

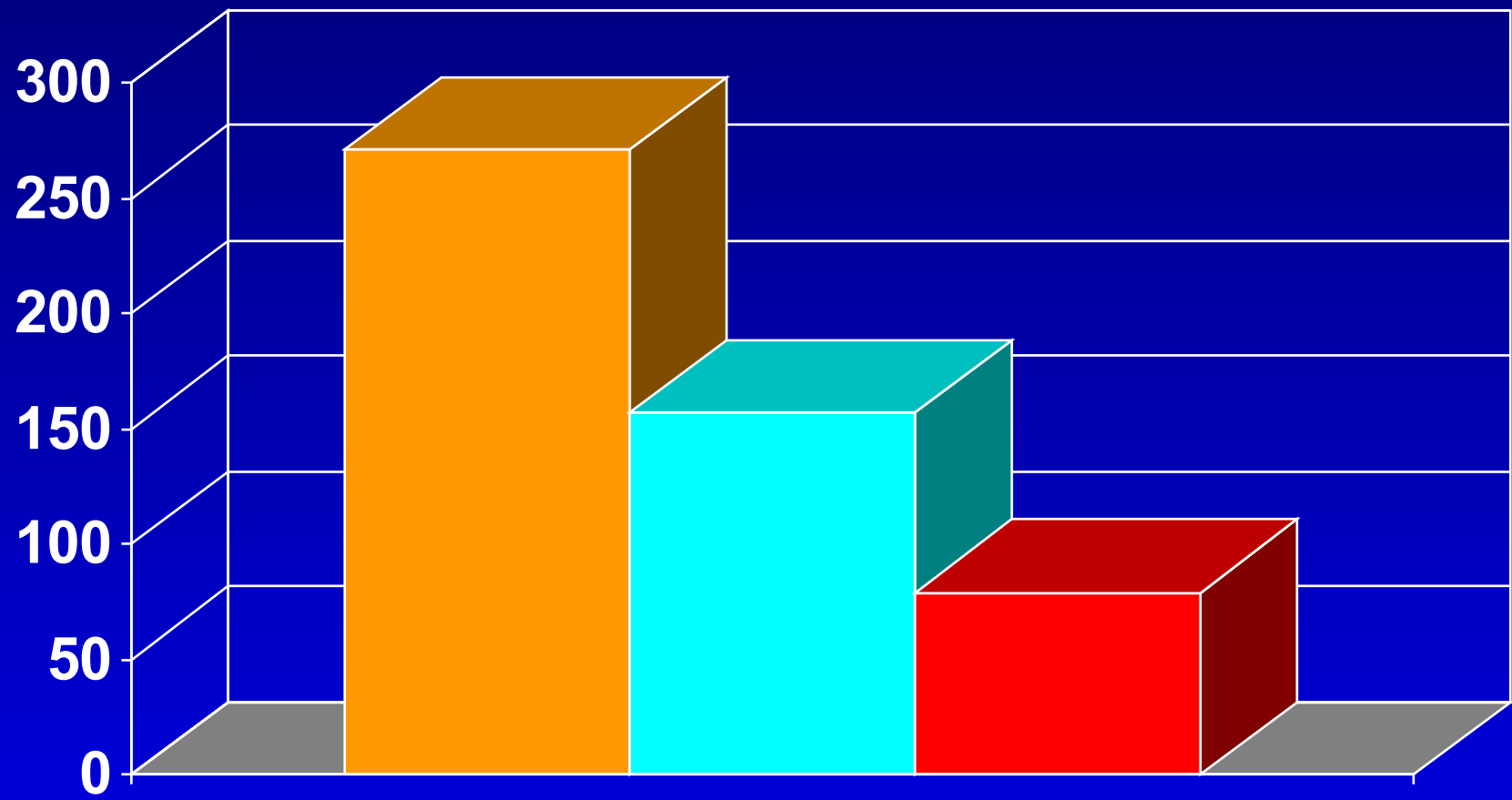
Rice and water

**Crop and Environmental Sciences Division
International Rice Research Institute
Los Baños, Philippines**

Irrigated rice and water

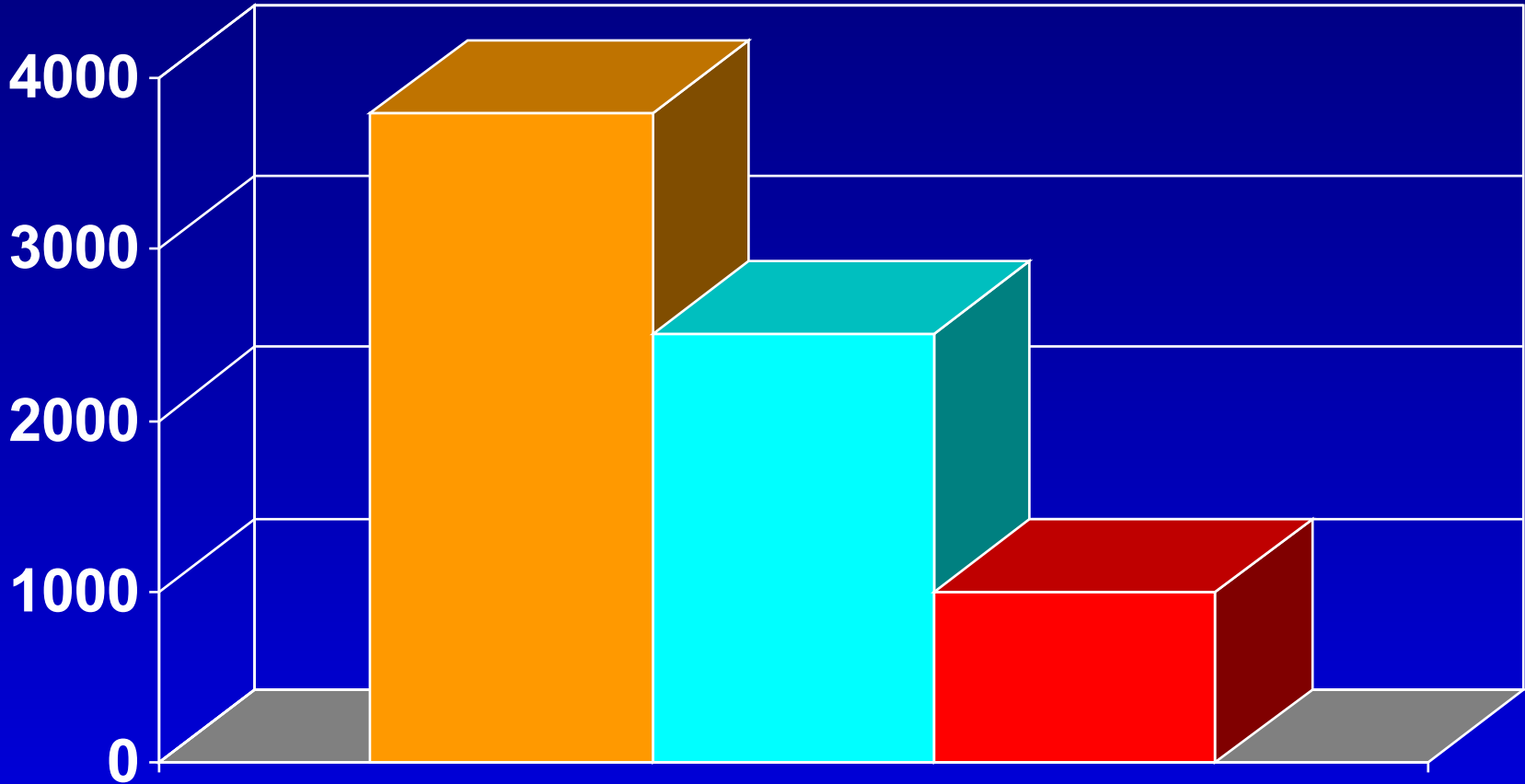
- **95% of the world's rice is produced in Asia**
- **75% of rice produced is irrigated (75 m ha)**
- **Irrigation in developing countries:
uses 80-90% of fresh water developed
In Asia: > 50% of this is for rice**
- **Rice requires much water: 3000-5000 l kg⁻¹ rice**
- **Rice receives 34-43% of world's irrigation water**
- **Rice receives 24-30% of world's developed fresh water**
- **Rice is biggest single 'user' of developed fresh water**

10⁶ ha



- World irrigated area**
- Asia irrigated area**
- World irrigated rice area**

km³



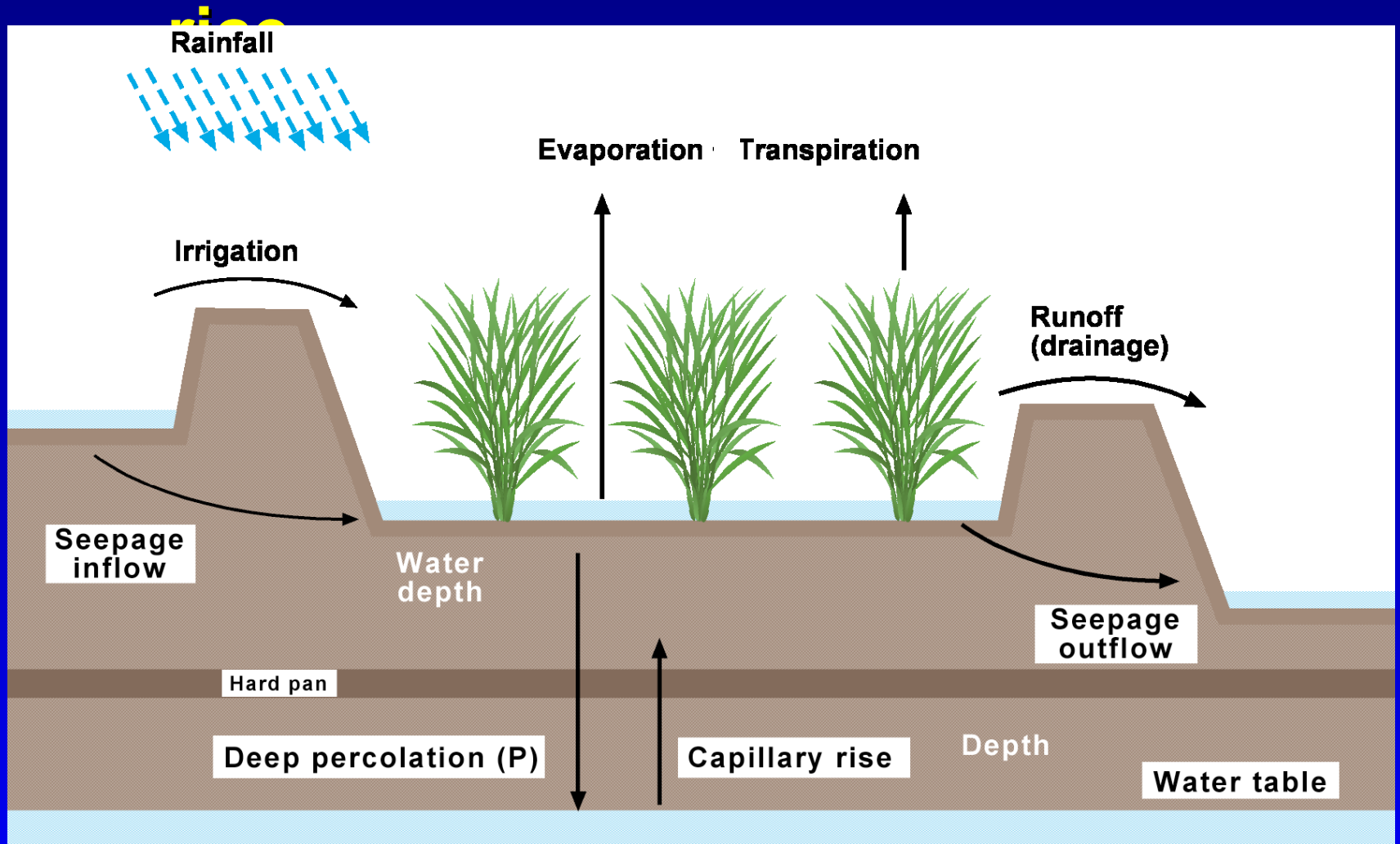
 World water withdrawal

 World water use in irrigation

 Rice water use in irrigation

Why does rice require so much water?

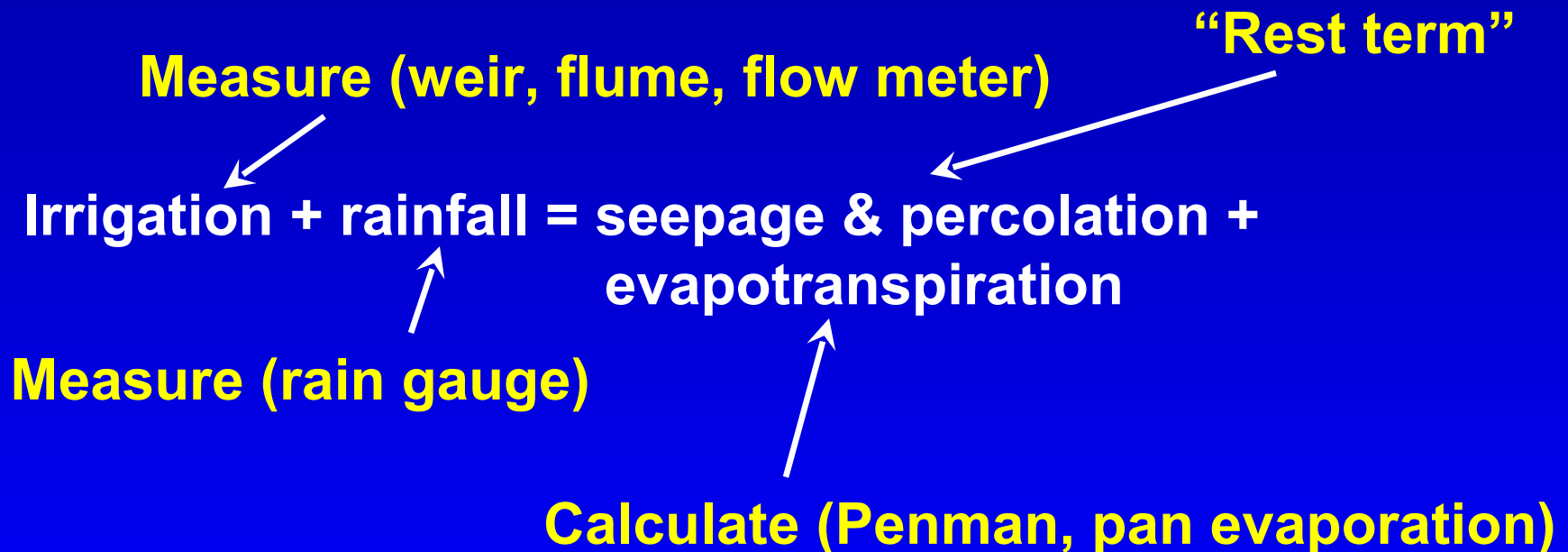
Field water balance lowland



Computing water balance

Input – outputs = storage change

Neglect storage change: Inputs = outputs



Water requirements in lowland rice

	Daily (mm d ⁻¹)	Season (100 d)
Land preparation		175-750
Evapotranspiration		(30-40% evaporation)
Wet season	4-5	400-500
Dry season	6-7	600-700
Seepage & percolation		
Heavy clay	1-5	100-500
Loamy sand	25-30	2500-3000

Total season : 675-4450 mm

Typical value : 1300-1500 mm

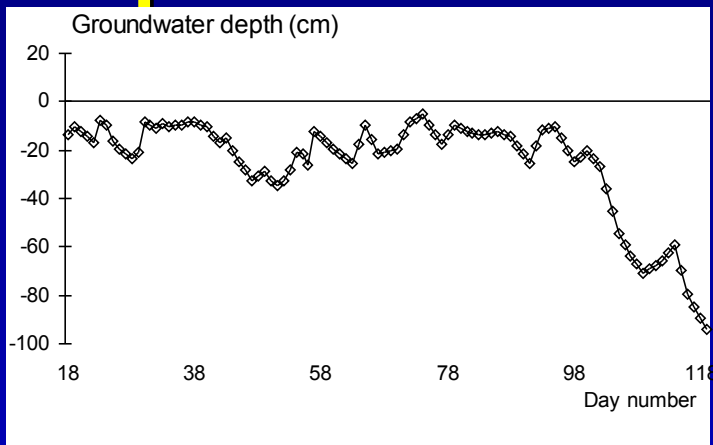
Examples water use; China 1999-2000

	Water (mm)	SP (mm d ⁻¹)
ZIS (Wuhan)		
• Experiment	750-1150	4.0-6.0
• Farmers	650- 940	1.6-2.8
• Mezo site	750-1525	4.0-8.0
Shimen (HZ)		
• Early	850-950	1.0-6.0 (3.8)
• Late	575-700	1.0-6.0 (3.8)

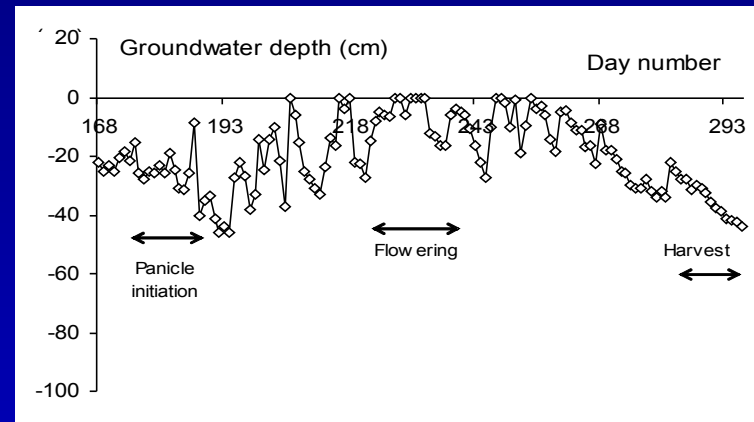
Examples water use; Philippines 1988-2001

	Water (mm)	SP (mm d ⁻¹)
Guimba 88	2197	18.3
89	1679	12.5
90	2028	16.4
91	3504	32.8
Muñoz 91	1019-1238	5.2-7.6
Talavera 93	577- 728	0.3-2.0
San Jose 97	2874	25.8
San Jose 96	1417 (DS)	9.6
97	1920 (DS)	15.2
PhilRice 01	600	1.1 (-> 4.4)

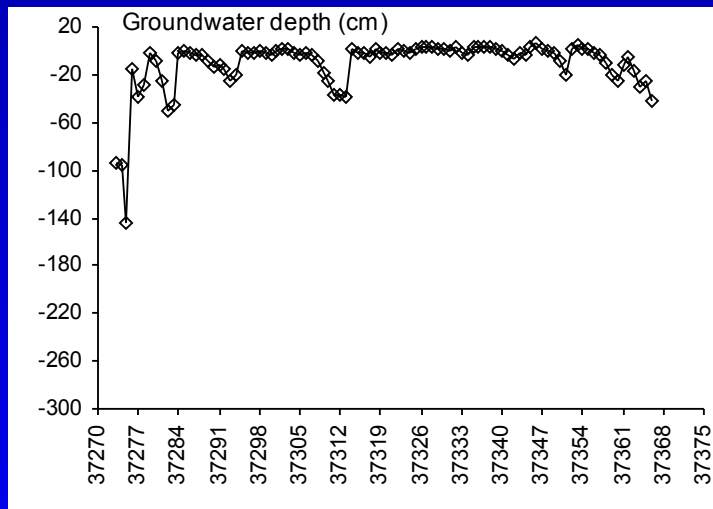
Groundwater: a “hidden” source of



Tuanlin, China, 2002



Changle, China, 2002



Dolores, Philippines, 2002

Direct uptake of water by plant roots

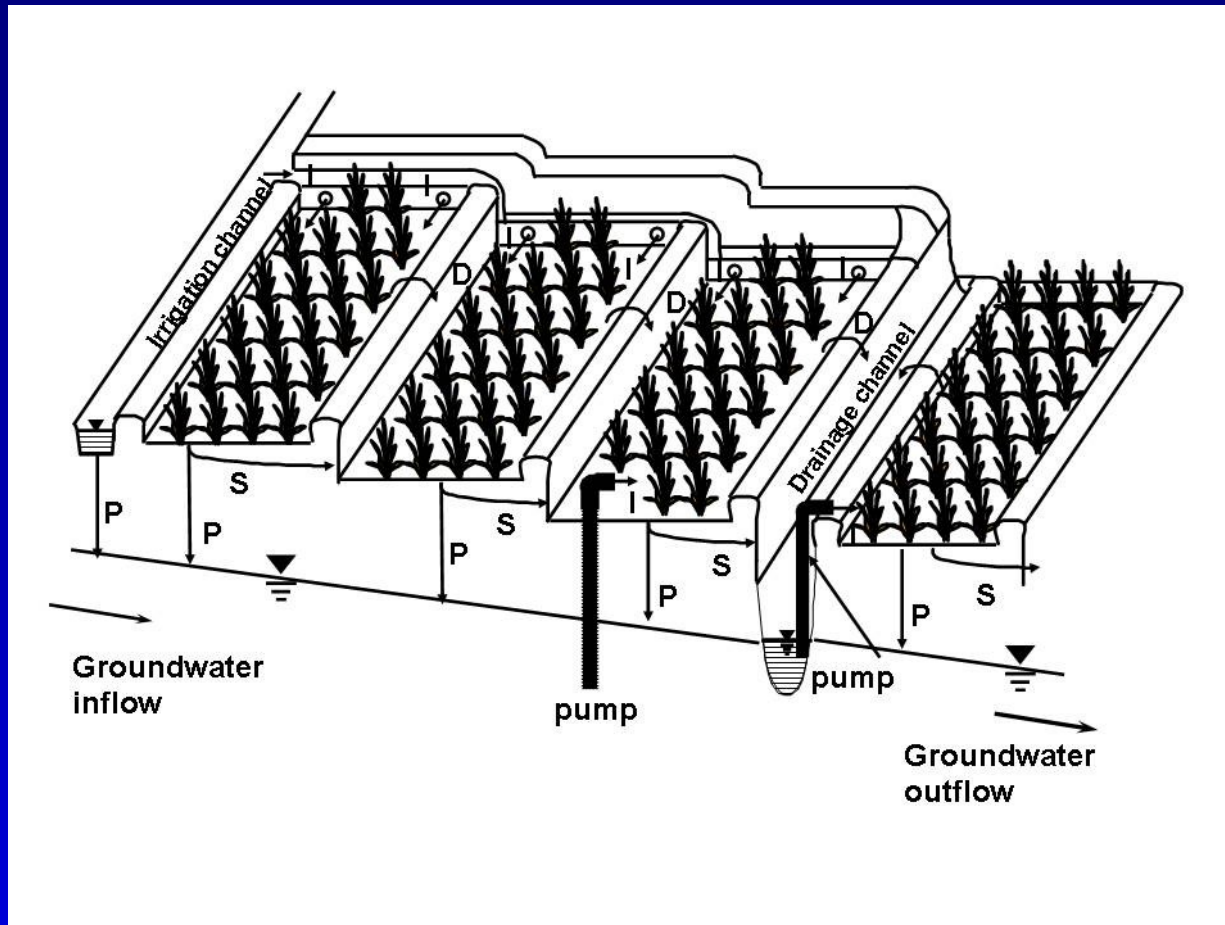
Where do the outflows go?

Evaporation and transpiration: unrecoverable
Overbund flow, seepage, percolation: reusable



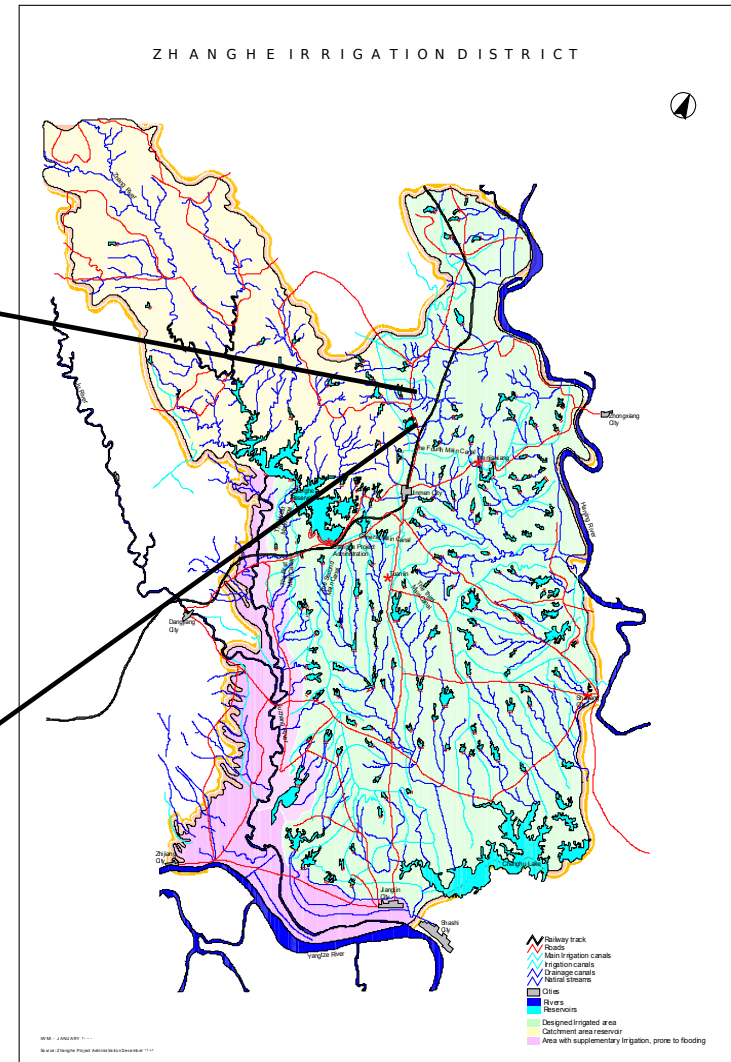
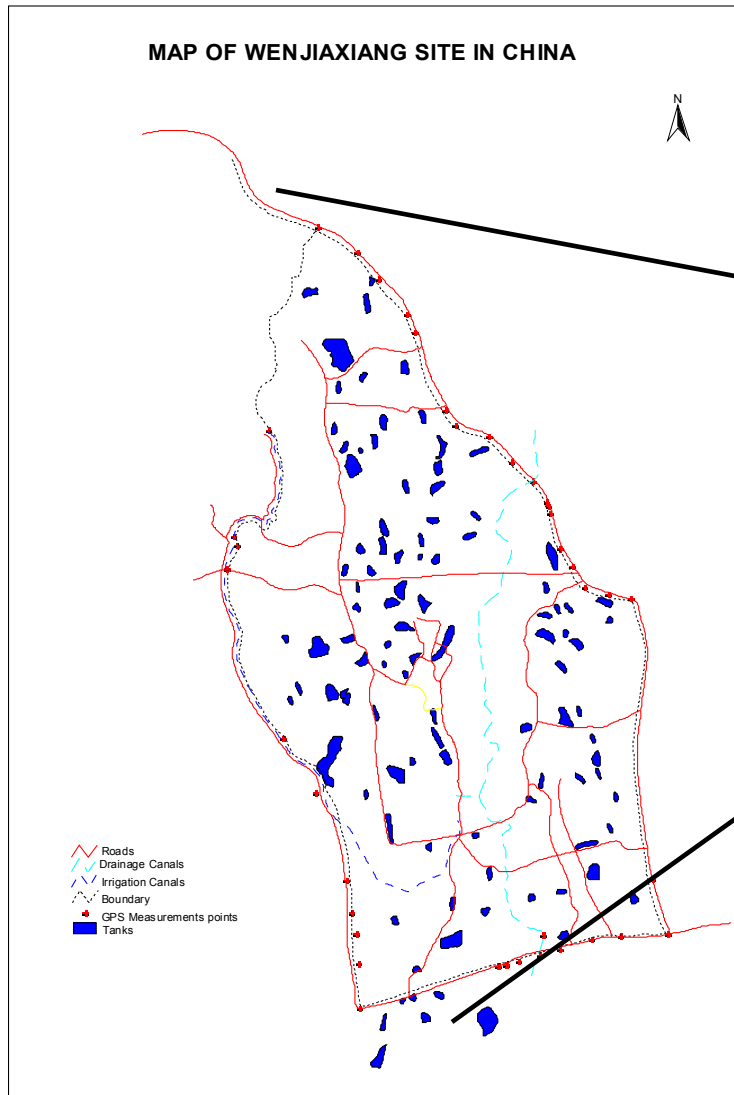
Pokhara, Nepal, 2006





Surface and subsurface water flows across a toposequence of rice fields. D = drainage (over-bund flow); I = irrigation, P = percolation; S = seepage.

Water re-use through reservoirs and on-farm ponds







UPRIIS irrigation scheme, Philippines District I: 18,000 ha

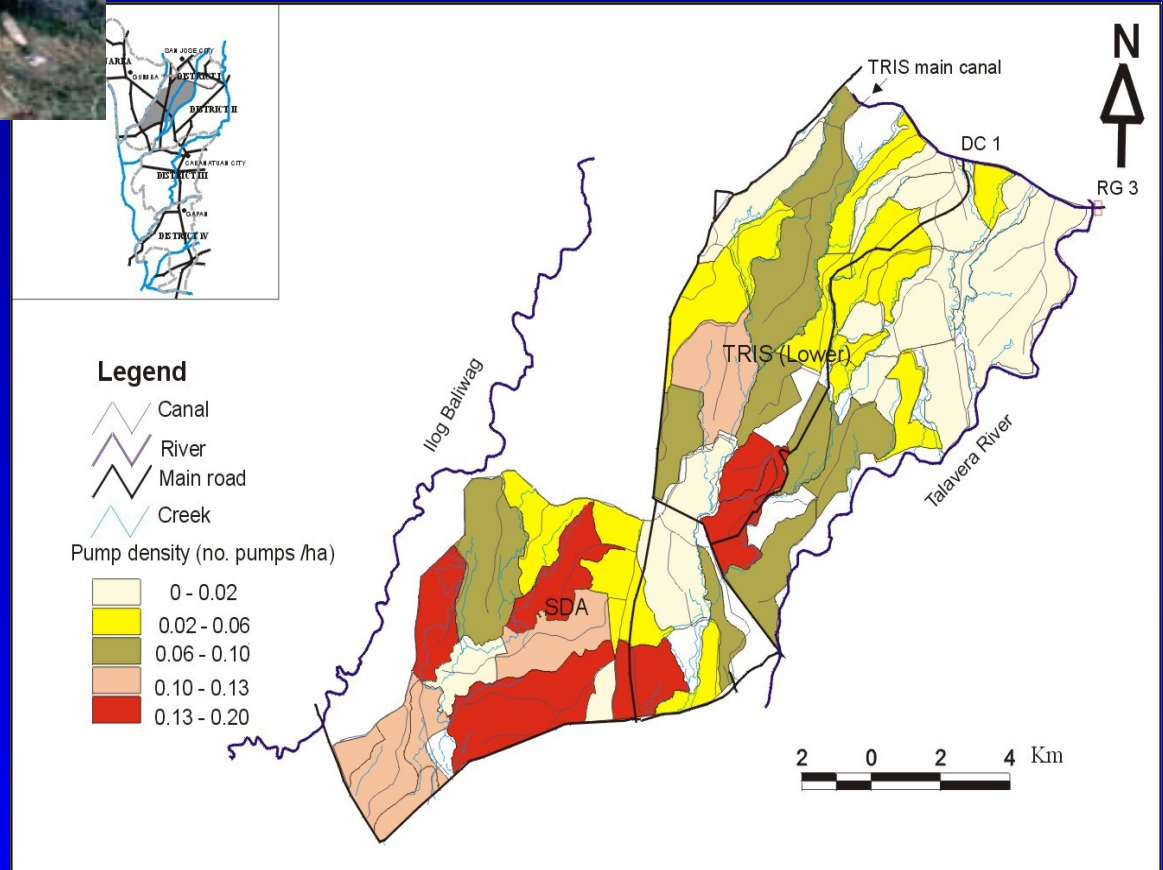
Increased production with increase in scale, using same amount of irrigation

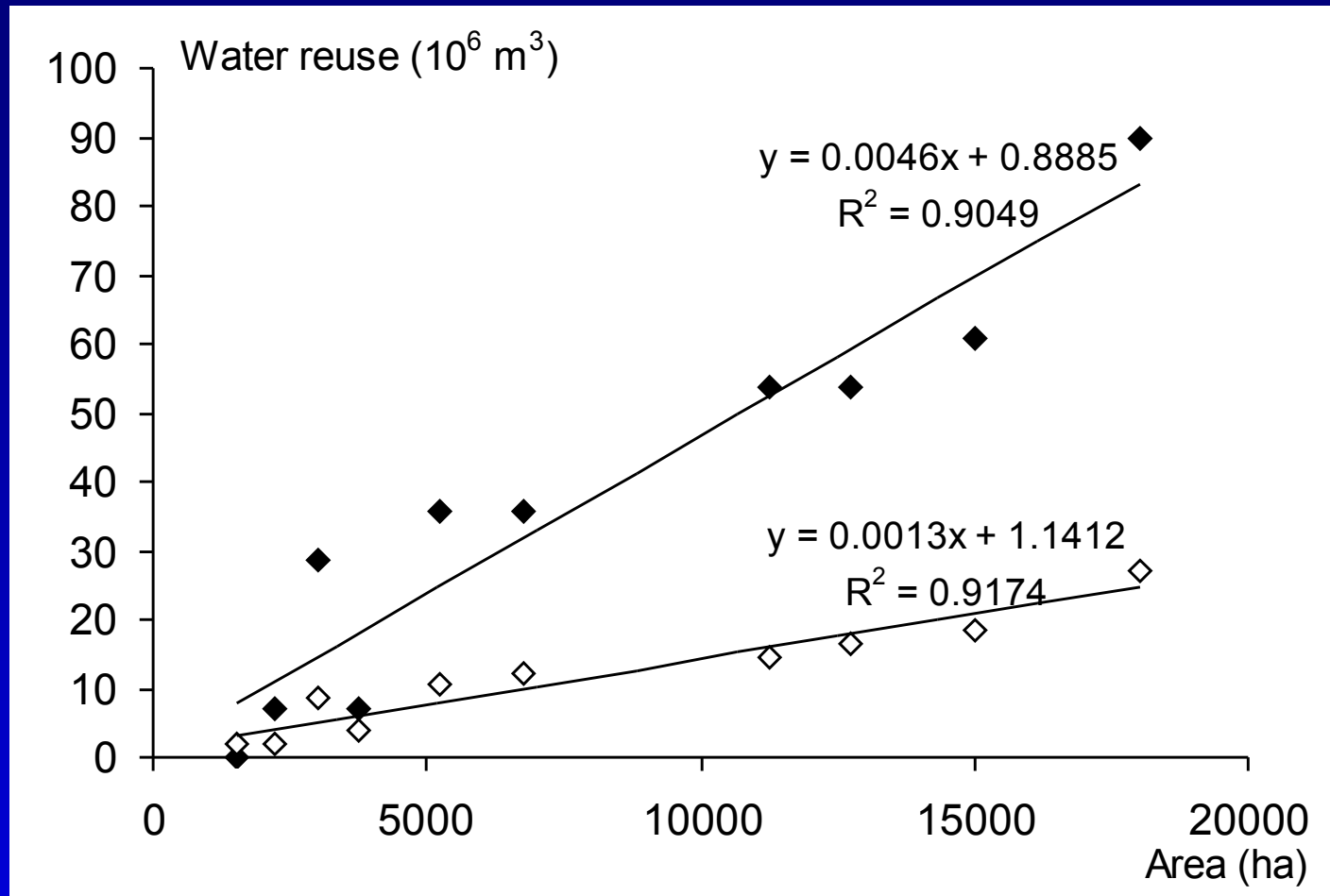
Water re-use by pumps:

- 18% farmers
- 23% area
- 10% water reused

Reuse surface water by small dams

- 45% water reused





**Water reuse by check dams in creeks/drains (◆) and by pumping from shallow groundwater (◇)
District I, UPRIS, Philippines, 2002**

Water productivity (WP)

Amount of grain produced per unit of water used
kg grain m⁻³ water

What water used?

WP_T : water transpired

WP_{ET} : water lost by evapotranspiration

WP_I : water put in by irrigation

WP_{IR} : water put in by irrigation and rainfall

Start counting water at land preparation or at crop establishment

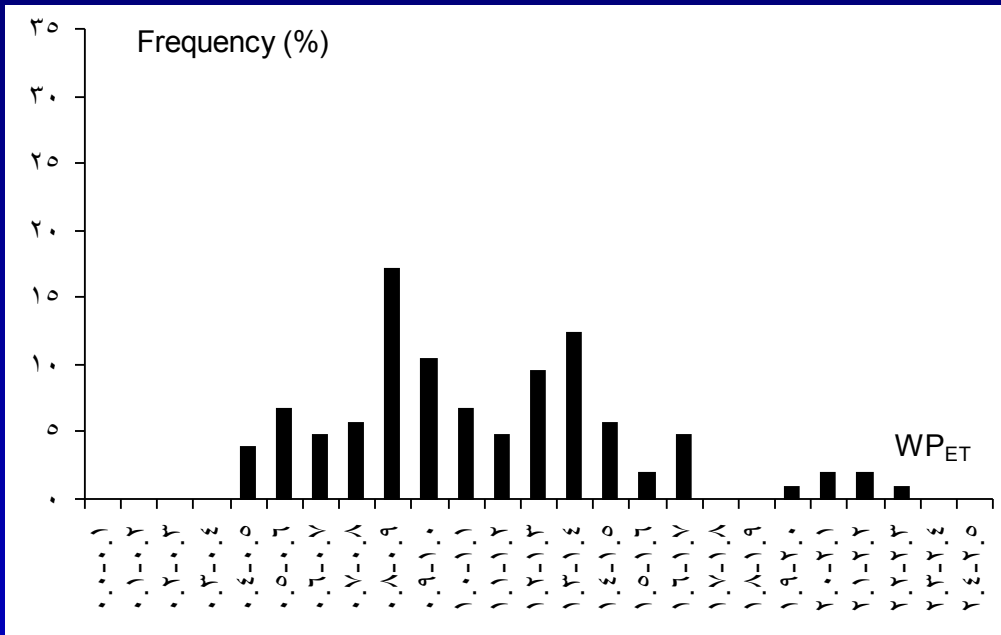
Water productivity (WP)

Water productivity (kg grain m ⁻³ water)	Rice	Dryland cereal
Per transpiration (T) ¹	up to 2	wheat: up to 2
Per evapotranspiration (ET) ²	0.6-1.6 (1.1)	wheat: 0.6-1.6 maize: 1.1-2.7
Per inputs by rain and irrigation (RI) ²	0.2-1.2 (0.4)	

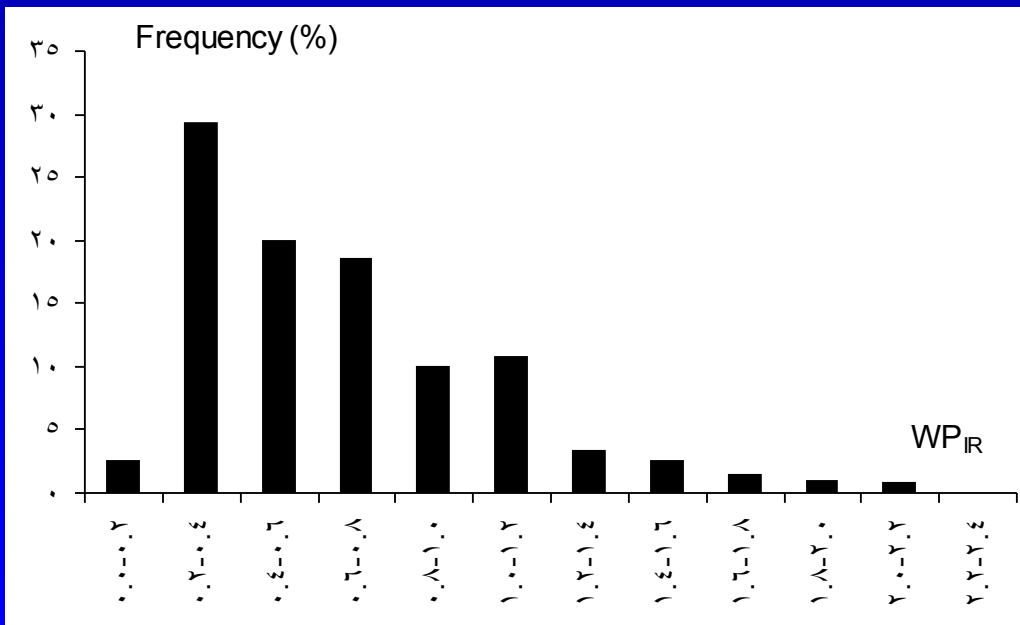
¹ : measured in pots

² : measured in fields

Zwart and Bastiaans, 2005



Tuong, Bouman, Mortimer, 2005



Some conclusions

- Rice plant same WP_T as other C_3 cereals

- Rice field same WP_{ET} as other C_3 cereals

Variation in WP_{ET} caused by variety, climate, management

- Rice field requires 2-3 times more water than other cereals, mainly because percolation and seepage losses (25-50% in heavy soil with shallow groundwater, to 50-85% in lighter soils with deep groundwater)

- Percolation and seepage are/can be reused downstream

Pressure to produce more food (rice) is getting greater because of ever increasing population



But also:

More people want

- more industry
- more drinking water
- more cities
- more swimming pools
- more....

=> Water is getting scarce and expensive

⇒ Need to develop technologies to help farmers cope with water shortage (ie, not enough water to keep rice fields continuously flooded)

Water-saving technologies