



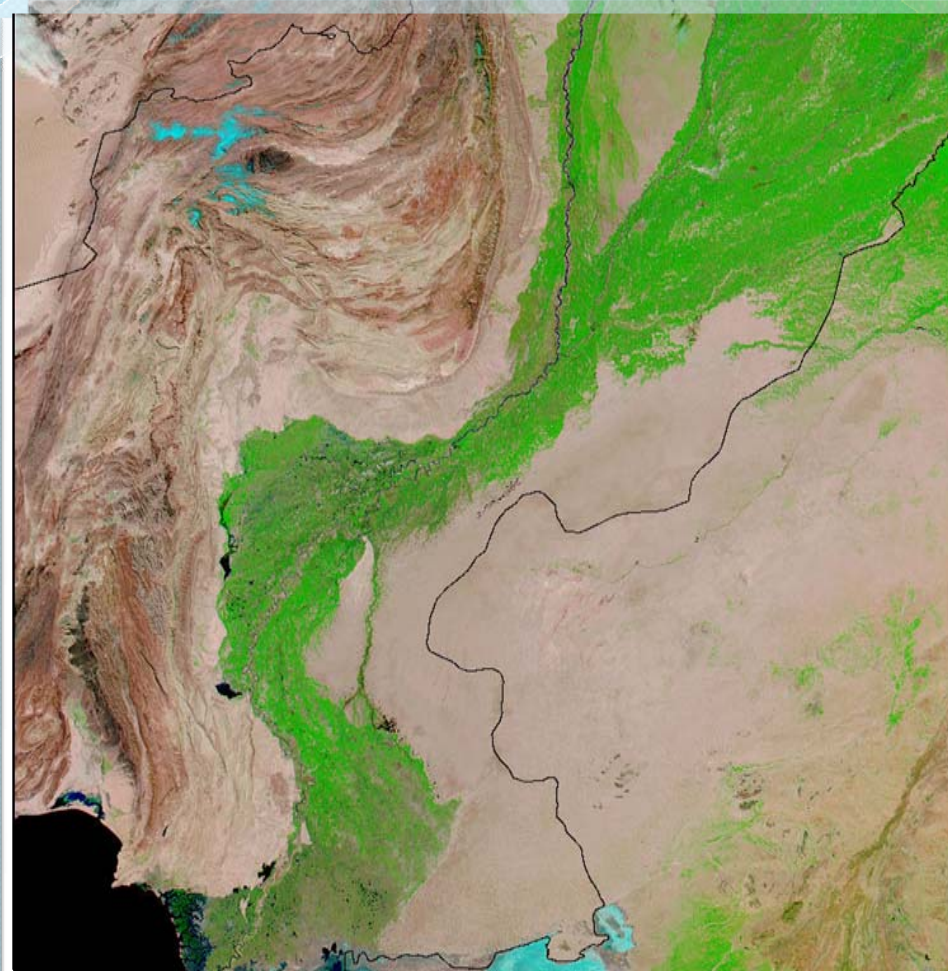
# **Use of Water for Agriculture in Pakistan: Experiences and Challenges**

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Conference on  
The Future of Water for Food  
3<sup>rd</sup> – 5<sup>th</sup> May 2009  
University of Nebraska  
Lincoln, Nebraska

# Framework of Paper

- Water Resources Development and the Green Revolution
- Best Practices Based on Technological Advances
- Trends of Degradation
- Infrastructure Inefficiencies
- Best Practices Based on Governance Reforms
- Challenges and Way Forward



# Pakistan from Space

Source: The World Bank Report,, **Pakistan's Water Economy: Running Dry**, November 8, 2005, pg vii

# Agriculture

- 92% of Pakistan's land area is arid or semi arid
- The Indus Plain covers about 25% of total land area
- Most of the irrigated agriculture takes place in this area, which now supports 65% of Pakistan's population
- The irrigated area, which is about 80% of total cultivated area, produces 90% of Pakistan's food and fiber requirements
- About 25% of Pakistan's GDP comes from Agriculture



# History of Water Resources Development

- 1960- Indus Waters Treaty
- 1960's- Irrigation System Expansion and Green Revolution
- 1980-90s- Opposition to New Dams
- 1991- Water Accord

## *The Indus - The Treaty (1960)*







# Irrigation Infrastructure

<b>Heading</b>	<b>Number</b>
<b>Dams</b>	<b>3</b>
<b>Barrages</b>	<b>16</b>
<b>Headworks</b>	<b>2</b>
<b>Inter-link Canals</b>	<b>12</b>
<b>Canal Systems</b>	<b>44</b>
<b>Water Courses</b>	<b>107,000</b>



# Current Irrigated Area

<b>Irrigated Area</b>	<b>36 million acres (14.56 million hectares)</b>
<b>Length of Canals</b>	<b>56,073km</b>
<b>Length of Water Courses</b>	<b>1.6 million km</b>

# Warabandi System- An Established Practice

- A system of water sharing prevalent in northern parts of India and Pakistan where irrigation water is supplied as per crop assessment, size of landholding and cropped area
- It is provided according to announced schedule, which changes from season to season depending on water availability

# Green Revolution

- 1960s- covering three five year plans
- New high yielding varieties of wheat and rice
- Agricultural growth rate reached 6 percent per annum in the period of third five year plan (1965-1970)
- Per acre production increased
- Wheat and rice production doubled between 1960-1969
- West Pakistan became self-sufficient in food grains
- Catered to requirements of East Pakistan
- Started exporting rice

# Stages of Green Revolution

- Scientific advances
  - Mexipak wheat variety
- Technological advances
  - IRRI rice varieties
  - Mechanizations
  - Water resources development
  - Fertilizers, Chemicals and pesticides

Source: Munich Personal RePEc Archive, **Why The Green Revolution Was Short Run Phenomena In the Development Process Of Pakistan: A Lesson For Future**, 2004, <http://mpira.ub.uni-muenchen.de/9520>

- 
- Agricultural advances

Increased yields, increased incomes, cropping changes

- Support Actions
- Support prices, favourable terms of trade, subsidies and credit

# Green Revolution not Sustained

- Farm practices remained largely unchanged
- Flood irrigation methods remained unchanged
- Poor marketing
- Low storage capacities for agricultural produce
- Agro-based industries not developed
- Credits and subsidies benefited big farmers and agricultural land owners

Source: Munich Personal RePEc Archive, **Why The Green Revolution Was Short Run Phenomena In the Development Process Of Pakistan: A Lesson For Future**, 2004, <http://mpra.ub.uni-muenchen.de/9520>



# Water Accord of 1991

Based on:

- 114.35 MAF per year
- 3 MAF estimate for ungauged canals
- Varies from year to year and is normally less than 117.35 MAF

Source: Pakistan Water Accord, 1991 (Agreement), March 1991 and Water Accord 1991, Section 6 (article), available from [www.waterinfo.net.pk/pdf/wa.pdf](http://www.waterinfo.net.pk/pdf/wa.pdf) and <http://64.233.169.132/search?q=cache:DFk0lbKiB6cJ:www.waterinfo.net.pk/pdf/wa.pdf+1991+Water+Accord&hl=en&ct=clnk&cd=1&gl=us>.

# Division Among Provinces

- Punjab 55.94 MAF
- Sindh 48.76 MAF
- NWFP 8.78
- Balochistan 3.87 MAF

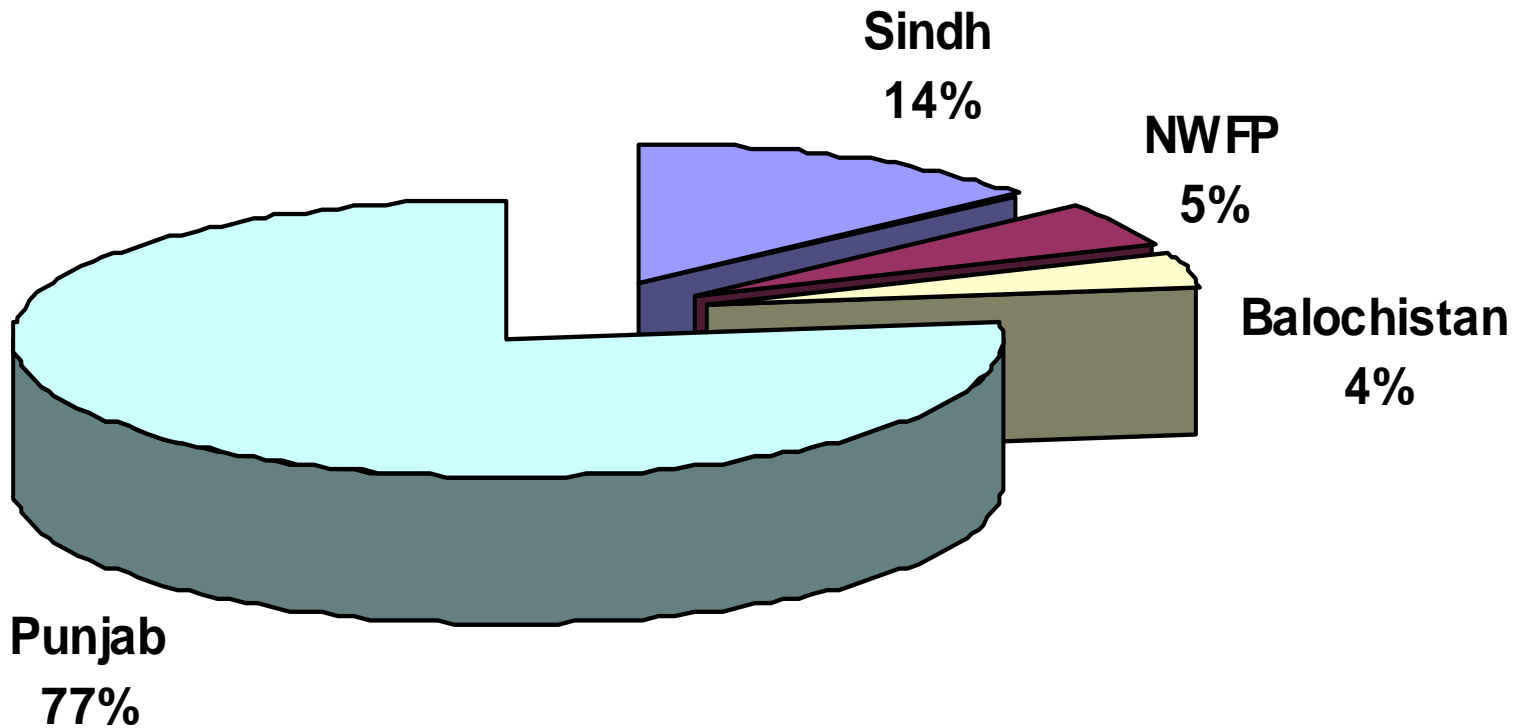
**Total 117.35 MAF**

- 10 MAF provision for downstream flow is demand of Sindh, but not yet finalized

Source: Pakistan Water Accord, 1991 (Agreement), March 1991 and Water Accord 1991, Section 6 (article), available from [www.waterinfo.net.pk/pdf/wa.pdf](http://www.waterinfo.net.pk/pdf/wa.pdf) and <http://64.233.169.132/search?q=cache:DFk0lbKiB6cJ:www.waterinfo.net.pk/pdf/wa.pdf+1991+Water+Accord&hl=en&ct=clnk&cd=1&gl=us>

# Provincial Distribution of Irrigated Area

## Province-wise Irrigated Area






# Degradation of the Agricultural Resource Base (Current Situation)


- 38 percent of Pakistan's irrigated lands are waterlogged
- 14 percent saline
- Only 45 percent of cultivable land is under cultivation at a given time
- Salt accumulation in the Indus basin
- Saline water intrusion into mined aquifers

# SCARPS for Reclaiming Degrading Resource Base


- Salinity Control and Reclamation Projects (SCARPS) between 1960-2000
- 18.3 million acres (7.40 million hectares) were reclaimed
- The salt affected (saline/sodic) area was decreased in almost all the SCARPs
- Water logging was also controlled

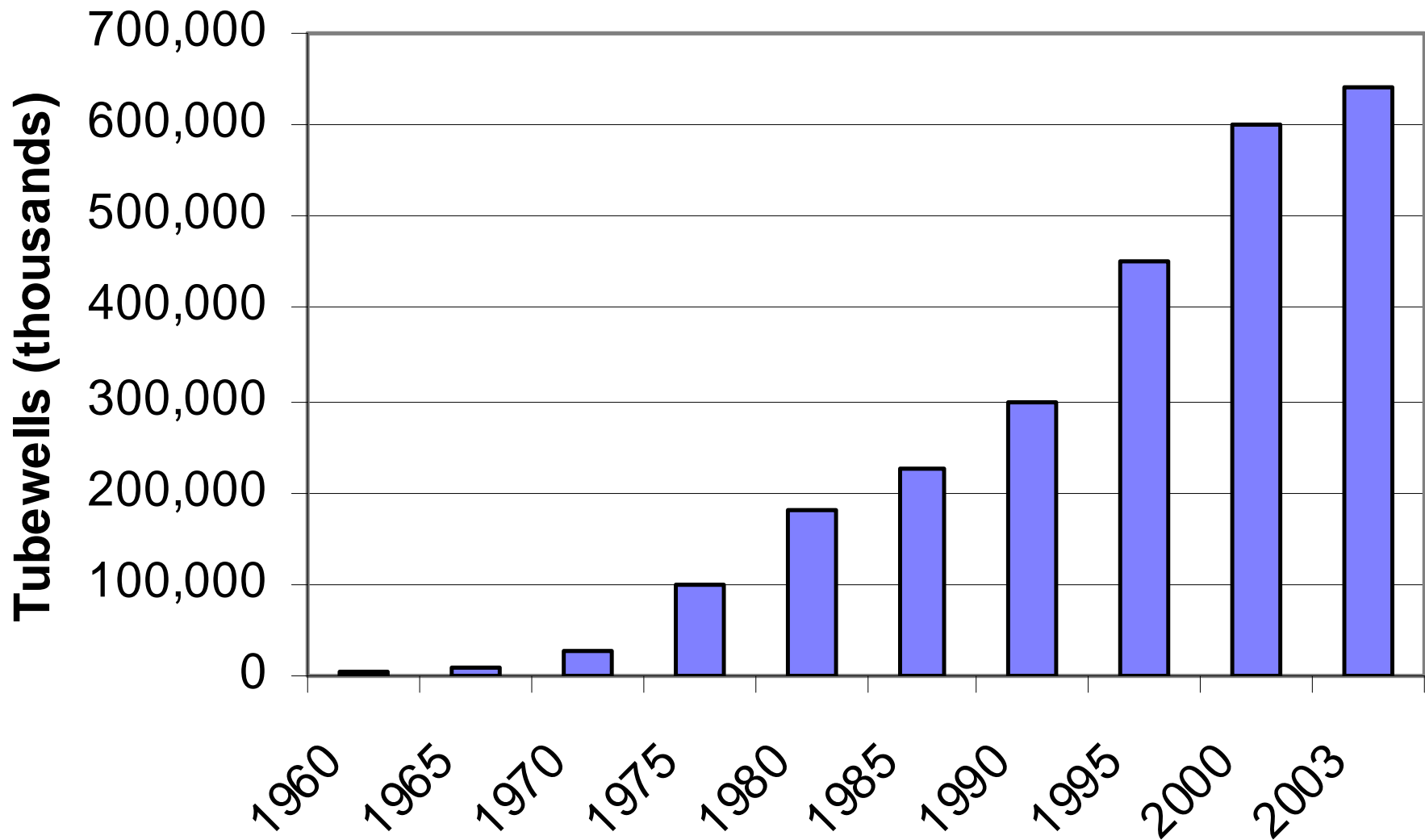
- 
- Crops yield increased
  - Socio-economic status of the farmers communities improved
  - The gross value of production (GVP) of SCARPs was enhanced substantially
  - The water of these tube wells was used in conjunction with canal water






# Groundwater and Conjunctive Use with Surface Water

- 
- Conjunctive use of surface and ground water has been hailed as a giant step forward
  - The Indus basin also has fresh groundwater reserves of about 55 MAF
  - Groundwater now accounts for half of all on farm irrigation requirements (supplementing the 34 MAF of surface water that actually gets to the farm lands )
  - Indications of aquifer mining



## The Growth in use of Tubewells

Source: Steenberg and Gohar, quoted in **Pakistan's Water Economy: Running Dry**, Report, The World Bank, November 8, 2005, pg 15

- 
- Groundwater irrigation has been rapidly developed by the private sector
  - Groundwater quality is highly variable
  - Long-term use of groundwater may lead to secondary salinization
  - The knowledge of mixing ratios that can sustain the irrigated agriculture in the long run is usually lacking

# Population, Poverty and Water Today

- Pakistan has a population of 165 million
- 98 million rely on agriculture
- 49 million are below the poverty line
- 54 million do not have access to safe drinking water
- 76 million have no sanitation

# Crop-wise Area Under Cultivation 2006-2007

<b>Crop</b>	<b>Area</b>
<b>Wheat</b>	<b>8.6 Million Hectares</b>
<b>Rice</b>	<b>2.6 Million Hectares</b>
<b>Maize</b>	<b>1 Million Hectares</b>
<b>Sugarcane</b>	<b>1 Million Hectares</b>
<b>Cotton</b>	<b>3 Million Hectares</b>
<b>Jowar</b>	<b>0.3 Million Hectares</b>

Source: Ministry of Food, Agriculture & Livestock (Economic, Trade & Investment Wing),  
**Agricultural Statistics of Pakistan, 2006-2007**, Government of Pakistan



# Crop-wise Production 2006-2007

<b>Crop</b>	<b>Production</b>
<b>Wheat</b>	<b>23.3 Million Tonnes</b>
<b>Rice</b>	<b>5.4 Million Tonnes</b>
<b>Maize</b>	<b>3.1 Million Tonnes</b>
<b>Sugarcane</b>	<b>55 Million Tonnes</b>
<b>Cotton</b>	<b>13 Million Tonnes</b>
<b>Jowar</b>	<b>0.18 Million Tonnes</b>

Source: Ministry of Food, Agriculture & Livestock (Economic, Trade & Investment Wing),  
**Agricultural Statistics of Pakistan, 2006-2007**, Government of Pakistan

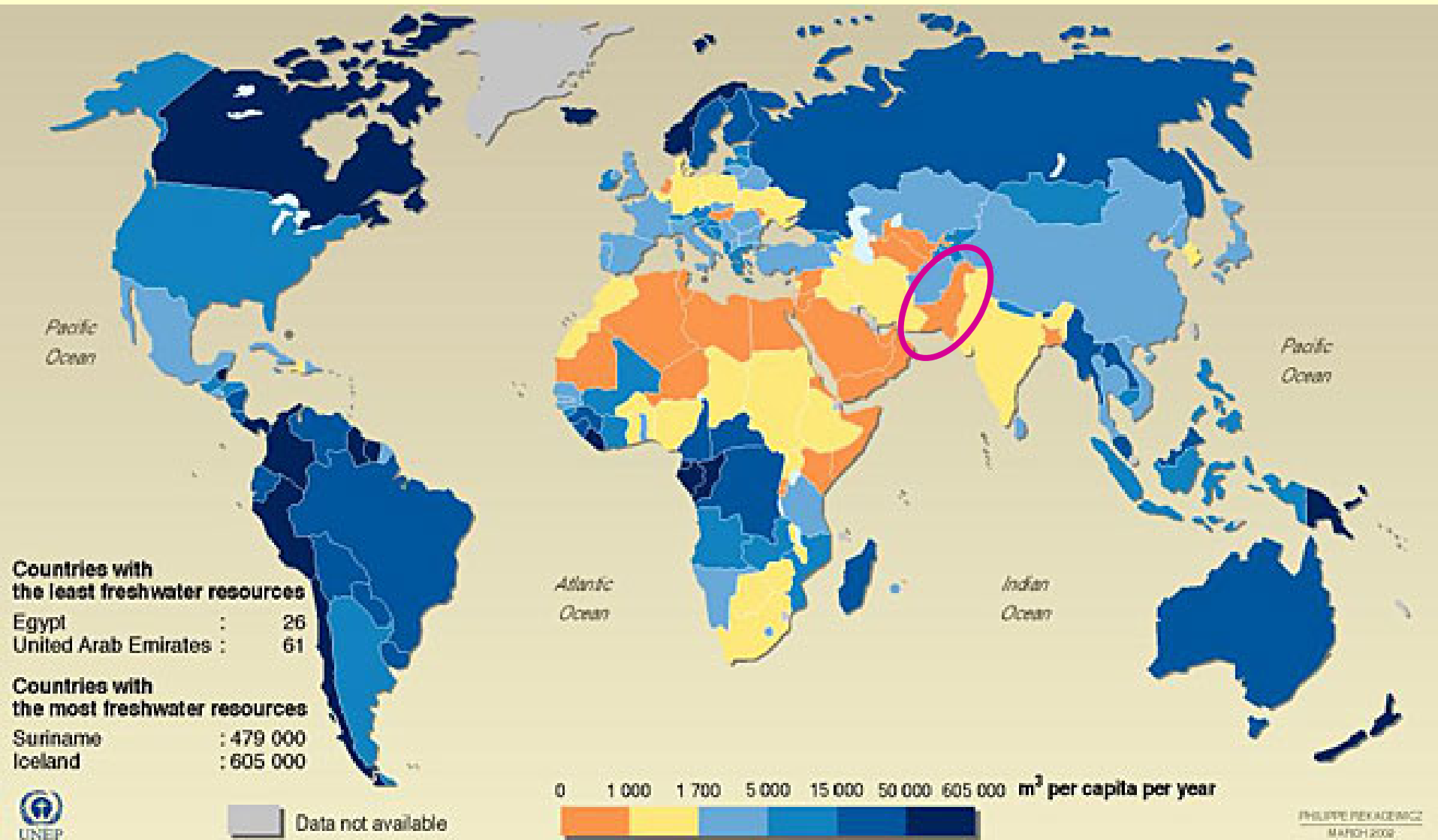
# Water and Food Security

- Deficit in grain production in relation to population is predicted to reach 12 million tons by the year 2013
- Water availability went down to 1500 m<sup>3</sup> in 2002, making Pakistan a water stressed country
- Water scarcity (1000 m<sup>3</sup>) expected in 2035
- Water and food security are, therefore, Pakistani's major issues this century

Source: United Nations Population Fund/ Ministry of Population Welfare, "Population Stabilization, a Priority for Development," Government of Pakistan, undated and World Bank, Pakistan's *Water Economy: Running Dry*. 2006

# Availability of Freshwater in 2000

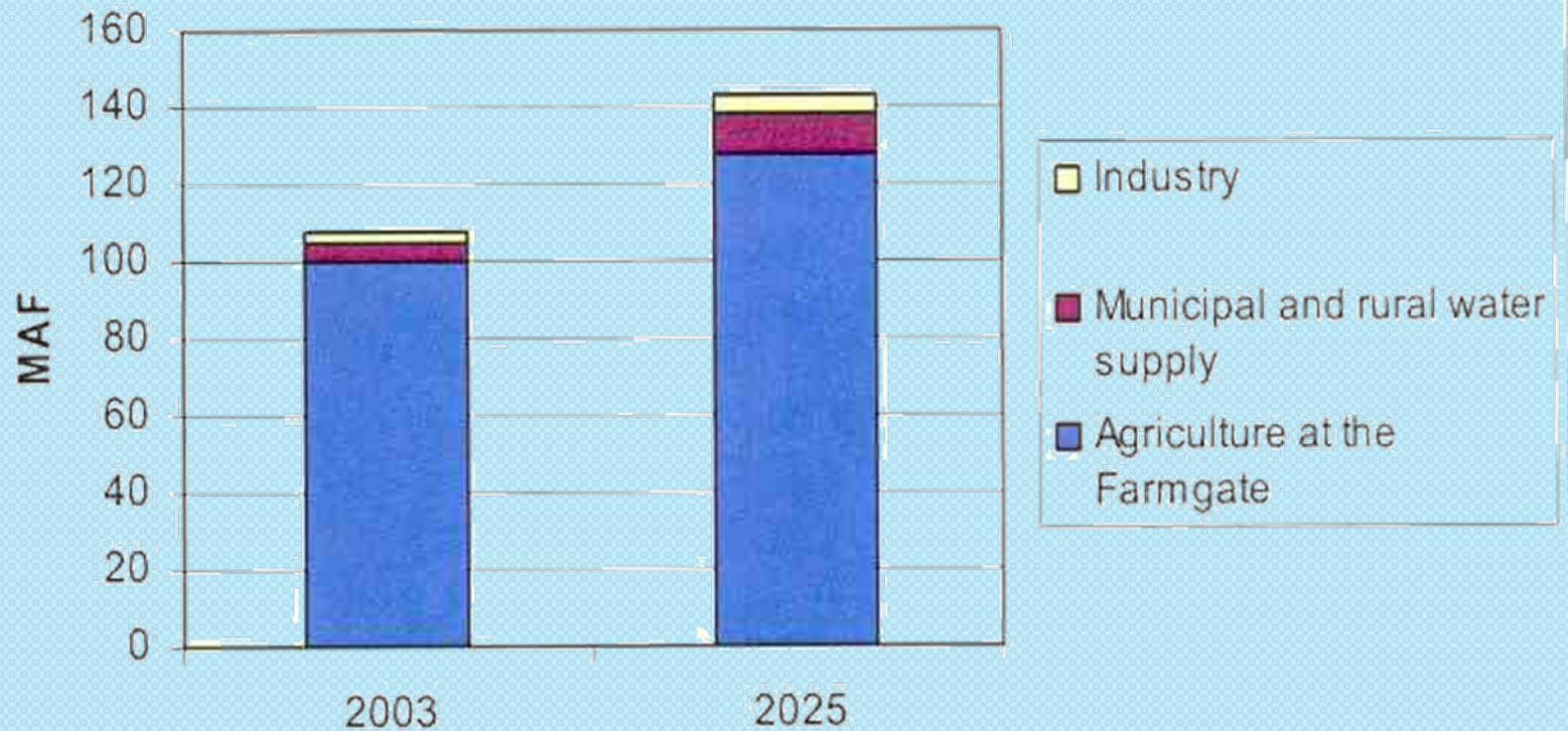
## One of the Worlds most Water-stressed Countries




Source: World Resources 2000-2001, People and Ecosystems: The Fraying Web of Life, World Resources Institute (WRI), Washington DC, 2000.

Source: [www.UNEP.org](http://www.UNEP.org), quoted in The World Bank, Report, **Pakistan,s Water Economy: Running Dry**., November 8, 2005, pg 3

# Projected Demands for Water






Pakistan is using 97 percent of its surface water resources and mining its groundwater to support one of the lowest productivities in the world per unit of water and per unit of land


# Comparison of Productivity per Unit of Land and Water

<b>Productivity Per Unit of Land</b>		<b>Productivity Per Unit of Water</b>	
<b>France</b>	<b>7.60 Tons/hectare</b>	<b>Canada</b>	<b>8.72 Kg/m<sup>3</sup></b>
<b>Egypt</b>	<b>5.99 Tons/hectare</b>	<b>America</b>	<b>1.56 Kg/m<sup>3</sup></b>
<b>Saudi Arabia</b>	<b>5.36 Tons/hectare</b>	<b>China</b>	<b>0.8 Kg/m<sup>3</sup></b>
<b>Punjab (India)</b>	<b>4.80 Tons/hectare</b>	<b>India</b>	<b>0.39 Kg/m<sup>3</sup></b>
<b>Average Pakistan</b>	<b>2.24 Tons/hectare</b>	<b>Pakistan</b>	<b>0.13 Kg/m<sup>3</sup></b>

Source: Tariq S, Presentation on **Water Productivity**, presented in National Seminar on Integrated Water Resources Management, Islamabad, Pakistan,, Dec 21-22- 2005



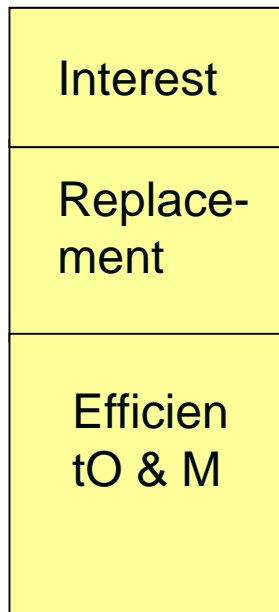
- 
- The storage capacity is very low at only 150 m<sup>3</sup> per capita per year only 30 days of supply
  - Mangla and Tarbela have lost 25 percent of their storage capacity
  - Canals work on rotation
  - Water loss between canal heads and farms is 2/3
  - Little additional water that can be mobilized over and above what is currently used

- 
- River Indus downstream from Kotri Barrage has virtually dried out
  - Only one out of 17 main creeks of Indus Delta now active
  - Balance between seawater and fresh water in the tidal zone disturbed
  - Delta gets only 0.50 to 0.70 MAF per year
  - Sixth biggest mangrove forest in the world now disappearing
  - Sea water intrusion has reached 225 Kms

# Value of Water

- Partially recognized in Pakistan that water does have 'value'
- Common perceptions do not include an awareness that irrigation water (and water for other uses) is currently provided far below its economic value
- Very low irrigation service charges in Pakistan
- Very low consumer charges in urban areas

## Financial Requirements



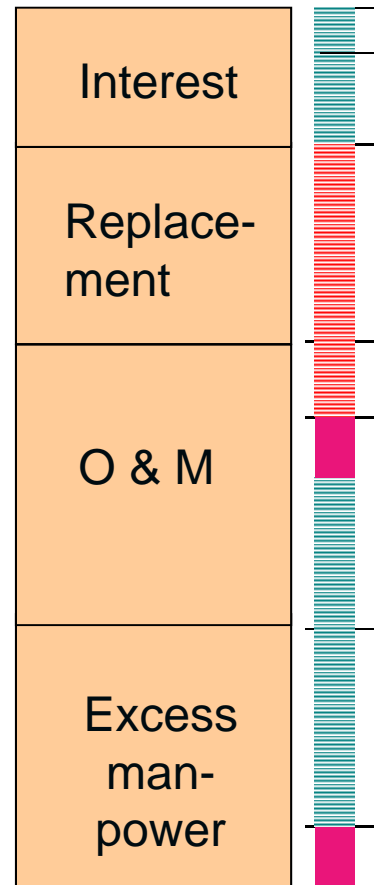
## Who pays

**Taxpayers**

**Users**

**a. Australia**

## Financial Requirements



## Who pays

**Taxpayers**

**No one**

**Users**

**Taxpayers**

**Taxpayers**


**Users**

**b. Pakistan**

# The Financing of Water Services in Pakistan

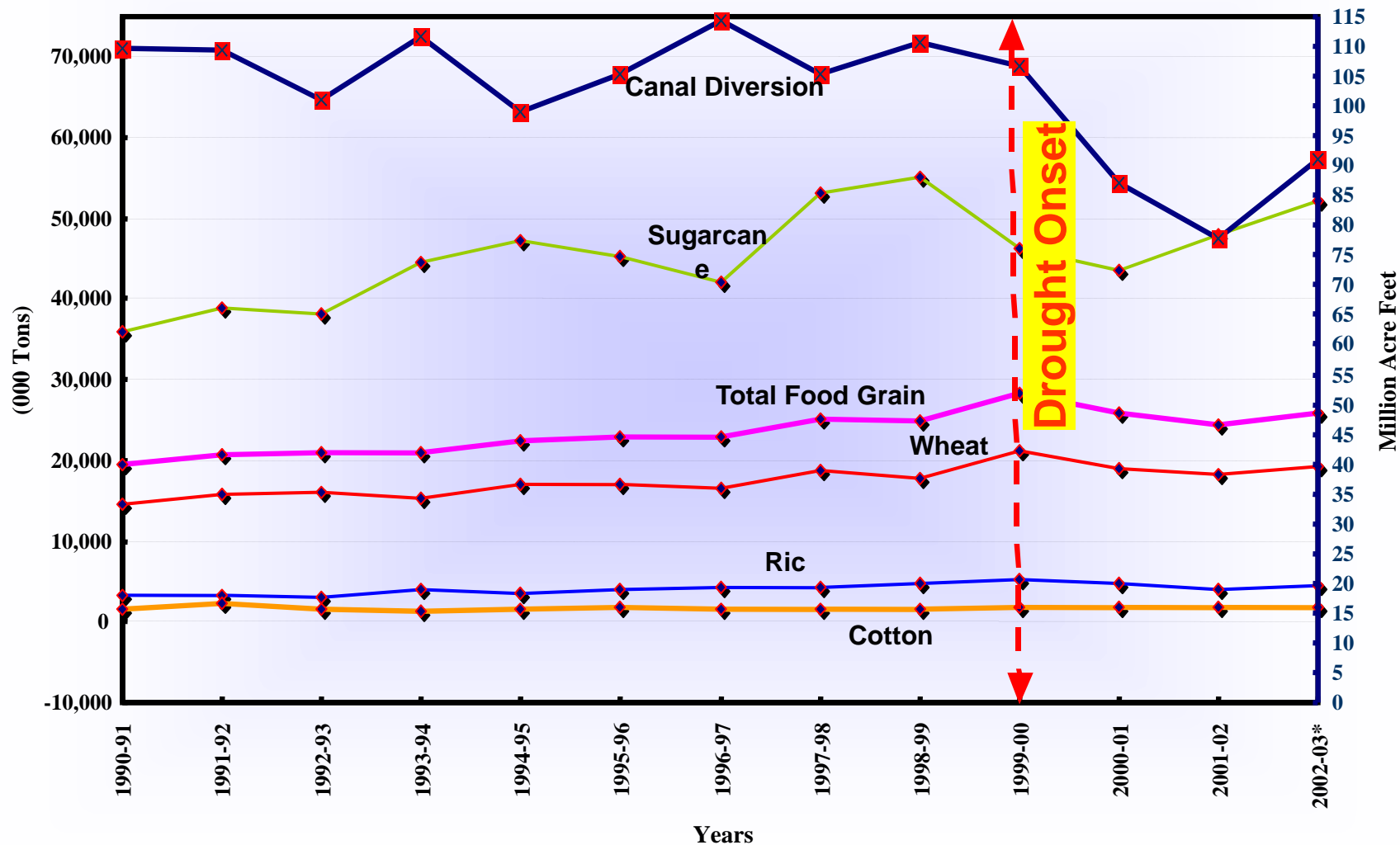
# Drainage Projects

- Ill-fated drainage projects designed to remove saline water from irrigated lands
- Increased the danger and damage of tidal action and sea water intrusion
- World Bank (the principle funder of the drainage projects) had to send its Inspection Panel



**While the realities of water availability, water regime, climate and delta conditions have changed, the demand for more and more water for agriculture continues to grow in most parts of Pakistan**

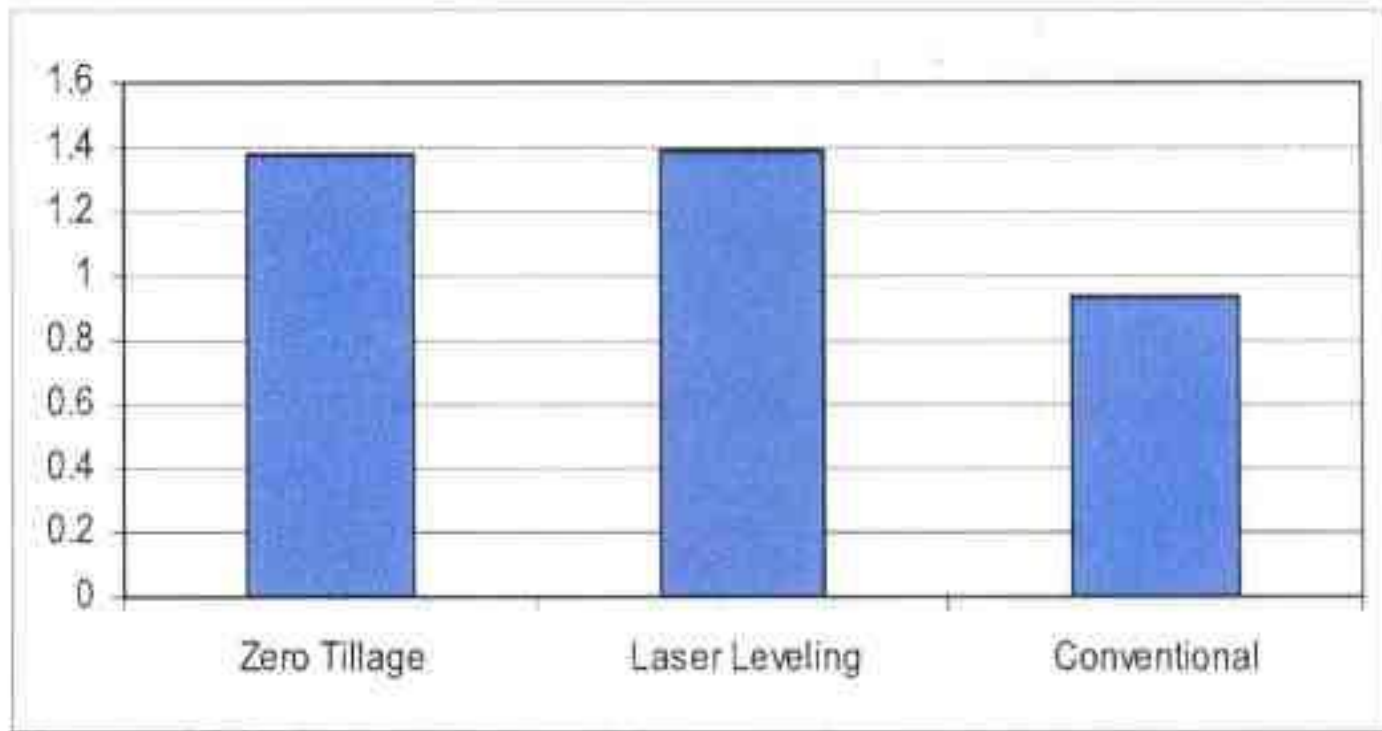
# DROUGHT AND CROP PRODUCTION



## Crop Production and Drought

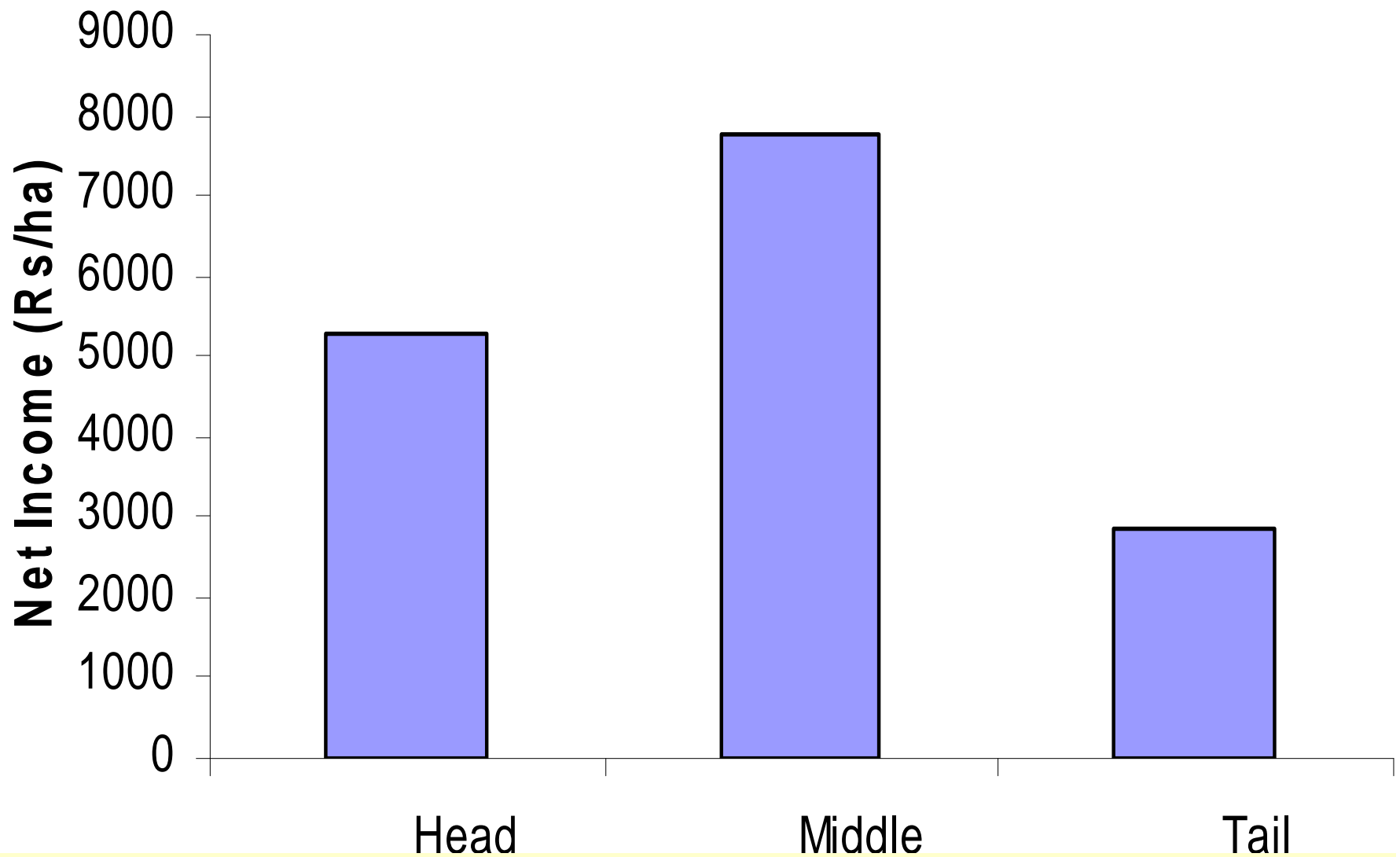
Source: World Bank 2003, quoted in **Pakistan's Water Economy: Running Dry**, Report, The World Bank, November 8, 2005, pg 31

# Production (kg/cubic meter of water) Under Different Agricultural Practices



Source: Amir, quoted in **Pakistan's Water Economy: Running Dry**, Report, The World Bank, November 8, 2005, pg 34





**How Returns to Irrigation vary by Location in a Canal**

# Policy Debate

- Not everyone in Punjab has excess, or even adequate, water
- Not everyone in Sindh is deprived of water
- Both provinces face the same issues in terms of equitable distribution among users
- Discourse needs to be redefined in terms of head, middle and tail farmlands in irrigated areas
- Water other than agriculture – for domestic use, for industry, for urban areas, and for the environment – should all be key components of discussion




# Land Ownership as Proxy to Water Rights

- Ownership of land remains a proxy for water rights especially in agricultural areas
- This excludes all landless people and landless farmers who are responsible for managing irrigation water
- Few women own agricultural lands, and usually do not control the lands even if owned
- Their 'rights' to water are ill-defined

# Benefits of Irrigation

- Benefits of irrigation infrastructure and rehabilitation has directly enriched the landowners
- Increased land values of 30 percent over the past decade
- Landowners are likely to continue to receive the lion's share of the benefits of low water charges and infrastructure improvement



Pakistan does not have a comprehensive set of water laws that define:

- Water rights
- Uses
- Principles of pricing
- Subsidies
- Conservation
- Polluter penalties


# Water Policy Framework

- National Water Policy (latest draft 2006)
- The Pakistan Water Resources Strategy (Ministry of Water and Power, 2002)
- Ten Year Perspective Plan (Planning Commission, 2001)
- Vision 2025 (Water and Power Development Authority, 2001)
- Pakistan Water Strategy (Ministry of Water and Power, 2000)
- Medium Term Development Framework (MTDF, 2005-10)



# Reform-based Good Practice Example

Irrigation and Drainage Sector Reforms  
supported by the World Bank (2000 to date)

- 
- Implemented in parts of the irrigated areas of the two larger provinces, Punjab and Sindh
  - Reforms have combined irrigation and drainage functions into single Provincial Irrigation and Drainage Authorities supported by Water Management Ordinances 2002
  - Eventual take over the rehabilitation and maintenance of 10 canal command areas



# Structure of Irrigation Sector Reforms

Provincial Irrigation and Drainage Authority (PIDA)



Area Water Boards (AWBs)



Farmers Organizations (FOs)



Water Course Associations (WCAs)

# Functions of PIDA

- Operate and maintain barrages and outlets assigned to it
- Operate and maintain spinal drains and link drains
- Carry out river flood protection and maintain the infrastructure in the Province of Sindh

Source: Raasta Development Consultants, SDSC University of Sindh, Mehran University of Engineering and Technology Jamshoro, **Third Party Monitoring and Evaluation of Institutional Reforms in Water Sector in Sindh**, conducted for National Drainage Programme Sindh

# Functions of AWB

- Operate and maintain main canals and branch canals
- Operate and maintain drainage tube-wells drains with capacity larger than 15 cusecs
- Carry out flood protection and maintain infrastructure within its command areas
- Promote the formation, development and growth of the FOs

Source: Raasta Development Consultants, SDSC University of Sindh, Mehran University of Engineering and Technology Jamshoro, **Third Party Monitoring and Evaluation of Institutional Reforms in Water Sector in Sindh**, conducted for National Drainage Programme Sindh

# Functions of Farmer Organization (FO)

- Operate and maintain the part of the irrigation system conferred on it
- Ensure equitable/judicious distribution of water including small and tail end farmers
- Supply non-agricultural users
- Guarantee minimum drinking water
- Carry out flood protection
- Maintain infrastructure within its command area

Source: Raasta Development Consultants, SDSC University of Sindh, Mehran University of Engineering and Technology Jamshoro, **Third Party Monitoring and Evaluation of Institutional Reforms in Water Sector in Sindh**, conducted for National Drainage Programme Sindh





# Impeding Factors to Water Sector Reforms

- The way the Ordinance of 2002 defines a farmer as one who owns land
- This leaves out the majority of farmers that actually deal with water and cultivation on a daily basis and till the land – the poor landless sharecroppers
- Inequitable land distribution
- Organization of production heavily dominated by sharecropping arrangements
- Tenants are insecure
- Benefits to all water users not guaranteed

Question:

**Can Pakistan Meet its  
Water and Food  
Production Challenges?**

- 
- Yes, Pakistan can meet the challenges
  - But not through business as usual
  - A paradigm shift will be required to reframe the whole discourse on water for agriculture
  - Address the fundamental issues of rights and access to water

- 
- Design policy and reform from more inclusive and comprehensive perspectives
  - Shift from provincial distribution of water for agriculture to a comprehensive water use programme
  - Shift from the Sindh-Punjab debate to better managed water for all of Pakistan, in both irrigated and rain-fed areas



# Focus on Managing Water Demand

- Shift from management of water supply to management of water demand
- The argument for more irrigation infrastructure is based on uncritical capitulation to the demand for more irrigation water for agriculture



# Unpacking of Demand for More Water in Agriculture

- Agriculture already absorbs 97 percent of the total mobilized surface water
- Almost all the groundwater
- Supports one of the lowest agricultural productivity in the world per unit of water and per unit of land



Can this demand be reduced through producing more by using less water?

**Yes!**



# Integrated Water Resources Management (IWRM)

- A useful framework to reorient water demands and improve water management
- Economic efficiency
- Environmental sustainability
- Equity




# Positive Traditions in Irrigation and Agriculture

- A system of water entitlements within the irrigated areas
- Options for increasing water supply by repairing and priming the canal system
- Tremendous scope for increasing water productivity

# Conditions for Significant Outcomes


- Land holdings of more or less of the same size (and not skewed between some huge farms and many tiny ones)
- Socio-economically homogeneous farmers (i.e. all hold land titles rather than some owning land while the others are landless and caught in a system of sharecropping land tenure)


- 
- Incentives in place for better managing service delivery and quality
  - Farmers pay for water based on satisfactory service delivery (ie service providers are made accountable)
  - Irrigation schemes and programmes specifically designed to benefit the poor by putting in specific conditions for investments, repairs and rehabilitation of water infrastructure



# **WAY FORWARD**



- 
- Concept of agro-climatic zoning
  - Division of Indus basin into its sub-regions and targeted long-term water strategy and programming for each
  - Changes in agricultural practices
  - More crop per drop technologies
  - Micro irrigation techniques where feasible
  - Rehabilitate existing irrigation infrastructure and better maintain it

- 
- Improvement in water quality
  - Water quality standards and control of water pollution from all sources
  - Aggressive promotion of water conservation
  - Measures to rehabilitate the freshwater-seawater interface on coasts
  - Adaptation to climate change