Agricultural Water Management 97 (2010) 495–501

Contents lists available at ScienceDirect

Agricultural Water Management

journal homepage: www.elsevier.com/locate/agwat

Investing in water for food, ecosystems, and livelihoods: An overview of the comprehensive assessment of water management in agriculture

Charlotte de Fraiture *, David Molden, Dennis Wichelns

International Water Management Institute PMB, CT 112, Cantonments, Accra, Ghana

ARTICLE INFO

Article history:
Available online 3 October 2009

Keywords:
Irrigation
Poverty
Food Security
Wastewater
Rainfed
Productivity

ABSTRACT

The authors of the recently completed Comprehensive Assessment of Water Management in Agriculture (CA) concluded that there are sufficient water resources to produce food for a growing population but that trends in consumption, production and environmental patterns, if continued, will lead to water crises in many parts of the world. Only if we act to improve water use will we meet the acute fresh water challenge. Recent spikes in food prices, partially caused by the increasing demand for agricultural products in non-food uses, underline the urgent need to invest in agricultural production, of which water management is a crucial part. The world experienced similar pressure on per capita food supplies and food prices in the 1960s and 1970s, but the challenges now are different than those we experienced 50 years ago. The world's population is substantially larger, there are many more people living in poverty, and the costs of many agricultural inputs are much higher. The current situation and the long-term outlook require a fresh look at approaches that combine different elements such as the importance of access to water for the poor, providing multiple ecosystem services, rainwater management, adapting irrigation to new needs, enhancing water productivity, and promoting the use of low-quality water in agriculture. This special issue highlights the analysis behind a number of policy options identified by the CA, a five-year multi-disciplinary research program involving 700 scientists. This introductory article sets the background and context of this special issue, introduces the key recommendations from the CA and summarizes the papers in this issue.

1. Introduction

Investments in water for agriculture have made a positive contribution to rural livelihoods, food security and poverty reduction (Molden, 2007). During the second half of the 20th century food production outpaced population growth, with some 78% of the production growth over the period 1961–1999 deriving from yield increases (Bruinsma, 2003) as opposed to agricultural land expansion. Higher yields have been achieved, in part, due to the expansion of irrigated areas and improvements in water management on irrigated lands. The area equipped with irrigation expanded from 139 million ha in 1961 to 277 million ha in 2003 (FAO, 2007). Food prices – in absolute and real terms – have fallen over the past two decades, though recently prices have risen sharply, due partly to increasing demand for agricultural products in non-food uses. During the last 50 years, productivity gains have generated higher yields and incomes for food producers, while consumers have benefited through lower food prices. Throughout those years, irrigation development helped alleviate poverty by creating employment opportunities, lowering food prices, and increasing the stability of farm output (Lipton et al., 2003; Hasnip et al., 2001; Hussain, 2005). Investments in irrigation have increased rural incomes, resulting in greater demands for non-farm goods and services. Bhattarai et al. (2007) estimate this multiplier effect to be as high as 2.5–4.

From a global perspective the benefits from investments in water have exceeded the costs, but the gains could have been more equitably distributed (Molden et al., 2007). In 2004, 850 million people were undernourished, most of whom live in rural areas in developing countries (FAO, 2004). Globally, agricultural productivity has increased during the past 50 years, but regional differences are considerable. For example, maize yields started rising before the 1940s in the US, in the 1960s in China, and in the 1970s and 1990s in Latin America. By contrast, maize yields have hardly changed in Sub-Saharan Africa (Fig. 1).

While many investments in irrigation and agricultural management have improved productivity and enhanced livelihoods, some have been unsuccessful and some have generated notable external costs. Some poorly conceived or poorly implemented water management interventions have incurred high social and environmental costs, such as inequity in the allocation of benefits and undesirable impacts on natural resources. In some cases, common

* Corresponding author. Tel.: +233 21 784753; fax: +233 21 784752.
E-mail address: c.fraiture@cgiar.org (C. de Fraiture).

0378-3774/$ – see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.agwat.2009.08.015

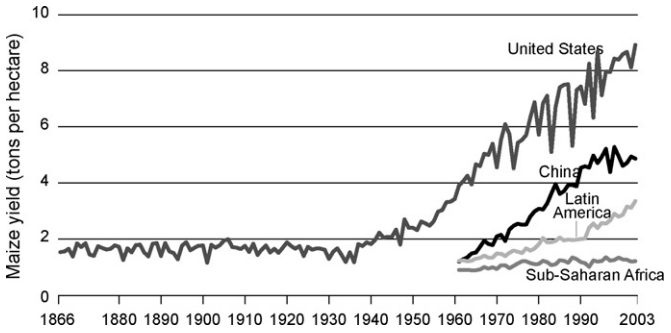

Fig. 1. Growth in maize yields in USA, China, Latin America and Sub-Saharan Africa. Source: Molden, D. 2007.

pool resources such as rivers and wetlands, that are important for poor fishers and resource gatherers, have been appropriated for other uses, resulting in a loss of livelihood opportunities (Gowing et al., 2006). Some communities have been displaced, especially in areas behind dams, without adequate compensation (World Commission on Dams, 2000).

Many of irrigation's negative environmental impacts arise from the diversion of water away from natural aquatic ecosystems, such as rivers, lakes, oases, and other groundwater-dependent wetlands. The direct and indirect negative impacts have been well documented, including salinization, channel erosion, declines in biodiversity, introduction of invasive alien species, reduction of water quality, genetic isolation through habitat fragmentation, and reduced production of floodplains and inland and coastal fisheries (Richter et al., 1997; Revenga et al., 2000; Bunn and Arthington, 2002; Pimentel et al., 2004; MEA, 2005; Khan et al., 2006; Falkenmark et al., 2007). One challenge in moving forward is to determine the best ways for improving agricultural productivity and enhancing livelihoods, while protecting natural resources and sustaining environmental amenities. This challenge might be described also as seeking the optimal balance between productivity gains and environmental costs. It is likely unhelpful to consider only one aspect of interventions in agricultural water management. We must consider the farm-level and societal costs and benefits, and we must evaluate inevitable tradeoffs as we seek the optimal forms and levels of public interventions.

2. Trends and challenges ahead

As noted above, the challenges today are markedly different from 50 years ago. In the past, the fear of famines was a major driving force behind new water developments to increase agricultural production (Barker and Molle, 2004). New challenges have come to the fore: changing diets, increasing water scarcity, urbanization and migration, agricultural transformation, climate change, energy policy, environmental restoration.

2.1. Changing diets and increasing food demands

As incomes rise, food habits change in favour of more nutritious and more diversified diets. Generally this leads to a shift in consumption patterns away from cereals toward livestock products and high-value crops such as fruits, vegetables, sugar, and edible oils (Rosegrant et al., 2002; Pingali, 2004). While the trends in diets follow similar patterns, regional and cultural differences are pronounced. Considerable uncertainties remain regarding some of the major factors driving future food and feed demand. Cereal demand projections range from 2800 million tons to 3200 million tons by 2050, an increase of 55–80% from today. Meat demand projections vary between 375 million tons and 570 million tons by 2050, an increase of 70–155%[1] compared to 2000. Sugar, oil, vegetable and fruit demand are projected to increase by 70–110% (De Fraiture et al., 2007).

2.2. Urbanization

In the 1960s two-thirds of the world's population lived in rural areas, and 60% of the economically active population worked in agriculture. Today, half of the people live in rural areas, and just a little more than 40% of the economically active population depend directly on agriculture (FAO, 2007). By 2050 two-thirds of the world's people will live in cities, but global averages will mask considerable regional variation. In many poor countries in Sub-Saharan Africa and South Asia, the rural population will continue to grow until about 2030, and the number of people depending on agriculture will continue to increase. Urbanization increases competition for water between the urban and agricultural sectors, and changes the production structure of agriculture.

2.3. Structural changes

Changes in global markets, trade policies and the spread of globalization will determine the future profitability of agriculture. While grain production will remain important, a variety of shifting niche markets will emerge, creating opportunities for innovative entrepreneurial farmers, where suitable infrastructure and national policies are in place. In some countries, where other sectors of the economy have a competitive advantage, the contribution of farming to the national economy will shrink, and this may have significant implications for smallholders and subsistence farmers who rely on extension, technology, and regional markets. Yet agricultural development remains the single most promising engine of growth in most sub-Saharan countries. To ensure the sustainability of the agriculture sector in many of these countries, investments in technology and capacity building are needed, along with policies that make farming profitable (Molden et al., 2007).

2.4. Climate change

Climate change will impact many aspects of society and the environment, directly and indirectly, with particular influence on water resources and agriculture. Changes in average temperatures, shifting patterns of precipitation, and changes in the frequency and intensity of extreme weather events can impact agriculture in ways that are not completely predictable. However, it seems likely that water availability for agriculture will be considerably reduced in semi-arid and arid areas, with major consequences for agriculture in Sub-Saharan Africa.

Estimates of the future impacts of climate change and thoughtful strategies for adapting to those impacts must be incorporated into project planning efforts. Public policies and investments regarding infrastructure, public management of projects and resources, and policies that influence human behaviour must be informed by careful consideration of the potential impacts of changes in climate. Investments in water storage and control will be important components of rural development strategies that respond to climate change. Policies and laws designed to reduce greenhouse gas emissions or adjust to a changing climate will have both intended and unintended impacts that must be considered in the context of the resources required to achieve food production goals. For example, investments in biofuels and other projects under the clean development

[1] The wide range is explained partly by substantial uncertainty in income projections, as meat consumption is highly correlated with income.