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ICARDA News

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Sustainable Production through Improved Soil, Water, and Nutrient Management in Africa

ALEPPO, SYRIA and JOHANNESBURG, SOUTH AFRICA. 26 August 2002 — Demand for food and feed is fast rising in Africa and elsewhere in the world, placing more pressure on already strained natural resources. In response, ICARDA scientists and their partners in Africa are conducting research into soil, water, and nutrient management (SWNM). Their approach combines modern science with traditional practices.

By year 2030, the world's population is expected to increase by more than 2 billion to 8.27 billion people. Agenda 21 of the United Nations Conference on Environment and Development, and the 2020 Vision Initiative of the Consultative Group on International Agricultural Research (CGIAR), question the capacity of available production systems to meet the demands of this growing population for food and other agricultural commodities without simultaneously accelerating the degradation of the natural resource base.

The situation in Africa is critical. Land available for expansion of agricultural area is limited to a few parts of the continent where the production potential has been proven but current output is low due to poor soils and mismanagement. Production increases from fertile lands have been reported to be declining. Marginal and fertile lands are currently undergoing varying degrees of degradation, including nutrient depletion, soil acidification, soil erosion, and reduction in soil water retention. As a result, water is becoming scarce in some areas and its quality is deteriorating.

The SWNM Program addresses this challenge by bringing together four complementary research consortia that develop strategies to implement improved management practices for sustainable agricultural production on both fertile and marginal soils.

SWNM activities focus on four themes involving several partners:

- Combating nutrient depletion (CNDC) in East and West African sub-humid savannas and hillsides: International Fertilizer Development Center (IFDC); Tropical Soil Biology and Fertility Programme (TSBF), Kenya Agricultural Research Institute (KARI)
- Managing infertile soils (MIS) in Latin America and Africa: Centro Internacional de Agricultura Tropical (CIAT), Colombia; Universidad Nacional Agraria (UNA), Nicaragua



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Power of partnership

- Managing soil erosion in South and Southeast Asia: International Board for Soil Research and Management (IBSRAM) now incorporated into International Water Management Institute (IWMI), Sri Lanka; and Center for Soil and Agroclimate Research (CSAR), Indonesia
- Optimizing Soil Water Use (OSWU) in West Asia and North Africa and sub-Saharan Africa: International Center for Agricultural Research in the Dry Areas (ICARDA), Syria; International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India; and Agricultural Research Council of the Institute for Soil, Climate and Water (ARC-ISCW), South Africa.

Program goals

The SWNM goals are to increase long-term agricultural productivity, reduce human poverty, and conserve and enhance land and water resources.

OSWU achievements in Africa

- The Agricultural Production Systems Simulator (APSIM) package: APSIM, a state of the art cropping systems simulator, has been further developed to make it more useful in the African semi-arid tropics. Pigeonpea and pearl millet growth and development modules have been developed jointly with the Agricultural Production Systems Research Unit (APSRU), which is a partnership between scientists from several organizations, including the Commonwealth Scientific and Industrial Research Organization, the Queensland Departments of Primary Industries and Natural Resources, and the University of Queensland in Australia. A manure module that simulates decomposition and nutrient mineralization of manure in relation to manure quantity and quality; a phosphorus module developed by APSRU with assistance from OSWU; and a weeds module for maize are also now in use at ICRISAT to assist research in African semi-arid tropical regions.
- Key research and development issues in the context of optimizing soil water use in the semi-arid regions include soil surface management to increase infiltration and decrease run-off and evaporation, and the manipulation and adaptation of cropping systems to optimize crop water use. A decision support tool for choosing optimum technologies was developed for use by researchers, extension agents, and farmers.
- OSWU has looked at the use of organic amendments to increase nutrient uptake by millet grown using the *zai* water harvesting technique in the Nigerian Sahel. This study addressed the issue of resource use efficiency of organic inputs (animal manure, compost, and millet stover) with different sized catchment areas (zero, 25 cm diameter, and 50 cm diameter). *Zai* is one of many traditional techniques used in sub-Saharan Africa to reduce the risks to production in drought-prone areas, where there is a great variation in rainfall across and within the seasons. Other techniques include half-moons, stone bunds, and other surface management practices, such as tied-ridging, plowing, and crop residue management. These technologies are mostly related to appropriate soil management, including no-till options for conservation, the use of adapted crop cultivars, inorganic fertilizer, crop residue management, cropping system management, pest control, integrated watershed management, and combinations of these factors. A steady release of nutrients from the organic amendment, in combination with the water collected in the *zai*, favors the development of a larger rooting system to make better use of water and nutrients.

- The potential impact of OSWU research was evaluated using the ‘Bayesian belief network approach,’ which is a method for representing relationships between variables, even if those relationships involve uncertainty, unpredictability, or imprecision. Preliminary analysis using a simple belief network showed that the impact on agricultural production could be significant in areas with a high demand for OSWU technologies and where there is significant scope for yield improvement.
- OSWU researchers conducted summer and winter studies on sandy loam and clay soils to evaluate the effects of crop residue and stone mulches on evaporation from the soil surface, and on soil temperature. A 50% stone mulch was as effective as a 50% organic mulch in inhibiting evaporative water losses and reducing soil temperatures. This result has beneficial socioeconomic implications for smallscale farmers, because crop residues are important animal feedstuffs. The effects were more pronounced on the clay than on the sandy loam soils.
- On-farm experimentation in Zimbabwe is aimed at increasing the productivity and incomes of small-scale farmers in the semi-arid tropics. The work follows an on-farm participatory approach at three locations representing a transect from the better-endowed to the marginal semi-arid tropics. Included are researcher-designed, replicated trials implemented by farmers, and farmer-led and implemented unreplicated trials. Technologies tested included those aimed at making more efficient use of water (modified tied ridging, seed priming, weed management) and nutrients (manure inputs using different types and storage, small inputs of fertilizer with or without manure, legume rotations). Both farmyard manure and fertilizer-N increased yield in an average season.

ICARDA's (www.icarda.org) mission is to improve the welfare of people and alleviate poverty through research and training in dry areas of the developing world by increasing production, productivity, and nutritional quality of food, while preserving and enhancing the natural resource base. ICARDA is a Future Harvest Center.

Future Harvest (www.futureharvest.org) is a global nonprofit organization that builds awareness and support for food and environmental research for a world with less poverty, a healthier human family, well-nourished children, and a better environment. Future Harvest is an initiative of 16 food and environmental research centers that receive funding from the Consultative Group on International Agricultural Research (CGIAR).