Journal of Hydrology 513 (2014) 204–215

Contents lists available at ScienceDirect

Journal of Hydrology

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

The impact of food and agricultural policies on groundwater use in Syria

Aden Aw-Hassan [a,1], Fadel Rida [b], Roberto Telleria [c,*], Adriana Bruggeman [d]

[a] Social, Economic, and Policy Research Program (SEPRP), International Center for Agricultural Research in the Dry Areas (ICARDA), P.O. Box 950764, 11195 Amman, Jordan
[b] International Center for Agricultural Research in the Dry Areas (ICARDA), P.O. Box 114/5055, Beirut, Lebanon
[c] Social, Economic, and Policy Research Program (SEPRP), International Center for Agricultural Research in the Dry Areas (ICARDA), P.O. Box 950764, 11195 Amman, Jordan
[d] Hydrology and Water Management Energy, Environment and Water Research Center (EEWRC), The Cyprus Institute, P.O. Box 27456, 1645 Nicosia, Cyprus

ARTICLE INFO

Article history:
Received 20 September 2013
Received in revised form 13 February 2014
Accepted 18 March 2014
Available online 29 March 2014
This manuscript was handled by Geoff Syme, Editor-in-Chief

Keywords:
Syria
Groundwater
Subsidy
Energy
Irrigation
Sustainability

SUMMARY

During the last three decades, the expansion of irrigation using both surface water and groundwater resources has had an important positive impact on Syria's agricultural production. It is an example of success in achieving food policy objectives, but it has also introduced the challenge of groundwater sustainability. This paper examines the trends in groundwater abstraction for irrigation and the effect of government policies, including input subsidies – such as the diesel fuel subsidy and the crop procurement price support. The fuel subsidy is an important driving force in groundwater depletion and overabstraction. This analysis examines the interaction between policy signals and the use and allocation of water by farmers. The rapid decline in groundwater resources shows the limitations of this agricultural development strategy and questions its sustainability unless policies change and the rate of abstraction is changed so as not exceed the recharge rate.

1. Introduction

Water scarcity is globally recognized as a serious development constraint and a potential source of international and intra-national conflicts. Lack of water is already constraining agricultural production in many parts of the world (Biswas, 2010; FAO, 2009; Jhorar et al., 2009; Dhehibi and Telleria, 2012). The Middle East and North Africa (MENA) region is the most water scarce one in the world (World Bank, 2007). Worldwide, the average water available per person is about 7000 m^3/person/year; in the MENA region, it is only around 1200 m^3/person/year. In this region, the population is expected to grow from about 380 million today to about 500 million in 2025 (World Bank, 2007), while per capita water availability is expected to fall to 500 m^3/person/year by 2025 (UNOCHA, 2010).

The challenges of water scarcity are heightened by the increasing costs of developing new water resources, land degradation in irrigated areas, groundwater depletion, water pollution, and ecosystem degradation (Rosegrant and Cline, 2003). Unsustainable water management practices, which exceed the system's carrying capacity, impose direct significant costs, in terms of lost farm productivity, and indirect costs which are potentially enormous (Khan and Hanjra, 2008). Over-extraction of groundwater and aquifer depletion threatens many of the world's most important food-producing regions, including the North China Plain, the Indian Punjab, parts of Southeast Asia, large areas of MENA, and much of the western United States (Rosegrant and Cline, 2003; Postel, 1999). Results from recent climate change models suggest greater water stress from decreased precipitation in many arid and semi-arid regions worldwide, including parts of the Middle East, Africa, Australia, and the United States (Qureshi et al., 2010; Christensen et al., 2007). A fundamental shift in water and energy use is needed in food policy to avoid a severe food crisis in the future (Hanjra and Qureshi, 2010).

Excluding the Gulf region, agriculture is the largest consumer of water in the MENA region, taking an average 85% of the supply (Richards and Waterbury, 2008). Syria is located within the water-critical region. Agriculture accounts for 87% of the water withdrawn from Syria's aquifers, rivers, and lakes (FAO AQUASTAT, 2012). Renewable water resources in Syria are estimated at 808 m^3/capita/year (FAO AQUASTAT, 2012), which is below the water scarcity threshold of 1000 m^3/capita/year (Roudi-Fahimi et al., 2009). With a rate of population growth consistent with the UN's medium variant population projection (UN-DESA, 2011), the country will approach the absolute water scarcity threshold

* Corresponding author. Tel.: +962 65903120; fax: +962 65903113.
E-mail addresses: a.aw-hassan@cgiar.org (A. Aw-Hassan), f.rida@cgiar.org (F. Rida), r.telleria@cgiar.org (R. Telleria), a.bruggeman@cyi.ac.cy (A. Bruggeman).
[1] Principal author.

http://dx.doi.org/10.1016/j.jhydrol.2014.03.043
0022-1694/

(500 m^3/capita/year) by 2050. However, both climate change and developments in neighboring countries are likely to reduce these resources even further, considering that half of Syria's annual renewable water resources originate from cross-border flow, with the majority of it flowing in from Turkey by way of the Euphrates.

Groundwater-based agriculture comprises 53% of the total irrigated land (MAAR, 2010). Expansion of the use of groundwater use in agriculture has had a positive effect on production so far, but it could have a considerable adverse effect on the availability of water resources in the long run. In effect, the sustainability of agricultural incomes and rural livelihoods are at stake. However, the effects of such expansion on the sustainability of water resources have received less attention than the effects on food and income security. Policy makers have only recently come to consider the issue of resource capacity (Salman and Mualla, 2008).

Energy, mainly diesel fuel, is used to power groundwater abstraction and currently constitutes the major component of the variable costs involved. Diesel prices in Syria increased with the world oil price surge in 2011. Yet, diesel fuel prices remain subsidized, and are reckoned to cost Syria around 5% of gross domestic product (GDP) a year (The Economist, 2011). Prior to the increase in these fuel prices, farmers did not consider the cost of pumping to be a critical production constraint, though this perception might change as a result of the higher diesel prices.

This study analyzes the effects of food and agricultural policies on groundwater use in Syria. The driving forces that have contributed to the high-intensity of groundwater use in Syria are examined and their effects on the development of groundwater-based irrigation are discussed, along with the potential consequences. The study evaluates the effects of changes in energy prices (i.e. through the removal of fuel subsidy) on the profitability of different crops. The study undertakes a simulation of how farmers might respond, in terms of crop choice and water use, to changes in energy policy. We argue that groundwater abstraction in the dry areas, if it continuously exceeds the recharge rate, resembles a mining process – extracting a limited resource, with its inevitable depletion and its economic, social, and environmental consequences.

2. Background on Syria's food and irrigation policies

Based on the overall government development policy objectives, the expansion in irrigated agriculture in Syria can be categorized into three broad phases. The first phase, from 1966 to 1984, was an expansion of irrigation systems as a result of policies to improve food security and agricultural and rural development (Wakil, 1993). Since the 1960s, wheat has covered more hectares than any other crop in Syria. By 1966 wheat cultivation was already above 800,000 ha, providing more than 550,000 tons of wheat (FAOSTAT, 2013). By 2005, wheat was covering almost 2 million ha and this decreased to about 1.5 million ha by 2010. In general, wheat cultivation has followed an up and down pattern, though the long-term trend was positive from 1966 to 2010 (Fig. 1). Cotton has been an important crop since the 1960s. It accounted for 60% of the irrigated land, or about 220,000 ha, in the period 1966–1969. The irrigated wheat and vegetable areas each occupied 14% of the irrigated land during the same period. During this period, the cotton area experienced a declining trend; it recovered a little through the 1990s, but again followed a downward trend from 2000 onwards.

The second phase marked the period between 1985 and 2000. To ensure that production targets were met in this period, agricultural production plans were drawn up every year for the country's main products and guaranteed prices were set for strategic crops, such as wheat and cotton. Farmers participating in the official production schemes would receive direct subsidies on farm inputs, such as seeds, fertilizers, farm equipment, and fuel. Farmer participation was used to facilitate the granting of well licenses, and sometimes these schemes took precedence over the observance of drilling restrictions. Farmers registered for government production schemes were given greater access to low-interest loans, which were, in turn, used to purchase inputs. In addition, to allow farmers to dig wells and purchase pumps, medium-term loans were provided at an interest rate of 5%, which was low in comparison with the official rate of 9%, while the informal market rate could be as high as 50%. (For a detailed description of the Syrian policy's specific measures that related to irrigation water in the 1990s, see Varela-Ortega and Sagardoy, 2001.)

As domestic diesel fuel prices did not fluctuate in line with international petroleum prices, the domestic diesel price in Syria used to be as low as 20% of the world market price. The difference was an explicit fuel subsidy. Of the various agricultural input subsidies provided during the 1990s (Table 1), the largest was applied to diesel fuel, constituting approximately 80% of the local purchase price. Thus, in Syria, approximately 75% of the groundwater pumps and well rigs and the equipment for drilling and deepening wells

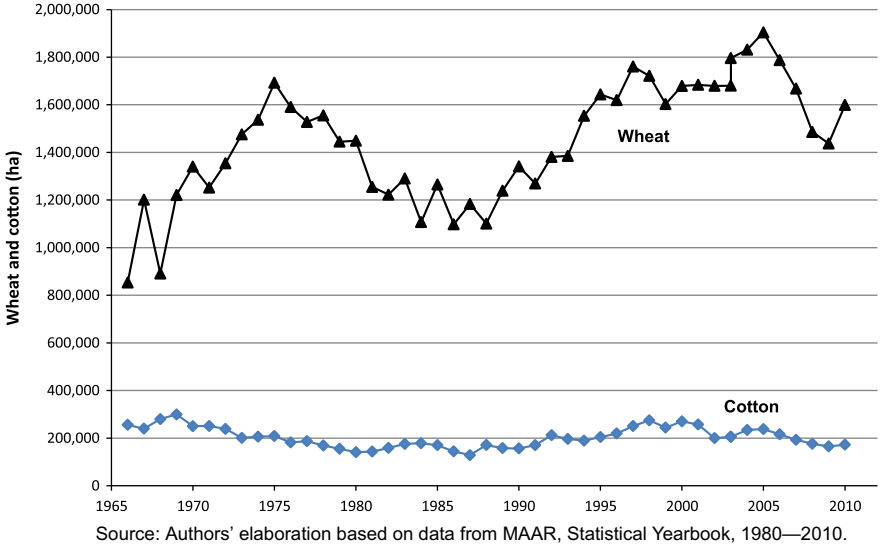

Fig. 1. Wheat and cotton cultivation in Syria, 1966–2010.