Discussion by Herve Plusquellec[7] and Charles M. Burt,[8] Member, ASCE

The authors (Kirpich et al.), discuss the key problems that, in their views, restrict and diminish the benefits of irrigated agriculture, which would be crucial for the food security of developing countries in the coming decades. The authors endorse a statement made by former president of the International Commission of Irrigation and Drainage (ICID) in a keynote address in 1992: "Irrigation schemes in many parts of the world are known to be performing well below their full potential . . . [There is now] wide recognition that deficiencies in management and related institutional problems, rather than technology of irrigation, were the chief constraints of poor performance of irrigation systems."

On the question of appropriate technology, Kirpich et al. also state that they prefer low-level technology, with greater emphasis given to eliminating deficiencies in management and institutional problems. They contrast their preferences to those of practitioners who favor rapid modernization using up-to-date, sophisticated technology. The writers of this discussion consider that the above statement on choice of technology is an inadequate interpretation of our 1994 publication (Plusquellec et al. 1994). Furthermore, we do not share the view that the causes of poor performance of irrigation systems are due predominantly to management. Finally, Kirpich et al. ignore some recent fundamental changes in management of irrigation in some countries, such as in Mexico and Turkey, which have resulted in higher levels of performance.

CHIEF CONSTRAINTS OF POOR PERFORMANCE OF IRRIGATION SYSTEMS

There is no question that irrigation systems have been haunted for decades by a multitude of problems. This is sometimes referred to as a continuous and vicious cycle of rehabilitation, deterioration, rehabilitation, deterioration, etc. Admittedly there are some important management-related and institutional deficiencies, such as conflicts between farmers and irrigation agencies, farmer interference and vandalism, poor coordination between agencies, poor cost recovery of investments and recurrent costs. Few writers have challenged the widespread wisdom that these are the causes of poor performance of irrigation, and Kirpich et al. reinforce the prevailing wisdom. A noticeable exception is the book recently published by IWMI (Horst 1999), which discusses irrigation system design dilemmas. The underlying reasons for professor Horst's writing of this book were a combination of the denial of the importance of technology vis-a-vis management, the increasing indifference to system design, the persistent shortage of manpower, and the lack of transparency of technology and operational procedures. In the preface of his book, Horst raises unusual questions: "Is management really the crux of irrigation problems? . . . Do we not apply cosmetic surgery by only trying to improve the management environment without considering the technology? Is it not time to examine the root of the problem: the design of irrigation systems?"

In this light, we have consistently alerted the irrigation community to the importance of the technology in the performance of irrigation projects. In our 1994 publication, examples of unrealistic designs and operational problems were discussed in detail. A quote from that publication is, "Often the design and layout of an irrigation system fail to consider some basic laws of hydraulics, such as lag time, unsteady nature of water flow, and fluctuations of water level resulting in poor performance of the scheme . . . All too often the designer assumes the canals will operate well with unsteady flow, but in reality the design prohibits effective operation because it lacks a control strategy, sufficient communications, suitable gate spacing or other design errors." Many designs are difficult to manage under real conditions. Many failures and problems are caused by a design approach that pays insufficient attention to operational aspects. There is, of course, tremendous room for improvements of operational procedures. But the point we make is that if a

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hydraulic design is simple to operate for good water delivery service, safety, and efficiency, then many management and institutional problems disappear. It is our observation that many management and institutional problems are self-inflicted wounds that could be minimized or eliminated with proper designs and operational instructions.

As an example, Burt and Styles (unpublished, 1998) studied 16 partially modernized irrigation projects throughout the world and found that problems were almost equally matched between design and management/institutional categories. In some projects, the design problems were the major hindrance to good operation, while other projects suffered primarily from management and institutional problems. All projects suffered from both categories. An integrated approach to modernization must always consider both aspects (hardware and software), not just one. As an example, Burt and Styles (1998) found that the density of turnouts had a huge impact on the degree of water delivery service. If one turnout (offtake) supplied 40–50 farmers, a tremendous amount of interfarmer cooperation (i.e., institutional work) was required in order to achieve some reasonable form of equity and reliability of water delivery.

As another example, manual water level control in canals is typically accomplished with sluice gates. Not only are sluice gates difficult to move, they are also the wrong hydraulic structure. Overflow structures (either independently such as longcrested weirs in small canals, or as wing walls on the sides of undershot gates in large canals) provide significantly better and easier water level control than undershot gates in a manual operation mode.

As a third example, the flexibility and reliability of water delivery to users, as well as the overall project irrigation efficiency, could often be greatly improved if the designers had incorporated some physical means of recycling spills and drain flows. Recapturing and recycling these flows is very often a simple and relatively inexpensive alternative to much more sophisticated canal control systems.

The above comments lead to our raising of two questions: (1) Why is there so little recognition of the importance of irrigation technology as a principal cause of poor project performance?, and (2) what are the causes of deficiencies in designing irrigation systems? The second question is crucial since irrigation projects are often designed by international or national consulting firms that are selected on strict procurement procedures. Implementation of donor-financed projects is supervised by well-trained staff who are recruited after 15 to 20 years of experience. Since borrowers know how to design and build large dams meeting international safety standards, what are the unique characteristics of irrigation systems that tend to provide such mediocre results?

Our 1994 publication addresses these questions. Among other things, we point out that, first, irrigation is a hybrid technique combining civil engineering and agronomy. Most civil engineers are well-trained in structural engineering and construction techniques but not in the practical and theoretical aspects of unsteady flow hydraulics that are the norm in most irrigation systems. They are also unfamiliar with the constraints of the end use—i.e., the on-farm irrigation management requirements. We believe that appropriate irrigation design and management is much more complicated than most engineers, administrators, and donors assume.

Second, designers are rarely confronted with the consequences of how their designs function once they are installed. We believe that most designers are unfamiliar even with how an irrigation project should be evaluated with regard to ease of operation and the service provided. The dearth of simple, service-oriented operations and designs even in recently modernized projects was well documented by Burt and Styles (unpublished, 1998).

Third, many irrigation agencies cling to outdated design standards and often resist changes by external experts. Most consulting firms have no contractual motivation and no financial incentives to introduce new concepts.

Fourth, there is very little vision for the future. We firmly believe that the demands for water are increasing and that mere rehabilitation and usage of standard designs are simply insufficient to meet future needs. Yet many (if not most) modernization projects are actually rehabilitation projects that continue the vicious cycle.

Are the international research or professional organizations doing better in addressing the question of technology in irrigation? Some indications are less than heartening. The International Water Management Institute (IWMI) was created in 1984 based on the emerging consensus among irrigation professionals that most problems were found in the field of irrigation management. The focus of IWMI was continuously on management; irrigation technology has received only a very small level of attention. In the late 1980s, the International Program for Technology Research in Irrigation and Drainage (IPTRID) was created by ICID and the World Bank to specifically address the technical aspects of irrigation research. Modernization was one of the themes identified as a major gap in irrigation research in developing countries. However, modernization has not attracted the interest of major donors. Also, the importance of appropriate (and necessary) technology is largely left out of the discussion on the intensive campaign for the transfer of irrigation management to user associations.

On the bright side, there are encouraging examples of large-scale projects with successful adoption of modern technologies, such as the Guilan rice scheme in northern Iran, the Muda project in Malaysia, the Jaiba project in Brazil, and several projects in northwestern Mexico. The World Bank is working hard to encourage appropriate and sophisticated thought processes in pending modernization projects in China. Some schemes in North African countries adopted some aspects of modern control technology that was developed as early as the 1940s.

SOPHISTICATED VERSUS LOW TECHNOLOGY

The writers of this discussion agree with the Kirpich et al. recommendation that caution be exercised in introducing high technology in irrigation. Electronic equipment for centralized and remote control require skilled maintenance staff, excellent equipment, superb design and installation, and extensive initial shake-down periods. They also require reliable long-term maintenance programs and budgets—institutional issues that are problematic in many projects. Reliable sources of energy are required for motorized gates, and small-floated operated gates are easily subject to tampering. However, our opinions diverge with Kirpich et al. on the definition of high-level technology.

The preference of Kirpich et al. and others for low technology may be related to the number of poor pilot irrigation projects that have attempted to introduce new design concepts. Unfortunately, there seem to be more bad pilot projects than good. Pilot projects are often half-hearted efforts by irrigation agencies, or they are placed in the wrong environment. Sometimes the application is too sophisticated for the application. Often pilot projects are dropped during implementation because of poor commitment of host governments and donor agencies. Poor quality of construction of civil works and poor manufacturing of special equipment of some pilot projects guarantee failures soon after commissioning.

We disagree with the Kirpich et al. interpretation of our 1994 publication that assumes we favor rapid modernization using sophisticated technology. The 1994 publication provided this extensive definition of modern irrigation design: ". . . the

result of a thought process that selects the configuration and the physical components in light of a well-defined and realistic operational plan which is based on the service concept." Modern irrigation design was not defined by specific hardware components and control logic. Rather, it is a combination of physical improvements and institutional reforms. We attached a number of definitions to the term "modern design," such as the following:

- Modern irrigation schemes consist of several levels with clearly defined interfaces. If there is no recirculation of water in the project, each level must be technically able to provide reliable, timely, and equitable water delivery services to the next lower level.
- Modern irrigation schemes are responsive to the needs of the end users.
- The hydraulic design of the water delivery system is created with a well-defined operational plan in mind.
- The hydraulic design is robust, in the sense that it will function well in spite of changing channel dimensions, siltation, and communications breakdowns. Automatic devices (to include simple devices such as long created weirs) are used when appropriate to stabilize water levels in unsteady flow conditions.
- There is recognition of the importance and requirements of agricultural irrigation and the existing social conditions.
- A good design makes maximum use of advanced concepts of hydraulic engineering, agronomic science, irrigation engineering, and social science to produce the simplest and most workable solution. The sophistication that we promote is a sophistication of design principles and thought processes.
- A good design is user- and operator-friendly. Modernization should not be confused with fancy and complicated equipment.

The discussers believe that there is no such thing as a "best" water control strategy. Some modern designs use very simple water control devices; others may require sophisticated controllers and communications equipment to achieve a desired level of performance. Still others rely on simple recirculation designs to improve water delivery efficiency, equity, and flexibility at a low cost. Designers must be aware of the resource limitations and the implications of their design for maintenance, operation and flexibility of water use.

RECENT CHANGES IN IRRIGATION MANAGEMENT

Kirpich et al. discuss several problems affecting irrigation projects with poor performance, such as high water losses, nonpayment of water charges, and neglect of pilot projects. Their paper fails to report on the very substantial progress in performance of irrigation that have been made in Mexico and Turkey. In these two countries, the management of about 90% of the irrigated areas has been transferred from the irrigation agencies to water user associations. The average collection of water charges has increased from about 30% before transfer to over 95% after transfer. Irrigation conveyance and distribution efficiencies have progressively returned to their original values of about 60–62%. Interestingly, the most active user associations in these two countries are now requesting financial and technical support for rehabilitating and upgrading their outdated irrigation infrastructure. This evolution of the user associations supports the definition of modernization of the discussers: a combination of physical improvements with managerial changes.

CONCLUSIONS

The discussers believe that the case for appropriate irrigation project modernization is compelling. There is a need for a new vision for irrigation projects based on the water delivery service that is needed 20 years from now. We believe that strategies for irrigation development focusing mainly on institutional and managerial aspects and leaving out the technical aspects would have very serious negative consequences for the food supply and demand equation in coming decades. These strategies also conflict with the objectives of overall water resources policies promoted by donor agencies. Technology should not be taken for granted by research, donor, and professional organizations. It is only if the water delivery distribution system is well operated that many management objectives can be satisfactory realized, such as the introduction of higher water charges, introduction of water rights, and quotas. Only then will the farmers invest in on-farm development work and other complementary inputs.

APPENDIX. REFERENCES

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