Improving performance of Canal irrigation Systems is long-overdue: Hope or desperation-giving up

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Agriculture production has increased during last 5 decades to feed an additional 5 billion people

Irrigation contributes to 44 percent of food production on 16 percent of cultivated lands through development of:

- Application technologies: 53 million ha are irrigated through pressurized systems (sprinkler: 43; micro-irrigation: from 1.6 to 10 million in two decades)

- Development of tube well technologies: About 113 out of 310 million ha depend on groundwater

- Agricultural research (CGIAR and others..)
Canal Irrigation: A technically stagnant sector for 50 years !!!

- Transport: air, train
- Medical: Surgery
- Communications: Smart phone, e-book
- Office technology: Computers....
- Dam engineering (RCC)
- Geo-synthetics: widely adopted in all civil engineering but Adherence to concrete canal lining techniques.
Hassles of Manual Operation:
Frequent daily re-settings of gates in most projects
Irrigation: an hybrid sub-sector:
Water Resources or Agriculture??
A turning point in the 1980s:
An irrigation system is a socio-technical and environmental entity!
Outline

• Why Improving agricultural water productivity is an urgent matter?
• The missed opportunities during the last two decades
• The constraints to modernization of canal irrigation schemes
• The four technical options of canal modernization
FAO Definition of Modernization

• Modernization is defined as a process of technical and managerial upgrading (as opposed to rehabilitation) with the objective to improve resource utilization (labor, water, economics, environment) and improves service to users (Seminar, Bangkok, 1997)

• Service-oriented management
Dr. Norman Borlaug, the father of the Green Revolution, is estimated to have saved more than one billion lives by introducing dwarf, rust-resistant, high-yielding wheat varieties to Mexico, India, Pakistan, and Turkey during the 1960s. In accepting the Nobel Peace Prize in 1970, Borlaug said that the Green Revolution had provided three decades of “breathing space” in the war against hunger and deprivation.
The boost to agricultural Production by Groundwater since the 1980s has been significant

- Increase use of groundwater was driven by the poor quality of service of surface government-funded-large and medium scale systems: lack of reliable and flexible water delivery
Groundwater areas increase three times in some countries in the 1990s.

The groundwater revolution
## Countries >500,000 ha. serviced by groundwater

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>Area equipped for irrigation (ha)</th>
<th>Area equipped with groundwater source (ha)</th>
<th>% by GW</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>66,340,000</td>
<td>41,790,420</td>
<td>63</td>
</tr>
<tr>
<td>China</td>
<td>62,392,392</td>
<td>18,794,951</td>
<td>30</td>
</tr>
<tr>
<td>United States of America</td>
<td>27,913,872</td>
<td>16,576,243</td>
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<tr>
<td>Pakistan</td>
<td>16,725,843</td>
<td>5,172,552</td>
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<tr>
<td>Iran (Islamic Republic of)</td>
<td>8,297,031</td>
<td>5,151,186</td>
<td>62</td>
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<tr>
<td>Bangladesh</td>
<td>4,695,520</td>
<td>3,458,592</td>
<td>74</td>
</tr>
<tr>
<td>Mexico</td>
<td>6,418,803</td>
<td>2,489,785</td>
<td>39</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>1,730,767</td>
<td>1,678,867</td>
<td>97</td>
</tr>
<tr>
<td>Turkey</td>
<td>4,983,000</td>
<td>1,669,112</td>
<td>33</td>
</tr>
<tr>
<td>Spain</td>
<td>3,828,120</td>
<td>1,445,360</td>
<td>38</td>
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<tr>
<td>Italy</td>
<td>3,977,380</td>
<td>1,327,809</td>
<td>33</td>
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<tr>
<td>France</td>
<td>2,695,660</td>
<td>1,213,543</td>
<td>45</td>
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<tr>
<td>Syrian Arab Republic</td>
<td>1,396,400</td>
<td>950,308</td>
<td>68</td>
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<tr>
<td>Australia</td>
<td>3,343,448</td>
<td>753,998</td>
<td>23</td>
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<tr>
<td>Greece</td>
<td>1,521,590</td>
<td>735,365</td>
<td>48</td>
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<tr>
<td>Morocco</td>
<td>1,484,160</td>
<td>677,201</td>
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<tr>
<td>Brazil</td>
<td>3,149,217</td>
<td>591,439</td>
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<tr>
<td>Afghanistan</td>
<td>3,197,671</td>
<td>575,212</td>
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<tr>
<td><strong>WORLD</strong></td>
<td><strong>300,895,091</strong></td>
<td><strong>112,936,434</strong></td>
<td><strong>38</strong></td>
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</table>
Irrigation has reached a plateau ...
# Areas Equipped for Irrigation

<table>
<thead>
<tr>
<th></th>
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<td>World</td>
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<td>302</td>
<td>314</td>
<td>322</td>
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<td>1.3</td>
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<tr>
<td>Developing countries</td>
<td>103</td>
<td>235</td>
<td>246</td>
<td>253</td>
<td>1.9</td>
<td>1.7</td>
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<tr>
<td>idem excl. China and India</td>
<td>47</td>
<td>108</td>
<td>114</td>
<td>119</td>
<td>2.0</td>
<td>1.4</td>
<td>0.2</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>3</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>1.9</td>
<td>0.7</td>
<td>0.5</td>
</tr>
<tr>
<td>Latin America</td>
<td>8</td>
<td>20</td>
<td>22</td>
<td>23</td>
<td>2.1</td>
<td>1.0</td>
<td>0.3</td>
</tr>
<tr>
<td>Near East / North Africa</td>
<td>15</td>
<td>31</td>
<td>32</td>
<td>34</td>
<td>1.9</td>
<td>1.2</td>
<td>0.2</td>
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<tr>
<td>South Asia</td>
<td>37</td>
<td>90</td>
<td>90</td>
<td>93</td>
<td>2.1</td>
<td>1.6</td>
<td>0.1</td>
</tr>
<tr>
<td>East Asia</td>
<td>40</td>
<td>88</td>
<td>95</td>
<td>96</td>
<td>1.6</td>
<td>2.2</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Actual and Projected Growths of Area Equipped for Irrigation by Region (1961-2050) (Base Year 1961=100)

The CHALLENGE of Food Production

• To produce 60% more food (and fiber) within next 3 decades, but

• Groundwater and surface water development for irrigation has reached its physical limits in many countries in a context of competition for water and climatic changes

• “30 to 40% of food production water comes from unsustainable groundwater” (Water Efficiency magazine)

• Current climate change models suggest that cereal yields will decline between 15 to 20% from current levels if business continue as usual.
Farmers will not invest in water-saving technologies if the service of water is not reliable....

- It is only if the main distribution system is well operated that many other important objectives can be satisfactorily realized.. and it is only then that high returns can be obtained from agricultural extension of other complementary inputs.. (Bottrall 1979)
….and they will not pay water fees if there is no confidence that the organization that charges for water services will not provide high quality of service.

Then the vicious cycle ..
Some Solutions

- Increase productivity of irrigated lands through modernization
- Promoting water saving techniques at farm level
- Developing very expensive projects such as regional water transfers in India (Ganges), China (Yang-Tse, Peru (From Amazone to coastal zone)
- Investments by governments of wealthy food-importing countries in large tracts of cultivable lands in developed countries (China in Kazakhstan and SSA)
- Bio-genetics: new varieties and GMO: No breaktroughts in sight
With the diminishing availability of groundwater and the declining expansion of irrigation worldwide, addressing the deficiencies and poor performance of large-scale irrigation in some emerging countries and less developed countries can no longer be evaded.
Outline

• Why Improving agricultural water productivity is an urgent matter?
• The missed opportunities during the last two decades
World Bank Investments in irrigation
1960-2005
Irrigation lending 1991-2011
Lending Program 1990-2010

• Much of the investments in the 1990s addressed the huge backlog in deferred maintenance and repairs supported by related improvements in management and institutions PIM and IMT_. Few projects have addressed the central objective of achieving a demand-responsive water delivery service.

• .. And completion of the earlier projects (on-farm, drainage..)
Performance of the irrigation sector: Mixed at best

- Generally below technical and economic potential
- Performance of large scale irrigation particularly disappointing
- Many schemes are incapable of responding to changes in demand
- Designers have not paid attention to how schemes would be operated: full or nearly full supply
In the 1980s, common wisdom was deficiencies in management and related institutional problems, rather than technology, were the chief constraints of poor performance of irrigation systems.
A few performing projects support this assumption: Chancay-Lambayeque in Peru.

- Pre-arranged demand and Water charges on volumetric basis
- Long Experience of the operators and social cohesion
- Water consumption per ha of rice is half that of Yequetetepeque;
- Case of Yamaikou, China
The slow recognition of design as a main reason of the poor performance of irrigation projects.

*Is management the crux of irrigation problems? Do we need to 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 projects* (HORST)
WORLD BANK INITIATIVES

Creation of IPTRID (with ICID)
Creation of INPIM
Rapid Appraisal Process (RAP)

PILOT PROJECTS:
- India: Majalgaon (SCADA, duckbill weirs) 1990’s
- Vietnam (SCADA, automation, duckbill weirs) 2004-2013
- Mali: Office du Niger (1980s)
- Jordan (Conversion to pressurized systems. Dynamic regulation)
- New technologies of Canal lining using geosynthetics: Pakistan 1996; China 2003
- Morocco: Dynamic regulation (1980s); (conversion to drip: 2012)

Failures
- Indonesia: kedung Ombo (failed)
- Mexico: Sidorejo (failed)
Outline

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Causes of slow adoption of modern design

• Resistance to changes by irrigation managers and engineers and others; risk aversion and adherence to outdated standards
• Lack of operational experience and service motivation by planners and irrigation departments
• Experience in modernization of international consulting firms (in USA: Local specialized small firms)
• Outdated curricula in universities
• Lack of evidence of the superiority of modern systems
• Failure of pilot projects (kedung-Ombo in Indonesia, Cupatizio in Mexico)
Donor agencies impose severe constraints to the modernization of large-scale systems:

• Duration of loans (<7 years)
• Budget and time for preparation
• Limited budget for supervision

• New instruments of lending: PPP (Ethiopia, Morocco, Peru….)
Sole Source of Procurement

Sole Source of procurement for automated gates (NEYRPIC and RUBICON)

Accepted by World Bank procurement rules but many countries are resistant to this procedure
ICID and National Committees

ICID events:

• Progressive desertion of the industry sector and practitioners during the last 2 decades
• Inactive Working groups dealing with main and distribution systems
• ICID has lost its mission of promotion of advanced techniques with regards to canal systems
• Hope: Organizations of technical events by some active National Committees
Policy reforms cannot be implemented without an appropriate physical environment.

Investments may be required to improve systems to provide better control and measurement of water delivery before volumetric pricing, the establishment of water rights and trade of rights can be implemented.
The concept of client service is not widely adopted in irrigation

- Irrigation water is considered an input to crop production
- Irrigation water is not considered as a commodity (with exception of irrigation districts in Australia, USA …which are organizations of water provider industry)
Conditions favorable to modernization in developed countries and some emerging countries

• Well maintained, upgraded, as needed. Minimum rehabilitation
• Excellent legislation on water rights and ability to enforce these rights
• Highly qualified consulting firms
• Large choice of modern good quality equipment
• Great mobility of operating staff and good communications
• Water delivery on pre-arranged demand
Modernization in advanced countries

• Drivers: labor cost, better service, water saving, environment
• Australia, Canada, U.S.A, Spain, Italy …
• Main activities:

1. SCADA and automation of control structures; canal control software
2. Overshot gates
3. Buffer reservoirs (USA)
4. Selected canal lining using geosynthetics materials
5. Conversion to pressurized systems and drip irrigation
Australia

• Replacing an outdated irrigation infrastructure with a new automated water management… using solar panel regulators, electronic meters and IT-based system providing automatic channel control and monitoring.
Negative factors for modernization in some emerging and less developed countries

• Misconceptions about modernization: Modernization is too costly and too sophisticated for developing countries (IIMI Seminar 1982.)

• Most irrigation systems have deteriorated over years being affected by the vicious cycle (lack of maintenance, poor service, low rates of collection of fee collection etc. . . Modern control cannot be implemented on a deteriorated system.

• Adherence to old design standards and operational procedures
VIETNAM Experience in Modernization

- Training in modernization at ALL levels including academics, training institutes, consultants, contractors, government and local agencies, project managers and Systems operators.
- Combining rehabilitation with modernization: Rehabilitated projects do not meet user needs.
- Preparing Modernization Guidelines for country wide application.
CHINA

• Despite the government’s enormous investment in renovating the large and medium irrigation schemes over past decades, many of them are still in needs of upgrading to improve water use efficiency and productivity.
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Several levels in improving irrigation service

• Equity (or respect of water rights)

• Reliability: Stabilization of flows - guarantee of service delivery

• Flexibility: A condition to adopt water-saving techniques

Efficiency: A subject of debate!! And waste of money!!!
Control technology
Long-crested weirs
Adopted in California and .. failed in .. MEXICO
HYDRO_MECHANICAL control equipment
SCADA: Fergana valley and Vietnam
Australia: automated equipment
Australia
Technological Revolution: EDF
Techniques modernes de revêtement avec geomembranes
Tarim II project, China:
5 Mm2 over 750 km of large canals
QUESTIONS ??

• 1. Can a new food crisis be averted without improving productivity of large-scale irrigation?

• 2. Have the governments, donors and the consulting firms the willingness and capabilities to correct the deficiencies in design and water management of large-scale irrigation systems?

• 3. Why transfer of technology is so slow in canal irrigation?
“I only hope that (my failure to speak out three decades ago) will encourage others to be bolder so that policies and practice can be better grounded in realities and ........ offset the professional, institutional and personal forces that so easily distort perceptions and generate and sustain misleading and damaging myths. We need not just to struggle to know reality. We need whistle blowers. And we need them to blow more and a good deal louder than I did”– Robert Chambers