A vision for farming in 2050

- climate and environmentally friendly farming and healthy diets by 2050
- giving UK farming a secure future
- while farming does more than other industries to cut ghg emissions by storing Carbon in the soil – will cover:
  - nature of the changes needed
  - assumptions about the future
  - what will drive change
  - soil C – what organic systems can achieve
  - what else will organic farming deliver

Background – revolution or incremental change?

The UK Government's Chief Scientist's 'perfect storm' of rising demand for food, feeding the hungry and climate change "…requires changes in the way food is produced, stored, processed, distributed and accessed that are as radical as those that occurred during the 18th-19th century industrial and agricultural revolutions and the 20th century Green Revolution. Increases in production will have an important part to play, but they will be constrained as never before by the finite resources provided by the earth's lands, oceans and atmosphere."

Food Security: The Challenge of Feeding 9 Billion People; H. Charles J. Godfray, John R. Beddington, Ian R. Crute, Lawrence Haddad, David Lawrence, James F. Muir, Jules Pretty, Sherman Robinson, Sandy M. Thomas, Camilla Toulmin

Background – what is ‘sustainable farming’?

“…it is now widely recognized that food production systems and the food chain in general must become fully sustainable. The principle of sustainability implies the use of resources at rates that do not exceed the capacity of the earth to replace them. By definition, dependency on non-renewable inputs is unsustainable even if in the short-term it is necessary as part of a trajectory towards sustainability.”

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Assumptions – ghg cuts and food

- UK 80% target for emissions reductions across all sectors will remain, or rise to 90% before 2050 given science and decision to allow air travel to make no overall cuts
- agriculture can exceed 80% target
- agricultural land in the UK will be used mainly for food production (more food for people, less for animals) – not biofuels or big biomass – less reliance on imports

Assumptions – population and diet

- UK and world population grows to 2050
- significant changes to current diets in line with WHO and UK health departments' policies (UK and internationally) – direct cost to NHS of diet-related ill health £6 bn p.a.
- globally, large reductions of grain-fed meat and dairy in the North and West, and no significant increase in diets high in grain and protein fed (intensive) meat in the South and East – we stop exporting the diet killing us to the developing world
- secure, affordable, accessible, adequate and healthy food supply remains a political priority

Assumptions - inputs

- farming will face increasing scarcity and higher prices of key inputs
- rain and rain-fed irrigation main source of water
- phosphates and nitrates continue to be available from renewable sources (solar for N, recycling human and animal wastes for P & K) but mined phosphates and fossil fuel based N increasingly too expensive (tipping point for N from oil to clover around $200 a barrel – starting to happen on grass at $140 a barrel)

Assumptions – yields and resource use

- increases in yield achieved through crop breeding and best practice
- after 60 years of almost no crop or breed development for low input and organic systems, very significant increases in output/resources used/hectare reasonably expected
- key measure of output will be tonnes of protein, nutrients and roughage used in human diet per tonnes or calories of resources used, per hectare – not current crude ‘tonnes per hectare’

Assumptions - welfare

- current trend of continuously higher welfare standards continues
- by 2050 industrial/factory systems of animal (meat and dairy) production ended due to market pressures (unacceptability of imported soya from Latin America and increasing demand for open-ness about welfare standards), carbon footprint of products that includes land use changes in Latin America, and EU law

Key assumption - farming has to deliver multiple outcomes

Farming in the EU (and UK) will have to meet multiple objectives (all based on current policies and/or trends):

- dramatically reduced ghg emissions
- a healthier diet based on mainly locally produced, seasonal, unprocessed food, with less meat and dairy products overall (proportionately more grass-fed dairy and red meat, significantly less grain and protein fed pork and chicken)

…farming has to deliver multiple outcomes

- providing more and more rewarding jobs and contributing to the economic and social well-being of rural areas
- far higher levels of farmland wildlife
- far higher levels of animal welfare
- significantly less diffuse pollution
- maintaining smaller farms and farming in remote areas, the uplands and mountains
- lower or no use of any persistent, bio-accumulative, hormone disrupting pesticides

…farming has to deliver multiple outcomes

- improved drought resistance (deeper and denser rooting crops)
- improved natural resistance to disease and other pressures
- less or no use of irrigation except where rainfall used
- improved water holding capacity, reducing speed and scale of run-off after heavy rains
- conserving and building fertile soils

A note on diet

In England, the Climate Change Committee's current scenarios do not take into account any possible attempts to change diet. They assume diet and thus farming-as-usual. CCC say:

"Lifestyle change may offer significant abatement opportunities, for example if diets were to shift towards less carbon intensive food products. The analysis that we have carried out, however, does not cover changes in demand. We recognise that this is an important area to consider going forward, and intend that it will form part of our future work programme."

In all current scenarios for farming in 2050, diets are assumed to have changed radically.

What will drive change?

Costs of inputs:

• price of fertiliser inputs – N (driven by rising fossil fuel prices), and P (driven by increasing scarcity)

and the market:

• dietary change in response to public health policies and campaigns (Michelle Obama)

• public expectations (as displayed in most food marketing) of high animal welfare, small scale production, wildlife friendly, pesticide free

What will drive change?

In England, policy drivers (including the UK's stringent ghg emission targets and EU-driven policy instruments like the reformed CAP) will tend to follow market signals rather than lead changes in farming.

Policy may prove more effective in Scotland and Wales, because of the closer match between the health and climate agendas, the greater political priority given to farming, and maybe greater political willingness to influence the market, putting farmers in those countries in a better position.

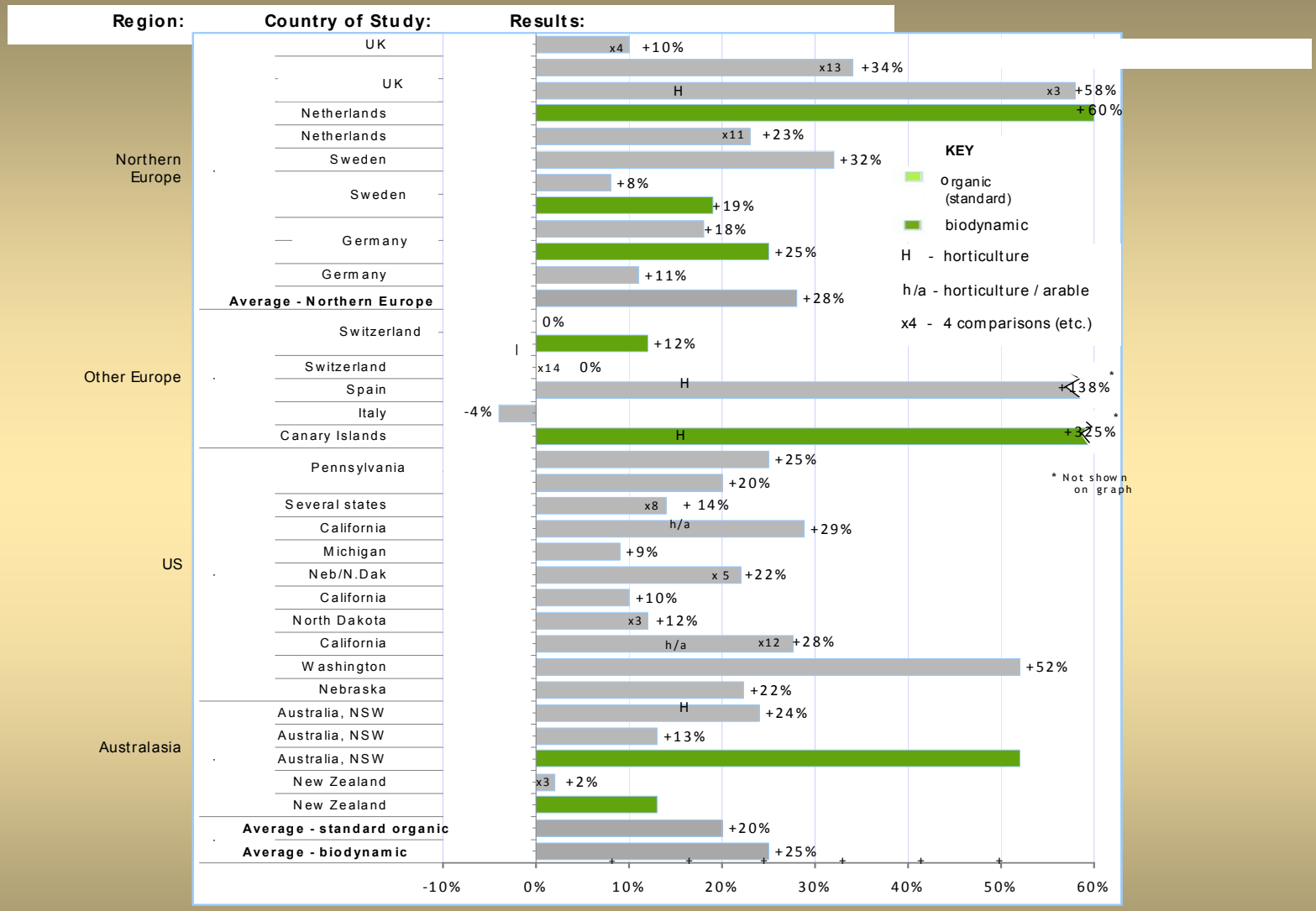
Alternative set of assumptions

- farming exempt from full 80% ghg cuts – reductions in ghgs mainly via 'efficiency' – more output/yield for same inputs
- public health concerns ignored, consumption of meat and dairy increases in line with population growth – and any trend to healthier diets is reversed, plus massive change in diets to widespread acceptance of GM food
- farming is not 'sustainable' – does rely on non-renewable inputs
- N and P supplies same or up to increase in output; water not a constraint
- biofuels and biomass production increases – UK and local food production less important – imports fill gap
- GM N fixing wheat and other crops provide magic bullet
- farm animals kept in larger units (8,100 dairy in Lincs) – welfare not an issue; most protein (GM) grown in vats – livestock not connected to land
- main policy drivers Government policy – promoting GM, subsidising biofuels
- farming outputs biofuels and food – landscape, wildlife, social/jobs, farming in remote areas – all only achieved via specific, increased public funding

Soil carbon & climate change

- Soil carbon is a key issue both for reducing greenhouse gases (GHGs) and for climate adaptation
- soil carbon accounts for $^{1}/_{10}$ all CO_2 emitted since 1850
- unlike fossil fuels, the carbon lost from soil is reversible
- tiny increases in soil carbon levels (<1%/year) mean removal of millions tC at national level, >bn tC globally
- agriculture is key: accounts for most soil carbon losses.

Organic farming soil carbon levels compared to non-organic farming – summary of studies



References, in order:

Northern Europe: UK, Gosling & Shepherd, 2005; UK, Armstrong Brown *et al*, 2000; Netherlands, Pulleman *et al*, 2003; Netherlands, Pulleman *et al*, 2000; Sweden, Kirchmann *et al*, 2007; Sweden, 'K-trial'; Germany, IBR Darmstadt trial; Germany, Friedel *et al*, 2008

Other Europe: Switzerland, FiBL 'DOK' trial; Switzerland, Oberholzer *et al*, 2000; Spain, Melero *et al*, 2006; Italy, Marinari *et al*, 2007; Canary Islands, Garcia *et al*, 1989

US: Pennsylvania, Rodale Institute FST trial; US, Marriott & Wander, 2006; California, 'LTRAS' trial; Michigan, Robertson *et al*, 2000; Nebraska/North Dakota, Liebig & Doran, 1999; California, Clark *et al*, 1998; North Dakota, Gardner & Clancy, 1996; California, Drinkwater *et al*, 1995; Washington, Mulla *et al*, 1992; Nebraska, Fraser *et al*, 1988

Australasia: Australia, NSW, Wells *et al*, 2000; Australia, NSW, Derrick & Dumaresq, 1999; Australia, NSW, Forman, 1981; New Zealand, Nguyen *et al*, 1995; New Zealand, Reganold *et al*, 1993

Results of the comparative studies

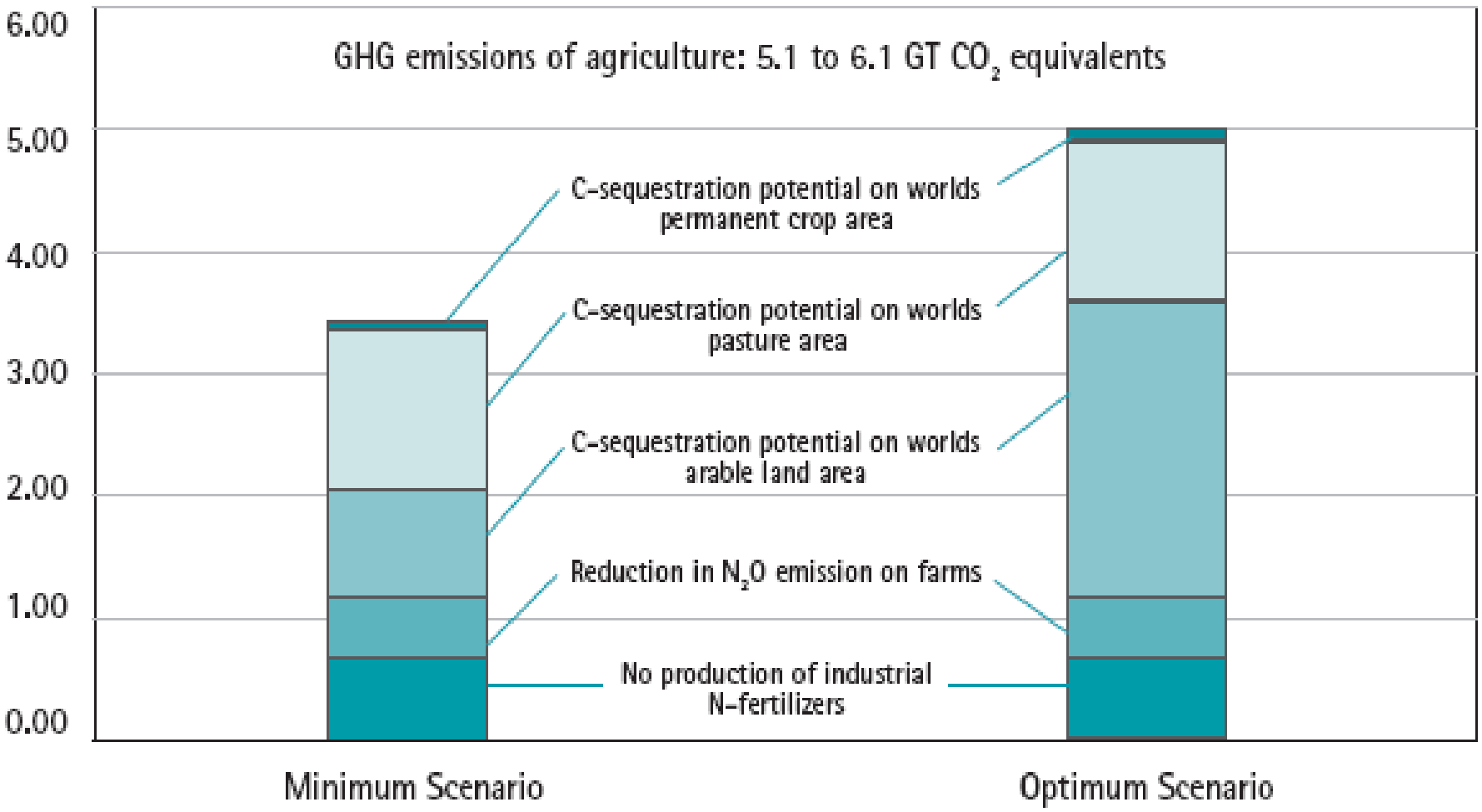
- The review covered over 100 individual comparisons, and included both controlled trials and farm surveys.
- On average, organic farming produces **28% higher soil carbon levels than non-organic farming in Northern Europe**, and 20% higher levels for all regions studies (Europe, US & Australasia).
- For the UK, we estimate this represents a sequestration rate of **+560kgC/ha/yr** ($2tCO_2$) for each hectare converted to organic farming, for the next 20 years (the crucial time period in climate change terms).

Estimates of soil carbon sequestration levels

On this basis **and considering only soil carbon impacts**, widespread adoption of organic farming:

- at a national level: would remove **3.2million tC per year and offset at least 23% of UK agriculture's official GHG emissions** (very conservative estimate);
- globally: could perhaps remove **1.5billion tC per year and offset c.11% of global GHG emissions**.
- these figures are for arable land converted to organic farming systems only **(soil C gains from grassland would be additional – and are being considered in report to WAG)**

GHG reduction and mitigation potentials



- 3.5 GT reduction in CO_2e is a 57% reduction in global agriculture's current 6.1 GT emissions

- 5 GT reduction is an 82% cut

Dynamics of the soil carbon store

- Most fresh organic matter is decomposed and rapidly releases its carbon as CO_2.
- Normally only a small amount is converted to stable soil carbon (humus), eg. just 5-7% of the carbon in straw.
- There are therefore effectively **two** connected cycles of carbon in the soil: 1) the fast cycling of carbon that provides nutrients for crops in organic systems, and 2) the very slow cycling of carbon via humus.

Why organic farming creates more soil carbon

- Organic farming is based on inputs of organic matter to the soil and its decomposition by microbial activity
- this releases nutrients for crops **and** produces humus.
- key aspects of organic farming that raise soil C levels:
  - supply of additional organic matter sources (eg. grass leys)
  - use of forms of organic matter that are more effective
  - integration of crop and livestock systems
  - greater level of vegetation cover (eg. green cover crops)

Conclusion

- There is now solid evidence that organic farming produces higher soil carbon levels than non-organic farming (around +28% in Northern Europe).
- This translates into significant levels of carbon sequestration: about 3.2million tC/yr in the UK (very conservative estimate) & maybe c.1.5bntC/yr globally.
- Organic farming produces this benefit as a by-product, without taking land out of food production, while also…..

while also:

- increasing farmland biodiversity by 30% (species) and 50% (numbers)*
- increasing jobs on farms by 73%**
- reducing pesticide use by 98%**, and fertiliser use by 95%**
- eliminating most diffuse pollution
- eliminating factory reared pigs and poultry, and ensuring high welfare standards
- providing the best system to produce food in poorest countries (IAASTD, UNCTAD)

* Hole et al

**'England and Wales under organic agriculture: how much food could be produced'; Centre for Agriculture Strategy, University of Reading; 1998

If all England and Wales organic (Reading University):

- all organic agriculture could produce more (and healthier) beef and lamb - up 168% and 155% on current levels
- chicken, egg and pork production roughly 1/4 of current levels
- wheat and barley production would drop by 30%, but we'd feed far less grain to animals (currently half we grow goes to animals), and could have as much wheat and barley for human consumption as we have now
- production of field peas and beans similar to now; production of oats and other cereals rises from current levels
- if we stop growing sugar beet (likely in this time period) we could grow a similar tonnage of potatoes as at present
- dairy production down by 30%-40%, unless dairy farms and dairies return to parts of the country which have lost them
- fruit and vegetable output maintained and could increase in response to demand

A final point:

- farming has to meet multiple objectives
- these objectives are going to be most efficiently met with a system that delivers all (or almost all) the objectives, as organic farming does, rather than relying on a myriad of policy interventions to try and achieve each one separately
- ideally we will go for a system - as with organic - where any compliance costs (inspection and certification) are met by farmers not taxpayers, and that has existing market support
- often specific interventions will work against each other – increasing output of milk per cow to reduce GHGs will tend to worsen animal welfare; planting trees will reduce land available for growing food
- piecemeal approaches increase administrative burdens on farmers and costs to taxpayers – but reductionist approaches appeal to UK policy makers (and scientists), and typically systemic changes are avoided until the last possible moment.