

## CONCLUSIONS

Achieving sustainable agro-ecosystems is a major challenge of the current century. With increasing populations and improved living standards, the demand for food and fibre will drive the development of sustainable and more productive agro-ecosystems, particularly in less favourable regions, including drylands. This challenge will become substantially greater if the recent trend of using cereals for producing ethanol for fuel continues to expand and encourages cereal production into even less favourable regions. There is an imbalance between natural resources, population and basic human needs in many places, particularly in semi-arid regions. Agro-ecosystems in these areas can be developed and sustained, but careful management will be required and productivity will be low and highly variable even when the best technologies are used.

The prevention of soil degradation is the first and most important issue that must be addressed in dryland agriculture. Soil organic matter is correlated significantly with soil water-holding capacity, fertility and productivity. Therefore, maintaining and increasing SOM is of critical importance. A permanent cover on the soil reduces or eliminates runoff and erosion, reduces soil surface temperatures and thus slows down the decomposition of organic matter. Tillage drastically increases the rate of decomposition. Therefore, it is imperative that tillage be reduced or avoided and that cover be maintained on the soil surface in dryland cropping systems if soil degradation is to be reduced or reversed. This is a tremendous challenge in semi-arid regions because insufficient precipitation seriously limits organic matter production. Moreover, the generally warm conditions accelerate the decomposition of in situ SOM during periods of favourable soil-water conditions. The challenge is even greater in many developing countries where crop residues are removed for livestock feed or household fuel – and in future may also be lost to the agro-ecosystem through use to produce biofuels.

Improved water management is the other key factor that must be addressed in dryland regions. Where water is severely limited, other technological advances such as improved varieties, fertilizers and pesticides, are generally not effective. Small increases in seasonal water use by plants can increase yields significantly. It is estimated that increasing seasonal plant water use by 25 mm, a realistic amount that can be gained through improved water management, could increase the average yields of wheat, maize and sorghum in developing countries by 30, 38 and 58 percent, respectively.

Water harvesting is also a promising practice for some situations. It is most attractive where water can be used directly by crops on an adjacent area. However, water harvesting also holds promise in some cases where harvested water can be stored in cisterns, ponds and other places for later use. This is because small amounts of water applied at critical growth stages can be highly effective.

A considerable body of research knowledge and producer experience exists. This information is sufficient in many cases for developing sustainable agro-ecosystems. Therefore, the greatest challenge is the implementation and execution of sound management plans. Such management plans must incorporate due consideration of the:

- impacts which climate change will inevitably have on dryland agro-ecosystems;
- methods of mitigating unintended impacts (downstream) of water harvesting and agricultural intensification;
- potential impacts of the developing biofuels industry, both beneficial and detrimental, as they raise new pressures on delicate dryland agro-ecosystems.

The techniques outlined in this text form a range of options for improved technologies and management practices, some of which will be appropriate in some situations and not in others. Some options may be 'stand-alone', others complementary so could be beneficially used in a sequence to provide a locally appropriate solution. It is not possible to offer any ranking to suggest one option is better than another; such a judgement should only be made with the benefit of local knowledge, in participation with local land users (small-holders, agropastoralists and/or pastoralists). Lessons learned, particularly from South Asia, demonstrate that local participation and understanding are vital for success where watershed approaches are adopted.

Sustainable systems must focus on long-term goals, but the reality is that short-term benefits and solutions almost always take precedence over long-term issues. Historically, agro-ecosystems have been developed for short-term benefits without a thorough analysis of the long-term consequences. Lessons learned, particularly in areas of South Asia, indicate that integrated watershed management approaches can contribute to poverty reduction and economic development. These provide models for developments elsewhere, notably in Africa; offering ways to reduce the fertilizer, labour and energy demands of agriculture, while sustaining or raising crop and pasture production. Producers, scientists, policy-makers and governments must work closely together to produce adequate amounts of food and fibre and meet the challenge of sustaining the natural-resource base.