Agricultural development in northern Australia

Cropping for ~120 years, expanded last 50 years

- Ancient soils with low phosphorus, zinc and soil organic carbon
- 500 - 650 mm summer dominant rainfall
  - Crop dependence on stored soil water (winter <80%; Summer <30%)
  - Zero-tillage used to capture rain with stubble
  - Crops only use 20-40% of rainfall (evaporation 60%)
Fertility decline in aging soils and systems

Soil organic carbon and nutrients are still declining
RDE on overall systems performance

<30% crop sequences reaching 75% water-limited yield potential

- **Strategies to improve farming system performance**
  - Crop intensity (increase, decrease)
  - Crop diversity (increase)
  - Increased legume crops
  - Increased nutrient supply
  - Boosting soil fertility (pasture, manure, compost)

- **System performance and soil health metrics include**
  - Profitability per hectare ($/ha/year) and per mm rainfall ($/mm/year)
  - Soil organic carbon (organic matter)
  - Nutrient balances (N, P, K, Zn...)
  - Pathology, weeds
  - Costs, cashflow, labour etc
Emerging challenges for modern cropping systems

Gross margin (GM) varied by $200-500 /ha/year at each site
Cover crop: surprise results from an old idea

Cover crops protect against erosion in low-cover fallows, build organic matter...even boost net fallow water storage

Shows surface moisture 3 days after 30 mm rain

Effects last for ~21 days to store extra rain
Terminate cover crops before they use too much water!

Cost: 40-60 mm water in low-cover years
‘Predicted’ recovery or gain in 70% of years (mean +15 mm)
Deep placement of fertiliser for immobile nutrients

- Crop residues and fertilisers returned to soil surface (0-10 cm)
- Immobile nutrients stratified (0-10 cm - high; 10-30 cm - low)
- Fertiliser at ~20 cm is in moist soil for longer in dryland systems
- Major growth and yield responses
Deep-P yield responses for at least 5-10 years

This example:

- Costs recovered in the first year
- Still responding after six years (42% overall)
Simple agronomy for pasture legume establishment

- Legumes can double animal production, but over-sowing legumes into established pastures usually fails.
- Competition is usually too high for young seedlings. Increased sowing rates just loses more money.
- Simple agronomy with fallowed strips boosts establishment dramatically.