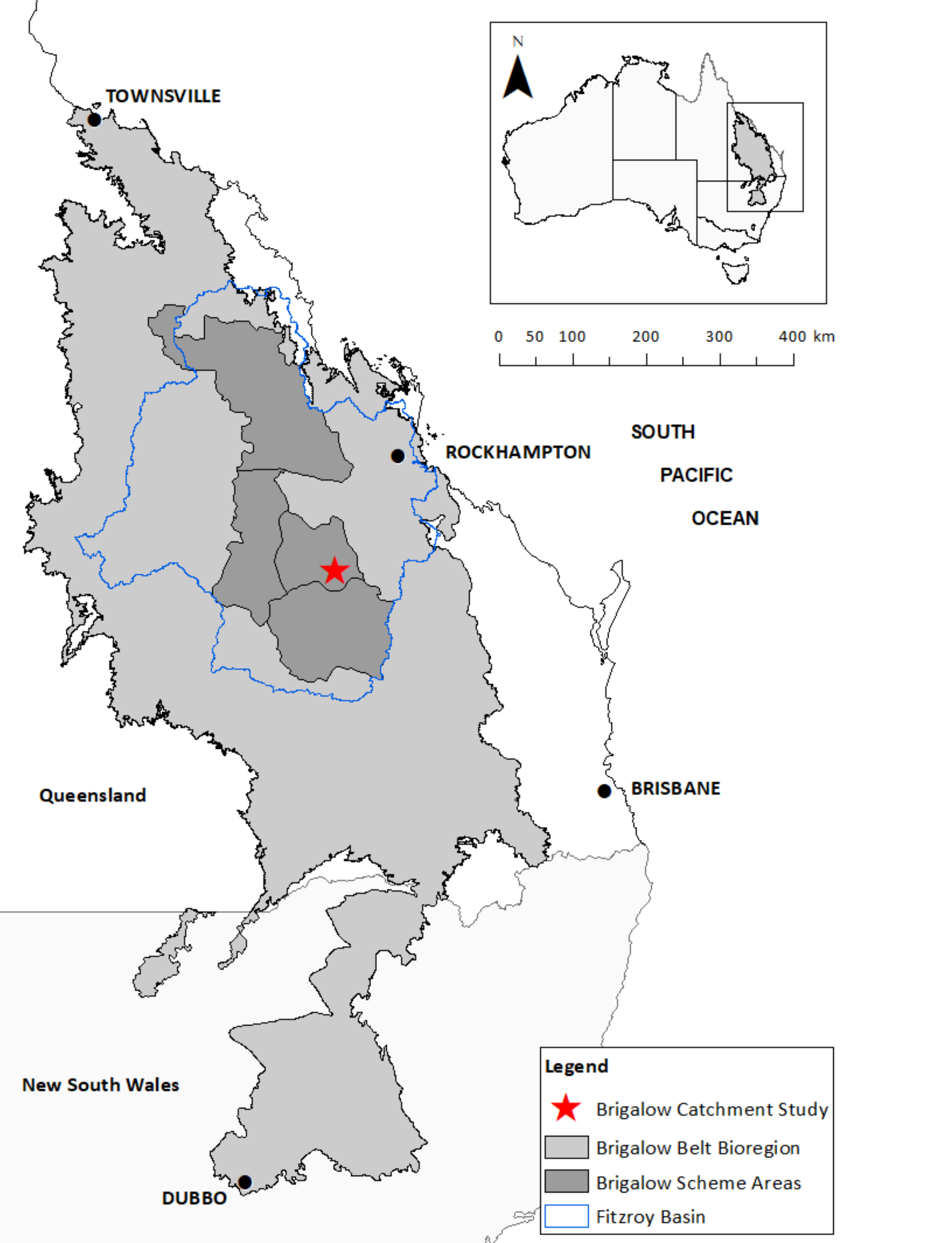
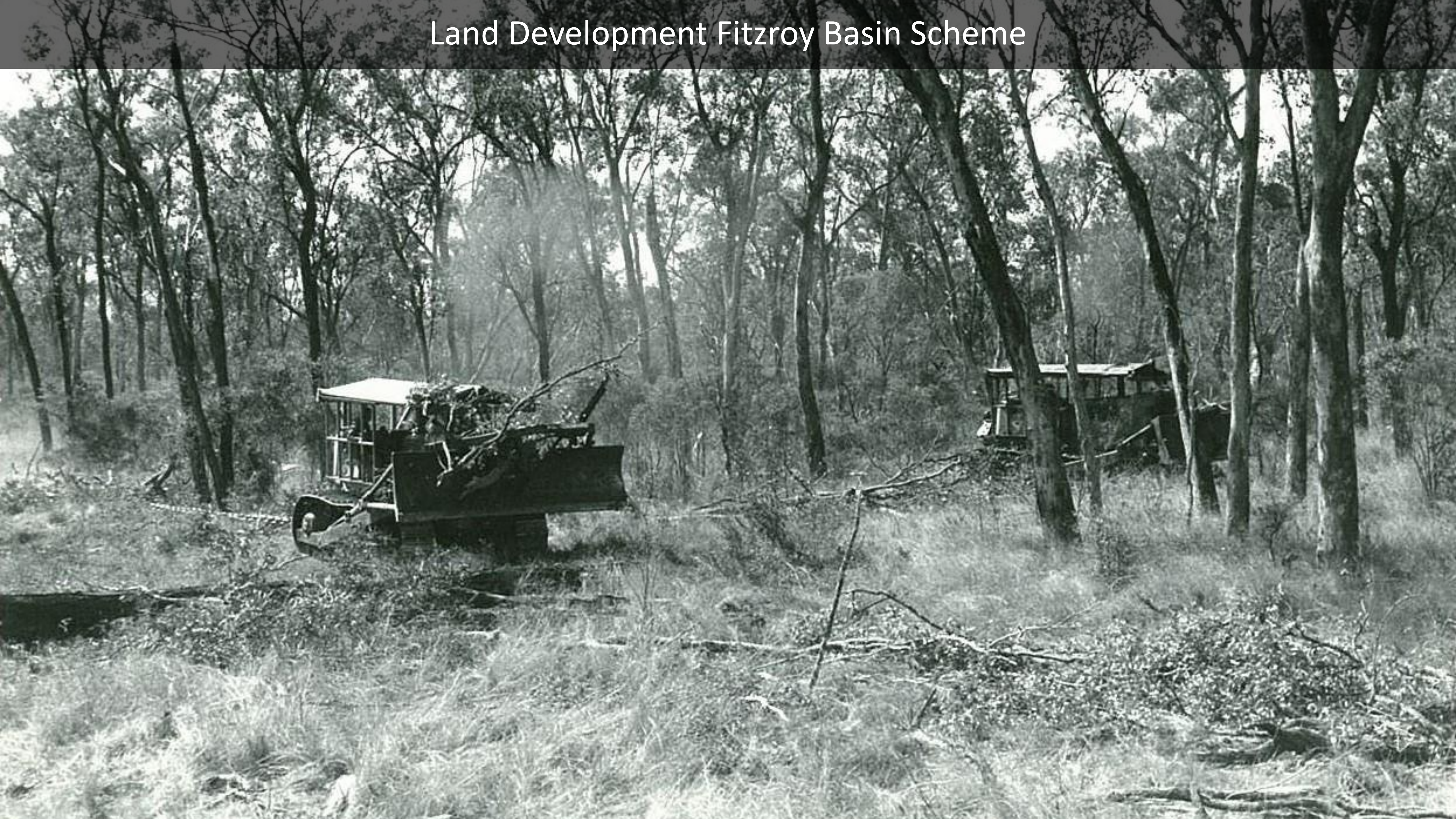
What are the impacts of land use change on soil fertility in the Fitzroy Basin?

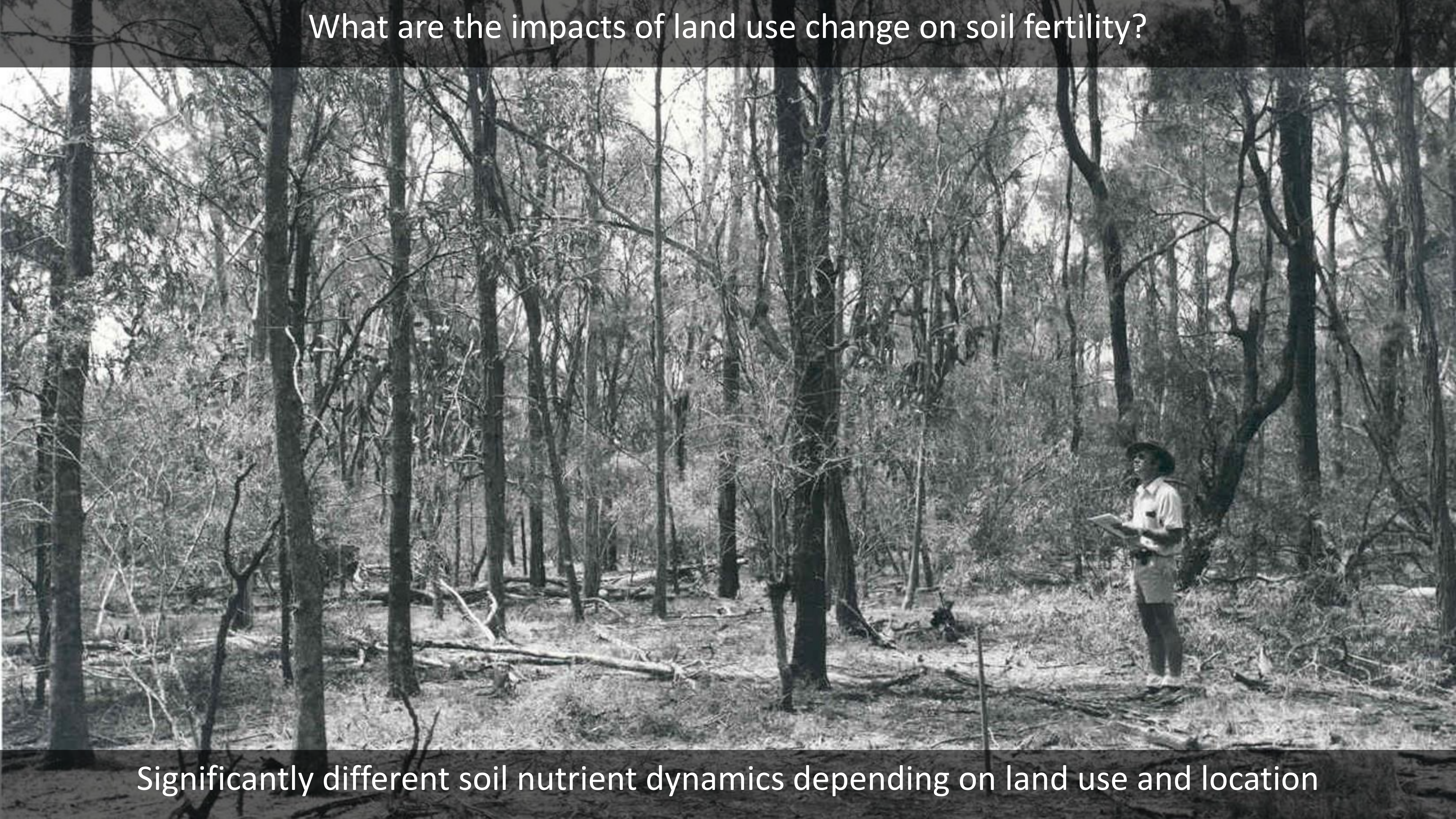
Lessons from both long-term and broad scale monitoring


TOWNSVILLE
ROCKHAMPTON
SOUTH
PACIFIC
OCEAN
BRISBANE
Queensland
New South Wales
DUBBO
N
0 50 100 200 300 400 km
Legend
Brigalow Catchment Study
Brigalow Belt Bioregion
Brigalow Scheme Areas
Fitzroy Basin

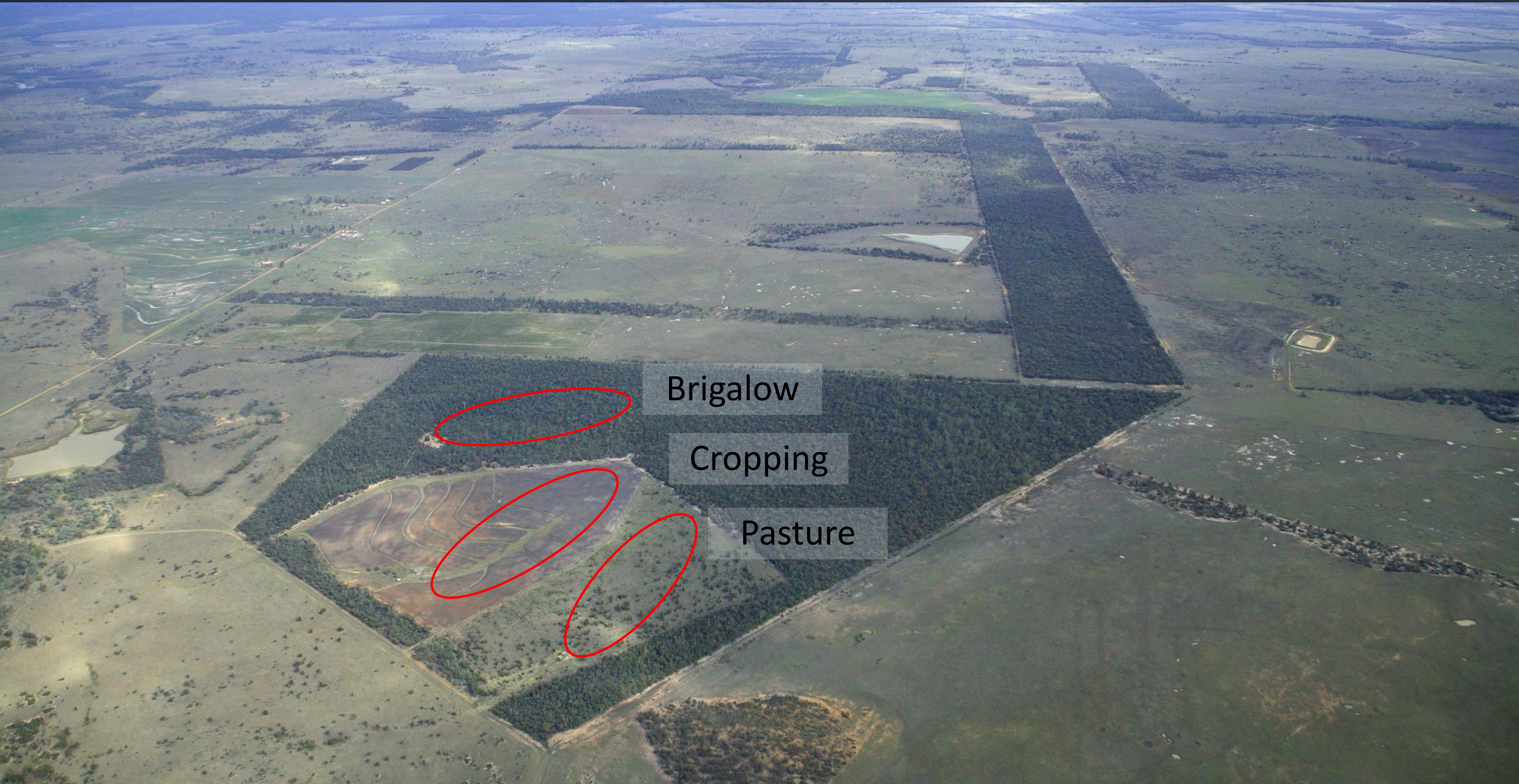
Land Development Fitzroy Basin Scheme



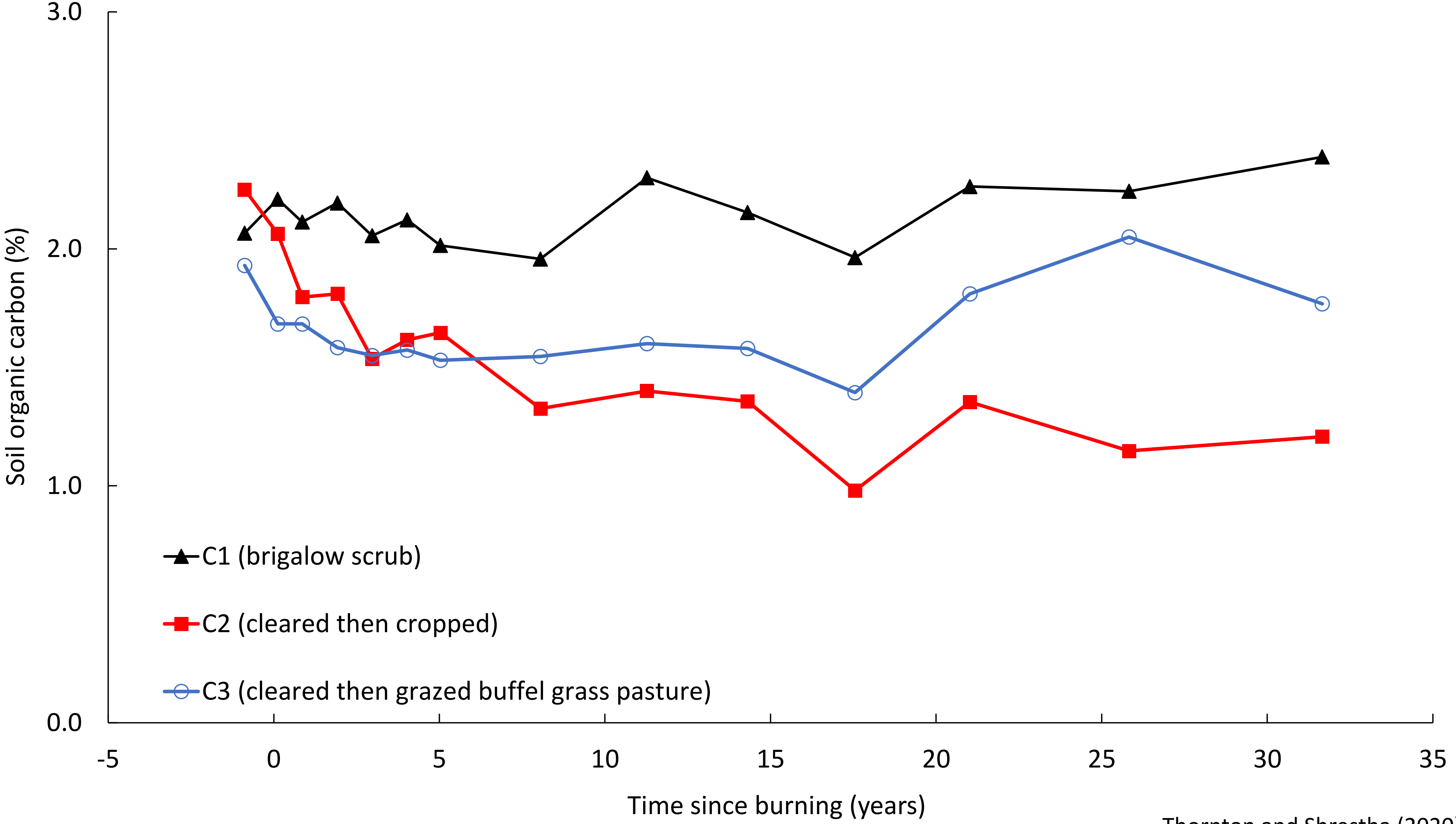
Primary agricultural land uses of the Fitzroy Basin


What are the impacts of land use change on soil fertility?
Significantly different soil nutrient dynamics depending on land use and location

The Brigalow Catchment Study; Measuring the effects of land development since 1965

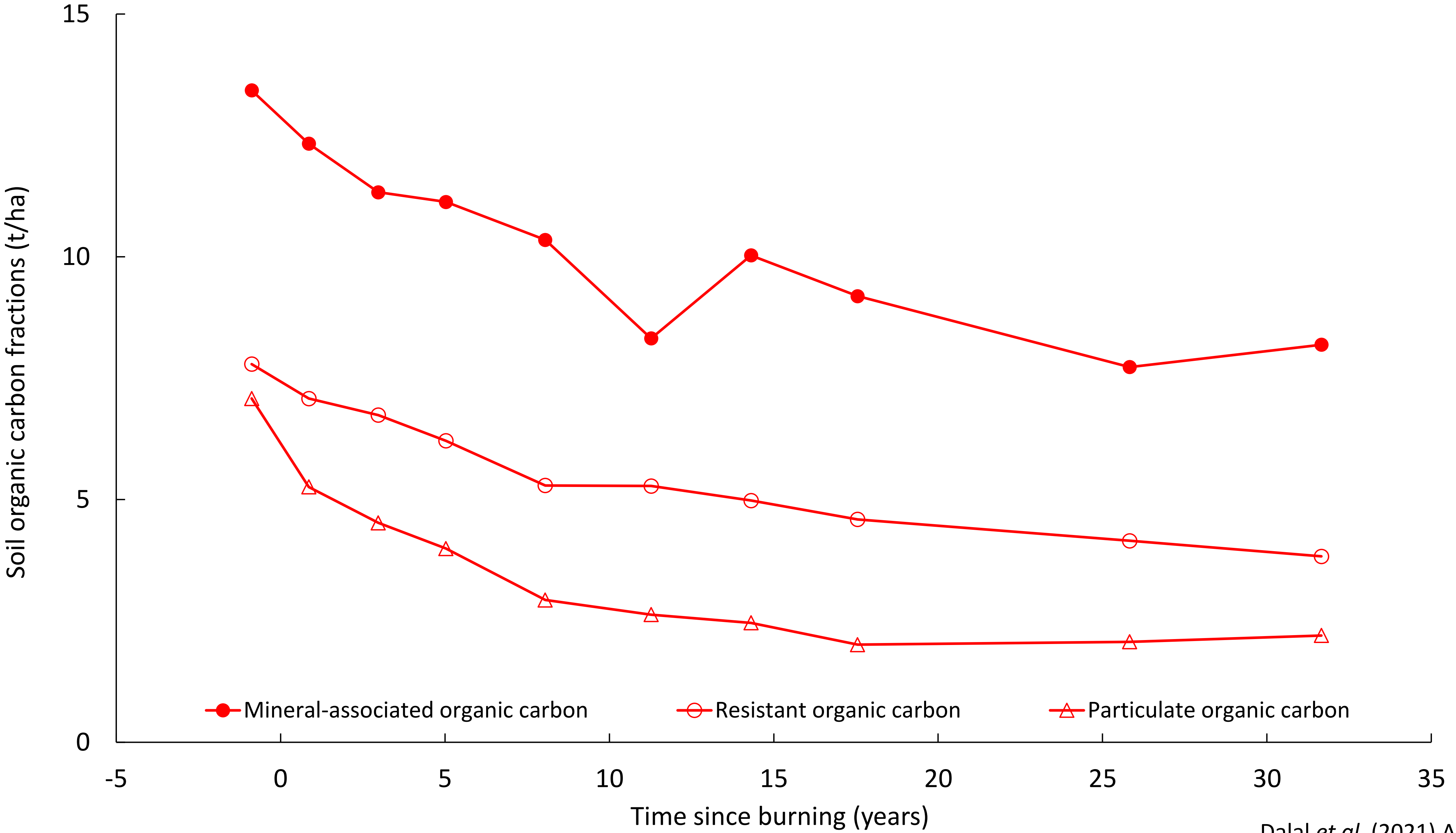


Soil organic carbon (0-0.1 m) (Walkley and Black)



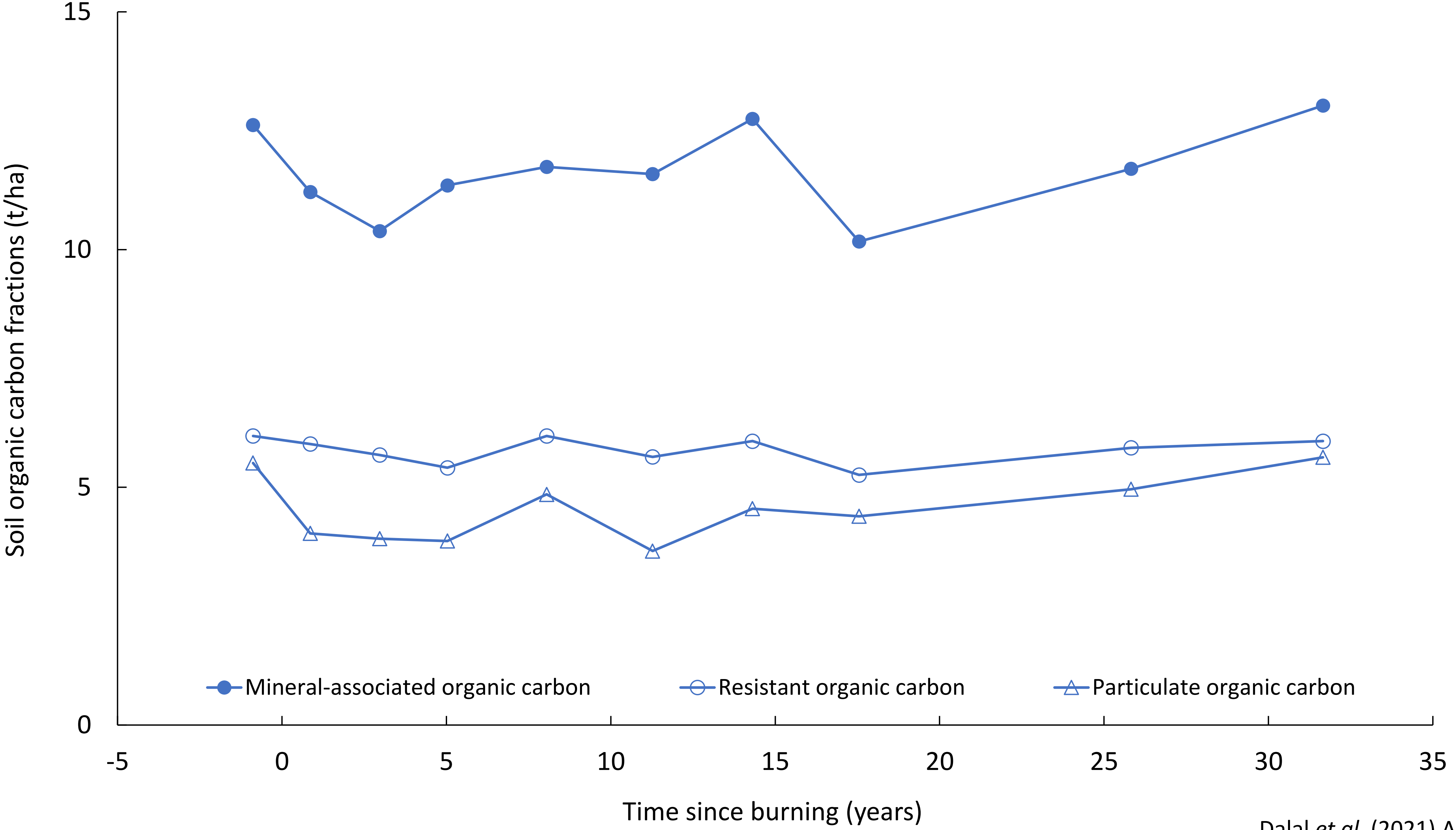
Thornton and Shrestha (2020) SR

Soil organic carbon fractions under cropping (0-0.1 m) (MIR spectroscopy)

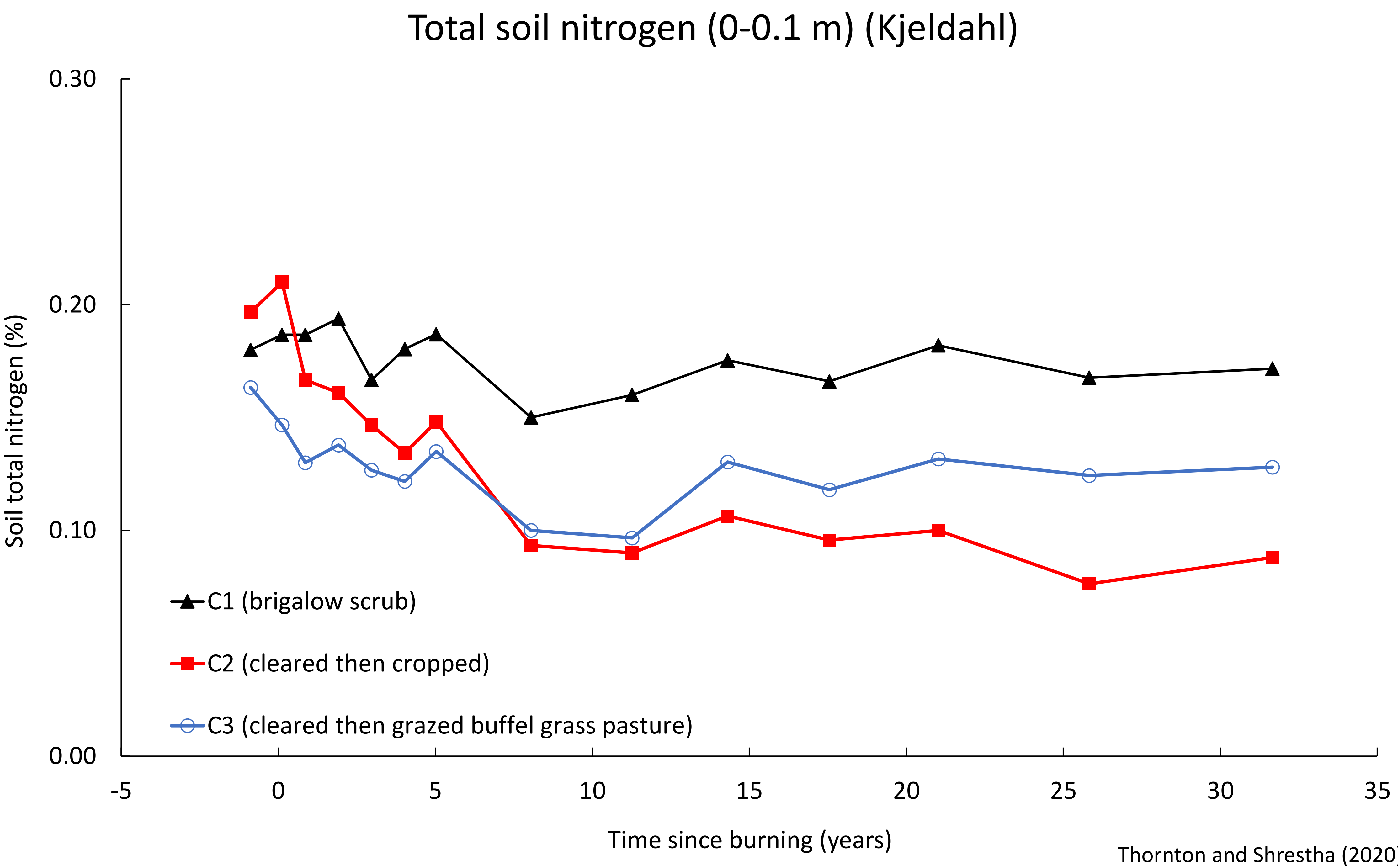


Dalal *et al*. (2021) Ag EE

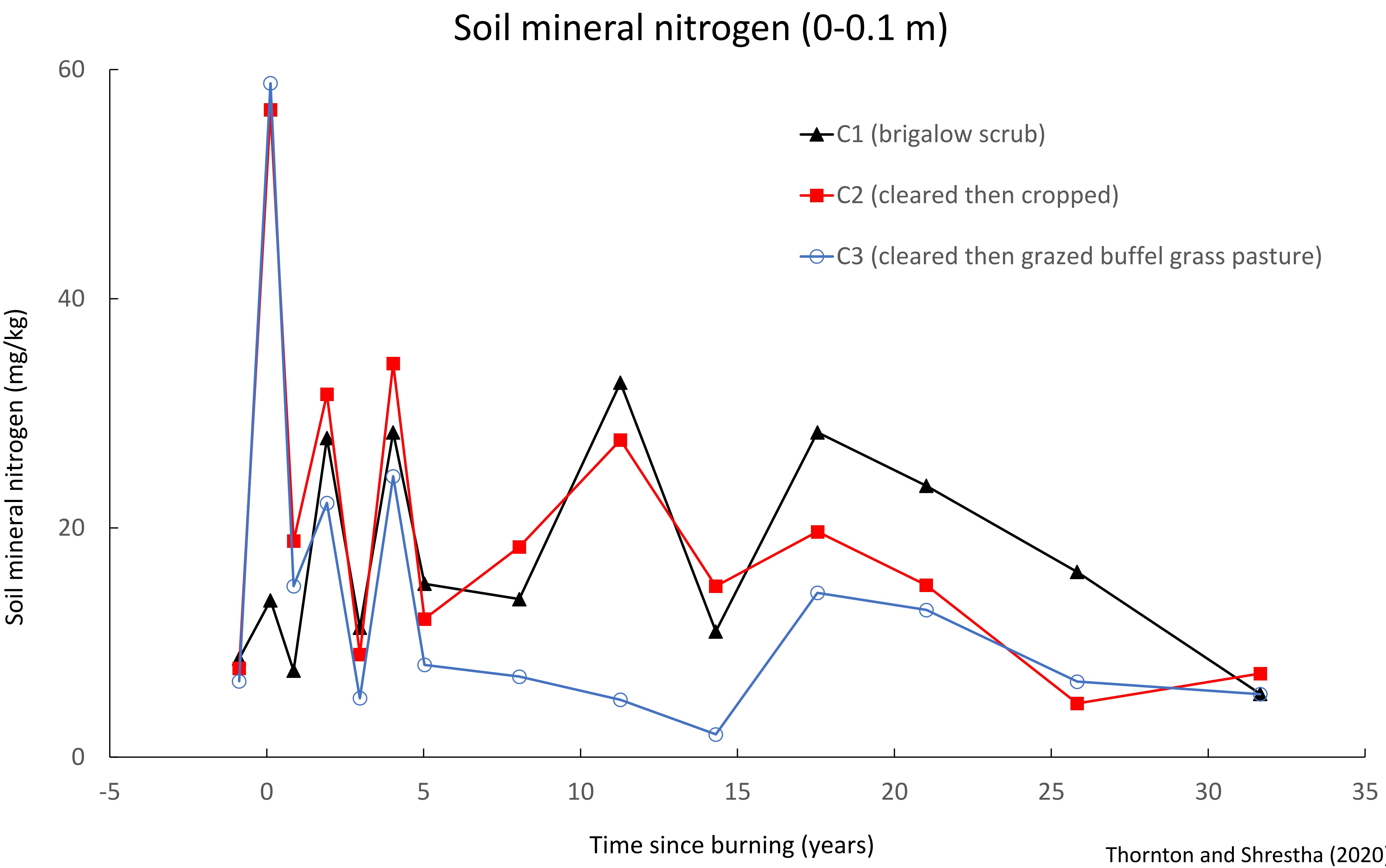
Soil organic carbon fractions under pasture (0-0.1 m) (MIR spectroscopy)



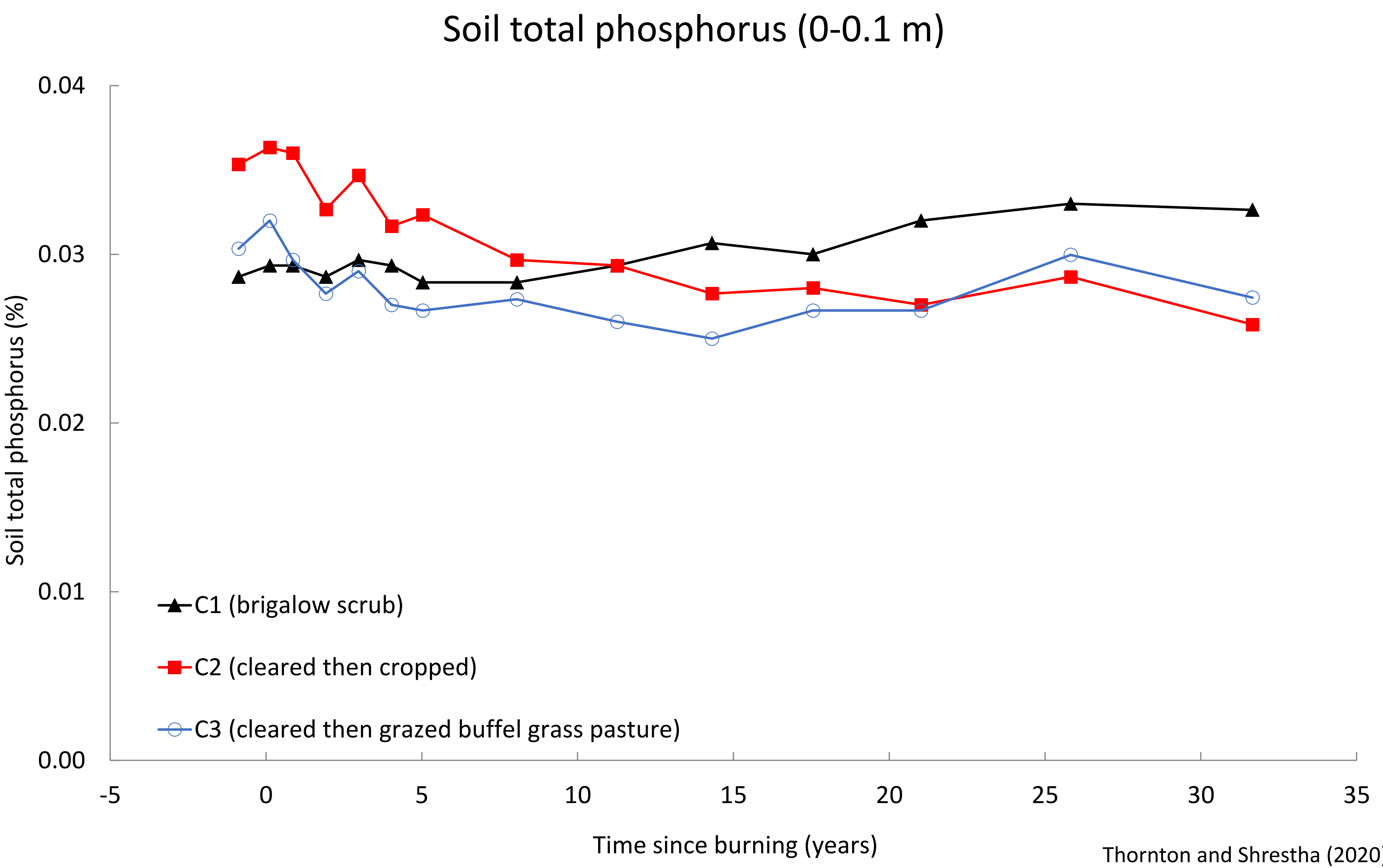
Dalal *et al*. (2021) Ag EE



Thornton and Shrestha (2020) SR

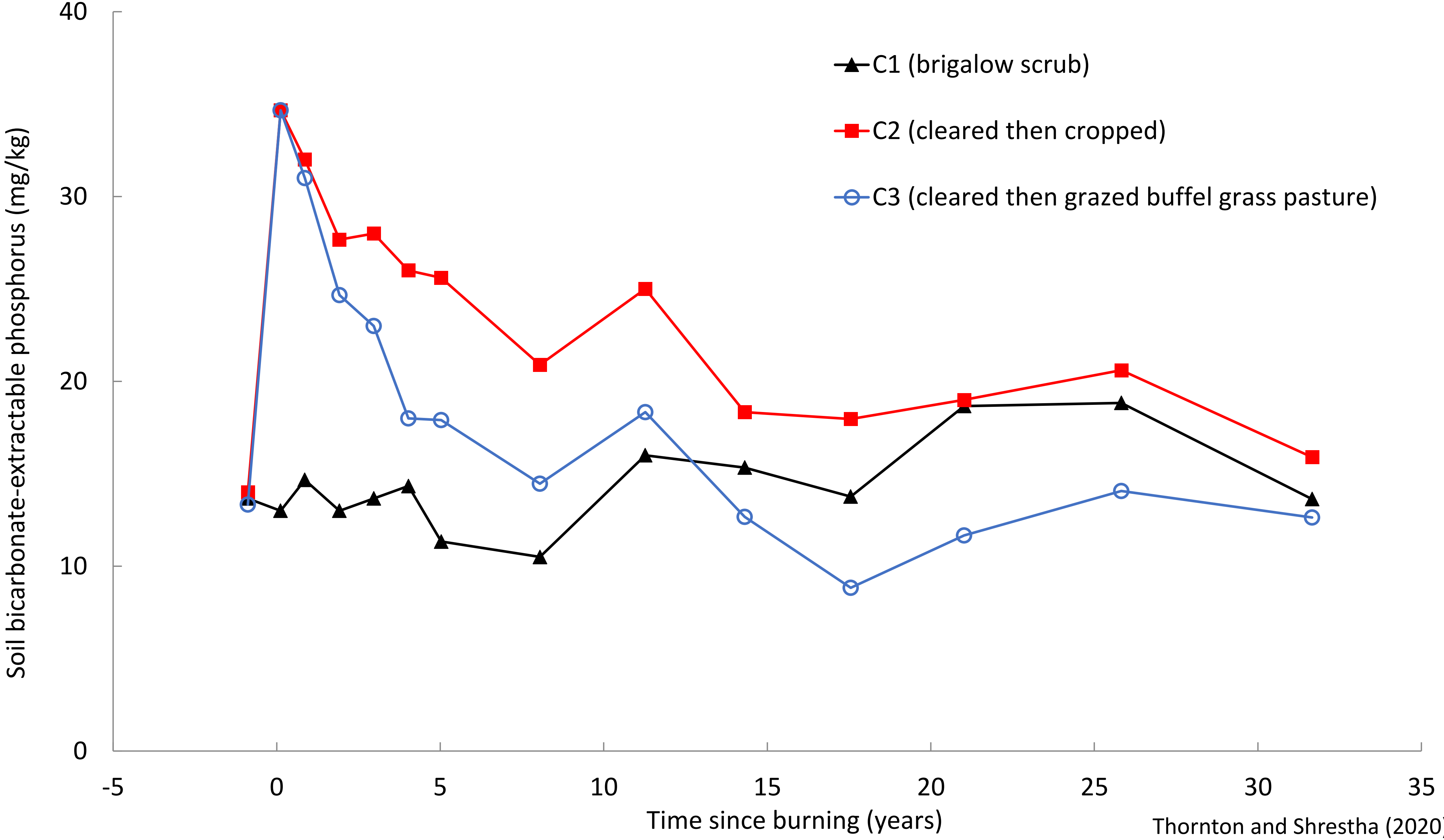


Thornton and Shrestha (2020) SR



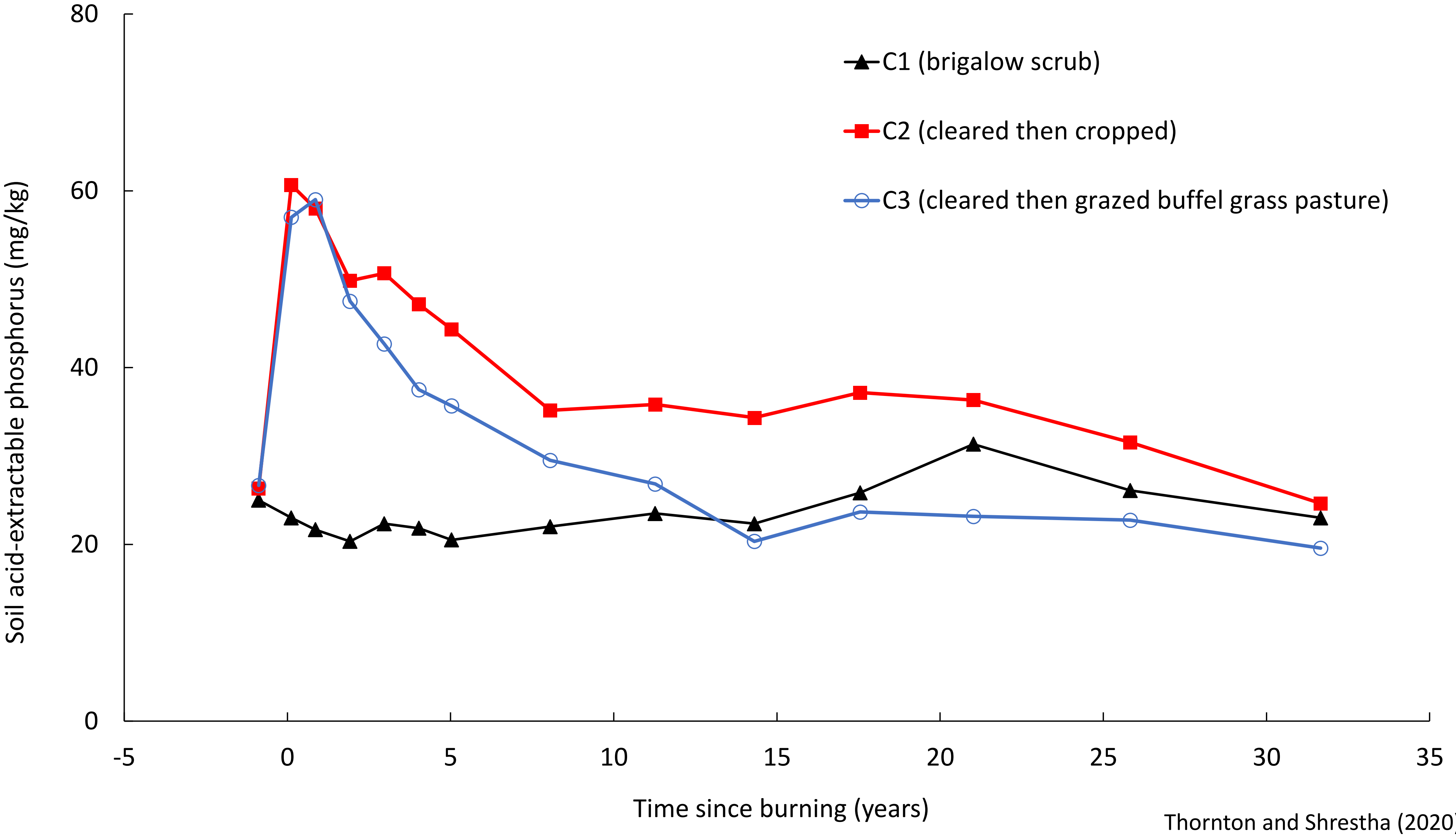
Thornton and Shrestha (2020) SR

Soil available phosphorus (0-0.1 m) (bicarbonate extraction)

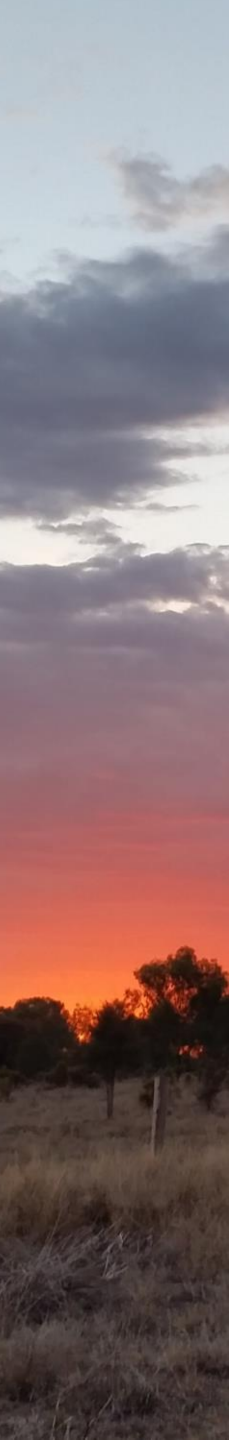


Thornton and Shrestha (2020) SR

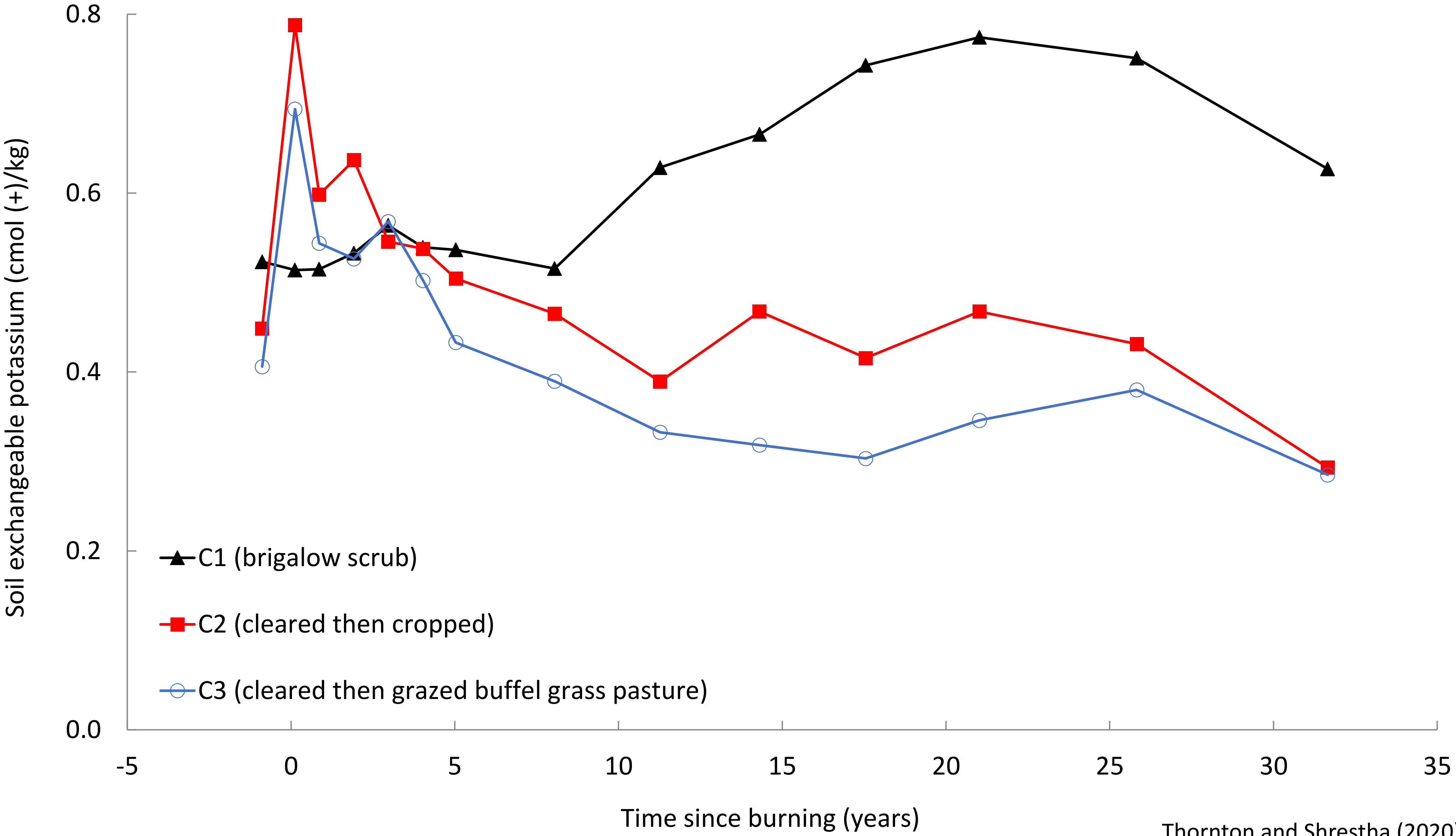
Soil available phosphorus (0-0.1 m) (acid extraction)



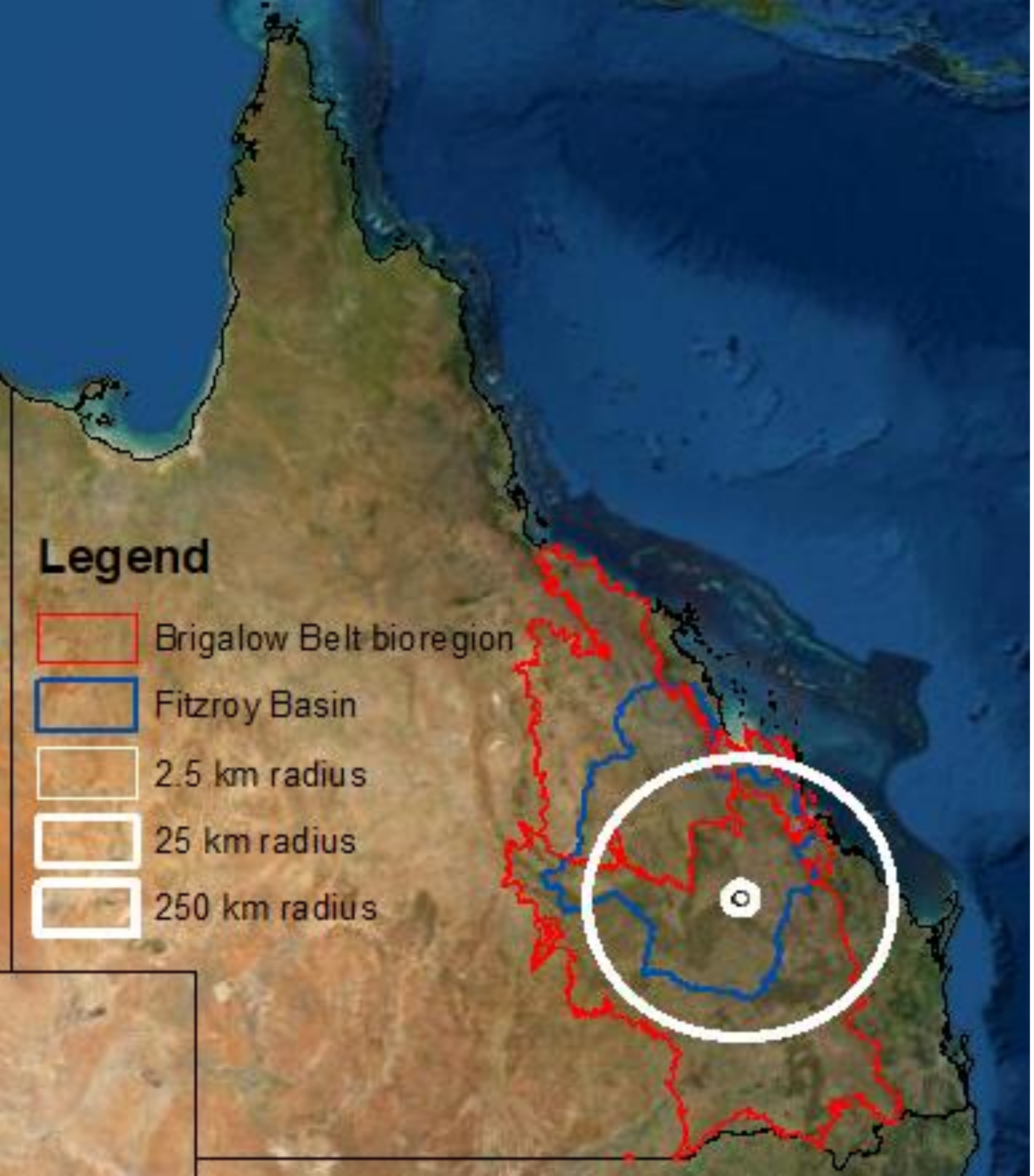
Thornton and Shrestha (2020) SR



Soil exchangeable potassium (0-0.1 m)



Thornton and Shrestha (2020) SR



Integrating long-term research at Brigalow with

- Broad scale research
- Other long-term research

Fertility survey of Dawson – Callide Valley areas (a) Gilgaied clays of the Highworth land system

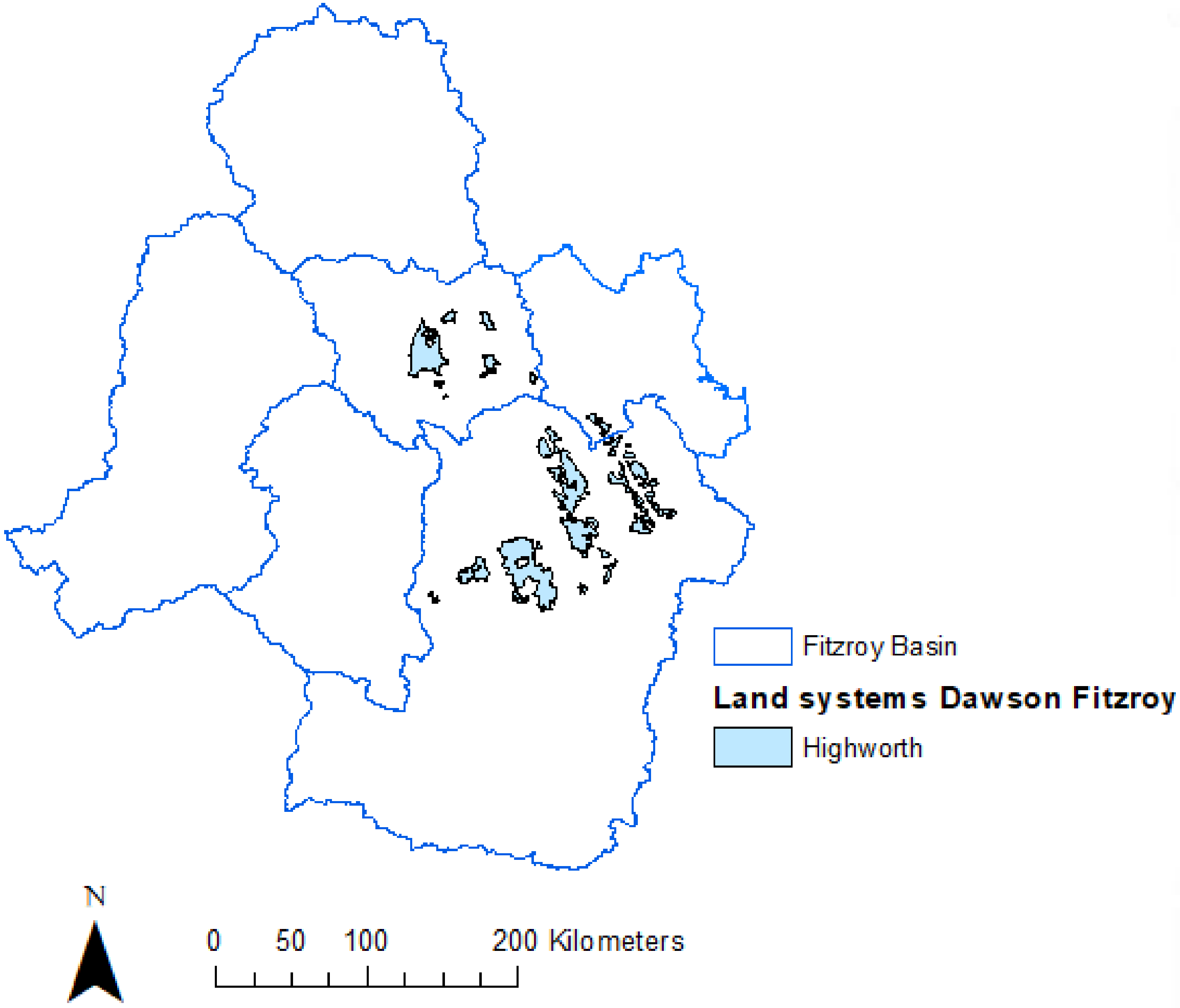


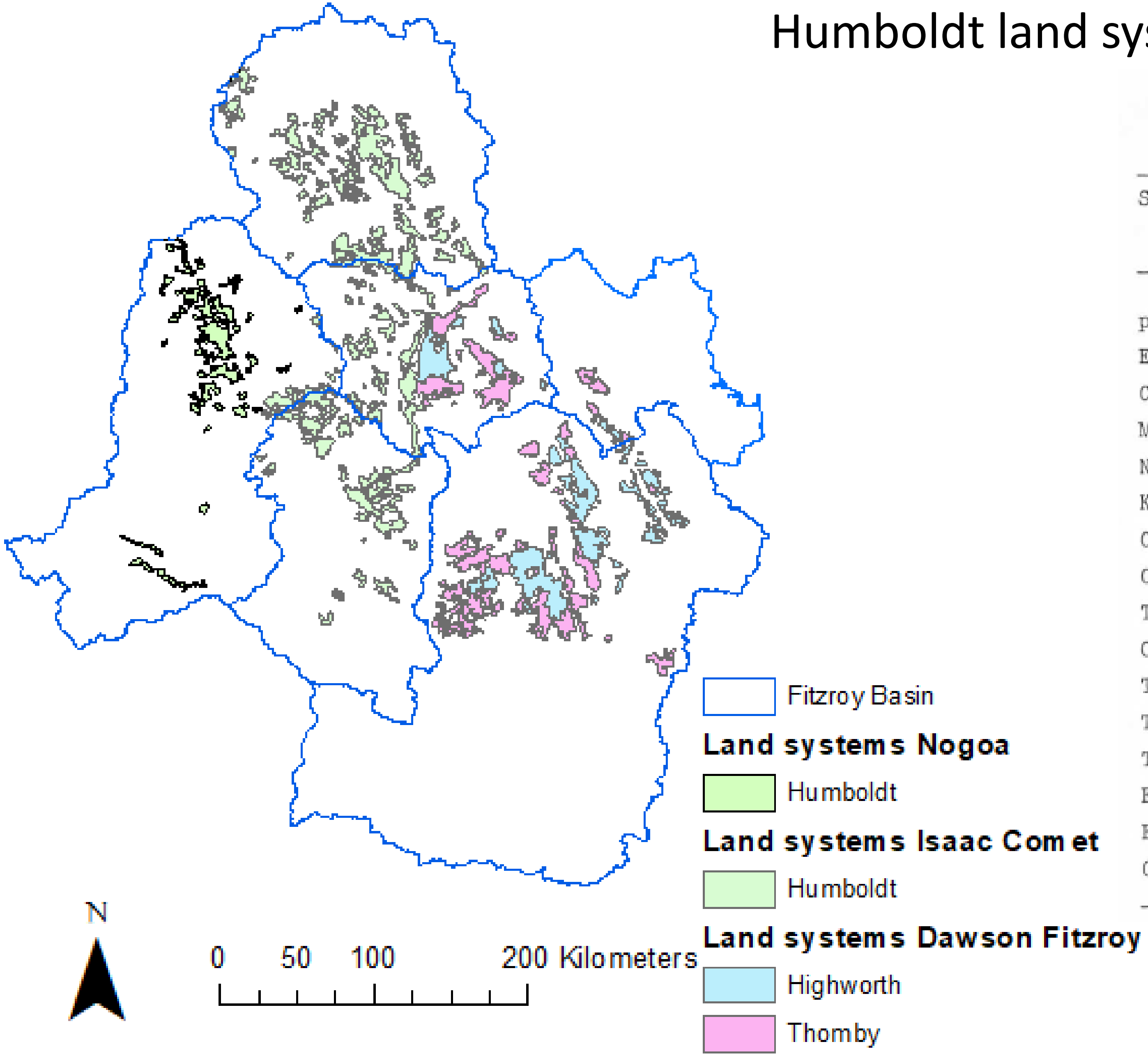
TABLE 2.

Mean values for a number of attributes for surface soil (0-10 cm) of the gilgaied clays in virgin, cleared and cultivated sites in the Pengunny (P) area, the Callide Valley (C), and the Dawson Valley (D).

Progression of development->

Attribute	Site	Virgin	Cleared	Cultivated	
pH	P C D	7.5 6.1 6.9	7.4 7.0 7.5	7.6 6.9 7.5	pH ↑
Phosphorus (B.S.E.S) (ppm)	P C D	19 34 30	23 42 31	34 51 40	P ↑
Exchangeable Potassium (m. equiv/100g)	P C D	.60 .54 .59	.51 .63 .41	.76 .52 .46	K ↑
Organic Carbon (%)	P C D	1.91 2.56 2.13	1.77 2.17 1.82	2.23 1.87 1.94	OC ↓
Chloride (ppm)	P C D	157 376 251	153 410 173	273 323 294	
Exchangeable Sodium(m. equiv/100g)	P C D	1.33 1.38 1.30	1.26 1.37 1.30	1.73 1.60 2.70	
Clay (%)	P C D	49 60 46	48 57 51	40 47 51	Clay ↓

Fertility survey of Dawson – Callide Valley areas (b) Duplex soils of Highworth, Thomby and Humboldt land systems



MEANS AND STANDARD ERRORS (S.E.) FOR PROPERTIES OF SURFACE SOIL OF FOUR SOIL GROUPS WITH DIFFERENT THICKNESS OF A HORIZON.

Soil Property	Group 1 n = 7		Group 2 n = 19		Group 3 n = 18		Group 4 n = 8	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
pH	6.6	0.29	6.5	0.18	6.5	0.18	6.9	0.27
Extr. P ppm	27	9.0	32	5.5	29	5.6	28	8.5
Ca meq/100 g	9.2	1.2	8.4	0.7	6.5	0.8	7.0	1.1
Mg meq/100 g	4.2	0.4	2.4	0.2	2.0	0.3	0.9	0.4
Na meq/100 g	0.61	0.09	0.22	0.06	0.19	0.06	0.14	0.09
K meq/100 g	0.67	0.12	0.42	0.07	0.54	0.07	0.52	0.11
C.E.C. meq/100 g	18	1	16	1	11	1	12	1
Chloride %	0.012	0.002	0.004	0.002	0.005	0.002	0.003	0.002
Total nitrogen %	0.14	0.02	0.15	0.01	0.11	0.01	0.11	0.02
Organic carbon %	1.8	0.3	1.6	0.2	1.5	0.2	1.6	0.3
Total P ppm	431	65	510	40	440	42	456	57
Total S ppm	256	36	274	23	209	23	210	32
Total K ppm	0.64	0.20	0.45	0.13	0.43	0.13	0.43	0.18
Extr. Cu ppm	2.1	0.38	2.5	0.24	2.1	0.25	1.9	0.34
Extr. Zn ppm	0.9	0.35	1.3	0.22	0.9	0.23	0.6	0.31
Clay %	20	2	17	1	13	1	13	2

Duplex soil pH, P, OC and clay content less than the gilgaied clay soils of the Highworth land system

Characterisation of the basaltic clays of Central Queensland 1. Clays of the Oxford and Waterford land systems

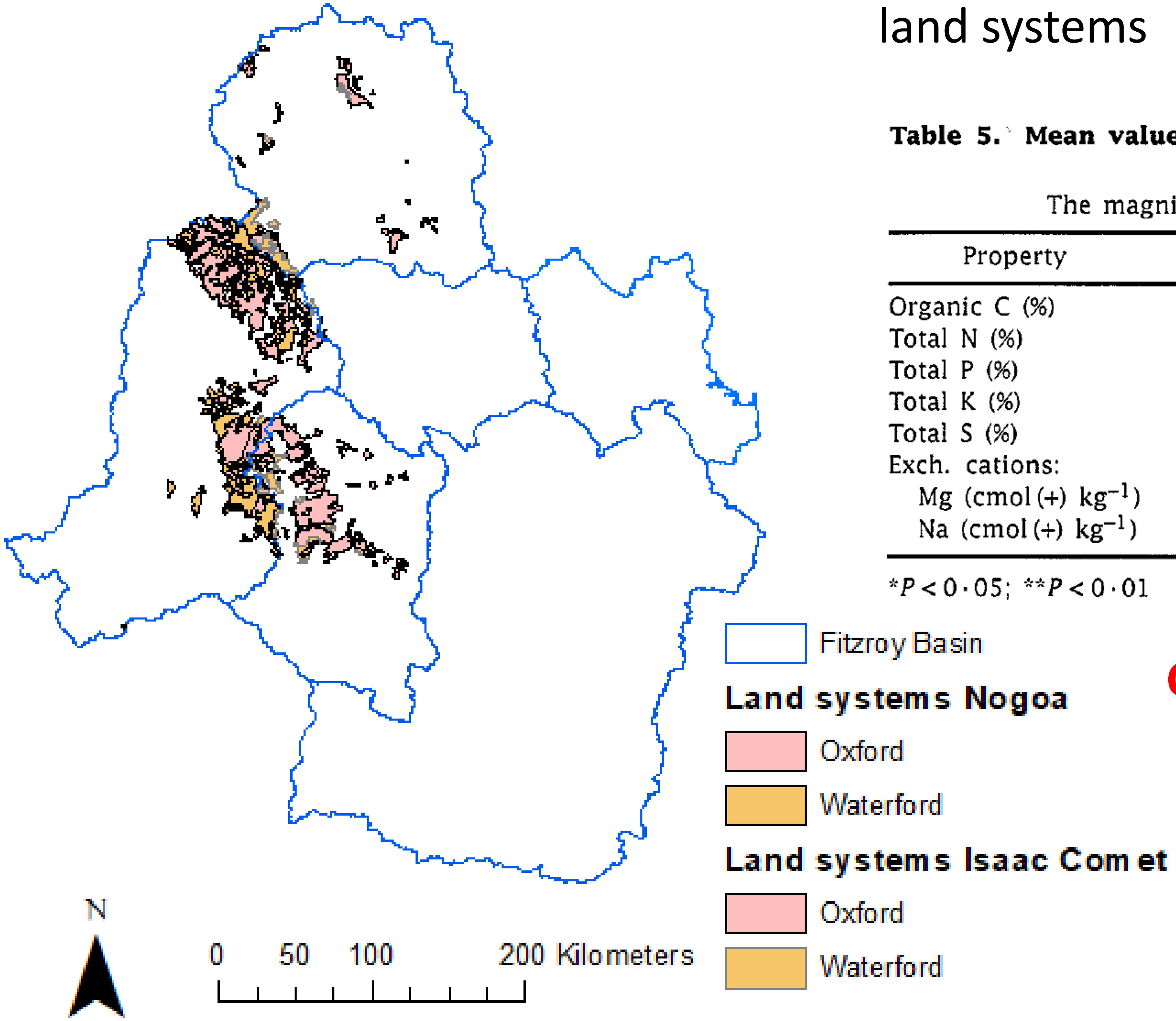


Table 5. Mean values for surface soil properties influenced by land use from 26 paired native pasture and cultivated sites

The magnitude, direction and significance of any change is shown

Property	Native pasture	Cultivation	Difference
Organic C (%)	1·10	0·89	−0·21**
Total N (%)	0·110	0·091	−0·020**
Total P (%)	0·082	0·076	−0·006*
Total K (%)	0·469	0·419	−0·050*
Total S (%)	0·016	0·014	−0·002**
Exch. cations:			
Mg (cmol (+) kg^{-1})	17·3	20·0	2·7**
Na (cmol (+) kg^{-1})	0·18	0·26	0·08**

*$P < 0·05$; **$P < 0·01$

Converting native pasture to cultivation

OC ↓

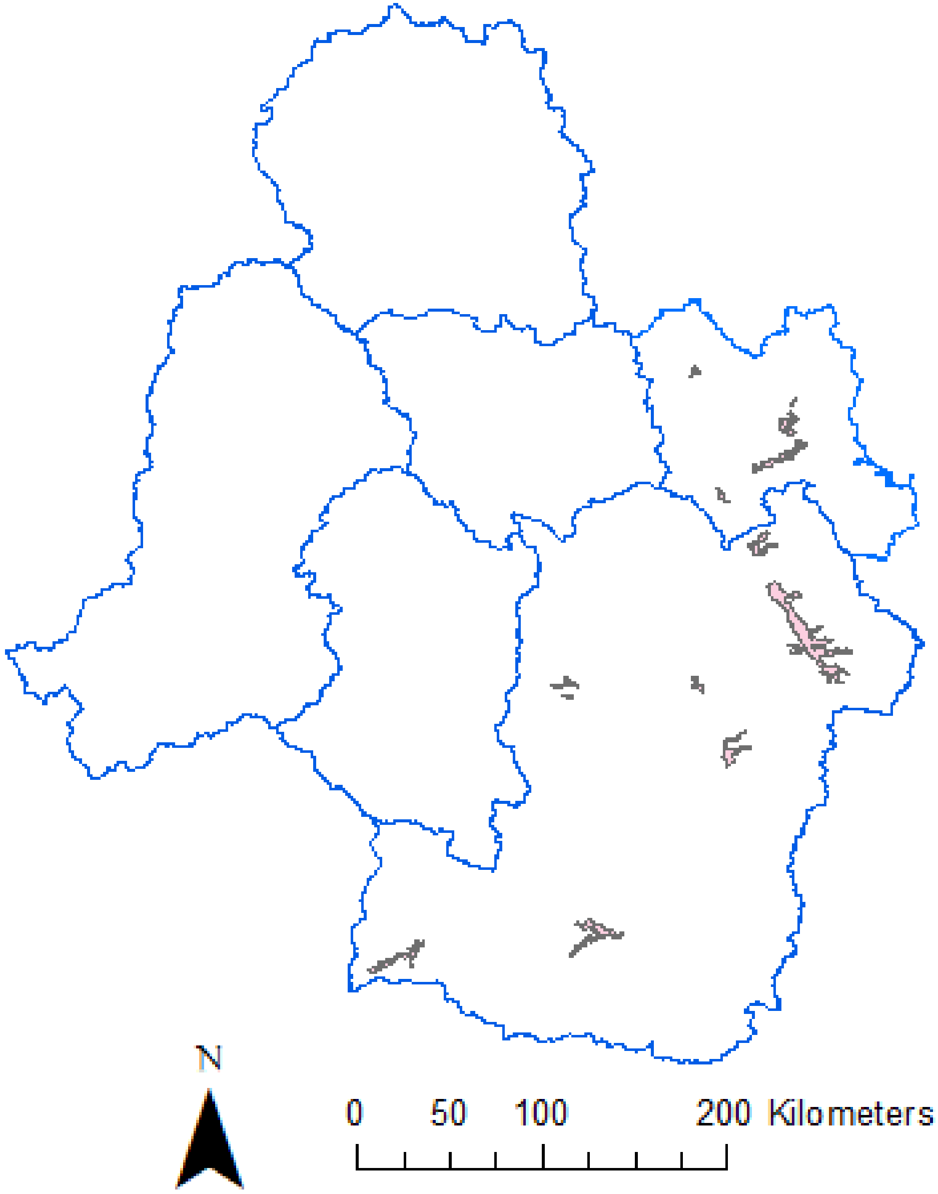
TN ↓

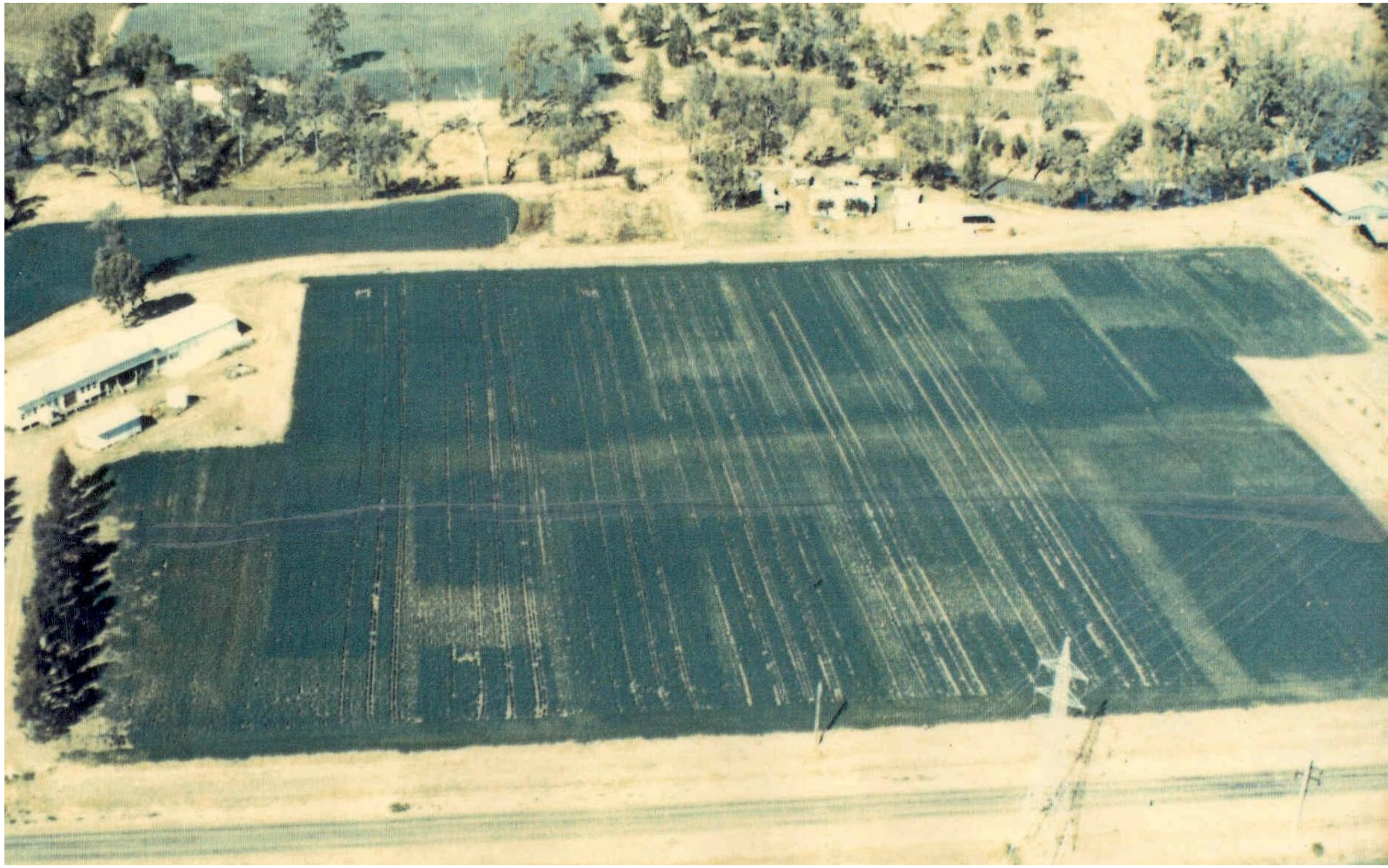
TP ↓

TK ↓

TS ↓

Biloela Tillage Trial (Kroombit land system)



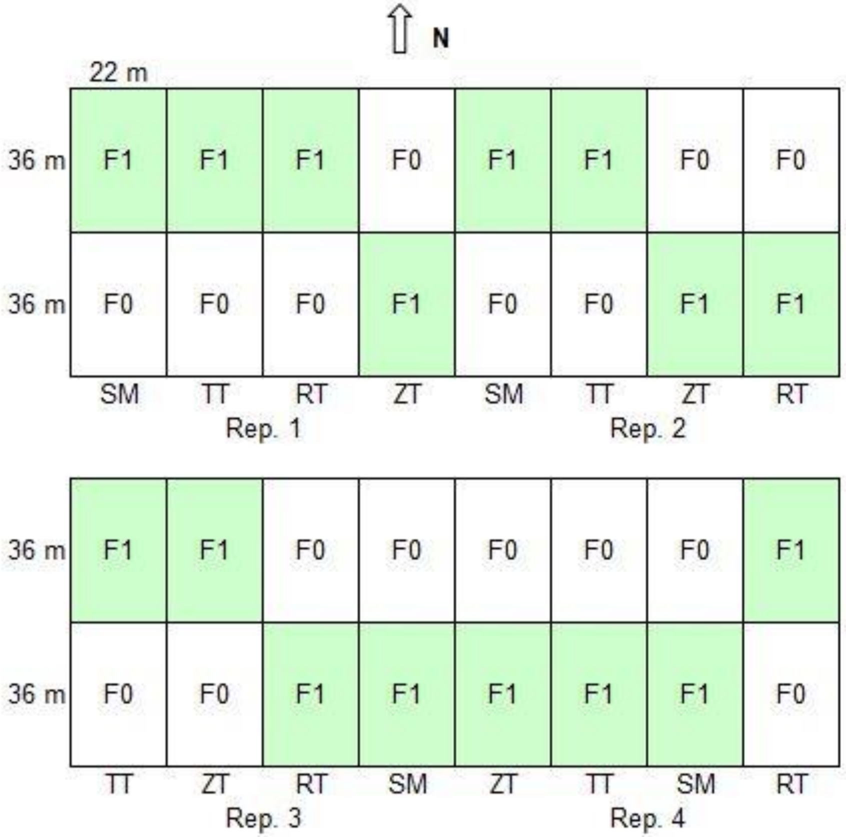


Fitzroy Basin

Land systems Dawson Fitzroy

Kroombit

Biloela Tillage Trial (Kroombit land system)



Tillage treatments

TT: Traditional tillage (Disc plough, scarifier)

SM: Stubble mulch tillage (Chisel plough, blade plough, rodweeder)

RT: Reduced tillage (Stubble mulching implements, herbicides)

ZT: Zero tillage (herbicides only)

Fertiliser treatments

F0: Control

F1: N + Zn

Figure 6. Infiltration after 125 mm of rainfall in a no till plot and a traditional tillage plot after 8 years of treatment application.

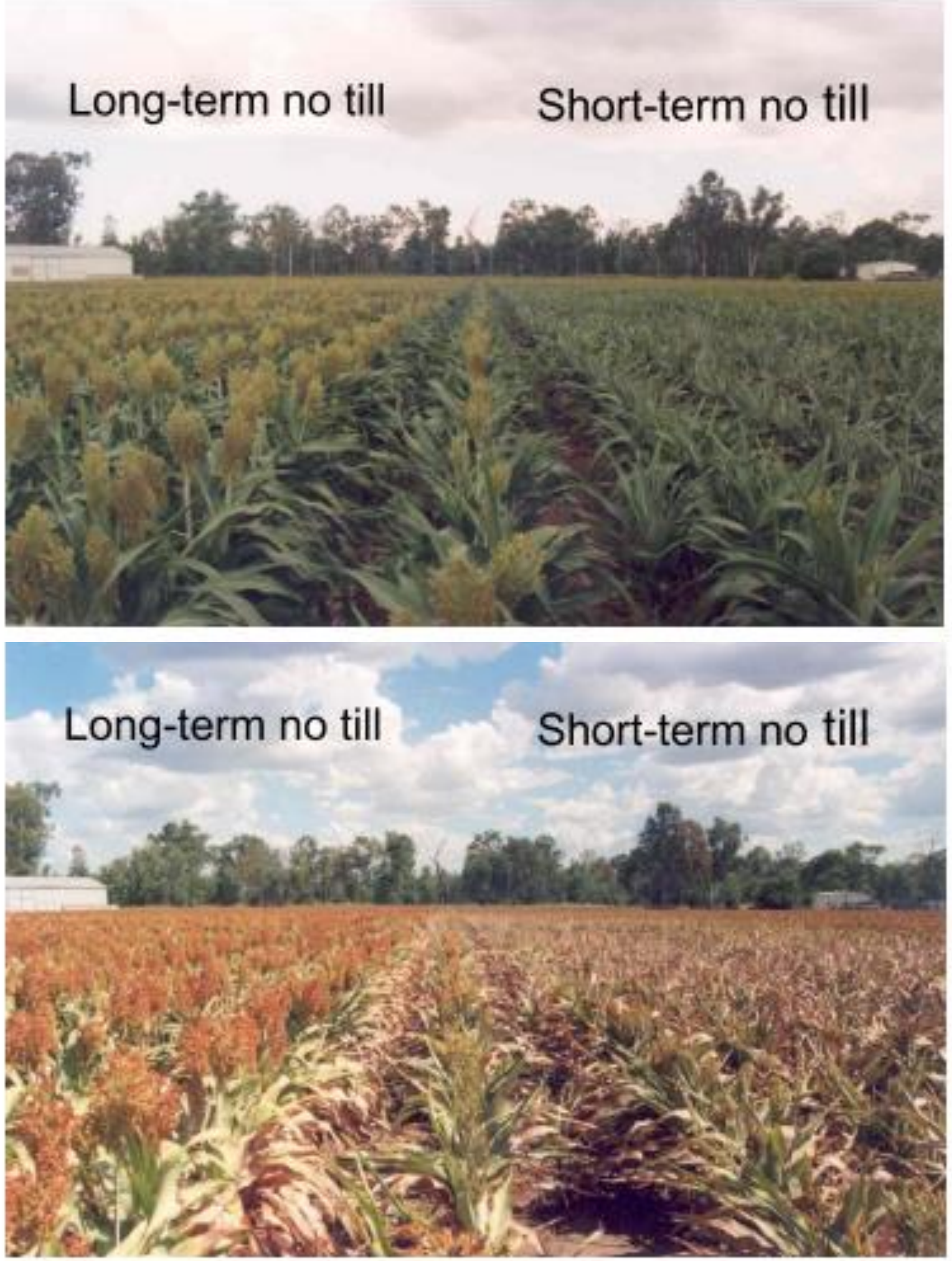


Figure 7. Sorghum crop in long-term (23 years) and short-term (3 years) no-till plots at 69 days (top) and 85 days.

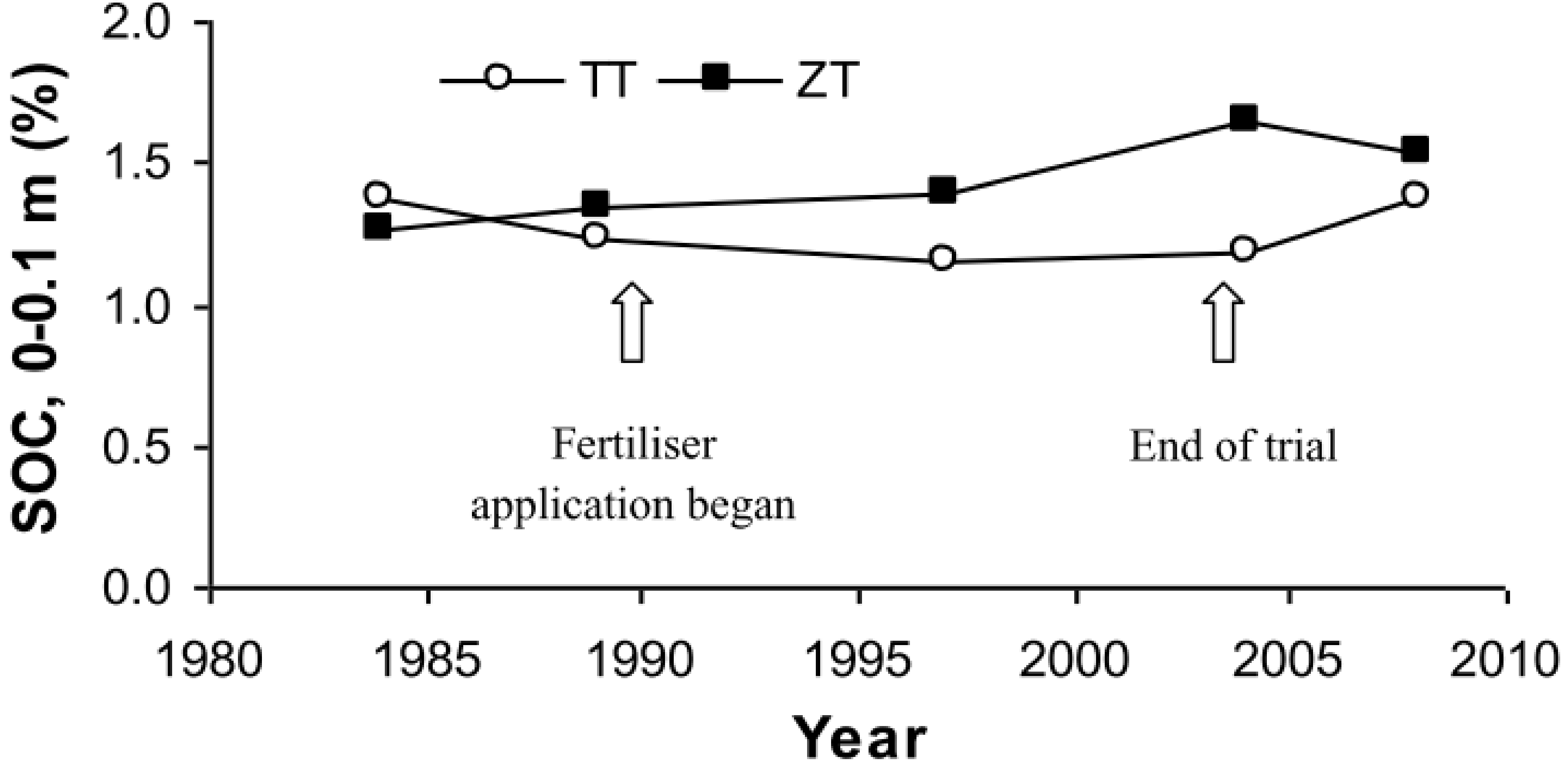


Figure 3. Soil organic carbon content at 0-0.1 m in fertilised NT and TT in 1984, 1989, 1997, 2004 and 2008 (NT = no tillage; TT = traditional tillage).

Mt. Murchison Tillage and Crop Residue Management Trial (Highworth land system)

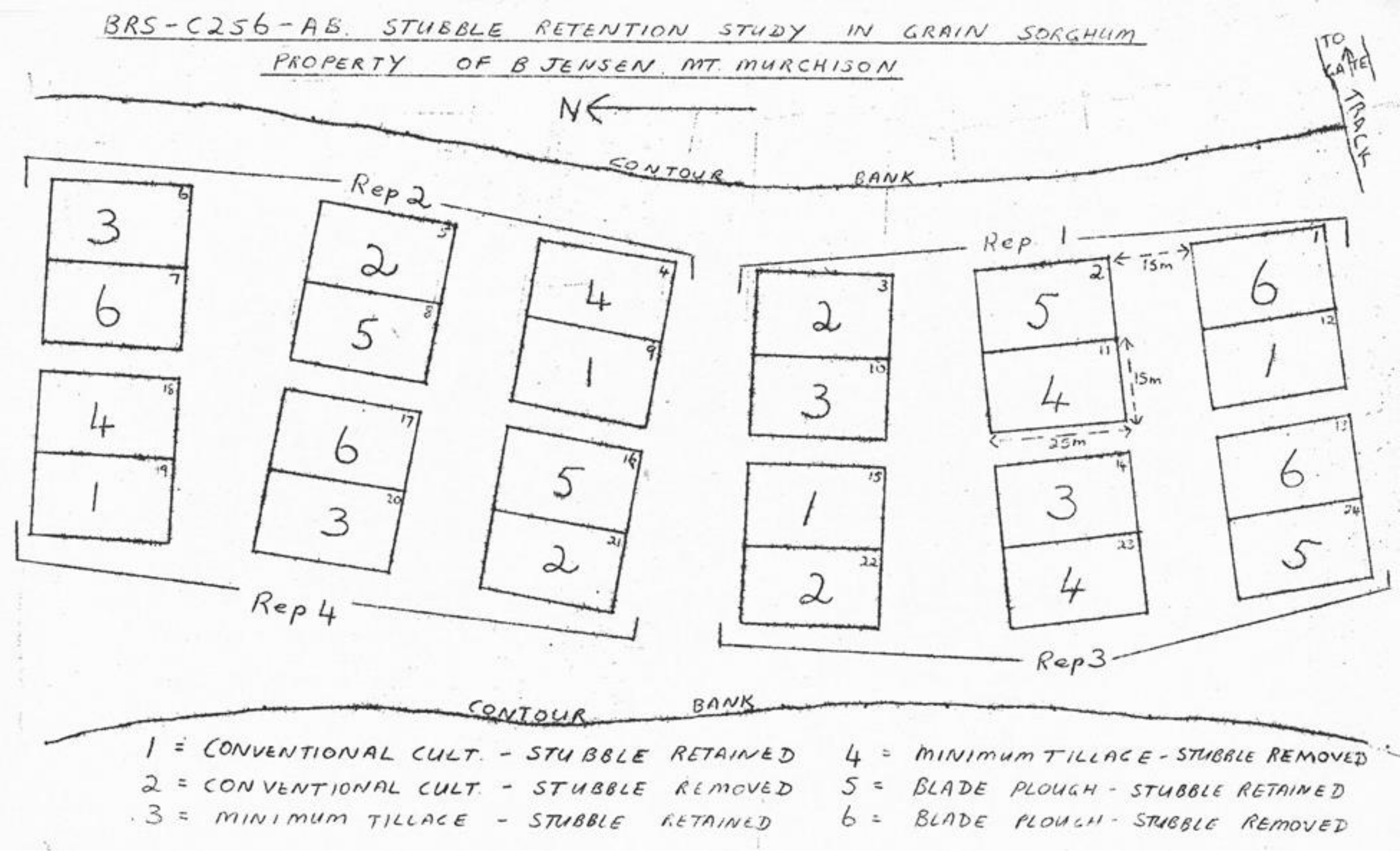


TABLE 1

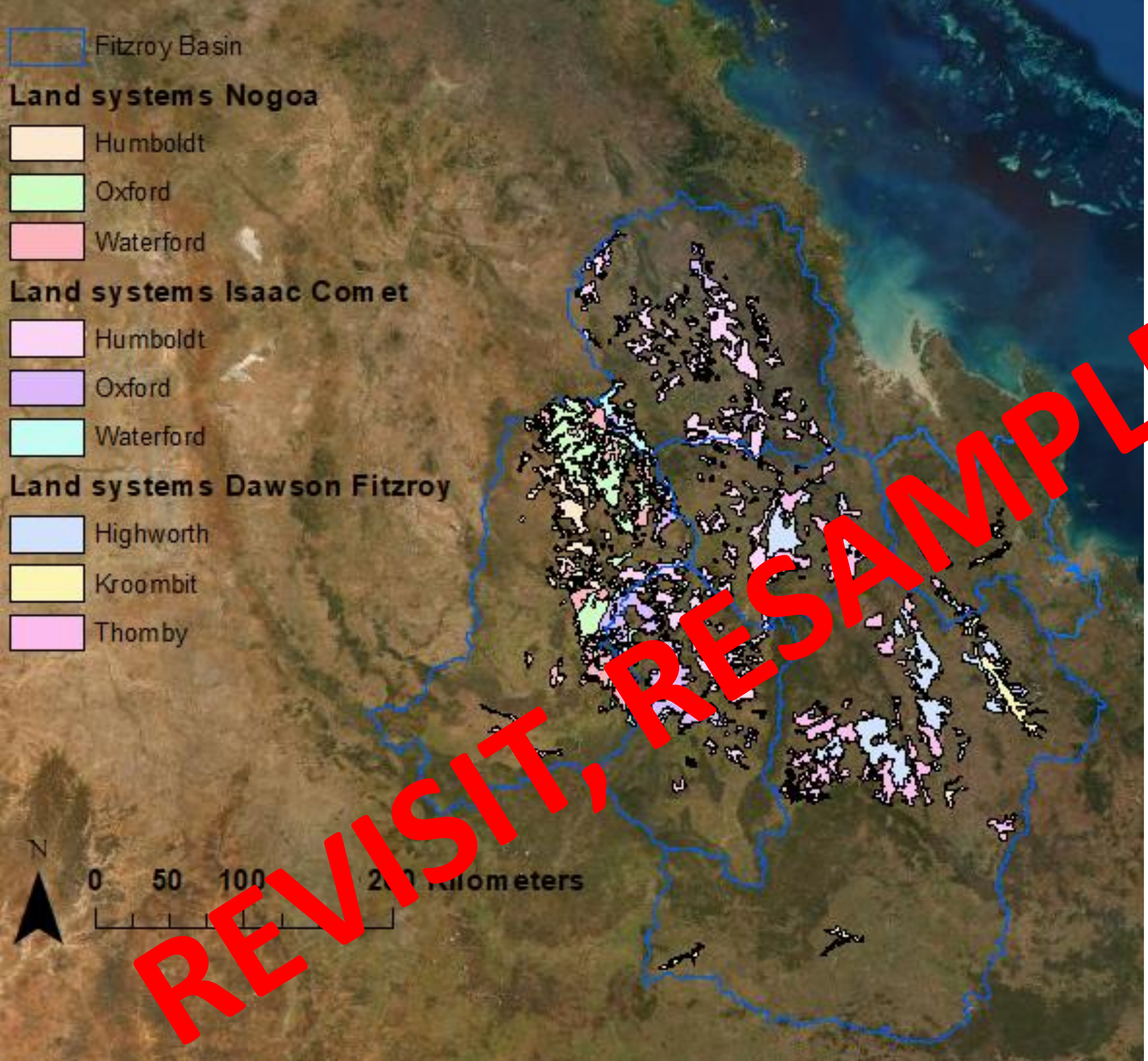
Initial means in 1978 and mean changes for various soil attributes during the experiment

Years of cropping ->

Attribute	Depth interval (m)	Initial mean[1]	Change ± SE after several years		
			3 years	5 years	7 years
Organic carbon	0–0.1	16170	−2060 ± 200	−2870 ± 170	−4360 ± 260
(kg ha^{-1})	0.1–0.2	12630		−550 ± 220	−2100 ± 310
Total nitrogen	0–0.1	1727	−187 ± 15	−207 ± 20	−373 ± 16*
(kg ha^{-1})	0.1–0.2	1371		−81 ± 30	−199 ± 43
Nitrate	0–0.6	16.4	−10.2 ± 0.8	−10.1 ± 0.8	−13.1 ± 0.8
(kg N ha^{-1})	0.6–1.6	156.2	−25.6 ± 4.1*	−47.1 ± 2.9*	−92.2 ± 5.4
Total phosphorus (kg ha^{-1})	0–0.1	644	−151 ± 58*	−126 ± 56	
Bicarbonate extractable	0–0.1	31.3	−8.1 ± 0.5*	−12.3 ± 0.8*	−16.4 ± 0.7
phosphorus (kg ha^{-1})	0.1–0.2	6.1		−1.5 ± 0.2*	−1.9 ± 0.2
Calcium chloride extractable phosphorus (kg ha^{-1})	0–0.1	0.19			−0.133 ± 0.008
Total sulphur (kg ha^{-1})	0–0.1	306	−78 ± 14	−37 ± 3	
Total potassium (kg ha^{-1})	0–0.1	1600	−184 ± 25	−250 ± 22	
Exchangeable cations (kg ha^{-1})					
Potassium	0–0.1	162	−29 ± 6	−29 ± 6	
Sodium	0–0.1	113	+37 ± 3*	+85 ± 3*	
Calcium	0–0.1	4787	+84 ± 33	+638 ± 34	
Magnesium	0–0.1	1766	+81 ± 8	+139 ± 8	
Cation exchange capacity (mEq kg^{-1})	0–0.1	329	0 ± 2	−1 ± 2	
Dispersion ratios					
Silt+clay	0–0.1	0.457			+0.006 ± 0.007
Clay	0–0.1	0.244			−0.015 ± 0.005

[1]Standard errors of the respective means ranged from 1.3 to 8.5%.
*Significant ($P < 0.05$) treatment effects found and presented later.

OC ↓
TN ↓
NO_3 ↓
TP ↓
Avail. P ↓
Clay ↓



Where have we been today?

What haven't we considered?

Lots of work!

- Soil survey for mapping
- Short term (<3 year) projects
- Non-government projects
- Many others

Where are we going tomorrow?

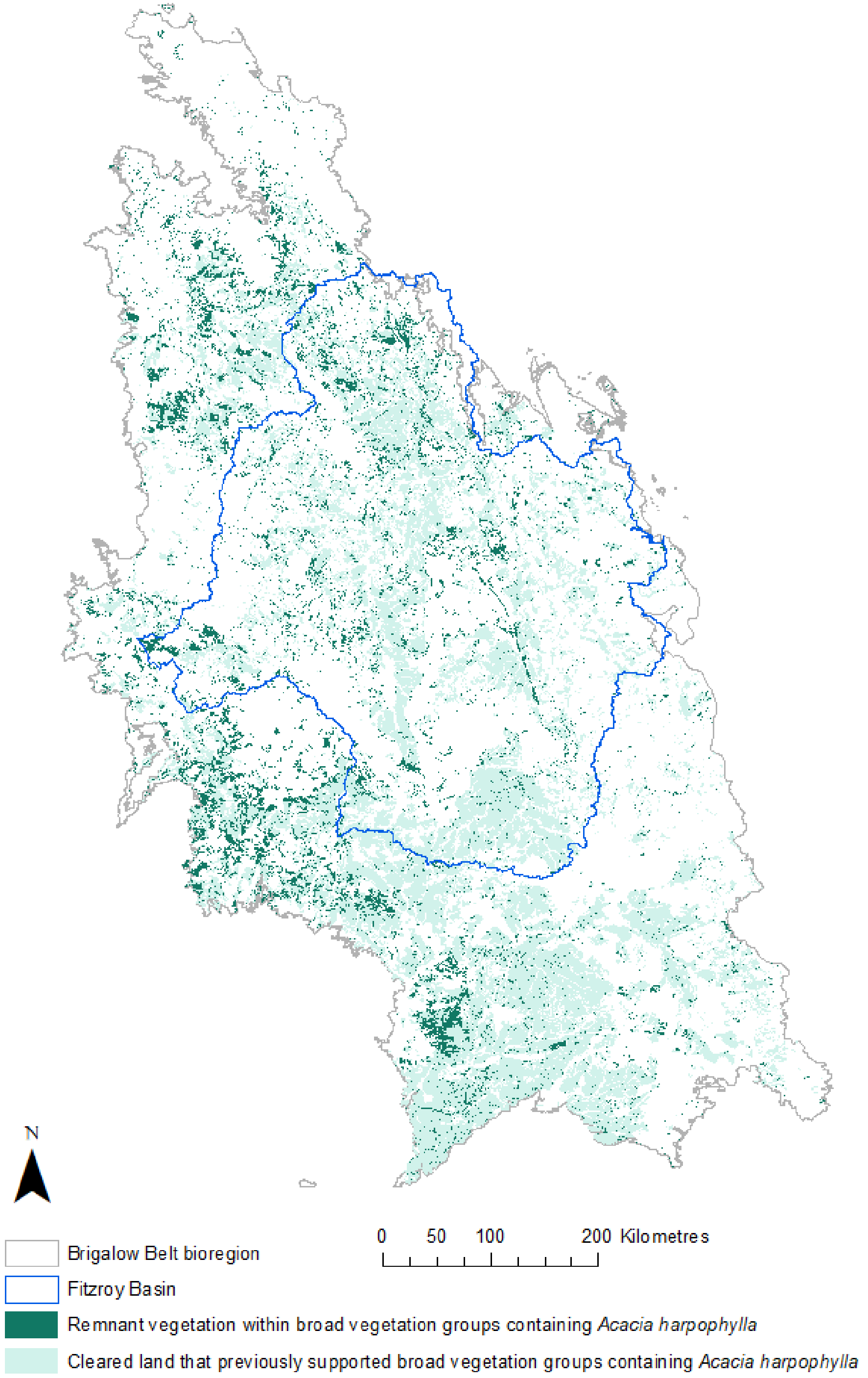
Did I mention we've still got all the samples!

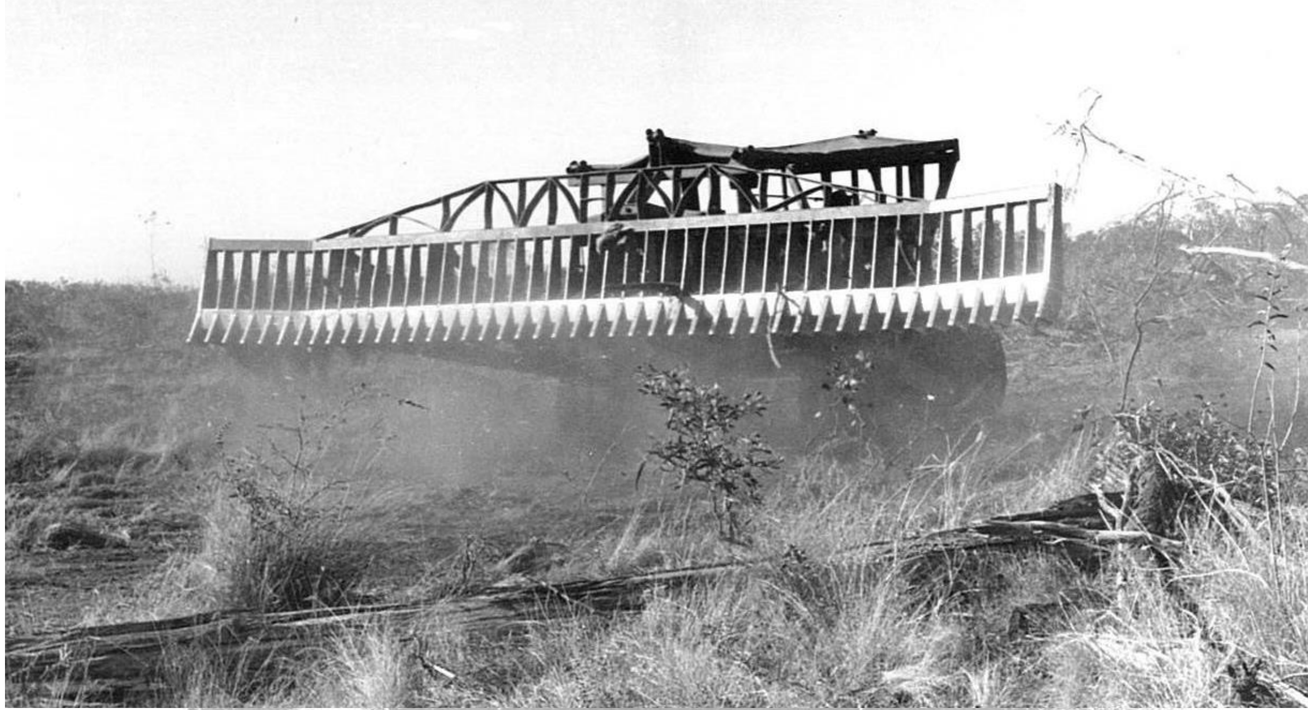
REVISIT, RESAMPLE, RETEST

How are we applying what we know now?

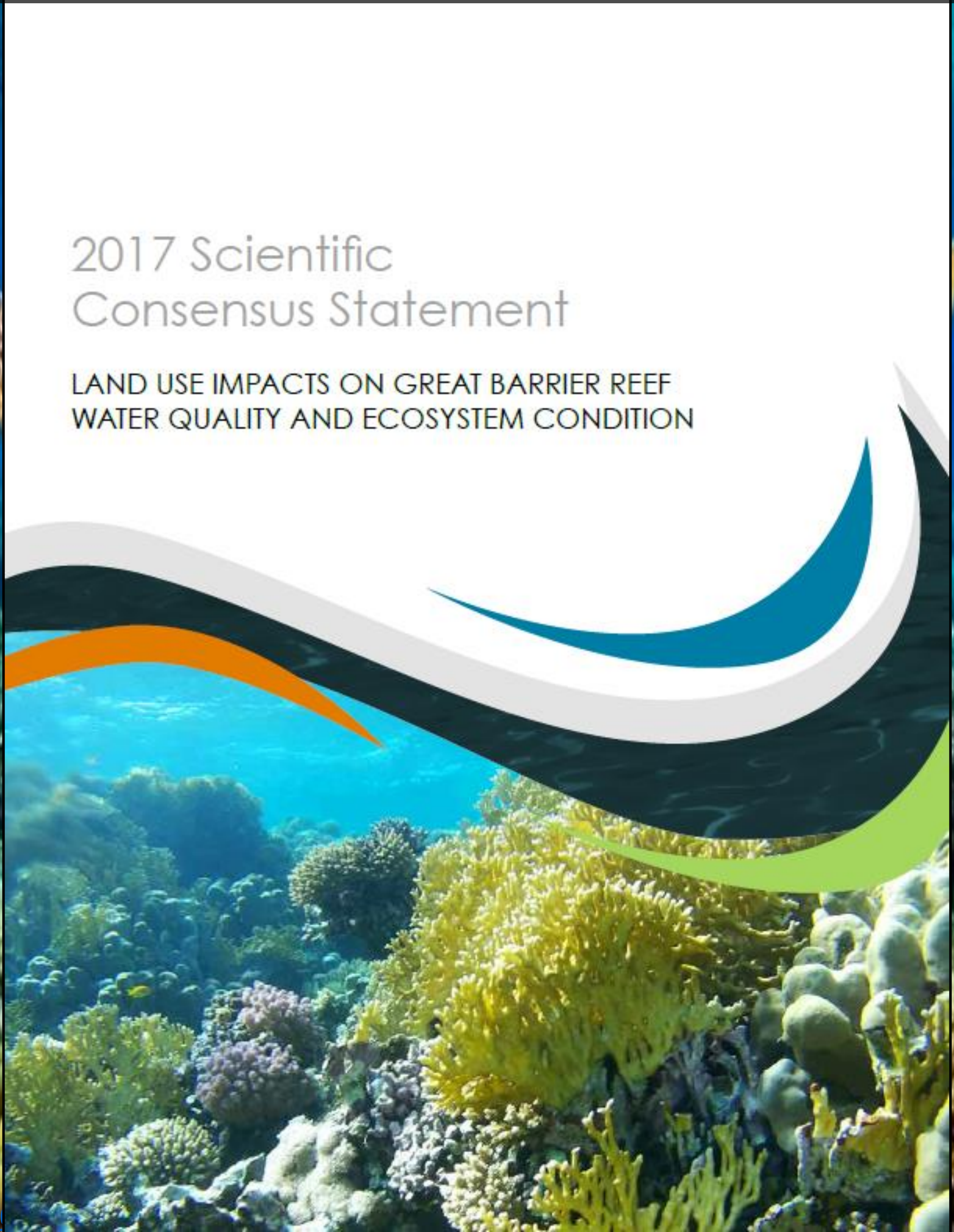
$1.8 billion 2020/21 in Queensland


$5.34 billion 2020/21 in Queensland


N
0 50 100 200 Kilometres
Brigalow Belt bioregion
Fitzroy Basin
Remnant vegetation within broad vegetation groups containing *Acacia harpophylla*
Cleared land that previously supported broad vegetation groups containing *Acacia harpophylla*



$6.4 billion with an economic, social and icon asset value of $56 billion in 2017



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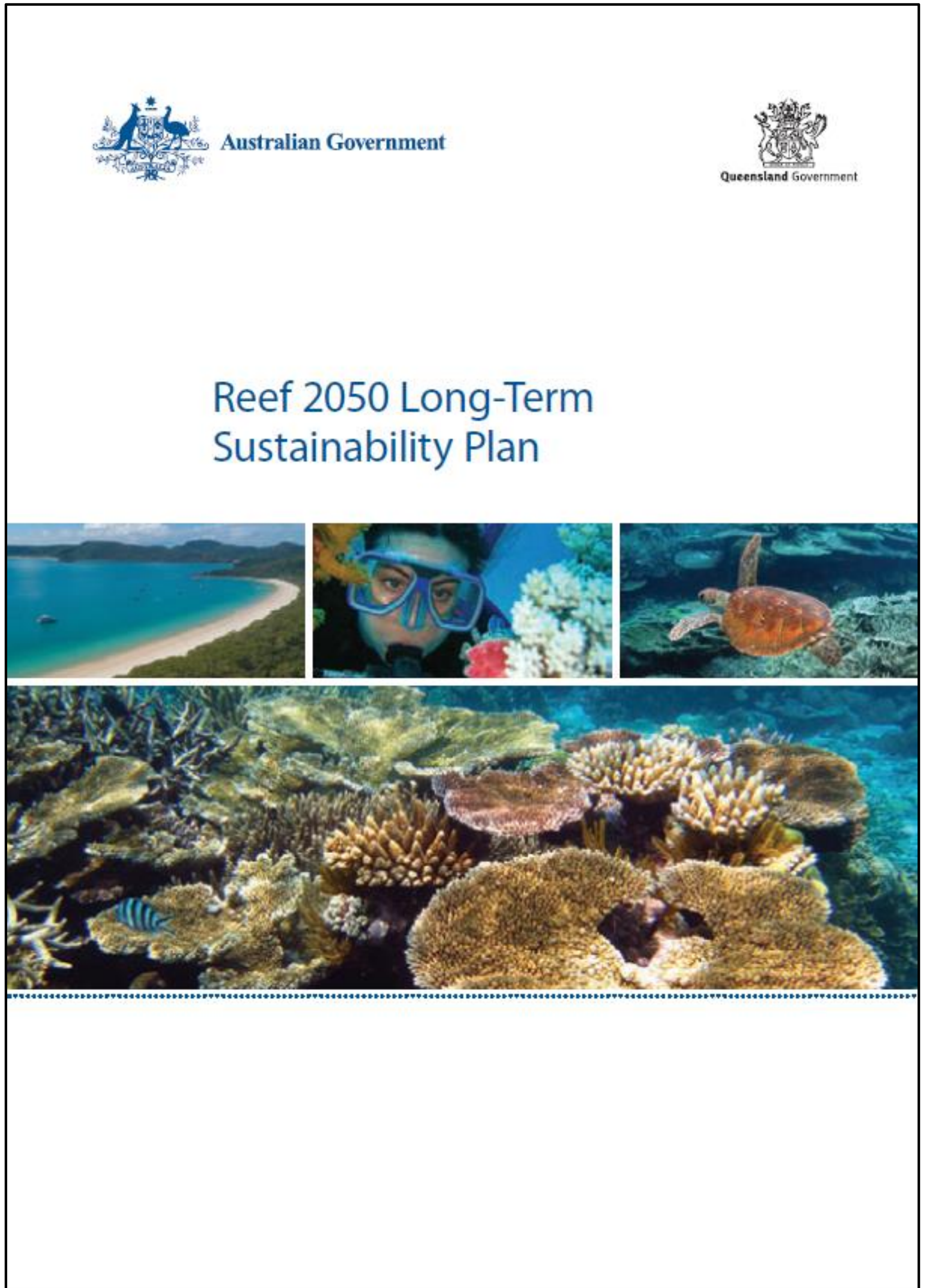
Why is there interest in water quality in the Brigalow Belt?



"Reef Plan"

An Australian and Queensland Government program to improve the quality of water entering the Great Barrier Reef

Policy driven by best available science

Contents lists available at SciVerse ScienceDirect
Marine Pollution Bulletin
journal homepage: www.elsevier.com/locate/marpolbul

Quantifying the sources of pollutants in the Great Barrier Reef catchments and the relative risk to reef ecosystems

J. Waterhouse *, J. Brodie, S. Lewis, A. Mitchell
Catchment to Reef Research Group, Australian Centre for Tropical Freshwater Research, ATSIP (Building 145), James Cook University, Townsville, Queensland 4811, Australia

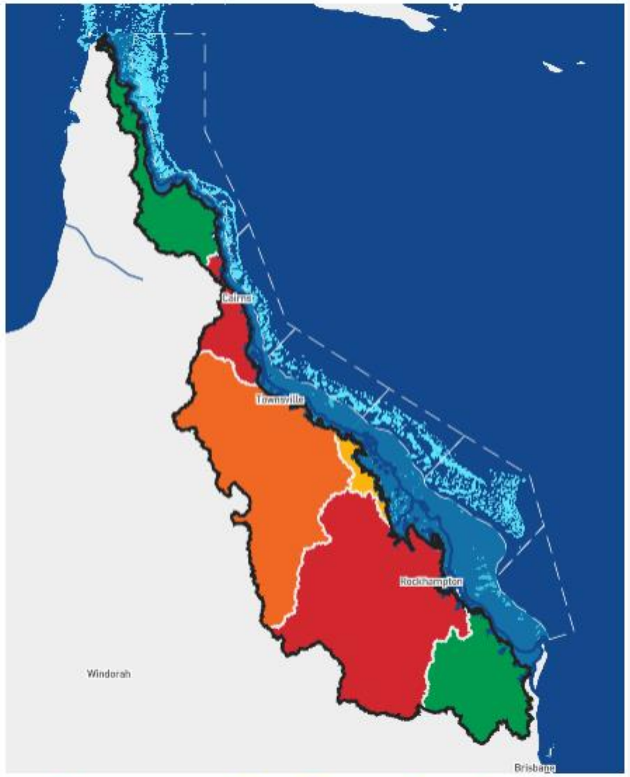
Reef Water Quality Report Card 2020

Change date

Overview | Reef and wetland condition | 2025 catchment targets

Showing **Sediment** > **Great Barrier Reef wide**

Change indicator · Change location



A Very good/Target met · B Good · C Moderate · D Poor · E Very poor · N No data/NA · MCL

Great Barrier Reef catchments

Area: 42,400,000 hectares

Average annual rainfall: 888 mm

Annual discharge to coast: 73,501 GL

Main land uses: Grazing (73%), conservation and natural environments (15%), forestry (4.6%), dryland cropping (2.4%), water (2%), sugar cane (1.2%), urban (0.7%), irrigated cropping (0.4%), horticulture (0.2%)

Number of NRM regions: 6

2025 water quality target: 25 percent reduction in anthropogenic end-of-catchment fine sediment loads.

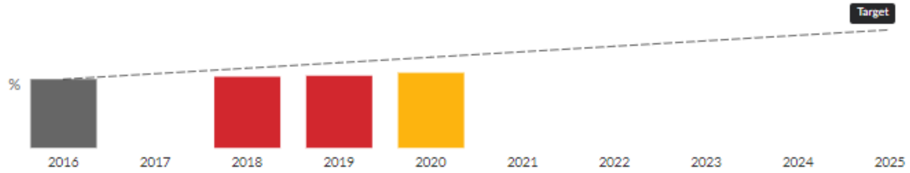
Results

Grade	2020 progress
C Moderate	+0.6% reduction

Data confidence ●●●●○

Overall progress

2025 Outlook



About the results

The fine sediment load leaving catchments showed a cumulative reduction of 15.2% to June 2020 and a modelled average annual reduction of 0.6% (approximately 37 kilotonnes) from July 2019 to June 2020.

The greatest annual reduction was 3.2% (approximately 18 kilotonnes) in the Burnett Mary region, with the majority of the load reduction attributed to riparian fencing.

The Cape York region had previously met the target and it continued to improve with an annual reduction of 2.1% (approximately 3.4 kilotonnes). Projects were focused on reducing grazing pressure and extensive riparian fencing.

The 2025 fine sediment target was previously met in the Cape York region and the Mulgrave-Russell catchment.

What's being done

158,161
hectares
engaged in improved grazing and gully management through the Queensland Government funded Grassroots project

1,163,977
hectares
engaged in improved grazing and gully management through the Australian Government's Reef Trust Reef Alliance: Growing a Great Barrier Reef project

483,819
hectares
engaged in improved grazing and gully management through the Australian Government's Reef Trust: Project Pioneer

293,804
hectares
engaged in improved grazing and gully management through the Australian Government's Reef Trust Partnership Reef Alliance Project Phase 2

https://reportcard.reefplan.qld.gov.au/

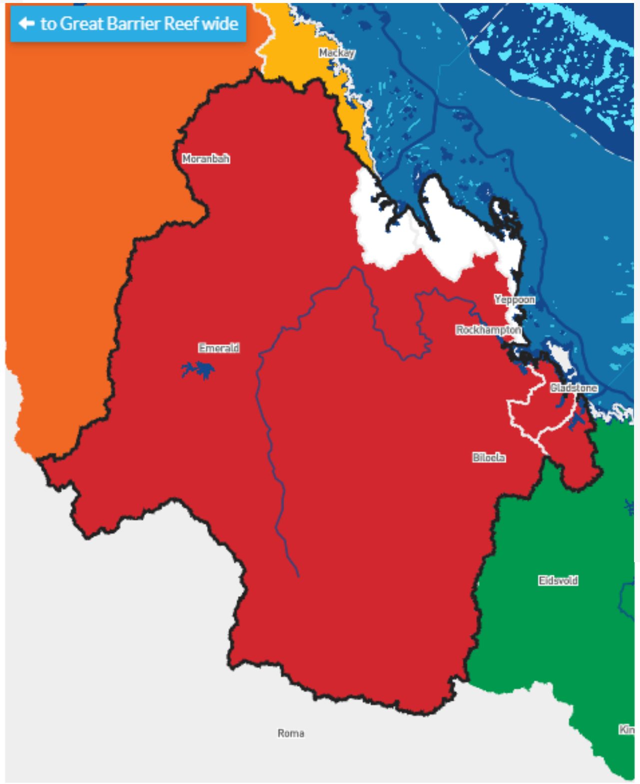
Reef Water Quality Report Card 2020

Change date

Overview | Reef and wetland condition | 2025 catchment targets

Showing **Sediment** (Change indicator) > **Fitzroy region** (Change location)

← to Great Barrier Reef wide



A Very good/Target met B Good C Moderate D Poor E Very poor N No data/NA MCL

Fitzroy region

Area: 15,549,409 hectares

Average annual rainfall: 716 mm

Annual discharge to the coast: 9,226 GL

Main land uses: Grazing (78%), conservation and natural environments (8%), forestry (6%), dryland cropping (5%)

Number of catchments: 6

2025 water quality target: 25 percent reduction in anthropogenic end-of-catchment fine sediment loads.

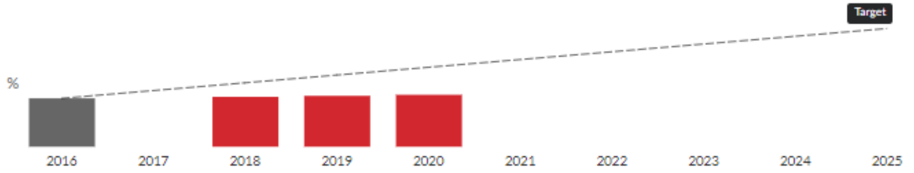
Results

Grade	2020 progress
E Very poor	+0.2% reduction

Data confidence ●●●○○

Overall progress: **10.3%** reduction to date

2025 Outlook



About the results

The fine sediment load leaving catchments showed a cumulative reduction of 10.3% to June 2020 and a modelled average annual reduction of 0.2% (approximately three kilotonnes) from July 2019 to June 2020.

The majority of the change occurred in the Upper Dawson catchment, with smaller areas of change in the Comet, Theresa Creek, Mackenzie and Fitzroy catchments. Changes were predominantly in hillslope management in grazing areas.

Grains cropping also reported improved soil erosion management through improved management and construction of contour banks across 2,800 hectares (approximately 0.5%) of the cropping area in the Fitzroy basin.

What's being done

7,274
hectares
of **improved farm management** through the Queensland Government's Sustainable Grains Extension Program

255,868
hectares
of **management practice improvements** through the Australian Government's Reef Trust Partnership Reef Alliance Project Phase 2

124,948
hectares
of **improved grazing management** through the Queensland Government's Grazing Resilience and Sustainable Solutions (GRASS) program

8,610
tonnes of sediment saved
through **streambank restoration** through the Queensland Government's Natural Disaster Relief and Recovery Arrangements - Fitzroy Basin Association Tropical Cyclone Debbie project

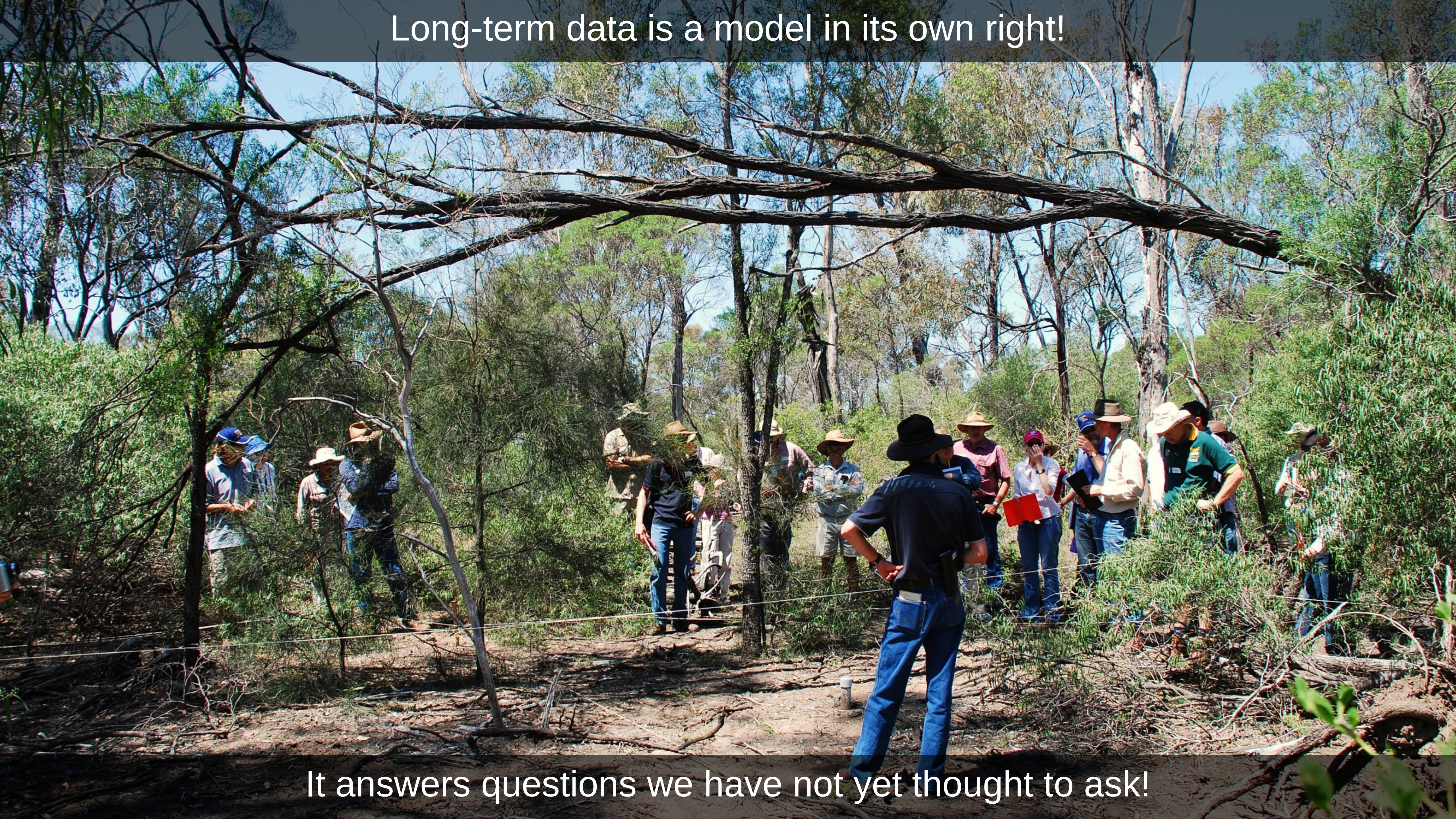
589
tonnes of sediment saved
through the **gully and streambank restoration** through the Australian Government's Reef Trust: F11 Fitzroy sub-catchment gully and stream bank erosion control program

98,746
hectares
of **improved grazing and gully management** through the Queensland Government funded Grassroots project

55,619
hectares
of **improved grazing and gully management** through the Queensland Government funded Forage Budgeting in the Fitzroy project

142,803
hectares
of **improved grazing and gully management** through the Australian Government's Reef Trust: Project Pioneer Innovation in Grazing Land Management project

77
tonnes of sediment saved
through the Australian Government's Reef Trust: Streambank and gully erosion through the **improved practices** in the Fitzroy project


Long-term data is a model in its own right!
It answers questions we have not yet thought to ask!

Brigalow Catchment Study Portal

Home Background Data Publications Contact

Welcome to the Brigalow Catchment Study portal. This portal provides access to rainfall and runoff data in addition to publications from the long-term paired catchment study. The study is conducted by the Department of Resources, Queensland, Australia.

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