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Khon Kaen University

METHANE EMISSION AND ENERGY UTILIZATION OF ZEBU CATTLE IN THE TROPICS

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Outline

- Introduction
- Enteric methane emissions
- Energy utilization of zebu beef cattle
- Conclusions

Food security : Beef Meat Demand and supply in SE Asia

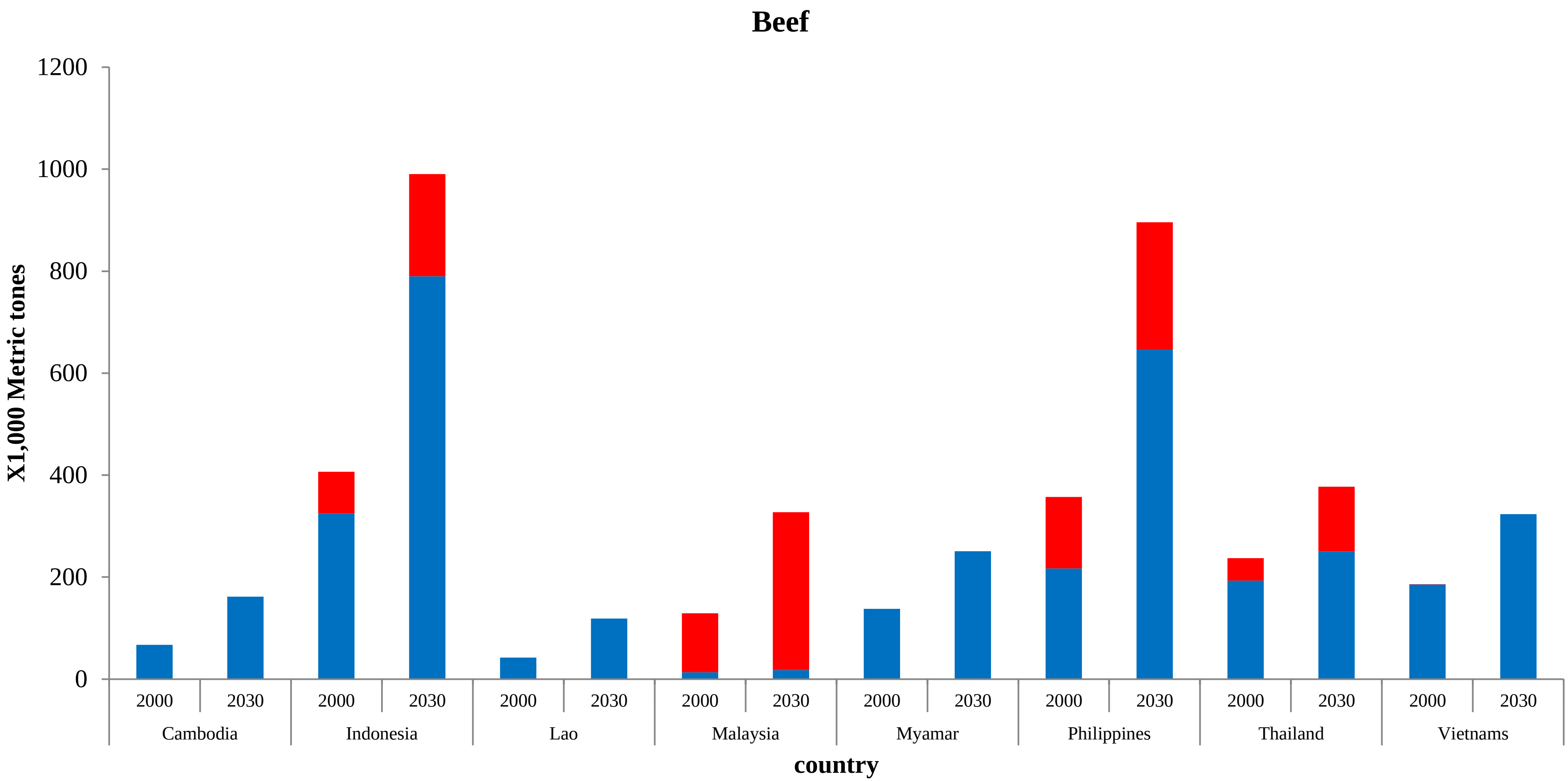
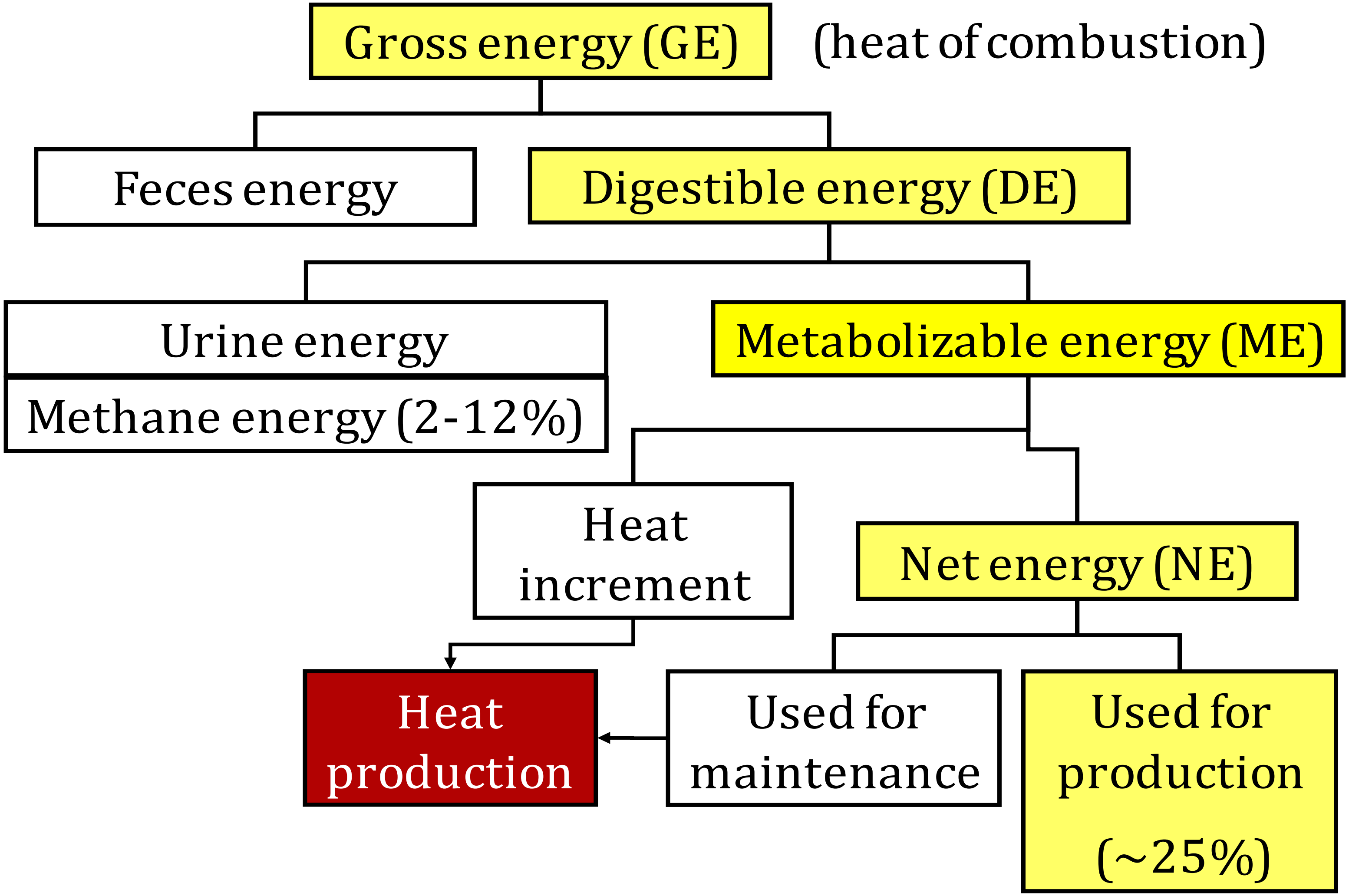


Figure 1 Production( ) and imported( ) of beef for 2000 and 2030 (FAO, 2013)

Enteric methane emission: Energy portioning in ruminant

Energy utilization: *The loss of enteric methane energy from ruminant feeding system is a problem not only with respect to climate change impact as the global greenhouse gas emissions, but also to less feed energy utilization efficiency and thus, low productivity.*



Enteric methane emission: measurement

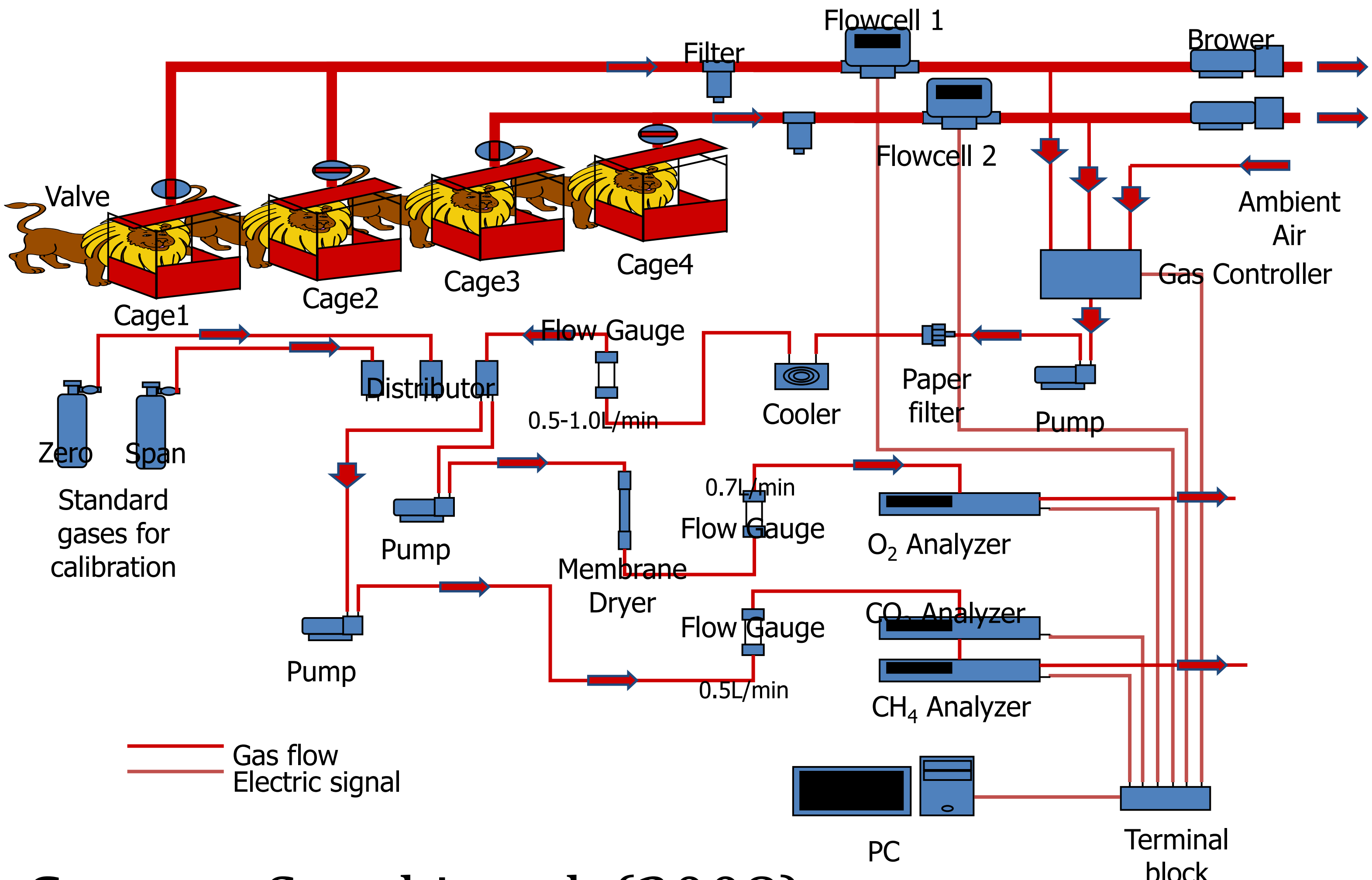
In vitro gas production Technique

SF6 tracer technique

Respiration chamber system

Source: Suzuki et al. (2008), Bhatta et al. (2007), Hill et al. (2016), Patra (2016)

Ventilated head-hood respiratory analysis system



Source: Suzuki et al. (2008)

Enteric methane emissions of zebu cattle

Table Enteric methane emission from beef cattle fed forage with or without concentrate supplementation

References	Animal (*n*)	BW (kg)	Forage (%)	DMI (kg/d)	GEI (MJ/d)	CH4 (L/d)	Ym (%GEI)
Beef cattle fed without concentrate supplementation							
Khuamankgorn et al. (2009)	8	367	100	5.8	86	197	9.1
Suzuki et al. (2008)	4	372	100	5.0	92	228	9.7
Chaokaur et al. (2007)	8	388	100	6.1	100	223	8.8
Beef cattle fed with concentrate supplementation							
Phromloungsri et al. (2012)	9	263	63	3.9	74	136	8.7
	9	235	63	5.0	95	186	8.9
Chuntrakort et al. (2014)	4	290	52	3.9	63	135	7.7
	4	401	52	5.2	86	171	8.5
Kongphitee et al. (2010)	12	345	30	4.3	80	159	7.9
Moonmat et al. (2009)	4	213	63	3.2	57	134	9.3
	4	207	57	3.1	55	124	8.9
Nitipot (2010)	4	191	98	2.4	40	92	9.0
	4	186	40	2.4	39	120	12.2
Tangjitwattanachai et al. (2015)	5	260	32	3.4	60	150	9.9
	5	285	32	4.9	86	189	8.6
Chaokaur et al. (2015)	4	332	30	3.5	57	166	11.5
	4	345	30	5.0	82	183	8.9
Chaokaur et al. (2009)	16	276	87	5.5	85	140	8.7
	16	276	23	5.5	85	190	8.9
Chaokaur et al. (2007)	3	385	63	5.8	98	195	7.9
	4	379	47	5.8	99	183	7.3

Table Energy partition, average daily gain and methane emissions of Brahman cattle (n=16) fed different levels[1]

Item	Feeding levels				SE	P-value[2]		
	1.0xM	1.4×M	1.8×M	*Ad libitum*		L	Q	C
Energy partition (KJ/kgBW$^{0.75}$)								
Gross energy intake	738	1028	1291	1516	22.4	<0.01	0.49	0.96
Feces	184	284	379	439	6.6	<0.01	0.17	0.65
Urine	15	15	20	24	0.3	<0.01	0.03	0.16
Methane	85	91	102	111	2.4	<0.01	0.89	0.76
Heat production	436	537	601	665	7.8	<0.01	0.32	0.65
Energy retention	18	99	188	278	11.2	<0.01	0.87	0.96
Average daily gain (kg/d)	0.46	0.88	1.39	1.58	0.43	<0.01	0.20	0.26
weight gain 70 d (kg)	31.6	57.2	96.8	106.4	2.8	<0.01	0.18	0.11
Methane emissions								
L/d	166.6	183.9	212.5	228.7	6.9	<0.01	0.97	0.71
MJ/d	6.6	7.3	8.4	9.0	0.2	<0.01	0.77	0.70
L/kgOMI	55.7	43.1	38.7	35.2	1.0	<0.01	0.05	0.43
MJ/100 MJ GEI	11.5	8.9	8.0	7.3	0.2	<0.01	< 0.05	0.45

[1]M, maintenance requirements (450 KJ ME/kgBW$^{0.75}$/d); SE, standard errors; BW$^{0.75}$, metabolic weigh.
[2]Probability of a significant effect of levels or of a linear (L), quadratic (Q), or cubic (C) effect of feeding levels.
Source: Chaokaur et al. (2015)

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Table Growth performance, energy partition and methane emissions of native Thai cattle (n=15) fed different level

Item	Feeding levels			SEM	Contrast	
	1.1M	1.5M	1.9M		L	Q
Number of animals, cattle	*n = 5*	*n = 5*	*n = 5*			
Growth performance						
Initial body weight, kg	223.2	219.2	231.4	1.74	NS	NS
Body weight gain 116 d, kg	23.0^{b}	49.4^{a}	58.4^{a}	0.71	**	**
Average daily gain, g/d	0.32^{b}	0.69^{a}	0.82^{a}	0.10	**	**
Energy partition, $kJ \cdot kgBW^{-0.75}$						
GE intake	926^{b}	1252^{a}	1303^{a}	17.7	**	**
Feces energy	246^{b}	367^{a}	358^{a}	12.0	**	**
Urine energy	19	24	23	2.3	NS	NS
Methane energy	92^{b}	108^{a}	110^{a}	6.1	NS	NS
Heat energy	543^{b}	647^{a}	656^{a}	15.8	**	NS
Energy retention	25^{b}	105^{a}	156^{a}	19.8	**	NS
Methane emission						
Methane production, L/d	150.8^{b}	189.7^{ab}	206.6^{a}	12.77	*	NS
Methane production, L/kgOMI	48.2^{a}	41.61^{ab}	40.3^{b}	2.11	*	NS
Methane energy, MJ/d	6.0^{b}	7.5^{ab}	8.2^{a}	0.51	*	NS
Methane energy/GEI, %	10.0^{a}	8.6^{ab}	8.4^{b}	0.44	*	NS

Source: Tangjitwattanachai et al. (2015)

Table Global warming impact using a life-cycle assessment in beef feeding system using plant oils seed (n=18; 75 to 350 kg BW)

Items	Total mixed ration silage					Crossbred cattle			
	Soybean seed	Kapok seed	Oil palm fruit	SEM	P	Charolais	Japanese Black	SEM	P
Total GHG emission									
t CO2eq head^{-1}	1.29^{b}	1.65^{a}	1.26^{b}	0.96	0.04	1.36	1.44	0.78	0.50
Carbon footprint									
kg CO2eq kg^{-1} BW	4.7^{b}	6.0^{a}	4.6^{b}	0.35	0.04	5.0	5.2	0.29	0.49
Inventory loads (g kg^{-1} CO2eq)									
Feed production	**299^{b}**	**295^{b}**	**367^{a}**	**6.70**	**<0.01**	**316**	**324**	**5.50**	**0.32**
Feedstuff transportation	76^{ab}	82^{a}	74^{b}	1.90	0.06	76	78	1.60	0.37
Animal management	17^{a}	17^{a}	15^{b}	0.30	0.01	17^{y}	16^{z}	0.30	0.02
Enteric methane	**496^{a}**	**494^{a}**	**441^{b}**	**11.40**	**0.02**	**480**	**475**	**9.30**	**0.69**
Methane from manure	10^{a}	10^{a}	8^{b}	0.20	<0.01	9	9	0.20	0.68
Nitrous oxide from manure	103	103	94	4.20	0.30	102	98	3.40	0.47

Source: Kaewpila (2016)

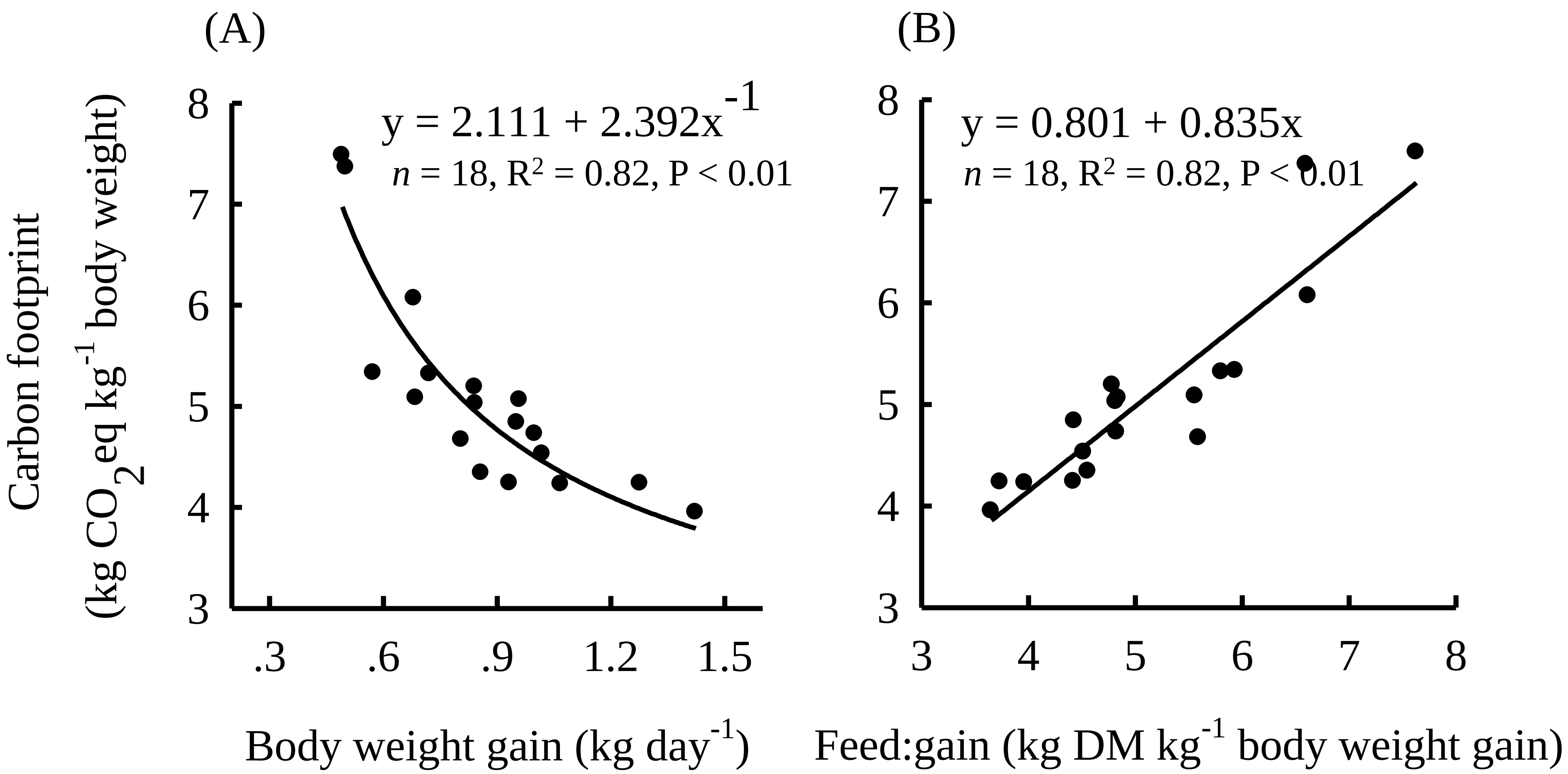
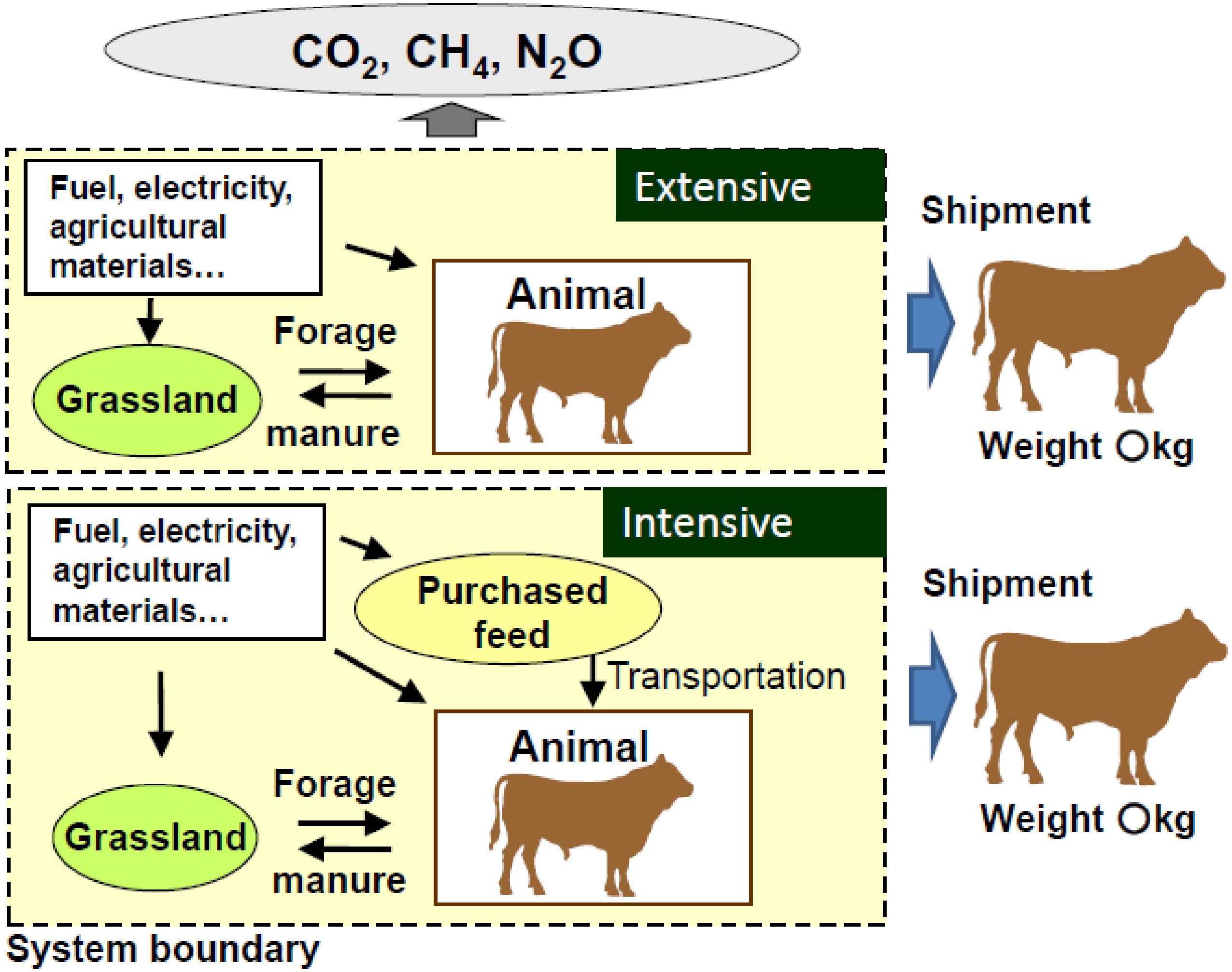


Figure The relationship between (A) daily BW gain and carbon footprint and (B) feed:gain and carbon footprint.

Source: Kaewpila (2016)

Beef cattle feeding systems compared (Ogino et al., 2016)



Evaluation of GHG emissions per unit product

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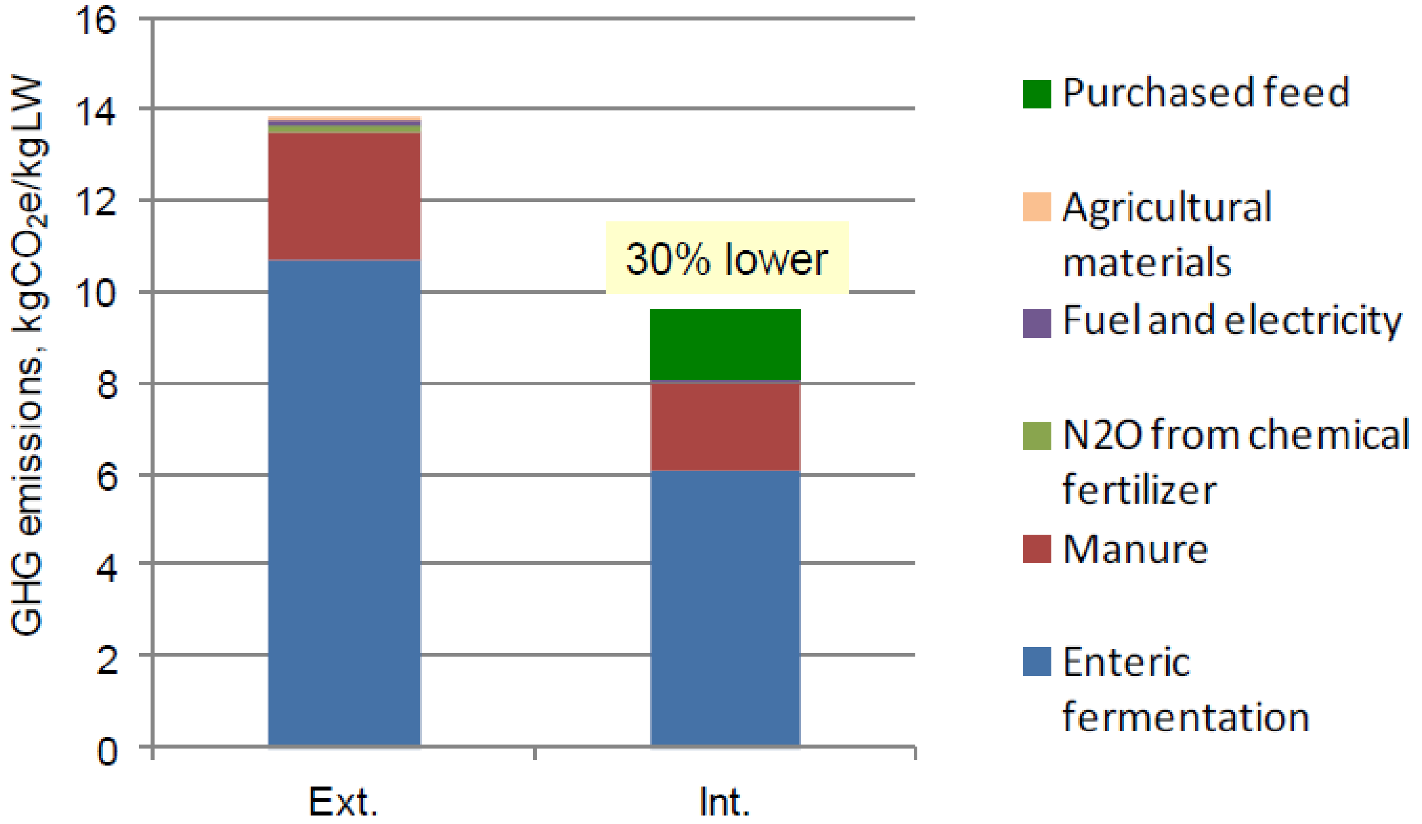
Average life-cycle GHG emissions from extensive and intensive beef production in Thailand



Ogino et al. (2016)

Conclusion

✓Methane emission is not only an important source of greenhouse gas that has great impact on climate change, but also a critical factor that affects the efficiency of feed energy utilization, and is therefore considered to be strongly associated with cattle productivity.

✓More research work is needed to develop a practical and economical zebu beef farming system to improve productivity and environmental sustainability.

Thank you for your kind attention