



Zentrum für Entwicklungsforschung
Center for Development Research
University of Bonn

February 2005

ZEF Policy Brief No. 3

Irrigation can be sustained - at a cost

by Daniel Hillel and Paul Vlek



Center for Development Research (ZEF)
Walter-Flex-Str. 3 - D-53113 Bonn - Germany
Email: zef@uni-bonn.de - Internet: www.zef.de

IRRIGATION MAIN FINDINGS

Conclusions

Irrigated agriculture must adapt to the long-term requirements of sustainability, particularly in view of changing social, economic, environmental, and political conditions.

Irrigated agriculture can be sustained only if society is able to prevent environmental damage and is willing to bear the necessary costs of doing so.

Additional research and extension is needed to obtain "more crop for every drop", particularly in arid and semiarid regions, where irrigated agriculture will remain indispensable while water supplies are limited.

Traditionally seen as a public good, water is increasingly becoming a traded commodity. Delivered at the farm gate it should have a price to avoid wastage and increase the returns on the public investments in water delivery.

Lessons learned

The problems posed by the practice of irrigation are real and age-old. In former times, irrigators were largely unaware of, and in many cases lacked the means to control, the processes of degradation engendered by the application of water to land in arid environments. Now we know much more about the dynamics of water and salts in the soil-plant-atmosphere continuum, and we have the techniques to prevent the degradation that could not be prevented in the past. We have the knowledge, the techniques, and above all - the imperative.

The sustainability of irrigation could never and is never to be taken for granted. Degradation of soils and depletion of water resources not only caused the collapse of irrigation-based societies in the past but are also threatening the viability of irrigation at present. The problem is global in scope. Decimation of natural ecosystems, deterioration of soil productivity, depletion and pollution of water resources, and conflicts among sectors and states over dwindling supplies and rising demands have become international problems closely linked with irrigation development.

Irrigated agriculture must strive for a balance between the immediate need to maximize production here and now, and the ultimate need to ensure continued productivity in the future. It must also strive to achieve a harmonious interaction with the external environment, including both natural ecosystems and other human enterprises. More



specifically, irrigation projects should ensure that water supplies of adequate quality are and will continue to be available, that the salt balance and hence the productivity of the land can be maintained, the drainage effluent can be disposed of safely, public health can be safeguarded, and the economic returns can justify the costs. Those requirements are conditioned on an effective program of monitoring and control.

Irrigated agriculture is not an insular industry and cannot be isolated from the overall contexts within which it functions. Those contexts are far from stable. Their dynamics force irrigation to change in response to new fiscal and political realities even if it seems internally sustainable. Evolving demographics and economies will require the adjustment of water-use patterns for all sectors, including agriculture. Rapidly growing urban centers, along with essential environmental and in-stream uses of water now compete increasingly with irrigated agriculture for limited supplies of water. Other market forces likely to affect irrigation are changing prices of such essential inputs as seeds, fertilizers, means of pest control, labor, equipment, and other services, as well as energy.



Deteriorated irrigation canal and water pump, Uzbekistan



Saline soil, Uzbekistan

Strategies

The trends in many places are such that irrigated agriculture will be increasingly difficult to sustain in the future, unless it is able to adapt to these changing conditions. Moreover, irrigated agriculture is certain to remain an important, indeed an indispensable, component of agricultural production in many arid and semiarid regions. Various strategies must come into play if irrigated agriculture is to meet and overcome the challenge of impending changes:

- One strategy is to alter the crop mix in favor of high-valued fruits, vegetables, industrial crops (e.g., fiber-producing and biochemical-producing plants).
- Another strategy is to implement more sophisticated technology and management at the field level. Greater emphasis must be given to efficient water and energy use and to the avoidance of environment degradation. More efficient irrigation methods could be the use of closed conduits (rather than unlined ditches), precision application of water in measured response to demand

rather than by uncontrolled surface flooding, drip tubes (place either on the ground surface or at some depth below the surface) and micro-sprayer technologies, as well as low-energy precision application sprinklers. Surface irrigation can be improved greatly by means of laser-guided land shaping, and surge-flow techniques. Computerized control systems can improve precision while reducing labor, while remote-sensing techniques (such as infrared monitoring of canopy temperature to detect plant stress) can help to tailor treatments to spatially variable field and plant conditions.

- The ability of irrigated agriculture to meet future challenges may well depend on the progress of new research to enhance the needed adaptation to changing conditions - social, economic, and climatic. Such research is itself costly in the short run, but is a wise investment for private, public, national and international agencies to pursue in the long run. Biotechnology is one area of research that seems to hold great promise for improving the yield and quality of crops, as well as their resistance to pests and their tolerance to salinity and drought. However, the genetic manipulation of crops also poses risks to natural ecosystems and must therefore be pursued with great caution.



Rice transplantation activities, Burkina Faso



Dam constructed for small-scale irrigation

- Much can be achieved by improving the efficiency of water use. Modern irrigation technology offers the opportunity to conserve water by reducing transport and application losses, while increasing yields. The sine qua non of ensuring the sustainability of irrigation is the timely installation and continuous operation of a drainage system to prevent waterlogging and to dispose safely of excess salts. All too often drainage creates off-site problems, beyond the on-site costs of installation and maintenance, since the discharge of briny effluent can degrade the quality of water its downstream course. Where access to the open sea is feasible, solving the problem is likely to be easier than in closed basins or in areas far from the sea. In those cases, the disposal terminus eventually becomes unfit for human use, as well as for wildlife. Hence the importance of reducing the volume and salinity of effluents, by such means as improving the efficiency of water use - a task that in itself can bring economic and environmental rewards.

All of these possibilities require intensive research and development efforts at the national and international levels. Public investment in basic and applied research



and extension is needed to make the benefits available to all rather than be the exclusive property of special interests.

Conditional Conclusions

In the face of the many pervasive problems, we come to the conditional conclusion, supported by practical experience and scientific research, that irrigated agriculture can be sustained, but only if and where certain stringent requirements are met. The requirements are effective prevention of upstream, onsite, and downstream environmental damage. Is society willing to heed those requirements and to bear the costs of ensuring the future sustainability of irrigation, even if that entails larger investments in the present? Stakeholders and policy makers are likely to respond positively only if the long-term environmental processes and their long-term implications are made abundantly clear to all.

Although there will be cases where the costs of continuing irrigation may be prohibitive (especially if severe damage has already occurred), in most instances the cost should be well worth bearing.



Traditional harrowing techniques, Thailand



Pumping water for irrigation, Ghana

Investing in the maintenance of irrigation and the integrity of the environment in general can result in improved economic and social wellbeing.

Developing and implementing an effective sustainability program requires an understanding of complex interrelationships with multiple causes, effects, and feedbacks, operating at different scales of space and time.

Irrigated agriculture will not only survive but indeed thrive in the proper circumstances and with appropriate measures. In some places, inherently inefficient, self-destructive, and environmentally damaging operations will be forced to terminate. On the whole, irrigated agriculture should be able to adapt to the long-term requirements of sustainability, and continue to help provide the growing needs of humanity, in the future even more than in the past.

The full paper appeared in "Advances in Agronomy", published jointly by the American Society of Agronomy, Madison Wisconsin, USA, and Elsevier/Academic Press, Amsterdam and London.



ZEF Policy Brief

For the purpose of applied research the ZEF Policy Briefs mainly address decision makers and practitioners of development cooperation with pointed comments on current and emerging topics. The ZEF Policy Briefs are published sporadically. They are complementary to ZEF's more extensive Discussion Papers that intend to stimulate discussion among researchers and practitioners.



The Center for Development Research (ZEF) is an international and interdisciplinary research institute at the Rheinische Friedrich-Wilhelms-University, Bonn. The Center came into actual operation towards the end of 1997.

The work of the Center is supported by an external International Advisory Board, currently chaired by Prof. Klaus Töpfer, Director General of the United Nations Environment Program (UNEP), Kenya. The Board monitors and evaluates ZEF's work.

IMPRINT

Published by:

Zentrum für Entwicklungsforschung (ZEF)
Center for Development Research
University of Bonn
Walter-Flex-Strasse 3
D - 53113 Bonn
Germany
Phone: +49-228-73-1846
Fax: +49-228-73-5079
E-Mail: zef@uni-bonn.de
<http://www.zef.de>

Editor:

Alma van der Veen

Layout:

Karina Waedt, Charlotte van der Schaaf

Print:

Rautenberg Media & Print Verlag KG, Troisdorf

Photos: ZEF

Copyright © 2005 Center for Development Research. All rights reserved. Sections of this document may be reproduced without the express permission of, but with acknowledgement to, the Center for Development Research.