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Soil as a Water Resource for Food Security

Leo Stroosnijder

Wageningen University, Soil Science Centre , Netherlands

Abstract

For decades the natural resource soil has received less attention than its counterpart water. This is unjust since nearly all the fresh water that is used by nature and humans comes from the soil. Soil is the best storage medium for water to overcome dry spells; it takes 1 liter of water to produce 1 kcal of energy in human food and most of this water comes from green water stored in the soil. Plant production suffers because water is not available due to deteriorated physical properties of the soil. Water scarcity and drought in Africa are often an indirect result of land degradation rather than a rainfall anomaly due to climate change. Where soil productivity is low and food security at stake, Green Water Use Efficiency (GWUE) is low. In sub-Saharan Africa GWUE is very low, only 15 % of the terrestrial rainwater is used by plants for the production of food, fodder and fibre. Although a millet crop grown under traditional circumstances uses only 50 mm in transpiration, the crop frequently suffers from agricultural drought due to excessive losses of rainwater.

Rainfall that meets land at the soil surface is divided over several pedo-hydrological components. Rain may be intercepted by vegetation, run off the ground surface, or infiltrate into the soil; this is reflected in the rainwater balance. Infiltrating water may be stored in the root zone or drain below the root zone to groundwater and stream base flow, contributing to what is nowadays called 'blue water'. These processes are reflected in the infiltration water balance. The maximum amount of water stored in the root zone available for plant growth is a very important soil characteristic because it determines the potential survival of plants during a dry spell. Water stored in the root zone may be lost as evaporation from the soil surface into the atmosphere, or taken up by plants and used as transpiration. This is reflected in the soil water balance. Land degradation decreases infiltration, water holding capacity and transpiration, but enhances runoff, percolation and soil evaporation. These agro-physical processes cause a decrease in GWUE.

A range of land management practices is available in sub-Saharan Africa to help improve GWUE. They can be classified according to their function: for reducing runoff; for improving water availability; and for improving GWUE. A focus on soil as a water resource will address problems of land degradation and drought, thereby improving productivity and food security in semiarid Africa. Going from 1500 to 3500 kg ha^{-1} yr^{-1} in Eastern Africa is easier than going from 5500 to 8600 kg ha^{-1} yr^{-1} in Eastern Asia. It could be that in 2030 an agriculturally active Africa helps alleviate global shortages of cereal production thereby turning the standard food security paradigm on its head.

Keywords: Africa, desertification, food security, land and water use, land degradation, soil and water conservation, soil water balance, sustainable land management, water use efficiency

Contact Address: Leo Stroosnijder, Wageningen University, Soil Science Centre , P.O. Box 47, 6700 AA Wageningen , Netherlands, e-mail: leo.stroosnijder@wur.nl