Carbon Conference

Use of Biofertilisers to reduce carbon footprint in crop production and increase soil carbon levels

Outline of talk

1. Overview of microbial biofertilisers
2. Interactions between N fertilisers and soil carbon and carbon footprint of crops
3. Biofertiliser trial results
4. Carbon footprint audit and carbon offsets

Microbial biofertilisers – what are they?

MBs supply beneficial bacteria to crops

- Bacteria can live in plants as endophytes
- Bacteria can colonise the rhizosphere

Mutual benefits:

- Bacteria supply benefits to crop plants
- Crop plants supply carbohydrates to bacteria

Relevance to soil carbon?

- Fix N
- Induce larger root mass
- Allow different types of farming systems to be profitable

Microbial biofertilisers can enable high crop yields with reduced N fertiliser application

How?

1. If correct species are used N_2 is fixed from the atmosphere for use in the crop

$$\mathbf{N_2 + 8H^+ + 8e^- \longrightarrow 2NH_3 + H_2}$$

= a steady supply of nitrogen for crop

2. Improved root growth
3. Improved soil health – develop a vigorous soil microflora

Note: the relevance of reducing N fertiliser using TwinN or NitroGuard to maintain high yields is that N fertiliser has a very high C footprint

- TwinN produces **larger root systems** due to auxin synthesis (IAA)
- Greatly increased root hair density gives better nutrient capture
- **Improved capture of any applied N (increased Nitrogen Use Efficiency is an important mechanism of** TwinN **in crops)**

Breakdown of Carbon footprint of N fertilisers

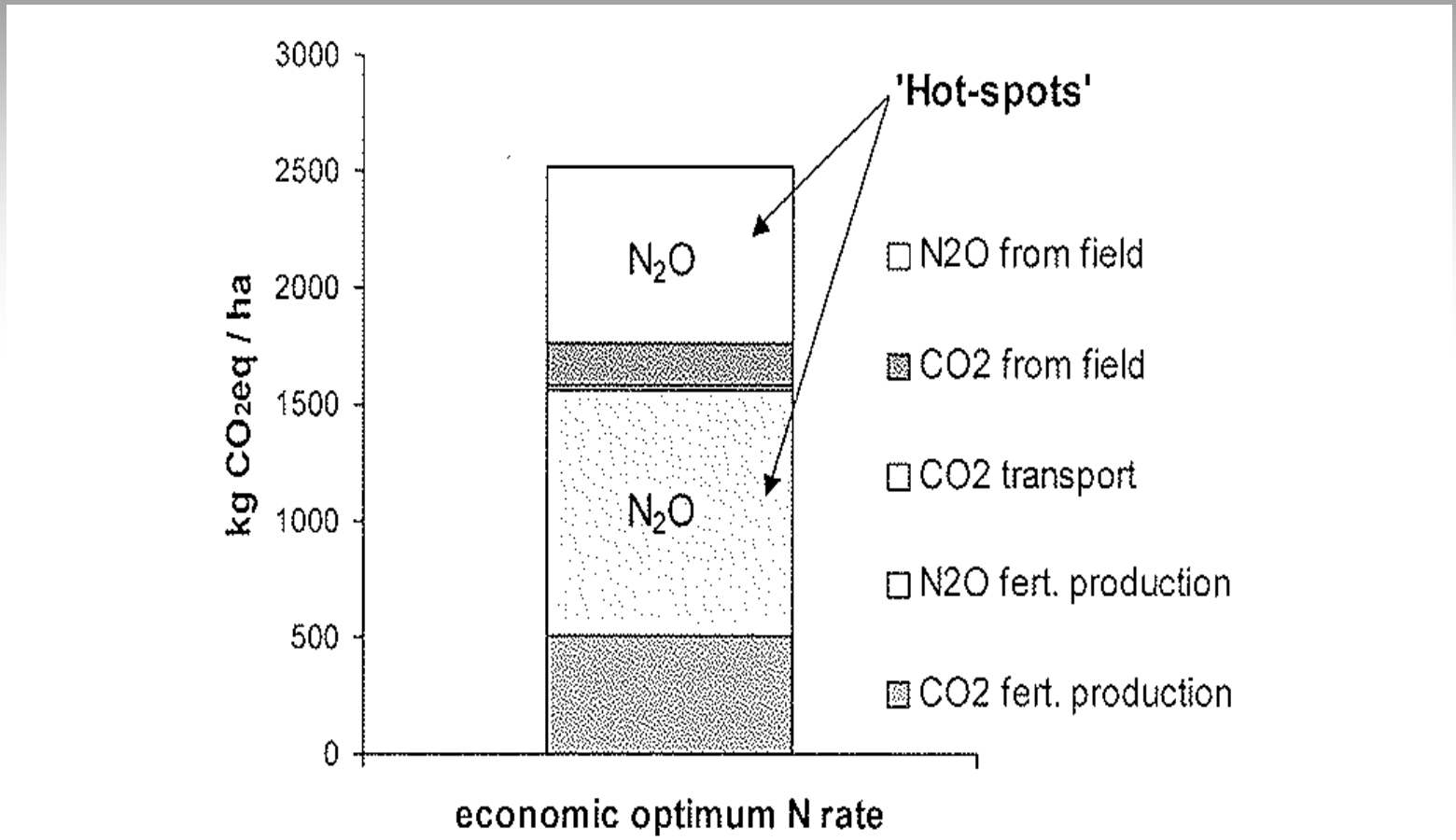


Figure 9: *Carbon footprint of wheat production in kg CO_2eq per ha separated into different greenhouse gases and their sources.*

Source: International Fertiliser Society Conference, Proceedings 639, 2008

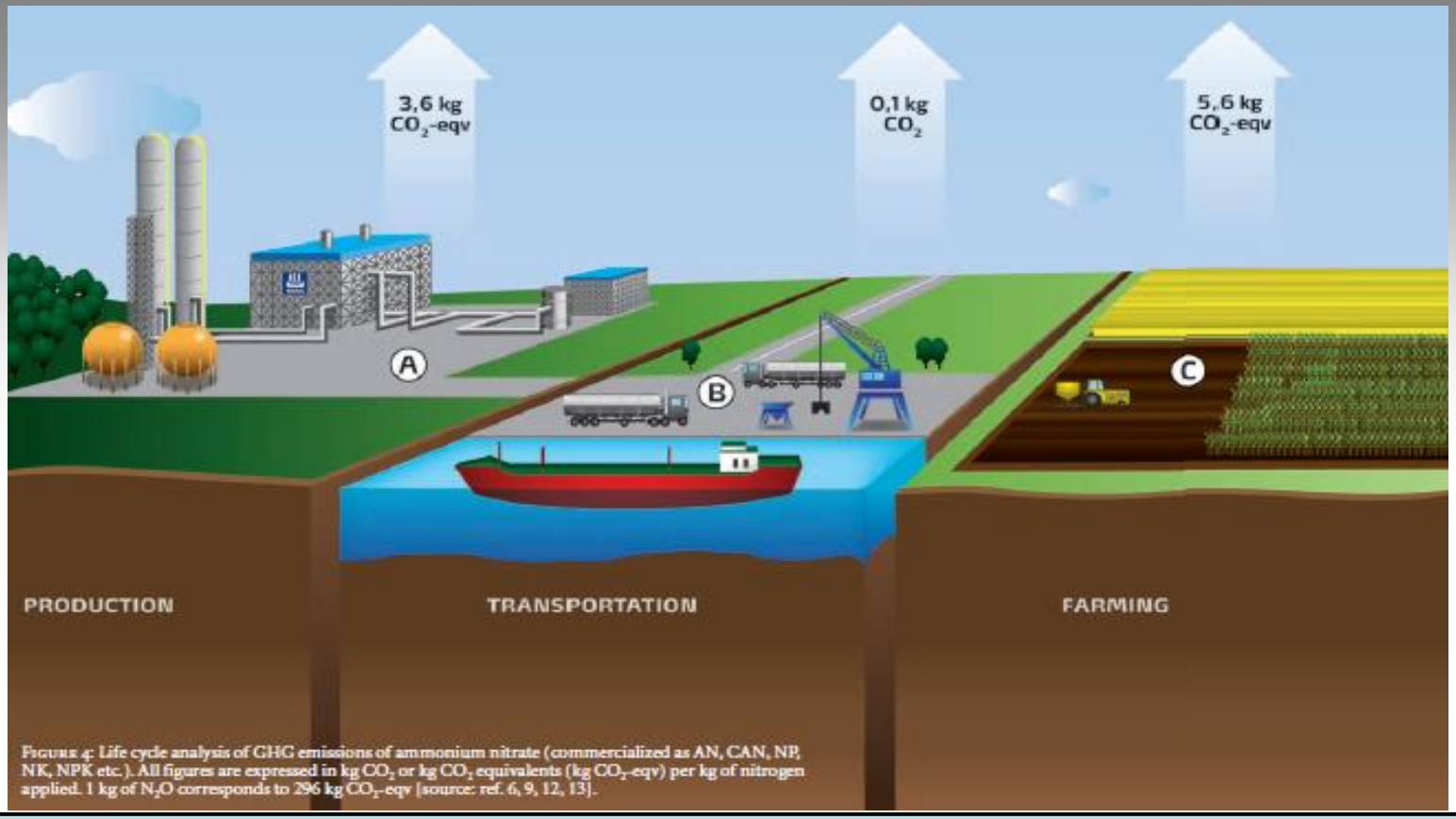


FIGURE 4: Life cycle analysis of GHG emissions of ammonium nitrate (commercialized as AN, CAN, NP, NK, NPK etc.). All figures are expressed in kg CO_2 or kg CO_2 equivalents (kg CO_2-eqv) per kg of nitrogen applied. 1 kg of N_2O corresponds to 296 kg CO_2-eqv (source: ref. 6, 9, 12, 13).

Total CO2 eq per kg of N supplied = 9.3 kg CO2 eq/kg for ammonium nitrate
Source: Yara International publication, 2010

Total CO2 eq per kg of N supplied for urea (production and field use)
European average 2006 10.9 kg CO2 eq
Potential with full BAT 10.47 kg CO2 eq

Source: International Fertiliser Society Conference, Proceedings 639, 2008

C footprint of wheat at different N fertiliser rates

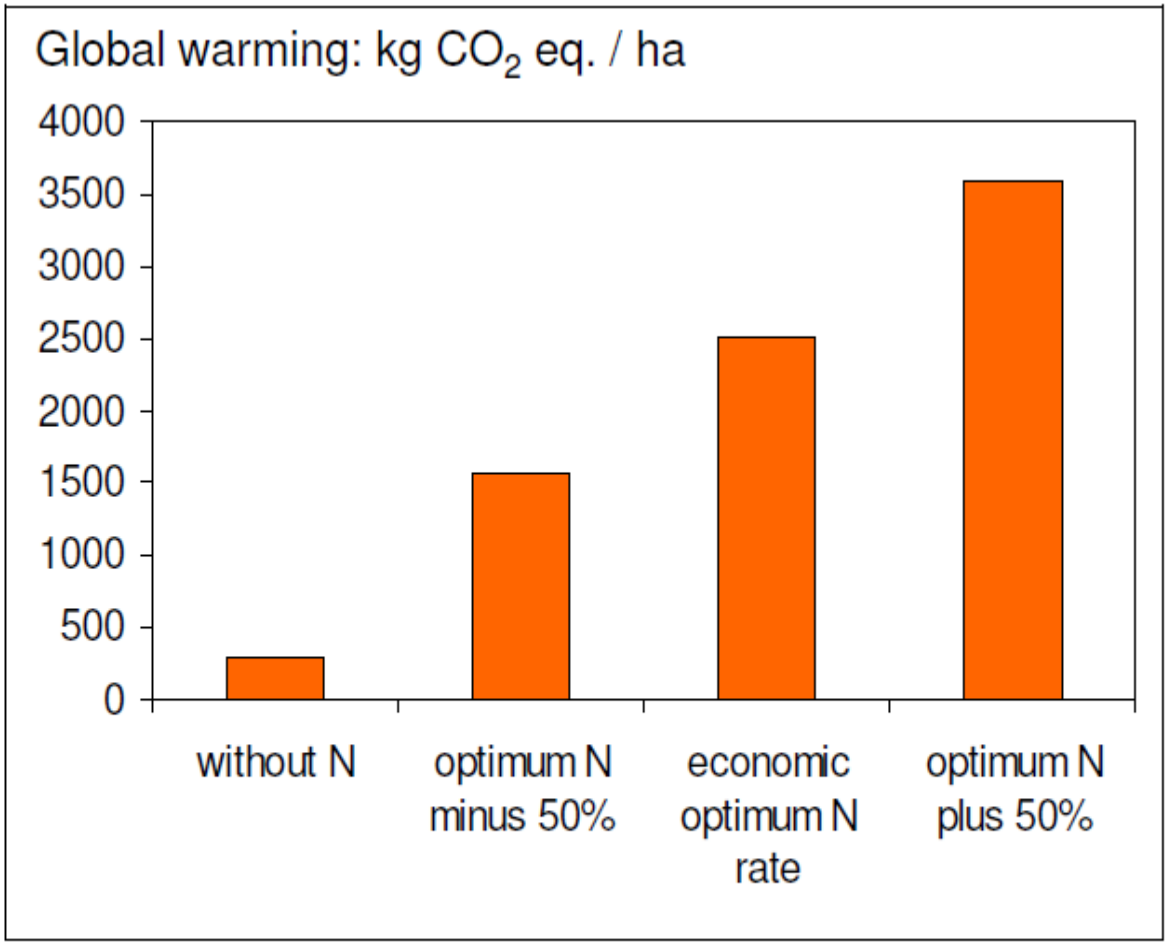


Figure 3: Greenhouse gas emissions of wheat production in kg CO_2eq per ha (including production and transport of farming inputs) at different N fertilizing intensities

Source: Proc Int Plant Nut Colloq. UC Davis 2009

Effects of N fertilisers on soil carbon levels

Summary

- In some low fertility situations low to moderate application of N fertiliser can increase soil C

- In soils with normal fertility and C levels long term or excessive use of N fertilisers will reduce soil C levels

The Morrow plots – a landmark study of effects of long term N fertiliser effects on soil organic matter

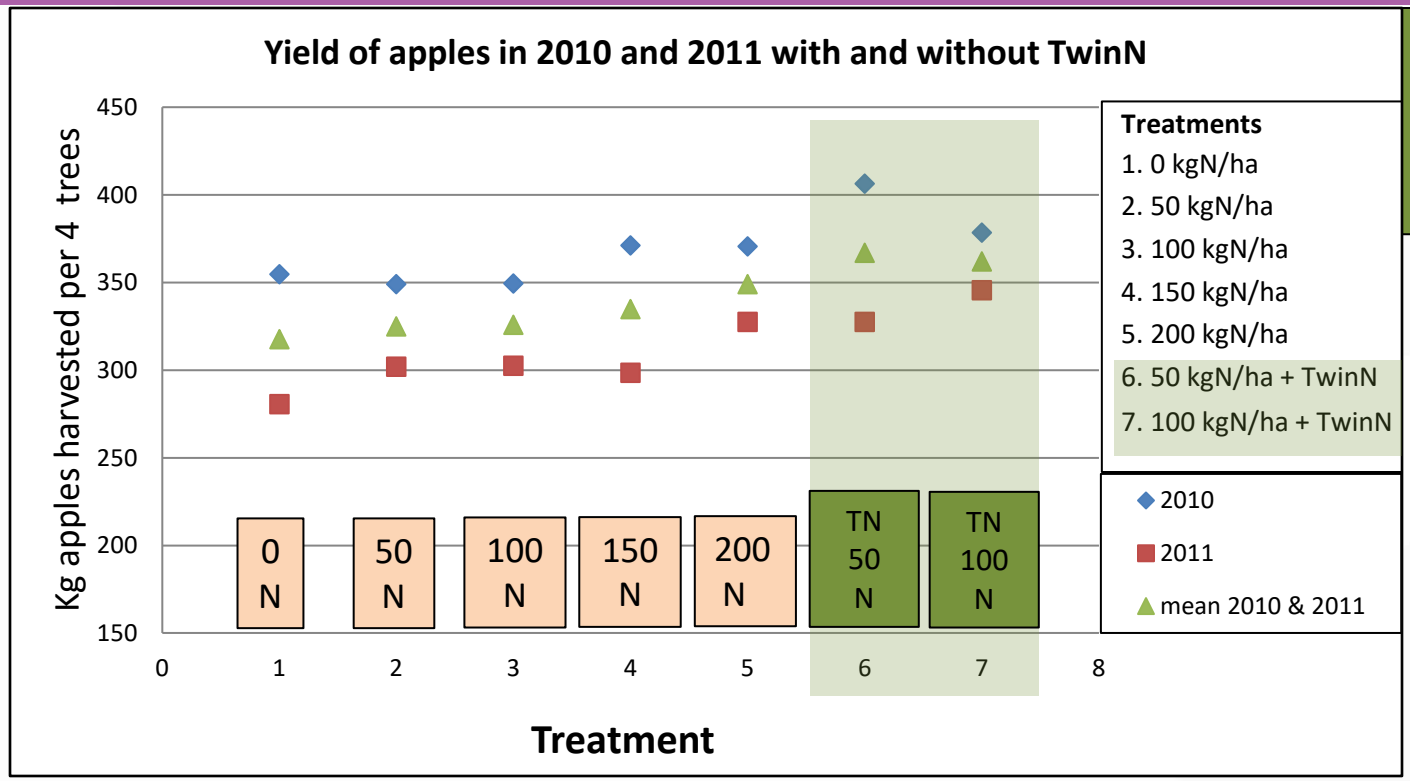
Table 1. Effect of NPK fertilization on soil organic C concentrations measured for the Morrow Plots between 1955 and 2005.

Rotation†	Fertilizer treatment‡	Sampling depth	Soil organic C§			
			1955	2005		Net change in 51 yr¶
				Mean	SD	
		cm	g kg^{-1}			
C-C	None	0–15	15.3	15.3	1.5	0
		15–30	14.2#	13.0	0.8	−1.2
		30–46	11.8	13.2	1.4	+1.4
	NPK	0–15	15.3	16.4	1.0	+1.1
		15–30	14.2#	15.5	1.1	+1.3
		30–46	11.8	9.5	0.7	−2.3*
	HNPK	0–15	19.5	18.2	0.2	−1.3* **-7%**
		15–30	19.1	17.1	0.1	−2.0* **-12%**
		30–46	16.2	12.2	1.5	−4.0* **-33%**

Source: Khan et al. (2007) J. Env. Qual. 36: 1821 – 1832. The myth of nitrogen fertilisation for soil carbon sequestration

1. Better production from the same N fertiliser use

Bulmer Cider, Independent replicated trial, Apples, UK, 2010 & 2011



TwinN was applied to soil via two applications per year in spring and late summer

This trial was conducted to test TwinN's capacity to increase profits via improved yields and reduced fertiliser costs.

Improved sustainability of production was also noted.

Conclusions

- TwinN plus 50 or 100 kgN produced the highest yield in 2010 & 2011
- TwinN plus 50 kgN/ gave a 12.6% yield increase over 100 kgN with no TwinN
- This translates to reduced N costs, increased returns, decreased C footprint (see next slide) and improved long term soil health due to reduced N fertiliser applications

Organic Potato Herefordshire UK - 2007

Trial Results

Treatment All treatments had 80 units N from organic fertiliser	Milva		Valor	
	T/ha	% of control	T/Ha	% of Control
Untreated Control	`14.5 (a)	100	18.6 (a)	100
Single TwinN at Planting	17.5 (b)	120	21.4 (b)	120
TwinN at Planting and Tuber Initiation	18.6 (c)	128	23.9 (c)	129

Note: Producing higher yield from the same amount of N fertiliser reduces the C footprint per unit of yield

Canola (OSR) trial, UK – reduced N fert & increased Yield = reduced CO2/ ton Yield

kgN/ha	Yield	Kg CO2 eq/T yield
240	4.5	596
160 + 1 TwinN	5.9	307

OSR trial Control

Mapleton International

Crop yield: ★ 4.5 Tonnes(feedstock)/ha

Emissions from land use change and soils

Emissions from land use: 0 kg(CO2e)/ha

subtotal 0 kg(CO2e)/t crop

Rate of nitrous oxide emissions per hectare: 1480 kg(CO2e)/ha

subtotal 329 kg(CO2e)/t crop

Farming inputs

Type / Description	Application rate mass of nutrient per area	Emissions factor Mass CO2e per Mass of nutrient	Nitrogen content Mass of N per mass of product	Total emissions kg(CO2e)/t crop
Calcium nitrate (CN)	★ 240 kg/ha	10.9 kg/kg	1 kg/kg	581
Triple superphosphate (TSP)	45 kg/ha	0.354 kg/kg	0 kg/kg	3.54
Potassium Chloride (K)	48 kg/ha	0.333 kg/kg	0 kg/kg	3.55
Lime fertiliser (CaO)	271 kg/ha	0.124 kg/kg	0 kg/kg	7.47

subtotal ★ 596 kg(CO2e)/t crop

Renewable Fuels Agency's Carbon Calculator.

Quantifying carbon footprints for products and buying offsets

MAB contracted Carbon Associates

www.carbonassociates.com.au to do a C footprint audit.

SUPER LOW CARBON FOOTPRINT

TwinN accounts for 7.2 Kg CO_2-e per 5 ha ie. *1.44 Kg CO_2-e per 1 ha*

- Delivered to farm gate
- Applied longest international transport route

Assessed by Carbon Associates

CORPORATE RESPONSIBILITY

Mapleton Agri Biotec have purchased carbon offsets equivalent of 128% of the carbon footprint of TwinN.

Conclusions

Biofertilisers can enable reduced rates of nitrogen fertilisers and this reduces the tendency of high N rates to reduce soil carbon

Reduced nitrogen fertiliser applications equates to reduced carbon footprint per unit yield

Larger microbial populations can also contribute directly to increases in soil carbon sequestration

Thank you

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