IRRIGATION’S FUTURE?

Nuffield International contemporary Scholars Conference, 27/02/08

John Blackwell and the Team from the

International Centre of Water for Food Security CHARLES STURT UNI; WAGGA

STRUCTURE

- TO ESTABLISH IRRIGATION AS BEING NECESSARY
- ELUCIDATE SOME THREATS TO IT'S SUSTAINABILITY
- Then DRAWING ON MY 40 YEARS EXPERIENCE IN THE INDUSTRY ("BEFORE IRRIGATION CHECK YOUR DRAINAGE"; Blackwell 1966):
- HIGHLIGHT A FEW WAYS WE MAY IMPROVE THE CHANCES OF ACHIEVING SUSTAINABLE IRRIGATION

OR WE WILL FOLLOW HISTORY:

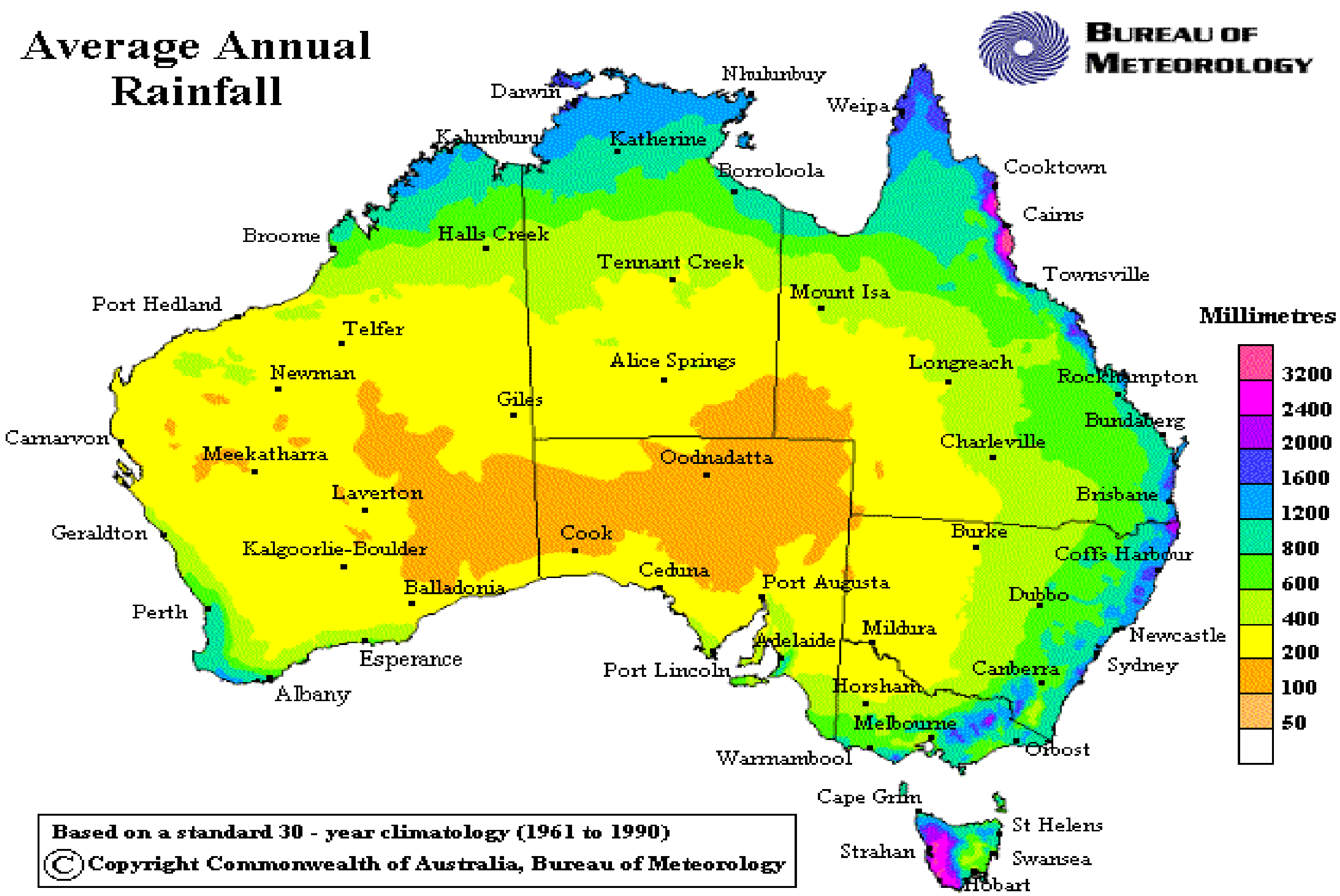
- MESOPOTAMIA and ONWARDS (ORD RIVER)

WHY IRRIGATE?

- 50% OF THE WORLDS TWO MAJOR STAPLES; RICE AND WHEAT
- 30% OF ALL FOOD CONSUMED
- IRRIGATION = FOOD VARIETY
- IRRIGATION = RELIABILITY of SUPPLY
- EXTENDED SEASONALITY
- SUSTAINABILITY OF RURAL COMMUNITIES
- IRRIGATION = QUALITY OF FOOD
- IRRIGATION = POVERTY REDUCTION
- In Australia with no irrigation or food imports:

Mutton, Beef, Damper and the occasional tropical Fruit and Nut

Why we need irrigation in Australia



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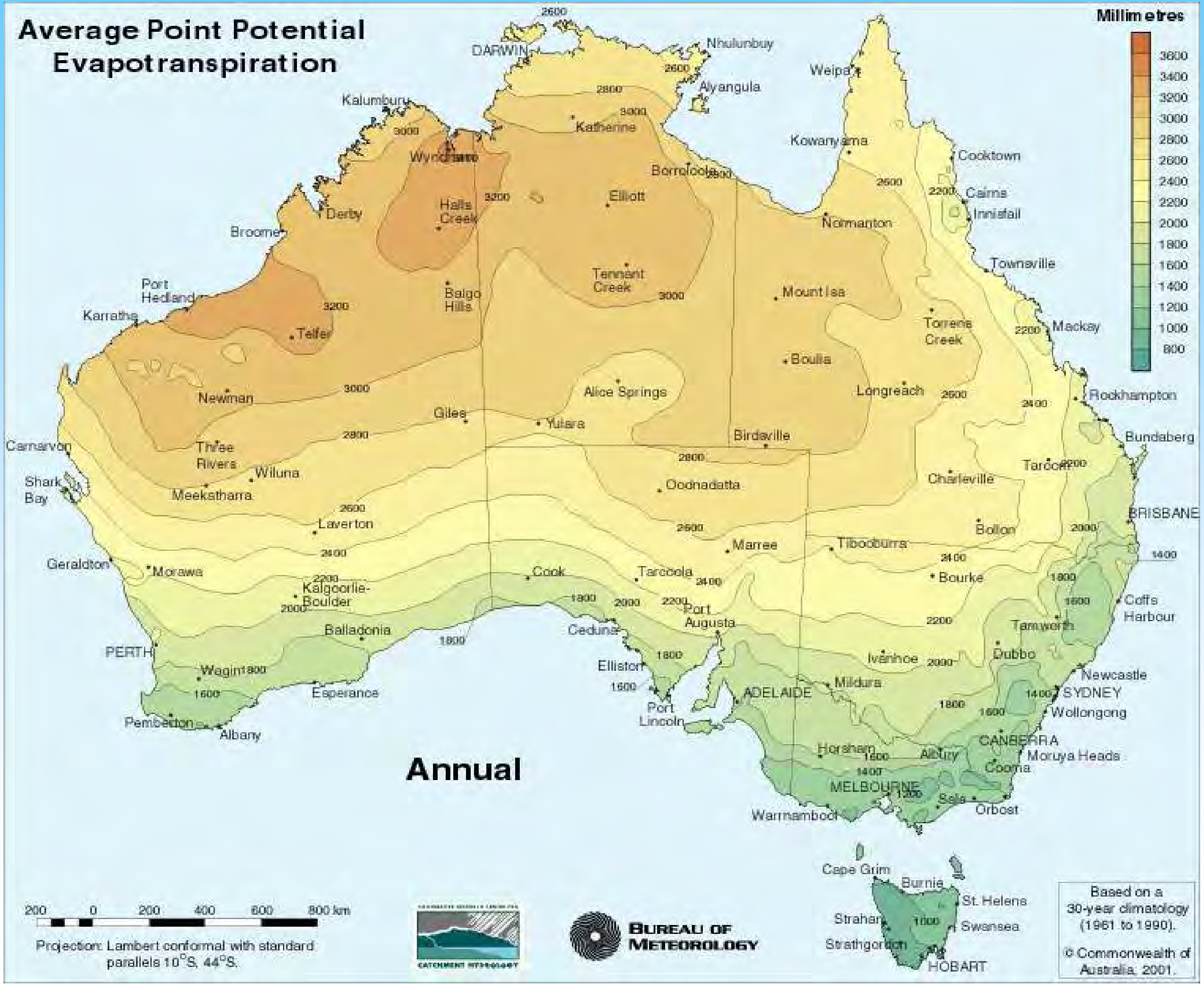
Why we need irrigation in Australia



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Australian Water Challenges


Over-allocation to Irrigation


Expanding Plantations


Bushfire Recovery Impacts

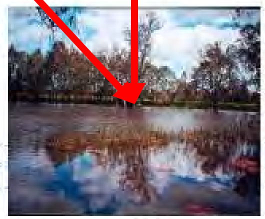

Growing Urban Demand

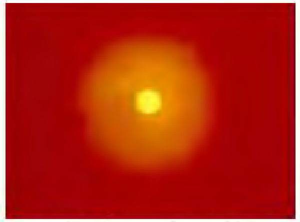
?

The big

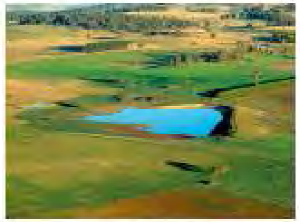
8

water scarcity factors


The Environmental Flows Imperative


Drying & Warming Climate


Uncapped Groundwater Extraction


Expanding Farm Dams

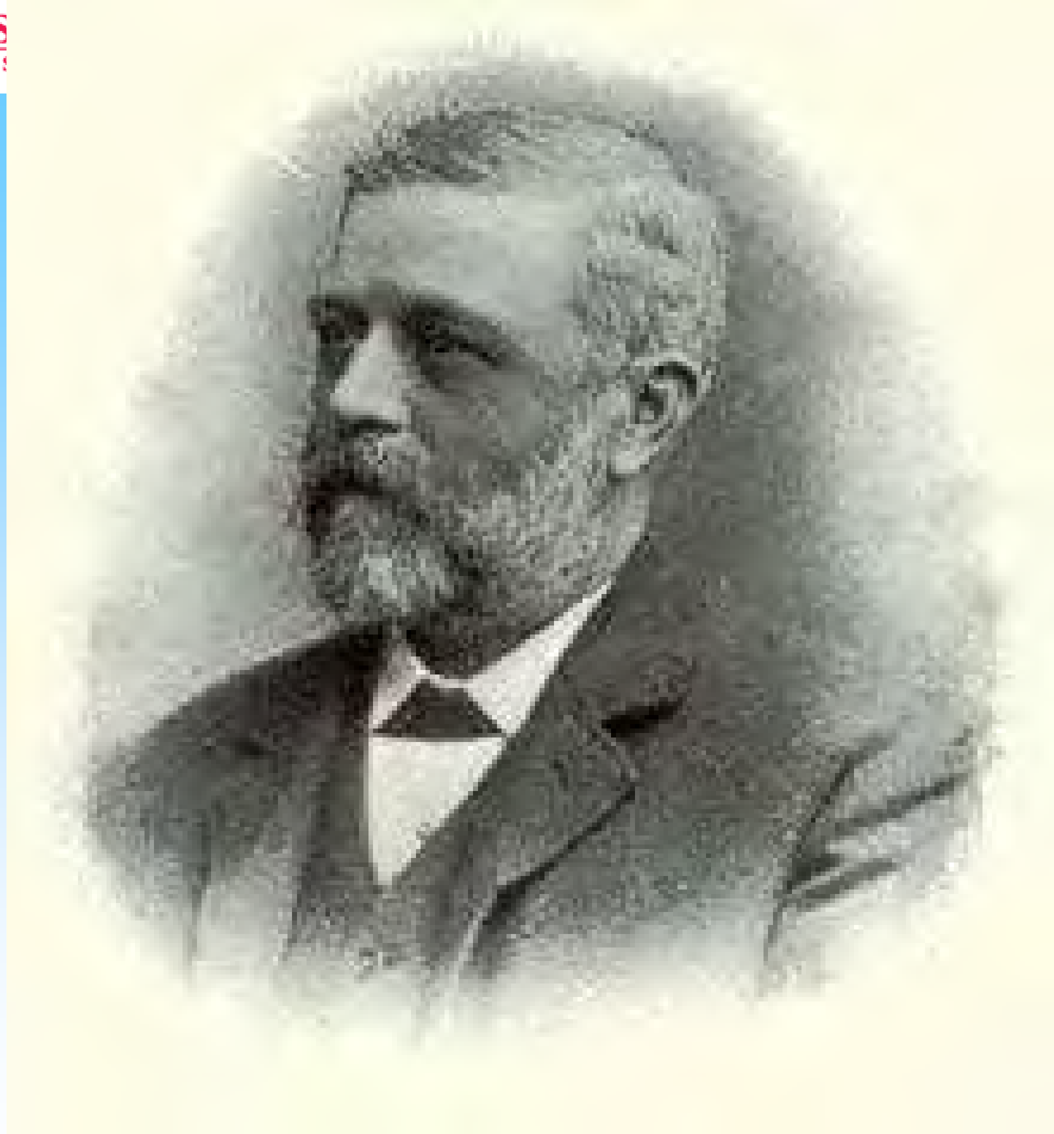
Some people have an almost pathological suspicion of technological solutions to ecological problems. The argument they use is pretty simple: it was technology that got us into this mess, and it's folly to count on it to get us out. (Marq de Villiers 2004)

* It is true that any new technology usually throws up further problems

Marq sees this concern as understandable but misguided. He sees engineering combined with a conservation ethic as providing solutions that can be arrived at in **no other way**.

Perhaps the best example of this situation is the man who purportedly gave us the flushing toilet and hence reticulated sewage systems. His invention and subsequent developments are credited with doing more for human wellbeing and health than any other efforts, medical or technical.

Who was he and were they panaceas???



MR. THOMAS CRAPPER

Perhaps we should not cast the first stone

Renewable Water Resources and Potential Water Availability by Selected Countries

Countries	Area (10^6 km^2)	Population (Millions)	Water Resources km^3/year								Potential Water Availability (10^3 m^3/year)	
			Inflow				Water Resources km^3/year					
			Aver.	Max	Min	c.v.*	Aver.	Max	Min	c.v*.	Per Km^2	Per Capita
Australia	**7.68**	**17.9**	**0**	**0**	**0**	**0**	**352**	**701**	**228**	**0.24**	**45.8**	**19.7**
Brazil	8.51	159	1900	2350	1600	0.08	6220	7640	5200	0.08	730	45.2
Canada	9.98	28.0	130	166	99.4	0.12	3287	3760	2910	0.06	329	120
China	9.60	1209	0	0	0	0	2701	3455	2015	0.12	281	2.23
India	3.27	919	581	697	508	0.03	1456	1794	1065	0.11	445	1.90
Russia	17.08	148	222	330	144	0.17	4053	4513	3533	0.05	237	28.1
USA	9.36	262	148	178	107	0.13	2930	3864	2058	0.11	313	11.5

* Coefficient of variation (c.v.), a statistical measure of the deviation of a variable from its mean. A greater c.v. indicates high variability and a smaller c.v. indicates low variability in the data.

Source: Shiklomanov, I. A. (2000). "Appraisal and Assessment of World Water

Some inescapable facts

Irrigation and rain apply salt

Plant growth concentrates salt

The only way to manage salt is to establish a net downward flow of water and salt through the rootzone

Before irrigation ensure adequate drainage

My hypothesis: Short of another ‘green’ revolution (perhaps inspired by biotechnology???), Irrigation will be critical in feeding the global population.

Why worry?

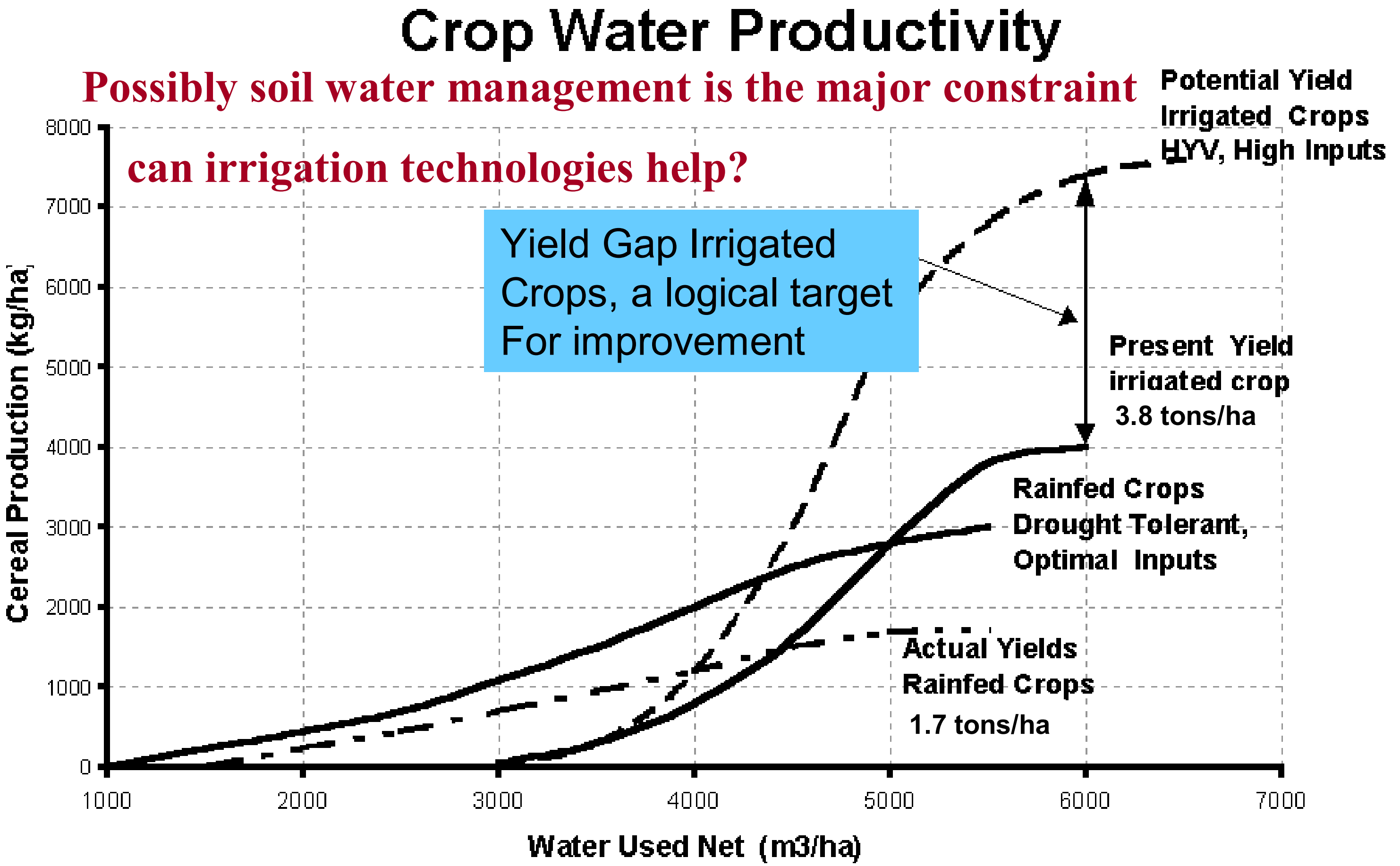
•Average world yields of cereal crops have increased at a rate of 2.6%/annum over the past three decades due mainly to the application of science, including development and application of chemical pesticides and fertilisers, fossil fuel, irrigation and:

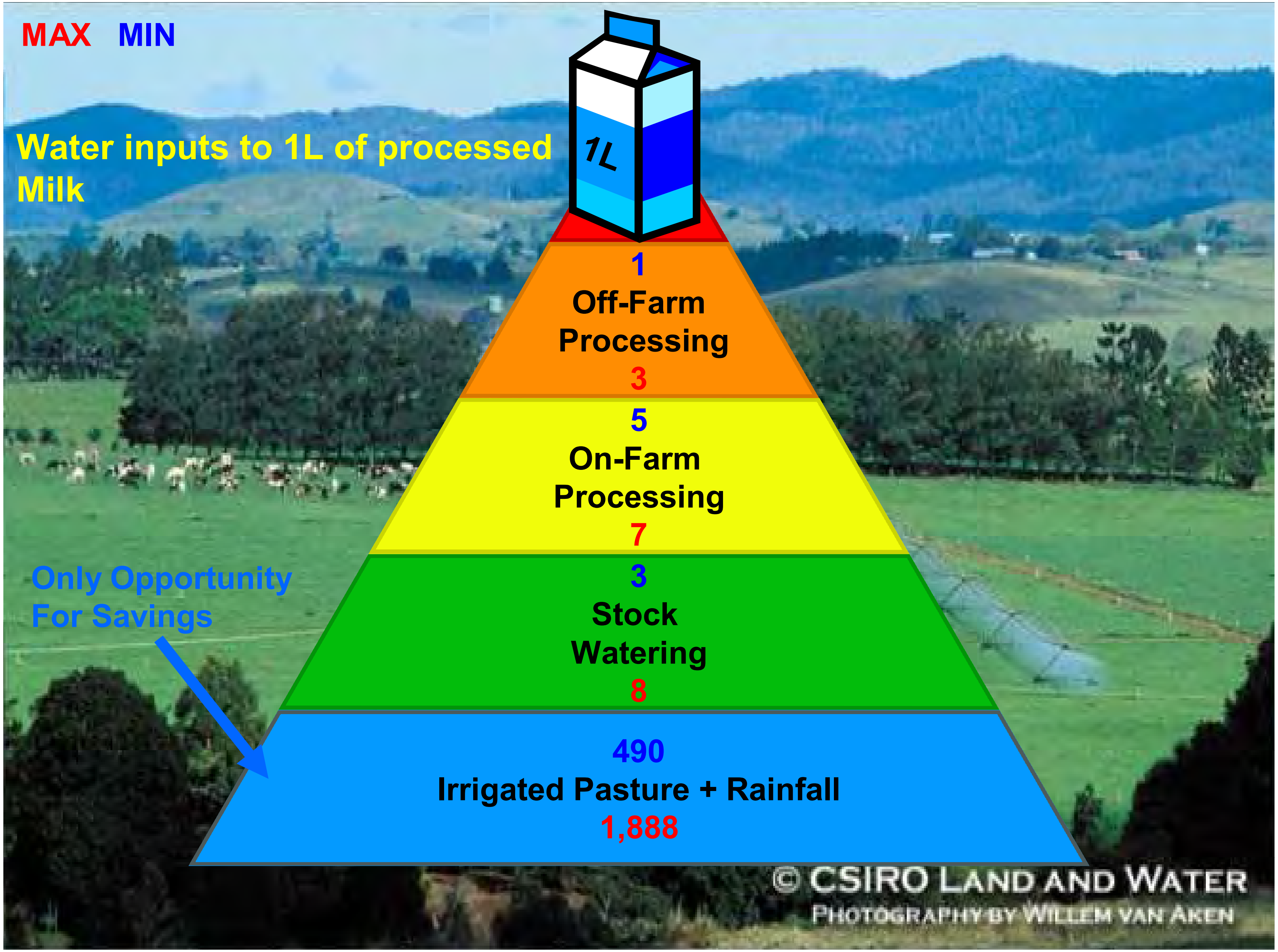
• selected breeding programs. (the Green revolution)

•It is unclear whether these technologies can continue to provide the basis for sustaining high rates of growth in yield

•To feed a global population growing exponentially. Feb; 2008 6.65 Billion ~9.7 billion by 2150

The Global Challenge to Improve Water Productivity




MAX MIN
Water inputs to 1L of processed Milk
1L
1
Off-Farm Processing
3
5
On-Farm Processing
7
3
Stock Watering
8
490
Irrigated Pasture + Rainfall
1,888
Only Opportunity For Savings
© CSIRO Land and Water
Photography by Willem van Aken

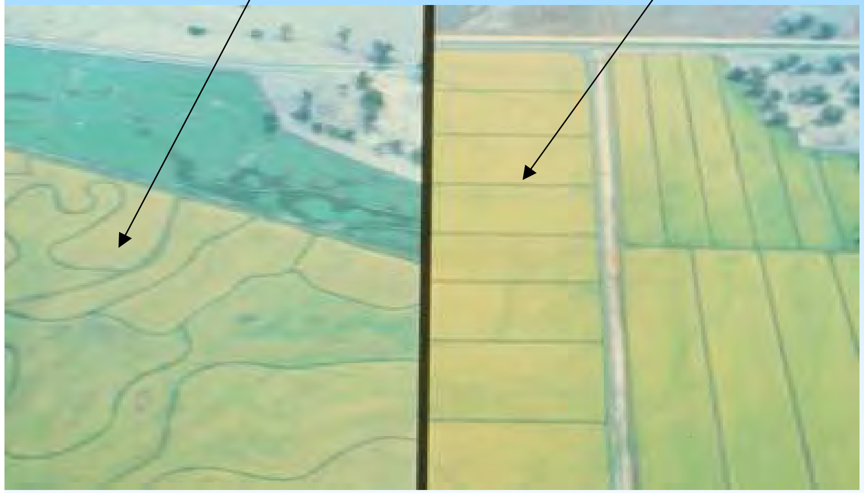
Change Ricegrowing layout

1 lasered within contours

2 swap to border check layout

Thanks to Yanco DPI

3 swap to raised bed layout down the slope



Natural Contour Landformed / lasered Raised beds within bankless channel

Increase crop range, increase yield, improve wo/wo times, improve management

Irrigation Salinity with Surface Irrigation Systems

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Change to pressure based application systems: Lateral move with Low pressure droppers (LEPA)

Drip Irrigated Wheat/Rice

Modern Irrigation Systems do not necessarily solve the problem

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Net Recharge

equals

Rainfall +

Irrigation

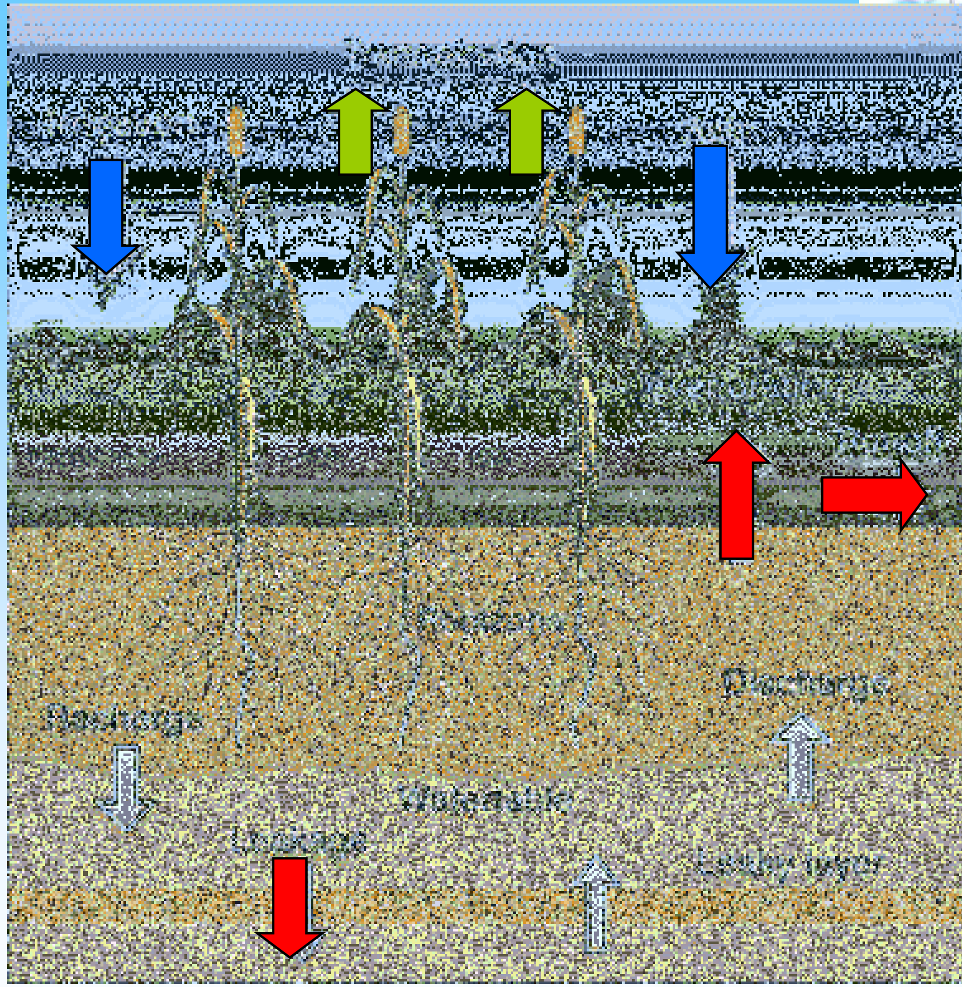
minus

Evaporation

+transpiration

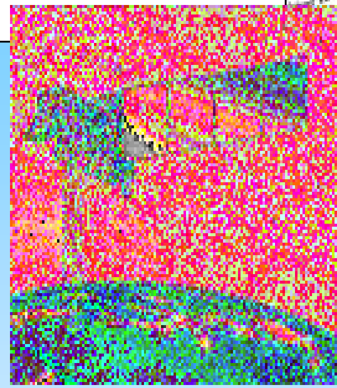
+Leakage +

Runoff

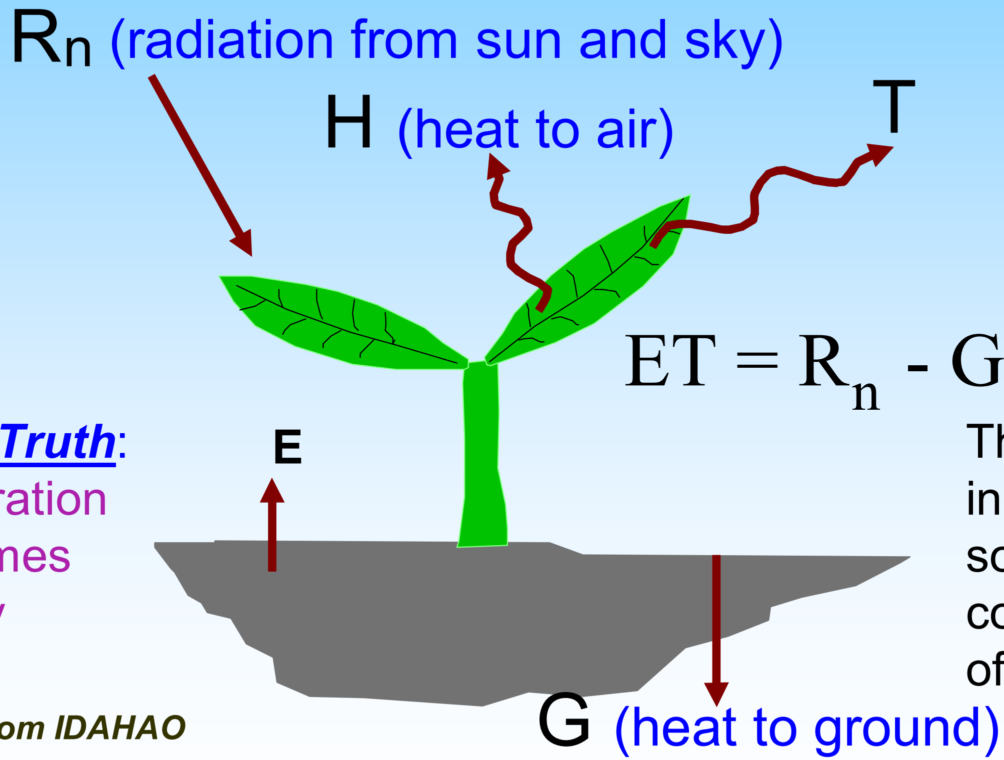


To manage these interactions and avoid secondary Salinisation due to over-watering
We need to improve our irrigation scheduling:

Remote Sensing for Actual ET Estimation and Accurate Irrigation Scheduling



- ET is calculated as a "residual" of the energy balance



$$ET = R_n - G - H$$

The energy balance includes all major sources (R_n) and consumers (E,T, G, H) of energy

Basic Truth: Evaporation consumes Energy

Adapted from IDAHAO

Or we can adopt a simple method for Irrigation Scheduling

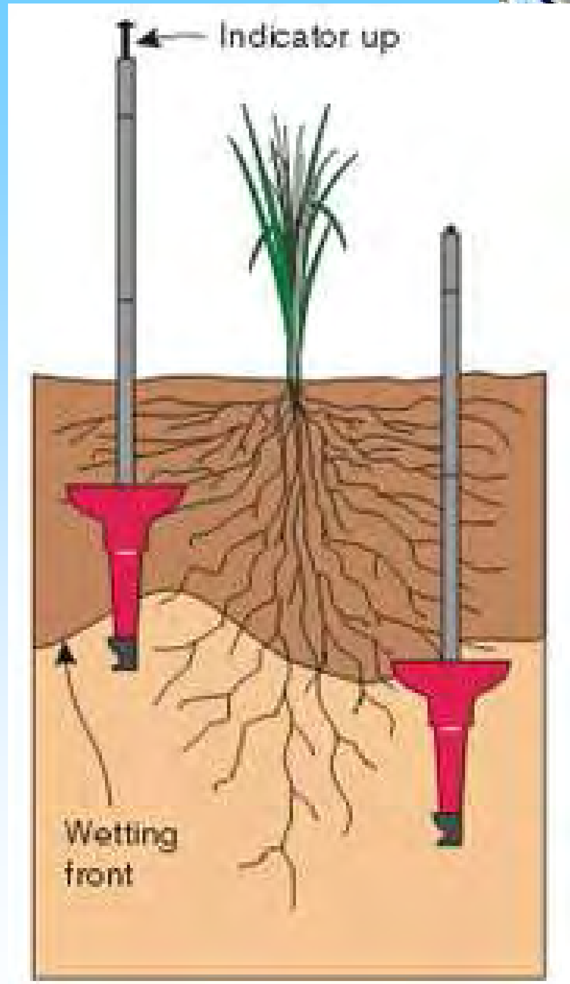
Smart Monitoring and Learning

Full Stop Simple and Robust

A flow distortion instrument that captures soil solution from unsaturated soil at known suction

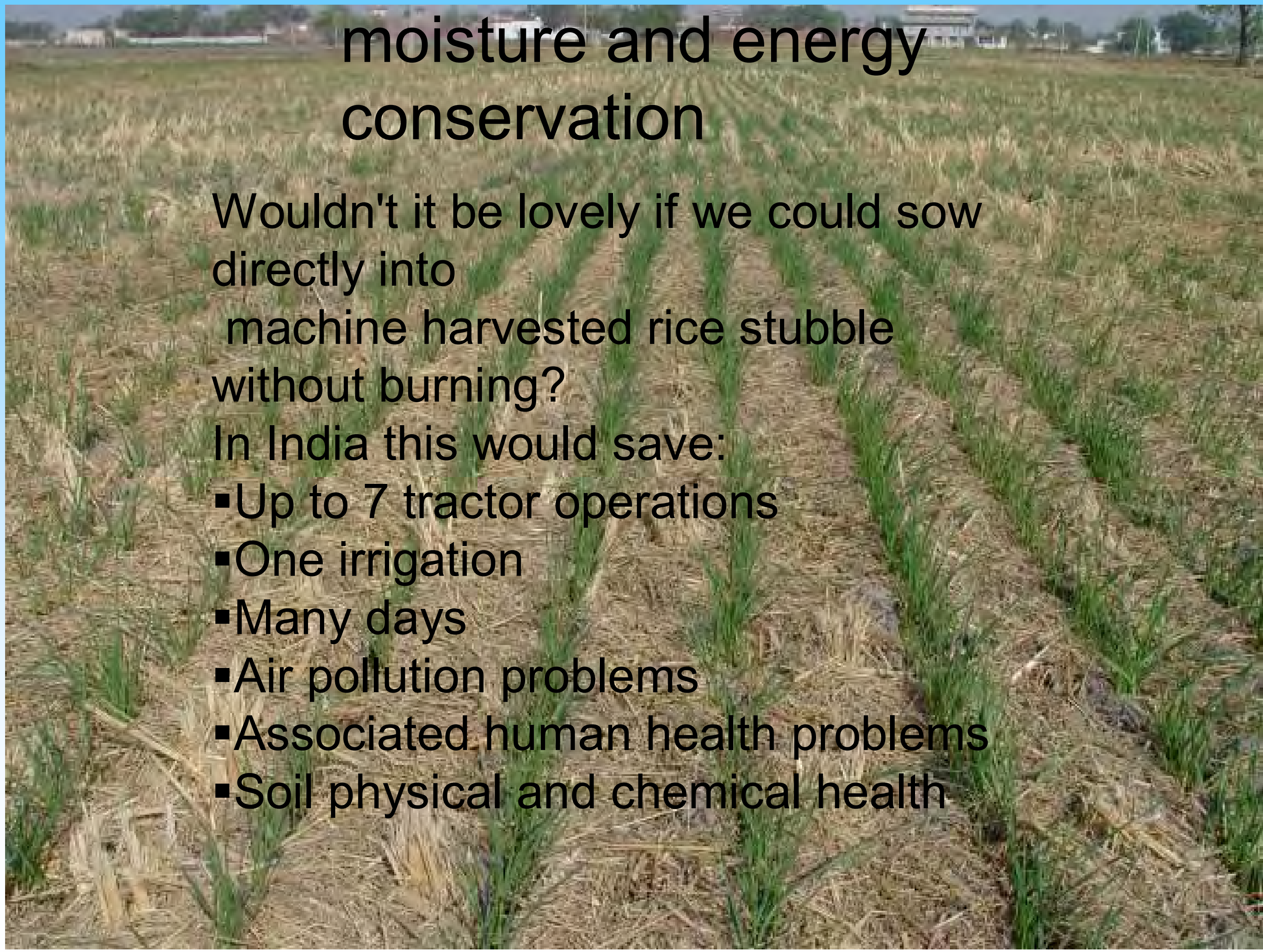
WATSAVE TECHNOLOGY AWARD

- Water saving in Agriculture from the International Commission on Irrigation and Drainage (France 2003; 77 countries)



Or we can modify our farming and husbandry practices:

e.g. MULCH FARMING for moisture and energy conservation



Wouldn't it be lovely if we could sow directly into
machine harvested rice stubble without burning?

In India this would save:

- Up to 7 tractor operations
- One irrigation
- Many days
- Air pollution problems
- Associated human health problems
- Soil physical and chemical health

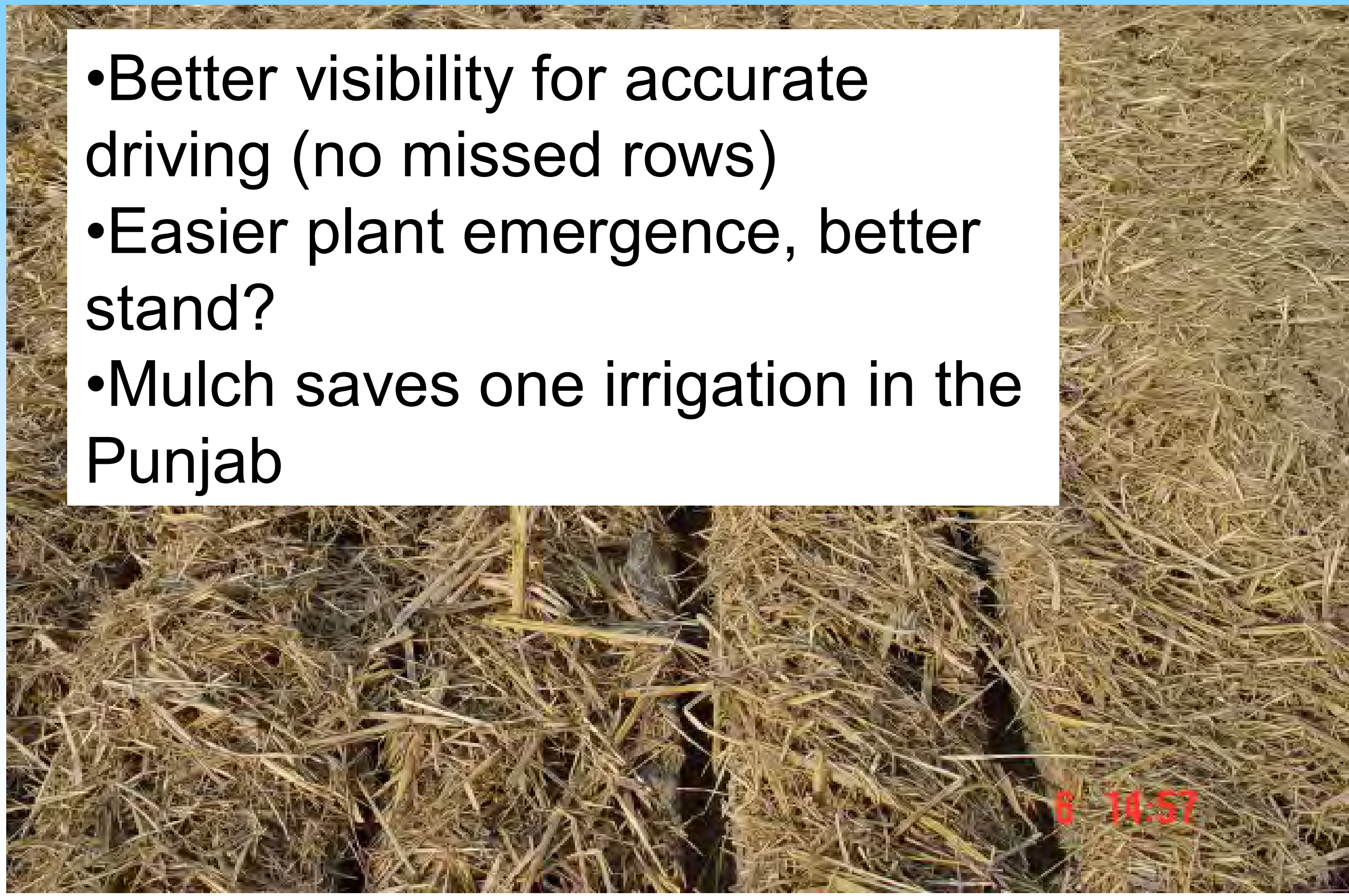
Well now you can thanks to the "Happy" seeder

- Heavy dust with blowing Happy
- Trailed version shown, although more cumbersome was very versatile
- Happy Combo and FMI are more compact but still create a dust problem
- Can handle heavy straw loads

- Reduced dust with turbo (no blowing)
- Smaller more compact, hence lighter machine, cheaper??
- Better driver visibility
- Easier crop emergence
- Limited to about 10 tonne rice straw loads

Turbo leaves uncovered seed rows

- Better visibility for accurate driving (no missed rows)
- Easier plant emergence, better stand?
- Mulch saves one irrigation in the Punjab



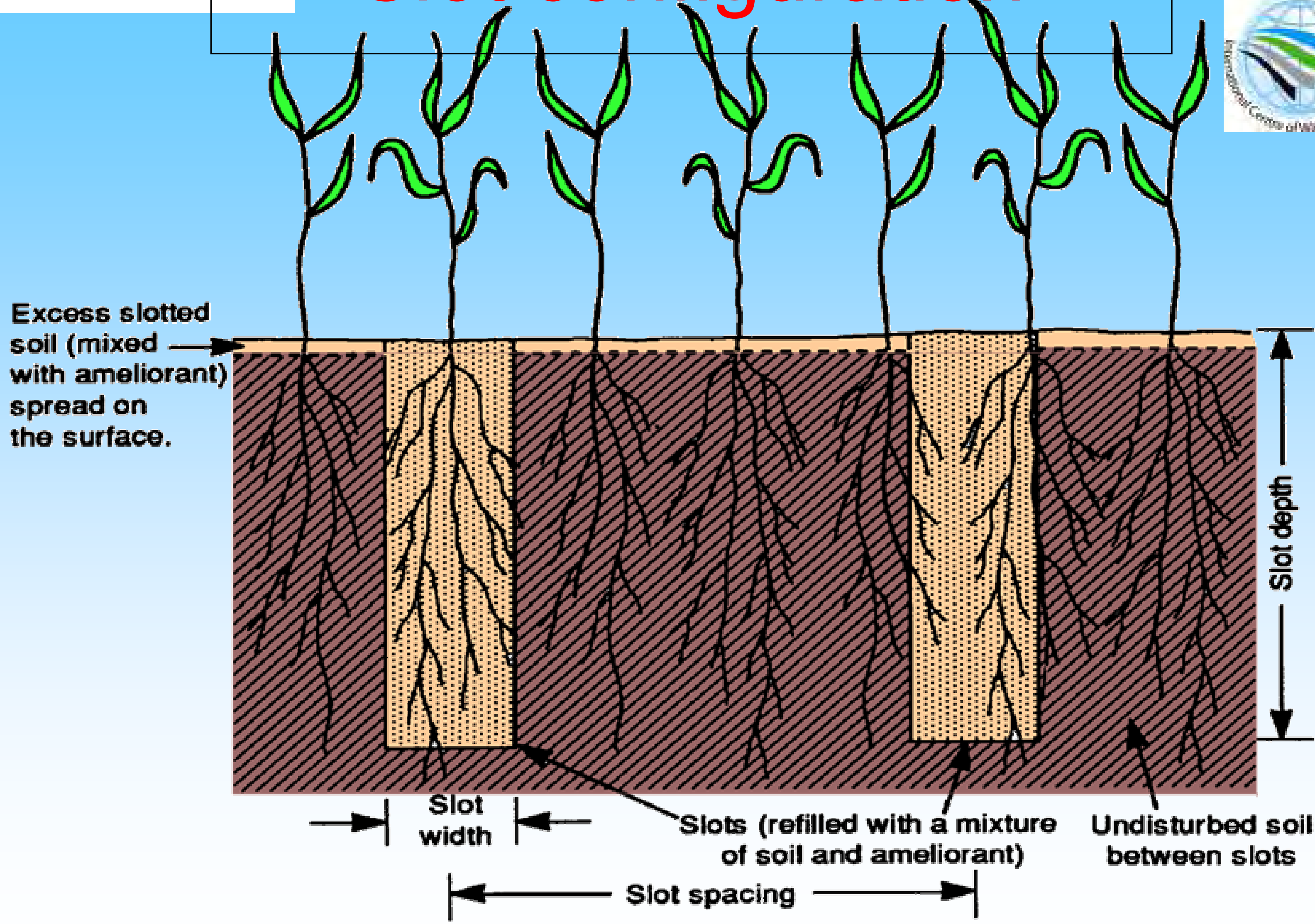
We can adopt Precision Agricultural practice

- This can increase our overall yield
- Saving on inputs (less wastage)
- For the same applied Water
- Thus improving our Water Use Efficiency
- For instance only apply fertiliser where it is Needed:

We can improve the soil we are growing in; overcoming soil constraints to production

- We do not always have to ameliorate the total volume of soil to gain the full ameliorative effect of the input
- To achieve this we invented the SLOTTING technique:

Slot configuration



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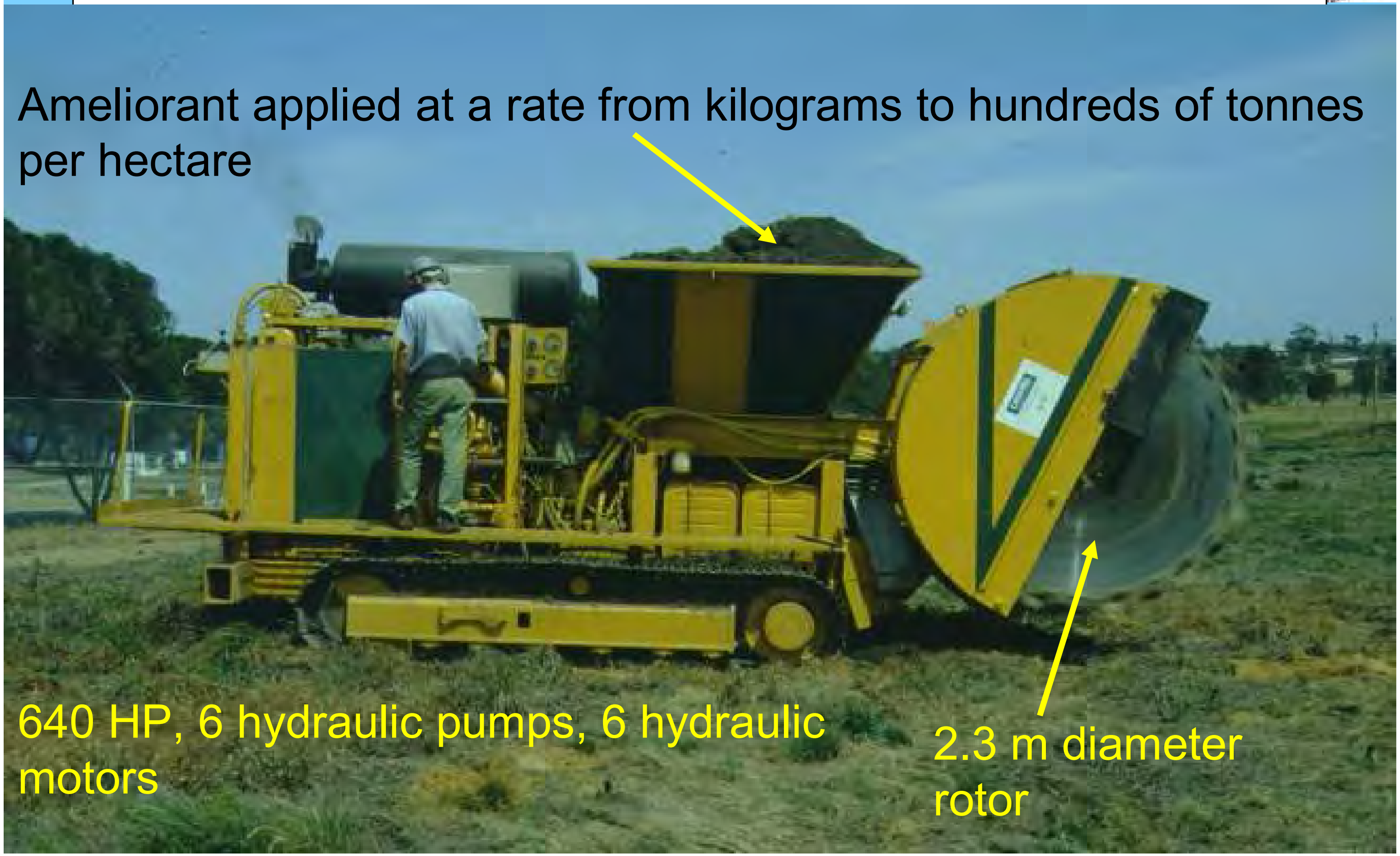
Soil Slotting to Depth



Potential uses of soil slotting

Problem	Ameliorant
Sodic soil	Gypsum, sludge
Acid Soil	Lime, Gypsum, sludge
Sandy, heavy clay	Organic residues, sludge, (micro) nutrients
Nutrient deficiency	(micro) nutrients
Dense layers	No ameliorant

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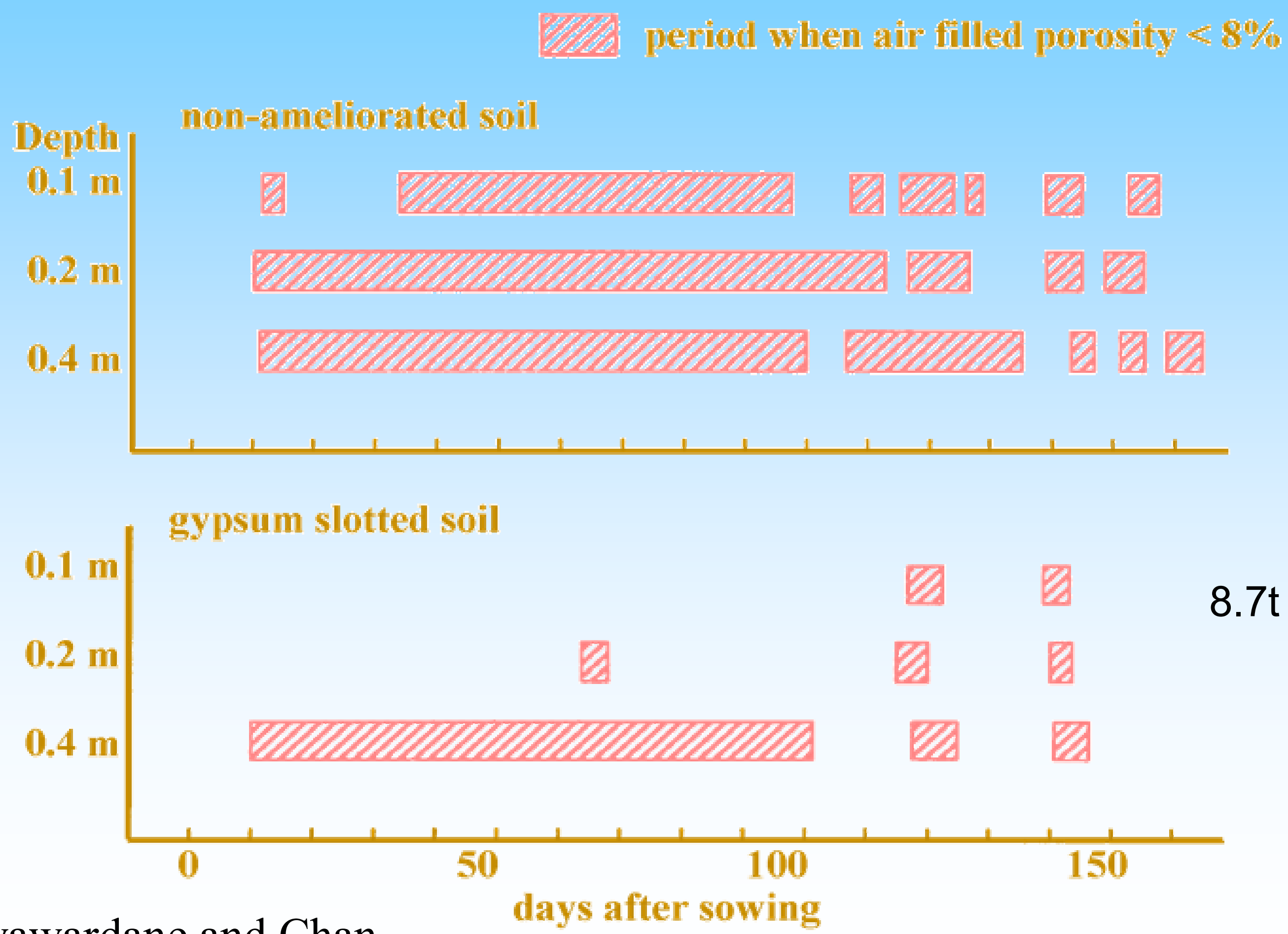
Air filled porosity (Gypsum slots to 40cm overcoming water-logging in a sodic transitional red-brown earth)



0.2 t wheat/ha

8.7t wheat/ha

after Jayawardane and Chan, 1994

Or we can:

Substitute water of inferior quality thus freeing up irrigation water:

- We can use secondary treated sewage water
- We can use drainage water from irrigation areas
- but in both situations must be conscious of the increased threat of **salinisation**
- FILTER (Filtration Irrigation Land Treatment and Effluent Reuse) and the derived SBC (Sequential Biological Concentration) are both sustainable approaches:

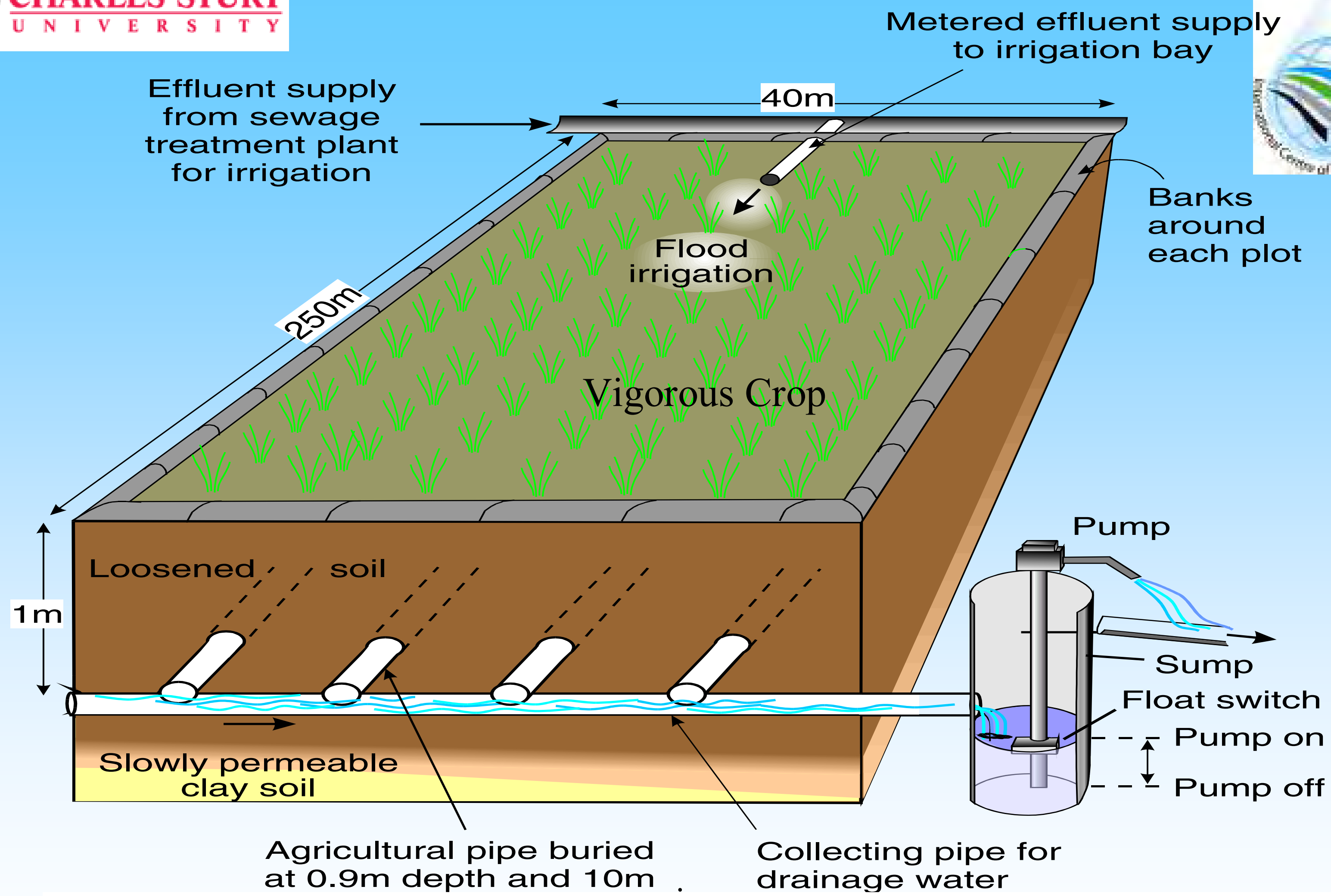
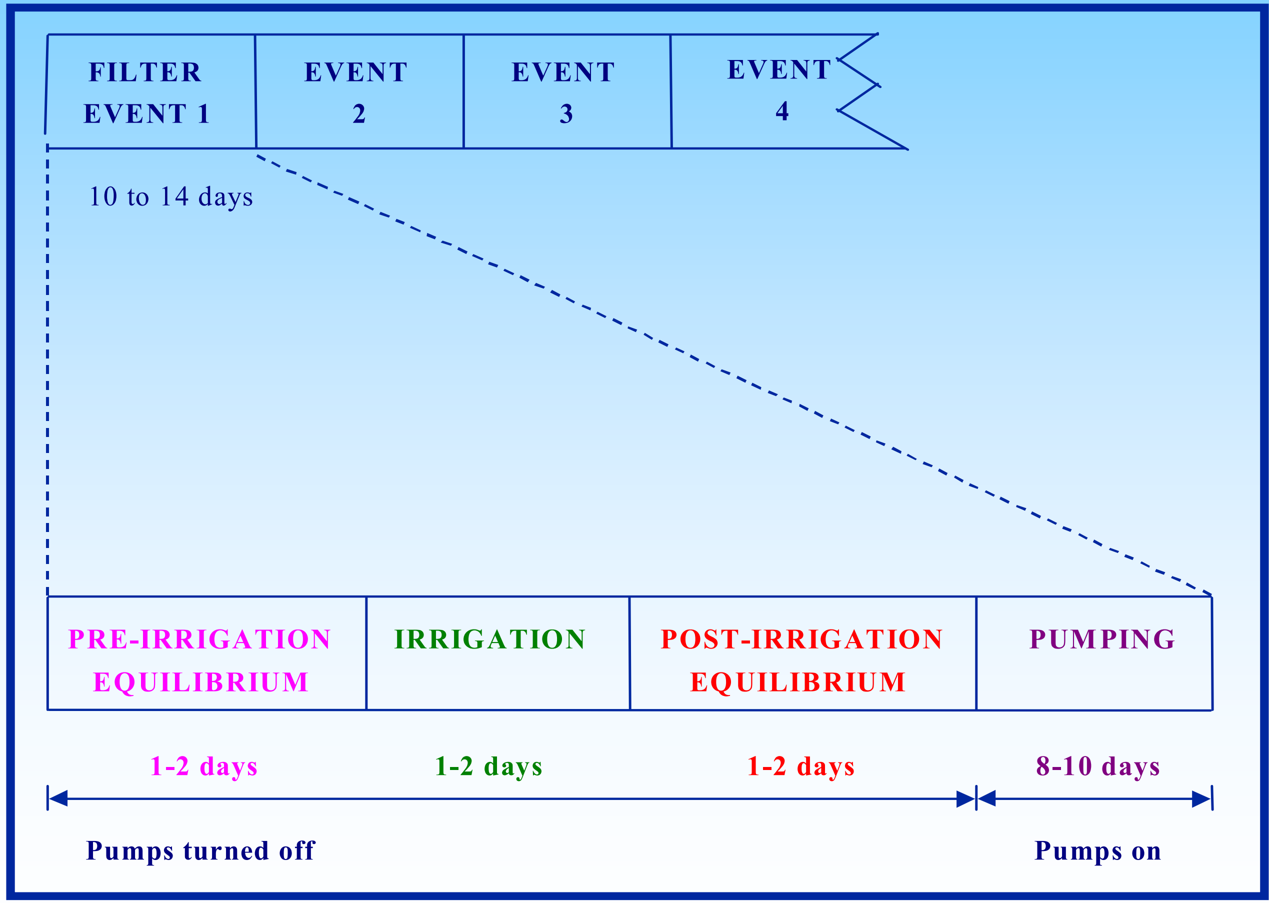
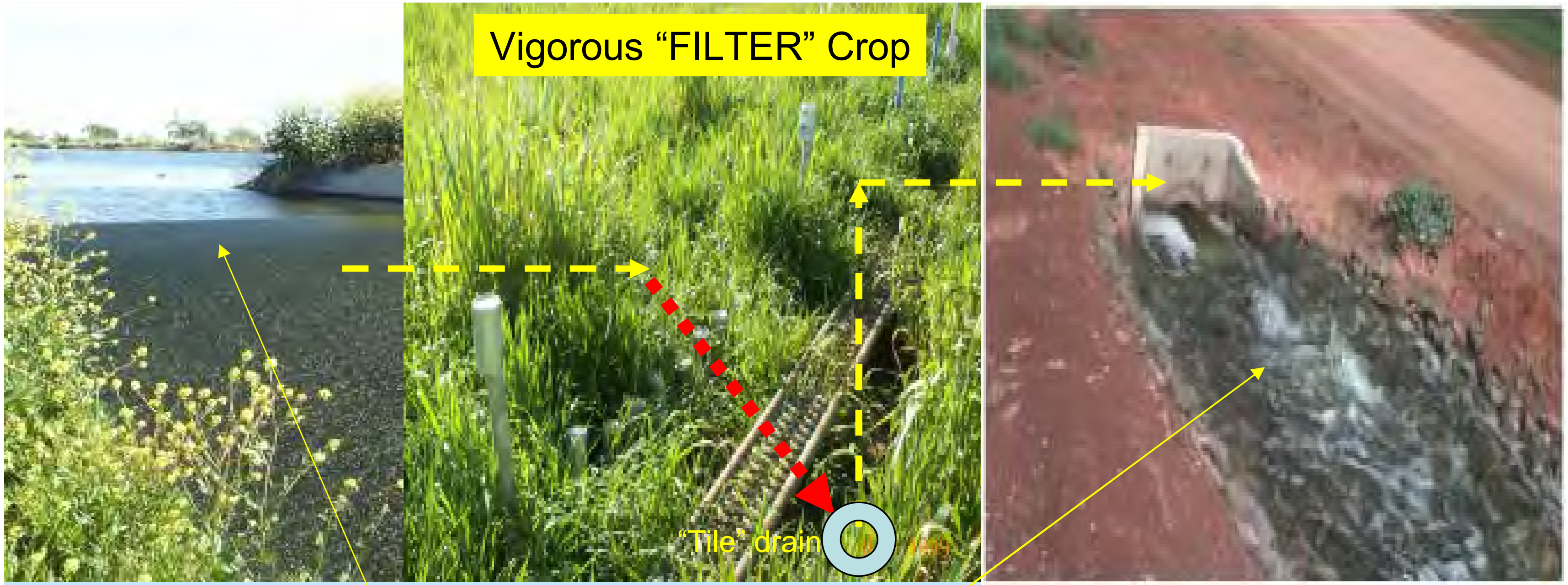


Figure 1. Schematic diagram of a typical FILTER bay.

F.I.L.T.E.R: Filtration, Irrigation, Land Treatment and Effluent Reuse

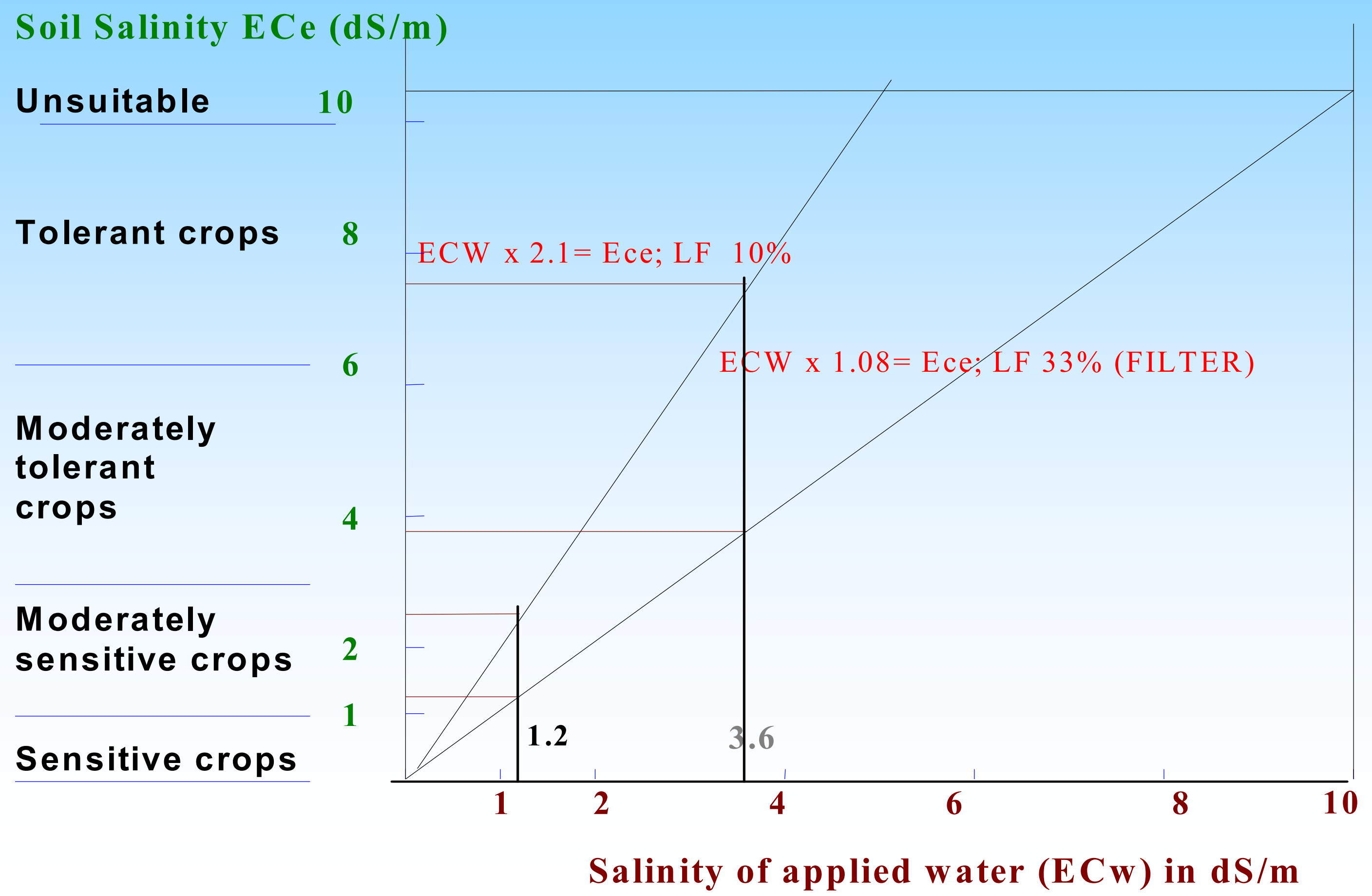
The FILTER operation procedures

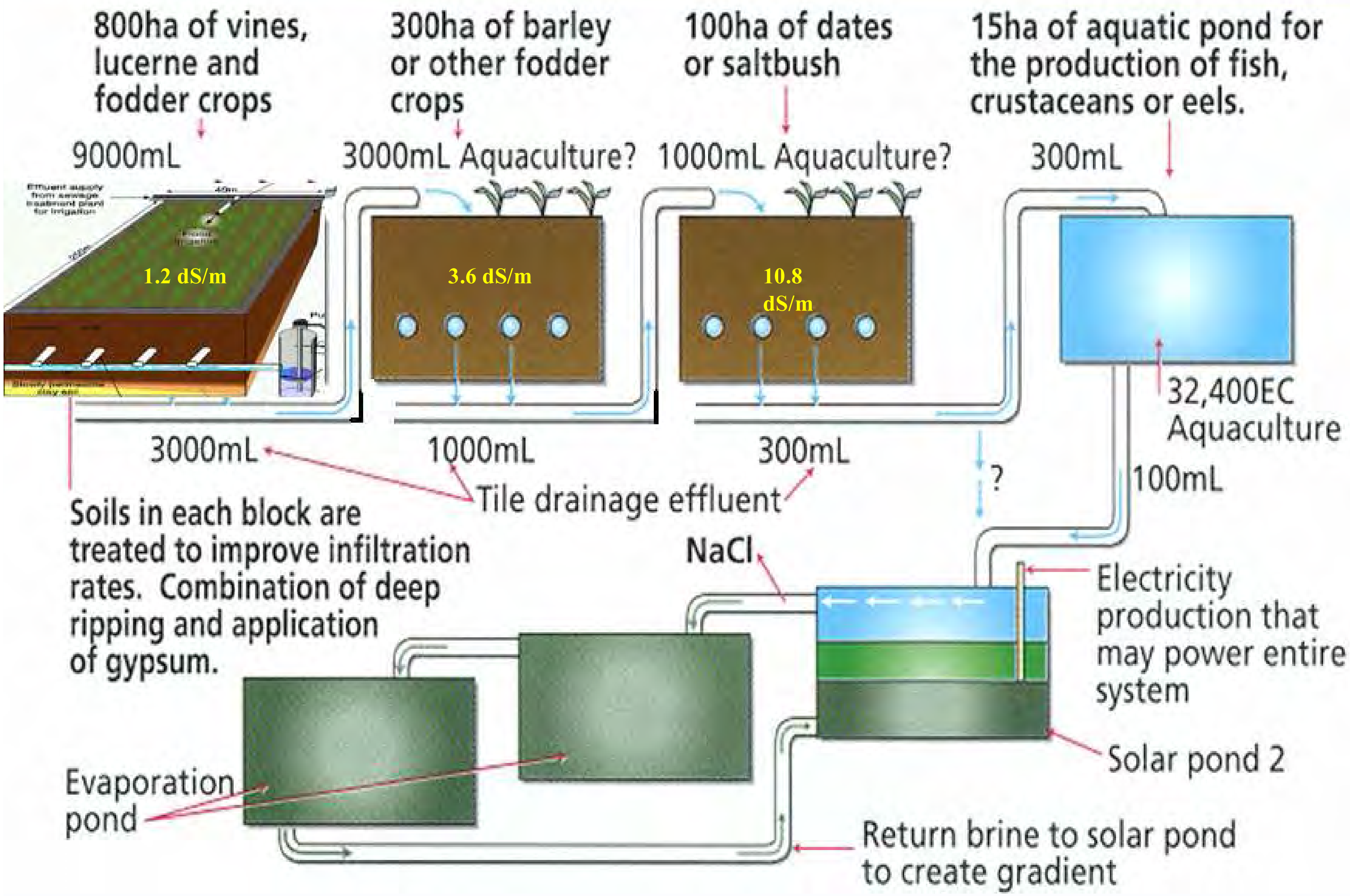




INFLOW	PARAMETER	OUTFLOW	EPA Guidelines
15	TN	8	15
5	TP	0.3	1
17	BOD	2	20
56	SS	13	25
53	Chl_a	0	0
19	Ecoli	0	150 cfu
1200	Ec	3600 (8000) antecedent salt	-

Figure 5. Relationship between salinity of applied water and soil salinity at different leaching fraction (adapted from USSL Staff, 1954)





Serial Biological Concentration of Salts based on FILTER

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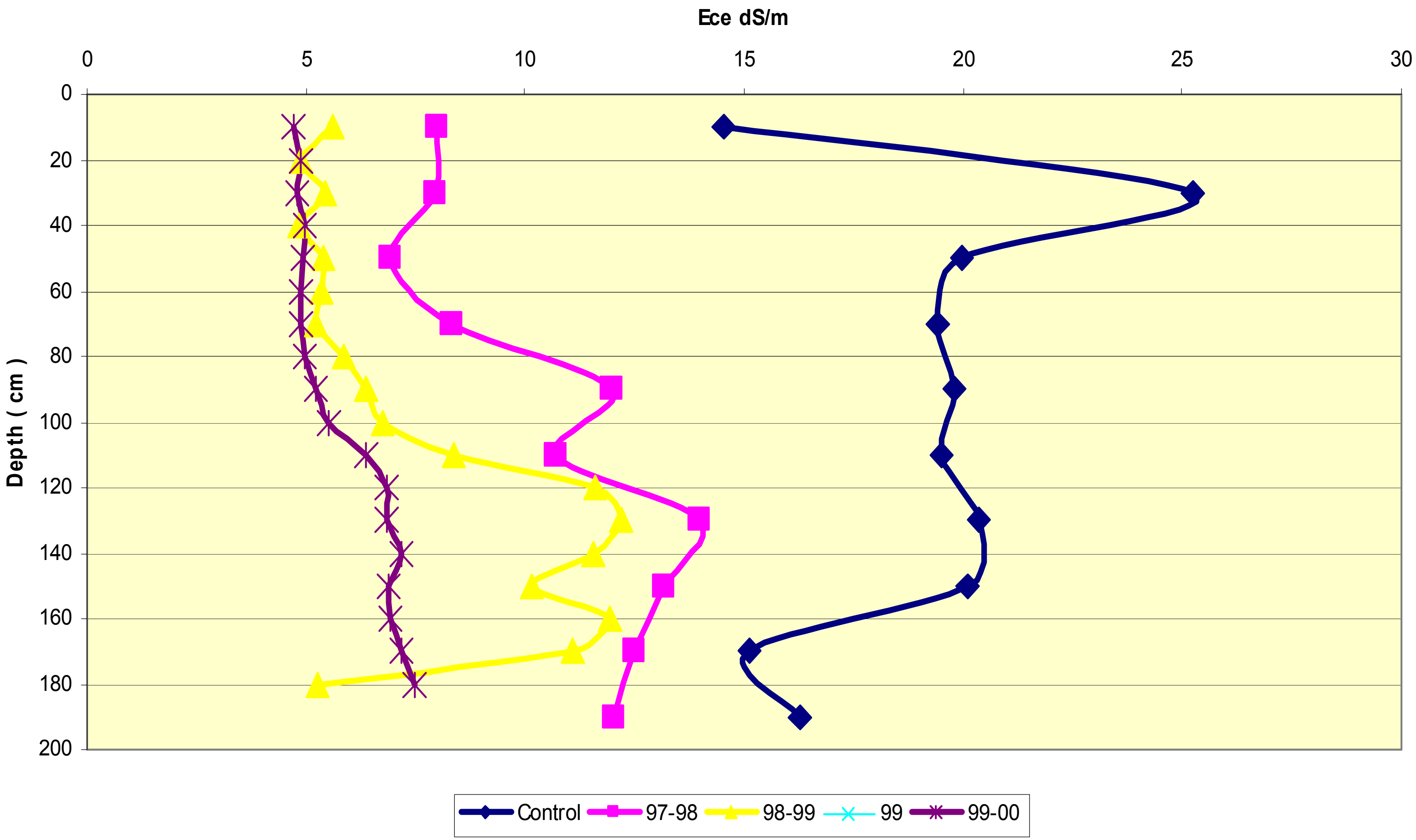
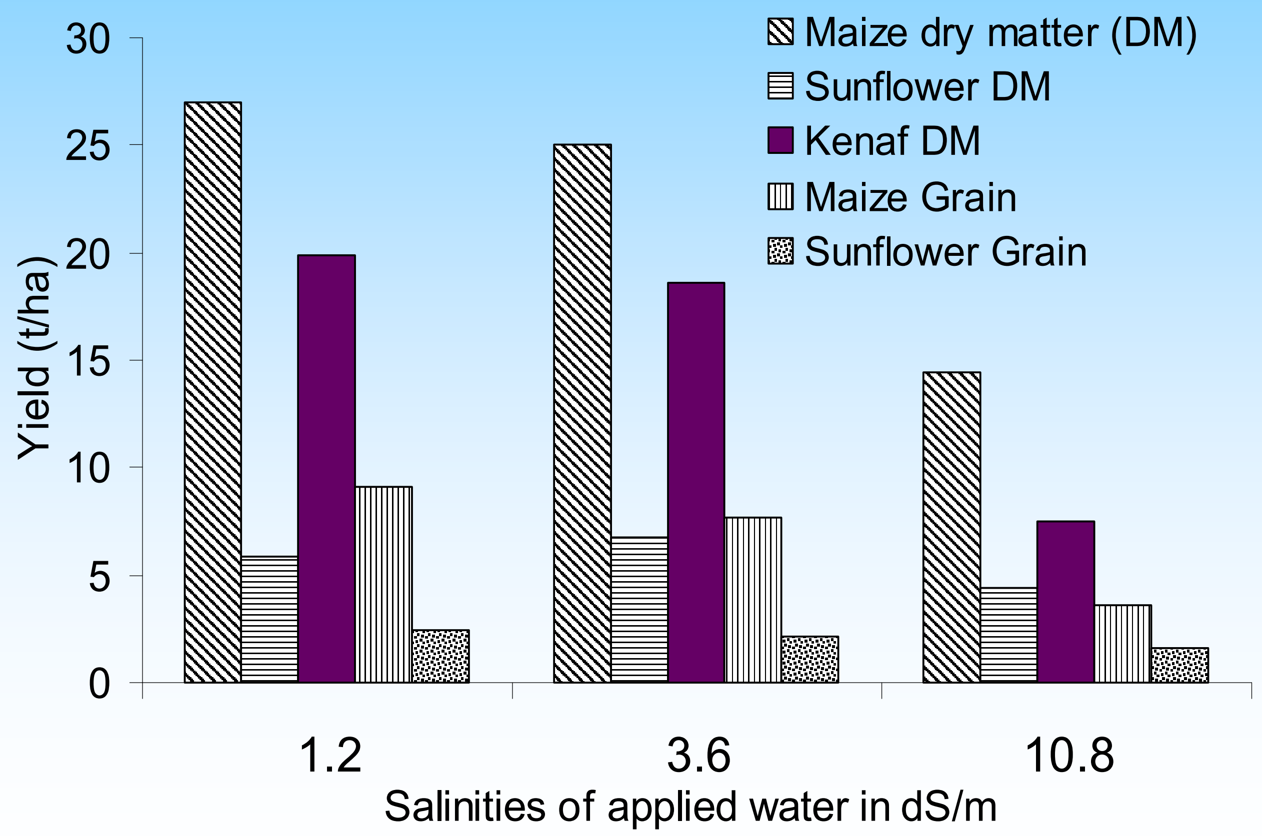
Soil salinty changes - SBC stage two



A selection of crop yields in the SBC system



CONCLUSION

The world's needs

- Maybe 10 billion will need to eat
- To eat, we need to irrigate
- To irrigate sustainably, we need to drain

And this drainage must be MANAGED