

Modelled greenhouse gas emissions from beef cattle grazing irrigated leucaena in northern Australia

Chris A. Taylor^{A,E}, Matthew T. Harrison^B, Marnie Telfer^C and Richard Eckard^{A,D}

^AFaculty of Veterinary and Agricultural Sciences, The University of Melbourne, Vic. 3010, Australia.

^BTasmanian Institute of Agriculture, University of Tasmania, PO Box 3523, Burnie, Tas. 7320, Australia.

^CRamp Carbon, Level 1, 8 Shelley Street, Richmond, Vic. 3121, Australia.

^DPrimary Industries Climate Challenges Centre, The University of Melbourne, Vic. 3010, Australia.

^ECorresponding author. Email: ctaylor@unimelb.edu.au

Table S1. Tropical Grass required sustaining Metabolisable Energy requirements for steers in the Baseline

Allocation	Value	Unit
Steers	596	head
Steer start wt	152	kg/hd
Steer end wt	550	kg/hd
LWG	398	kg/hd
Term	1,095	days
LWG/day	0.36	kg LWG/day
Bush Paddock Area	9,556	ha
ME of Grass	8.1	MJ ME/kg DM
ME requirement	51	MJ/kg LWG
MJ required/steer	20,431	MJ/steer
MJ for all steers	12,176,677	MJ/all steers
Grass required/steer	2,515	kg DM /steer
Total Grass required	1,499	t DM Grass required
Predicted Grass consumed	0.16	t DM Grass required/ha

Table S2. Tropical Grass required sustaining Metabolisable Energy requirements for steers in the Current leucaena scenario

Allocation	Value	Unit
Steers	1,247	head
Steer start wt	152	kg/hd
Steer end wt	302	kg/hd
LWG	150	kg/hd
Term	304	days
LWG/day	0.49	kg LWG/day
Bush Paddock Area	9,170	ha
ME of Grass	8.1	MJ ME/kg DM
ME requirement	51	MJ/kg LWG
MJ required/steer	7,700	MJ/steer
MJ for all steers	9,601,900	MJ/all steers
Grass required/steer	948	kg DM /steer
Total Grass required	1,182	t DM Grass required
Predicted Grass consumed	0.13	t DM Grass required/ha

Table S3. Tropical Grass required sustaining Metabolisable Energy requirements for steers Extended leucaena scenario

Allocation	Value	Unit
Steers	3,431	head
Steer start wt	152	kg/hd
Steer end wt	302	kg/hd
LWG	150	kg/hd
Term	304	days
LWG/day	0.49	kg LWG/day
Bush Paddock Area	8,495	ha
ME of Grass	8.1	MJ ME/kg DM
ME requirement	51	MJ/kg LWG
MJ required/steer	7,700	MJ/steer
MJ for all steers	26,418,700	MJ/all steers
Grass required/steer	948	kg DM /steer
Total Grass required	3,252	t DM Grass required
Predicted Grass consumed	0.38	t DM Grass required/ha

Table S4. Tropical Grass required sustaining Metabolisable Energy requirements for steers in the Alternative leucaena scenario

Allocation	Value	Unit
Steers	2,091	head
Steer start wt	152	kg/hd
Steer end wt	302	kg/hd
LWG	150	kg/hd
Term	304	days
LWG/day	0.49	kg LWG/day
Bush Paddock Area	8,909	ha
ME of Grass	8.1	MJ ME/kg DM
ME requirement	51	MJ/kg LWG
MJ required/steer	7,700	MJ/steer
MJ for all steers	16,100,700	MJ/all steers
Grass required/steer	948	kg DM /steer
Total Grass required	1,982	t DM Grass required
Predicted Grass consumed	0.22	t DM Grass required/ha

Table S5. Leucaena and companion grass required sustaining Metabolisable Energy requirements for steers in the Current leucaena scenario

Leucaena Allocation	Value	Unit
Steers	1,244	head
Steer start wt	302	kg/hd
Steer end wt	550	kg/hd
LWG	248	kg/hd
Term	240	days
LWG/day	1.03	kg LWG/day
Leucaena area	386	ha
ME of leucaena	8.5	MJ ME/kg DM
ME requirement	103	MJ/kg LWG
MJ required/steer	25,612	MJ/steer
MJ for all steers	31,860,876	MJ/all steers
Whole leucaena/steer	3,013	kg DM /steer
Fraction leucaena consumed	0.38	Proportion
Leucaena consumed/steer	1,123	kg DM/steer
Total leucaena required	1,406	t DM leucaena grazed
Predicted leucaena growth	3.64	t DM leucaena grazed/ha
Companion Grass Allocation		
ME of Grass	8.13	MJ ME/kg DM
ME Requirement	103	MJ/steer
MJ required/steer	25,612	MJ/steer
MJ for all steers	31,860,876	MJ/all steers
Grass/steer	3,152	kg DM/steer
Fraction grass consumed	0.62	Proportion
Grass consumed/steer	1,970	kg DM/steer
Total grass consumed	2,451	t DM grass required

Table S6. Leucaena and companion grass required sustaining Metabolisable Energy requirements for steers in the Extended leucaena scenario

Leucaena Allocation	Value	Unit
Steers	3,428	head
Steer start wt	302	kg/hd
Steer end wt	550	kg/hd
LWG	248	kg/hd
Term	240	days
LWG/day	1.03	kg LWG/day
Leucaena area	1,061	ha
ME of leucaena	8.5	MJ ME/kg DM
ME requirement	103	MJ/kg LWG
MJ required/steer	25,612	MJ/steer
MJ for all steers	87,796,689	MJ/all steers
Whole leucaena/steer	3,013	kg DM /steer
Fraction leucaena consumed	0.38	Proportion
Leucaena consumed/steer	1,129	kg DM/steer
Total leucaena required	3,873	t DM leucaena grazed
Predicted leucaena growth	3.65	t DM leucaena grazed/ha
Companion Grass Allocation		
ME of Grass	8.13	MJ ME/kg DM
ME Requirement	103	MJ/steer
MJ required/steer	25,612	MJ/steer
MJ for all steers	87,796,689	MJ/all steers
Grass/steer	3,013	kg DM/steer
Fraction grass consumed	0.62	Proportion
Grass consumed/steer	1,970	kg DM/steer
Total grass consumed	6,754	t DM grass required

Table S7. Leucaena and companion grass required sustaining Metabolisable Energy requirements for steers in the Alternative leucaena scenario

Leucaena Allocation	Value	Unit
Steers	2,088	head
Steer start wt	302	kg/hd
Steer end wt	550	kg/hd
LWG	248	kg/hd
Term	240	days
LWG/day	1.03	kg LWG/day
Leucaena Area	647	ha
ME of leucaena	8.5	MJ ME/kg DM
ME requirement	103	MJ/kg LWG
MJ required/steer	25,612	MJ/steer
MJ for all steers	53,477,097	MJ/all steers
Whole leucaena/steer	3,013	kg DM /steer
Fraction leucaena consumed	0.38	Proportion
Leucaena consumed/steer	1,130	kg DM/steer
Total leucaena required	2,359	t DM leucaena grazed
Predicted leucaena growth	3.65	t DM leucaena grazed/ha
Companion Grass Allocation		
ME of Grass	8.13	MJ ME/kg DM
ME Requirement	103	MJ/steer
MJ required/steer	25,612	MJ/steer
MJ for all steers	53,477,097	MJ/all steers
Grass/steer	3,013	kg DM/steer
Fraction grass consumed	0.62	Proportion
Grass consumed/steer	1,970	kg DM/steer
Total grass consumed	4,114	t DM grass required

Table S8. Leucaena and companion grass required sustaining Metabolisable Energy requirements for heifers in the Extended and Alternative leucaena scenarios

Leucaena Allocation	Value	Unit
Heifers	399	head
Heifer start wt	350	kg/hd
Heifer end wt	518	kg/hd
LWG	168	kg/hd
Term	240	days
LWG/day	0.7	kg LWG/day
Leucaena area	1,061	ha
ME of leucaena	8.5	MJ ME/kg DM
ME requirement	103	MJ/kg LWG
MJ required/heifer	17,350	MJ/steer
MJ for all heifers	6,922,577	MJ/all heifers
Whole leucaena/steer	2,014	kg DM /heifers
Fraction leucaena consumed	0.38	Proportion
Leucaena consumed/heifer	765	kg DM/heifers
Total leucaena required	305	t DM leucaena grazed
Predicted leucaena growth	0.29	t DM leucaena grazed/ha
Companion Grass Allocation		
ME of Grass	8.13	MJ ME/kg DM
ME Requirement	103	MJ/heifer
MJ required/heifer	17,350	MJ/heifer
MJ for all heifers	6,922,577	MJ/all heifers
Grass/steer	2,135	kg DM/heifer
Fraction grass consumed	0.62	Proportion
Grass consumed/heifer	1,335	kg DM/heifer
Total grass consumed	533	t DM grass required

Table S9. Allocation of *Leucaena leucocephala* (Lam.) de Wit cv. Cunningham for first four years of growth

Allocation	Leaf	Branch	Bark	Stem	Course Roots	Fine Roots
1st Year Sample Weight (t/ha)	2.02	2.19	0.00	9.17	1.49	0.76
1st Year Allocation in relation to Stem	0.22	0.24	0.00	1.00	0.16	0.08
1st Year Fraction in relation total A/G Biomass	0.15	0.16	0.00	0.69	-	-
1st Year Fraction Consumed	0.90	0.90	0.00	0.50	0.00	0.00
2nd Year Sample Weight (t/ha)	3.61	3.86	0.00	15.66	2.54	1.31
2nd Year Allocation in relation to Stem	0.23	0.25	0.00	1.00	0.16	0.08
2nd Year Fraction in relation total A/G Biomass	0.16	0.17	0.00	0.68	-	-
2nd Year Fraction Consumed	0.90	0.90	0.00	0.15	0.00	0.00
3rd Year Sample Weight (t/ha)	3.46	12.43	0.00	39.62	6.42	3.30
3rd Year Allocation in relation to Stem	0.14	0.29	0.00	1.00	0.16	0.08
3rd Year Fraction in relation total A/G Biomass	0.10	0.20	0.00	0.70	-	-
3rd Year Fraction Consumed	0.90	0.90	0.00	0.15	0.00	0.00
4th Year Sample Weight (t/ha)	3.32	21.01	0.00	63.57	10.30	5.30
4th Year Allocation in relation to Stem	0.05	0.33	0.00	1.00	0.16	0.08
4th Year Fraction in relation total A/G Biomass	0.04	0.24	0.00	0.72	-	-
4th Year Fraction Consumed	0.90	0.90	0.00	0.15	0.00	0.00

Table S10. Tropical grass biomass required to meet the metabolisable energy requirements for growing steers and heifers across the scenarios and Baseline

Allocation	Value	Unit
<i>Leucaena leucocephala</i> (Lam.) de Wit cv. Cunningham		
ME requirement	108	MJ/kg LWG
Predicted leucaena consumed	3.64	t DM leucaena required/ha
Total growth rates of leucaena per year to meet consumption		
Year 1	5.82	t DM leucaena required/ha
Year 2	7.11	t DM leucaena required/ha
Year 3	4.06	t DM leucaena required/ha
Year 4	4.13	t DM leucaena required/ha

Table S11. Expanded Leucaena Paddock – example of modelled event sequence for FullCAM

Date	Event	Leaves Affected (%)	Branches Affected (%)	Stems Affected (%)	Root Affected (%)
1 April 2015	Initial Clearing of Eucalyptus populnea - No product Recovery	100	100	100	100
31 May 2015	Site Preparation - Windrow and Burn	100	100	100	100
3 April 2015	Plant Leucaena leucocephala (Lam.) de Wit cv. Cunningham	-	-	-	-
3 July 2016	First Light Graze	30	30	10	0
1 November 2016	First Heavy Graze	90	90	50	25
2 April 2017	First Year Graze (1)	90	90	50	25
31 May 2017	First Year Graze (2)	90	90	50	25
30 July 2017	First Year Graze (3)	90	90	50	25
28 September 2017	First Year Graze (4)	90	90	50	25
2 April 2018	Second Year Graze (1)	90	90	15	25
31 May 2018	Second Year Graze (2)	90	90	15	25
30 July 2018	Second Year Graze (3)	90	90	15	25
28 September 2018	Second Year Graze (4)	90	90	15	25
2 April 2019	Third Year Graze (1)	90	90	15	25
30 May 2019	Third Year Graze (2)	90	90	15	25
30 July 2019	Third Year Graze (3)	90	90	15	25
29 September 2019	Third Year Graze (4)	90	90	15	25
28 November 2019	Stem Cutting	100	100	95	25
1 April 2047	Initial Clearing of Leucaena leucocephala (Lam.) de Wit cv. Cunningham	100	100	100	100
30 May 2047	Chopper Roller	100	100	100	100

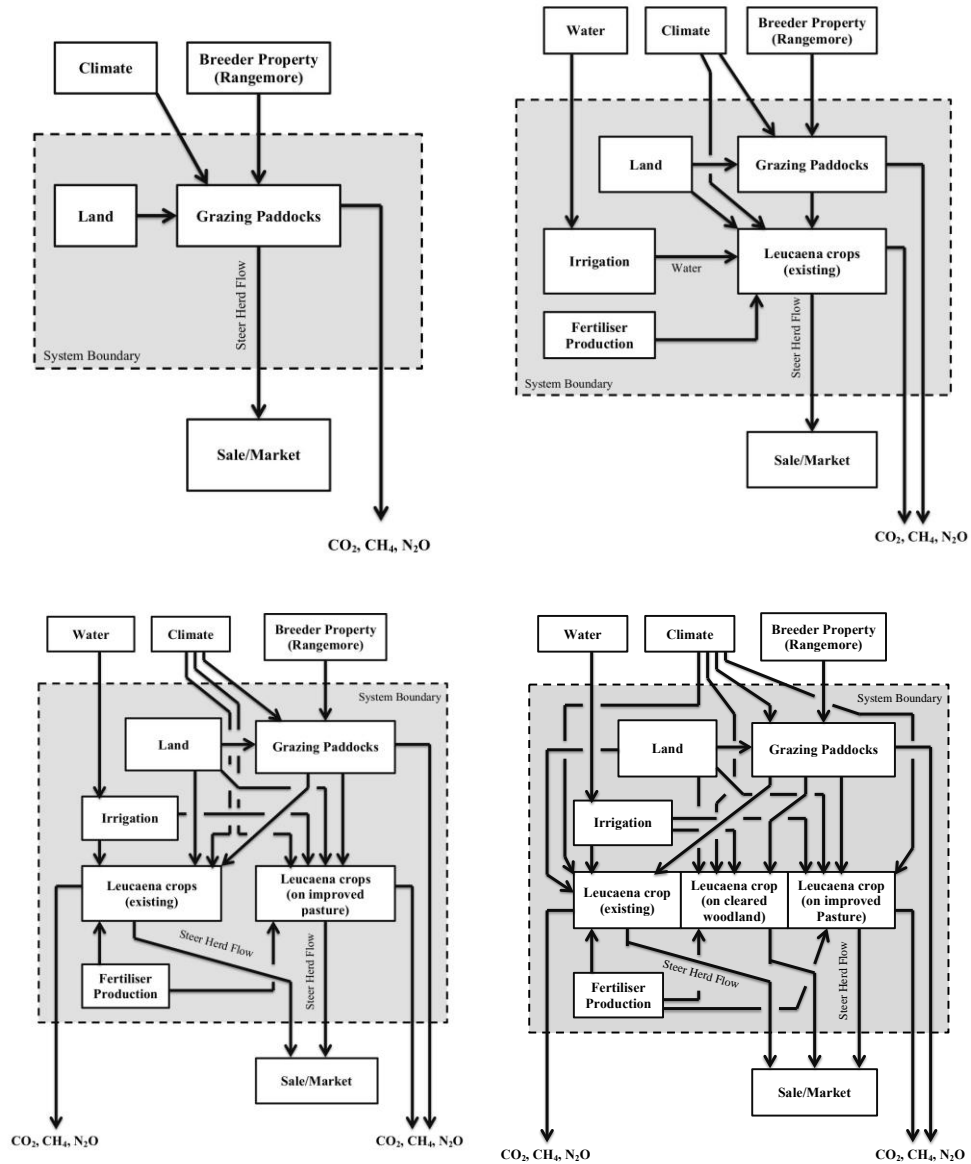


Figure S1. The production system and system boundaries for the Baseline (top left), Current leucaena scenario (top right), Extended leucaena scenario (bottom left) and Alternative leucaena scenario (bottom right).