, farming systems zoning and agro-ecological zone delineations. GIS is also used as a tool for the maintenance and management of the national soils database. Research activities on soil fertility and management include identification of soil fertility constraints, development of technologies for fertilizer use and soil conservation techniques. Activities relating to soil analytical services include soils, plant tissue, fertilizer materials and irrigation water analysis by the five major soil analytical laboratories, and the central soils laboratory in Mlingano which is the largest and most equipped laboratory in Tanzania.

Soil research and development activities in Tanzania are undertaken to develop appropriate soil and water management technologies for sustainable agricultural production. The ongoing laboratory training programme includes training in soil, plant and water analysis, management of agricultural laboratories, natural resources inventory and interpretation and utilization of thematic maps and cartography. Other soil and land resources management training includes land suitability assessments, GIS applications in natural resources management, fertilizer quality control and application, soil and water conservation, remote sensing and aerial photo interpretation.

**National Priorities to address soil fertility decline**

Two projects focus on increasing fertilizer use: 1) AGRA's project (2010/11-2012/13) aims to increase fertilizer use from current 8 kg $ha^{-1}$ to 30 kg $ha^{-1}$, empower several institutions on Tanzania's Fertilizer Regulation Authority (TFRA) and ensure inspections of quality control; 2) The Accelerated Food Security project aims to establish fertilizer subsidies and update fertilizer recommendations in Tanzania. Activities for integrated soil fertility management were established in 1999. The SOFRAIP/PADEP project rehabilitated four soil laboratories and established GIS infrastructure. Relevant policy initiatives include the decentralized planning and management process initiated in 1998 through the Agriculture Sector development program

(ASDP). Through this initiative, resources were directly channeled to the District Councils, which are close to the farmers, for timely response on ISFM. They also ensure farmers' access to credit and markets for agricultural inputs and farm products (National Agriculture Input Voucher System) where farmers reduce their costs by 50%. The policy initiatives were also geared towards creating favorable macro-economic policies in the country.

**Priorities and needs for soil challenges in Tanzania**

The challenges facing the implementation of ISFM programs are socio-economic, cultural and institutional factors such as the high cost of fertilizers, building capacity on restoration of degraded soils among rural communities, facilitation vouchers to those who cannot afford to buy fertilizers, and the need to establish and strengthen national, regional and international Integrated Soil Fertility Management programs .

## 2. 16. Status and priorities for sustainable soil and land resources in Lesotho.

*Refuoe Boose. Department of Soil and Water Conservation*

Lesotho has a land size area of 50,000km$^2$. The country is divided into four Agro-ecological zones and crop production is mainly found in the lowlands while livestock are predominant in the highlands. Desertification, land degradation and drought are estimated to cover 60% of the land area of the country and seriously threatening livelihoods. Main challenges aggravating soil degradation and nutrient depletion are severe erosion on steep slopes, poor rangeland management and agricultural practices that lead to decline in soil fertility. The extension services are not effective and mono-cropping systems are common. The severe threat of climate change for crop productivity and soil health is due to the increase of droughts. Soil data are outdated as they date from 1988. The lack of soil scientists is also a concern. Due to low remuneration there is a tendency to migrate to other countries where higher salaries will be received.

**Priorities and needs for Lesotho**

The priorities and needs for Lesotho to attain sustainable management of land and soil resources are: i) support to update soil mapping and information for the assessment of erosion rates and soil organic carbon; ii) increase cooperation between departments of different ministries dealing with land and water conservation; iii) developing national policies on soil and water conservation; iv) adoption of ISFM technologies; v) increase the number of research stations; and vi) maintain soil scientists in the country through offering increased salaries.

## 2. 17. Status, priorities and needs for Sustainable Soil Management in South Africa.

*Liesl Wiese. Agricultural Research Council Institute for Soil, Climate and Water.*

South Africa has a dual agrarian structure of commercial production and small-scale farming. Of the population of 50 million people some 32% are hungry or at risk of hunger. The potential arable land size for cropland is 17% (16,8 million ha), 13,7% is of low potential while 68% (21,6 million ha) is not suitable for agriculture. The soil data available at scales of 1:1 M and 1: 250,000 include 19 different soil classes. Soils vary in condition among the regions but in general 81% are slightly weathered and 30% of sandy content (Figure 14). Due to these properties there are limited potentials for intensive agriculture and high vulnerability to soil degradation. Three recent studies (2009-2011) were commissioned on land degradation in South Africa, including land degradation assessment in drylands (LADA), the soil protection strategy (SPS), which has not been completed, and erosion modeling, which revealed a soil loss rate of 12.6t ha$^{-1}$ yr$^{-1}$. Hence, soil erosion is considered as the major challenge for soil health enhancement in South Africa. Gullies have been digitized and estimated to cover 2% of the country. Soils suffer from sealing, crusting, compaction, reduced water holding capacity, and increased rainwater run-off.

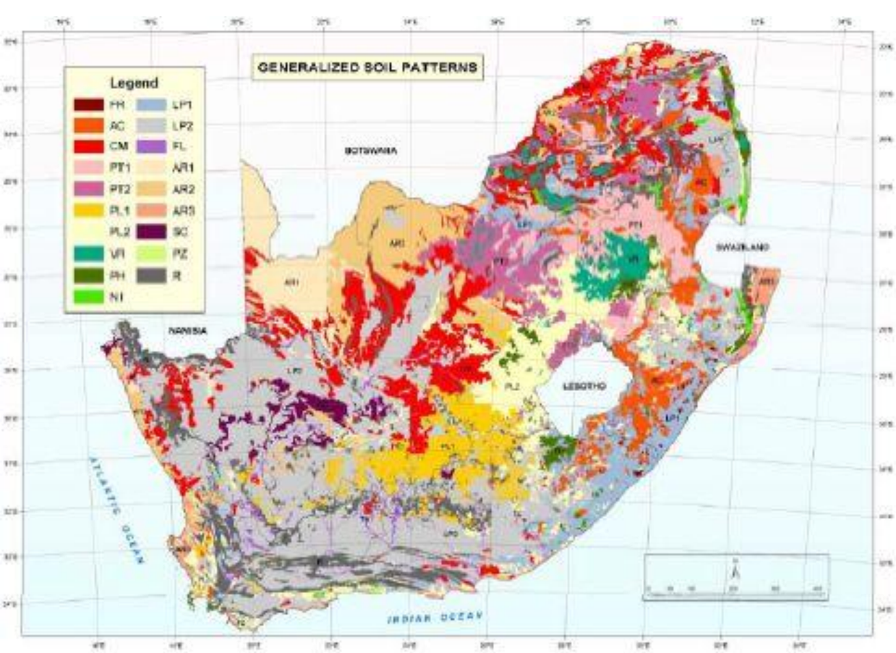



**Figure 14**. Generalized Soil Patterns Mapping

A specific challenge confronting the public sectors and producers that depend on soil resources in South Africa is the underuse of fertilizers in small-scale farming leading to decrease of nutrients and soil organic matter content. In commercial systems, the past trend in use of fertilizer was reversed resulting in high soil acidity due to excess N inputs. Other challenges involve weak political will, lack of proper planning and implementation on ground, lack of governmental support and incentives since smallscale farming does not generate a profitable market, and the lack of youth engagement among the rural population. Normally school punishments involve land labour creating a negative perspective towards agriculture. There is a need to improve databases including more detailed and long term monitoring of impacts.

Priorities to ensure sustainable management on soil and land resources in the country involve: i) increased awareness on sustainable soil management practices and land degradation challenges among all stakeholders; ii) strengthen capacity development of soil mapping and management at all levels; iii) update of soil databases with more detailed and long term monitoring; iv) increase cooperation between institutions to avoid overlapping of mandates; v) create incentives for affordable and effective inputs and solutions; and vi) harmonization of technical data from research institutions for decision makers to implement good policies.

**Current Initiatives**

The free publication of the Soil Survey Journal to compile soil surveys in South Africa, an on-line journal accessible through webpage http://sosj.journals.ac.za/pub. has been launched. Currently, it is seeking soil survey reports for compilation.

## 2. 18. The Status of soil resources, needs and priorities towards sustainable management in Swaziland.

*Bongani Magongo. Swaziland Ministry of Agriculture*

| Background Box | |
|---|---|
| **Total Land Area** | 17 363 $Km^2$ |
| **Climate** | Sub-Humid and temperate (Highveld) to semi-arid (Lowveld) |
| **Mean rainfall** | 788 mm |
| **Rainfall pattern** | About 75% from October to March |
| **Temperature** | 12 $^oC$ -28 $^oC$ (Highveld) and 18 $^oC$-37 $^oC$(Lowveld) |

The country background is summarized in the background box. The country is divided into four agro-ecological zones from west to east. In the west is the Highveld (covering 30% of the total area), then moving eastward the Middleveld (28%), and to the East, the Lowveld (33% of the area). The Lubombo Escarpment is the fourth region and covers about 9% of the total area. There are two major land tenure systems in the country. The Title Deed Land (TDL), privately owned and covering about 46% of the land area and used mainly for ranching, forestry or estate crop production such as pineapples. The Swazi Nation land (SNL) held in trust by the King for the Swazi people covers 54 % of the country. The Major land use systems consist of rainfed agriculture, irrigated crop production and livestock grazing, whereby 50% of the land is communally grazed and 19%

under commercial ranching. Forest plantations cover about 8% while parks and natural reserves cover 4% of the total land area.

**Challenges, need and priorities for sustainable soil and land resources management**

Major challenges for sustainable soil management include land degradation (nutrient leaching, erosion), deforestation, overgrazing and soil acidity. The identified needs and priorities include soil conservation (agronomical, mechanically), liming input, subsidies to increase fertilizer input, rational land use practices, the updating of soil and land use maps from 1984, the use of remote sensing and GIS and afforestation practices.

## 2. 19. Status, priorities and needs for sustainable soil management in Zambia.

*Stalin Sichinga .Zambia Agriculture Research Institute*

The country has a land size of about 750,000 km$^2$ and 55 - 60% of the land is covered by natural forest and 6% by water. In addition, only 14% of the 9 million ha cultivable land is cropped every year. The country consists of three agro-ecological regions consisting of various rainfall patterns, soil types and other climatic conditions namely regions I, II, and III, as summarized in Table 10.

**Table 10.** Soil types in the agro-ecological regions of Zambia and physical and chemical soil limitations

| Agro-Ecological Region | Annual rainfall per year | Common soil types | Physical Limitations | Chemical limitations |
|---|---|---|---|---|
| I | <750mm | slightly acidic Nitosols to alkaline Luvisols with pockets of Vertisols, Arenosols, Leptosols and Solonetz | Limited soil depth soil erosion, hardpans, low water-holding capacity and wetness in valleys. | Some soils face challenges of sodicity and salinity |
| II | 750 - 1000mm | IIa: Productive soils hosting major part of the agricultural sector Lixisols, Luvisols, Alisols, Acrisols, Leptosols and Vertisols.<br>IIb: Another region contain a range of Arenosols, Gleysols, Histosols and Podzols. | IIb: low water holding capacity, shallow rooting depths, rapid physical deterioration, erosion hazard and poor workability | low nutrient reserves and retention capacity, low Ca, Mg, P, organic matter content and high acidity in some pockets |
| III | > 1000 mm | Acrisols and some Ferralsols developed in conditions of high leaching | soil degradation | soil acidity, low base retention capacity, soil organic matter,low soil fertility |

### Main challenges and on-going efforts for enhancement of soil productivity in Zambia

Challenges limiting the realization of sustainable land and soil utilization in Zambia include: i) nutrient depletion; ii) soil erosion; iii) underuse of manure and fertilizers; and iv) climatic conditions characterized by erratic rainfall. Table 11 summarizes the ongoing initiatives to address soil nutrient depletion and degradation in Zambia in collaboration with different actors.

**Table 11.** Interventions so far used to address issues of improving soil fertility in Zambia

| Technology Category | | Practice | Advantage |
|---|---|---|---|
| Cultural Practices | Crop rotations | Legumes after cereals | Reduction in fertilizer use,<br>Improved soil fertility, pest and disease control, weed control (e.g. Striga) |
| | Agro forestry improved fallow | 2-3 year fallow phase with tree species like: *Gliricidia, Acacia, Leucaena, Sesbania, Tephrosia* | Improve soil fertility<br>Control and avoid soil erosion<br>Cost effective or reduce the use of chemical fertilizer<br>Improve soil structure |
| Cultural Practices | Green manure<br>Crop fallows | Velvet beans and Sun hemp either incorporated or left on the surface | Improve soil structure and fertility, leading to vigorous growth of the following crop and reduce erosion |
| Compost manure practices | Mixed plant residues, animal dung, earth /soil materials, wood ash, water | | Improves soil structure, reduce erosion and improves water and nutrient holding capacity of the soil |
| Erosion control practices | Conservation tillage | Ripping, basins and minimum tillage | Erosion control and rain water infiltration |
| Liming | Dolomitic (more magnesium than calcium) or calcitic (more calcium than magnesium) lime | | Reduces soil acidity, make nutrients readily available for crop uptake and eliminates aluminium toxicity |
| Inoculum | *Rhizobia* inoculum | | Enhances biological nitrogen fixation in legumes and increases yields |
| Fertilizers | Basal and top-dressing fertilizers | | Supply the nutrients needed for enhanced crop production |

## 2. 20. Status of soil resources in Zimbabwe. The needs and priorities for sustainable soil management.

*David Dhliwayo. Chemistry and Soil Research Institute.*

The majority of smallholder farmers (i.e., 75%) in Zimbabwe lack resources and knowledge for enhancement of soil health and conservation. Sandy soils cover 70% of the land in Zimbabwe and have inherently poor conditions of low soil organic matter content, are prone to leaching and contain limited amounts of nitrogen, phosphorous as well as Ca, Mg, Zn and Bo. In areas with high rainfall, soil acidity is causing a reduced effect of fertilizer inputs such as phosphorous (fixing to the positive aluminum and hydrogen ions instead). The low effectiveness of NPK fertilizers and poor agricultural practices in densely populated areas is another problem. The average NPK depletion map of Africa for the period of 1993-1995 (Figure 15) is presented to illustrate the urgent need to increase fertilizer input for improvement of soil health.

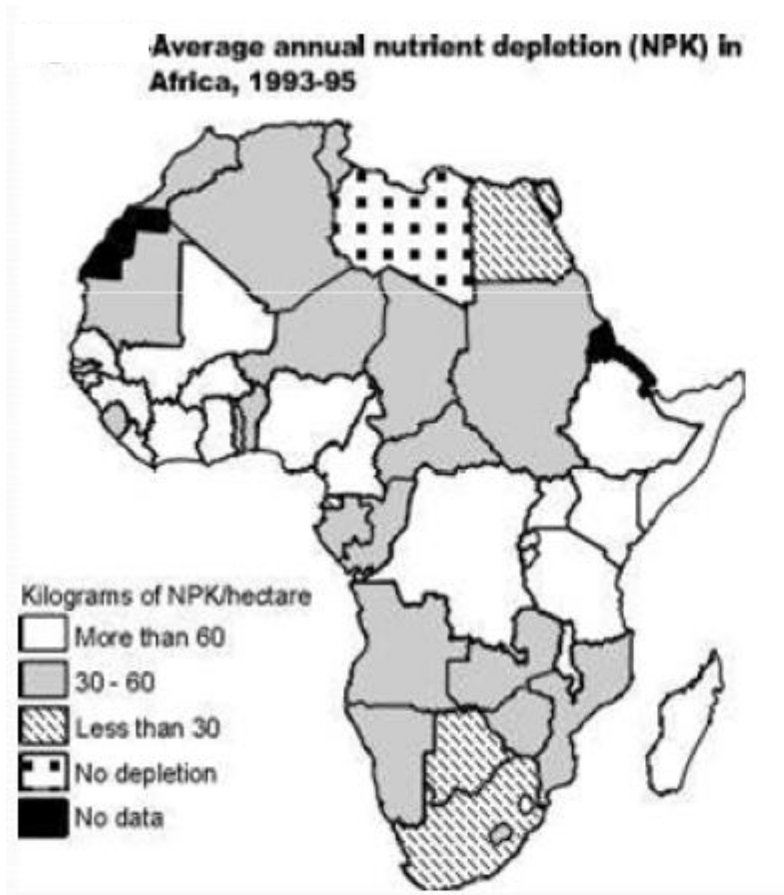



**Figure 15.** Nutrient depletion rates on the major fertilizers (NPK) in Africa 1993-1995.

The low amount of fertilizer input in 2002-2003 of 9 kg $ha^{-1}$ compared with other continents as East and South East Asia with 135 kg $ha^{-1}$ (FAO, 2004) is also striking (Table 12). As a consequence the average grain yield produced in Africa is only 1 T $ha^{-1}$ compared with the rest of the world 3 T $ha^{-1}$( Africa Fertilizer Summit, 2006).

**Table 12**. Average nutrient application rates in 2002-2003 in kg $ha^{-1}$ in the world(FAO,2004).

| Continent | NPK input kg $ha^{-1}$ |
|---|---|
| Sub-Saharan Africa | 9 |
| Latin America | 73 |
| South Asia | 100 |
| East and South East Asia | 135 |

**Status and needs of the soils in Zimbabwe**

The Zimbabwe National Soil Classification System is based on classifying parent material and physical and chemical properties of the soil. Figure 16 shows the agro-ecological zones of Zimbabwe associating the high variability of soil types with Land-use systems. For instance in Region I the high rainfall leads to high soil leaching of nutrients in Acrisols and proper fertilizer and liming would be required for efficient crop production.

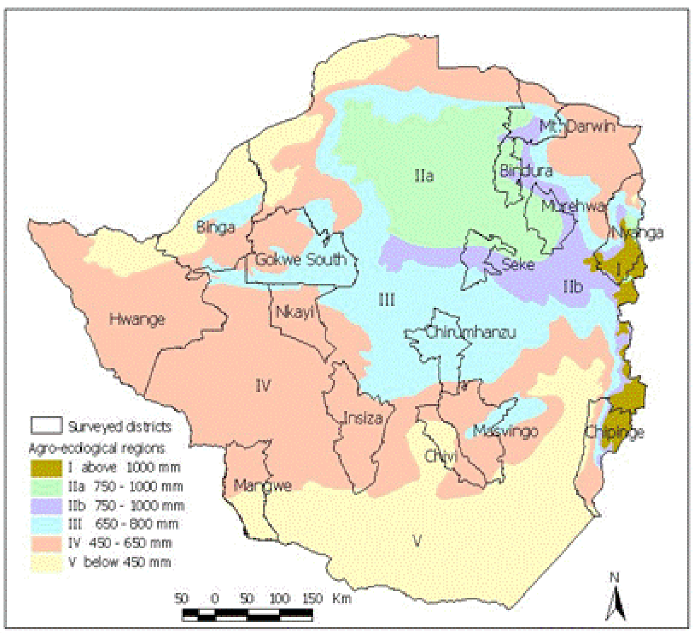



**Figure 16.** The agro-ecological zones in Zimbabwe.

The most extensive soil types found in Zimbabwe are Nitisols, and Luvisols (or Fersalitic soils) which are cultivated to maize. These are distinguished from other soil types by their moderate phosphorus sorption capacity and high amount of free sesquioxides. Other soil types found in the country, the geographical distribution, and common land use are summarized in Table 13.

**Table 13**. Soil type distribution including characteristic and common land use in Zimbabwe

| Soil type WRB 2006 | Geographical region | Characteristics | Common Land use |
|---|---|---|---|
| Leptosols | North-North WestSteep slopes | limitation of depth by *continuous rock within 25 cm of the soil* surface susceptible to erosion | Game Reserves and National Parks |
| Arenosol | Western part of the country i.e. Hwange, Lupane and Nkayion flat or gentle undulating topography | Thick sand profiles<br>Show little or no horizon development | Used for National Parks, Game Reserves, Forests<br>and some smallholder farming areas. |
| Vertisol | semi-arid regions of Zimbabwe | Seasonal cracking<br>High clay content consisting of mainly expansive clay<br>high moisture-holding capacity | Sugarcane, cotton and citrus tree plantations |
| Siallitic (Luvisols, Gleysols, Cambisols) | North-western and South-eastern lowveld. | Clay soils comprising of both 2:1 clay minerals.<br>Profile mostly shallow to relatively shallow.<br>High agricultural potential soils but are limited by aridity of the environment where they occur. | Used for irrigated sugarcane and wheat production in the South-eastern lowveld.<br>Used for ranging of cattle and wild life |
| Fersialitic (Nitisols, Luvisols) | Most extensive soil group | High content of free sesquioxides.<br>Moderate phosphate sorption capacity | Most of Zimbabwe's maize belt lies within the<br>area covered by these soils |
| Paraferrallitic (Lixisol, Acrisol) | On the uplands of the central plateau<br>at relatively high altitudes . | Highly leached soils found in high rainfall zone. | Tobacco, maize |
| Orthoferralltic (Acrisols, Ferralsols ) | eastern highlands, the Bikita – Ndanga highlands in the south-east of the country | Moderately deep soils.<br>Very fine weakly developed crumb structure<br>Very high porosity.<br>Poor nutrient status | Forestry<br>Plantations crops e.g. coffee and tea |
| Sodic (Solonetz, Solonchaks) | These soils are found in the Zambezi and Save valleys (on the south eastern part of the country) | Sodic soils high concentration of Na (E.S.P ≥ 15). | These are not suitable for most croppingactivities.<br>Used to grow crops tolerant to high Na and high<br>pH, e.g. cotton, sorghum, millet. |

**Current Interventions**

Ongoing efforts by the government to address soil challenges affecting crop productivity in Zimbabwe are through its research and extension arm which promotes: i) biological nitrogen fixing legume production through a government owned factory for Rhizobia production; ii) Integrated Soil Fertility Management, currently targeting over 90% of the farmers; iii) Conservation Agriculture for control of soil erosion, over 100,000 households have been targeted; iv) the use of micro-dosing to encourage fertilizer use in semi-arid areas where fertilizer previously was not used; v) promotion of water harvesting techniques in semi-arid areas (tied ridges, graded contours, infiltration pits, etc.); vi) liming and fertilizer management in acidic and highly leached soils; vii) land use change to game reserves, national parks and forests for soils with thick sandy profiles with little or no horizon development and sodic soils used for cotton, sorghum and millet production; and viii) soil testing based fertilizer and liming recommendations.

# 3. Plenary and Working Group Discussions on Main Needs and Priorities for sustainable soil management in Eastern and Southern Africa (Pillar 1 of the GSP).

## 3.1 Discussion on the actionable areas for the Global Soil Partnership (GSP) in Eastern and Southern Africa

In launching a Regional soil Partnership under the Global Soil Partnership (GSP) it is important to:

- Promote soil matters in the countries of the region; and
- Distinguish the soil needs and priorities, hence contribute in determining how and what to address based on country level needs without duplicating on-going efforts but to strengthen and fill the gaps of the current soil initiatives.

The GSP is developing a global plan of action for each of the 5 pillars of action and a regional plan where every country in the region is represented. The GSP intends to catalyze funding to implement the plans of action and also assist in proposal development, fund mobilisation and training/capacity development at national and regional level. Some soil related problems cut across countries and therefore there is a need for linkages and a regional approach. The challenges, needs and priorities for the Eastern and Southern African region are the following:

**Challenges**

1. Soil erosion.
2. Loss of soil biodiversity and fertility.
3. Management of specific soil types and nutrients.
4. Policy implementation.
5. Lack of water harvesting development.
6. Lack of sustainable response use to inputs.
7. Lack of coordination/partnerships.
8. Lack of up-to-date (digital) soil maps.
9. Little information on ongoing policy activities concerning soils in countries.

**Needs**

1. Capacity building.
2. Database management.
3. Digital soil mapping.
4. Scaling up of existing maps.

5. Soil testing equipment.
6. Policy regulation.
7. Raising awareness on soil importance.
8. Adoption of technologies.
9. Correct price policy.
10. Education and targeting of the young.
11. Research targeting farmers.
12. Fertilizer technologies and nutrient blending.
13. Incentives for farmers.

**Priorities**

1. Infrastructure and equipment (soil testing, laboratories, etc).
2. Management of specific soil types.

**Gaps**

1. Capacity building towards advocacy and communication with policy makers.
2. Lack of understanding where technologies work.
3. Sustainable management of livestock.
4. Climate change and soil carbon research.

## 3. 2 Plenary agreements on actionable areas (priorities) for the region

Possible actionable areas that require follow-up attention:

1. Dissemination of GSP plans of action (PoA) and review/adaptation for regional needs. Support for developing implementation plans.
2. Inventory of national soil information – Individual countries to lead.
3. Develop a training/capacity development program for identified areas/priority areas - Individual countries to develop this and lobby for FAO support through GSP.
4. Carry out training - GSP Secretariat to lead in consultation with partners.
5. Develop an (online) national soil database/information service – countries.
6. Work with other partners to produce promotional material from what is already available and known and facilitating interaction with other global initiatives.
7. GSP to facilitate funding from donors in the region and assist in applying for the funds.
8. Develop realistic proposals for action as soon as possible.

9. GSP to facilitate policy dialogue so that the message given is clear and strategic.
10. Identify the comparative advantage of the GSP *vs.* all other initiatives.
11. Identify success stories and current research activities that address our needs.
12. Possible selection of specific sites to test available holistic approaches - Link participatory approaches like FFS with action research to obtain rapid and effective results.

# 4. The suggested way forward for Global Soil Partnership in Eastern and Southern Africa.

A communiqué with key points was prepared on what has been agreed in the workshop for improving soil health and management in the Eastern and Southern Africa region. In addition, the following was also agreed upon:

i. The setting up of a regional secretariat for the GSP (The Sudan, CIAT, NEPAD and South Africa volunteered to act as a temporary regional secretariat). The permanent terms of reference for the secretariat would be made available as soon as available. In the meantime, these volunteers would act as an information hub between the GSP Secretariat in FAO headquarters, countries and institutions
ii. The need to hire a communication agency to help with branding the soil activities and targeting the various stakeholders.
iii. The intergovernmental technical panel on soils (ITPS) would meet in Rome, Italy in June, 2013 and prepare a Global Plan of Action.

## 4.1 Group discussions and agreements on needs and future actions

### GROUP I

**Question 1:** ***What actions are needed in your country/region to address identified soil priorities and needs? And How can one ensure a participatory stakeholder driven process?***

| KEY NEEDS | ACTIONS |
|---|---|
| Capacity building. | • Laboratory infrastructure.<br>- National laboratories for basic analysis.<br>- Regional labs. for specialized analysis.<br>- Analytical standards harmonization.<br>• Extension/Service Providers/Farmer capacity building.<br>- Interpreting soil analysis reports, visual assessment.<br>- Soil sampling procedures.<br>- Basket of options for specific soil problems.<br>- Need for decision guides for diagnosis for specific soil problems.<br>- Mainstreaming indigenous knowledge in dealing with soil condition. |
| Scaling up of existing technologies. | • Take stock of existing technologies.<br>• Engaging with development partners.<br>• Targeting technologies to farmer methods (what works where and why?).<br>• Risk assessments that are associated with particular technologies.<br>• M&E framework to enable identification of new technologies.<br>• Adapting innovations from other areas/regions. |
| Specific soil management. | • Soil and crop specific fertilizer blends.<br>• Better understanding of technologies for farmer conditions.<br>• Other approaches of soil/nutrient/water management (e.g. CA).<br>(There was no specific discussion on adaptation to climate change) |
| Policy. | • Facilitating national and regional cross learning/sharing of success stories/technologies.<br>• Facilitating cross border movement of technologies.<br>• Price policy for accessing inputs.<br>• Quality control of inputs and deterrent measures.<br>• Packaging information for policy makers.<br>• Communicating sustainable management practices to policy makers.<br>• Identify the anchor for policy dialogue on soil management.<br>• Africa ministerial conference on ISFM.<br>• Find specific Ministry to house Soil related.<br>• Aware on soil/land tenure and related issues. |
| Awareness creation. | • Explore use of ICT and social media to create awareness on sustainable soil management.<br>• Explore use of e-Extension.<br>• Using media effectively e.g. Public service announcements in the media.<br>• Exploring how media can be used for cross-border learning.<br>• Observation of soil day – prepare publicity events during that week.<br>• Mainstreaming soil management issues in schools (farmers of the future). |

**Question 2:** ***What do you expect the GSP to provide to support these?***

- Support to streamline our prioritized needs.
- Provide direct support from GSP.
- Facilitate funding from donors.
- Facilitate policy dialogue.
- Facilitate regional exchange between GSP chapters.
- Work with other partners to produce promotional materials from what is already known.
- Facilitating interaction with other global initiatives.
- Physical presence in ESA, sub-regional, national.
- Governance structure in ESA with secretariat to support the chapters.

**Question 3: What Existing Initiatives can we Build On?**

The first task of regional GSP secretariat is to compile this information.

### GROUP II

Group two discussed targeting research to user and policy needs. The following three main questions had to be addressed.

**Question 1:** ***Why should we discuss this issue?***

- Farmers need to be organized
  - Identify needs through farmer organizations.
  - Representatives.
  - Grass root expression of needs.
- Designing a research project
  - Address real/actual farmers' needs.
  - Develop recommendations that farmers can use.
- Practical/applicable

**Question 2:** ***What needs to be done?***

- Communication between researchers and farmers.
  - Involve land users/farmers in the project development.
  - Interactive process.
- Extension link

- Difference between developed and developing.
- Missing in many developing countries.
- Under staffed and under budgeted.

- Funding
  - Not much funding for Agricultural-research in general.
  - Donors have their own needs and specifications that do not necessary address farmers' needs.
- Mismatch between donor objectives and farmers' needs
- Limited use of multidisciplinary teams
  - Systems analysts with specific solutions to specific problems.
- Lack of adaptation of participatory and adaptation approaches to soil management
  - e.g. No soil management curriculum for Farmer Field Schools.
- Research methods need adaptation to the on-farm situation
  - Currently on-station approach *vs.* on-farm approach.

**Question 3 :** ***How do we do that? Focus on GSP comparative advantage and generate 3 or 4 proposals***

- Creation of innovation of R4D platforms or agro-business platforms
  - Involvement of all stakeholders (farmers, researchers, government, NGOs etc.).
  - Focusing on value chain approaches.
  - Research problems should be identified through these platforms.
- Reorientation of measurement of research outputs
  - e.g. Journal Impact Factor *vs* Farmer Impact Factor.

### GROUP III

**Question 1:** ***How to address the challenges?***

1. **Generation of soil information**

a) Inventory of existing soil information (from national repositories and individual sources, FAO, AFSIS, ISRIC, JRC, NGOs, etc.).
   i. Each country to develop a Concept Note on how to inventory their soil information.
   ii. Share and interrogate the Concept Note through a regional coordinator (to be identified) and GSP.
   iii. Submit the Concept Note to GSP for enrichment and facilitation.

iv. Implement the Concept Note and develop status of national soil information.

v. Organize national workshop to critique and enrich the report on status of national soil information.

vi. Produce a report of status of national soil information in each country (and for the region, mainly from the country reports).

b) Identification of information gaps.

c) Processing of existing information into user-friendly formats (e.g. digitizing analogue data).

d) Production of new information (using existing and new data).

**2. Information packaging and dissemination**

a) Develop national digital soil information/database/library.

b) Develop user-specific and simplified soil information (e.g. demand driven maps, land suitability maps, fertilizer-requirement maps, etc.).

c) Develop soil management toolkits for farmers, schools, extension officers, policy makers etc.

d) Awareness creation (soil ambassadors, newspaper/media campaigns, internet, etc.).

**3. Networking and coordination**

a) Develop a framework for coordinating with similar organizations in the region.

b) Identify organization to network with (e.g. AFSIS, ASSS, EASSC, NEPAD, IGAD, etc.).

c) Develop a network and coordination team to reach out to the organizations.

**Question 2: How to address the needs?**

**1. Capacity building**

a) Training of staff

i. On new techniques for information generation (DSM, DSA, etc.)

ii. On online soil information service (development and setup).

**2. Information management**

a) Develop online repository for soil information (at national and regional levels).

b) Develop periodic synthesized data for land management, policy briefs, etc.

**3. Investments**

a) National/regional investment in soil (through legacy data, lobby for creation of soil information division within line-ministries, regional organizations, etc.).

b) Donor support and GSP facilitation.

c) Individual time (staff-time).

**ACTION POINTS**

- Dissemination of GSP plan of action (PoA) and review/adapting for regional needs – GSP to provide the PoA.
- Inventory of national soil information – Individual countries to lead.
- Develop a training program for identified areas/priority areas in capacity development- Individual countries to develop this and lobby for FAO support through GSP.
- Carry out training - GSP to lead in consultation with.
- Develop (online) national soil database/information service –countries.

## ANNEX 1. Workshop Agenda

| TIME | TOPIC | PRESENTER |
|---|---|---|
| **Day 1 : Monday 25 March, 2013** | | |
| **Session 1: Introduction to Global Soil Partnership and Regional initiatives** | | |
| Chair: Christian NolteFAO | | |
| 8:00-9:00 | Registration | |
| 9:00-9:15 | Opening by FAO | Sally Bunning, FAO |
| 9:15-9:30 | Introduction by participants | All |
| 9:30-10:15 | Introduction to the Global Soil Partnership<br>Presentation of Soil videos | Ronald Vargas, FAO |
| 10:15-10.30 | Coffee Break | |
| 10:30-10:40 | Status and priorities of soil resources in Eastern Africa | Anthony Esilaba, EASSC |
| 10:40-10:50 | Incorporating secondary and micronutrients into fertilizers | John Wendt, IFDC |
| 10:50-11:00 | Status and challenges of soil health management in Africa | Rebbie Harawa, AGRA |
| 11:00-11:10 | Status and challenges of soil fertility in Africa | Saidou Koala, CIAT |
| 11:10-11:20 | Status and challenges of ISFM in Africa | Bernard Vanlauwe, IITA |
| 11:20-11:30 | Status and challenges of Fertilizer Programme in Africa | Maria Wanzala, NEPAD |
| 11:30-11:40 | Experiences from the Global Partnership on Nutrient Management | Anjan Datta, UNEP |
| 11:40-12:30 | Discussions about regional challenges | |
| 12:30-13:45 | Lunch break | |
| **Session 2: National presentations on status, needs and priorities for sustainable soil management** | | |
| Chairs: Hanadi El El Dessougi and Justice Nyamangara | | |
| 13:45-14:00 | Status, priorities and needs for sustainable soil management in Burundi | Prosper Dodiko<br>Soil Fertilization, Ministry of Agriculture and Livestock |
| 14:15-14:30 | Status, priorities and needs for sustainable soil management in Eritrea | Kiflemariam Abraha<br>Head Soil Research Unit, Ministry of Agriculture |
| 14:30-14:45 | Status, priorities and needs for sustainable soil management in Ethiopia | Samuel Gameda<br>Ethiopian Agricultural |

| TIME | TOPIC | PRESENTER |
| --- | --- | --- |
| | | Transformation Agency |
| 14:45-15:00 | Status, priorities and needs for sustainable soil management in Kenya | Peter Macharia<br>Kenya Soil Survey, KARI |
| 15:00-15:15 | Status, priorities and needs for sustainable soil management in Rwanda | Nabahungu Nsharwasi Léon, Rwanda Agriculture Board |
| 15:15-15:45 | Coffee break | |
| 15:45-16:00 | Status, priorities and needs for sustainable soil management in Somalia | Ali Ismail<br>FAO-Somalia |
| 16:00-16:15 | Status, priorities and needs for sustainable soil management in Sudan | Abdel Magid Ali Elmobarak, Agricultural Research Corporation |
| 16:15-16:30 | Status, priorities and needs for sustainable soil management in South Sudan | Io Kowr, Ministry of Agriculture, Forestry, Cooperative and Rural Development |
| 16:30-16:45 | Status, priorities and needs for sustainable soil management in Tanzania | Shaban Hamisi, National Soil Service Milingano |
| | Status, priorities and needs for sustainable soil management in Uganda | Onesimus Semalulu, National Agricultural Research Labs |
| 17:00-18:00 | **Plenary discussion about status, needs and priorities in Eastern Africa** | |
| 19:00-20:30 | Cocktail | |
| **Day 2: Tuesday 26th March, 2013**<br>**Session 3: National presentations on status, needs and priorities for sustainable soil management** Chair: Peter Macharia | | |
| 8:45-9:00 | Status, priorities and needs for sustainable soil management in Botswana | Kabelo Mate<br>Ministry of Agriculture |
| 9:00-9:15 | Status, priorities and needs for sustainable soil management in Lesotho | Refuoe Boose<br>Department of Soil and Water Conservation |
| 9:15-9:30 | Status, priorities and needs for sustainable soil management in Madagascar | Razafinjara Lala<br>FOFIFA |
| 9:30-9.45 | Status, priorities and needs for sustainable soil management in Malawi | John Mussa<br>Land Resources Conservation, Ministry of Agriculture and Food Security |
| 9.45-10:00 | Status, priorities and needs for sustainable soil management in Mozambique | Jacinto Merione Falacusser<br>Instituto de Investigacao Agrária de Mocambique |
| 10:00-10:30 | Coffee Break | |
| 10:30-10:45 | Status, priorities and needs for | Magdalena Hangula |

| TIME | TOPIC | PRESENTER |
| --- | --- | --- |
| | sustainable soil management in Namibia | Ministry of Agriculture, Water and Forestry |
| 10:45-11:00 | Status, priorities and needs for sustainable soil management in South Africa | Liesl Wiese<br>Institute for Soil, Climate and Water |
| 11:00-11:15 | Status, priorities and needs for sustainable soil management in Swaziland | Bongami Magongo<br>Ministry of Agriculture |
| 11:15-11:30 | Status, priorities and needs for sustainable soil management in Zambia | Stalin Sichinga<br>Zambia Agricultural Research Institute |
| 11:30-11:45 | Status, priorities and needs for sustainable soil management in Zimbabwe | David Dhliwayo<br>Chemistry and Soil Research Institute |
| 11:45-13:00 | Plenary discussion about status, needs and priorities in Eastern and Southern Africa | |
| 13:00-14:15 | Lunch | |
| | **Session 4: Discussions about the needs and priorities towards sustainable soil management** | |
| 14:00-15:15 | Plenary discussion about the main needs and priority of actions towards sustainable soil management in Eastern and Southern Africa Chair: Sally Bunning | |
| 15:15-15:30 | Coffee break | |
| 15:30-17:30 | Working groups on key priorities identified by plenary Chair: Christian Nolte | |
| **Day 3: Wednesday 27th March, 2013**<br>**Session 5: Moving Forward** | | |
| 8:30-10:00 | Working groups on key priorities identified by plenary in regard to the GSP Pillars Chair: Saidou Koala | |
| 10:00-10:15 | Coffee break | |
| 10:15-13:00 | Working groups continued and Report back | |
| 13:00-14:00 | Lunch break | |
| 14:00-15:30 | Establishment of the Eastern and Southern Africa Soil Partnership .<br>Preparation on a Communiqué Chair: Ronald Vargas | |
| 15:30-15:45 | Coffee break | |
| 15:45-16:45 | The way forward Chair: Ronald Vargas | |
| 16:45-17:00 | Closure | |

## ANNEX 2. List of Participants

| Name | Organisation | Country |
|---|---|---|
| | | |
| Abdel Magid Ali Elmobarak | Land and Water Research Centre, Agricultural Research Corporation, Wad Medani | Sudan |
| Abednego Kiwia | AGRA | |
| Ali Ismail | FAO-Somalia | Somalia |
| Angeline Mwadime | CIAT | |
| Antony Esilaba | Eastern Africa Soil Science Society | Kenya |
| Bongani Magongo | Ministry of Agriculture | Swaziland |
| Christian Nolte | FAO | |
| Christian Omuto | University of Nairobi | |
| David Dhliwayo | Chemistry and Soil Research Institute | Zimbabwe |
| Emmanuel Twagirayezu | Ministry of Agriculture and Animal Resources | Rwanda |
| Fanossie Mekonnen | Ministry of Agriculture | Ethiopia |
| Hanadi El Dessougi | University of Khartoum | Sudan |
| Isaac Savini | CIAT | |
| Jacinto Merione Falacusser | Platform for Agricultural Research and innovation in Mozambique | Mozambique |
| James Mutegi | IPNI | |
| John Mussa | Land Resources Conservation, Ministry of Agriculture and Food Security | Malawi |
| John Wendt | IFDC, Programme Leader, NRM, | Kenya |
| Juliet Ogola | CIAT | |
| Justice Nyamangara | ICRISAT, Zimbabwe Soil Science Society | Zimbabwe |
| Kabelo Mate | Ministry of Agriculture | Botswana |
| Kayuki Kaizzi | National Agricultural Research Labs | Uganda |
| Kiflemariam Abraha | Soil Research Unit, Ministry of Agriculture | Eritrea |
| Liesl Wiese | Institute for Soil, Climate and Water, Pretoria | South Africa |
| Lucy Ng'ang'a | Ministry of Agriculture | Kenya |
| Magdalena Hangula | Ministry of Agriculture, Water and Forestry | Namibia |
| Maria Wanzala | NEPAD | |
| Mr Stalin Sichinga | Zambia Agricultural research Institute | Zambia |
| Nabahungu Nsharwasi Léon | Rwanda Agriculture Board (RAB) | Rwanda |
| Onesimus Semalulu | National Agricultural Research Labs | Uganda |
| Peter Kuria | ACT, Programme Officer | Kenya |
| Peter Macharia | KSS, Kenyan Agriculture Research Institute | Kenya |
| Peter Okoth | CIAT | |
| Pio Kowr | Ministry of Agriculture, Forestry, Cooperative and Rural Development | South Sudan |

| Name | Organisation | Country |
|---|---|---|
| Prosper Dodiko | Ministry of Agriculture and Livestock | Burundi |
| Razafinjara Lala | FOFIFA Soil Scientist | Madagascar |
| Rebbie Harawa | AGRA | |
| Refuoe Boose | Department of Soil and Water Conservation | Lesotho |
| Robin Buruchara | CIAT | |
| Ronald Vargas | FAO | |
| Saidou Koala | CIAT | |
| Sally Bunning | FAO | |
| Samuel Gameda | Ethiopian Agricultural Transformation Agency | Ethiopia |
| Shaban Hamisi | National Soil Service Milingano | Tanzania |

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