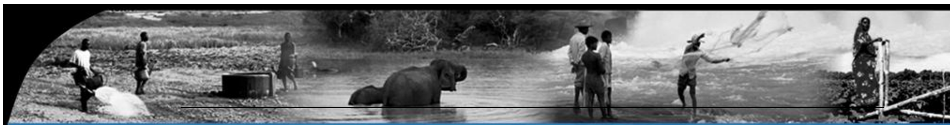

Enhancing water and nutrient use efficiency: The key to transforming agriculture and meeting future food demand.

Andrew Noble

IWMI-SEA, Vientiane Lao PDR

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International Water Management Institute

Outline of Presentation

- Setting the scene – water challenges.
- Water and nutrients – inseparable resources – 3 examples.
- Future opportunities / challenges

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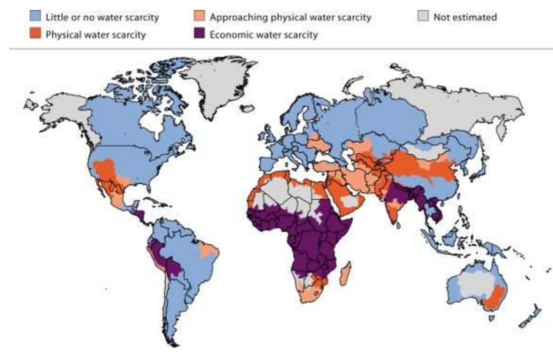
1. We Live in a Water Scarce World – and it is going to get worse with Change Drivers!

- As much as 60% of the global population may suffer different forms of water scarcity by the year 2025
- Water resources, both in terms of quantity and quality, will be critically influenced (compromised) by human activities



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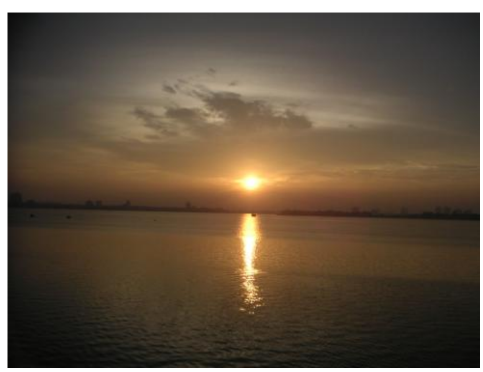
1. The Question to be Asked

Do we have enough water resources to grow enough food to meet future demand for food and biofuels in the context of a diverse array of drivers.



No!

unless ….

We change the way we think and act on water issues .

1. Current and future demand for water

- By 2030, under average economic growth scenario and if no efficiency gains are assumed, global water requirements would grow from 45,000 km^3 today to 69,000 km^3.
- This is 40 % above current accessible, reliable supply!
- Agriculture currently uses 71% of current global water withdrawals.

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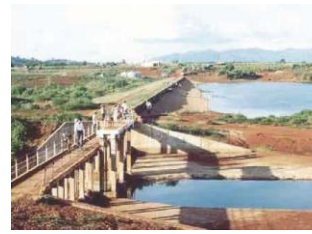
1. What are the drivers of increased water demand.

Diets and Water

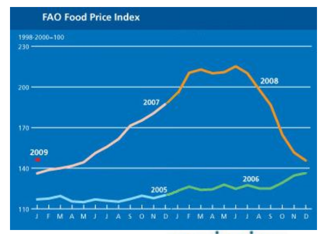
Between 2,000 and 5,000 liters per person per day – depending on type and amount of food eaten and how it is produced

Developed ←——————→ ***Developing***

1. The future: drivers, risks



- Population growth and demographic change
- Changed diets
- Global economic conditions
  - Decreased investment for 5-10 years
  - Return of urban workers to rural areas
  - Slowing export growth
  - Political instability
- Climate change (variability).
- Water resource development



We need to rethink the way we use and store water in the agricultural sectors

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2. Water and nutrients – inseparable resources for crop growth.

- **Water stress limits nutrient uptake.**
- **Soil water content is the single most important factor controlling the rate of chemical and biological processes.**
- **Water is the medium of transport of nutrients to roots, along slopes and in a river basin.**

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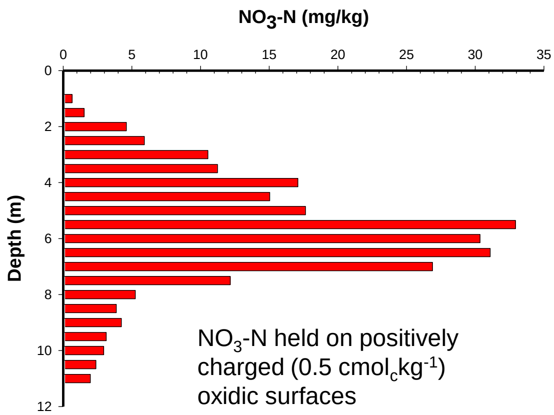
2. Role of water as a transport medium – the downside!



Rooting patterns of some tropical crops are unable to absorb applied NO_3 due to the large fluxes of water.

Total amount of NO_3 stored in profile under a sugarcane production system exceeds 2 tonne/ha

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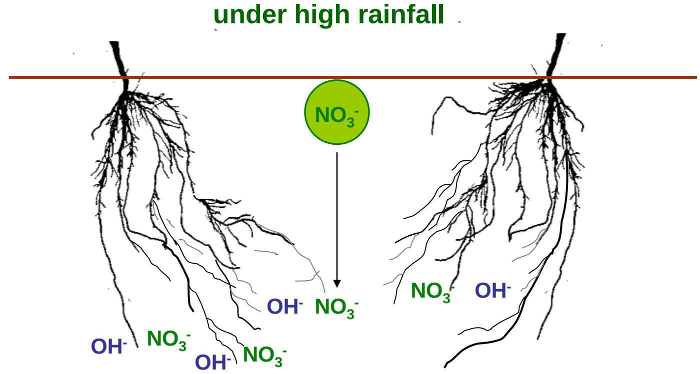
2. Role of water as a transport medium – the upside!

Deep and extensive root systems can enhance nutrient efficiencies under high rainfall



Leached nitrate taken up by roots result in a net excretion of alkalinity (OH^-) – soil pH increases

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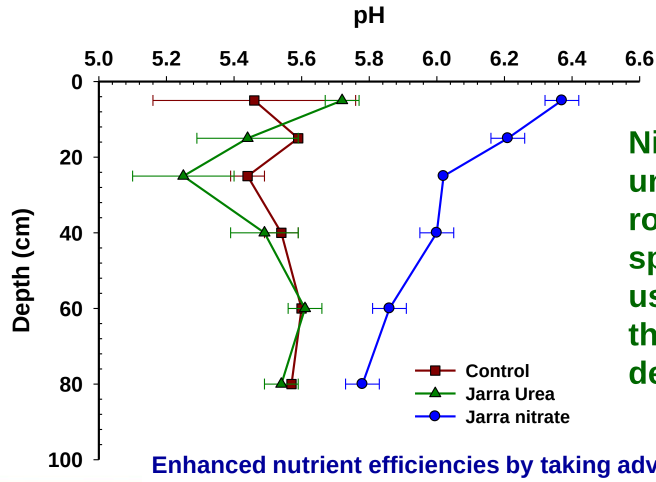
2. Role of water as a transport medium – the upside!



Nitrogen as nitrate under a deep rooted grass species can be used to change the soil pH to depth.

Enhanced nutrient efficiencies by taking advantage of water fluxes

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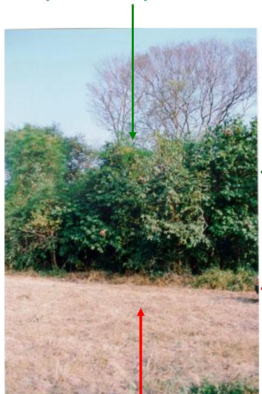
2. Soil degradation issues associated with land change.

Dipterocarp Forest



Long-term Agriculture

- ❖Species diversity
- ❖High biological activity
- ❖High productivity
- ❖High soil fertility and physical attributes

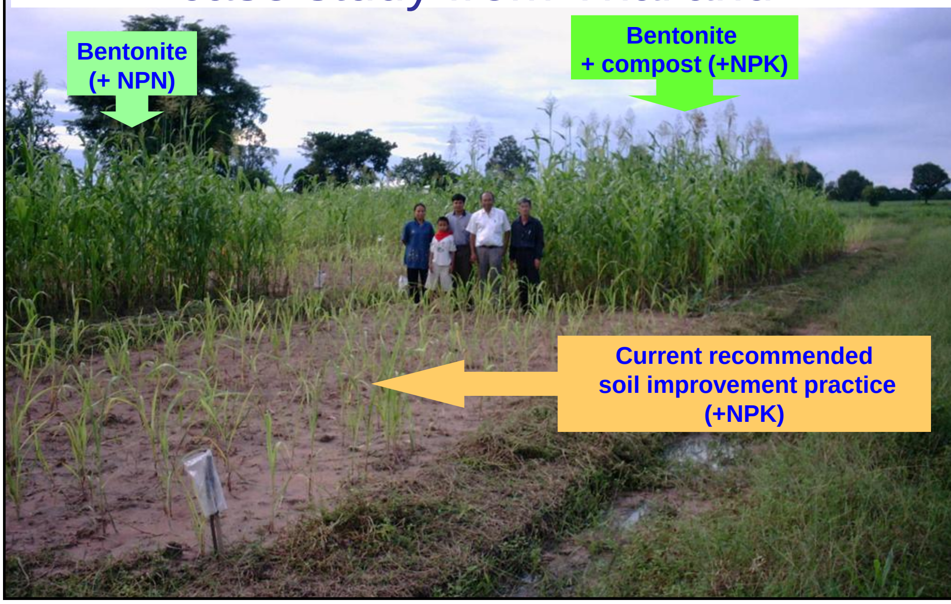
Aggrading system

Degrading system

- ❖Loss of nutrients
- ❖Loss of soil organic matter
- ❖Reduction in water holding capacity
- ❖Physical degradation (compaction)
- ❖Leaching losses and acidification

Improving water ar

2. Addressing soil fertility decline – a case study from Thailand.



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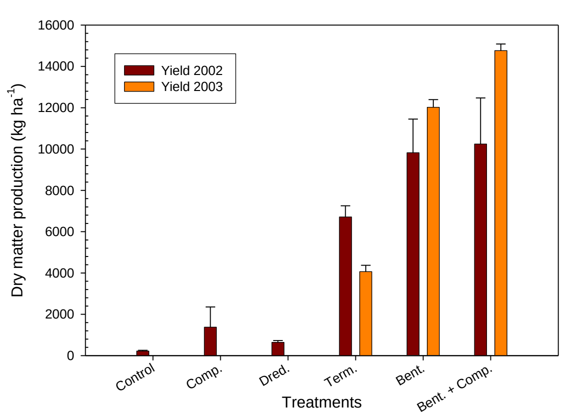
2. Addressing soil fertility decline – a case study from Thailand.



- Degree of degradation of these systems is extreme.
- Significant increase in productivity over 2 years to clay based amendments.
- Responses have **persisted** and **increased** in bentonite treatments.

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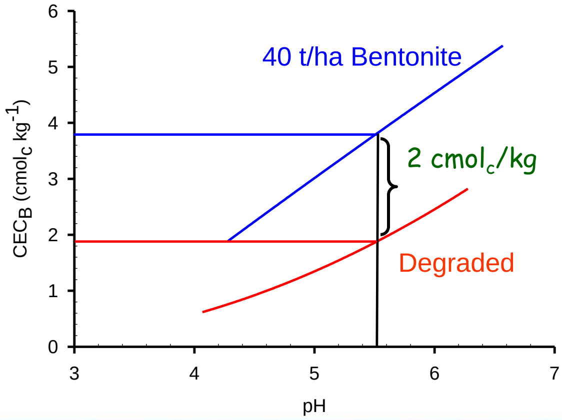
2. Charges in soil CEC associated with clay



Driver of response associated with increased charge generation through the addition of permanently charge clay.

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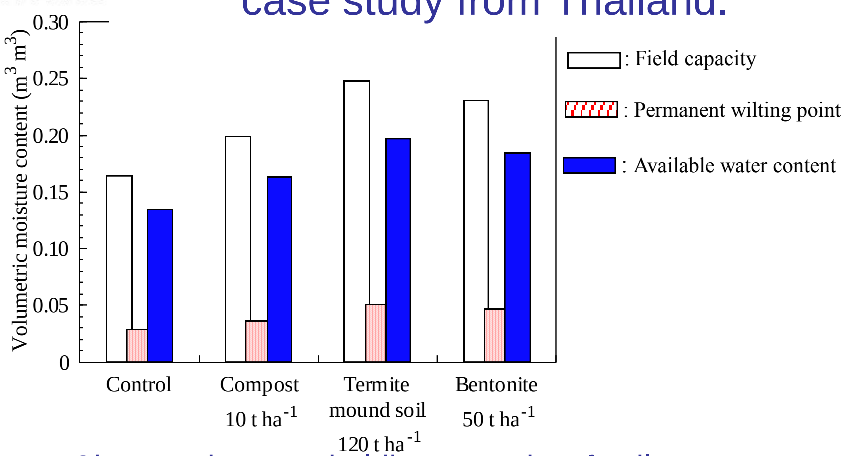
2. Addressing soil fertility decline – a case study from Thailand.



Changes in water holding capacity of soils – enough to prevent crop failure at critical periods

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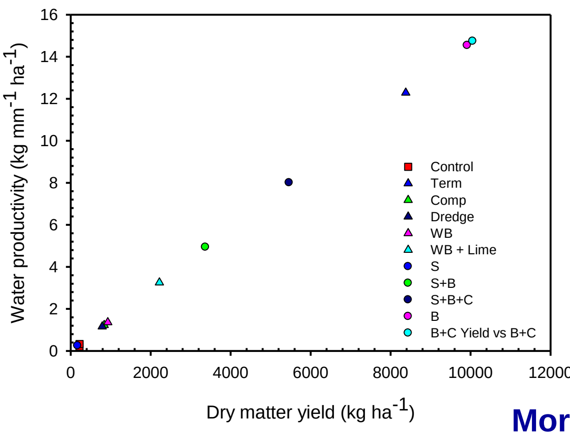
2. Addressing soil fertility decline – a case study from Thailand.



- Results clearly demonstrate the synergistic effect of **soil** (nutrients) and **water** productivity under rain-fed conditions.
- Changing soil characteristics and attributes have a significant impact on nutrient and water productivity.

More crop per drop and greater nutrient efficiency

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2. Changing the way nutrients are delivered

Bentonite Substrate (-)

Ammonium NH_4^+

Calcium Ca^{2+}

Magnesium Mg^{2+}

Potassium K^+

Hyrotalcite (HT) Substrate (+)

Nitrogen NO_3^-

Phosphorus HPO_4^{2-}

Sulfur SO_4^{2-}

Designer Fertilizers

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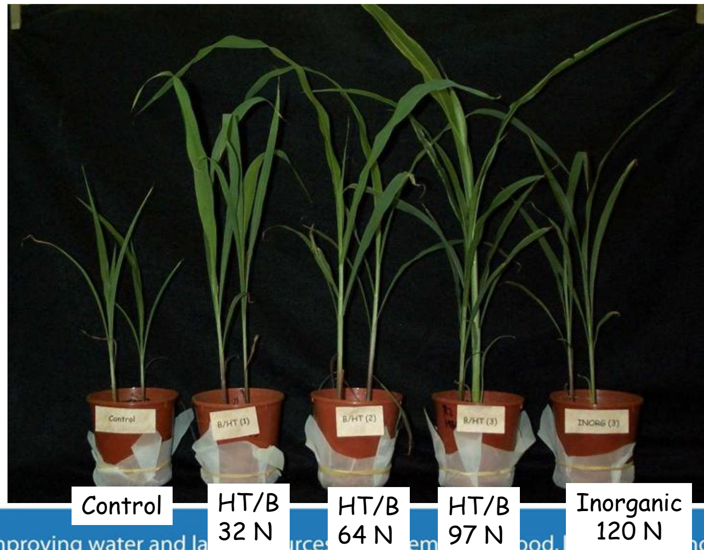
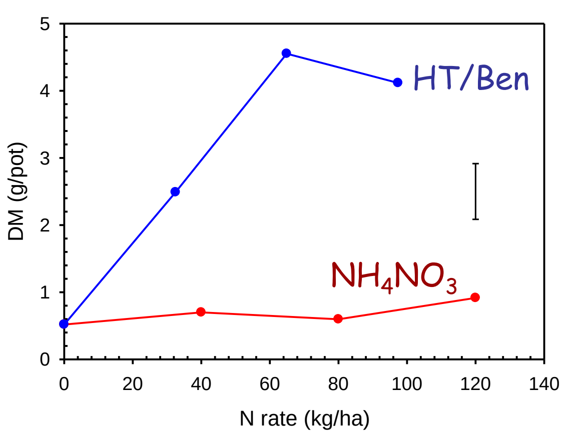
2. HT and bentonite as a nitrogen source



2. HT/Bentonite as a nitrogen source



By adding nutrients in an exchangeable form greater nutrient efficiencies are achieved under leaching conditions.

(Gillman and Noble)

3. Future Opportunities / Challenges

- Need to rethink the way we use water in agriculture – business as usual will not be sufficient to meet future demands.
  - Rainfed systems are a particular challenge.
- Nutrient efficiencies are generally low. The technology of delivery does not match the skills of the majority of farmers.

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3. Future Opportunities / Challenges

- Need to rethink the manner in which crop nutrients are delivered:
  - Closing the nutrient loop – organic/inorganic nutrient delivery platforms based on recycling wastes.
  - More efficient and conservative nutrient delivery platforms are required.
- Do not forget small producers – they will be critical in meeting future food demands.

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