

Water and Food Security in the Mediterranean Region *Challenges and Potential in a Changing Climate*

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A recent study on the “water footprint of humanity” shows that water used by the agricultural sector accounts for nearly 92 percent of annual global freshwater consumption (Hoekstra and Mekonnen, 2012). In the agricultural sector, 19 percent of the total water footprint relates to the production for export. Farmers generally tend to over-irrigate, as shown by studies in Syria, Iraq, Jordan and Egypt, conducted by ICARDA and the UN Economic and Social Commission for Central and West Africa, where farmers over-irrigated wheat by 20-60 percent (Shideed et. al., 2005). Producers perceive water as a fixed input in the short run, but allocable among competing crops on the farm. As water prices were highly subsidized, they did not have a major impact on water allocation.

Water use efficiency is low in many areas. For example, it is 40-60 percent for irrigated agriculture in Syria (Munlahassan, 2007). This low figure is due to the widespread use of traditional surface irrigation methods with their low efficiency, high seepage and evaporation losses and uneven field coverage. A recent ICARDA study (Yigezu et al., 2011b) conducted in the three provinces of Syria showed that if the current adoption level of improved supplemental irrigation (ISI) continued at 22.3 percent, it could save at least 120 million m³ of water per year. Introducing a water use charge of US\$0.20 for every cubic meter applied would encourage adoption and conserve an additional 46 million m³ of water per year (Yigezu et al., 2011a), and increase total farm profits by US\$16.14 million per year, generating a total yearly impact of US\$36-90 million. However, water pricing in dry areas remains a sensitive political issue.

Climate change amplifies the food security challenges, as it affects crop yields, availability and distribution of freshwater and rainfall, and food prices (Vermeulen, 2014). As a result of rainfall variability, temperature fluctuations and frequent drought, farming in rainfed areas is highly risky and unpredictable, implying that food production in Near East and North Africa (NENA) countries is insecure. This is evident in FAO food security indicators (FAO, 2013). Two important indicators of food security and vulnerability are the cereal import dependency ratio and the value of food imports in total merchandise exports. Data indicate that the average cereal import dependency ratio of all NENA countries during 1990-2011 was 73.9 percent, which is the highest globally. The world cereal import dependency ratio during this period was 15.7 percent and that of developing regions 15.5 percent. NENA countries are also prone to food shortages and food price fluctuations in the international markets. This situation is further complicated by the fact that the value of food imports accounts for nearly one-third of the total merchandise exports, while food imports represent only 5.6 percent of the world's total merchandise exports.

Studies show that food security in NENA countries can be substantially enhanced through increased adoption of currently available technologies supported by enabling policy and institutional environments (Khouri, Shideed and Kherallah, 2011). On-farm results show a huge potential for improving land and water productivity and profitability of smallholder rainfed agriculture, with desired investment levels.

Dryland agriculture – a core issue for climate change

Dry areas cover more than 40% of the world's land surface and are home to 2.5 billion people – one-third of the global population. Poverty, food insecurity, biodiversity loss, frequent drought and environmental degradation are widespread. In recent decades, food production has fallen significantly in most dry areas, while demand has increased due to high levels of population growth. These areas face several demographic challenges like rapid population growth, high urbanization, large youth populations and the world's highest unemployment rate. Climate change is already exacerbating these problems, and experts predict that the situation is going to worsen.

The global food crisis of 2007/8 and subsequent price hikes have highlighted the danger of policies based on food imports. The dryland areas have a strong reliance on imported food, especially wheat, which is a staple product and suffers from substantially lower yields than in many other regions – up to 30 percent below the global average.

Across all dryland areas, scarce water availability is the key limiting factor for food production. All these countries are suffering from severe groundwater depletion and salinity, compounded by rapid natural resource degradation and desertification.

The Middle East and North Africa is the most water scarce region in the world, and the problem is set to deteriorate. Famines and disasters have hit drylands with increasing intensity and, together with spikes in food prices, have led to political unrest in many countries. With climate change, such events may become even more frequent.

Interestingly, agriculture plays a key role in the linkages between food security, climate change, water security and poverty. With declining overall rainfall levels, caused by climate change, periods of drought are becoming more frequent and intense. Temperatures are getting extreme and climatic zones are shifting. These result in shorter growing seasons for farmers and increased prevalence of pests and diseases in areas where they were not previously a threat to crops.

Strategies, technologies and best practices to better respond to climate change

With sustainable intensification of higher-potential agricultural areas, improved crop varieties and livestock breeds, integrated crop-livestock systems and more targeted research and investment, there are good prospects of reducing risk and even improving agricultural output, despite climate change. Different land and water management practices can mitigate the challenge of producing more with limited resources. For this, it is crucial to favor crop varieties and livestock breeds that make efficient use of the available natural resources (ICARDA/CCAFC, 2012).

In high potential rural areas, food production needs to be done with an emphasis on sustainable intensification. Egypt is an example of this type of ecosystem. In high potential areas, 72 percent of the increased food production is expected to come from agricultural intensification, another 21 percent is expected to come from cropping intensity, and only 7 percent will come from an increase in arable land.

For low potential marginal lands, it is important to make the natural resource base more resilient to climate change, reducing risk and vulnerability for the worst affected rural communities. Food production here is likely to center on the rearing of sheep and goats, though this may be coupled with the production of hardy drought resistant fodder crops. A good example is the Awassi sheep, a native breed that gives resilience to rural communities in the Middle East.

In seven countries across Middle East and North Africa, new approaches tested by national research and extension systems, together with ICARDA, have produced a 22 percent increase in wheat yields for Egypt and a 58 percent increase in Sudan – based on actual farmer experiences. Techniques include the use of different planting methods, high yielding varieties, improved water management and integrated pest management.

Advances in crop science to produce improved and higher-performing crops and livestock hold exciting prospects for making dryland food production systems more efficient, and more resistant to climatic pressures and new pests and diseases. More than 900 improved cereal and legume varieties have been released by national programs in partnership with ICARDA, and adopted by farmers worldwide. Releases of plant genetic materials from ICARDA's gene banks, which host wild relatives of barley, wheat and legumes, has led to the development of crops with higher yields and greater resistance to a range of biotic stresses. Some varieties also offer large improvements in bread-making quality, nutritional value and other traits.

Already, scientists have produced the following convincing results:

- New varieties that have been released for cultivation are generating annual benefits worth US\$850 million.
- Dryland researchers have developed synthetic wheat varieties that can produce 2.5 tons per ha with just 220 mm of water.
- 'Gokce', a drought tolerant variety of chickpea introduced in Turkey was able to withstand the worst drought of 2007. It is now used for about 80% of the country's chickpea production. With a yield advantage of 300 kg/ha over other varieties and world prices of over US\$1000/t, this variety brought in an additional US\$165 million for Turkish farmers in 2007 alone.

Diversification of agricultural systems is also an effective means of mitigating risk and increasing income, both in high potential areas and marginal lands. Herders in rangeland areas are being encouraged to produce value-added products, such as yoghurt and cheese from their sheep and goats. In Tunisia, pastoralists are growing spineless cactus as fodder for their ruminants.

Integrating crop-livestock systems can be another highly effective way of cushioning each sector from the external factors. Successful technologies that combine crop and livestock systems include:

- On-farm feed production
- Rotation of barley with forage legumes
- Growing cactus and fodder shrubs
- Making feed blocks from crop residues and agro industrial by-products.

Conservation agriculture (CA), which includes zero tillage, conserving nutrients and water in the undisturbed soil, retaining crop stubble and crop rotation, is particularly well suited to dryland farming, especially in rainfed conditions. This produces significant benefits through lower production costs, higher yields and better soil health and nutrient recycling. Under conservation agriculture, soil carbon is retained and increased, contributing to climate change mitigation.

Field trials on wheat, barley, lentil and chickpea have produced documented evidence. By using conservation agriculture together with good crop management, farmers can increase net revenues by about US\$120 per hectare. The extra revenue comes from higher yields (12 percent increase) and lower production costs (saving of US\$40 per hectare for eliminated plowing).

In four years, adoption has grown from zero to almost 27,000 hectares in Iraq and Syria. To encourage mechanization, specially designed zero-tillage seeders have been developed. These are manufactured locally by small-scale entrepreneurs. They cost in the range of US\$1,500-US\$5,000, as compared to US\$50,000-US\$60,000 for imported machines.

Better water management is needed to address the challenges of water security. Irrigation efficiency, crop rotation and using biotechnology for enhancing efficient water use in crops, are all options for making maximum use of scarce water reserves. Adapting crop varieties to use less water is a promising approach that is already producing impressive results in some dry countries. Investments in water technologies, such as drip irrigation, hydroponics, vertical agriculture and water harvesting techniques must go hand-in-hand with improved soil and crop management techniques.

Involvement of rural communities is essential in developing options to enhance water security. Strategies available to farmers include careful conservation and management of renewable groundwater, rainfall harvesting and underground storage (in cisterns or aquifers).

A policy shift is also important, so that the users can have better incentives to adopt more sustainable water management practices. In dryland areas in particular, there is an urgent need for more data on groundwater reserves and water quality, and for improved monitoring strategies. The resilience and adaptability of rural communities should be harnessed along with the scientific know-how on water efficiency, especially for agriculture.

Sustainable water management options for the dry countries include:

- Modernizing irrigation systems and improving efficiency
- Modifying cropping patterns to enhance water productivity
- Supplemental irrigation
- Macro and micro water catchments
- Watershed management
- Deficit irrigation.

Thus, a comprehensive three-pronged approach should target:

- Sustainable natural resource management, especially water
- Genetic improvement of crop and livestock
- Socio-economic policy and institutional support.

Partnerships for agricultural research

Agricultural innovation systems can be strengthened through research, education and extension. Agricultural research offers practical solutions to many of the constraints posed by climate change (ICARDA/CCAFS, 2012). A range of practical techniques can be highly effective, especially if supported by an enabling policy environment. In Egypt, for example, sowing wheat on raised beds increased yields by 25 percent. Experience shows that an integrated 'agro-ecosystems' approach is required to apply technical options in a 'holistic' way, to deliver real benefits to people's livelihoods.

An enabling national policy environment is essential to support investment in agricultural development, drive sustainable productivity growth and encourage better farming practices including natural resource management. In many dryland countries, there is a strong need for more capacity development and institutional support. Agriculture, which is the backbone of most dryland economies, needs to be a national priority. With the support of advances made in science, technology and research, farmers can be equipped to adapt to the new and changing climatic conditions.

Agricultural research is not a high investment priority for governments of developing countries, despite agriculture being the main engine for economic growth. Many dryland countries spend only between 0.2% and 0.5% of agricultural GDP on research. This low investment in science and technology for enhancing food production could cost countries dearly in the long run. Countries that have made high investments in science and technology and agricultural research have seen impressive economic growth as a result. Some of the examples include Brazil, China and India, and, more locally, Egypt, Morocco and Tunisia. The benefits of investment in agricultural research extend far beyond the immediate farm sector. The impact that they have on transport and agro-industries helps in creating jobs and providing stable livelihoods. However, more funds are needed to promote adaptation. It will be important to develop a policy framework for public-private partnerships that can attract responsible private investment in the agriculture sector, and drylands in particular.

Partnerships are an important mechanism for sharing knowledge and solutions. Alliances can be developed between partners to help dryland countries improve agricultural performance and adapt to climate change challenges. ICARDA has successfully proven this through its collaborative work with partners like national programs, donors, ARIs, other CGIAR Centers, policy makers, farming communities, NGOs, etc. in all the above mentioned initiatives and achievements.

Concluding remarks

The problem in dry areas is not only natural resources scarcity, it is the combination of natural resources limitation (particularly water scarcity), degradation of natural resources, and low levels of resource use efficiency. Therefore, removing inefficiencies in resource use and food production systems is the key to achieve food and water security targets. Further growth in food production must come mainly from productivity growth and intensification, rather than expansion of cultivated areas.

From ICARDA's experiences in innovative dryland agriculture, it can be concluded that for attaining water and food security in the Mediterranean region in the context of climate variability, it is essential to achieve productivity growth and intensification through tested and proven scientific techniques together with enabling policy environment.

Promoting integrated systems approach is vital for the eco-efficiency criteria of sustainable food production systems. Focused attention and priority needs to be given to policy and investment in the rain-fed areas. Supporting dryland agriculture is of prime importance because it holds the key to future food security, and possibly a new Green Revolution.

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