



Empowering People



Agriculture & Climate

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Where are we Headed?



www.investors.com/cartoons



A dramatic sky with a massive, dark storm cloud formation over a green field. The cloud is dark and textured, with a bright light source behind it, creating a silhouette effect. The foreground is a lush green field with some trees in the distance.

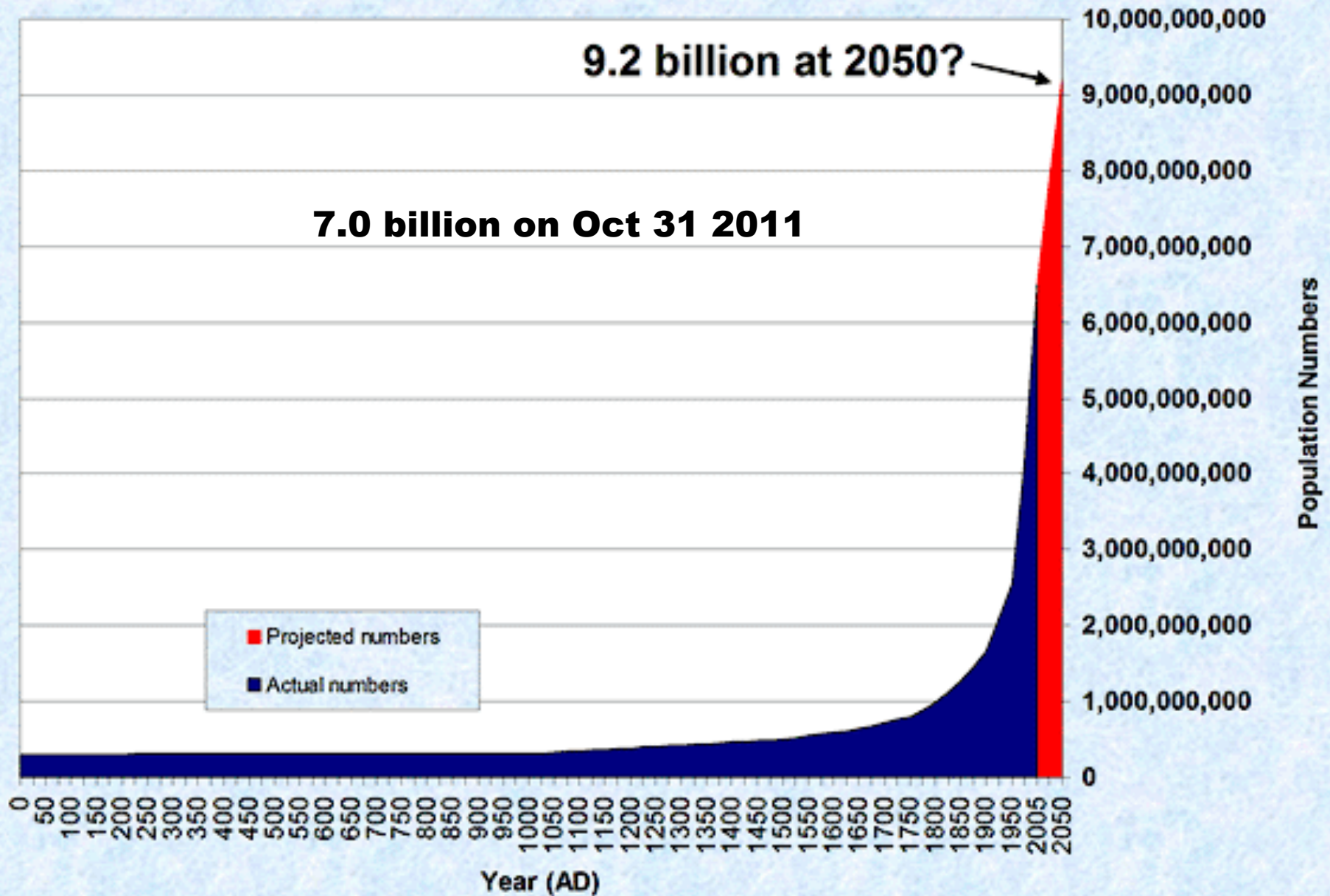
**"MAN IS A FUNNY ANIMAL.
HE CAN ONLY READ THE
WRITING ON THE WALL
WHEN HIS BACK IS UP AGAINST IT."**

**BUT is our back far
enough up against it yet?**

World population growth

Optimum Population Trust

Source: United Nations figures





HOW FAST ARE WE GROWING?

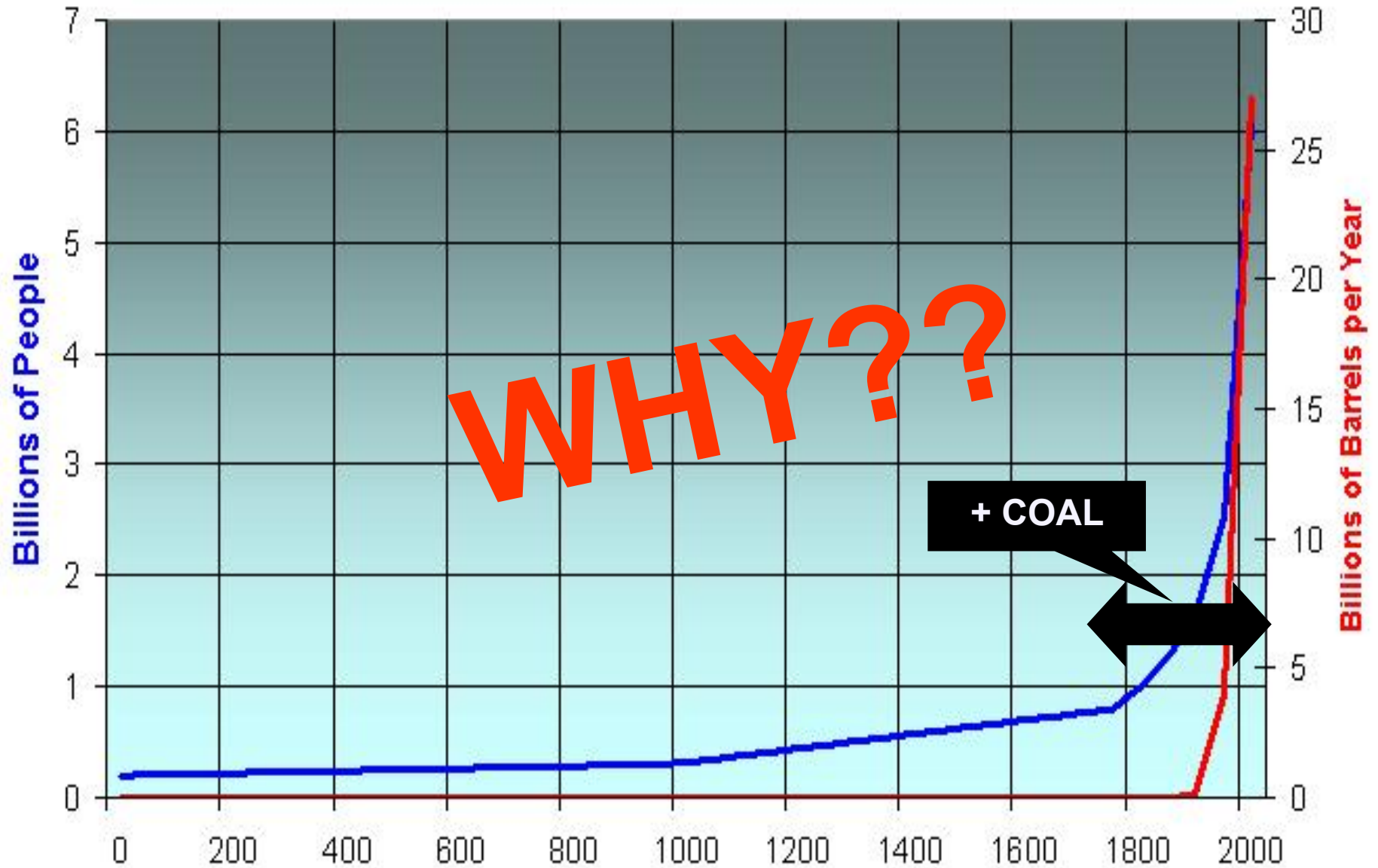
<u>Year</u>	<u>Population</u>	<u>Years to add 1 Billion</u>
1800	<1 Billion	
1930	2 Billion	130
1960	3 Billion	30
1975	4 Billion	15
1987	5 Billion	12
1999	6 Billion	12
2011	7 Billion	12

2016 =
7.5 billion

In the 7,000 years BC, the world population DOUBLED every THOUSAND YEARS !!



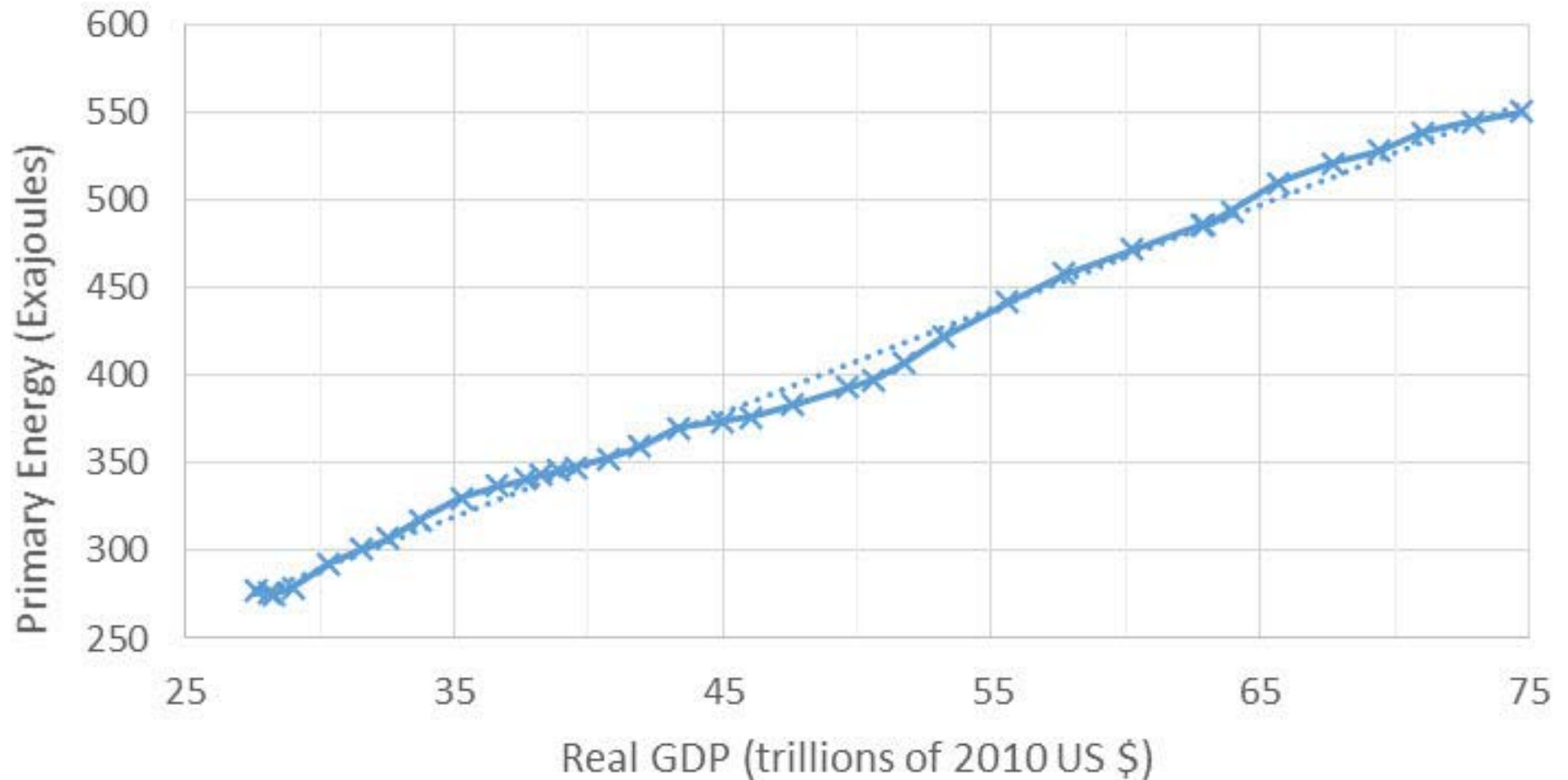
World Population and Oil Production





Energy and growth are linked

Primary Energy vs Real GDP 1980-2015



Positive proof of global warming.



**18th
Century**

1900

1950

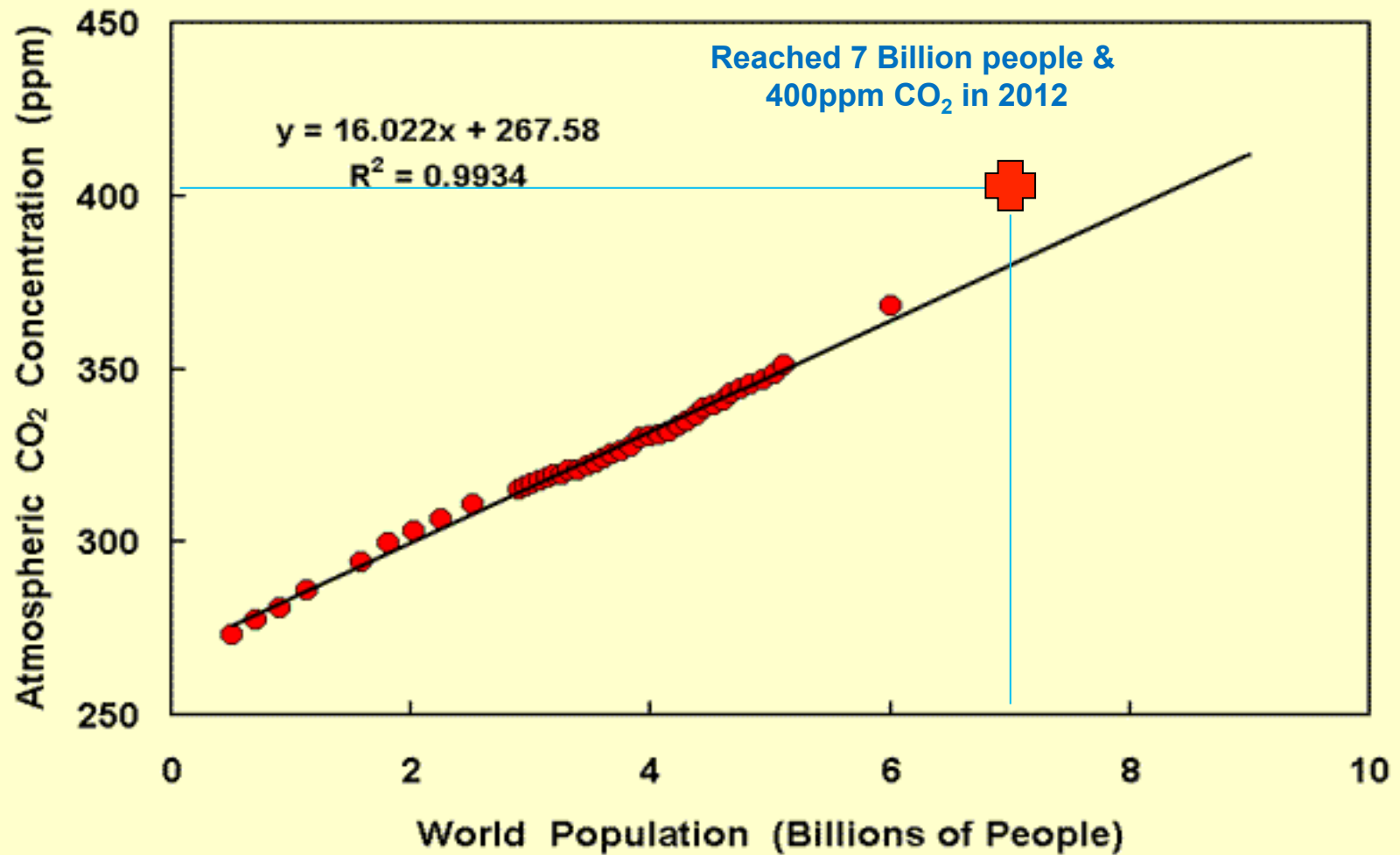
1970

1980

1990

2006

Human Perturbation of the Carbon Cycle:



Petit et al. 1999; Keeling and Whorf 2000



THE FARMING JOURNEY



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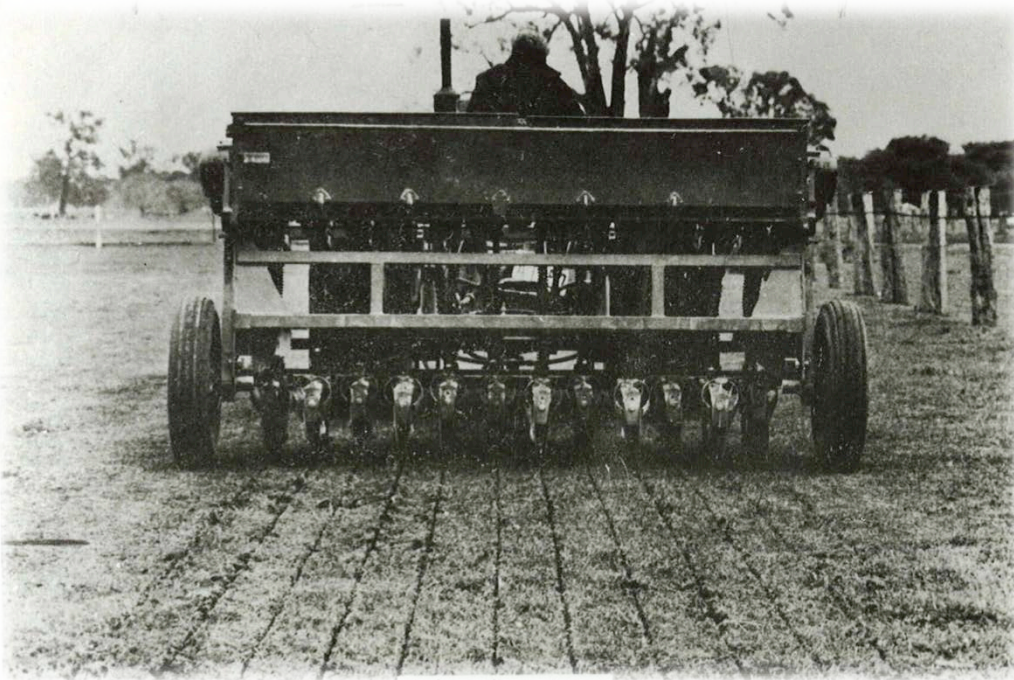


Infrastructure



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Sowing



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Irrigation



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Harvesting



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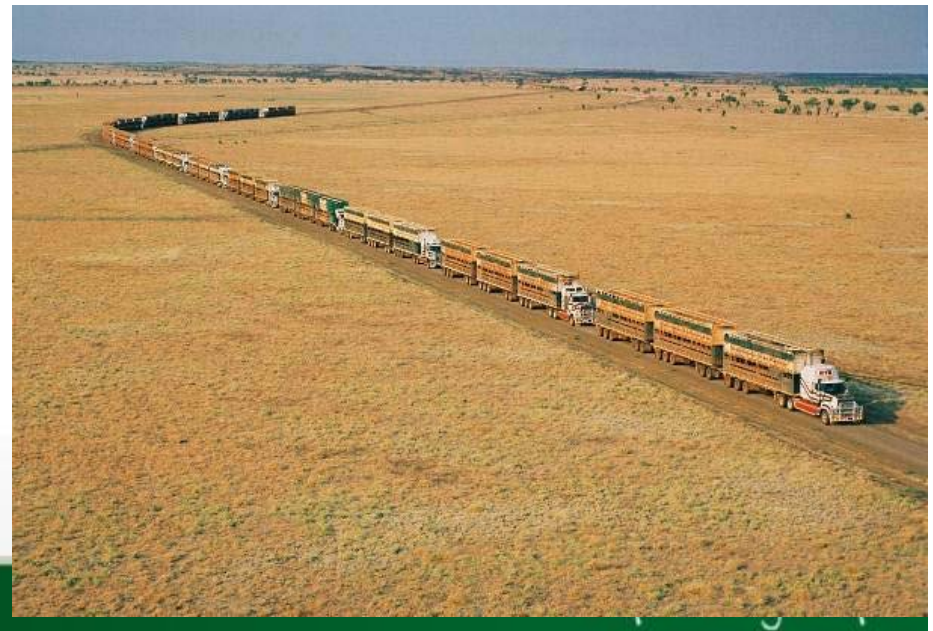


Labour

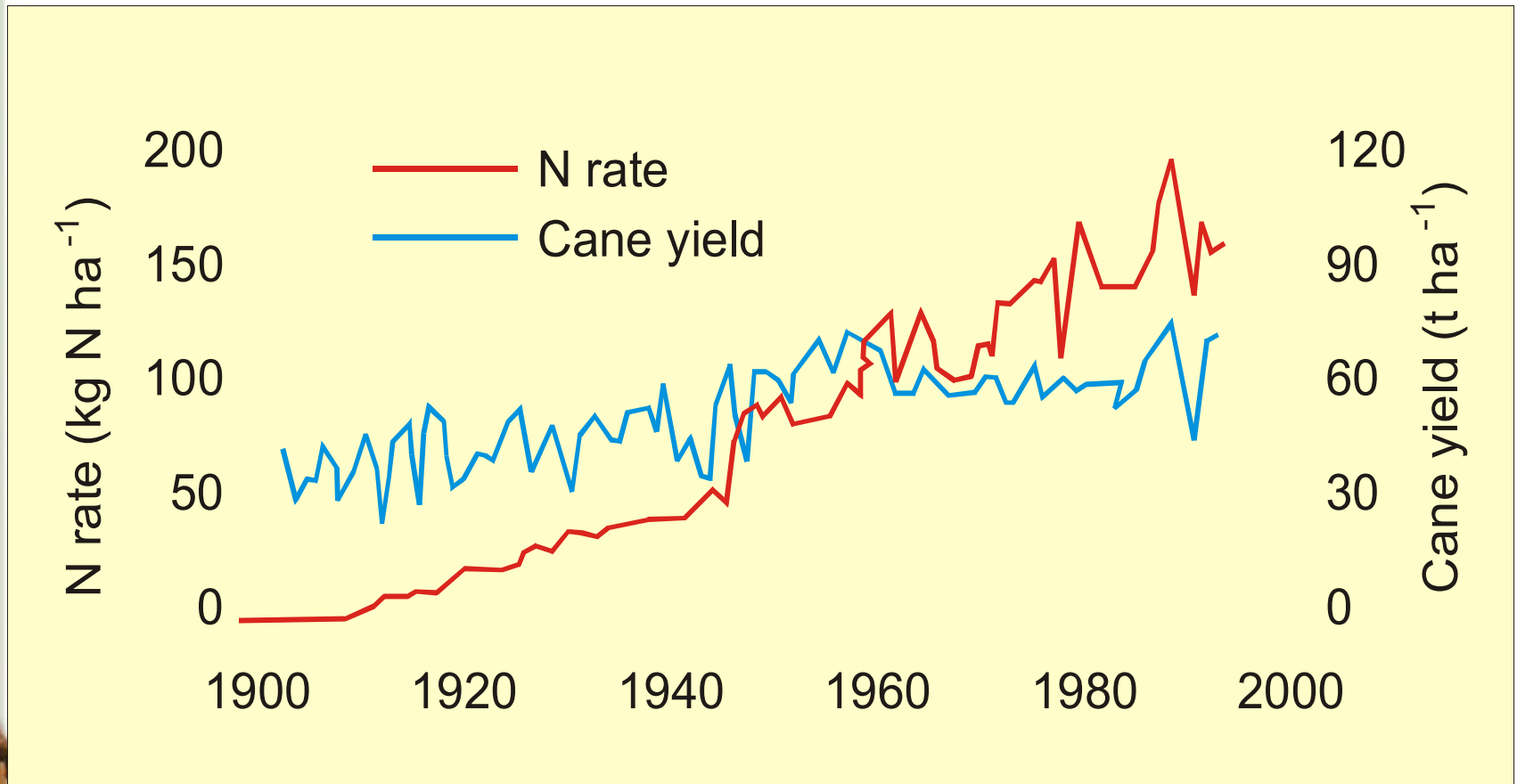


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Transport



Our efficiency is deteriorating

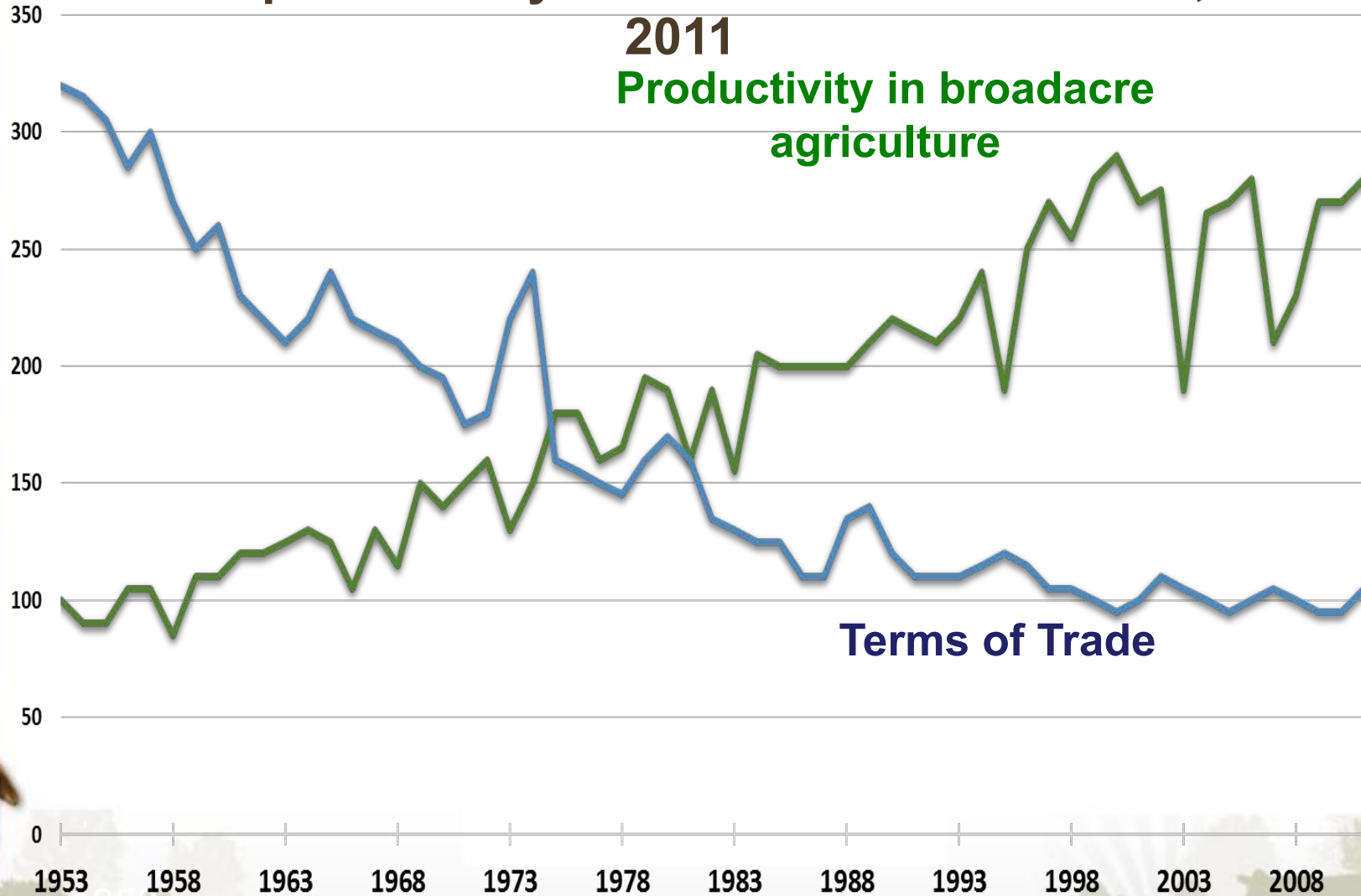


Wood & Kingston 2000



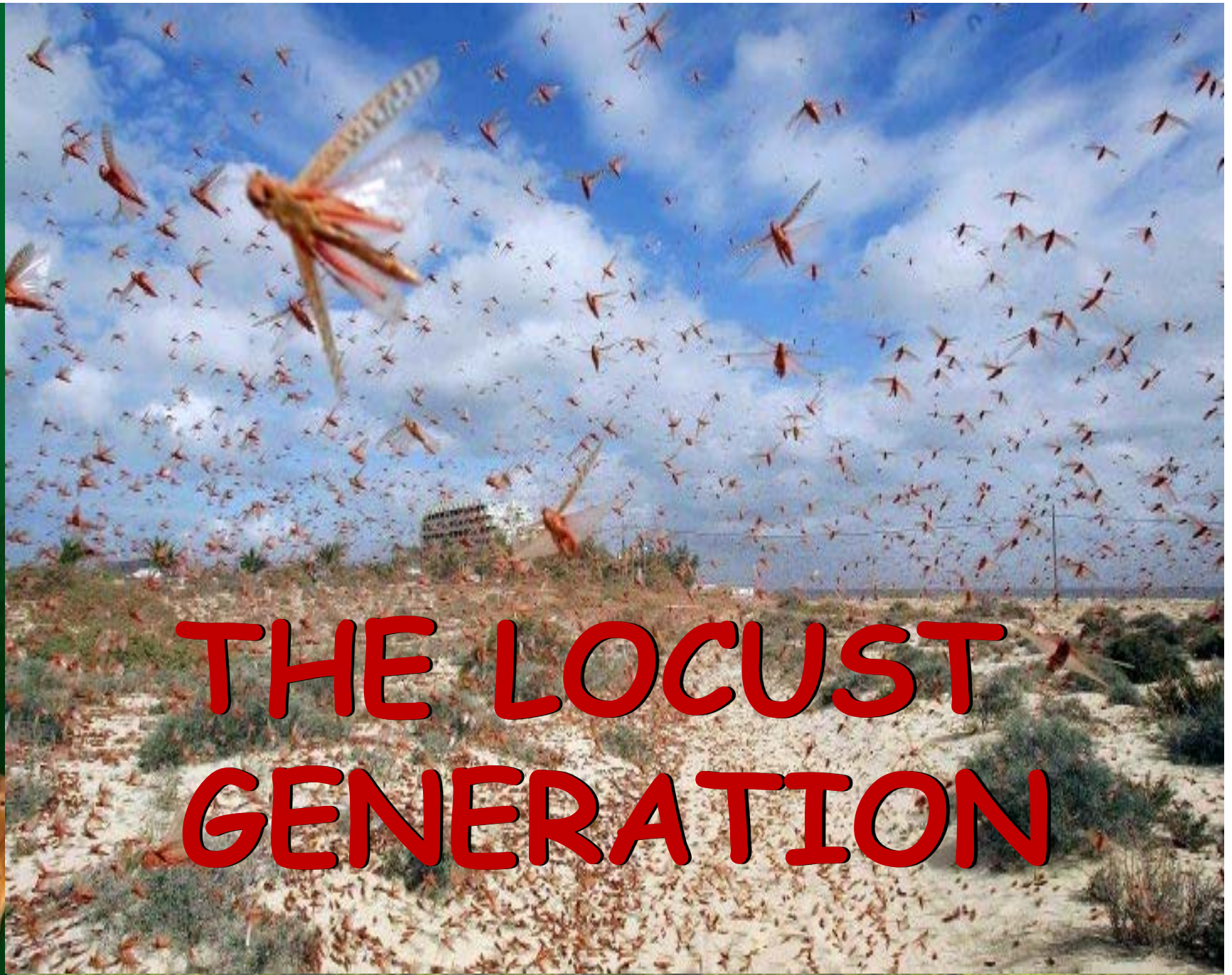
THE RESULTS

Broadacre productivity and farmer terms of trade, 1953 - 2011



Source: ABARE

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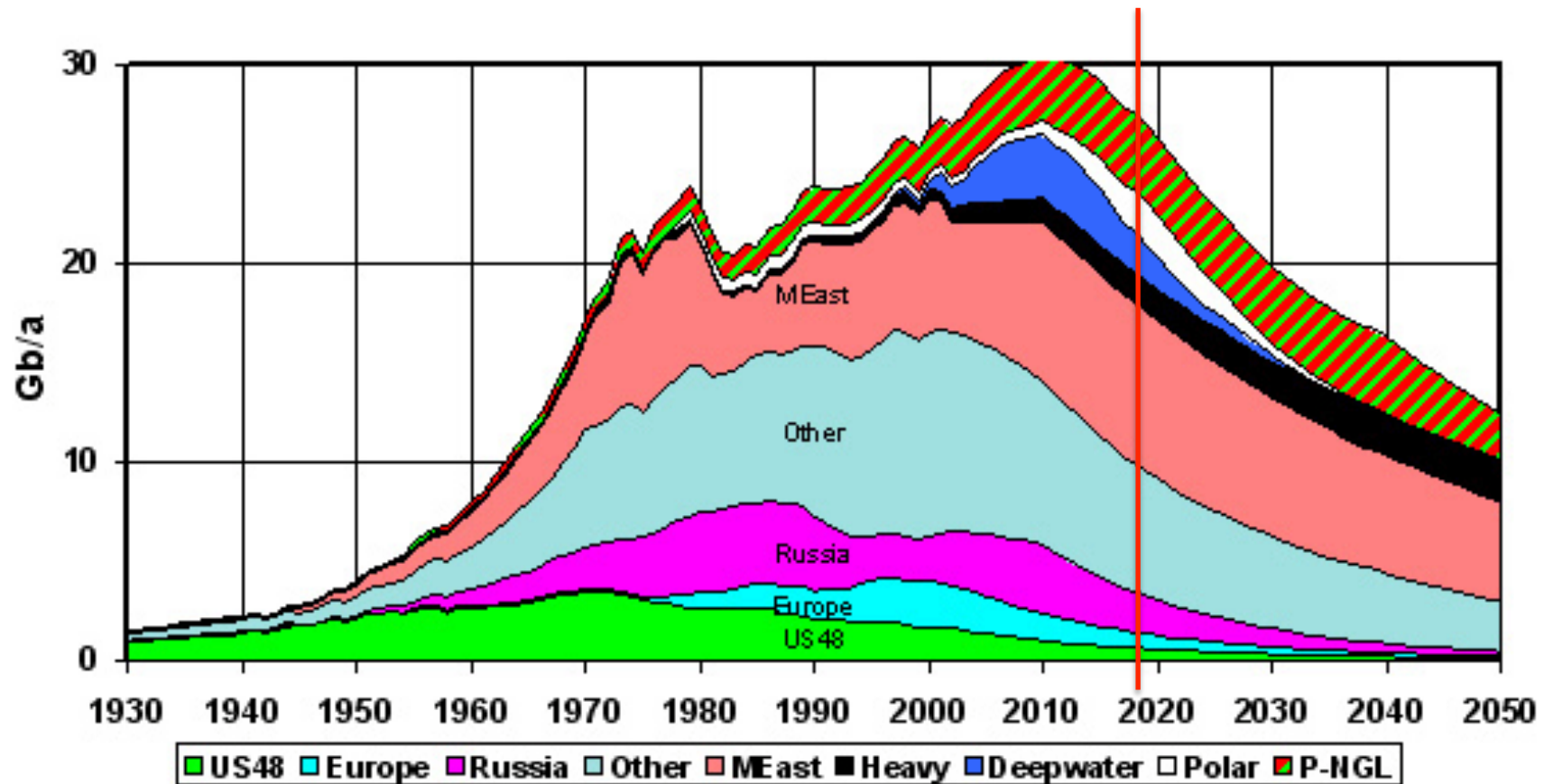
THE LOCUST GENERATION



R

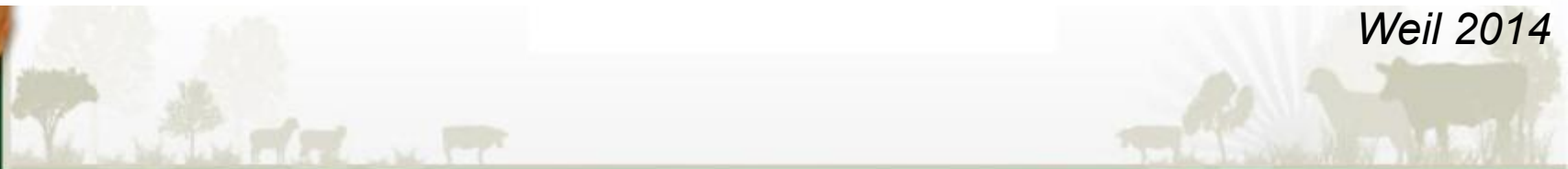
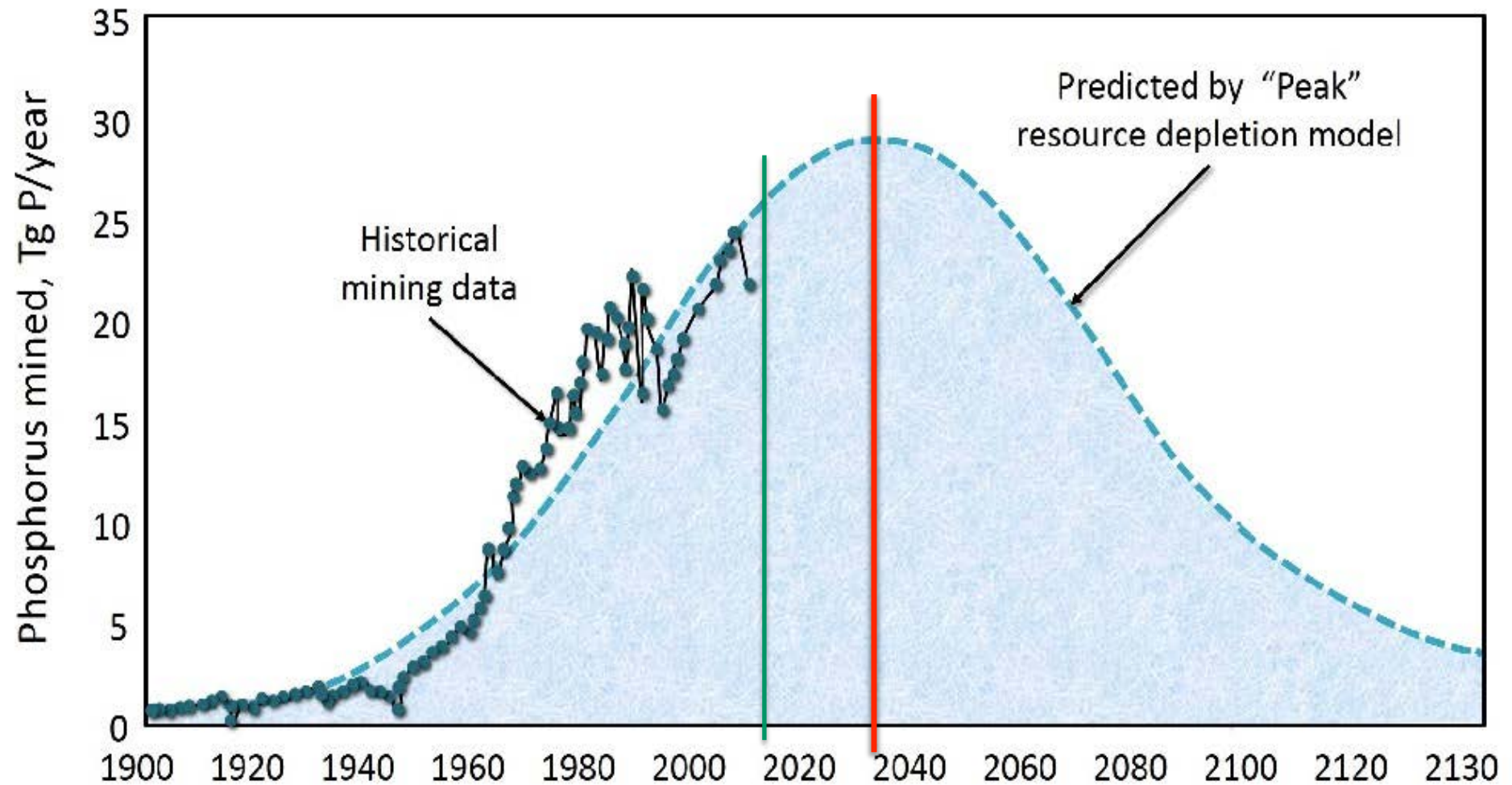
PEAK ENERGY

Regular Oil & Natural Gas Liquids
2003 Base Case Scenario





PEAK PHOSPHORUS



Weil 2014

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PEAK ECOLOGICAL WATER?

Depleting Fossil Aquifers

Ogallala Aquifer in US

Saudi Aquifer

North China Plain

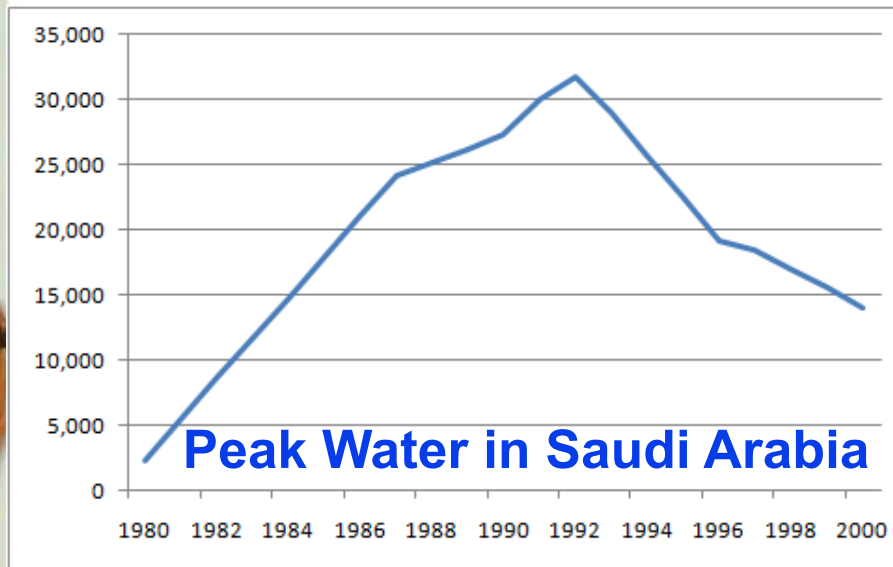


Aral Sea in Kazakhstan

India

15% of India's food supply is produced by mining ground water.

175 million Indians consume grain watered from irrigation wells that will soon be exhausted



Brown 2009.



IS THERE PEAK AGRICULTURAL LAND?

Estimated losses per annum

- Arable land lost to Erosion 7,000,000ha
- Desertification 12,000,000ha
- 19,000,000ha

In addition, agricultural land is lost to:

- National parks (162.8m ha. Aus =21%)
- Urban development (90,000ha/yr in US)
- Mining

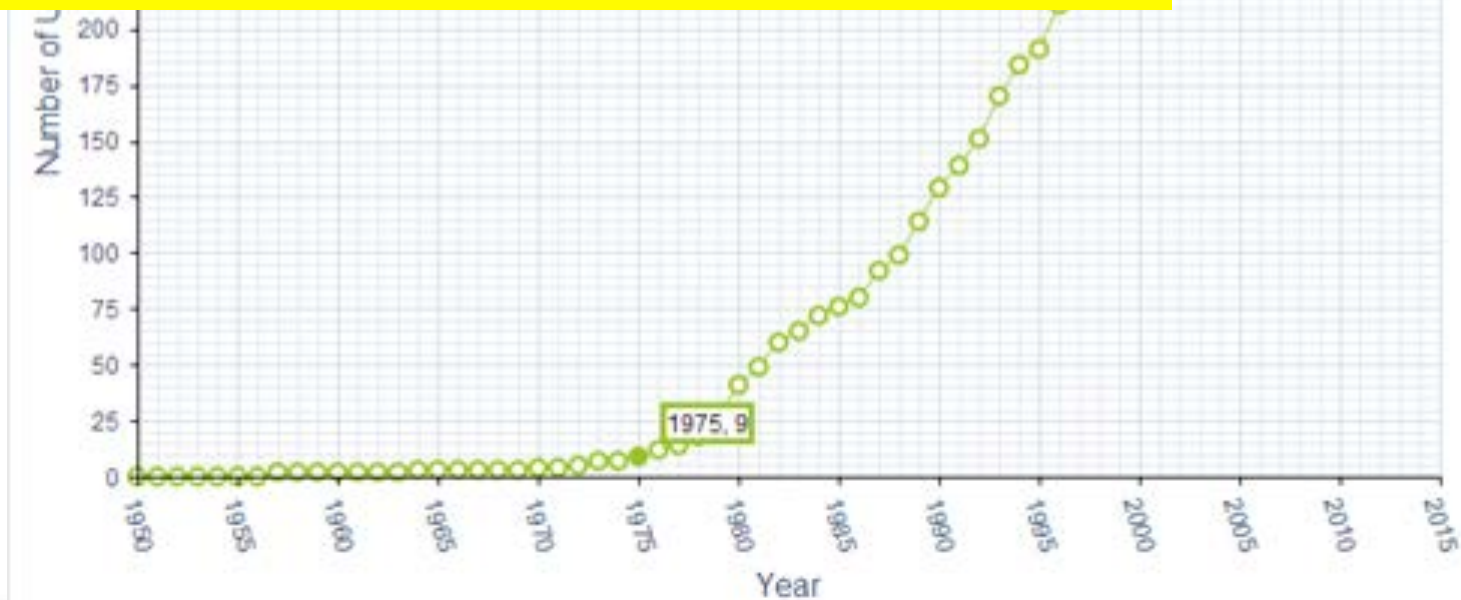
89,000,000ha lost to these 3 plus forestry since 1984 in Australia

World
The A

Resistant Weeds

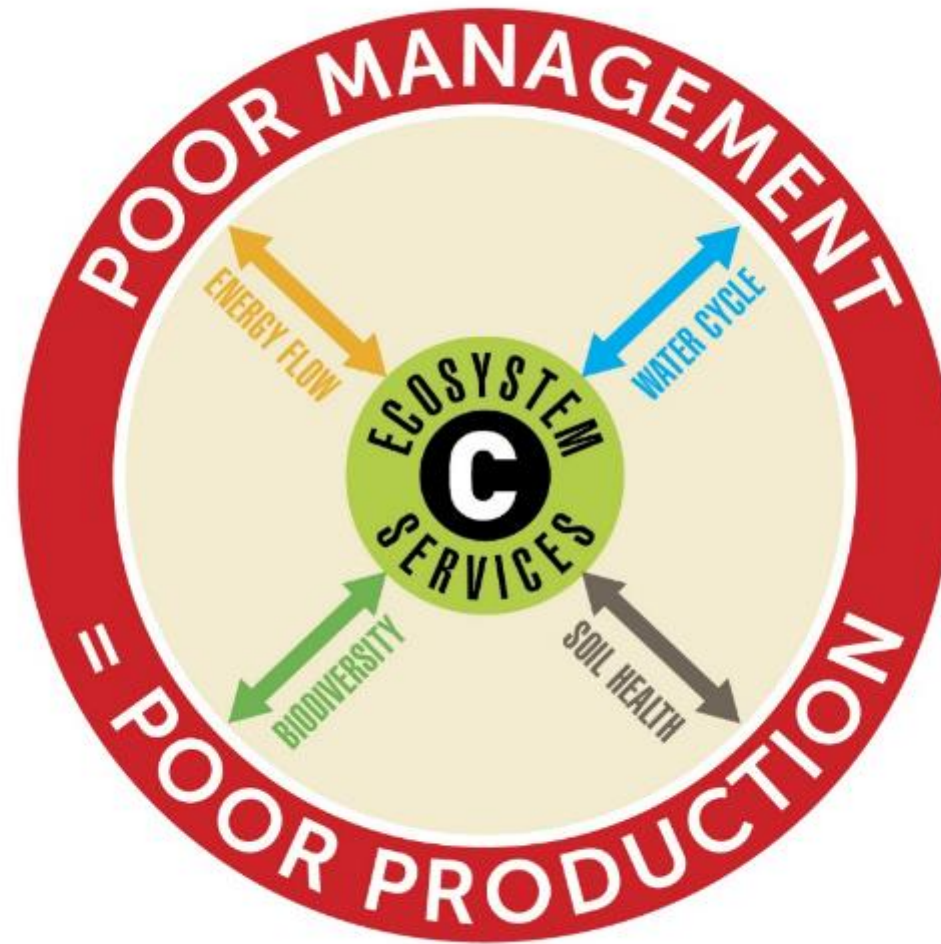
1975 = 9

2012 = 400



©2013 WeedScience.org, Dr. Ian Heap 05/13/2013

Source: Ian Heap, *International Survey of Herbicide Resistant Weeds* www.weedscience.org/graphs/soagraph.aspx (2013).

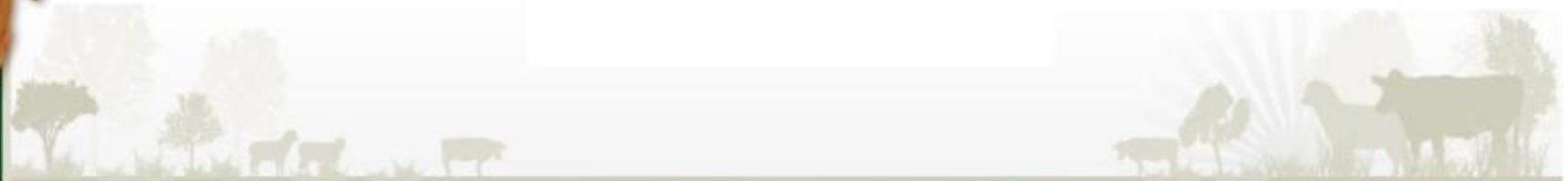




Collapse of Historic Civilizations

Civilization	Region	Era	Cause
Sumarian	Mesopotamia	10,000 BCE	Salinization
Harappan	Indus Valley	2,000 BCE	Desiccation
Inca	Andean Region	750-900 CE	Soil Erosion
Maya	Central America	750-900 CE	Soil Erosion
Axum	North Ethiopia	100-600 CE	Ecological Decline
Roman	Mediterranean	27 BC–395 AD	Exhaustion of Soil

Lal (2015)





HUMAN MIND





TWO MINDS of the HUMAN

**MECHANICAL
MIND**

**REDUCTIONIST
THINKING**

**resides in
LEFT BRAIN**

**EMERGENT
MIND**

**HOLISTIC
THINKING**

**resides in
RIGHT BRAIN**





There are two ways to view the world

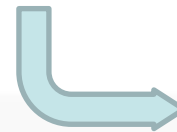
1. A REDUCTIONIST APPROACH WHERE THERE are SEPARATE ISSUES eg.

- Desertification
- Climate Change
- Biodiversity Loss

Or

2. A HOLISTIC APPROACH WHERE THERE is ONE SERIOUS ISSUE:

- Environmental & Social Malfunction

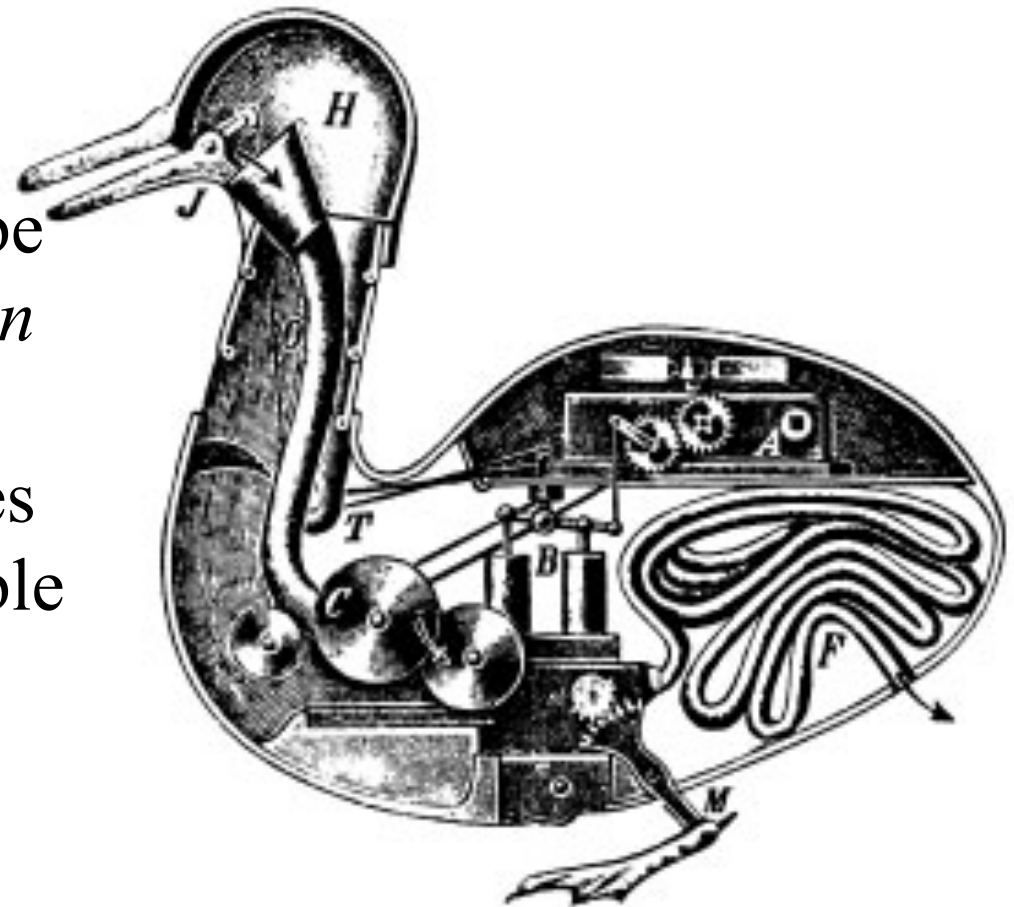


**Desertification
Climate Change
Biodiversity Loss**

Adapted from Savory

REDUCTIONISM - "a complex system is nothing but the sum of its parts".

Reductionism in science says that a complex system can be explained by *reduction* to its fundamental parts. eg, the processes of biology are reducible to chemistry which is explained by the laws of physics.





Holism - "the idea that natural systems should be viewed as wholes, not as collections of parts".

"When we try to pick out anything by itself we find it hitched to everything else in the Universe"

John Muir.





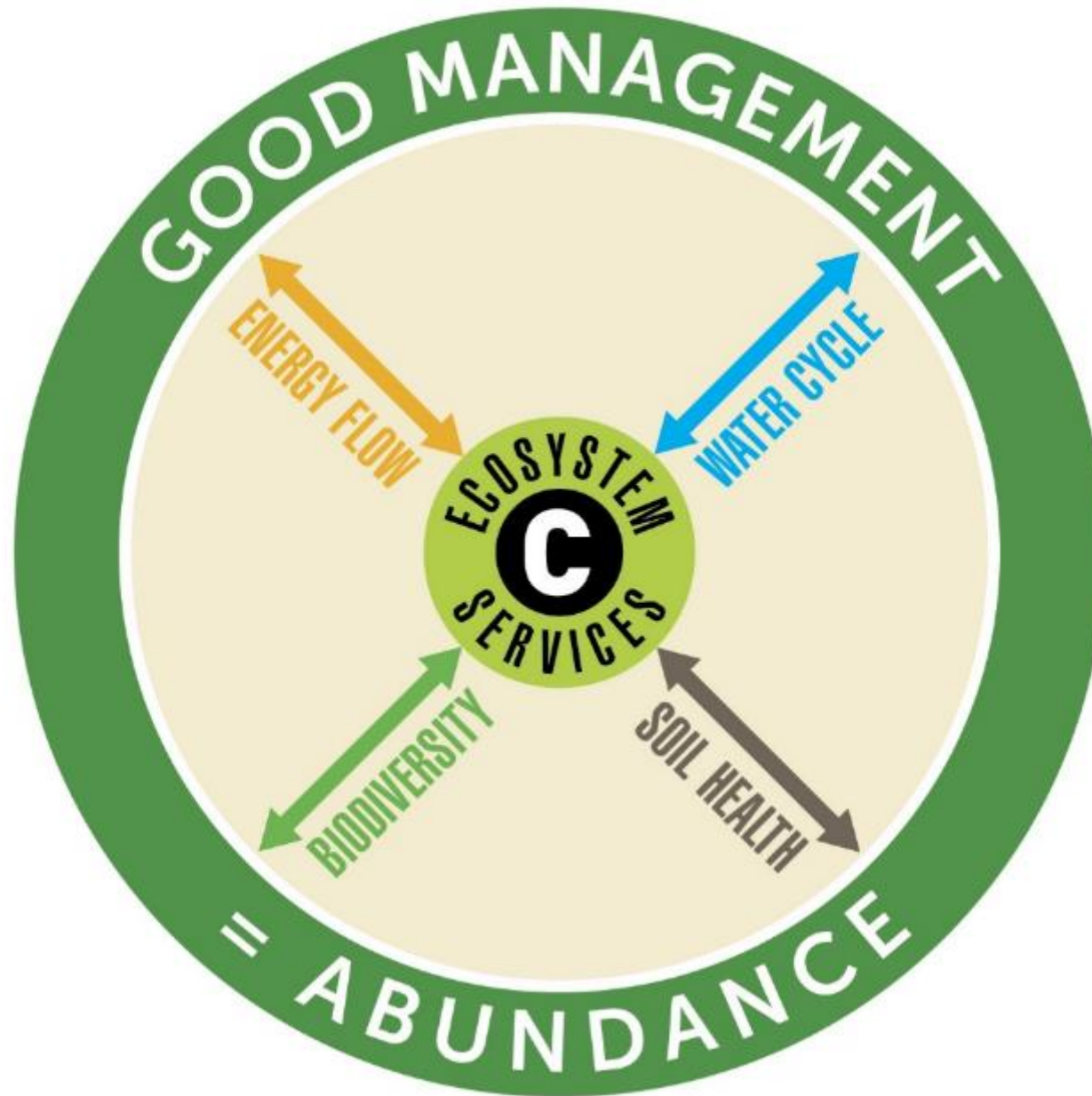
WE HAVE TAKEN AN
ELEGANT SOLUTION
AND TURNED IT

INTO TWO SEPARATE
PROBLEMS



WENDELL BERRY ON THE FEEDLOT INDUSTRY

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**CARBON is the BEGINNING and
END of all LIFE. It is a FORM of
ENERGY.**



The 375 million year old carbon cycle

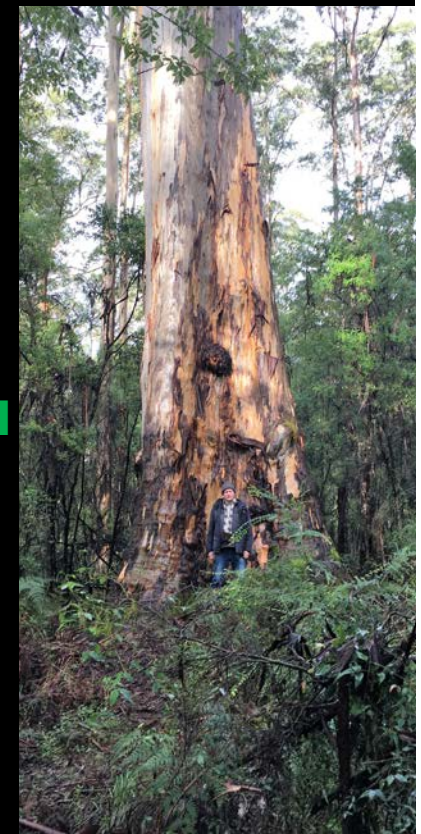
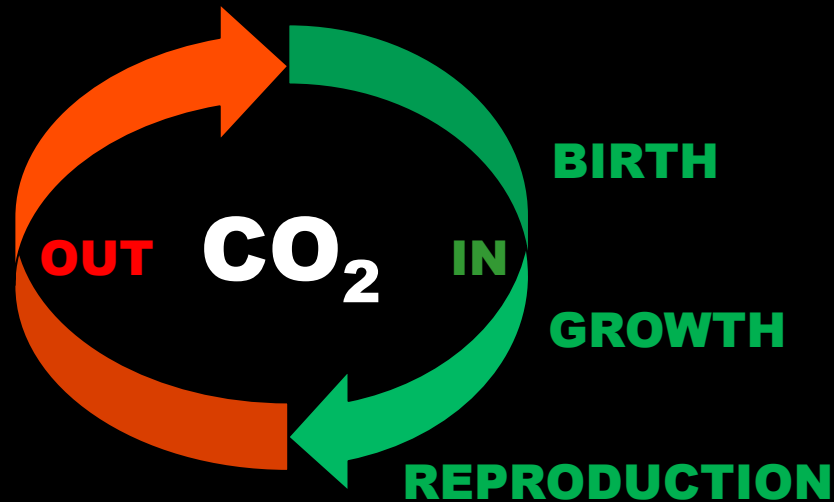
OXIDATION

PHOTOSYNTHESIS



DECAY

DEATH



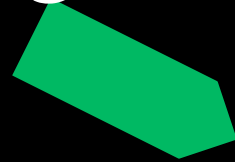
SEQUESTRATION

Where is the carbon?

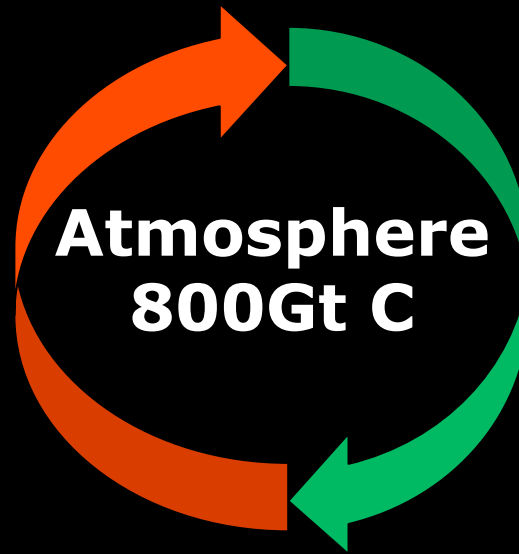
Cycle – 150Gt C



**Annual
emissions
10Gt C**



Soil – 1580Gt C



**Vegetation
610Gt C**

SPEARGRASS on sand @

PHOTOSYNTHESIS

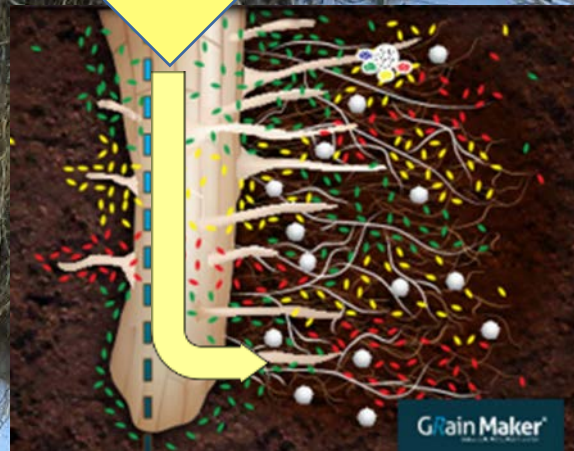
10m apart

SUGAR

DECOMPOSITION

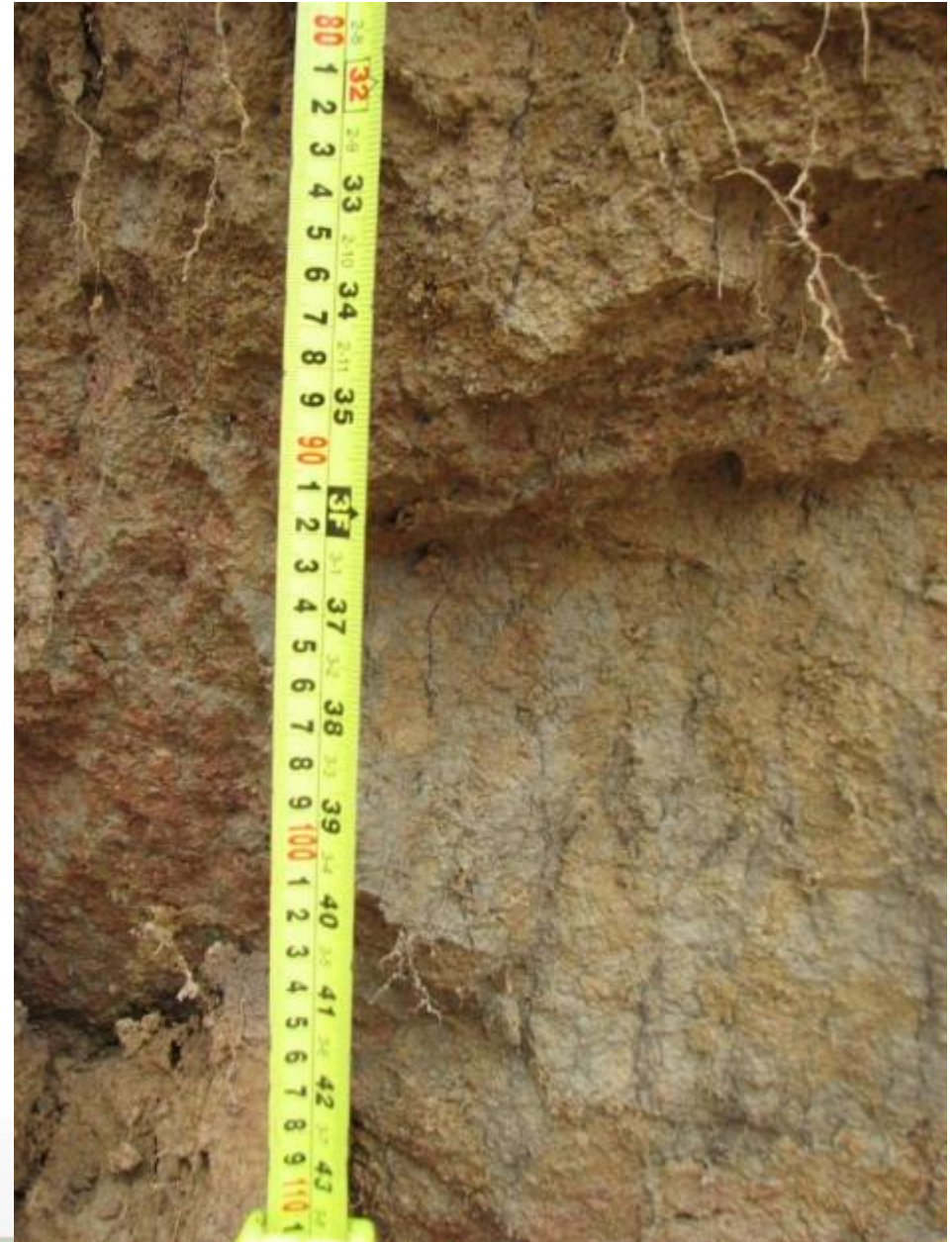
LIQUID CARBON

No Graze
Phase III





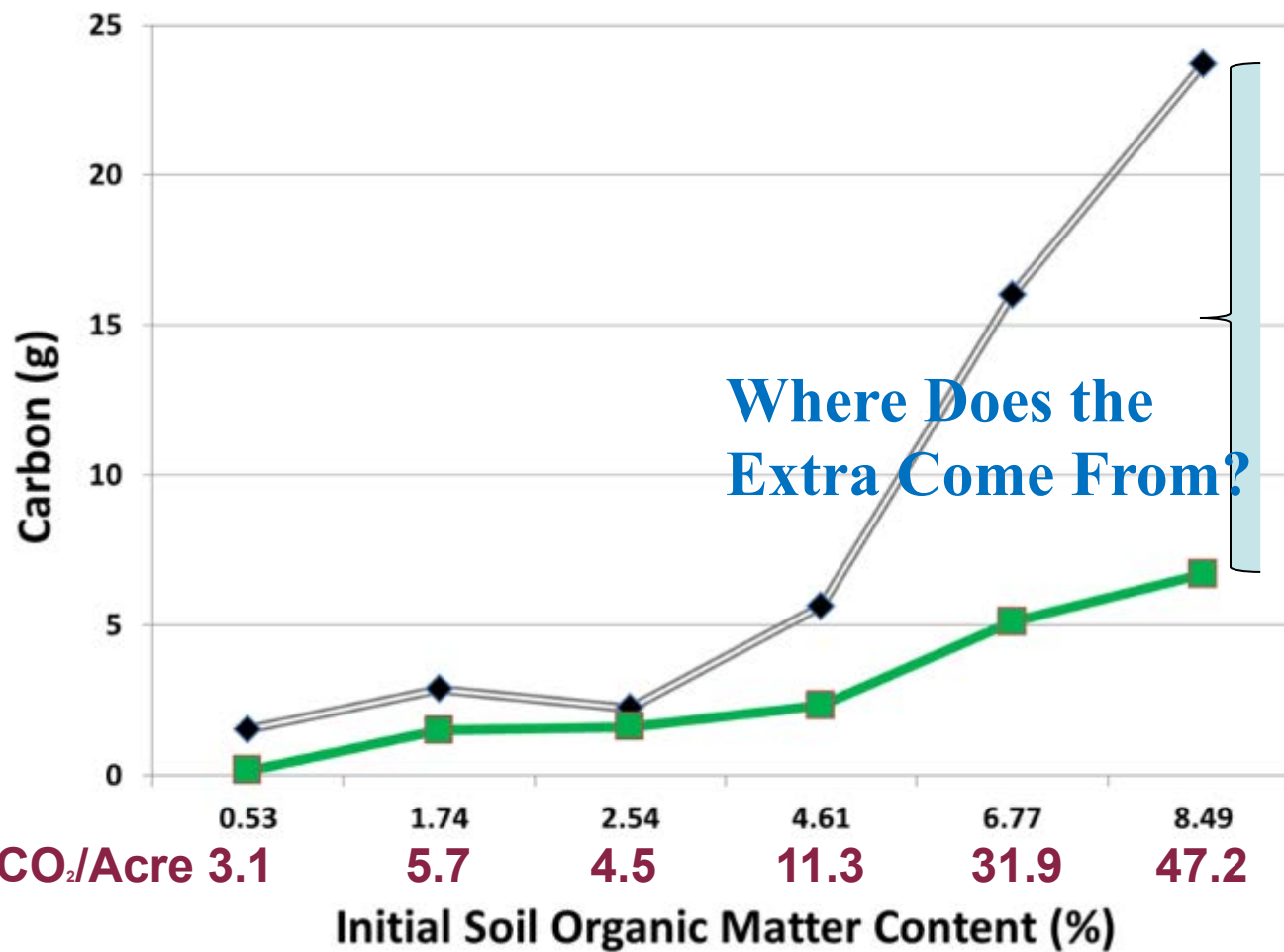
CARBON SEQUESTRATION





NEW Soil Carbon Accelerates above 3% Organic Matter

Carbon Partitions (Total New C & Plant+Root C)



Tons CO₂/Acre 3.1

5.7

4.5

11.3

31.9

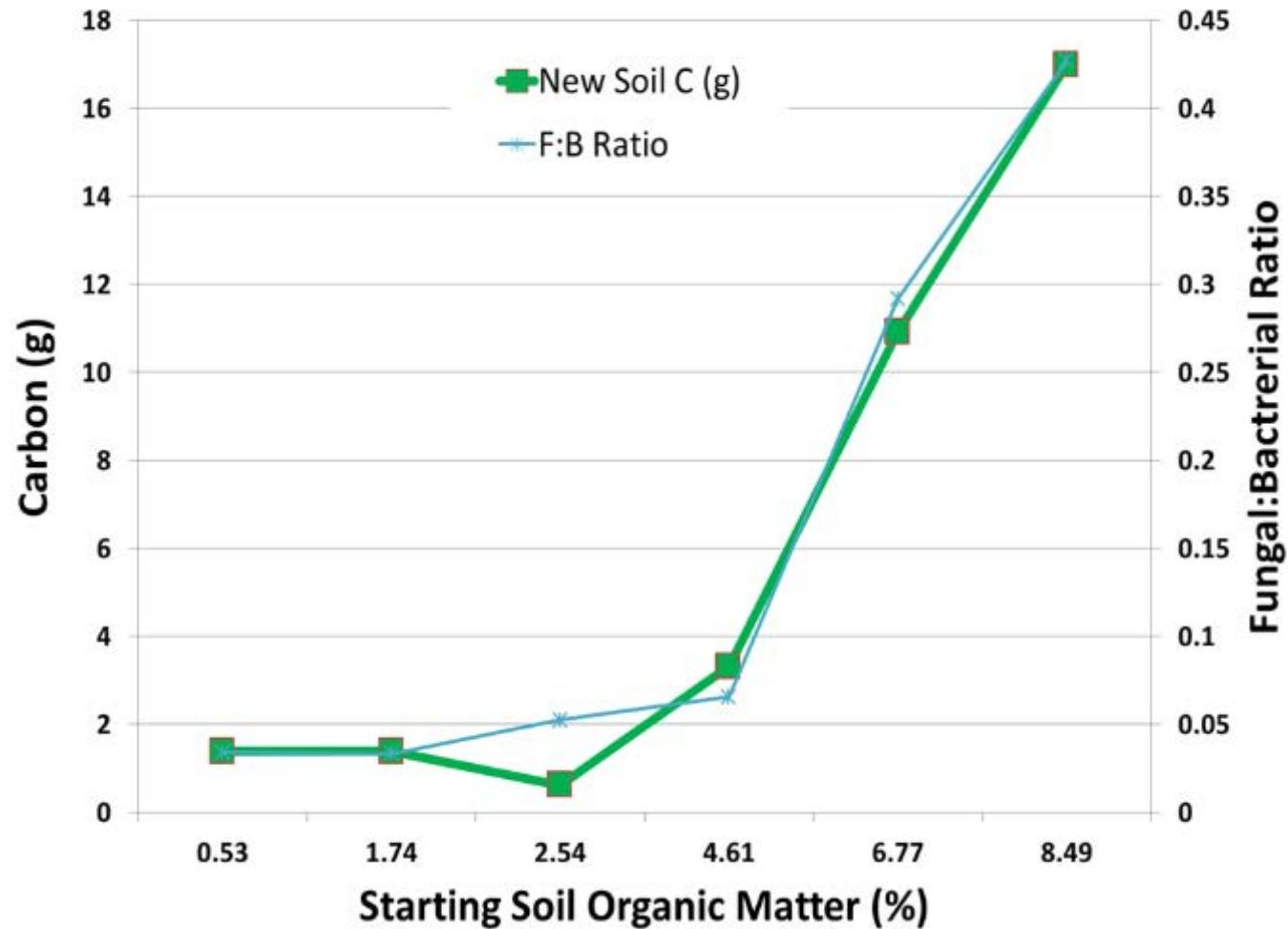
47.2

Johnson, D, Ellington, D and Eaton, W (2013) Institute for Sustainable Ag Research.



NEW Soil Carbon is correlated ($R^2=0.99$) to the F:B Ratio

New Soil Carbon (g) & F:B Ratio

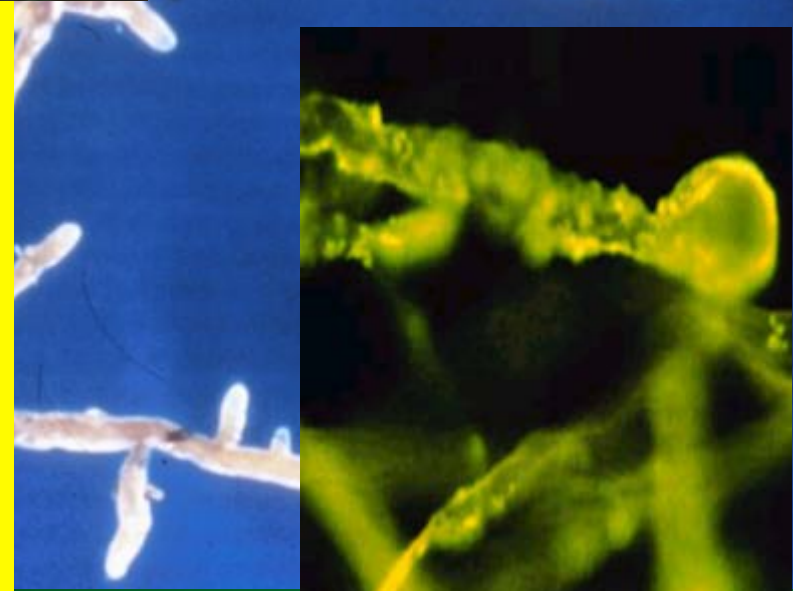
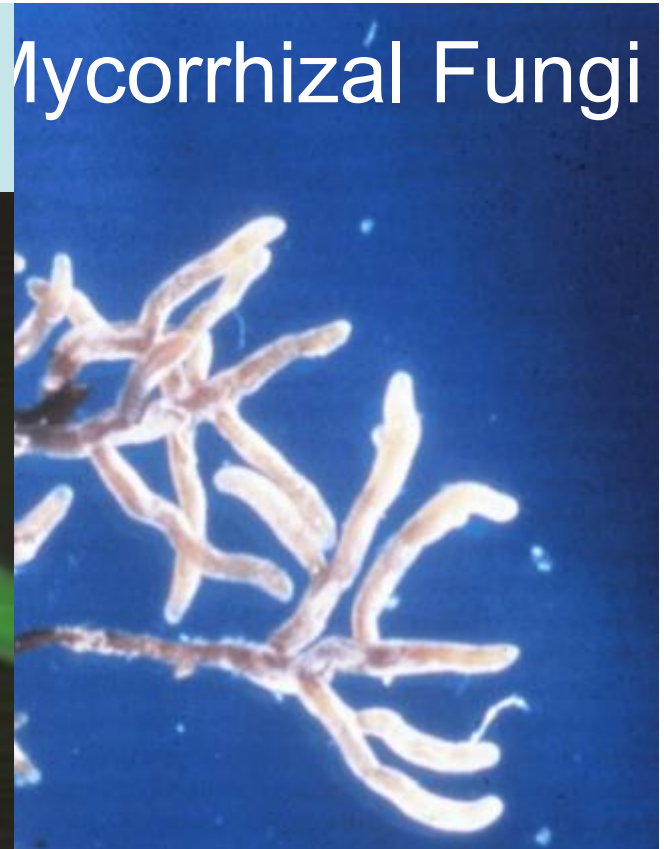
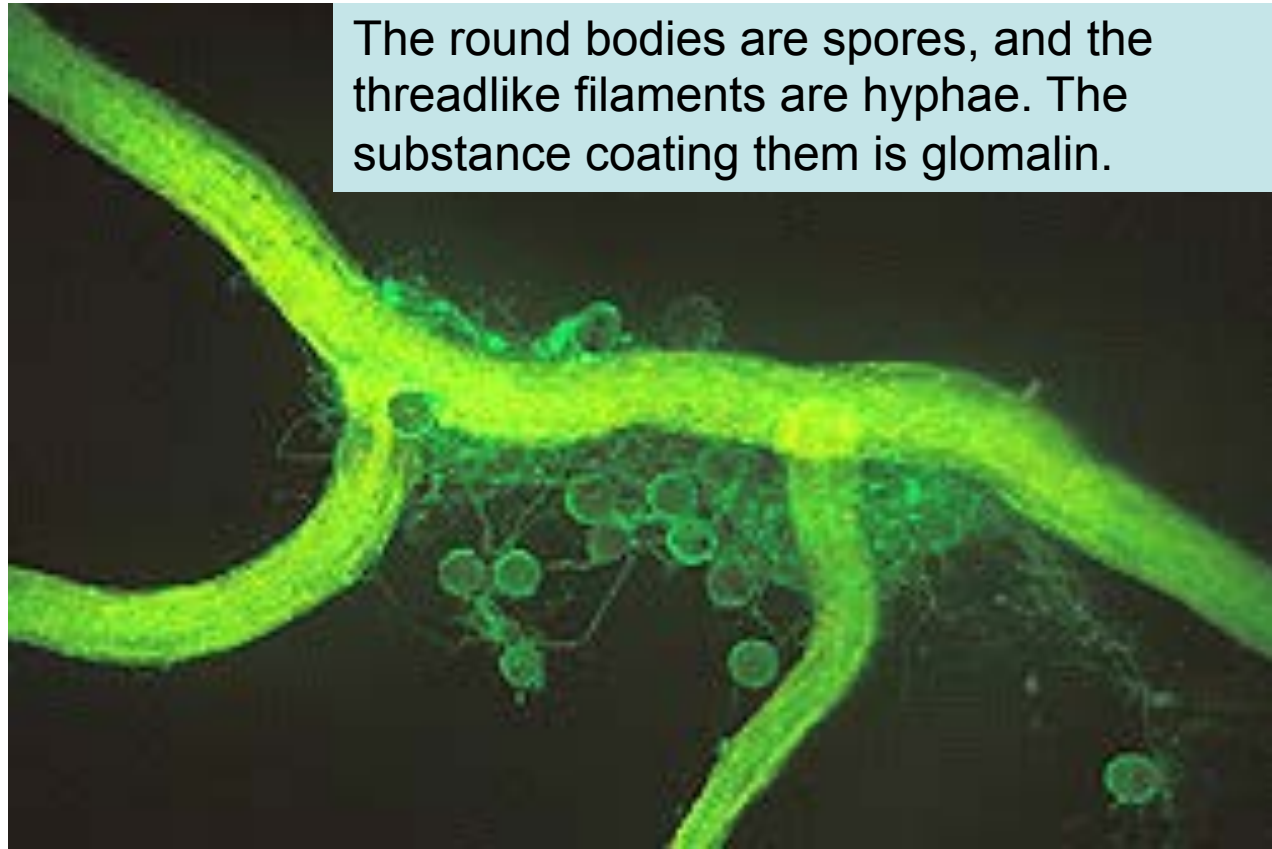


Johnson, D, Ellington, D and Eaton, W (2013) Institute for Sustainable Ag Research.

The round bodies are spores, and the threadlike filaments are hyphae. The substance coating them is glomalin.

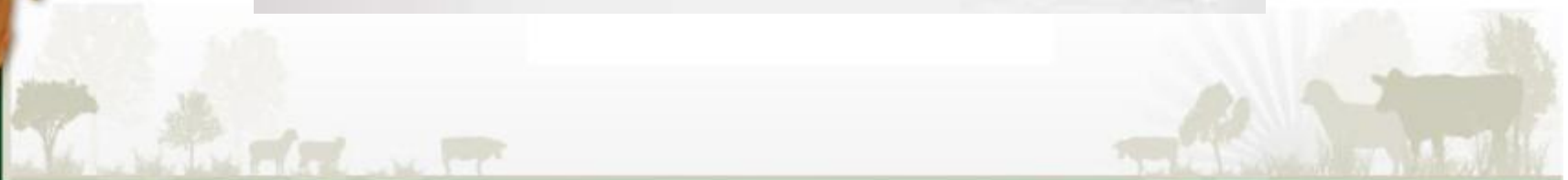
Mycorrhizal Fungi

- **Glomalin is 27% of stored Soil Carbon**
- **It is a sticky glycoprotein acting as soil “super glue”**
- **It is stable for 7 to 42 years**
- **Breaks down more quickly in the tropics**
- **Glomalin is 30 to 40% Carbon**
- **There is 4 times more Glomalin than Humic acids in soil.**
- **First discovered by Sara Wright in 1996**





Soils with Organic matter (top row) & without (bottom row).



**Agriculture flounders and
mines its resources because
consumers will not pay the full
price of food**

**CARBON or ENVIRONMENTAL
credits provide a mechanism to
return additional income to
landholders**



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4 Key Drivers of Return

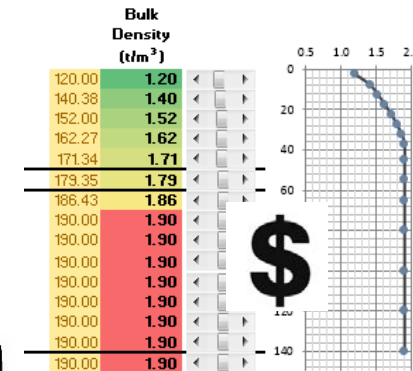
1. Sequestration rate
(tC/ha/year)



2. Price of carbon
(\$/T CO2e)



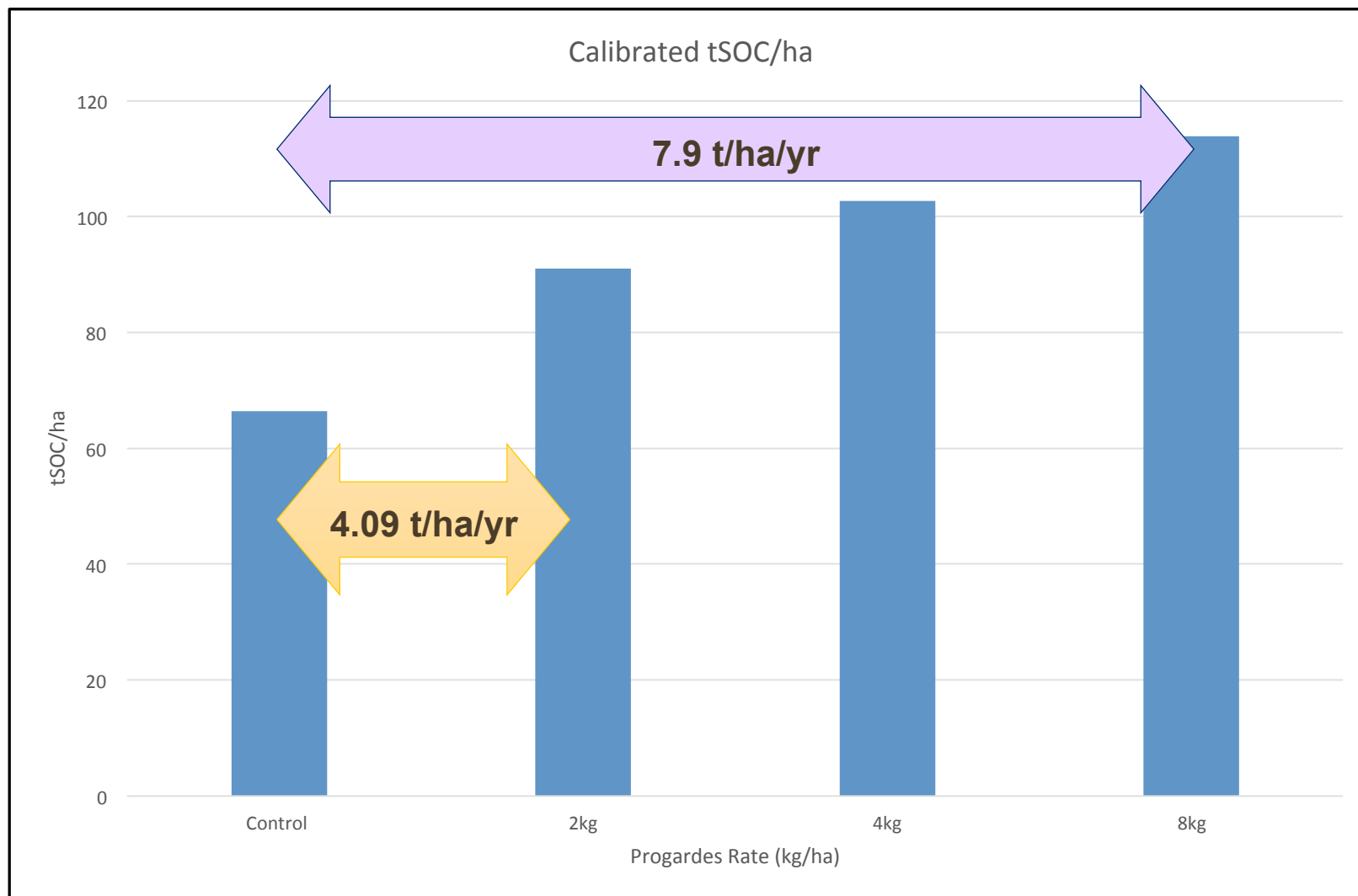
3. Cost of measurement
(\$/ha)



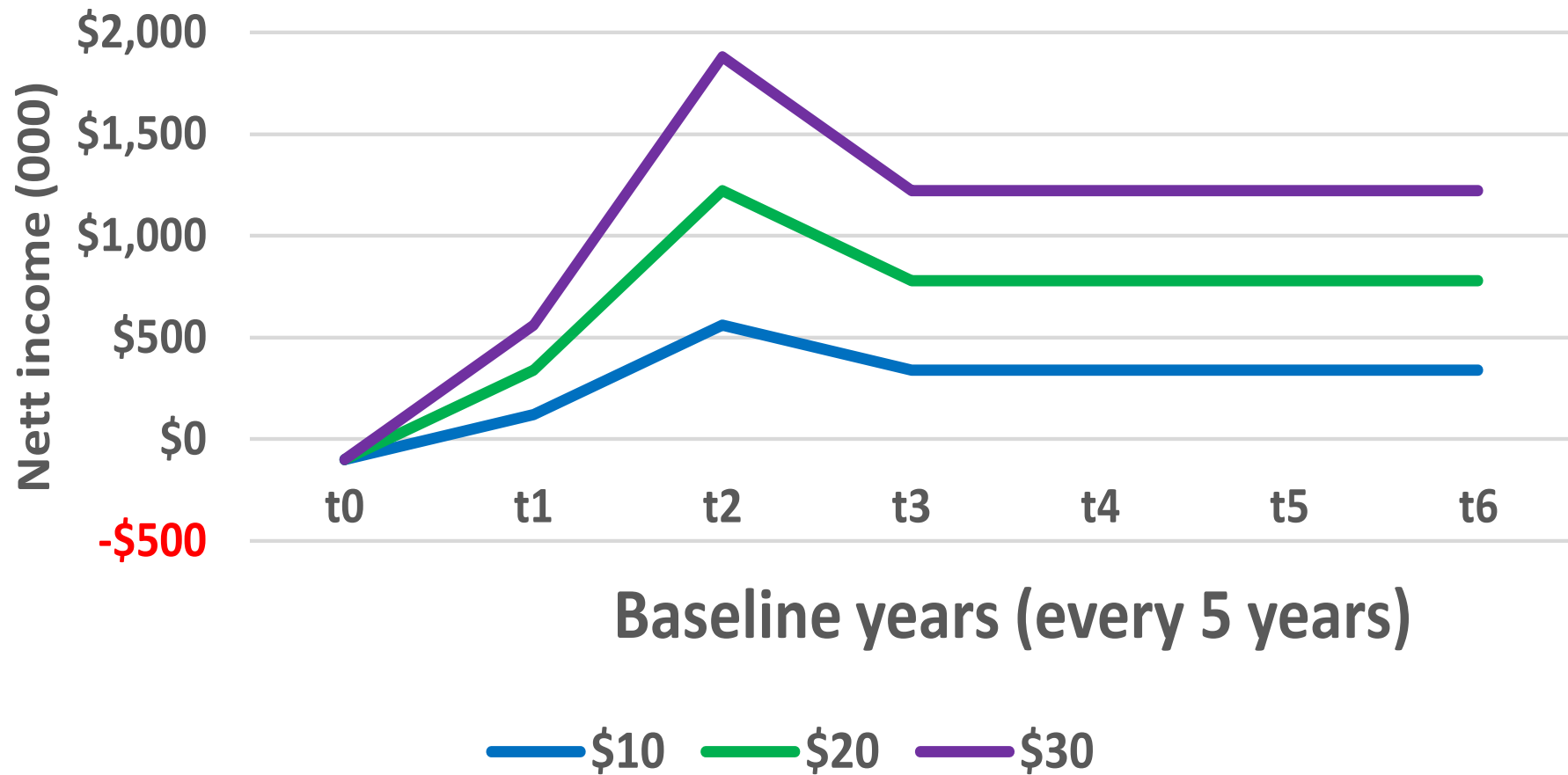
4. Scale of project
(ha)



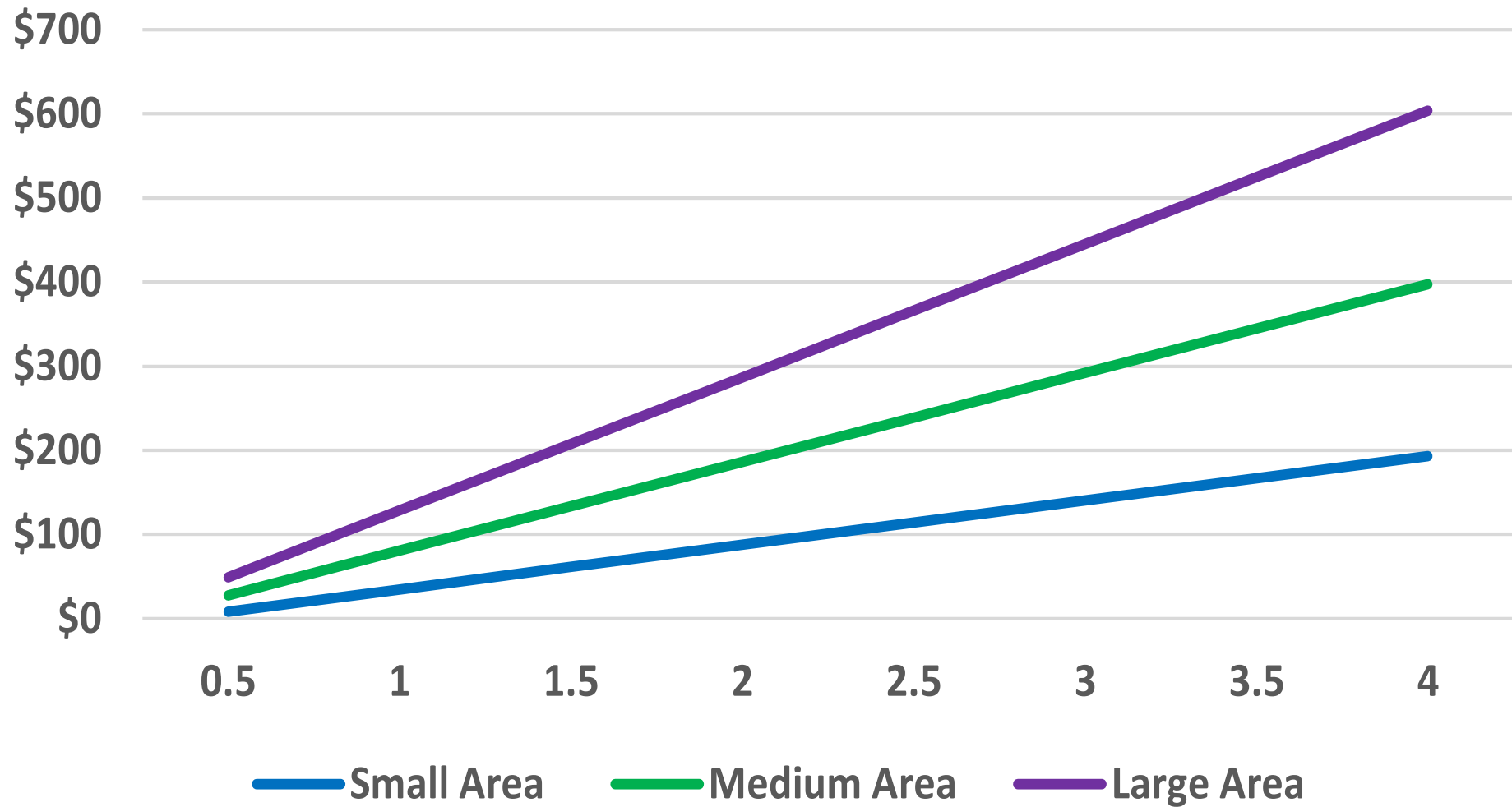
Carbon Sequestration from Progardes



Price per tonne of CO₂e- @ 1t/ha sequestration on 4,000ha

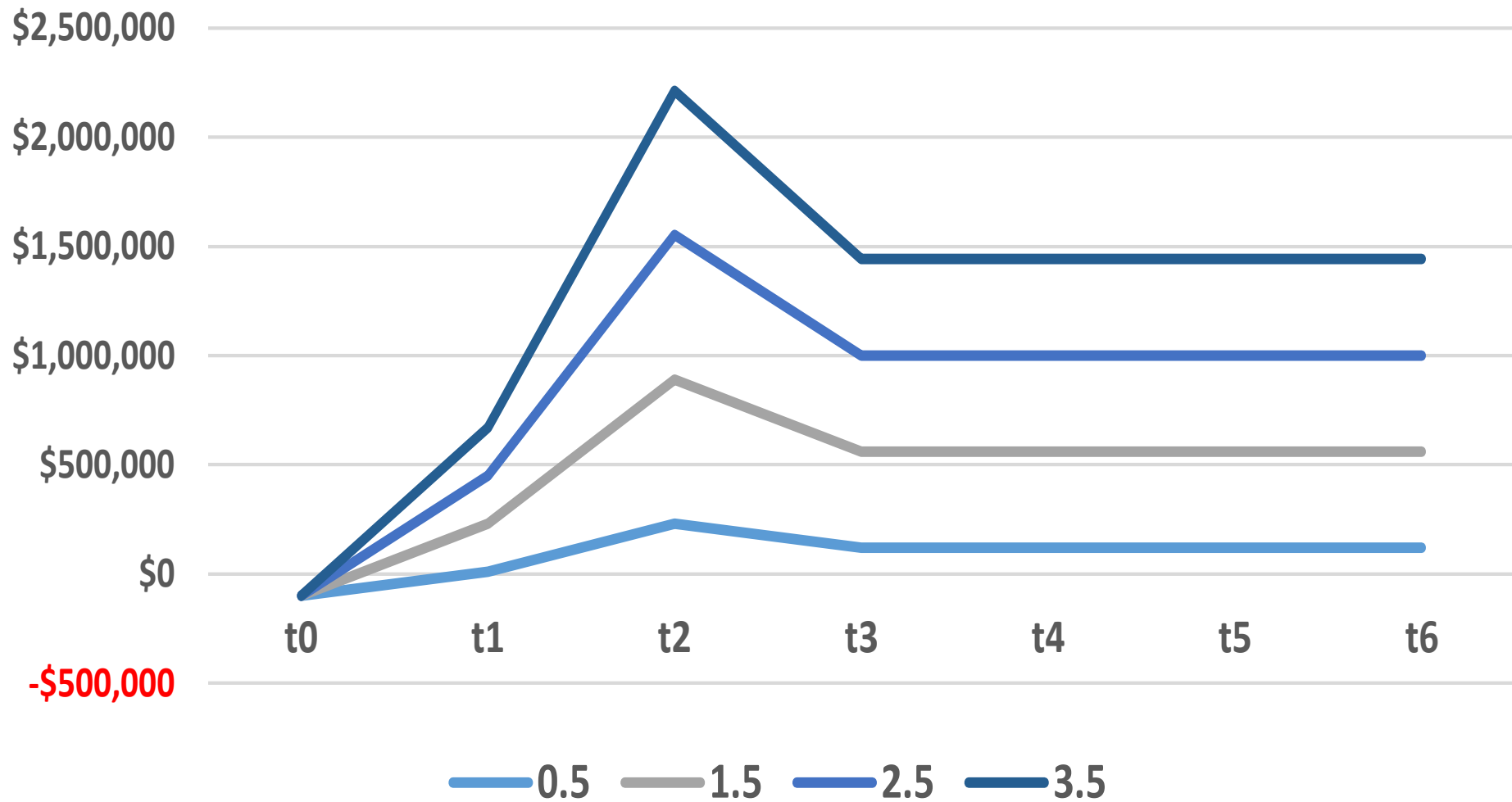


Average annual nett income per ha at \$20/t

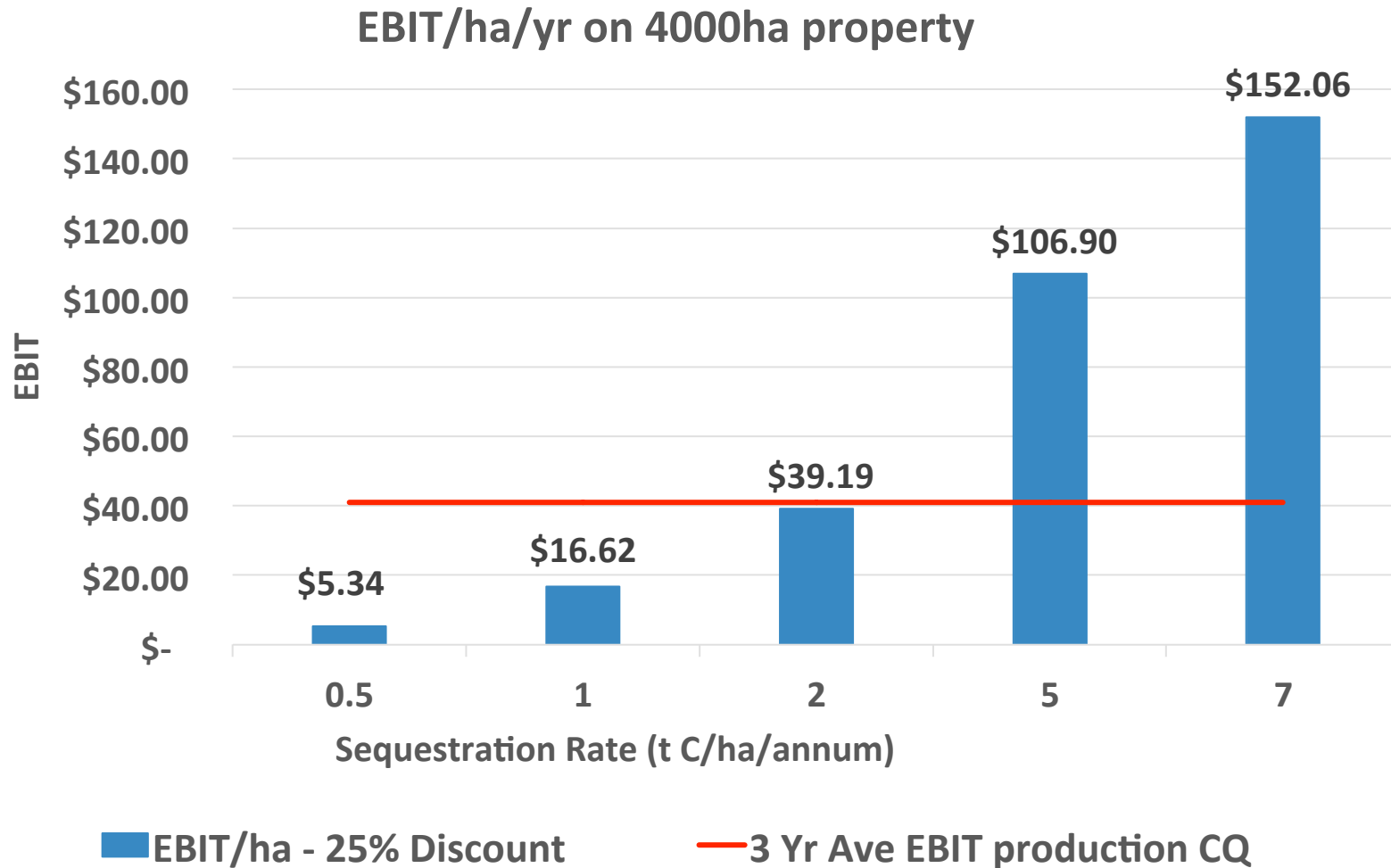


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Sequestration rates at \$10/t on 4,000ha



Soil Carbon Profit (@\$10/t)



Benefits of increasing Soil Carbon

- Improved soil health
- Increased carrying capacity & yield
- Increased water holding capacity
- Enterprise risk hedge
- Management of price and drought risk
- Increased ecosystem resilience
- Lower costs



CarbonLink

The Steps Involved in **Accurate** Soil Carbon Measurement

A. Stratification

B. Soil Sampling

C. Soil Analysis

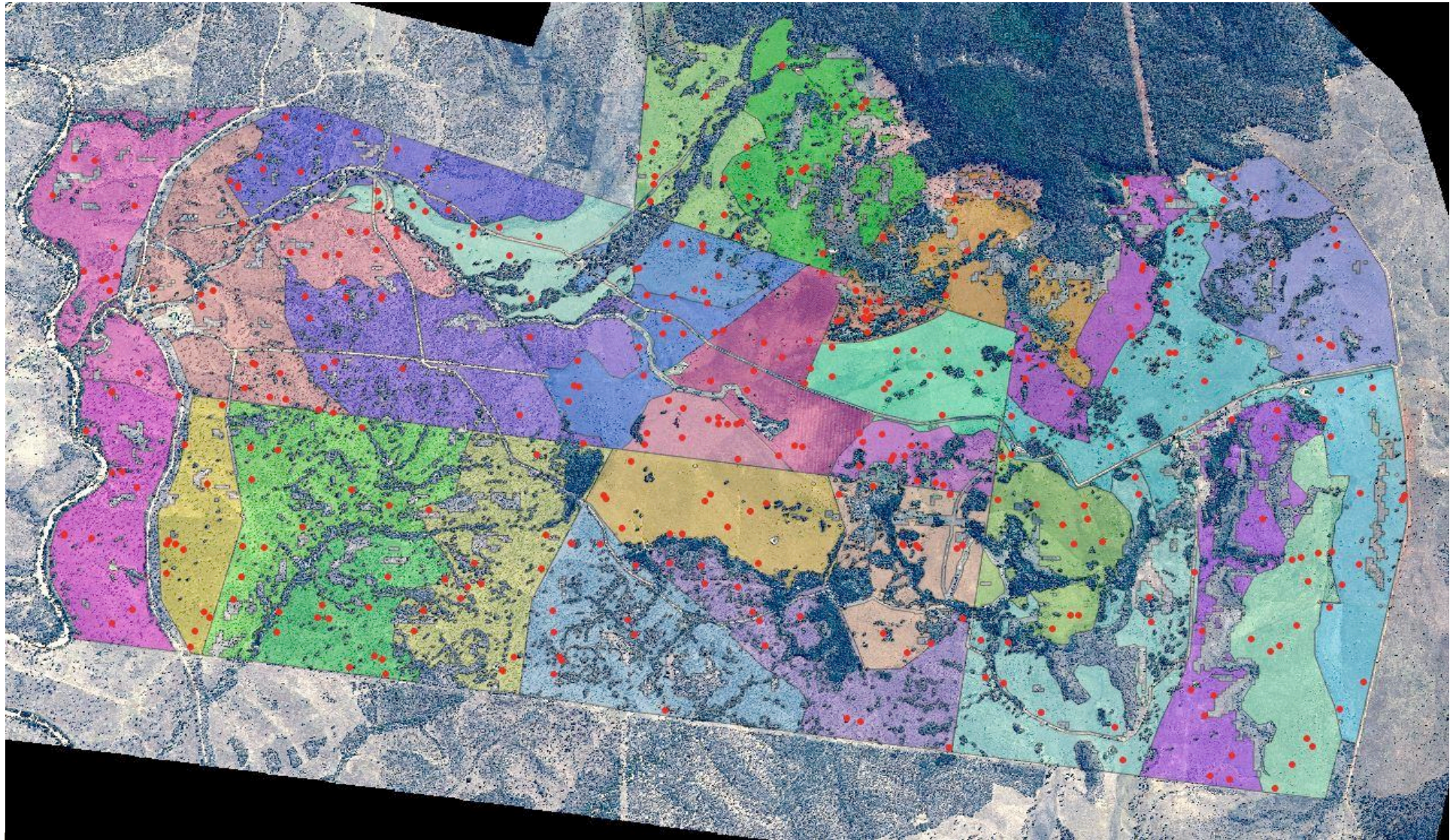
D. Calculate Soil Organic C

E. Calculate Carbon Yield

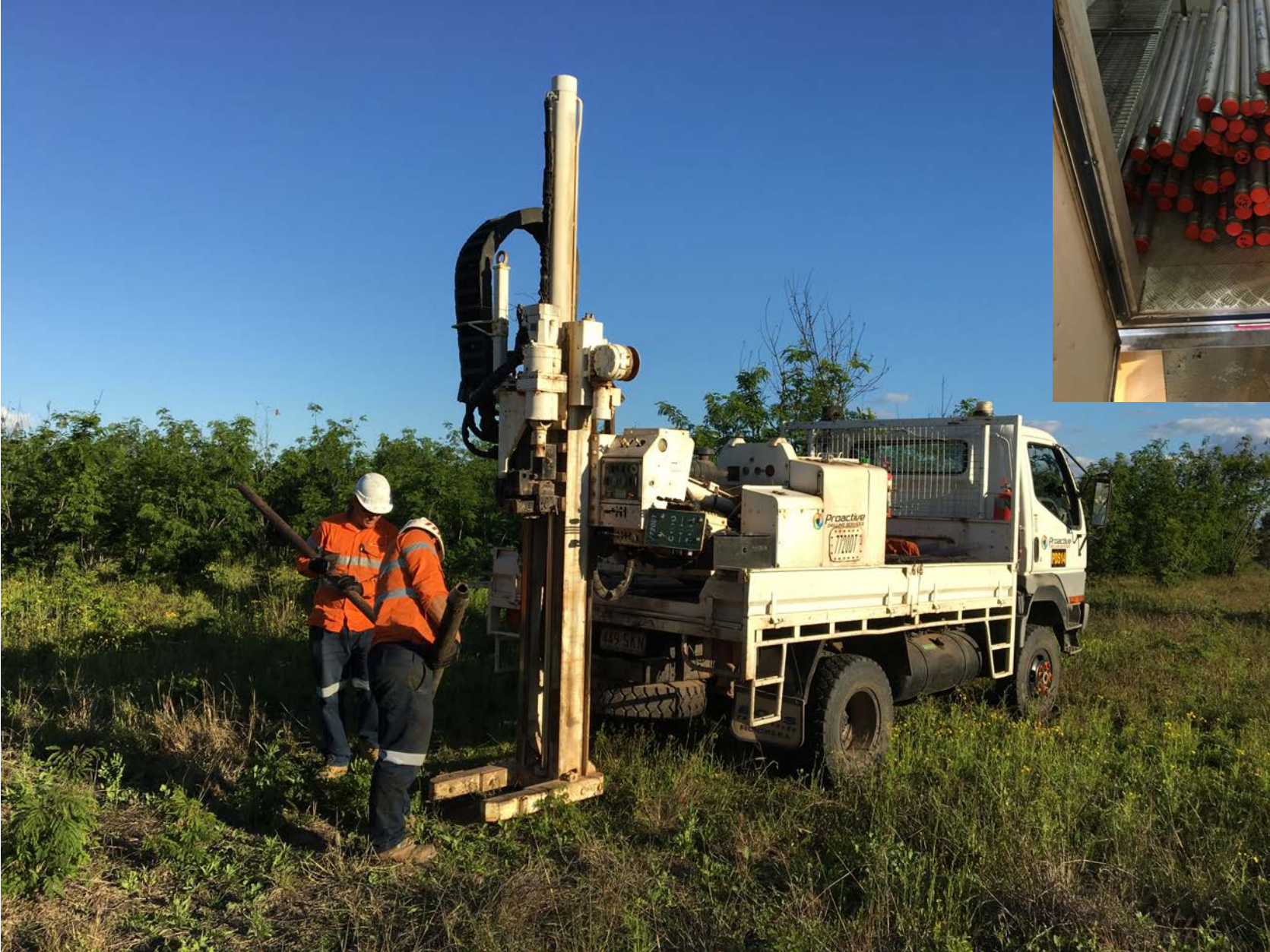


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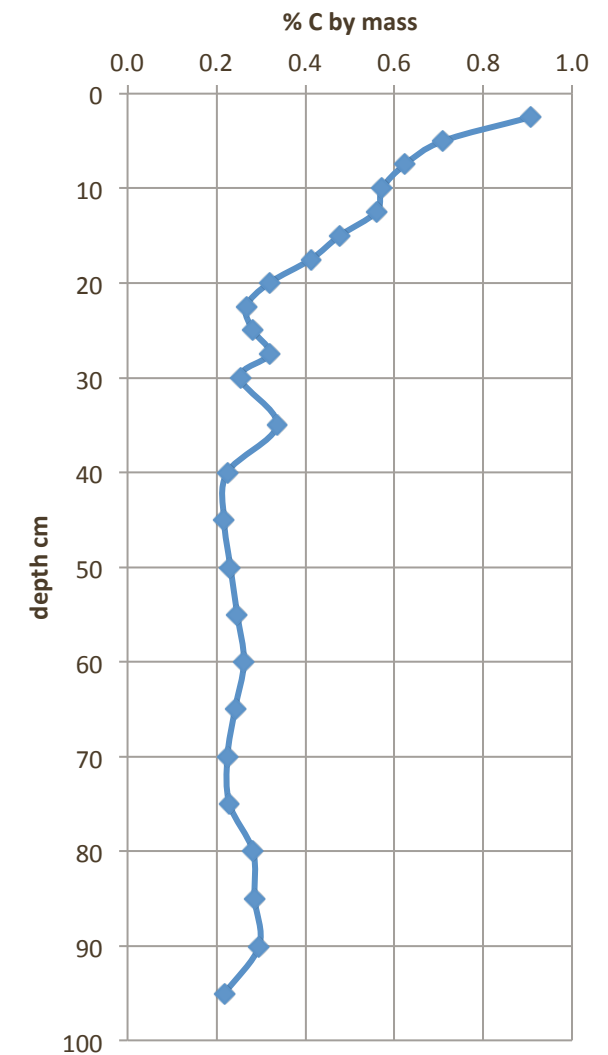
A. Stratification – 33 CEAs – 5,239ha



B. Soil Sampling



C. Analysis of Soil Carbon



3. Baseline

D. Calculating SOIL Organic Carbon



1. FIND THE DATA



2. CRUNCH THE NUMBERS

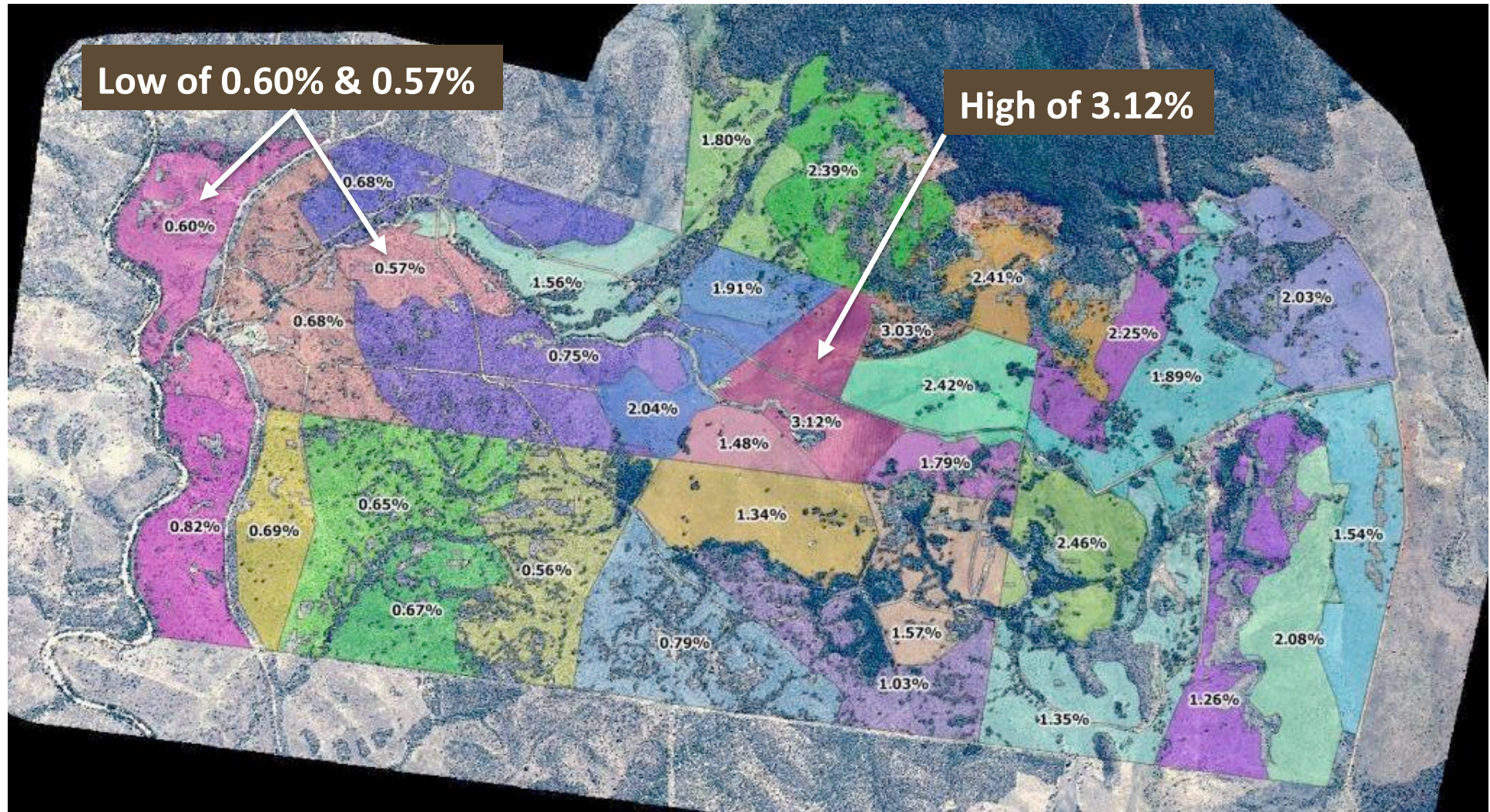


3. GET THE ANSWERS

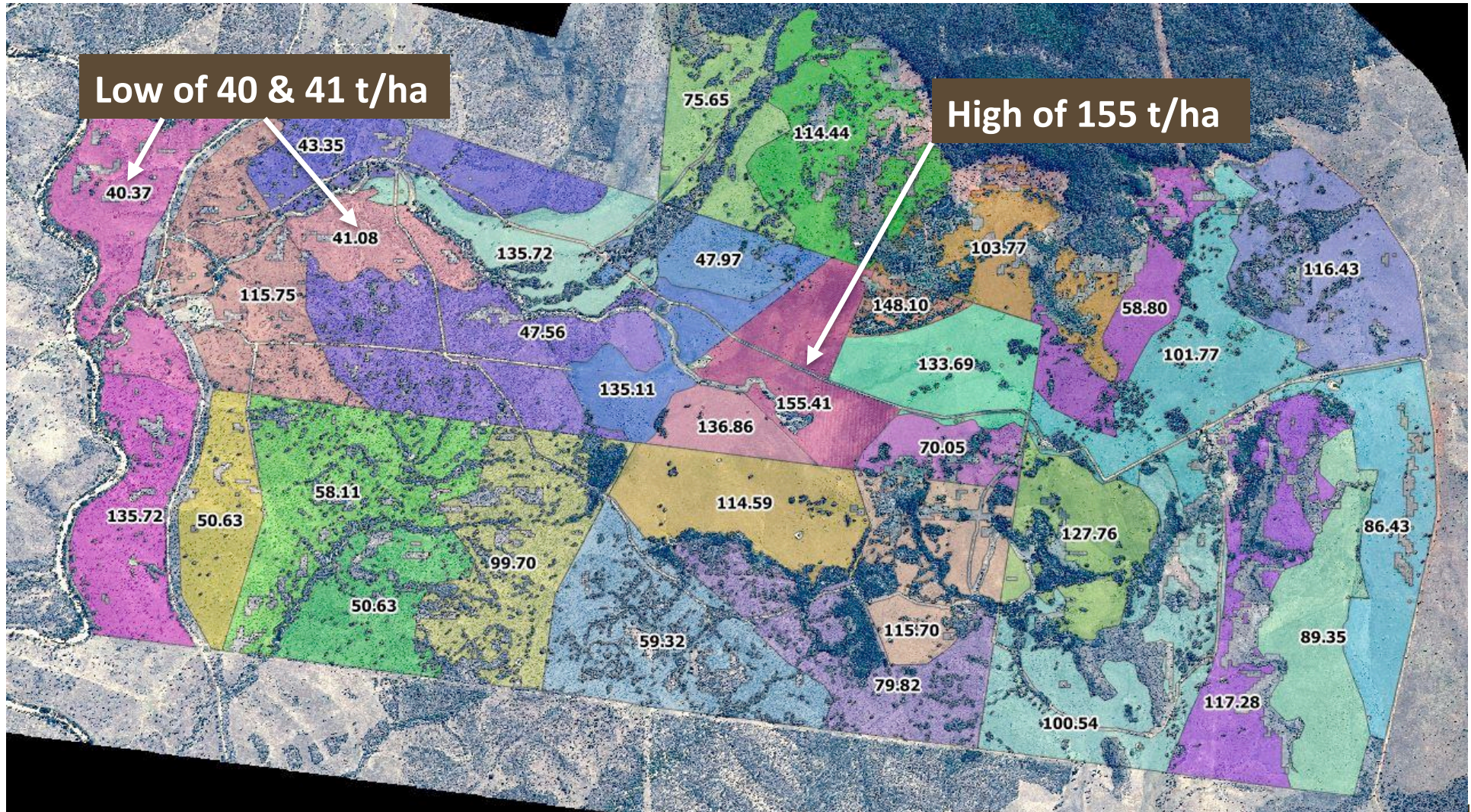


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Percent SOC in the TOPSOIL



TOTAL SOC (t/ha)



The MAGIC PUDDING



1 tonne of Soil Organic Carbon
=
3.67 tonnes of Carbon Dioxide
For SALE



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