INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
IFPRI

CGIAR
RESEARCH PROGRAM ON
Water, Land and Ecosystems

IFPRI Policy Note
January 2017

INVESTMENT IN IRRIGATION FOR GLOBAL FOOD SECURITY

Over the next decade and a half, more than one billion people will likely be added to our planet, with growth concentrated almost exclusively in the group of developing countries. On average, populations will be wealthier, but inequality will also increase. Under the medium population growth scenarios used by the Intergovernmental Panel on Climate Change in its Fifth Assessment Report (2013–14), the middle-of-the-road population estimate for 2030 is 8.3 billion, with a global gross domestic product (GDP) of US$143 trillion and global average per capita income of US$17,000.

As a result of this growth, by 2030 food demand is expected to have increased by 34 percent from its 2010 level. Supporting this increase in demand under growing natural-resource scarcity will require significant investments in agricultural research and agricultural water management—irrigation in particular—as well as improved natural-resource management and stronger support for enabling environments. Can increased expenditures in irrigation expansion and water-use efficiency mitigate the consequences of the population boom and growing wealth? IFPRI's economic-biophysical modeling shows that such investments could significantly improve food security and nutrition in the future.

IRRIGATION EXPANSION GENERATES MULTIPLE BENEFITS

While less than a third of the world's harvested land is irrigated, irrigated crop areas generate 40 percent of global food production. Yet the distribution of irrigated land varies widely. Almost 40 percent of total irrigated farmland is in the East Asia and Pacific region, and more than 30 percent is in South Asia. Thus these two regions together account for more than 70 percent of the world's irrigated crop area, while only 5 percent of harvested land in Africa south of the Sahara (SSA) is irrigated.

Under the status quo, or *business as usual* scenario, total irrigated crop area is expected to increase by 12 percent to 394 million hectares (ha) by 2030, with the largest increases occurring in SSA (44 percent), followed by South Asia and Latin America and the Caribbean (15 percent each). Roughly 90 percent (39 million ha) of the total increase in irrigation between 2010 and 2030 is expected to be in developing countries (see Table 1). Average annual costs of expanding irrigation across all developing countries are estimated at US$7.87 billion.

If water resources are to be used both productively and efficiently, irrigation expansion must be coupled with investments in efficiency enhancement. Efficiency can be increased by adopting high-efficiency irrigation technologies or by improving water management—for example, through upgrading water-delivery infrastructure and strengthening institutional mechanisms such as groundwater governance, farmer-led irrigation management, and water-user associations. Investing in plant breeding for increased transpiration efficiency, drought and heat tolerance, and other such advances would also contribute to efficiency gains. Implementing such improvements in developing countries would cost an estimated US$2.36 billion per year.

TABLE 1.1 Total harvested area (million ha) by region in 2010 and projected in 2030

	2010		2030	
Region	**Irrigated**	**Rainfed**	**Irrigated**	**Rainfed**
East Asia and the Pacific	136	139	145	151
South Asia	114	114	131	106
Former Soviet Union	13	94	14	99
Africa south of the Sahara	9	185	13	224
Middle East and North Africa	23	44	26	48
Latin America and the Caribbean	20	123	23	148
Developing countries	315	709	354	786
Developed countries	36	206	40	211
World Total	351	915	394	997

NOTE: Rest of the world not shown.

SOURCE: M. W. Rosegrant, T. B. Sulser, D. Mason-D'Croz, N. Cenacchi, A. Nin-Pratt, S. Dunston, T. Zhu, et al., "Quantitative Foresight Modeling to Inform the CGIAR Research Portfolio" (Washington, DC: International Food Policy Research Institute, forthcoming).

The development of irrigated agriculture has boosted agricultural yields and increased the number of cropping seasons to two or more in many parts of the world, thereby conserving important forest resources, contributing to price stability under climate variability, and helping to feed the world's growing population.

Irrigation can bring many benefits to a community, including greater diversity in available foods; income from market sales and employment generation, particularly in the lean season; and water supply, sanitation, and hygiene through multiple-use irrigation systems that can help reduce environmental enteric dysfunction (an acquired disorder of the small intestine). In addition, irrigation can increase women's opportunities for asset ownership, their control over resources, and their time, because they are often responsible for collecting water. As such, irrigation can make important contributions to women's empowerment as well as to nutrition and health outcomes.

Yet possibilities for expanding irrigation are increasingly under threat, as nonagricultural demands for water and biofuel production rapidly rise, and soil degradation, groundwater depletion, and water pollution from poor irrigation management continue to worsen. Climate variability and climate change only exacerbate these challenges. Moreover, if not properly managed, irrigation can cause increased exposure to waterborne diseases and pesticides and, therefore, possible health risks.

Finally, funding for international agricultural research and development in agricultural water management has been declining over the last several years, and government priorities are shifting to shorter-term threats. It is therefore uncertain whether the current projected investments *(business as usual)* in agricultural water management will materialize.

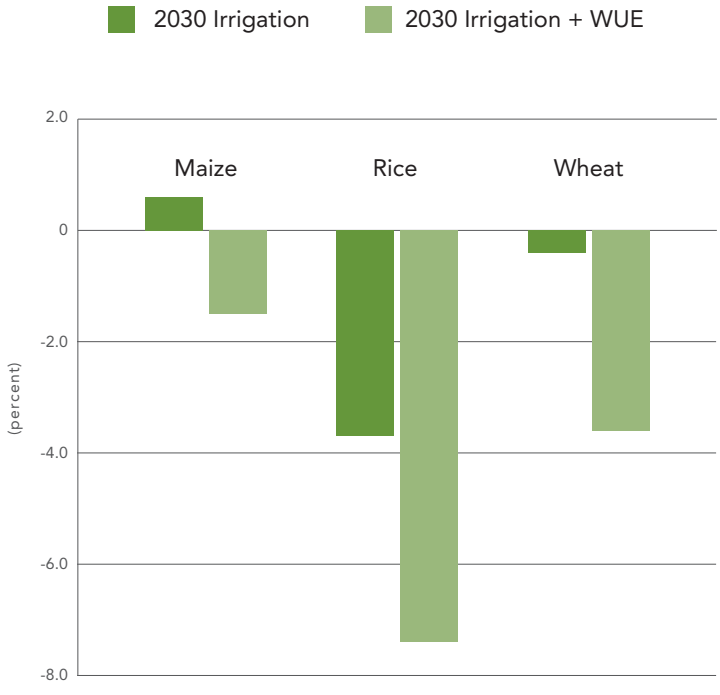
BENEFITS OF ACCELERATED IRRIGATION DEVELOPMENT

Irrigation can and should be an integral part of sustainable agricultural production. For this to happen, investment in irrigation infrastructure, policies, and institutions must be strengthened in those regions most threatened by food insecurity and climate change, and where irrigation development is most environmentally sustainable.

Figure 1 presents the results of two alternative scenarios *to business as usual*: the first is characterized by additional investments in irrigation expansion; the second, by additional investments in irrigation expansion plus increased water-use efficiency (WUE). Under the first scenario of additional investments, total irrigated crop area in developing countries would increase to 374 million ha by 2030—20 million ha more than under *business as usual*—and total rainfed crop area would decrease. Under the second scenario, irrigation investments plus WUE, basin-level water efficiency would increase by 15 percentage points more than under *business as usual*. This is a sharp improvement in overall irrigation efficiency at the basin level. Total incremental annual costs for the additional investments scenario and the additional investments plus WUE scenario are estimated at US$3.5 billion and US$8.1 billion, respectively.

The positive impacts of either scenario would be substantial. Increased irrigation investments alone would lower the international price of rice and wheat by 3.4 percent and 0.4 percent, respectively, though it would put slight upward pressure on the price of maize (Figure 1). The combination of the additional irrigation expansion with WUE would reduce maize, rice, and wheat prices by 1.5 percent, 7.4 percent, and 3.6 percent, respectively. Both investment scenarios would also lower the prices of fruits, vegetables, and other nutrient-dense foods.

FIGURE 1 Projected changes in international commodity prices under alternative irrigation investment scenarios as of 2030 (compared to business as usual)

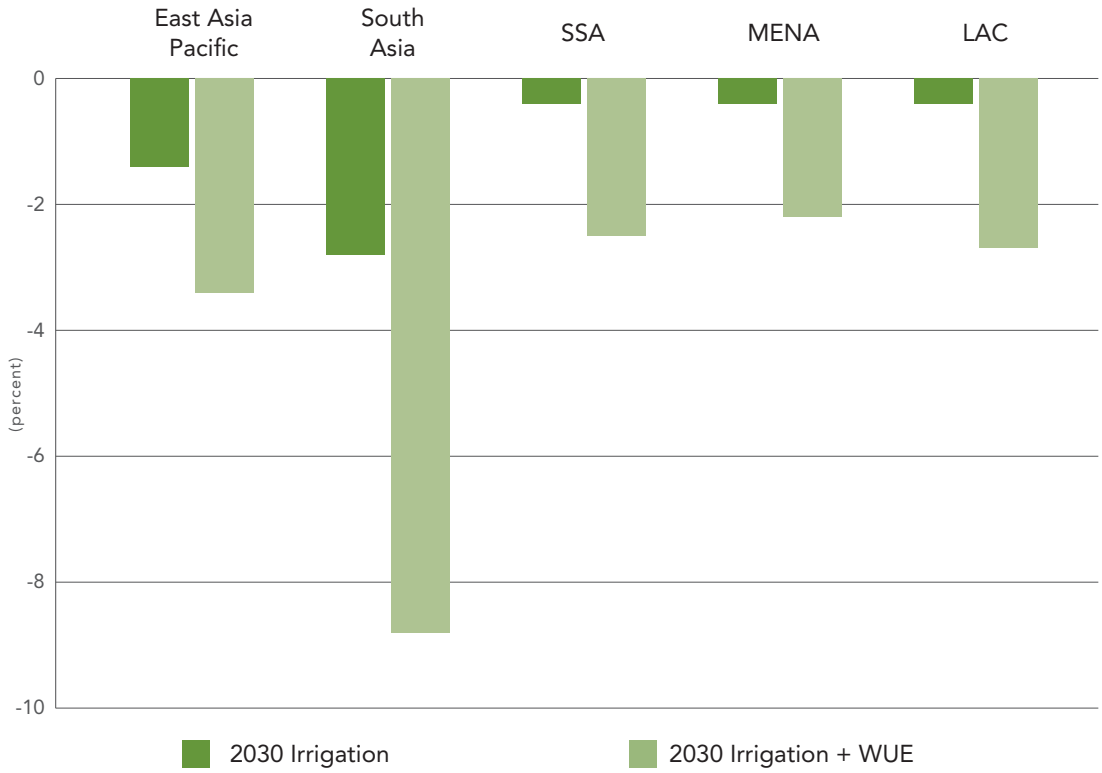


NOTE: WUE = water-use efficiency.

SOURCE: M. W. Rosegrant, T. B. Sulser, D. Mason-D'Croz, N. Cenacchi, A. Nin-Pratt, S. Dunston, T. Zhu, et al., "Quantitative Foresight Modeling to Inform the CGIAR Research Portfolio" (Washington, DC: International Food Policy Research Institute, forthcoming).

As a result of lower food prices, the number of people at risk of hunger would drop considerably. With greater investment in irrigation, 7.6 million fewer people would be at risk of going hungry; increased investment plus higher water-use efficiency would make an even more dramatic impact: 26.2 million fewer people would be at risk of hunger than under the *business as usual* scenario, with the largest effects in South Asia, where the majority of the world's poor live. Environmental, health, and nutrition benefits as well as gains in women's empowerment could also be significant (Figure 2).

FIGURE 2 Projected changes in number of people at risk of hunger under alternative irrigation investment scenarios as of 2030 (compared to business as usual)



NOTE: WUE = water-use efficiency; MENA = Middle East and North Africa; LAC = Latin America and the Caribbean.

SOURCE: M. W. Rosegrant, T. B. Sulser, D. Mason-D'Croz, N. Cenacchi, A. Nin-Pratt, S. Dunston, T. Zhu, et al., "Quantitative Foresight Modeling to Inform the CGIAR Research Portfolio" (Washington, DC: International Food Policy Research Institute, forthcoming).

ENCOURAGING INVESTMENT

What will it take to achieve a level of irrigation investment sufficient to support sustainable agriculture for improved food security and nutrition? Climate change and all the resulting uncertainties are sparking new interest in raising investments in irrigation to enable more stable food production. In order for these investments to pay off, they need to be targeted and ideally should be accompanied by the following:

1. *Support for smallholder irrigation systems whenever feasible*. The projections above assume traditional sizable investments in large-scale irrigation systems. Yet smallholder irrigation systems often cost considerably less (even including operation and maintenance) than do larger systems, particularly in Africa south of the Sahara. Current investment levels in SSA are extremely low, however, and therefore warrant a strategy of combined large- and small-scale irrigation investments.
2. *Improvements in water-use efficiency*. As pressures on water for various uses intensify and water becomes scarcer, the consequences mount: by 2050, 53 percent of the global population, 49 percent of global grain production, and 45 percent of global GDP could be at risk due to water stress. Yet, as the alternative scenarios

here show, these consequences can be mitigated. Although the regional benefits from enhanced water-use efficiency would be substantial everywhere, they would be particularly sizable in South Asia.

3. *Economic incentives to conserve water resources*. Incentives will be crucial for irrigation to thrive. Among the different possible incentives are irrigation service fees that encourage farmers to make more efficient use of water as well as payments for water saved (for example, through markets in tradable water-use rights). Alternatively, the collective management of surface or groundwater systems can generate incentives (for example, through strengthened joint monitoring of water flows or well depth).
4. *Linkages with other sectors*. If irrigation is to make an impact on food security and nutrition, irrigation development cannot be viewed in isolation. As energy consumption in agriculture grows, it is imperative to assess the energy requirements of both new irrigation projects and rehabilitation projects before they begin. To this end, the Asian Development Bank is piloting a checklist on energy needs for irrigation projects.
5. *Linkages between irrigation and nutrition*. Irrigation should improve the water supply not just for agriculture but also for domestic use, including sanitation. Likewise, irrigation should support and strengthen dietary diversity and raise incomes. Investments in irrigation should empower women by ensuring that they have access to information on water technologies, can obtain rights to use those technologies, and have decision-making power over the proceeds from irrigated production. At the same time, potential hazards such as waterborne diseases and water pollution must be minimized to ensure that irrigation development is sustainable and supports not only food security but also improved nutrition and health.

Irrigation has an important role to play for enhancing future food security and the time for targeted investments is now.

Claudia Ringler is deputy director of the Environment and Production Technology Division of the International Food Policy Research Institute, Washington, DC, USA.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
A world free of hunger and malnutrition

2033 K Street, NW, Washington, DC 20006-1002 USA | T. +1-202-862-5600 | F. +1-202-467-4439 | Email: ifpri@cgiar.org | www.ifpri.org

DOI: 10.2499/9780896292543