The Cool Farm Tool

Jon Hillier

FAO-EPIC consultation on soil carbon sequestration under CSA project
May 21 2013

CFT
COOL FARM TOOL

1495
UNIVERSITY OF ABERDEEN

The Cool Farm Tool

- History, demand
- Development, methods, and structure
- Piloting and testing
- Applications
- Current state

The Cool Farm Tool

- Farm/farmer-focused GHG calculator
  - User-friendly
  - Science based
  - Open source
  - Free for individual and non-commercial use
- Site and management sensitive estimate of GHG emissions on farm
- Decision support: allows exploration of mitigation options

The context

- We know about emissions from agriculture in general
- We know about general mitigation options
- Not at farm or site level

Much of retailers GHG emissions are often in the upstream agricultural supply chain

What to do about it?

Walkers carbon footprint (PepsiCo)

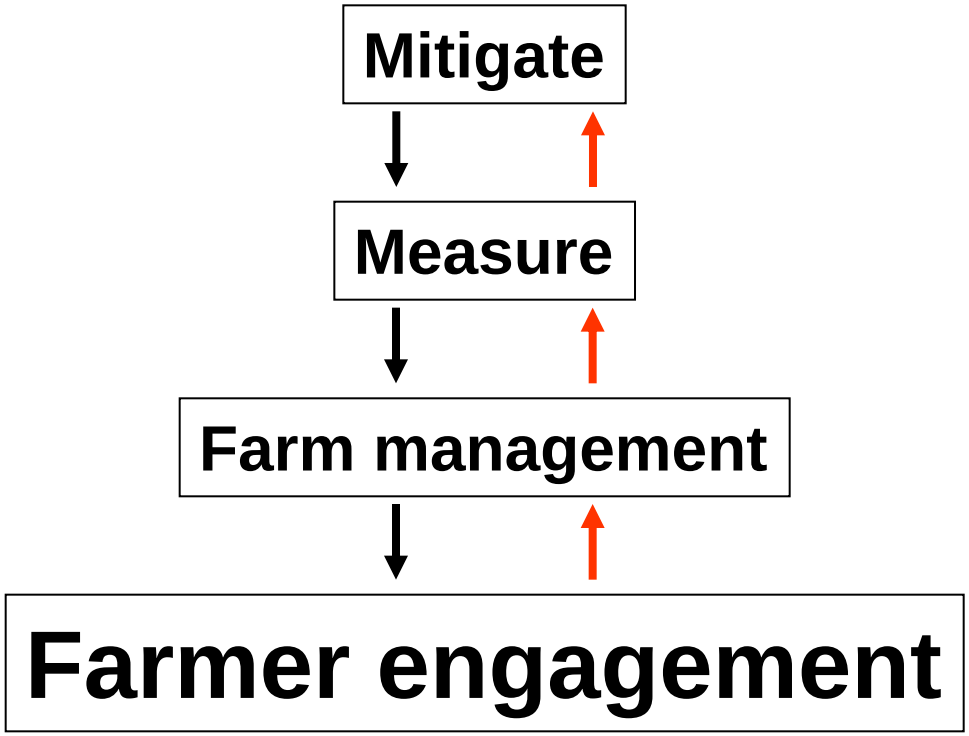
Unilever *2008 baseline study across 14 countries*

How to mitigate?

- Numerous possibilities, e.g.
  - **cropland**
    - management agronomy, nutrient management, tillage/residue management, water management (irrigation, drainage), rice management, agroforestry, set-aside, land-use change
  - **grazing land management/**
    - pasture improvement, grazing intensity, increased productivity (e.g. fertilization), nutrient management,species introduction (including legumes)
  - **management of organic soils**
    - avoid drainage of wetlands
  - **restoration of degraded lands**
    - erosion control, organic amendments, nutrient amendments
  - **livestock management**
    - improved feeding practices
    - specific agents and dietary additives
    - longer term structural and management changes and animal breeding
    - manure/biosolid management
    - improved storage and handling
    - anaerobic digestion - more efficient use as nutrient source
  - **bioenergy energy crops, solid, liquid,**
    - biogas, residues

Smith et al, Phil. Trans. R. Soc. B (2008) 363, 789–813

How to mitigate in my supply chain



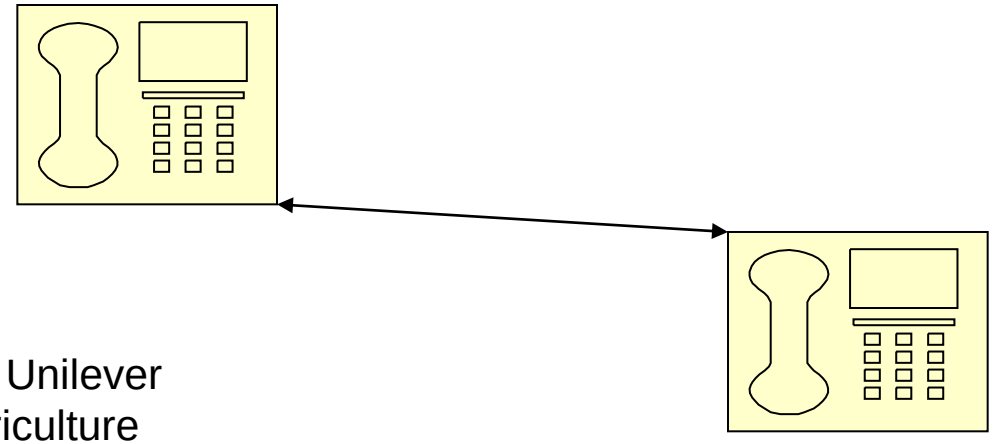
Origins,

Autumn 2008

We need some software because farmers lack….

…robust and credible methods for quantifying farm-level GHGs…

and …practical tools to identify the most effective emission reduction practices and quantify their effects.



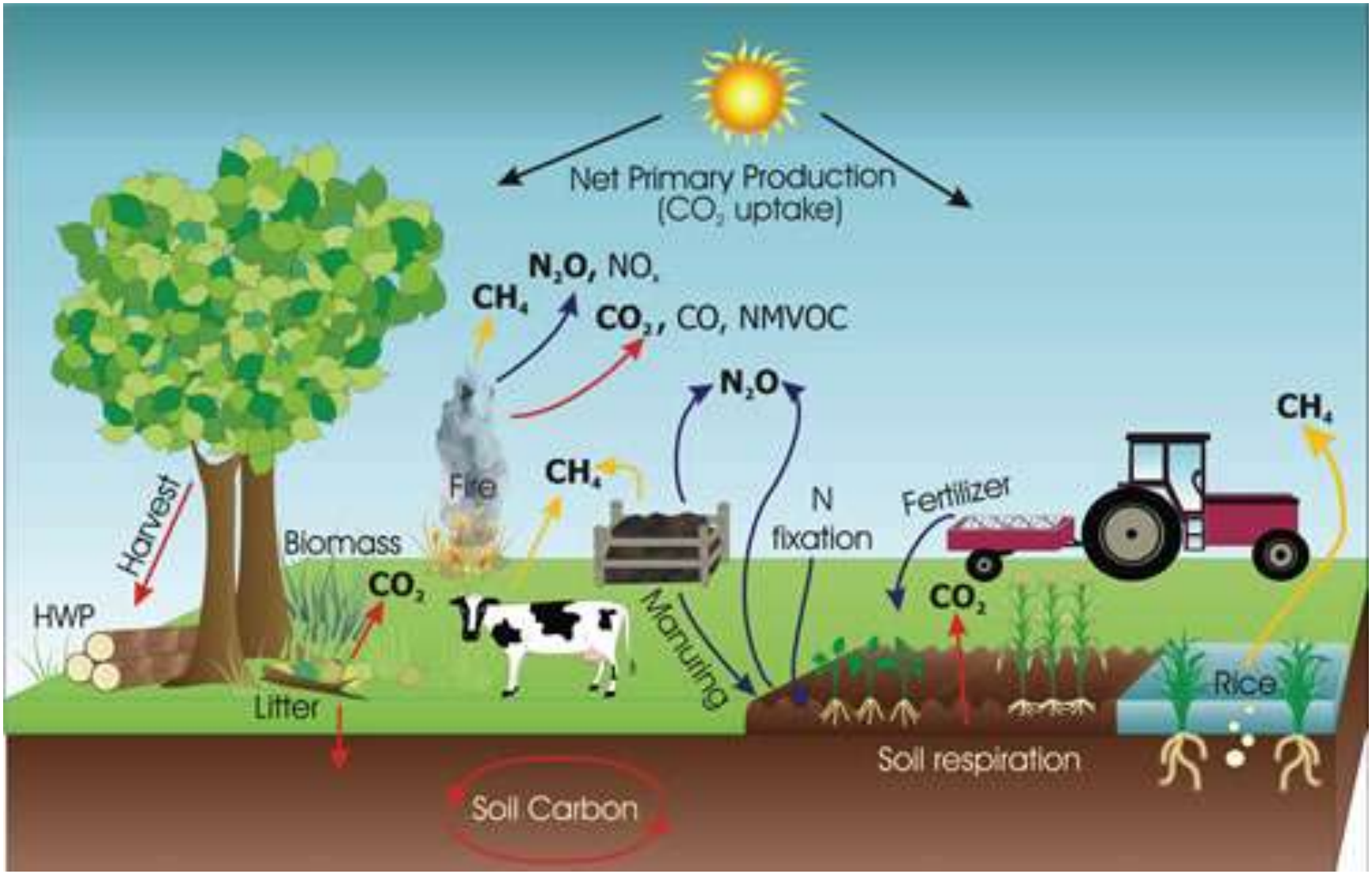
Christof Walter, Unilever Sustainable Agriculture (now Christof Walter consulting)

Pete Smith, Convening lead author
Several IPCC mitigation chapters

Modelling approach

- Product focus
- Single package: integrating sources of emissions on the farm
- Make the best use of farmers knowledge of site and management
- Use “off-the-shelf” models

Greenhouse gas (GHG) emissions on the farm



Which is the best model?

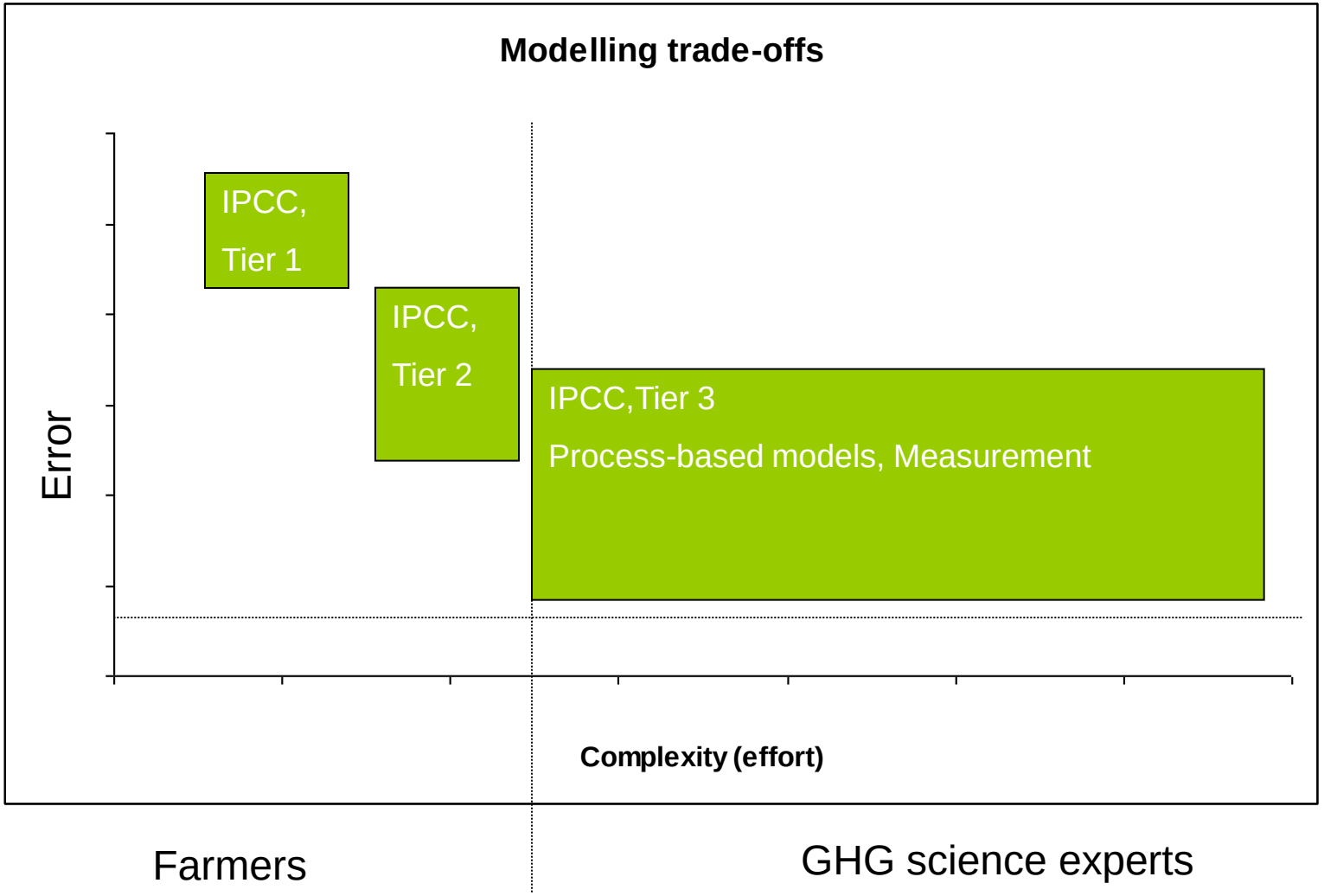
Complexity	Models	Requirements, data/money	Aggregation level, uncertainty	Notes
Tier 1	IPCC Tier 1	Nutrient application rates, animal populations, energy use	National, annual resolution	Suitable for rough overviews, limited data availability
Tier 2/Simple Tier 3	Cool Farm Tool	Intermediate spatial/temporal scale, product, crop, country, region specific energy data	Regional, annual resolution	Can be suitable for project based/regional accounting and inventory roll ups to national scale
Tier 3	Process-based models	N application rates/timing, soil properties, Daily resolution climate data	Site scale, daily resolution	Suitable for small scale applications where model parameterization and testing can be done;systems will be needed to make advanced modelling approaches accessible to project developers .
	Measurement	Money!	Site scale, daily resolution,	

Reproduced from Olander et al 2011. Technical Working Group on Agricultural Greenhouse Gases (T-AGG) report

Occam's razor

- **George Box**
  - "All models are false – some are useful"
- **Occam's razor**
  - "*lex parsimoniae"*: law of parsimony
  - "The best model is the simplest one"
- **Modified Occam's razor**
  - "The best model is the simplest one *that does the job in hand*". i.e. the simplest one which is fit-for-purpose

Fit-for-purpose models



What sort of information do growers have?

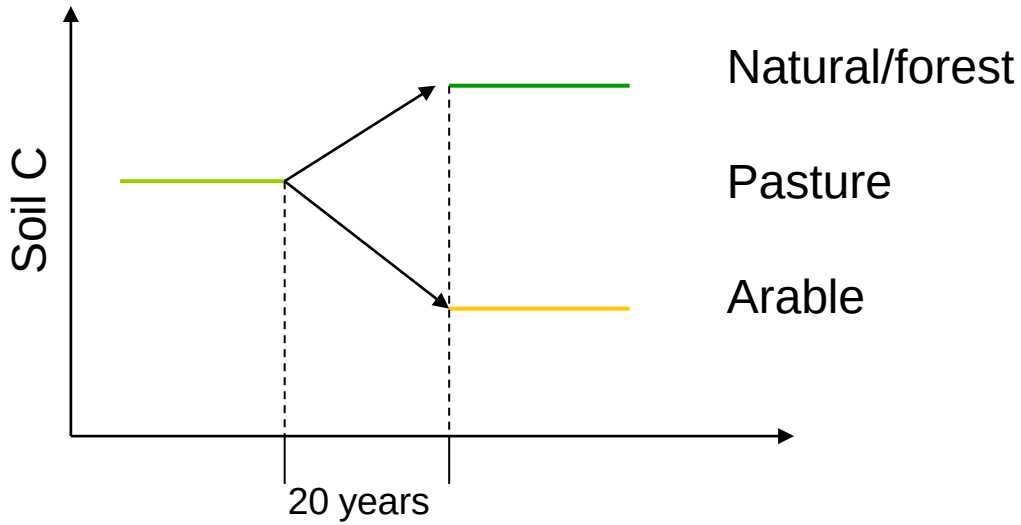
- Soil types
- Fertiliser types and rates
- Animal breeds, feed mixes, quantities
- Pesticides used
- Information on crop rotations and tillage
- Energy
  - Machinery operations
  - Energy used in storage and processing

“Off-the-shelf” models adapted for the farmer

- Fertiliser
  - Emissions from fertiliser production (e.g. Ecoinvent 2007, EFMA 2011)
  - Nitrous oxide emissions from the soil (Bouwman et al 2002)
- Pesticides (Audsley 1998, Green 1987)
- Land use change, tillage practice (IPCC)
- Cropping rotation (IPCC)
- Manure management system, composting etc (IPCC)
- Crop residue management (IPCC)
- Livestock feed, etc. (Lal 2004, Hiller et al 2009)
- Fossil fuel use from machinery (mostly ASABE)
- Energy use – e.g. electricity with national/regional emissions factors (GHG protocol)

Soil C changes

- Soil CO_2 – 20 year rule – depending on climate region (tropical/temperate, wet/dry)

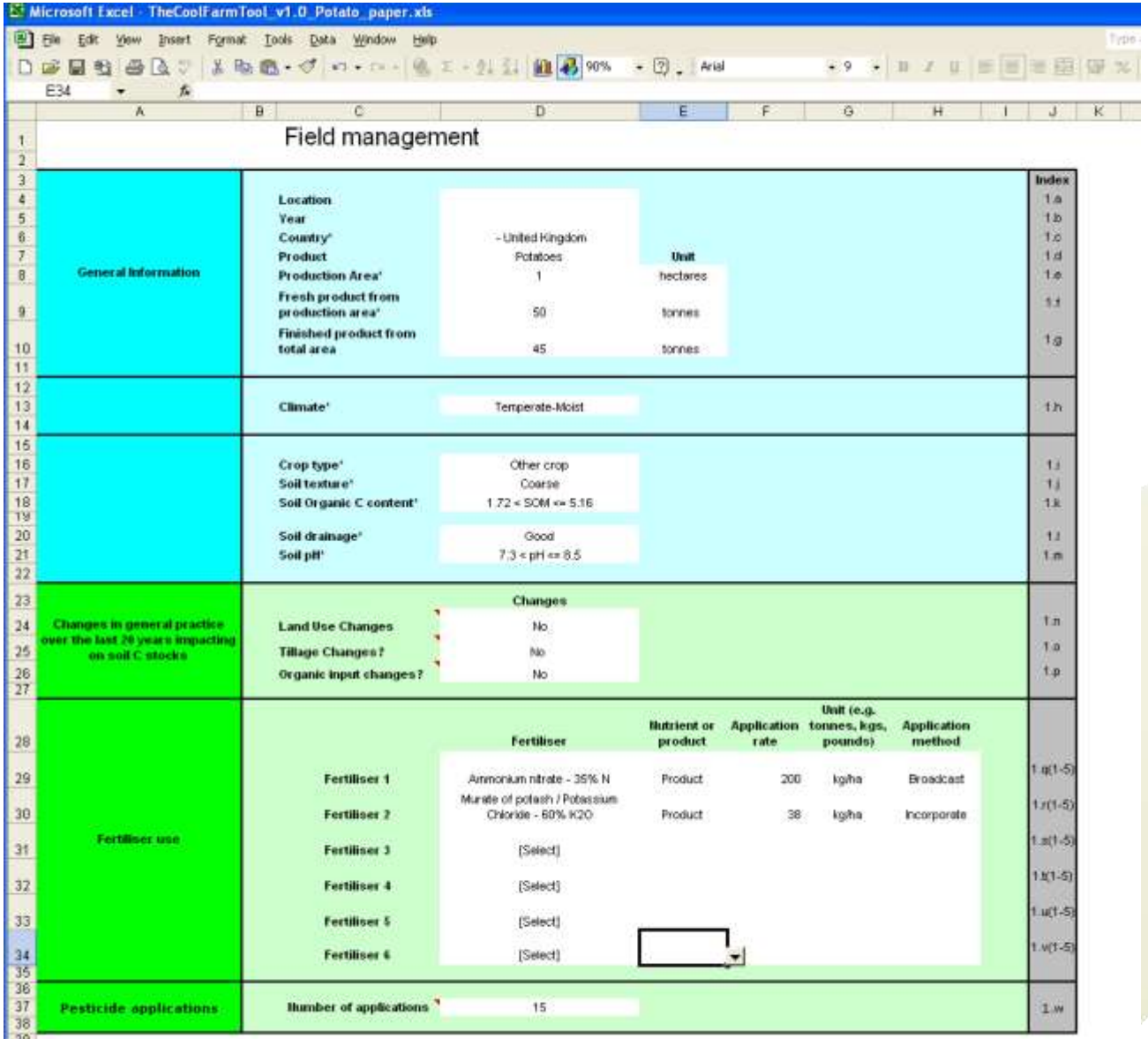


Soil model: Ogle et al 2005, Biogeochemistry 72: 87–121

The Cool Farm tool

- Farmer focused
- Scope: global, non-crop specific
- Utilises farmer knowledge with robust empirical data models
- Management focused, decision support
- Exploration of mitigation options
- (Hillier et al 2011. Environmental Modelling and Software 26, pp. 1070-1078)

Version 1.0



Microsoft Excel - TheCoolFarmTool_v1.0_Potato_paper.xls

File Edit View Insert Format Tools Data Window Help

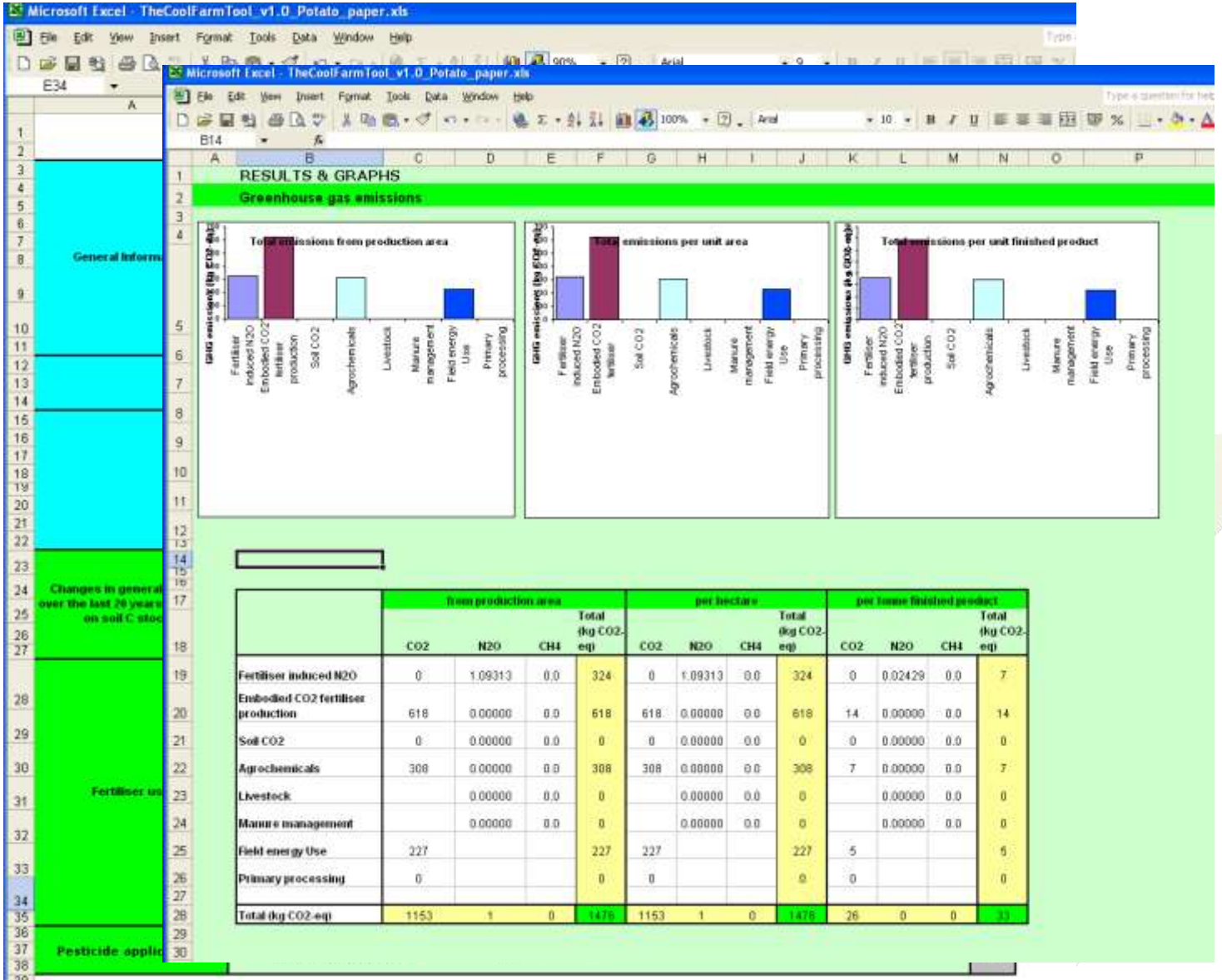
E34

Field management

					Index
General information	Location				1.a
	Year				1.b
	Country*	- United Kingdom			1.c
	Product	Potatoes	Unit		1.d
	Production Area*	1	hectares		1.e
	Fresh product from production area*	50	tonnes		1.f
	Finished product from total area	45	tonnes		1.g
	Climate*	Temperate-Moist			1.h
	Crop type*	Other crop			1.i
	Soil texture*	Coarse			1.j
	Soil Organic C content*	1.72 < SOM <= 5.16			1.k
	Soil drainage*	Good			1.l
	Soil pH*	7.3 < pH <= 8.5			1.m
Changes in general practice over the last 20 years impacting on soil C stocks		Changes			
	Land Use Changes	No			1.n
	Tillage Changes?	No			1.o
	Organic input changes?	No			1.p

		Fertiliser	Nutrient or product	Application rate	Unit (e.g. tonnes, kgs, pounds)	Application method	
Fertiliser use	Fertiliser 1	Ammonium nitrate - 35% N	Product	200	kg/ha	Broadcast	1.q(1-5)
	Fertiliser 2	Muriate of potash / Potassium Chloride - 60% K2O	Product	38	kg/ha	Incorporate	1.r(1-5)
	Fertiliser 3	[Select]					1.s(1-5)
	Fertiliser 4	[Select]					1.t(1-5)
	Fertiliser 5	[Select]					1.u(1-5)
	Fertiliser 6	[Select]					1.v(1-5)
Pesticide applications	Number of applications*	15					1.w

Version 1.0



	from production area				per hectare				per tonne finished product			
	CO2	N2O	CH4	Total (kg CO2-eq)	CO2	N2O	CH4	Total (kg CO2-eq)	CO2	N2O	CH4	Total (kg CO2-eq)
Fertiliser induced N2O	0	1.09313	0.0	324	0	1.09313	0.0	324	0	0.02429	0.0	7
Embodied CO2 fertiliser production	618	0.00000	0.0	618	618	0.00000	0.0	618	14	0.00000	0.0	14
Soil CO2	0	0.00000	0.0	0	0	0.00000	0.0	0	0	0.00000	0.0	0
Agrochemicals	308	0.00000	0.0	308	308	0.00000	0.0	308	7	0.00000	0.0	7
Livestock		0.00000	0.0	0		0.00000	0.0	0		0.00000	0.0	0
Manure management		0.00000	0.0	0		0.00000	0.0	0		0.00000	0.0	0
Field energy Use	227			227	227			227	5			5
Primary processing	0			0	0			0	0			0
Total (kg CO2-eq)	1153	1	0	1476	1153	1	0	1476	26	0	0	33

Sustainable Food Lab

- **Pre-competitive platform**
  - **Membership of > 50 companies, public interest and academic organisations**

- **Mission**
  - **To accelerate the shift of sustainable food from niche to mainstream.**

Cool Farming Options (2010-2012)

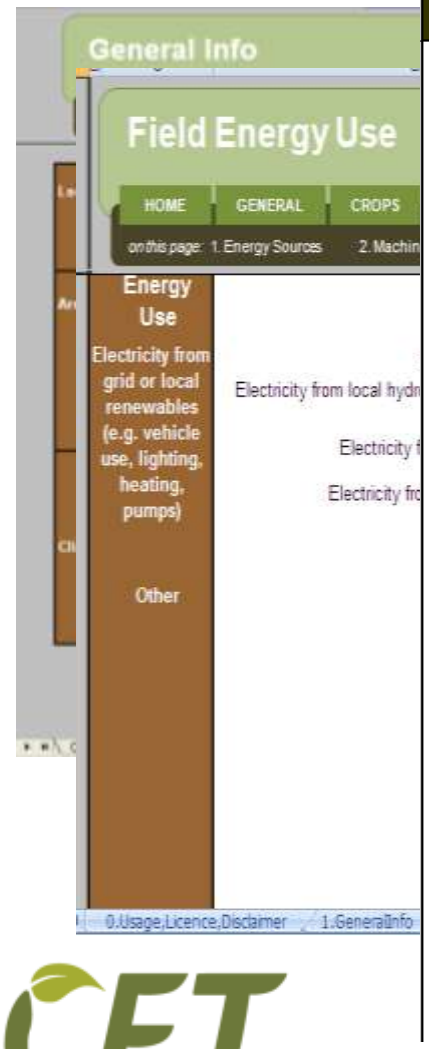
- A number of companies and sponsors involved:
- Pilot and improving
  - Global application, consistent approach
  - Context sensitive
- Data gathering

Cool Farming Options (2010-2012)

- Covering a range of farming systems and geographies:

Source: www.sustainablefood.org

Revised tool



RESULTS & GRAPHS

Summary

This first section gives a summary of the overall emissions.

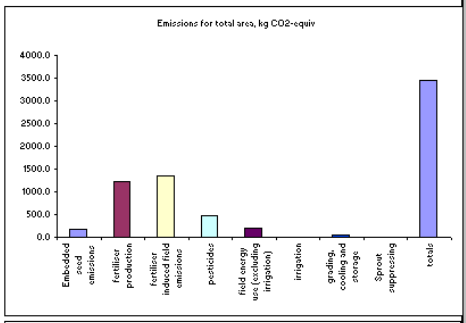
The total annual emissions from your farm system are 77 kg CO2-equiv per tonne finished product.

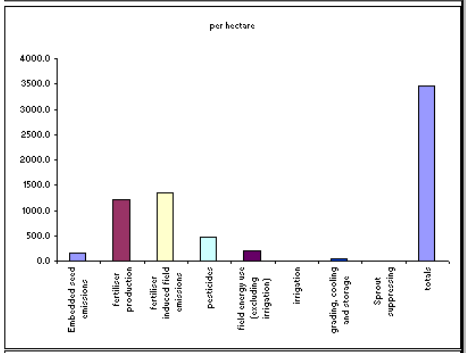
In terms of CO2 equivalents the greatest emissions in your case come from fertiliser induced field emissions, with a total of 30kg CO2 equiv per tonne.

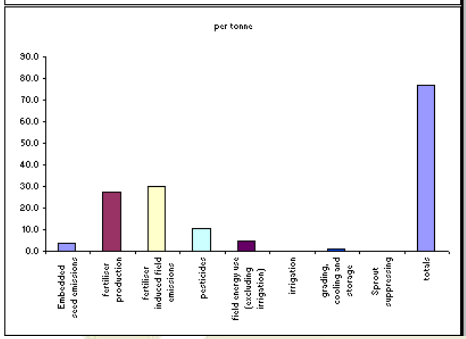
In terms of compounds the largest emissions in CO2 equivalents come from CO2

- with a total of 45.29kgs of CO2 per tonne.

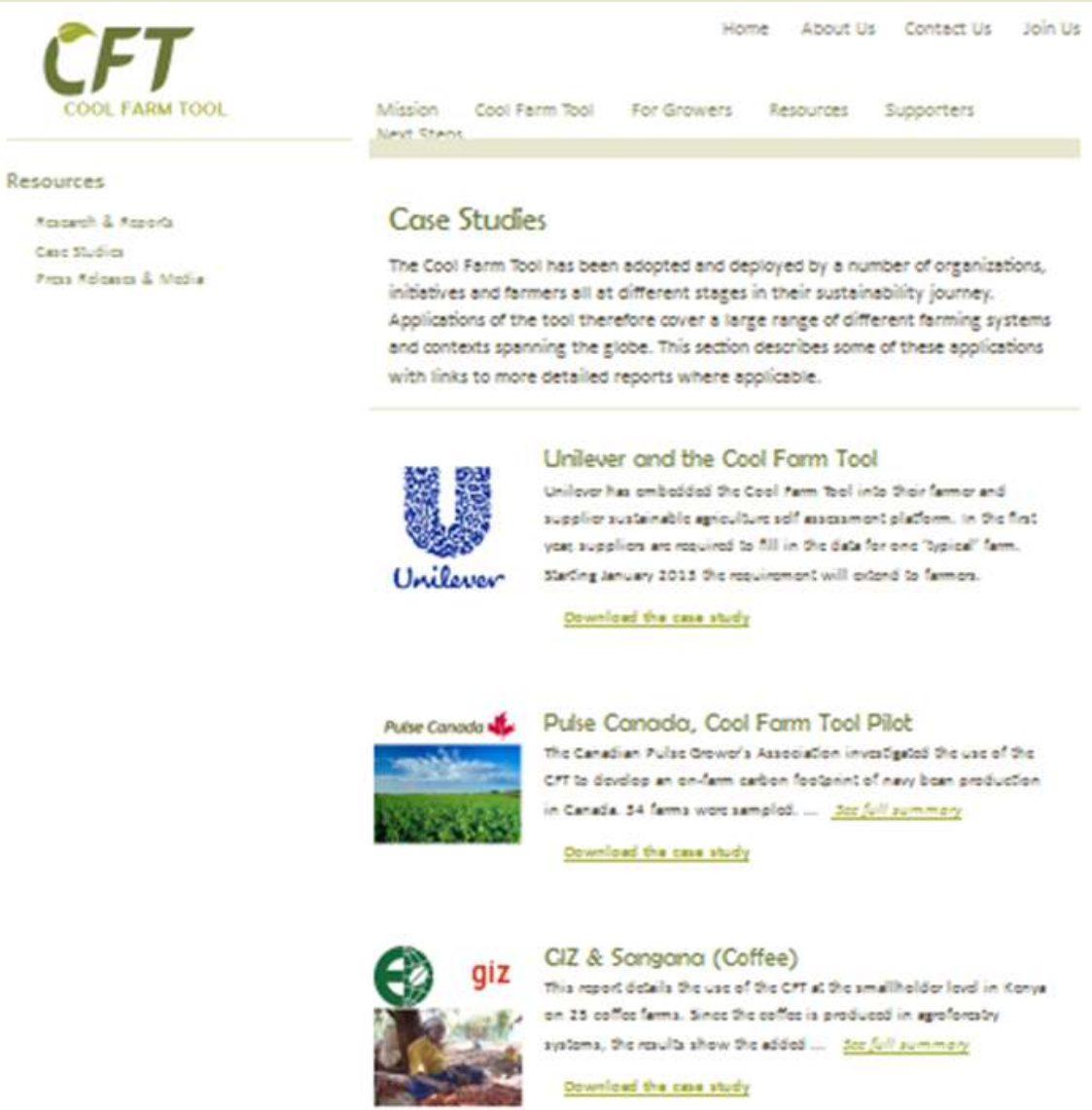
	CO2	N2O	CH4	Emissions for total area, kg CO2-equiv	per hectare	per tonne
Embedded seed emissions	97.1	0.228	0.00	164.7	164.7	3.7
fertiliser production	1222.9			1222.9	1222.9	27.2
fertiliser induced field emissions	0.0	4.570		1352.6	1352.6	30.1
pesticides	471.5			471.5	471.5	10.5
field energy use (excluding irrigation)	205.4			205.4	205.4	4.6
irrigation	0			0.0	0.0	0.0
grading, cooling and storage	41.5			41.5	41.5	0.9
Sprout suppressing	0.00			0.0	0.0	0.0
totals	**2038.3**	**4.798**	**0.00**	**3458.6**	**3458.6**	**76.9**







Case studies, www.coolfarmtool.org

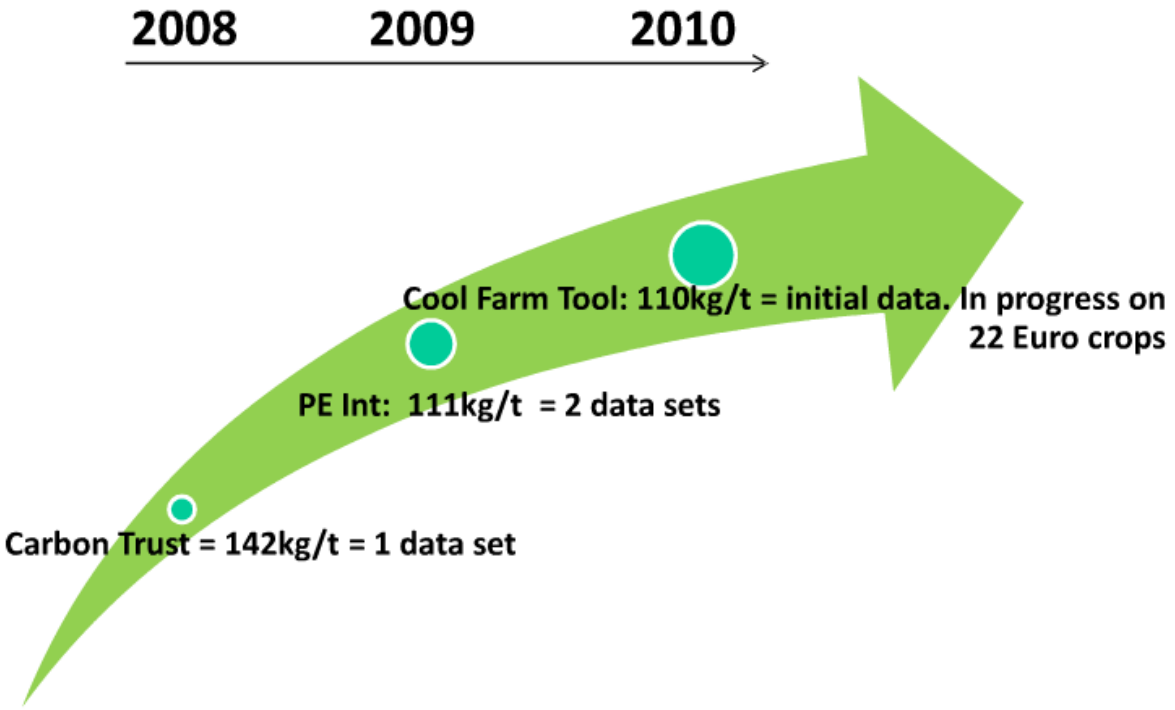


CFT

Others began to use it…

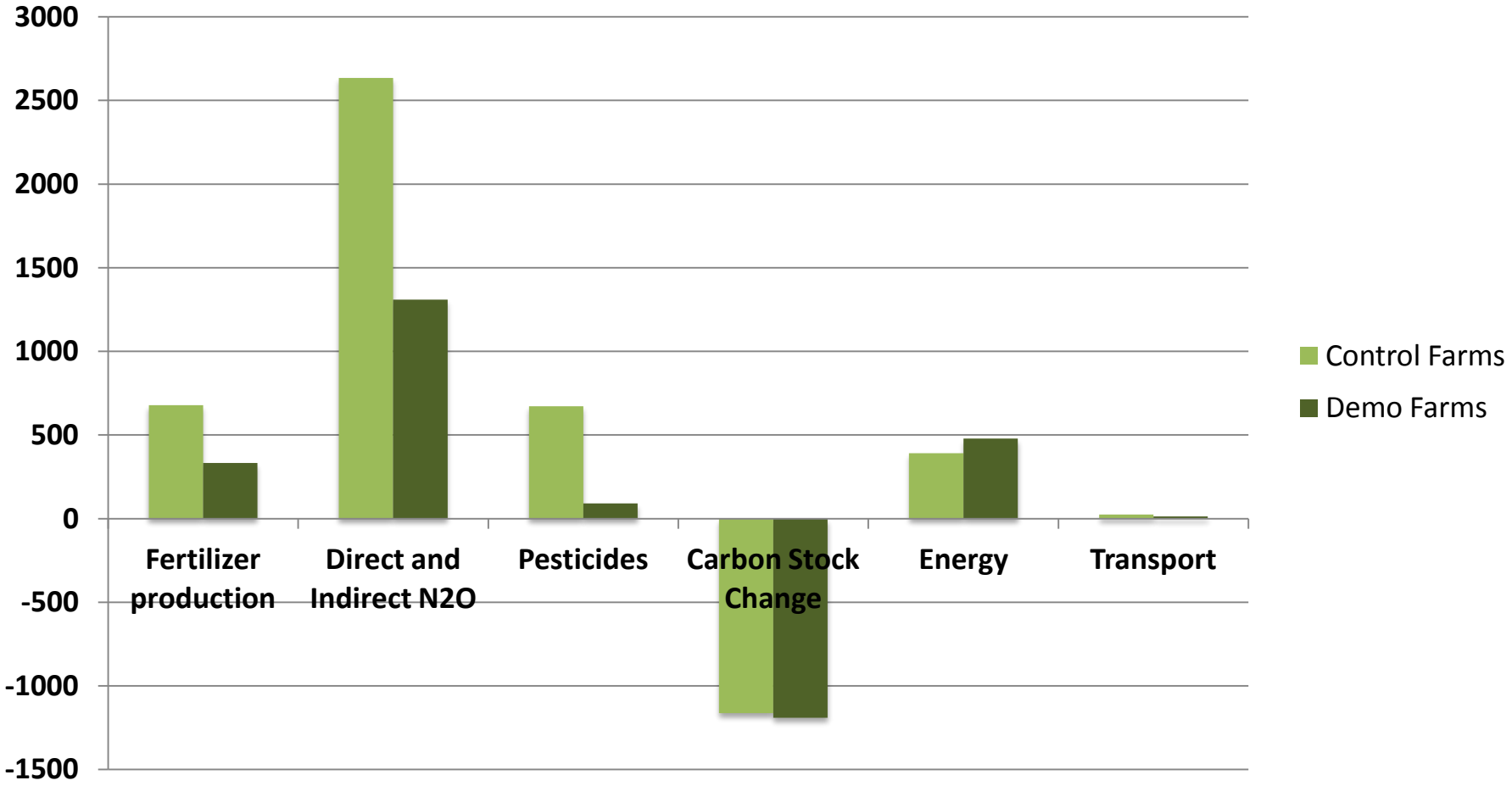
- PepsiCo are using CFT with Potato farmers in the UK to carbon footprint all their farms and test out new scenarios.
- Results from CFT have been comparable to other studies, therefore instilling trust in the use of CFT as a robust calculator.

PepsiCo's Carbon Footprint calculations so far.



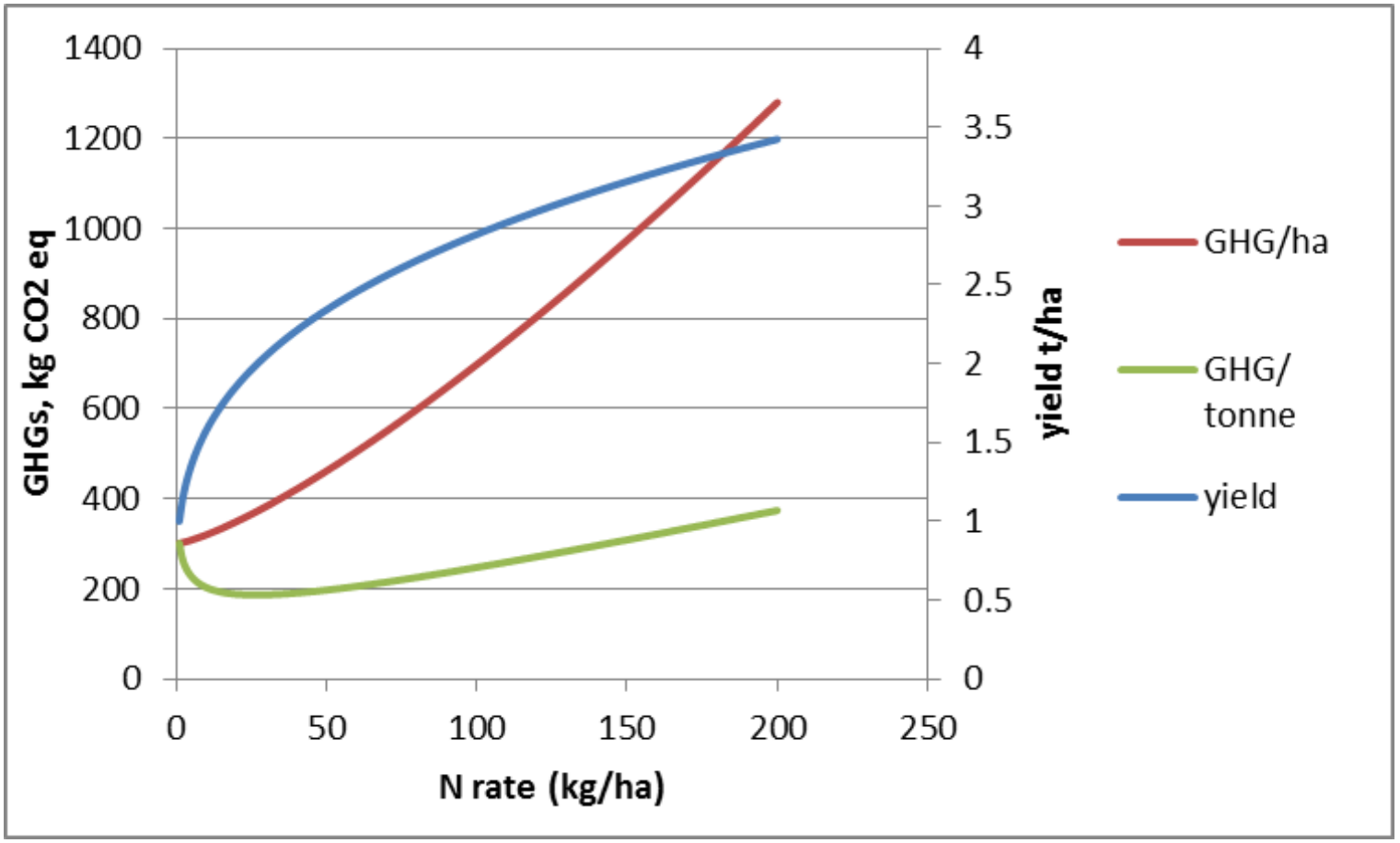
Case study…

- WWF-India and Marks & Spencer compared conventional cotton with "Better Practice Cotton".



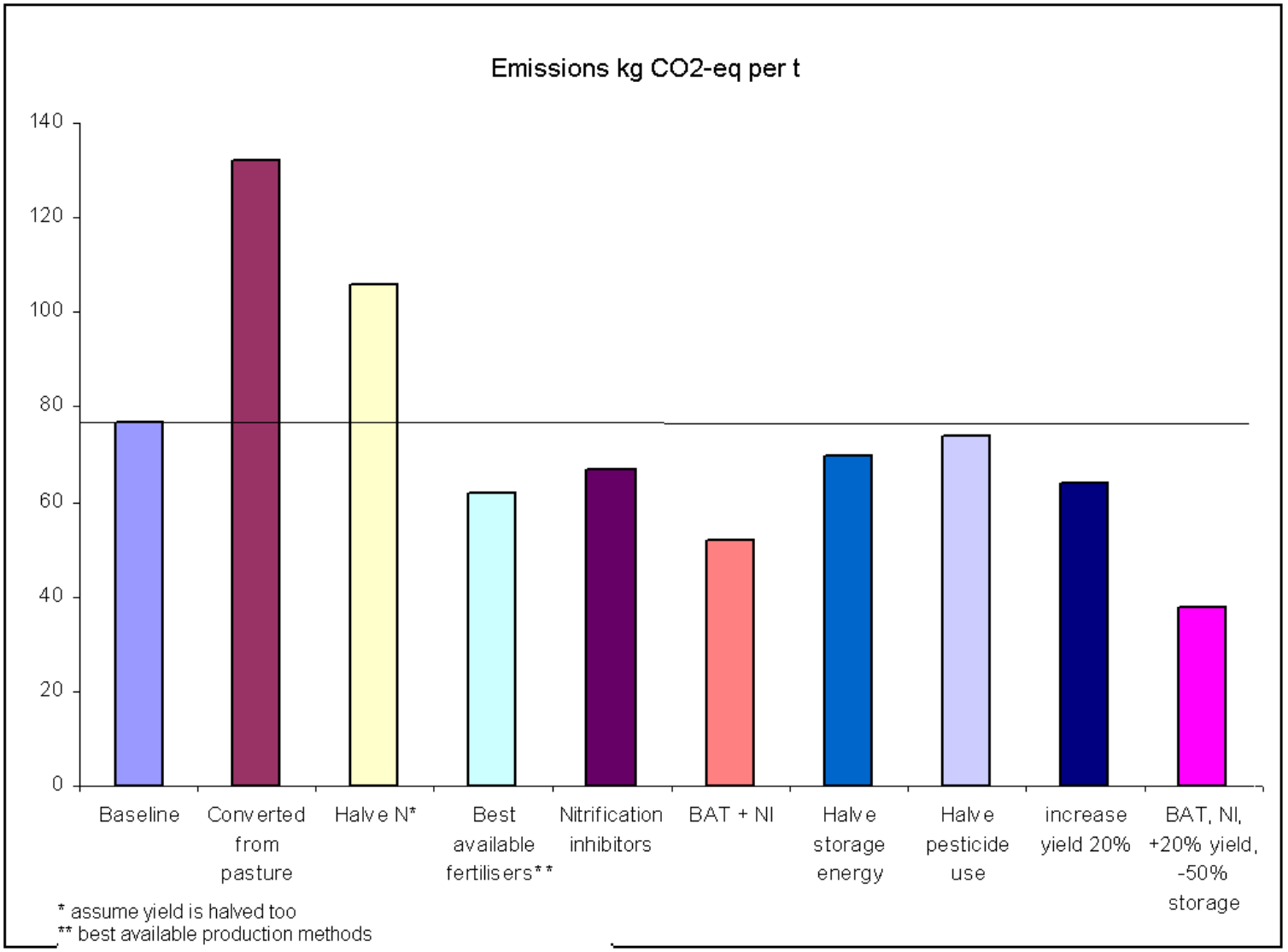
Case study…

- Other work. Environmentally optimum N rates



50-in-5?

http://www.pepsico.co.uk/purpose/environment/reports-and-updates/2010-environment-report/passionate-about-growing/50-in-5



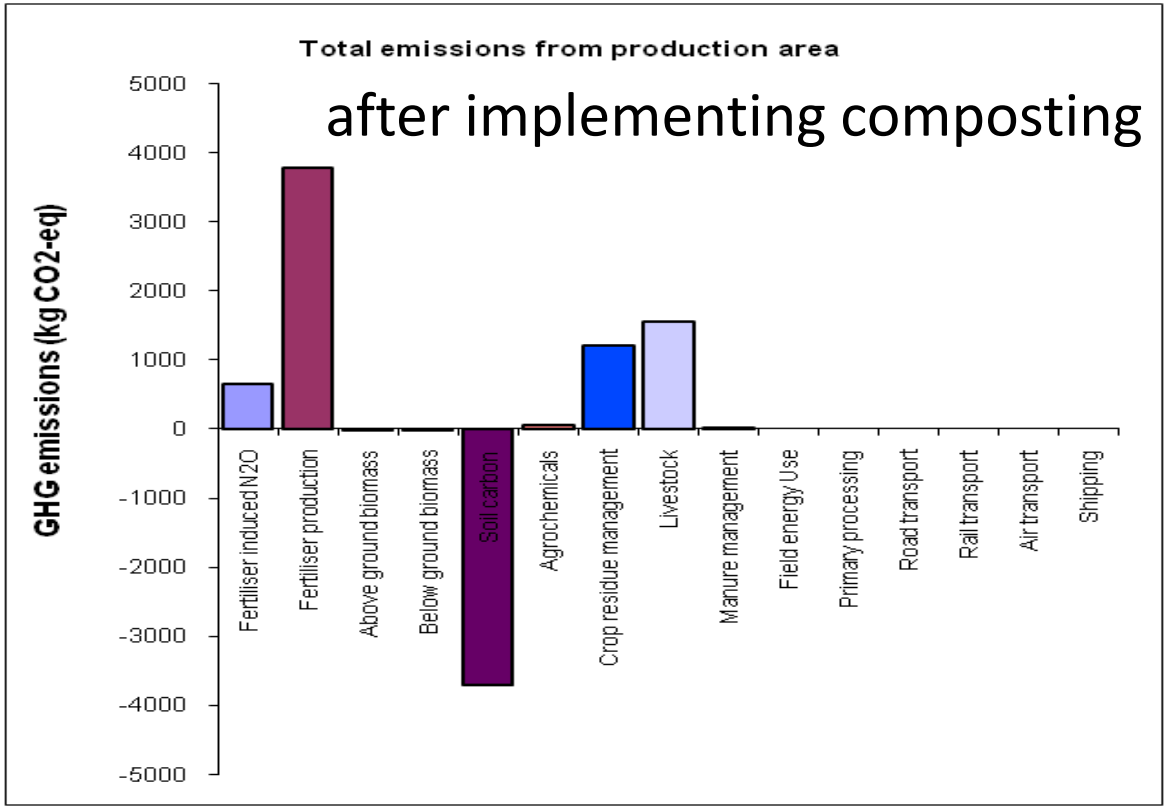
Example Darjeeling/India

- Tea cooperatives:
  - Current situation:
  - 30-40% yield cuts in the last 5-10 years
  - 7-800 kg of pruning material annually
    →left for aerobic decay
  - 5-8 tons of cow manure per year
    →left on pits for 1 year (+) and then used in vegetables
- The emissions were assessed and calculated with the CFT within 1 hour during an onsite visit
- →the CFT model showed 30% emission reduction through composting due to increased SOM
- →1 year later production went up by 20% through making carbon dynamics easy and obvious, using local resources

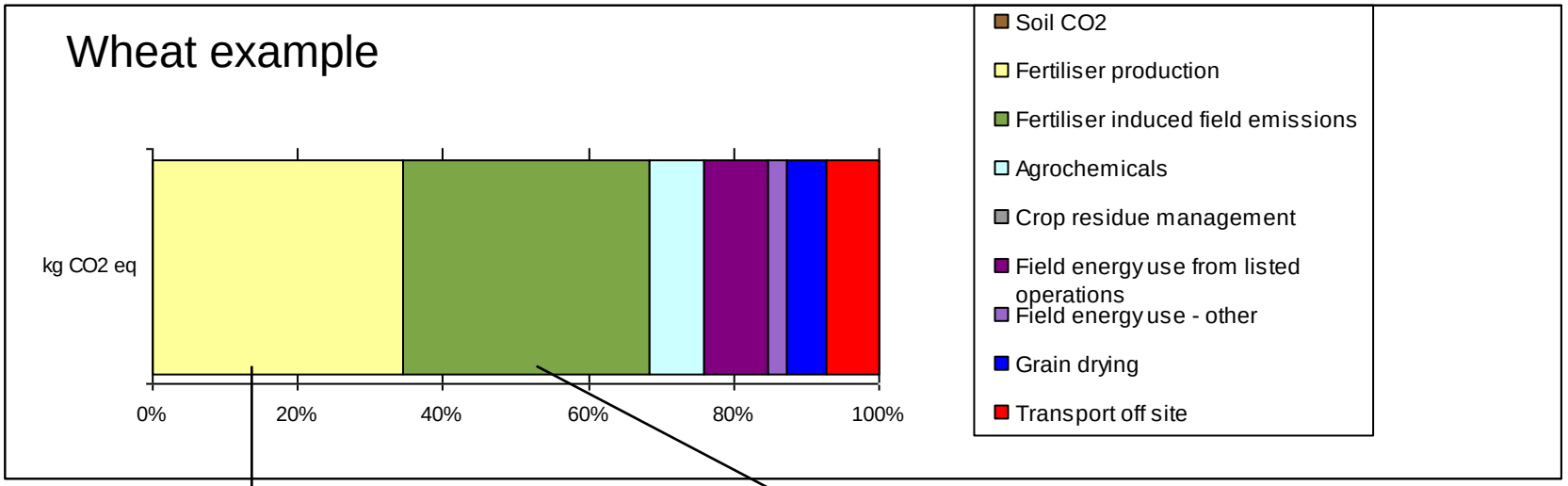
Training Indian tea growers on using available biomass (manure & pruning) for composting…

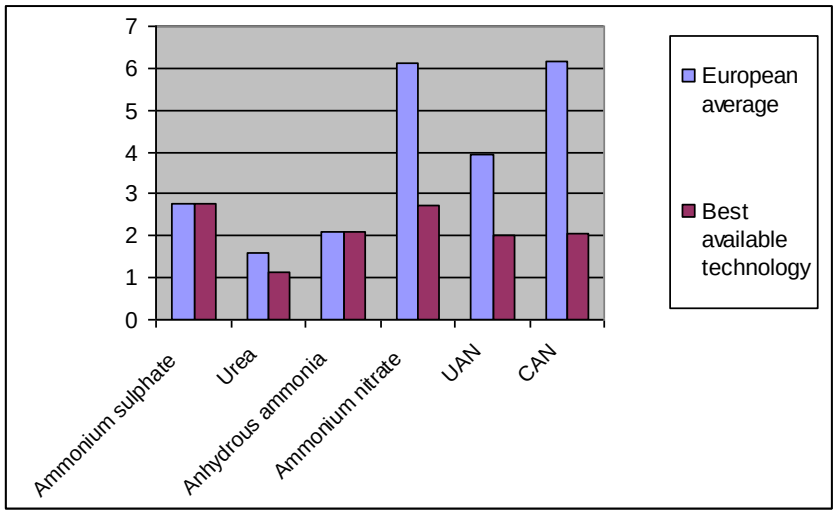
CO_2 Emission ➔ Sequestration

- 30% CO_2 Reduction
- Improving water holding capacity by up to 40%



Fertiliser production



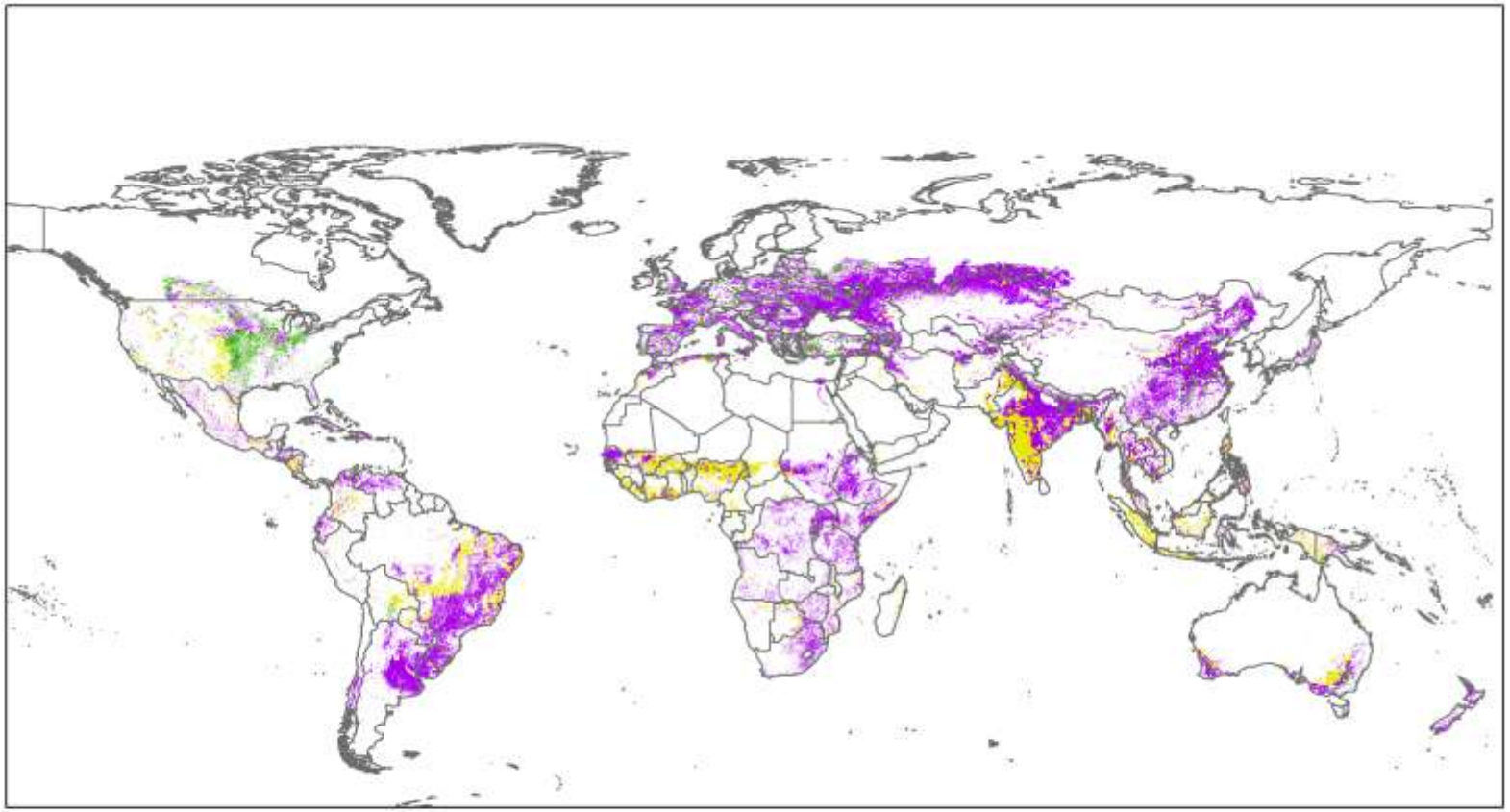


Nitrification or urease inhibitors
Slow the conversion of applied N to NO_{3-} avoiding peaks in concentration
Akiyama et al 2010

Collaborations and shared learning

- Examples
  - CIMMYT: using household data from Kenya and Ethiopia to model emissions
  - Shetland (northern Scotland) sheep emissions study
  - NERC – knowledge exchange programme
    - Inclusion of other environmental performance indicators (e.g. water use, biodiversity)
  - SEER (with UEA)
    - Use within project to explore optimal land use in UK with respect to production, environment, social value

Hillier et al 2012. Which cropland greenhouse gas mitigation options give the greatest benefits in different world regions? Global Change Biology 18(6) 1880–1894



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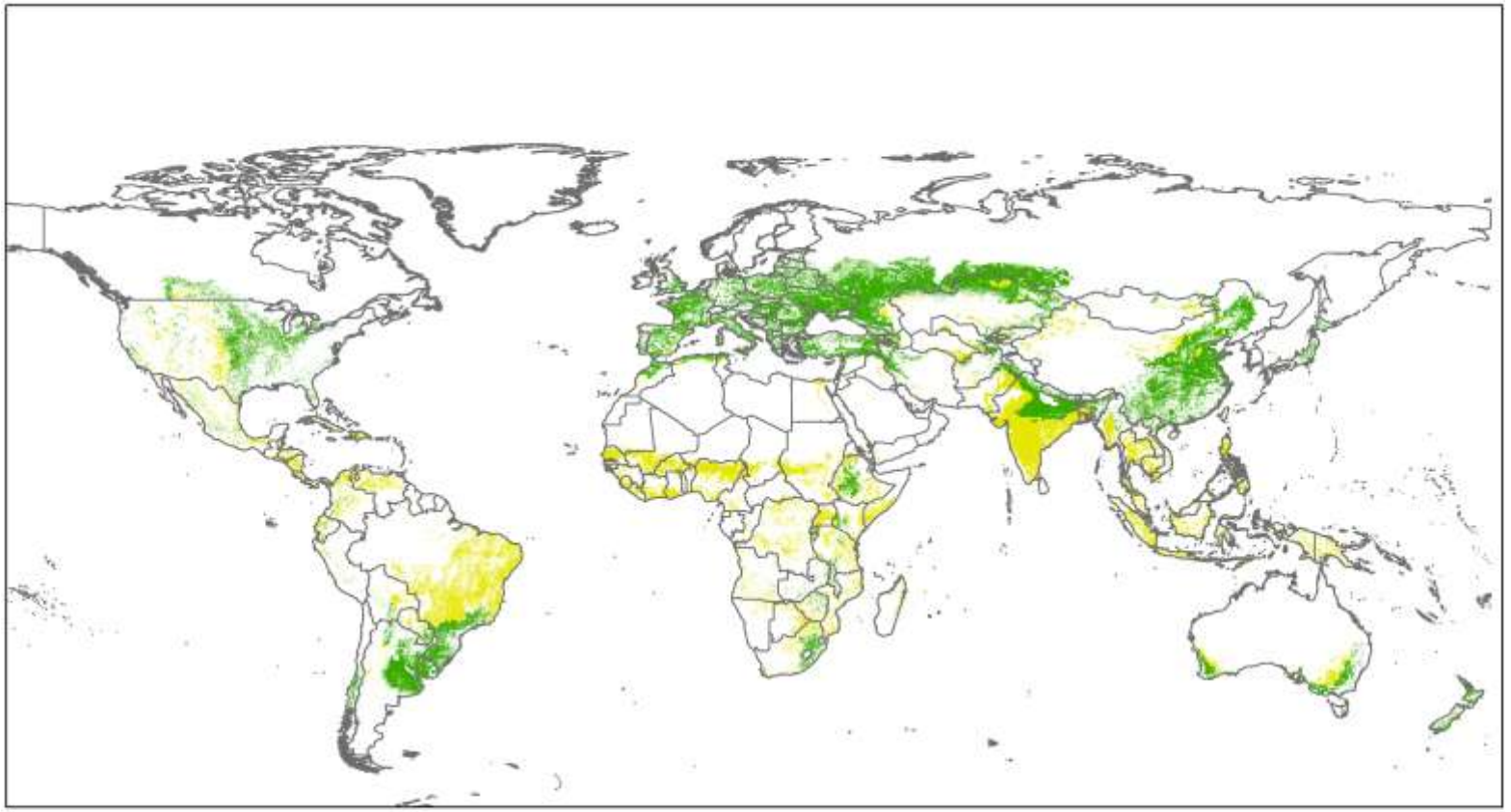


N application 0-100 kg N per ha

- BAT
- C+
- N-
- RT

N

Final sponsors meeting, February 2012

- Decision support tool
  - site & management specific tool
  - end-user value
  - wide range of applicability
- The problem
  - shared ownership, divergent goals of owners
  - no clearly defined management
- The Cool Farm Institute

The Cool Farm Institute

Farming and food chains:
A collaborative approach to GHG reductions in agriculture

About the Cool Farm Institute

The Cool Farm Institute is an independent not-for-profit organisation to help farmers and those businesses they supply make informed on-farm decision to reduce their environmental impact.

Partners & Members

MARKS & SPENCER

PEPSICO

SUSTAINABLE FOOD LABORATORY

TESCO

fertilizers europe

Unilever

UNIVERSITY OF ABERDEEN

YARA

HEINEKEN

CFT

CFI Mission Statement

The Cool Farm Institute enables millions of growers globally to make more informed on-farm decisions that reduce their environmental impact.

Initial Focus: GHG impacts

www.coolfarmtool.org

CFT
COOL FARM TOOL

Info for growers

Cool Farm Tool

The CFT is a new greenhouse gas calculator for farming. It is unique in being useful at both ends of the supply chain. Companies can use it to manage supply chain emissions and farmers can use it for decision support. The CFT is free for growers.

Learn more

Case Studies

The CFT has already been used in many countries, for lots of different agricultural systems. These case studies provide examples and evidence of the application of the CFT.

View case studies

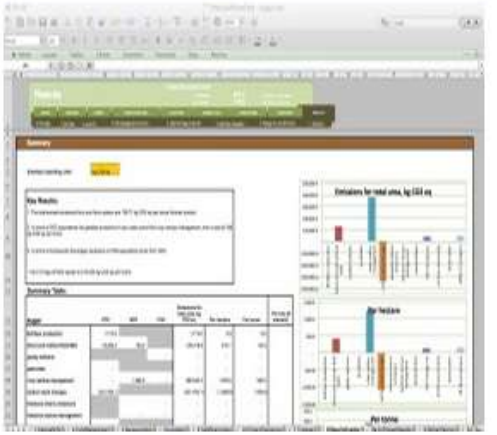
Cool Farm Tool

User Guides
CFT for Potatoes

Cool Farm Tool

Download Cool Farm Tool

The Cool Farm Tool is a greenhouse gas calculator that is free for growers to help them measure the carbon footprint of crop and livestock products.



CFT's user interface is designed to be highly intuitive.

The CFT was originally developed in collaboration between Unilever and researchers at the University of Aberdeen to help growers measure and understand on-farm greenhouse gas emissions. The tool is designed to be simple to use, but scientifically robust in the complex arena of carbon accounting. The CFT has been trialled and adopted by a range of multinational companies to enable them to work with their suppliers to measure, manage and reduce greenhouse gas emissions in the effort to mitigate global climate change.

The CFT is a farm-level greenhouse gas emissions calculator based on empirical research from a broad range of published data sets. It is designed to be approachable and easy to complete based on information that a farmer will have readily available. The tool identifies hotspots and enables farmers, simply and quickly, to test alternative management scenarios that will have a positive impact on the total net greenhouse gas emissions. Unlike many other agricultural greenhouse gas calculators, the CFT includes calculations of soil carbon sequestration, thereby enabling users to recognize one of the key features of agriculture that has both mitigation and adaptation benefits.

The CFT was vetted, improved and adapted over two years (2010-12) through the global farming

Current status

- Distribute the tool
- Formalise management structure
- Software Development with Best Foot Forward and CLM (October 2012-April 2013)
- Partners and members working collaboratively on a joint approach to agricultural GHG mitigation
- Identify crop and region best (good) practices

Online CFT Mock-up

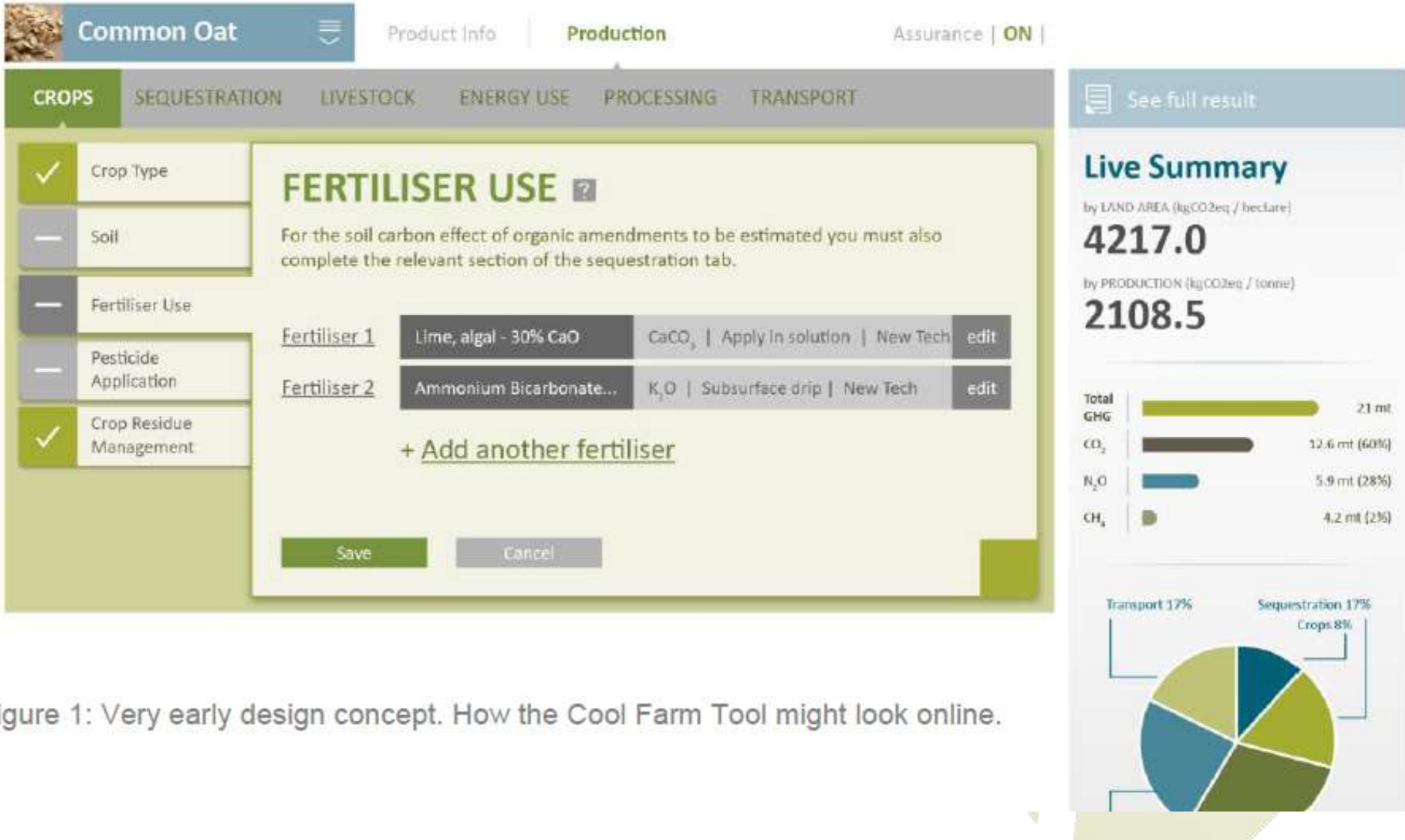


Figure 1: Very early design concept. How the Cool Farm Tool might look online.

Summary

- End-user led
- Farm focused and practical
- Focal point for growing user/developer/stakeholder communities
- Goal is shared learning

Acknowledgements

- **CFI:**
  - Christof Walter (Unilever)
  - Daniella Malin (Sustainable Food Lab)
  - Hal Hamilton (Sustainable Food Lab)
  - Mark Pettigrew (PepsiCo)
  - Carmel McQuaid (Marks & Spencer)
  - Andrew Yeo (Tesco)
  - Frank Brentrup (Yara)
  - Richard Heathcote (Heineken)
  - Christian Pallière (Fertilizers Europe)
  - Simon Miller and others (Best Foot Forward)

- Jon Hillier
  - NERC, Knowledge exchange fellowship scheme

CFT