

Economic perspectives on nitrogen in farming systems

David Pannell

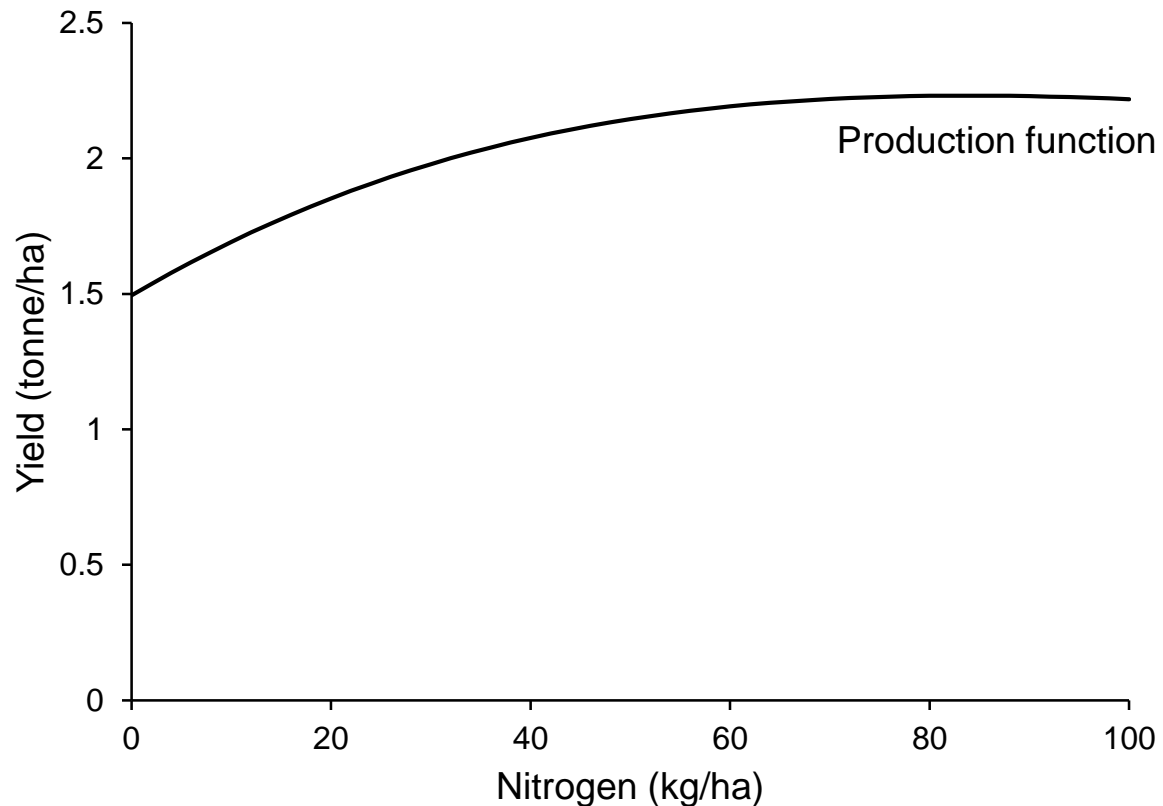
GRDC Grains Research Update, 26-27 February 2018

What's new?

- Bill Bowden highlighted some of the issues I'll be talking about decades ago
- Worth being reminded
- Never got picked up by GRDC
- Still see fertiliser recommendations that ignore economics
- Implications for variable-rate technology

Optimal nitrogen rates

- What rate of N fertilizer would maximise a farmer's profit?

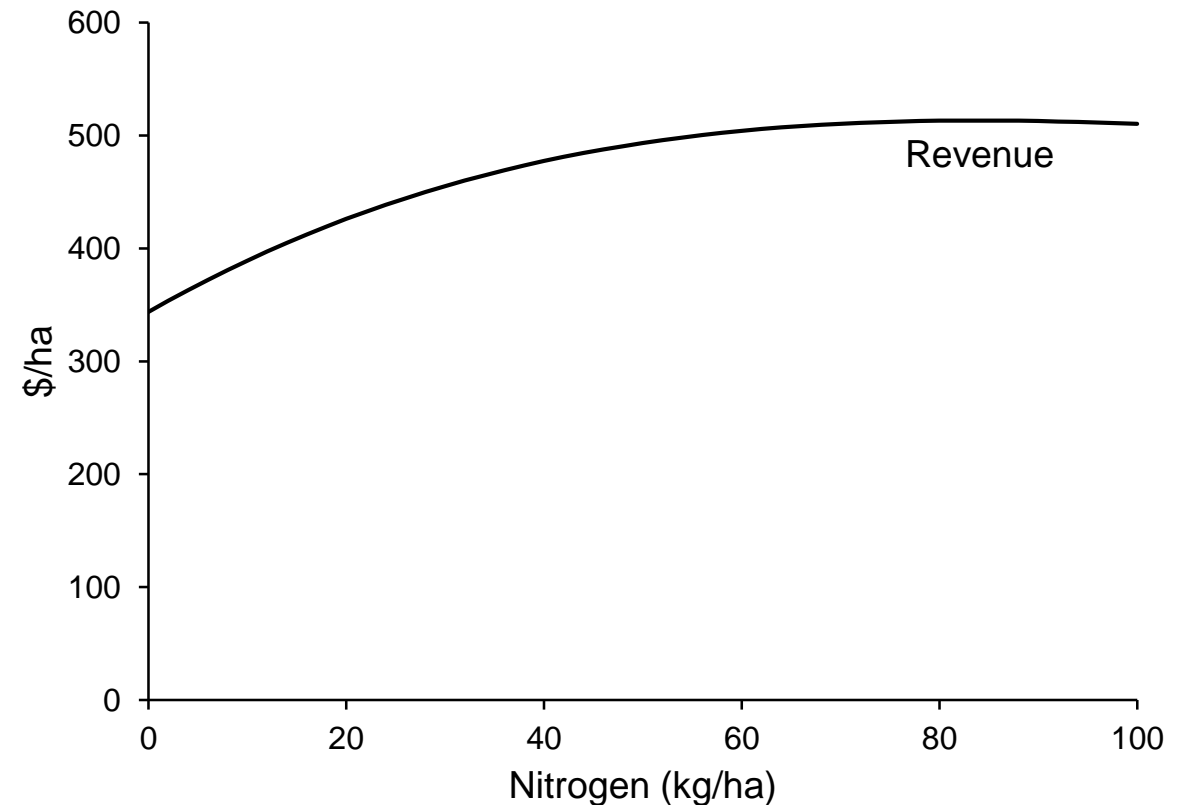
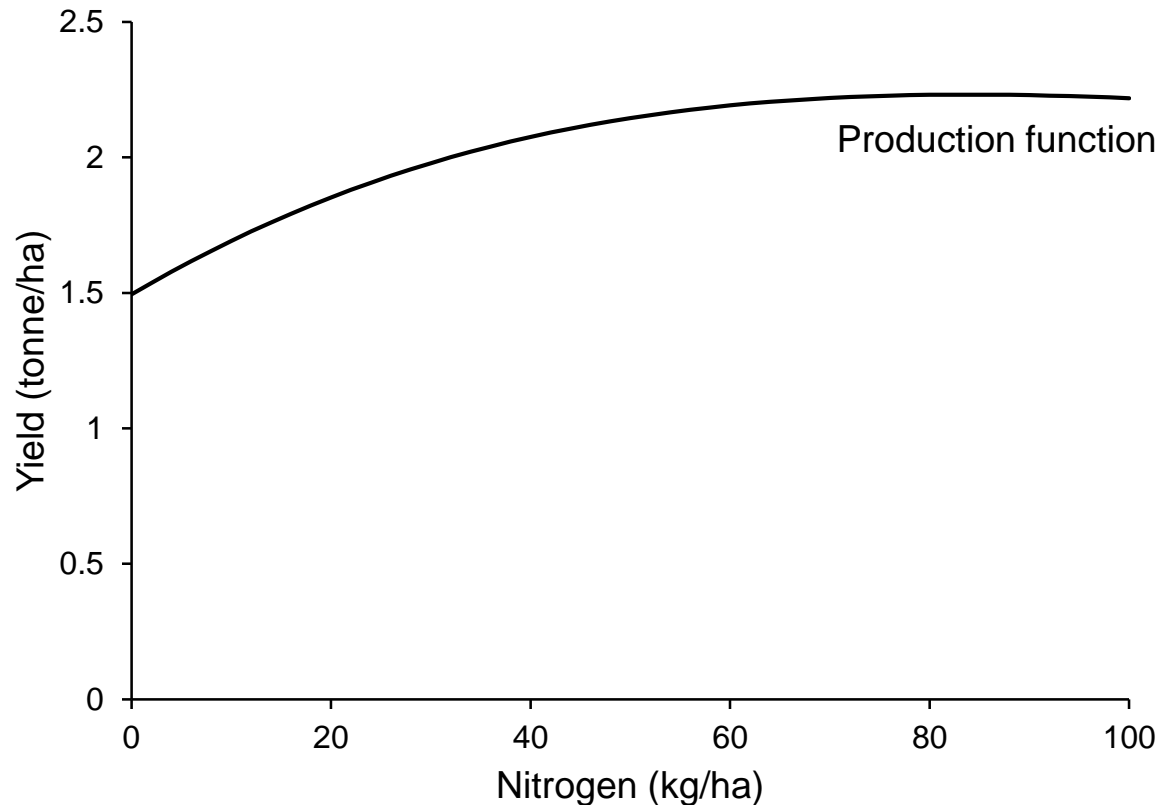


Context

Wheat after cereal
Shallow sandy loam over clay
Central wheat belt region
Western Australia

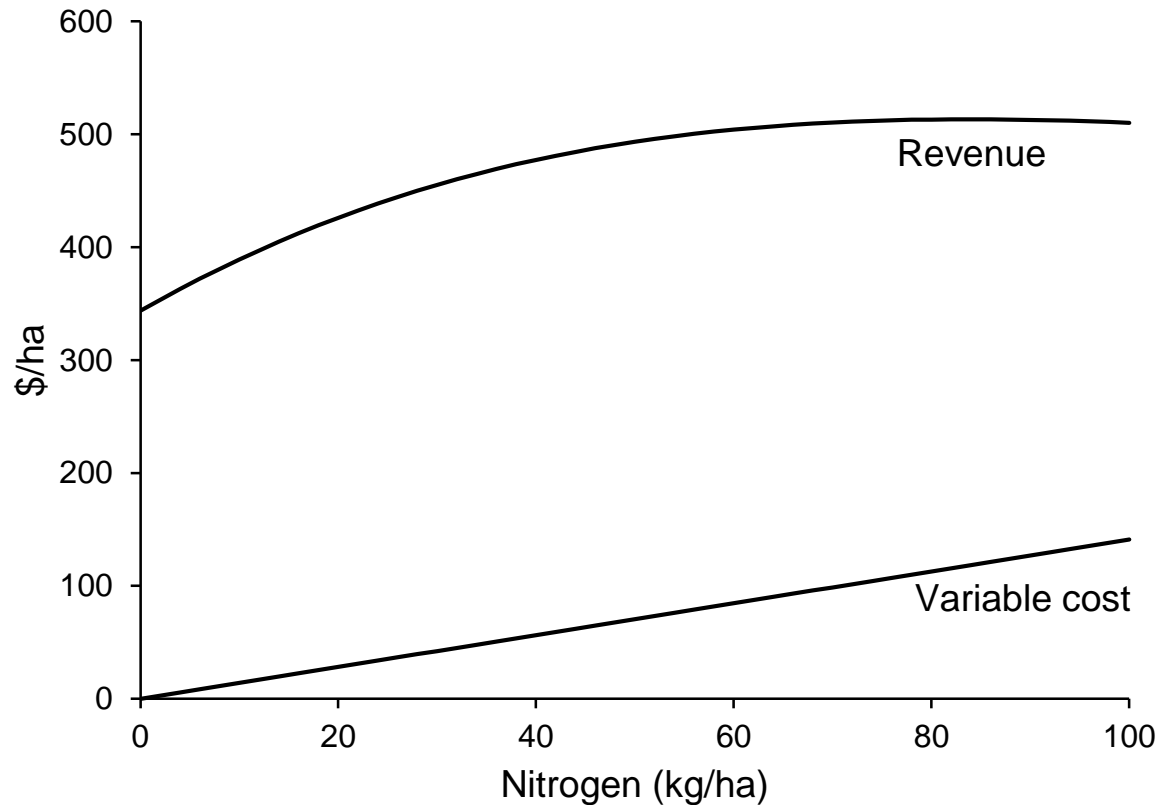
Optimal nitrogen rates

- What rate of N fertilizer would maximise a farmer's profit?



Optimal nitrogen rates

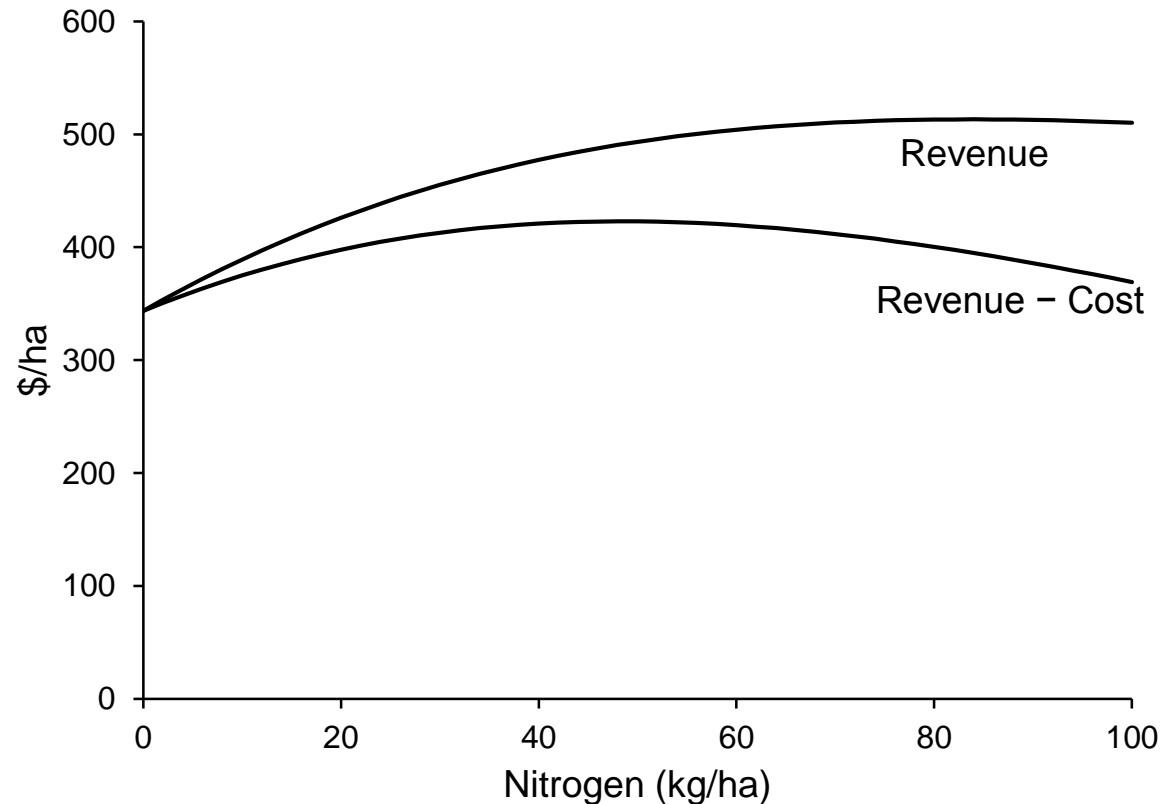
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Subtract cost from revenue at different N rates to get profit at each N rate

Optimal nitrogen rates

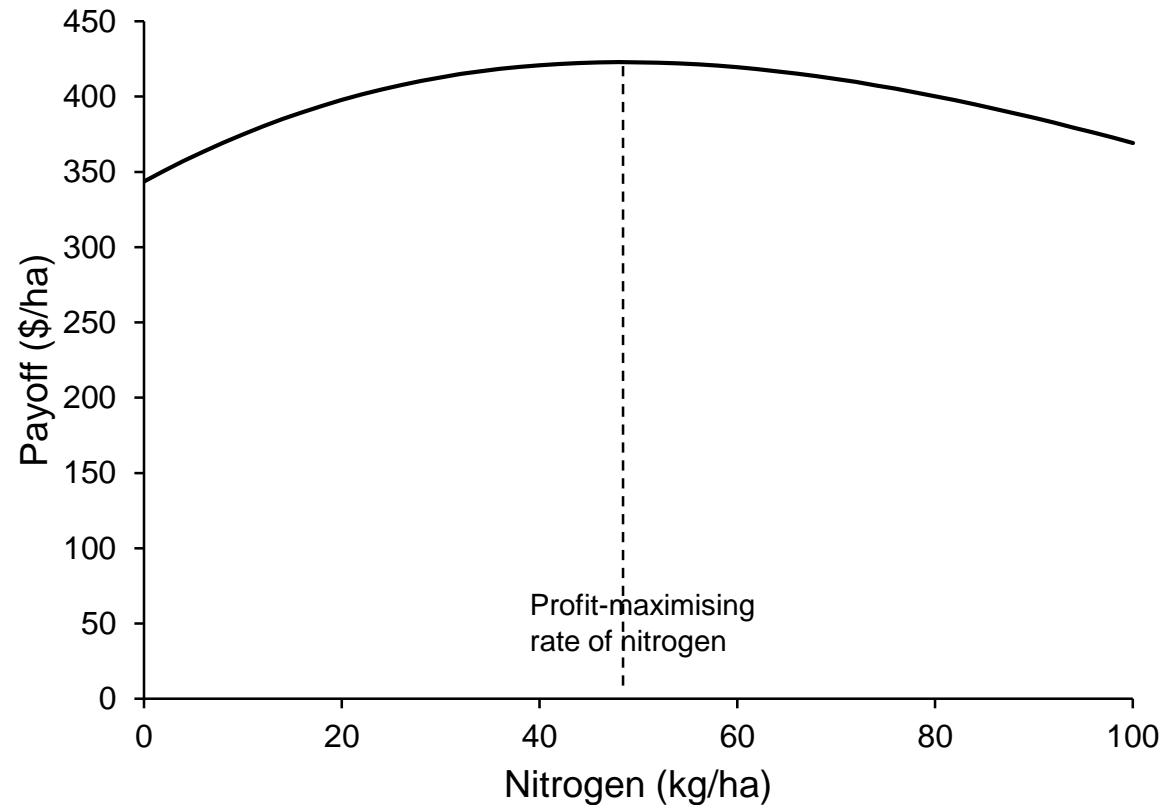
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Optimal nitrogen rates

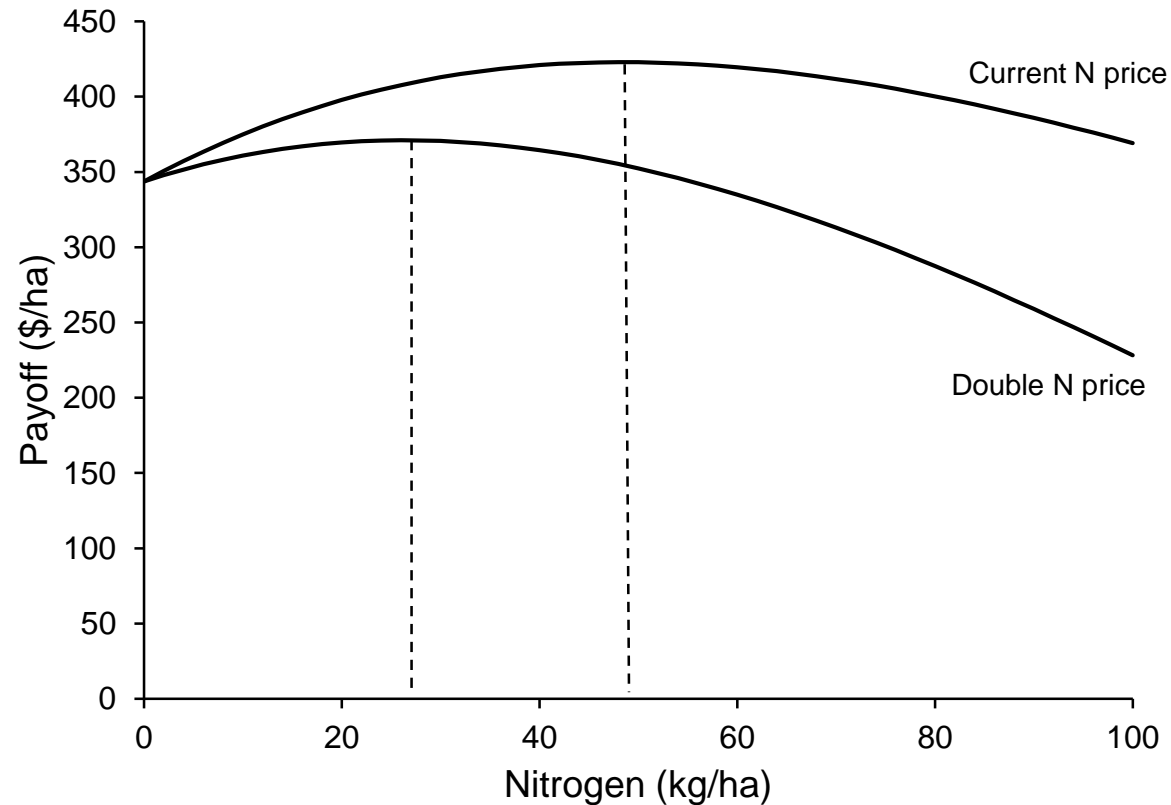
- What rate of N fertilizer would maximise a farmer's profit?



N rate that maximises profit is less than the rate that maximises yield.

Optimal nitrogen rates

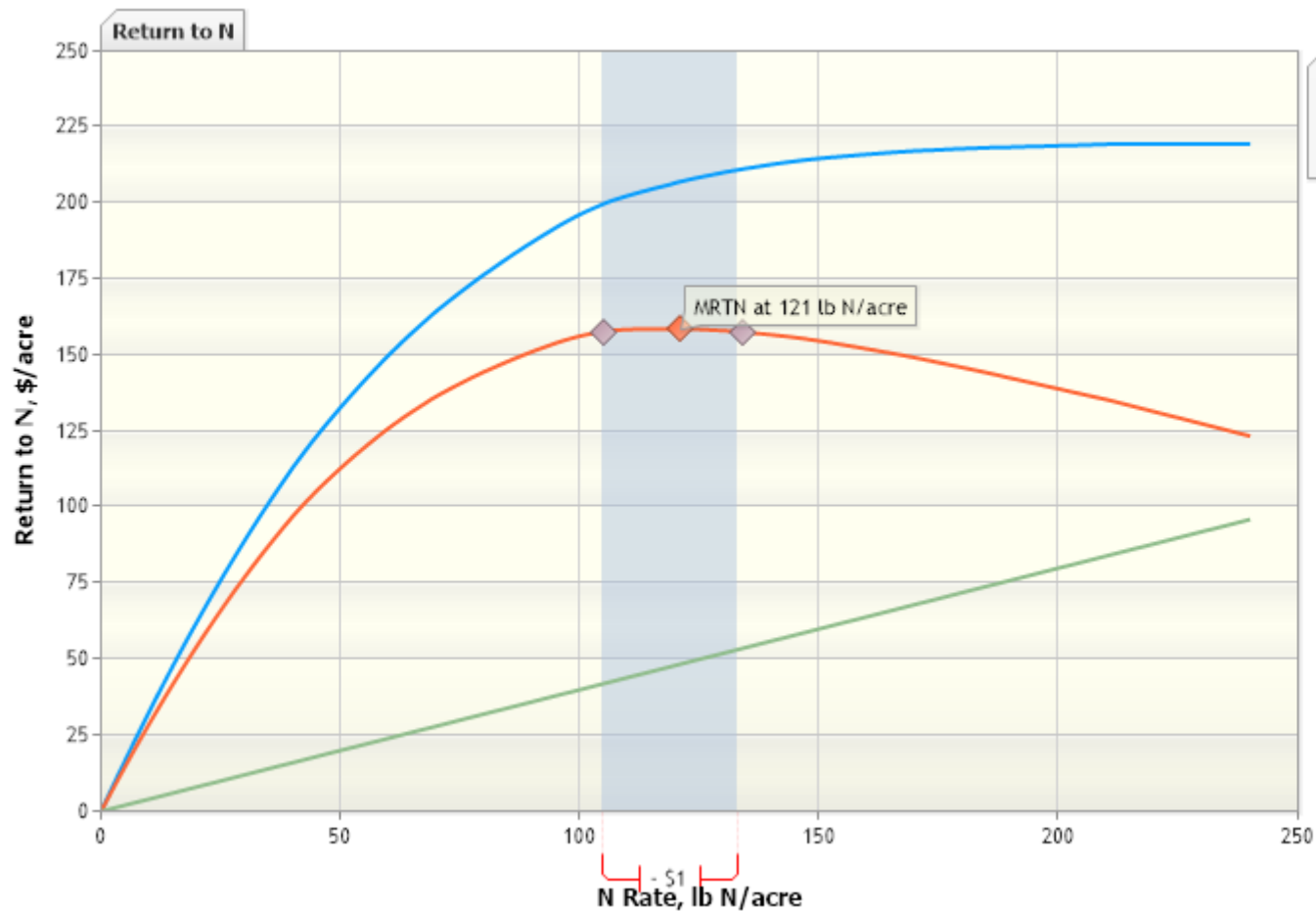
- What rate of N fertilizer would maximise a farmer's profit?



The higher the price of N, the lower the optimal N rate

The higher the grain price, the higher the optimal N rate

Online system in the US



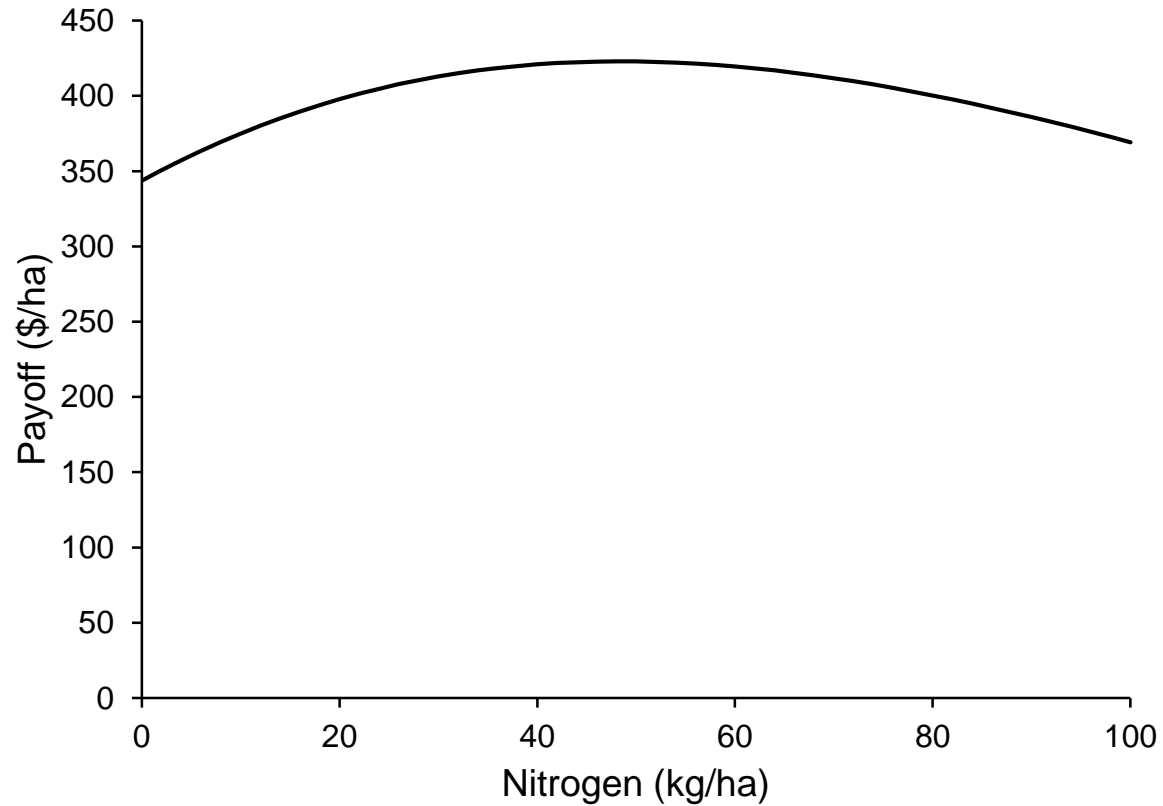
Rates and Charts

State: Wisconsin
Soil Type: HYP Soils
Number of sites: 51
Rotation: Corn Following Soybean

Nitrogen Price (\$/lb): 0.40
Corn Price (\$/bu): 4.00
Price Ratio: 0.10

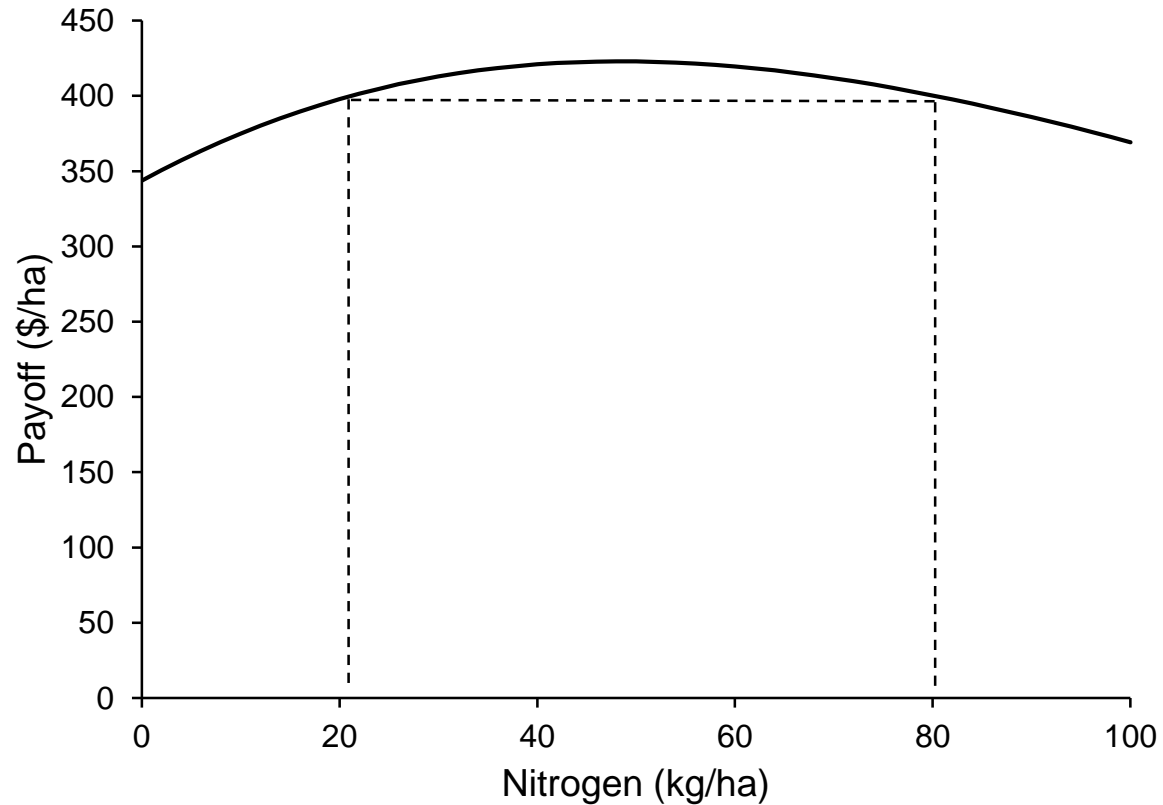
MRTN Rate (lb N/acre):	121
Profitable N Rate Range (lb N/acre):	104 - 133
Net Return to N at MRTN Rate (\$/acre):	\$158.72
Percent of Maximum Yield at MRTN Rate:	98%
Anhydrous Ammonia (82% N) at MRTN Rate (lb product/acre):	147
Anhydrous Ammonia (82% N) Cost at MRTN Rate (\$/acre):	\$48.40

Flat payoff functions



- What range of N application rates would give payoffs within 5% of the maximum payoff?

Flat payoff functions

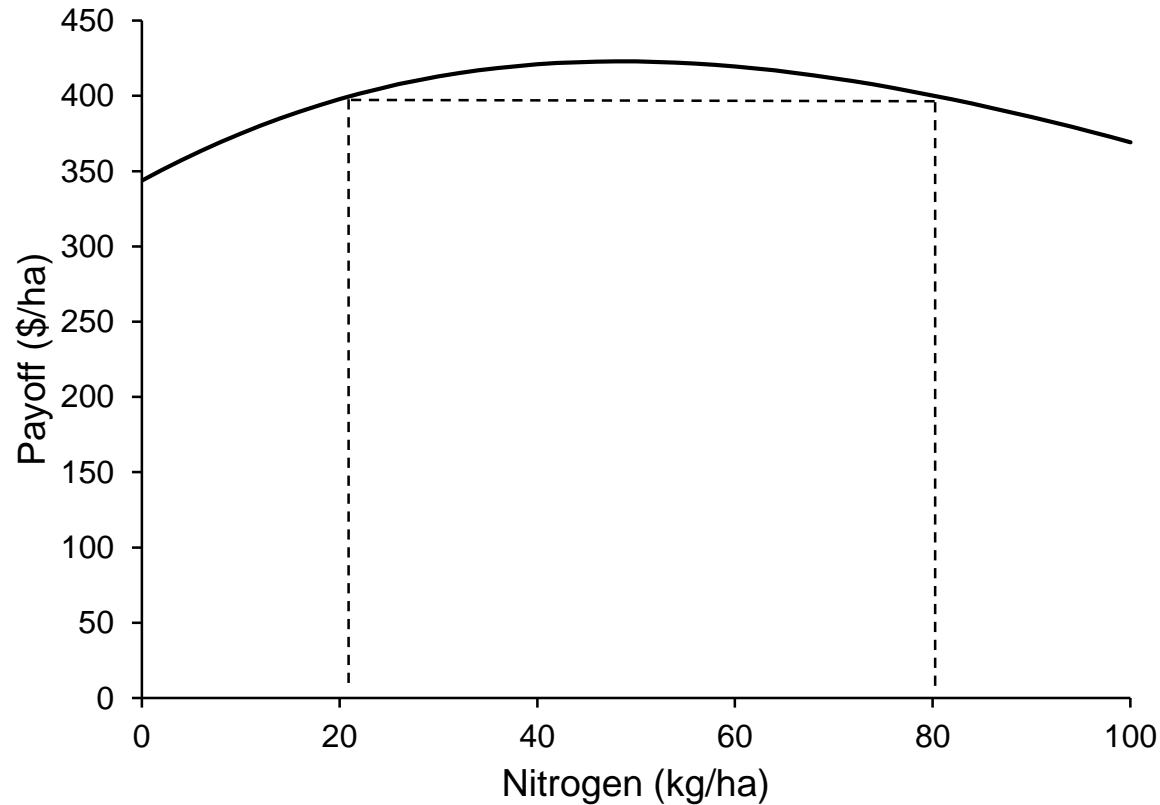


- 22 to 80 kg/ha!!
- Varying the N rate within the vicinity of the optimum doesn't make a big difference to profit

Flat payoff functions

- This result is common/normal
- The width of the flat area varies, but it's often pretty wide
- Not widely appreciated, but it's not a new insight
- Jardine (1975) told agronomists about it and “observed such reactions as complete disbelief, blank incomprehension, incipient terror, and others less readily categorized”.

Flat payoff functions: implications

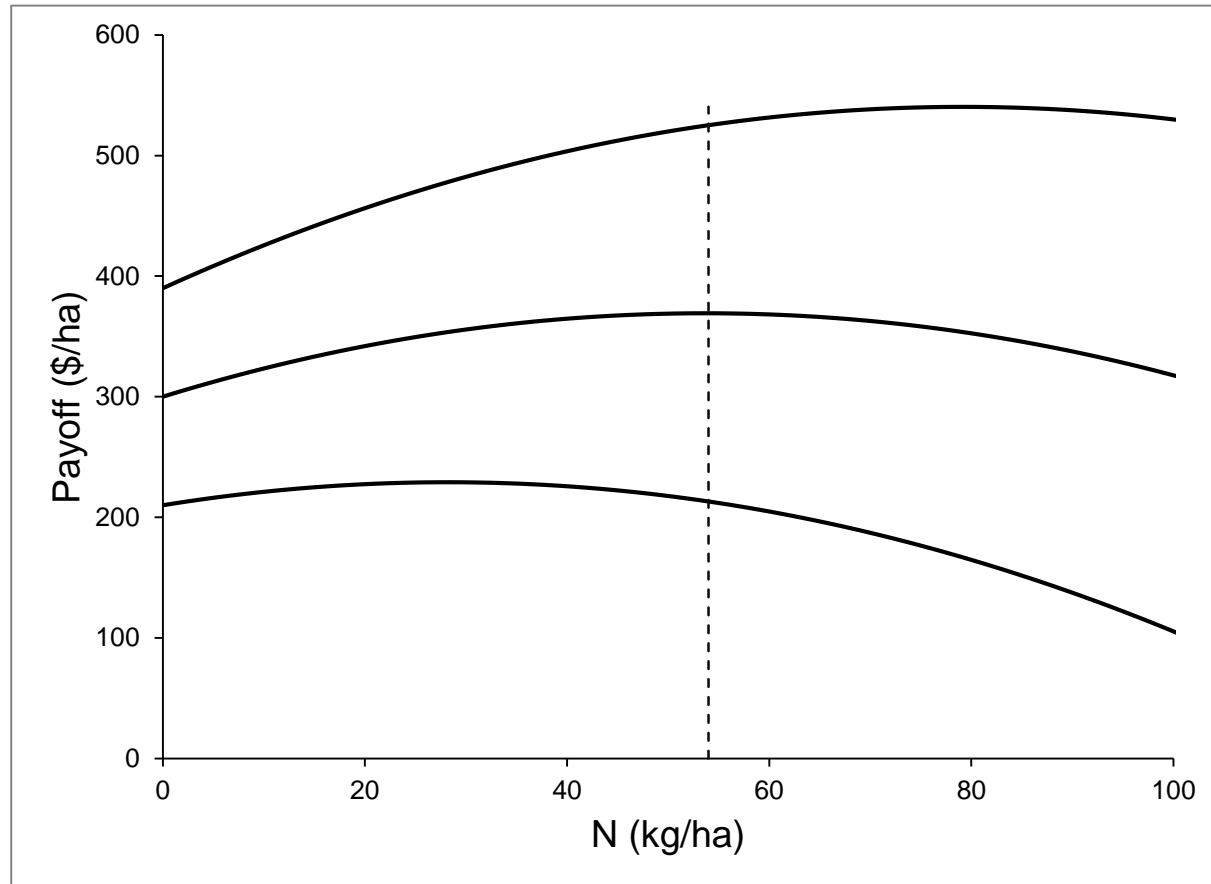


- Farmers have flexibility – can adjust rates for other reasons (e.g. risk) at low financial cost
- No need to be too fussy about getting the N rate precisely correct

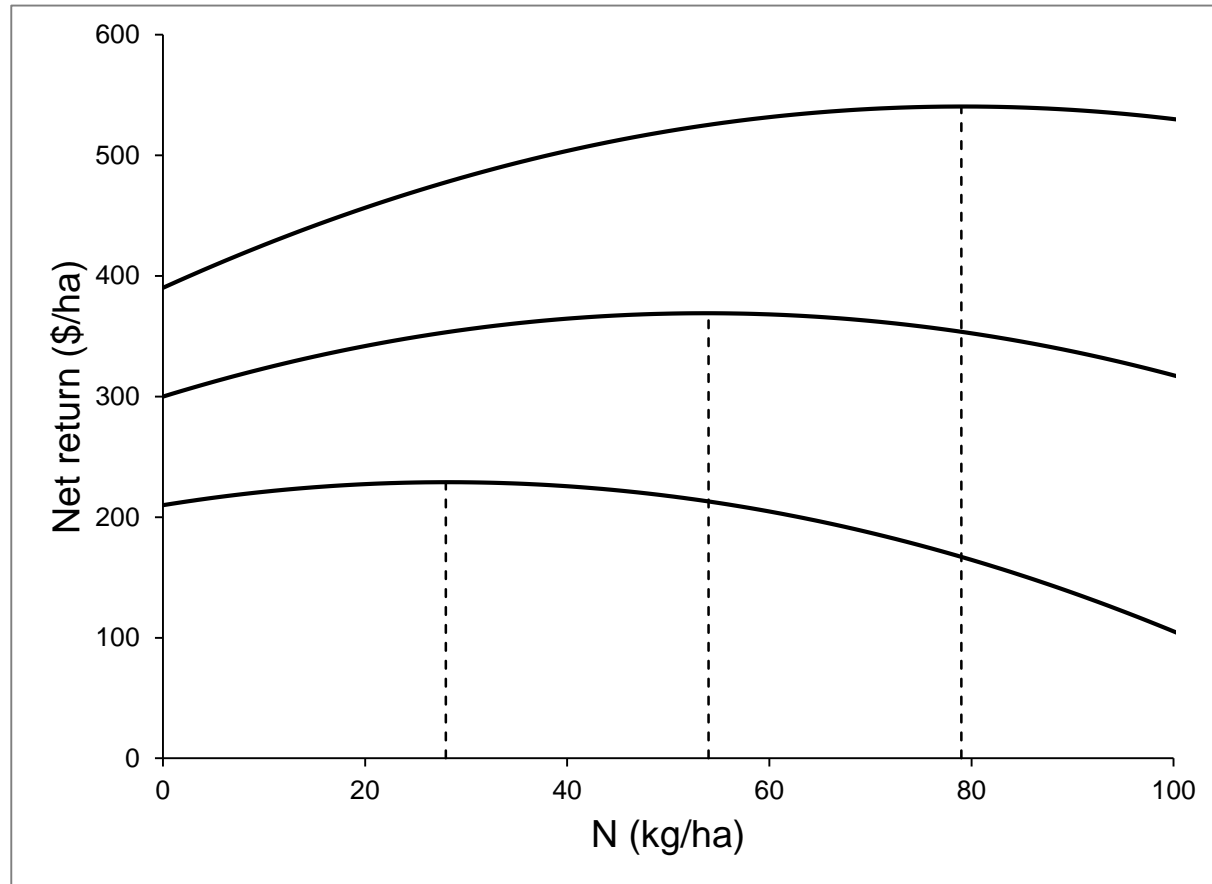
Flat payoff functions: implications

- Precision agriculture technologies that adjust rates not very beneficial to farmers

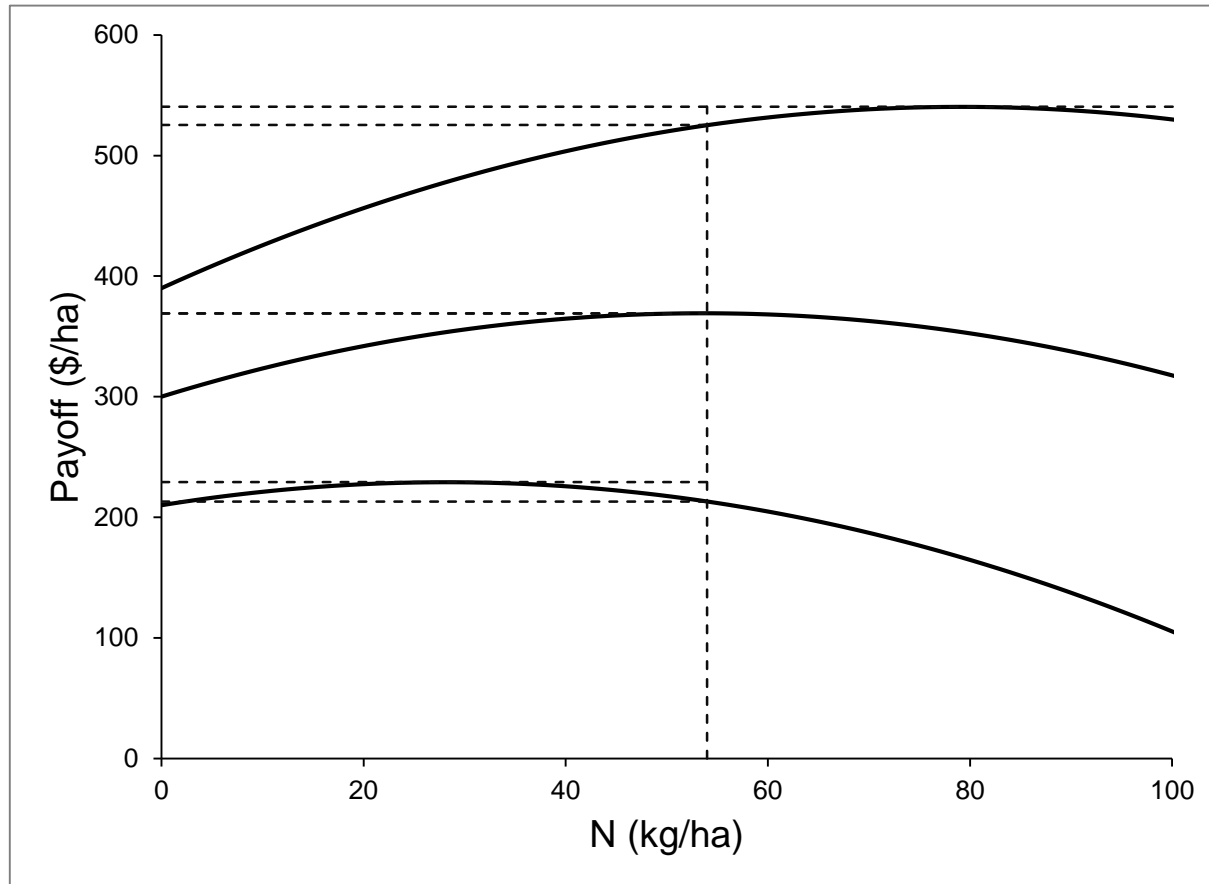
Paddock with high, medium and low yield patches



Paddock with high, medium and low yield areas



Profit gain from precision



Even quite large adjustments in N rates result in only small increases in profit.

Benefits from site-specific variable-rate technology are generally small

The technology needs to be cheap

Flat payoff functions: implications

- If farmers are over-fertilising, it probably costs them very little
- Little financial incentive to cut back
- But also no financial benefit from over-fertilising
- Could cut below recommended rate at low cost

Flat payoff functions: implications

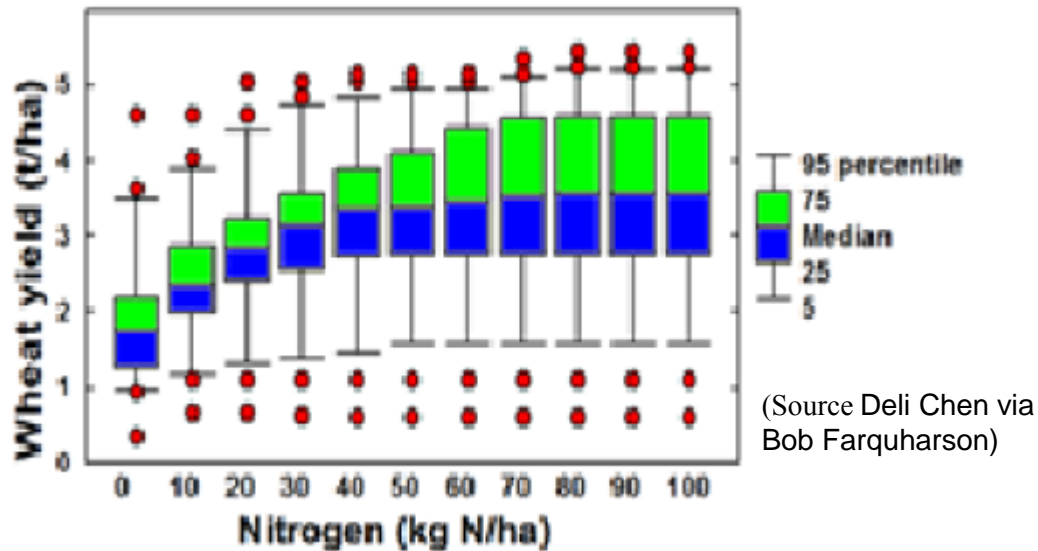
- Research or extension to recommend N rates is often not very beneficial to farmers (unless they are off the flat area)
- Giving a specific rate recommendation is ridiculous
- What matters is where the flat range is

N rates and Risk

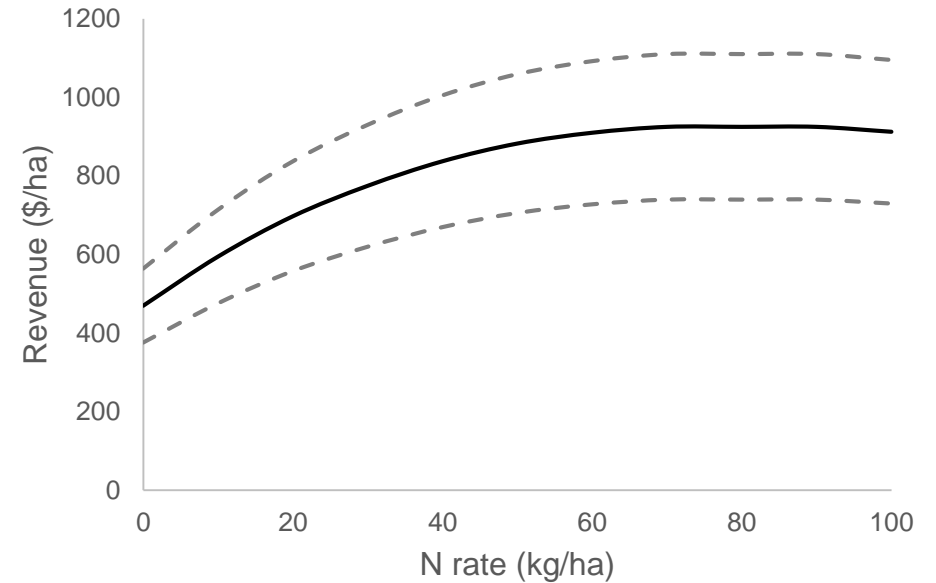
- Farmers vary in their attitudes to risk
 - A few a risk seekers
 - Most prefer to avoid risk if that's not too costly
- How does N affect risk

Are high N rates more risky or less risky?

- Some suggest $\uparrow N \Rightarrow \downarrow \text{risk}$
- Evidence shows the opposite



Wheat yield responses to applied N fertiliser, Wagga Wagga



Contribution of price risk to overall revenue risk

What does it mean for N rate?

- If risk = unpredictability of profit
- Increasing N rate does not reduce risk
- Near the profit-maximising rate, $\uparrow N$ leads to slight \uparrow risk
- Avoiding risk means reducing N rate, but usually not by much
- Still on the flat part of the payoff curve

- If you can predict high yields, higher N rate makes sense
- But not as an insurance policy

Conclusion

- N rate that maximises profit is less than rate that maximises yield
- Flat payoff functions are normal for fertiliser
- They mean that precision variable-rate technologies are not very beneficial
- Applying extra N is not a good insurance policy

Free online course: “Agriculture, Economics and Nature”



Introduction

- Course covers agricultural production and its interaction with the environment
- Economic perspective
- Enhances our understanding



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