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Opportunities to reduce the vulnerability of dryland farmers in Central and West Asia and North Africa to climate change

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Abstract

The world's drylands will face not only increasing temperatures with climate change but more importantly also disruptions to their hydrological cycles resulting in less and more erratic rainfall that will exacerbate the already critical state of water scarcity and conflicts over water allocation.

The rural poor in dry areas will suffer the most from these changes and will require a range of coping strategies to help them adapt to changing climates. Strategies will include changing of cropping systems and patterns, switching from cereal-based systems to cereal–legumes and diversifying production systems into higher value and greater water use efficient options. The latter include judicious use of water using supplementary irrigation systems, more efficient irrigation practices and the adaptation and adoption of existing and new water harvesting technologies. Scope for the application of conservation agriculture in dry areas is thought to be limited by low biomass production but current evidence suggests that even small amounts of residue retention can significantly decrease soil erosion losses. These options will be supplemented by the development of more drought and heat tolerant germplasm using traditional and participatory plant breeding methodologies and better predictions of extreme climatic events.

The majority of drylands are occupied by rangelands with some 828 Mha in West Asia and North Africa alone. These vast areas provide environmental services such as the regulation of water quantity and quality, biodiversity and carbon sequestration. Rangelands have been neglected in the past partly because of problems of ownership, access and governmental policies that discourage investments in rangelands. The idea of payment for environmental services in rangelands is in its infancy but is discussed here as a potential option for better use and management of rangelands and as a safety net to reduce the vulnerability of rangeland inhabitants to climate change.

In addition to the promising technological options to reduce vulnerability to climate change a brief discussion is included on the institutional and policy options needed to create a better enabling environment for increased adaptation and ecosystem resilience.

Keywords: Drylands; Climate change; Adaptation strategies

1. Introduction

The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change leaves no doubt that the Earth's climate is changing (Christensen et al., 2007). The last 60 years were the warmest in at least the last 1000 years, patterns of precipitation are changing with greater incidences of both floods and droughts. Mediterranean Africa is likely to experience as much as a 20% drying by the end of the 21st century with hotter summer temperatures and decreased precipitation and increased likelihood of summer droughts. Even though the global climate models are less reliable for Central Asia the region is likely to experience greater than average warming and decreased precipitation (Christensen et al., 2007). The AR4 concludes that the observed changes cannot be explained by natural phenomena and that there is now clear evidence of human influence.

For the drylands of Central and West Asia and North Africa (CWANA) it is not the effects of increased temperatures *per se* that are of major concern but rather the expected changes in precipitation, storm events, snow

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fall and snowmelt, evapotranspiration, run-off and soil moisture, that will disturb the hydrological cycles. These cycles are already stressed in the region by excessive water withdrawals (90% for agriculture). The WANA region has the world's lowest rates of renewable water resources per capita, e.g., less than 150 $m^3\ yr^{-1}\ capita^{-1}$ in Jordan (World Water Council, 2002), and suffers from associated environmental degradation and social problems.

These are some of the most dramatic and negative changes in climate predicted for any part of the world. Such areas will become affected by more frequent droughts, increased evapotranspiration, changes in rainfall patterns and associated wind erosion, increased salinization and decreased carbon mineralization. Ironically, an increase in heavy precipitation events is expected with a decline in the evenness of rainfall distribution adding to the risk of both flooding and drought for the main crops in these areas. Crop yields in the arid and semi-arid regions of Northern Africa, Southern Europe and the Middle East are expected to decrease by as much as 10–30% by the 2080 (IPCC, 2001).

As the WANA region is already the major grain-importing region of the world and because of the predicted negative affects of climate changes on agricultural production, there is likely to be a worsening of regional food security and negative affects on achieving the Millennium Development Goals of reducing hunger, poverty and environmental sustainability. Climate change is likely to add to the existing threats to food production and security from a number of converging trends such as high population growth rates, water scarcity, and land degradation. There is therefore an urgent need to increase the resilience of the production systems to these pressures via technical, institutional and policy options.

When vulnerability is defined as the degree to which production and livelihood systems are susceptible to, or unable to cope with, adverse effects of climate change, including climate variability, and extremes (IPCC, 2001), it is evident that the rural poor will be the most vulnerable to these changes both in terms of risk to their production systems and infrastructures (e.g., houses and roads) because they have less assets to call upon in order to cope with extreme events such as prolonged droughts, intense storms and subsequent flooding. The rural poor are dependent on the quality and functioning of the agro-ecosystems that they inhabit and they are particularly dependent on the natural resource base for their livelihoods through the provision of goods and services such as food, water, fodder, wood and other construction materials and fuel. Climate change will disrupt many ecosystem functions, altering their capacity to provide these goods and services and rendering them more susceptible to degradation.

Attempts to help the rural poor adapt to climate change must build on existing 'coping strategies' that generally involve three elements; preparing for harsh climates by developing various types of insurances, actually coping with the stress when it happens and thirdly, adapting and recovering from the stress (Dietz and Verhagen, 2004).

This article reviews some promising technological options that can improve ecosystem resilience to climate change and increase the adaptive capacities of land users, i.e. their ability to sustain the flow of diverse products and services that they depend on and to do so under constantly changing conditions (Sayer and Campbell, 2003). In addition the necessary accompanying institutional and policy changes required to enable the adoption and adaptation of these technologies are briefly discussed. These examples are illustrative of recent advances in dry areas rather than a comprehensive discussion of all of the possibilities.

2. Promising technological interventions to reduce vulnerability to climate change in CWANA

The range of technological interventions that can contribute to reducing the vulnerability to climate change by simultaneously preventing and reversing land degradation and sequestering carbon in drylands (mitigation) include; maintaining vegetative cover, grazing management, water management and salinity control, mulching and residue management, soil fertility management and crop rotations, improved fallows, shrub, halophyte and forestry plantations (Lal, 2001, 2002, 2003b). Below we discuss some recent developments in some of these interventions that can help farmers cope with and adapt to climate change in the CWANA region.

3. Improving water use efficiency

For dry areas it is clear that water, not land, limits agricultural production and that improving water use efficiency and decreasing demand must be major factors in the coping and adaptive strategies for climate change. This means a need to maximize water productivity in drylands rather than focusing on traditional approaches to maximize land productivity, develop additional sources of water where possible, and improve the utilization and management of all sources of water including low quality brackish, drainage and treated sewage water.

The adoption of supplementary irrigation, i.e., the addition of a limited amount of water to otherwise rainfed crops during water stress periods and critical plant growth stages, has been shown to increase the water productivity (kg biomass or kg grain m^{-3} water) of wheat (*Tritium* spp.), barley (*Hordeum vulgare*), lentils (*Lens culinaris*), chickpeas (*Cicer arietinum*) and faba bean (*Vicia faba*) under dryland conditions where water is available (Oweis and Hachum, 2003). Table 1 shows a typical result obtained with supplemental irrigation.

There is also a revival in the documentation and dissemination of indigenous water harvesting practices, some originating from ancient times, which concentrate