NATIONAL SOIL CARBON PROGRAM

Queensland Government
Department of **Science, IT and Innovation**

Land use impacts on soil carbon stores and opportunities to reduce greenhouse gas emissions

Ram Dalal

Department of Science, Information Technology and Innovation

NATIONAL SOIL CARBON PROGRAM

Australian Government
Department of Agriculture

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Program lead:

Queensland Government
Department of **Science, IT and Innovation**

Project leads:

THE UNIVERSITY of ADELAIDE

FUTURE FARM INDUSTRIES CRC

JAMES COOK UNIVERSITY AUSTRALIA

Department of Environment and Primary Industries

State Government Victoria

QUT

gcs

Government of Western Australia
Department of Agriculture and Food

NSW Government
Department of Primary Industries

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CSIRO

une University of New England

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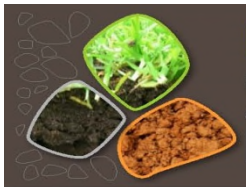

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Acknowledgements

Project Leaders and their project teams:

Dr Diane Allen (DSITI), Dr Keryn Paul (CSIRO), Dr Jonathan Sanderman (CSIRO), Dr Tim Smith (QDAF), Dr John McGrath / Dr Richard Hayes (CRC FFI/NSW DPI), Prof. Michael Bird (JCU), Dr Mark Farrell (CSIRO), Dr Jeff Baldock (CSIRO), Mr James Schultz (GCS), Dr Frances Hoyle (DAFWA), Dr Fiona Robertson (DEDJTR), Dr Glenn McDonald (UoA), Dr Cathy Waters (NSW DPI), Dr Richard Conant / Dr Clemens Scheer (QUT)

NSCP Investor Advisory Group:

Chairperson - Dr Beverley Henry (QUT), Dr Paul Lawrence (DSITI), Dr Brian Keating / Neil McKenzie (CSIRO), Dr Sue Carstens (QDAF), Dr John McGrath (CRC FFI), Dr Paul Nelson (JCU), Dr Jenny Sinclair (GCS), Dr David Bowran (DAFWA), Dr Michael Crawford / Dr Tom Baker (DEDJTR), Dr Ann McNeill (UA), Dr Georgina Kelly (NSW DPI)

DAFF/DoA representatives:

Lee Nelson, Jonathan Terlich, Margie Eddington, Dr Steve McMaugh, Dr Zaman Nuruzzaman

In addition:

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Numerous landholders from all over Australia, Department of the Environment (Rob Sturgiss, Shanti Reddy, Rachel Burgess, Joe Pryor, Richard Chisolm, Zoe Sinclair, Steve Refshauge), and rural industries, including GRDC (Jan Edwards), MLA (Dr Tom Davison), Dairy and Horticulture, SRA, RIRDC (Dr Simon Spiers).

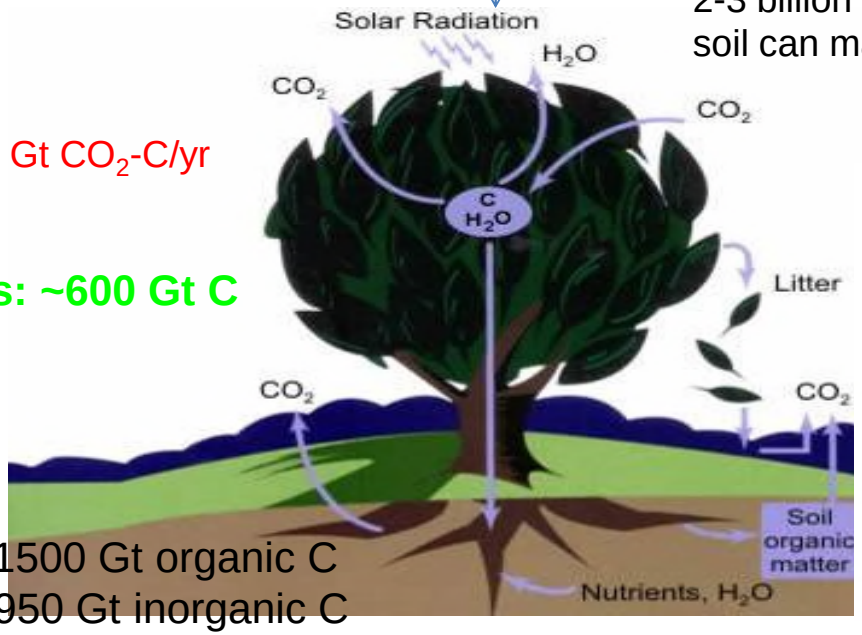
Atmospheric CO_2 852 Gt C = 400 ppm)

Fossil fuel ~10 Gt CO_2-C/yr

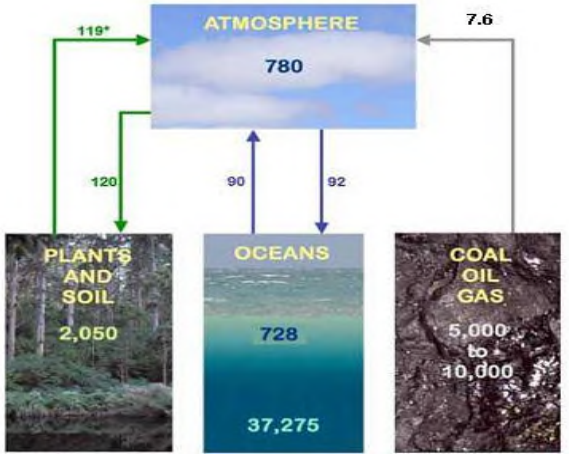
Plants: ~600 Gt C

Oceans

Soil: ~1500 Gt organic C
~ 950 Gt inorganic C

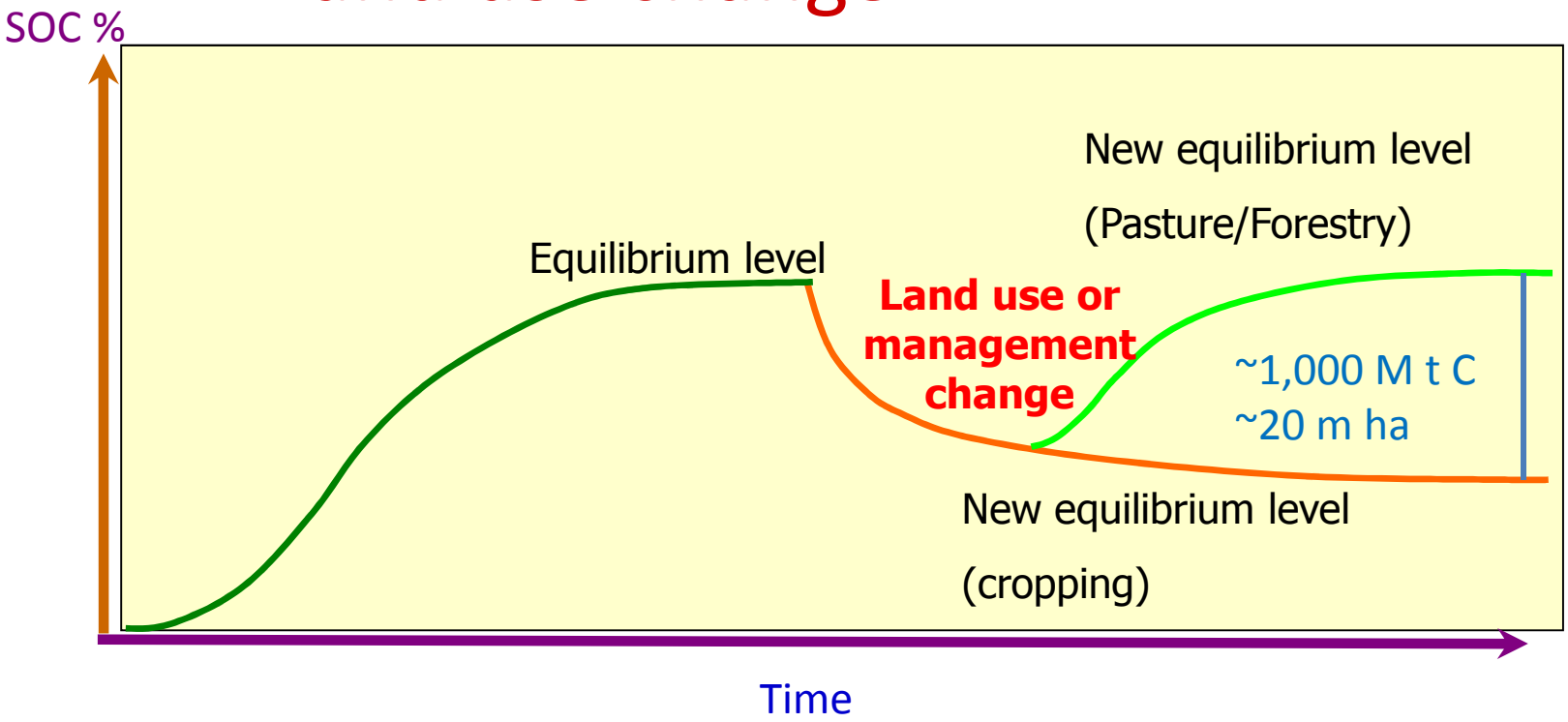


2-3 billion tonnes/year carbon sequestered in soil can make a difference!



Courtesy of Landcare Research, New Zealand

Land use change



Aims:

- Develop and deliver most effective and practical strategies for managing soil carbon
  - Increasing and / or reducing the loss of soil carbon
  - Improved modelling capability
- Land use impacts on soil carbon stores:
  - Vegetation management
  - Management practices
  - Organic amendments
- Continuing Need for Research

o Improved measurements to reduce uncertainty and costs

o Win-win for agriculture and natural resources

Vegetation management

- Reforestation or plantation forestry as well as afforestation of previously abandoned agricultural lands increase soil organic carbon

Project Leader Tim Smith (DAFF,QLD) soil carbon sampling in a spotted gum (*Corymbia citriodora* sbsp. variegata) plantation and adjoining pasture at Binjour, QLD

Vegetation management

- Understanding carbon (and nitrogen) in vegetation management is critical to the increasing productivity of food, fibre and energy from the land.

- Reforestation of pasture land **restored C loss** of 59 t/ha, mostly in the above-ground biomass and tree roots

Courtesy: Tim Smith

Vegetation management

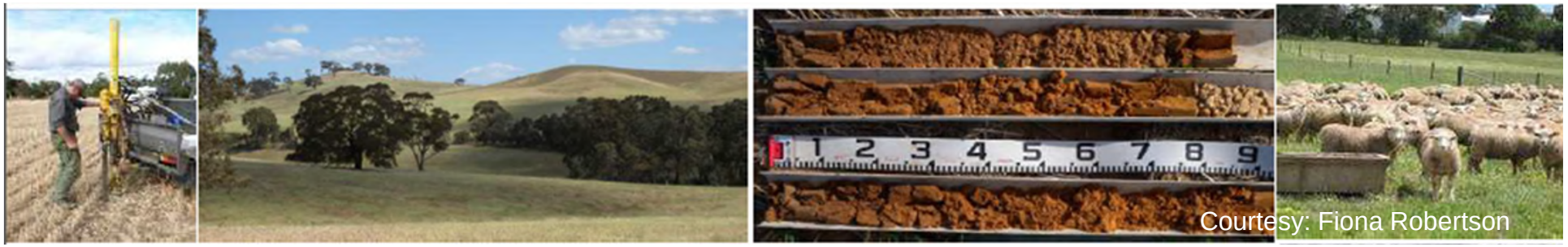
- **SOC stocks** increased by **0.55±0.13** t/ha per year on previously cropped lands, but only **0.24±0.09** t/ha per year on previously grazed lands
- Provide shade for livestock in grazing systems.

CFI Reforestation Modelling Tool (RMT) extension into a single ERF method, '**Modular Forest Sequestration Method**', including soil C stocks in this FullCAM-based method

Fensham and Guymer (2009) Env. Sci. Pol.

Management practices

- Management practices such as **crop residue retention, green trash burning, and no-till** have **negligible effects** on SOC stocks
- Conversion of land use **from cropping to pasture increases soil organic carbon** stocks by **0.1 - 0.2 tonnes carbon/ha per year**. In improved pastures with fertiliser inputs and/or introduced legumes, sequestration rates may be even higher
- Development of the methodology on 'Carbon Credits (**Sequestration of Carbon in Soil Using Default Values) Methodology Determination 2015**' in relation to crop to pasture, no-till, residue retention and fertiliser applications



Management practices

- Retention of crop residues and plant matter provides ground cover, which is essential to reduce soil erosion and soil organic carbon loss by water or wind erosion
- Reducing the **total grazing pressure** (excluding non-stock animals) had SOC stock 8.7 t/ha higher than total grazing pressure for some soils (Kandosols)
- It is essential to consider the total grazing pressure (both stock and non-stock animals) rather than domestic livestock only

Courtesy: Cathy Waters

Organic amendments

- Consistent yield increases of up to **25%** were recorded in field trials from combined compost and biochar used for sugarcane, banana, maize, papaya and peanut crops in northern Queensland.
- **Biochar** applied at 10 t/ha may sequester 5.4 t C/ha, but **compost** (25 t /ha) only 0.04 t C/ha, combined compost and biochar (COMBI, 25 t/ha), **1.4 t C/ha**




Field Sites – Courtesy: Michael Bird

Organic amendments

- Organic amendments increase the stocks of soil carbon and many amendments such as composts and manures are a good source of plant nutrients.
- Applying these amendments ensures sustainable land use and increased productivity, however, availability is limited, and transport and application costs may be substantial.

Organic amendment ready to be incorporated into WA Tenosol for an 18 month incubation – Courtesy: Mark Farrell

Continuing Need for R & D

Uncertainty analysis needs to be undertaken **for policy makers** in a format that can easily be understood by end users

Emissions Reduction Fund Update
Emissions Reduction Fund method prioritisation

emissions-reduction-Submissions@environment.gov.au

Emissions Reduction Fund: 1800 852 974

http://www.environment.gov.au/climate-change/emissions-reduction-fund

Improved Measurements and reduced costs of analysis

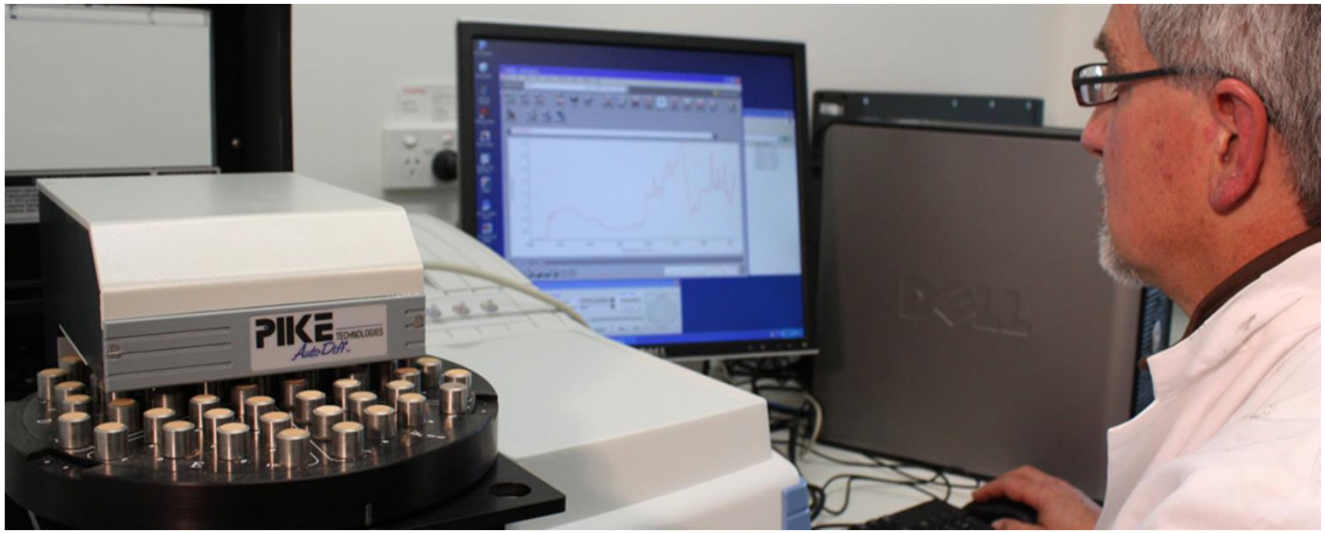
- Measuring soil carbon
  - Combustion such as Leco (expensive)
  - Near-infra red and mid-infra red (cost reduced)
  - Remote-sensing (low cost - in progress)
  - Modelling using Soil carbon models (APSIM, FullCAM-RothC, Century, DNDC and others) (cost further reduced)

Leco carbon analyser measures C by combustion process

Courtesy: Dave Lyons

Improved Measurements

- The ability to rapidly assess SOC fractions and various organic amendments using mid infra-red (MIR) and NIR spectroscopy provides datasets for FullCAM.

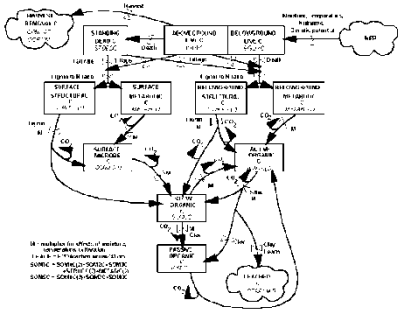


Courtesy: Jon Sanderman

Improved Measurements

- On-the-go *in situ* near infra-red (NIR) field estimation of soil organic carbon stocks has the potential to reduce the cost of soil organic carbon monitoring.

- Remote-sensing to estimate soil organic C and Modelling have potential to reduce costs of monitoring even further.



Courtesy: Jenny Sinclair

Continuing Need for R&D

1. A **statistical and scientific basis** needs to be developed for **identifying paired –sites**, very useful for substituting the 'time' for 'space' factor in lieu of **long-term** experiments
2. **Spatial-explicit information** is required for project-based carbon activities related to **ERF soil carbon methodology**, and rates of **carbon inputs** for **FullCAM-RothC model**
3. Further research is required for developing best management practice for **balancing carbon sequestration, or avoided carbon loss, with plant and animal productivity**
4. **Reforestation** provides one of the largest opportunities to sequester soil organic carbon, but further work is required to **quantify additional benefits from** farm-integrated plantation
5. **Quantify the economic and environmental benefits** from stabilising soil organic carbon
   - decreased **erosion** losses from establishment of riparian plantings and reforestation
   - **restoration** of degraded and highly eroded landscapes
   - **improving agricultural productivity** - fertility, soil structure, biology, shelter belts

Thank you