Food and Agriculture Organization of the United Nations

*A landscape of soil degradation after the floods in Nsanje District, Malawi. ©FAO/Luca Sola*

# Soils store and filter water

## improving food security and our resilience to floods and droughts

2015 International Year of Soils

Functional soils play a key role in the supply of clean water and resilience to floods and drought.[1] Water infiltration through soil traps pollutants and prevents them from leaching into the groundwater. Moreover, the soil captures and stores water, making it available for absorption by crops, and thus minimizing surface evaporation and maximizing water use efficiency and productivity.[2] Healthy soils with a high organic matter content have the capacity to store large amounts of water. This is beneficial not only during droughts when soil moisture is crucial to plant growth, but also during heavy rainfall because the soil reduces flooding and run-off by slowing the release of water into streams.[3] Healthy soils are therefore crucial for maintaining food production and clean groundwater supply, while also contributing to resilience and disaster risk reduction.

*Farmers clear weeds from a contour ridge and trench in Kiroka, Tanzania. The trenches and ridges retain water and prevent soil erosion during rains. ©FAO/Daniel Hayduk*

1 http://www.fao.org/post-2015-mdg/14-themes/land-and-soils/en/
2 http://www.fao.org/docrep/014/i2215e/i2215e.pdf
3 http://www.fao.org/docrep/009/a0100e/a0100e08.htm

## WHAT IS SOIL MOISTURE?

The amount or percentage of water in the soil (by weight) is generally referred to as soil moisture content.[4] [5] The maximum amount of available water that a soil can retain (the available water capacity) will vary depending on the soil's texture, organic matter content, rooting depth and structure. Soil organic matter is particularly important in that it can retain about 20 times its weight of water. [6] By implementing sustainable agricultural practices, farmers can influence the structure and organic matter content of the soil to improve its water infiltration and retention.

*A farmer tending his vegetable garden. In Honduras, where up to 78 percent of the land used for agriculture is on hillsides, water provision is a major problem for communities relying on rainfall for farming. ©FAO/Orlando Sierra*

## SOIL MOISTURE AND FOOD SECURITY

Water is the "lifeblood" of agricultural practice worldwide [7] — improved soil moisture management is critical for sustainable food production and water supply.[8] Reduction of a soil's capacity to accept, retain, release and transmit water reduces its productivity, whether of crops, pasture species, shrubs or trees. The great challenge for the coming decades will be the task of increasing food production with less water, particularly in countries with limited water and land resources. In order to minimize the impact of drought on food security, soil needs to capture the rainwater that falls on it, store as much of that water as possible for future plant use, and allow plant roots to penetrate and proliferate.

Problems with or constraints on one or several of these conditions cause soil moisture to be a major limiting factor for crop growth.[9] In fact, poor crop yields are more often related to an insufficiency of soil moisture rather than an insufficiency of rainfall.[10]

Poor and unsustainable land management techniques also decrease soil moisture content. Overcultivation, overgrazing and deforestation put great strain on soil and water resources by reducing fertile topsoil and vegetation cover, and lead to greater dependence on irrigated cropping. Meeting food security targets requires the implementation of sustainable agricultural policies that ensure improved soil quality and water retention. As most smallholder farmers in developing countries are reliant on rainfed agriculture, improved soil moisture optimization and management is crucial.[11]

A number of sustainable agricultural and land management practices can help to improve soil moisture retention capacity, including:

**Residue covers, cover crops and mulching** protect the soil surface, improve water infiltration rates, and reduce both erosion and evaporation, thus improving soil moisture compared to bare soils, even under low rainfall.[12] [13]

**Conservation tillage** is a general term which has been defined as "whatever sequence of tillage operations that reduces the losses of soil and water, when compared to conventional tillage"[14]

*A farmer in El Salvador clearing land where maize is grown. Once the maize has been harvested, the stalks are not removed from soil to avoid erosion. The maize acts as a fertilizer and the residue left in the ground will stop the rain from washing away the soil. ©FAO/Giuseppe Bizzarri*

4 http://www.fao.org/nr/water/aquastat/data/glossary/search.html
5 http://www.fao.org/docrep/r4082e/r4082e03.htm#2.3.1 soil moisture content
6 http://www.fao.org/docrep/006/y4690e/y4690e07.htm#bm07.3
7 http://www.fao.org/3/a-a0072e/index.html
8 http://www.fao.org/3/a-y4690e.pdf
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14 http://www.fao.org/3/a-x4799e.pdf

## WATER SCARCITY AND DESERTIFICATION

Water scarcity is the long term imbalance between available water resources and demands. Desertification is land degradation in drylands, resulting from various factors including climatic variations and human activities. Increasing occurrences of water scarcity, whether natural or human-induced, can trigger and exacerbate the effects of desertification through direct long-term impacts on land and soil quality, soil structure, organic matter content and ultimately on soil moisture levels. The direct physical effects of land degradation include the drying up of freshwater resources, an increased frequency of drought and sand and dust storms, and a greater occurrence of flooding due to inadequate drainage or poor irrigation practices. Should this trend continue, it would catalyse a sharp decline in soil nutrients, accelerating the loss of vegetation cover. This in turn leads to further land and water degradation, such as pollution of surface and groundwater, siltation, salinization, and alkalization of soils.[1]

**Zero-tillage**, which is the practice of leaving residue of the previous season's crops on farmland, can increase water infiltration while reducing evaporation as well as wind and water erosion.

**Conservation agriculture** employs the three principles of minimal soil disturbance, permanent soil cover and crop rotations to improve soil conditions, reduce land degradation and boost yields.

**Use of deep-rooting, drought-resistant, or less water-demanding crops** can help preserve soil moisture and improve food security.

**Capture of runoff** from adjacent lands can lengthen the duration of soil moisture availability.[15]

**Rainwater harvesting** through planting pits can rehabilitate degraded land by improving infiltration and increasing nutrient availability, leading to significant increases in yields, improved soil cover and reduced downstream flooding. [16]

**Knowledge-based precision irrigation**, although relatively capital-intensive, can dramatically increase crop yields through improved soil moisture. [17]

15 http://www.fao.org/3/a-i2215e.pdf
16 http://www.fao.org/3/a-i2215e.pdf
17 http://www.fao.org/3/a-i2215e.pdf

*A farmer in Senegal watering an acacia seedling that was just planted. The Acacia project has involved the planting and managing of Acacia forests in arid lands helping combat desertification while providing socio-economic benefits to local communities. ©FAO/Seyllou Diallo*

## FAO IN ACTION

### Agriculture Water Partnership for Africa (AgWA)

In Africa, only 7 percent of arable land is irrigated, with an even lower 4 percent in sub-Saharan Africa. Moreover, 93 percent of the African population rely on rainfall to live or even survive. Agricultural growth is the key to reducing poverty in Africa and driving economic development, but it requires large quantities of water. And although Africa is well endowed with water resources, water withdrawals are less than 3 percent of total renewable resources. As a response to those challenges, AgWA aims at promoting investment in developing the water and agriculture potential of the continent. The project makes extensive use of regional expertise and draws on the specific experience and knowledge of technical experts at FAO. AgWA is an autonomous voluntary partnership that includes a large set of networks and institutions from Africa and elsewhere, all of which bring specific Agricultural Water Management (AWM) capacities to the Partnership.

# FAO IN ACTION

*A lake in Yemen previously formed by waste water was reclaimed by an FAO forestry project and is now used for irrigation purposes. ©FAO/Rosetta Messori*

## Regional Initiative on water scarcity in the Near East

The Near East and North Africa Region (NENA) faces the challenge of addressing a wide range of complex and intertwined issues associated with the management of natural resources, particularly land and water, and to securing food supply for a growing population. To address these challenges, FAO launched a "Regional Initiative on Water Scarcity in the Near East". The overall goal of the initiative is to support member countries in streamlining priority areas of action in agriculture water management that can significantly contribute to boosting agriculture productivity, improving food security and sustaining water resources, by highlighting the specific areas that require action and building partnerships to move the process forward. The initiative injects fresh thinking into the process of finding sustainable solutions to water scarcity and food security problems by facilitating the implementation of cost-effective water investments and management practices.[18]

## Agricultural water management solutions project

The Bill and Melinda Gates Foundation is funding this project to help design agricultural water management strategies for smallholder farmers in sub-Saharan Africa and in India. The project is managed by the International Water Management Institute (IWMI) and jointly operated by IWMI, FAO, International Food Policy Research Institute (IFPRI), the Stockholm Environment Institute (SEI) and International Development Enterprises (IDE), an NGO specialised in small scale water technologies. Currently underway in Burkina Faso, Ethiopia, Ghana, Tanzania, Zambia and India, the project is helping to unlock the potential of smallholder farming by focusing on agricultural water management (AWM) solutions which include identifying technologies, necessary supporting policies, institutions and business models to make AWM solutions available and viable, so that poor farmers can benefit from them.[19] The project builds on smallholder farming potential to be an engine for economic growth, poverty reduction and food security. In many areas, reliable access to water is what's missing from the equation. Without the means to control and effectively manage water, poor farmers are unable to turn agriculture from a subsistence activity into an income-generating enterprise.

## KEY FACTS

- In the last century, water use has been growing globally at more than twice the rate of population increase.[20]
- Of the estimated 1.4 billion ha of crop land worldwide, around 80 percent is rainfed and accounts for about 60 percent of global agricultural output.[21]
- Many of the over 800 million people in the world who are food insecure live in water-scarce regions.[22]
- In water-scarce tropical regions such as sub-Saharan Africa, rainfed agriculture is used on more than 95 percent of cropland, and will remain the dominating source of food for growing populations.[23]
- More efficient use of water, reduced use of pesticides and improvements in soil health can lead to average crop yield increases of 79 percent.[24]

18 http://www.fao.org/nr/water/topics_scarc_RE.html
19 http://www.fao.org/nr/water/projects_agwatermanagement.html
20 http://www.fao.org/nr/water/projects_scarcity.html
21 http://www.fao.org/docrep/014/i2215e/i2215e.pdf
22 http://www.fao.org/3/a-y3918e.pdf
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24 http://www.fao.org/docrep/014/i2215e/i2215e.pdf

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