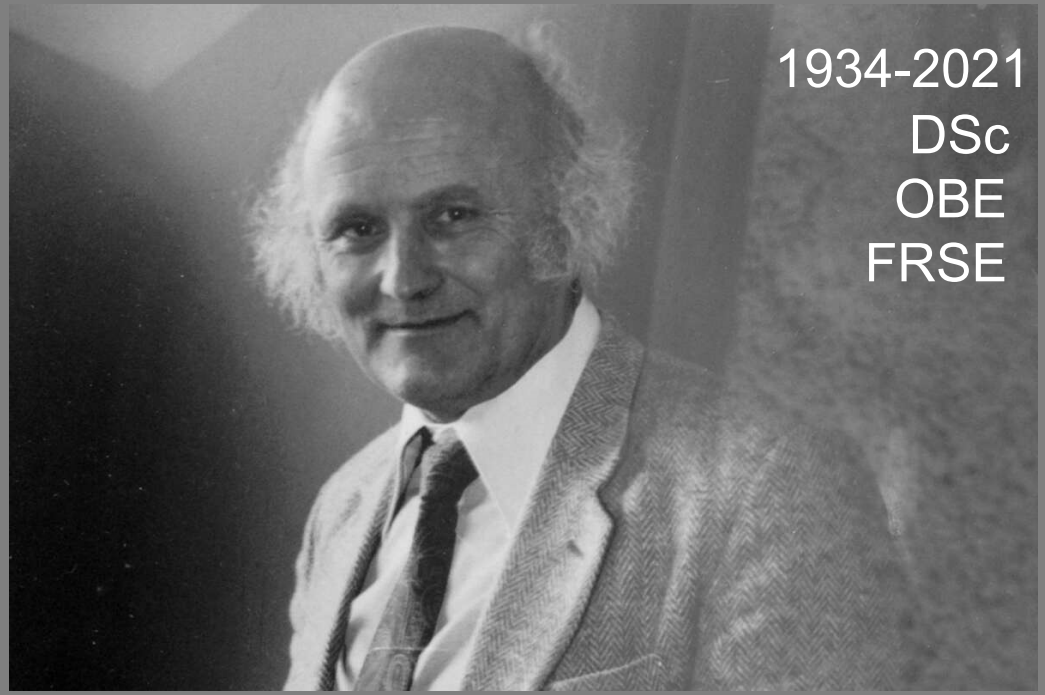
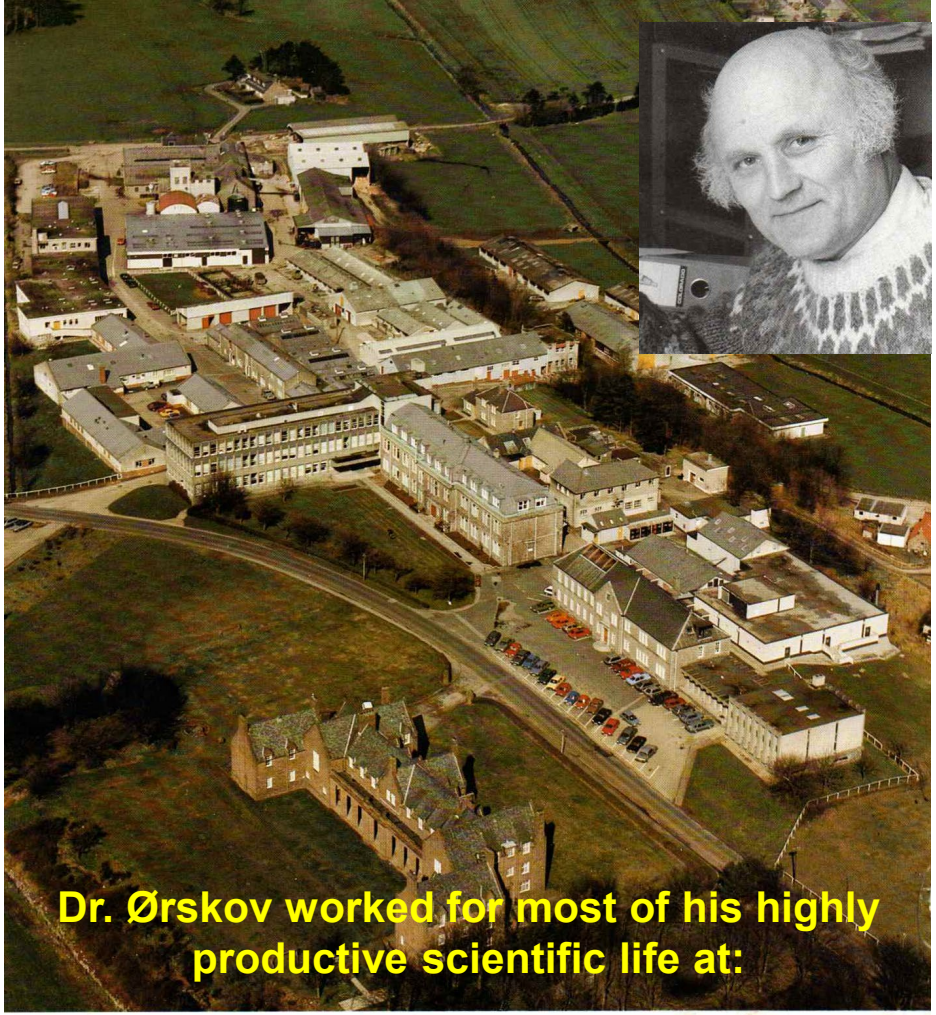
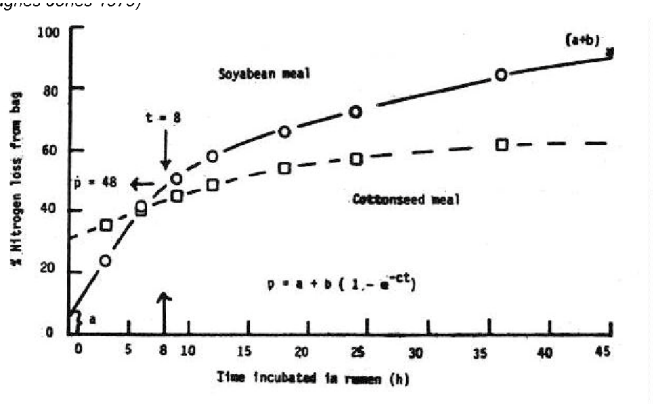
Bob Ørskov Memorial Talk: Methane mitigation in ruminants fed tropical feedstuffs



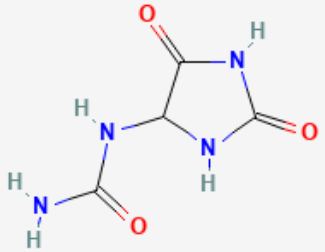
Juan Ku-Vera, University of Yucatan, Mexico

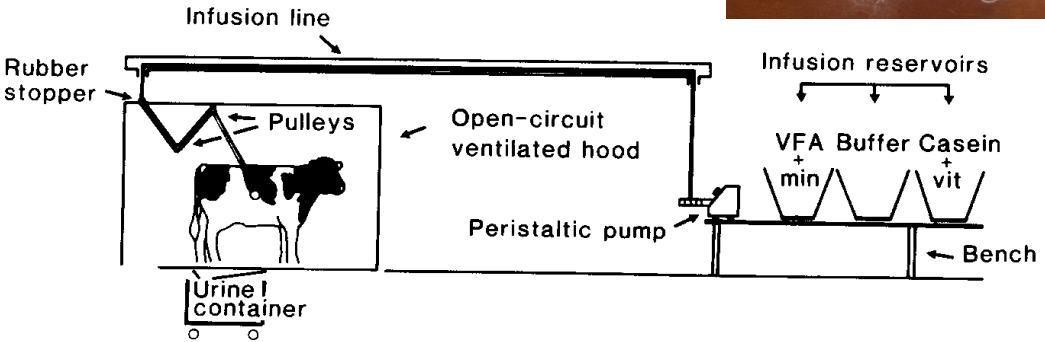

Dr. Ørskov worked for most of his highly productive scientific life at:
THE · ROWETT · RESEARCH · INSTITUTE

Nutritional techniques developed by E.R. Ørskov

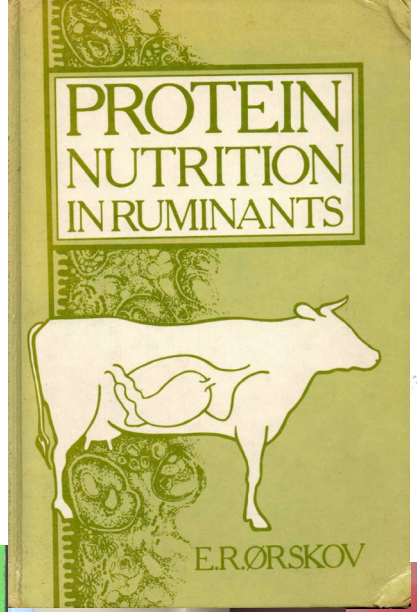


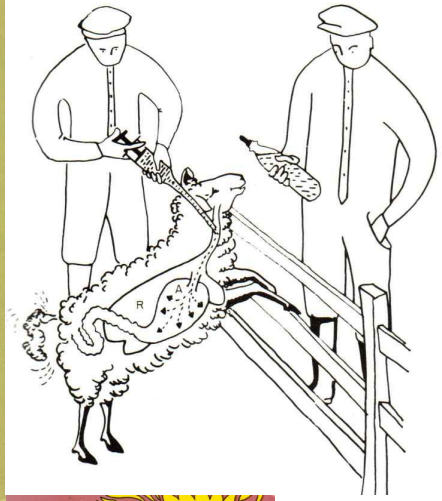
allantoin

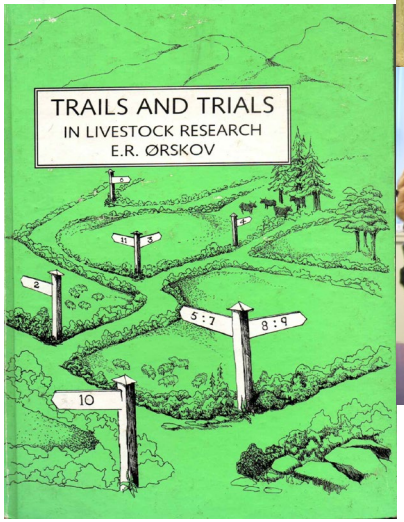


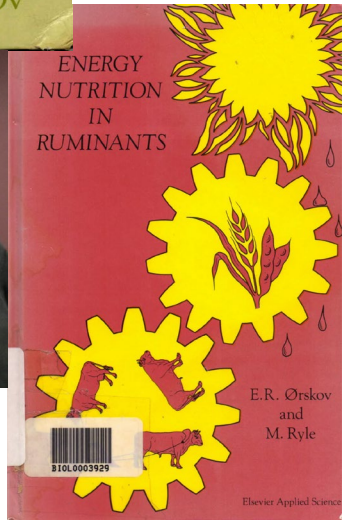


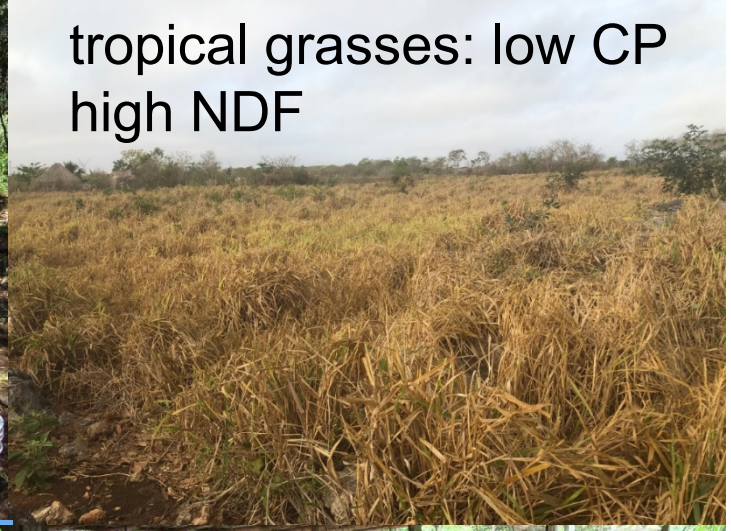

R
A

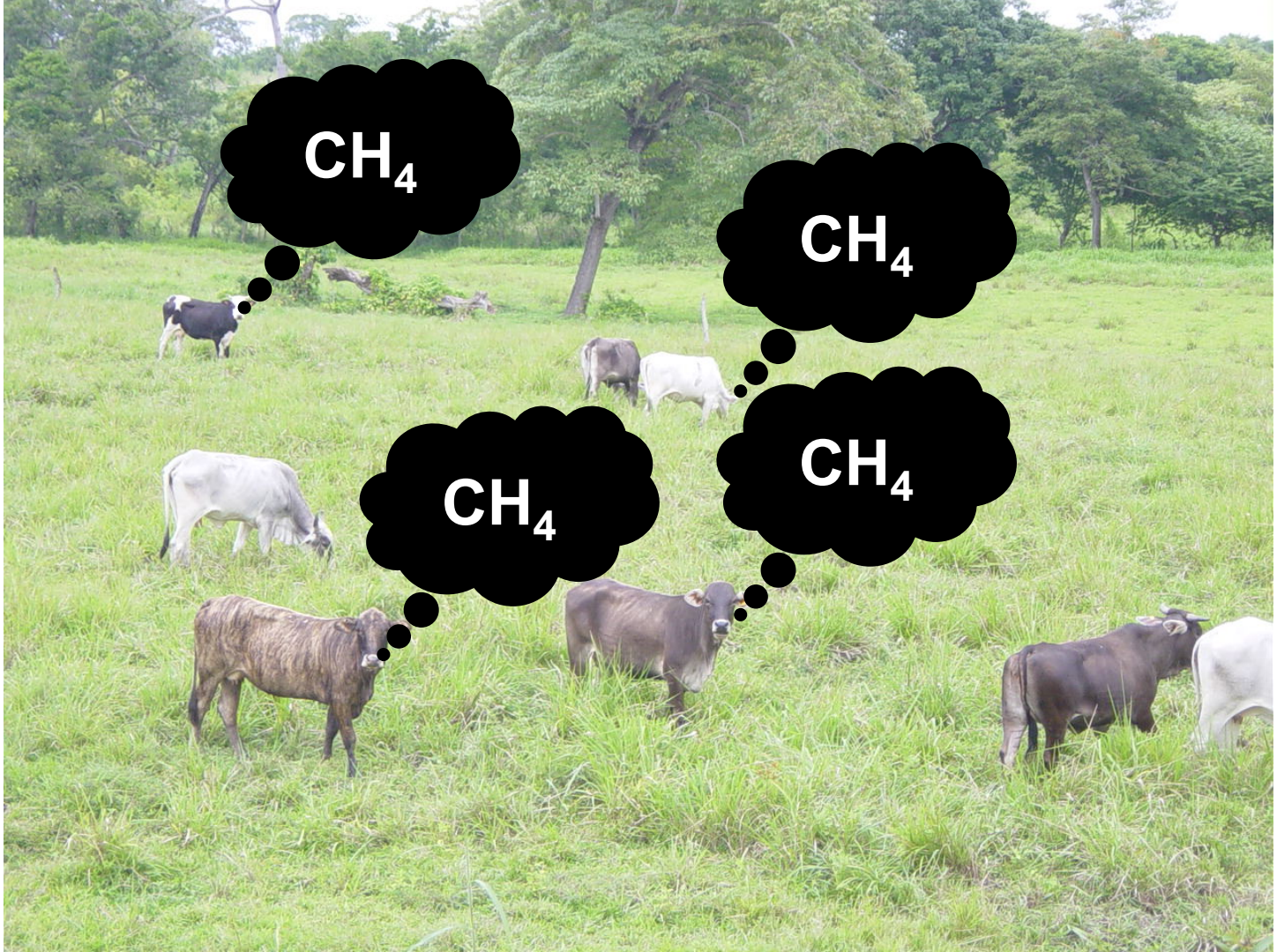

PROTEIN
NUTRITION
IN RUMINANTS
E.R.ØRSKOV


R
A


TRAILS AND TRIALS
IN LIVESTOCK RESEARCH
E.R. ØRSKOV
2
5:7
8:9
10


ENERGY
NUTRITION
IN
RUMINANTS
E.R. Ørskov
and
M. Ryle
BIOL0003929
Elsevier Applied Science

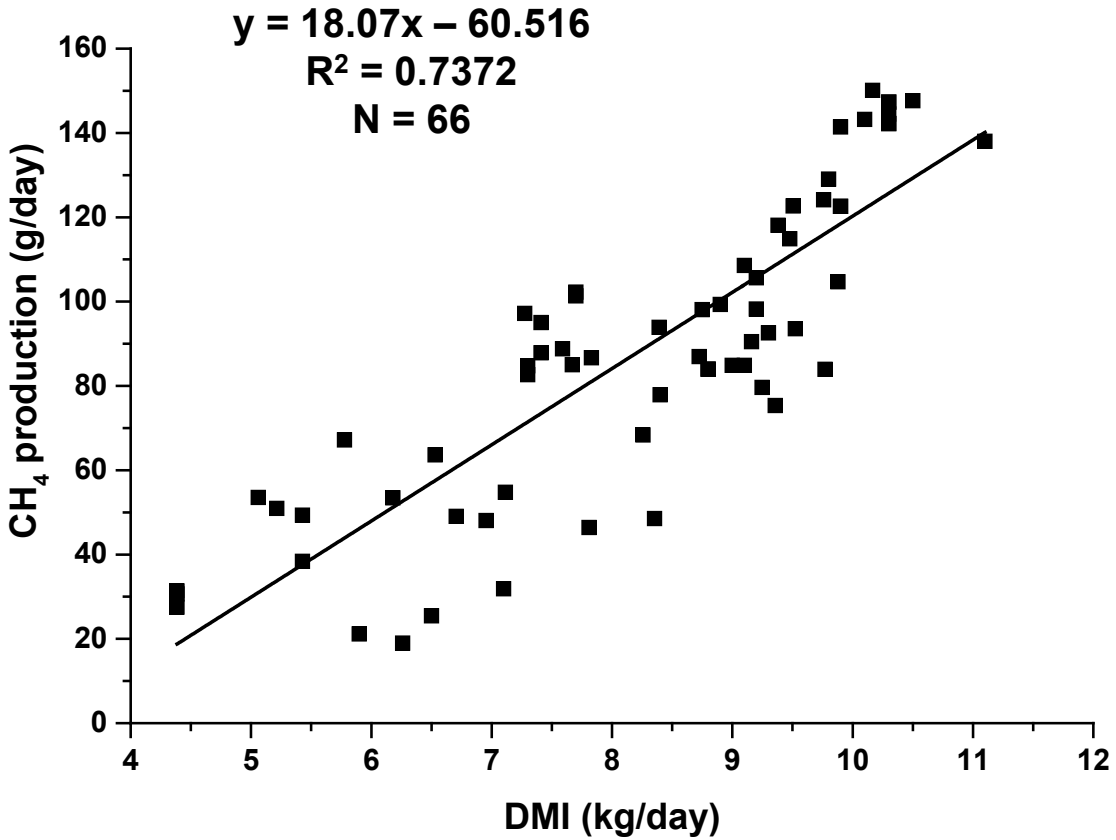

tropical grasses: low CP
high NDF

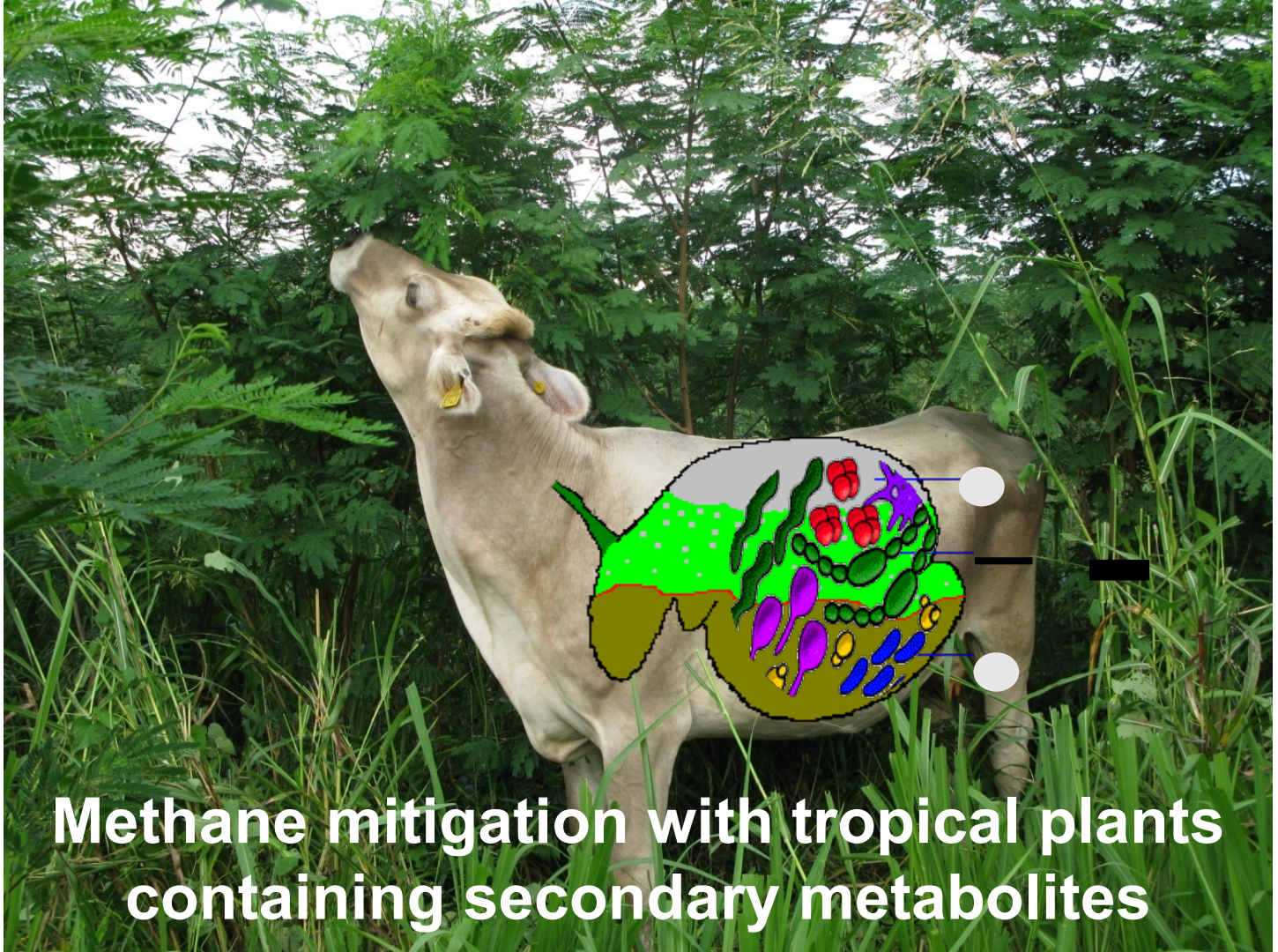

CH_4
CH_4
CH_4
CH_4

Open-circuit respiration chambers at the University of Yucatan, Mexico

opening of the respiration chambers in 2014

Methane yield in cattle fed a basal ration of low-quality tropical grass and a supplement (Ku-Vera *et al*., 2018)





Methane mitigation with tropical plants containing secondary metabolites

Methane emissions in crossbred heifers fed a basal ration of tropical grass hay and increasing levels of leaves of *Leucaena leucocephala* (Montoya-Flores, 2019) (respiration chambers)

Level of incorporation in the ration of ground leaves of *Leucaena leucocephala* (% DM) (intake condensed tannins (g/day)	0 (0)	12 (23)	24 (71)	36 (104)	SE	P-value	**Contrast** Linear
CH_4 (g/d)	174^a	163^b	155^b	140^c	3.03	0.0011	**
CH_4 (g/kg DMI)	20.8^a	19.7^a	18.0^b	16.5^c	0.41	0.0012	**
Y_m (% GEI)	6.50^a	6.07^b	5.54^c	5.05^d	0.13	0.0008	**
CH_4 emission factor (kg CH_4/head/year)	63.59^a	59.47^b	56.50^b	51.10^c	1.1	0.0011	**

Estimated DM intake (kg/d) and milk production of dual-purpose crossbred cows grazing in a grass monoculture or in a silvopastoral system of grass + *Leucaena leucocephala* (Bottini-Luzardo *et al*. 2016). Means ± SE **(alkane technique)**

	Monoculture system	**Silvopastoral system**
L. leucocephala	---	5.1±1.8
C. nlemfuensis	7.4±1.4	4.9±2.4
Sorghum grain		4.8±2.2
Concentrate	4.6±3.1	---
Total DMI	11.9±2.2	14.8±2.1
C.P.	1.3±1.0a	1.5±1.0a
ME	131±1.0b	161±1.0a
Milk yield	14.5±1.1a	13.5±1.1a

Cows consumed 34% of forage as *Leucaena leucocephala* while grazing (Bottini-Luzardo *et al*. 2016) [alkane technique]


Samanea saman (rain tree)

Pods of *Samanea saman*

(condensed tannins + saponins)

Intake and digestibility in crossbred heifers fed *P. purpureum* and increasing levels of ground pods *Samanea saman*

	Level of *S. saman* in ration (% DM)						Contrast
	0	10	20	30	SE	P-value	L
LW (kg)	262	261	263	260	0.64		
Intake							
DM (kg/d)	6.26	6.44	6.16	6.49	0.28	0.66	ns
DM (% LW)	2.39	2.47	2.34	2.49	0.09	0.45	ns
CP (g/d)	613.4	644.46	639.22	670.36	49.08	0.15	*
MJ/kg DM	15.82	15.99	16.19	16.32	0.08	<0.0001	**
Saponins (g/d)	0.00	7.69	15.6	23.3	0.54	<0.0001	**
Condensed tannins (g/d)	0.00	9.98	20.26	30.33	0.71	<0.0001	**
Digestibility (g/kg DM)							
DM	591	635	603	595	2.03	0.08	ns
NDF	537	591	519	531	3.24	0.32	ns

DM: dry matter, OM: organic matter; CP: crude protein; NDF: Neutral detergent fiber; ADF: Acid detergent fiber; L: linear contrast; SE: standard error ; * P<0.05; ** P<0.01; ns: non-significant (P>0.05).

Enteric methane emissions in crossbred heifers housed in respiration chambers and fed chopped *Pennisetum purpureum* and increasing levels of ground pods of *Samanea saman*

Items	Level of ground pods of *Samanea saman* in ration (% DM)				Contrast		
	0	10	20	30	SE	P-value	L
CH_4 (L/d)	120.84	89.63	72.03	59.30	9.39	0.03	**
CH_4 (L/kg DMI)	19.04	13.95	12.65	8.19	1.09	0.00	**
Loss of energy as CH_4 (MJ/ day)	4.69	3.48	2.80	2.30	0.36	0.03	**
Loss of energy as CH_4 (% GEI ; Y_m)	4.70	3.38	2.82	2.15	0.31	0.01	**

DMI: dry matter intake

Molar proportions of VFA's in rumen liquor of heifers fed *Pennisetum purpureum* and increasing levels of ground pods of *Samanea saman*

	Level of *Samanea saman* in ration (% DM)					Contrast		
	0	10	20	30	SE	P-value	L	Q	C
Rumen pH	6.90	6.87	6.97	6.80	0.04	0.06	ns	ns	*
Acetic acid (% molar)	70.32	68.39	66.72	60.05	1.27	<.0001	**	ns	ns
Propionic acid (% molar)	17.66	18.45	19.88	21.77	1.20	0.01	**	ns	ns
Butyric acid (% molar)	9.7	10.98	10.97	15.20	0.59	<.01	**	ns	ns
Acetic: propionic acids ratio	4.01	3.74	3.42	2.82	0.25	<.01	**	ns	ns

SE: standard error, * P<0.05; ** P<0.01; ns: non-significant (P>0.05)


Enterolobium cyclocarpum
(saponins)


pods of *E. cyclocarpum*

Chemical composition of pods of *Enterolobium cyclocarpum*	
Dry matter	92.63
Crude protein	16.72
Ether extract	1.59
Ash	4.27
Neutral detergent fiber	35.36
Acid detergent fiber	23.17
Lignin	8.83

Kinetics of rumen DM degradation of different components of *Enterolobium cyclocarpum*

Components of pods of *E. cyclocarpum*					**P value**
g/kg DM	Husks	Seeds	**Pods**	SEM	
A	701.3^{a}	510.4^{b}	567.3^{b}	19.21	<0.05
B	128.2^{c}	424.2^{a}	299.1^{b}	13.04	<0.05
A + B	829.5^{b}	937.3^{a}	**866.4^{b}**	9.88	<0.05
c	0.038	0.028	0.039	0.06	>0.05


highly palatable
for Pelibuey
hair sheep

Methane production in sheep fed low-quality *Pennisetum purpureum* and supplemented with different levels of ground pods of *Enterolobium cyclocarpum* (Albores-Moreno et al. 2017)

Level of saponins from *E. cyclocarpum* (g/day)					SE	P-value
	0	4.35	8.70	13.05		
Acetic acid (% molar)	67^{a}	60^{b}	58^{b}	59^{b}	0.019	0.035
Propionic acid (% molar)	18^{a}	21^{a}	22^{a}	22^{a}	0.013	0.076
CH_4 (L/day)	34.4^{a}	27.1^{b}	21.8^{c}	25.4^{bc}	1.26	0.0012
CH_4 (L/kg DMI)	34.4^{a}	25.8^{b}	20.4^{c}	20.8^{c}	0.92	0.0001
Energy lost as CH_4 (kJ/mol)	135.5^{a}	106.7^{b}	86.0^{c}	100.0^{bc}	4.95	0.001

SE: Standard error; P-value: ($p<0.05$)

Brosimum alicastrum

Rumen fermentation of foliage of *Brosimum alicastrum*

Parameter	DM	CP	OM	NDF
a %	21.18	33.84	20.50	-
b %	65.67	61.35	66.12	72.11
a + b %	86.85	**95.19**	86.62	72.11
c (%/h)	10.52	11.37	10.58	8.33

Dry matter intake, rate of passage and microbial nitrogen entering the duodenum of Pelibuey sheep fed *Megathyrsus maximus* grass and increasing levels of foliage of *Brosimum alicastrum* (% DM) (Valdivia, 1996)

	Megathyrsus maximus*:*Brosimum alicastrum			
	100	85:15	70:30	55:45
DM intake (g/d)	511	848	1106	1313
Rate of passage (%/h)	1.47	2.75	2.80	4.12
Rumen retention time (h)	68.02	36.36	35.74	24.27
Microbial N entering the small intestine (g/d)	2.20	4.92	7.93	9.72
a+ b % *Megathyrsus maximus* (OM)	41.5	40.6	39.9	38.6
c % *Megathyrsus maximus* (OM)	2.93	3.46	3.57	3.98

Bovaer (3-NOP), Mootral

Conclusions

Respiration chamber methodology is an appropriate tool for the precise measurement of enteric CH_4 emissions in ruminants

Methane yield in cattle fed low-quality tropical grasses ranges from 17 to 20 g CH_4/kg dry matter intake

Enteric CH_4 emissions in cattle fed low-quality grasses can be mitigated around 15-25% by incorporation in the ration of foliages and pods of tropical trees and shrubs containing condensed tannins and saponins (as well as starch)

Thanks for your attention!

The Rowett Research Institute

EX·SCIENTIA·SALUS