Session 30 – jbaudracco@yahoo.com

Prediction of herbage dry matter intake for dairy cows grazing ryegrass pasture

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Te Kunenga ki Pūrehuroa

Road map

- Background
- Objectives
- Methodology (simulation model)
- Results and discussion
- Conclusions

Background

In grazing dairy systems:

- Intake of herbage is a major constraint for milk production and it is difficult to quantify

- Accurate feeding of cows depends on the ability to predict dry matter intake of herbage

- Simulation models can assist to predict herbage intake at grazing

Objectives

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Objectives

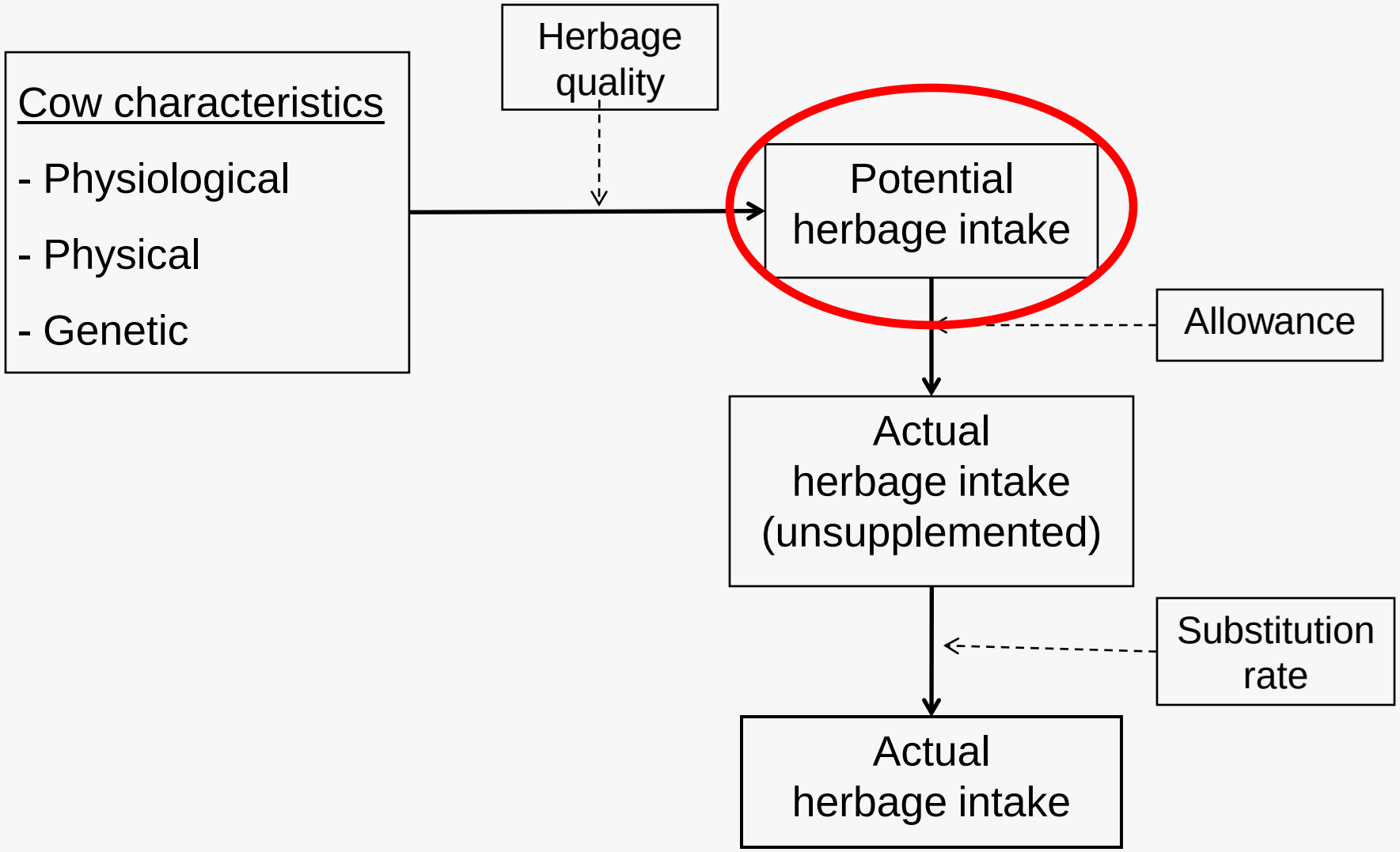
- To adjust and validate a model to predict herbage intake based on an **easy–to-obtain set of inputs**

- To simulate herbage DM intake:

  - Cows of different genetic merit
  - Different levels of herbage allowance
  - Different levels of supplementation

Methodology

Model overview



Potential herbage intake

Potential herbage intake is defined by the lowest of 3 Limits:

i) **Metabolic** limitation related to energy demand

ii) **Physical** limitation related to rumen fill

iii) **Grazing** limit related to grazing ability

Potential herbage intake

METABOLIC LIMIT

Potential intake (kg DM/cow/day)= $\frac{\text{Energy requirements}}{\text{Energy content of herbage}}$

Potential milk yield ➔ Mammary gland model (Vetharaniam *et al.*, 2003)

Potential herbage intake

PHYSICAL LIMIT

Potential intake (kg DM/cow/day)= Rumen capacity (kg NDF)

Fill effect (% NDF herbage)

↓

Neutral detergent fibre

Potential herbage intake

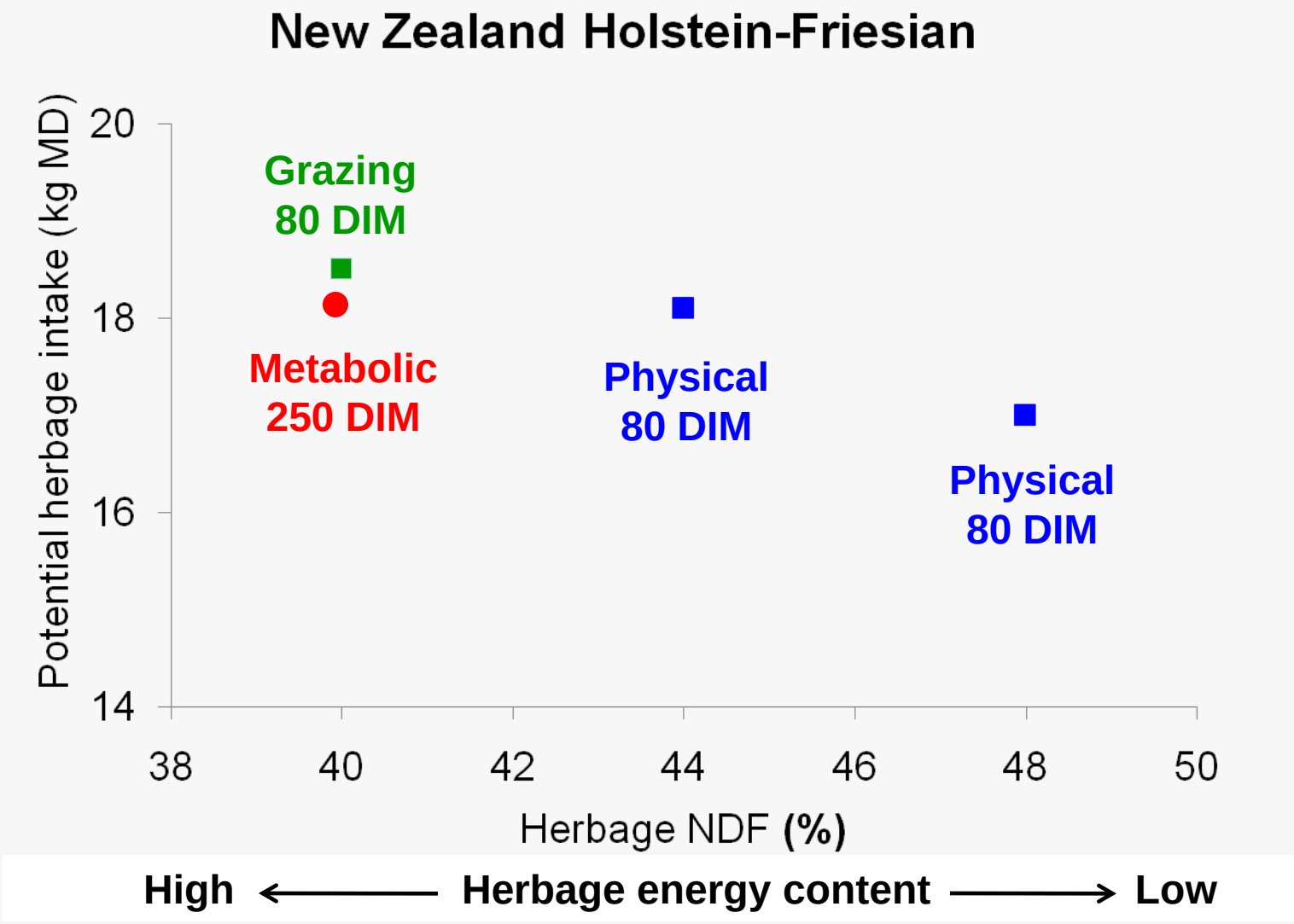
GRAZING LIMIT

Potential intake (kg DM/cow/day)= 0.0375 x LW x SOL

Maximum intake observed
Kolver and Muller (1998); McGilloway and Mayne (1996)

Accounts for restrictions at grazing, other than metabolic and physical

What limits potential intake ?



From Potential to actual herbage intake

Herbage intake =

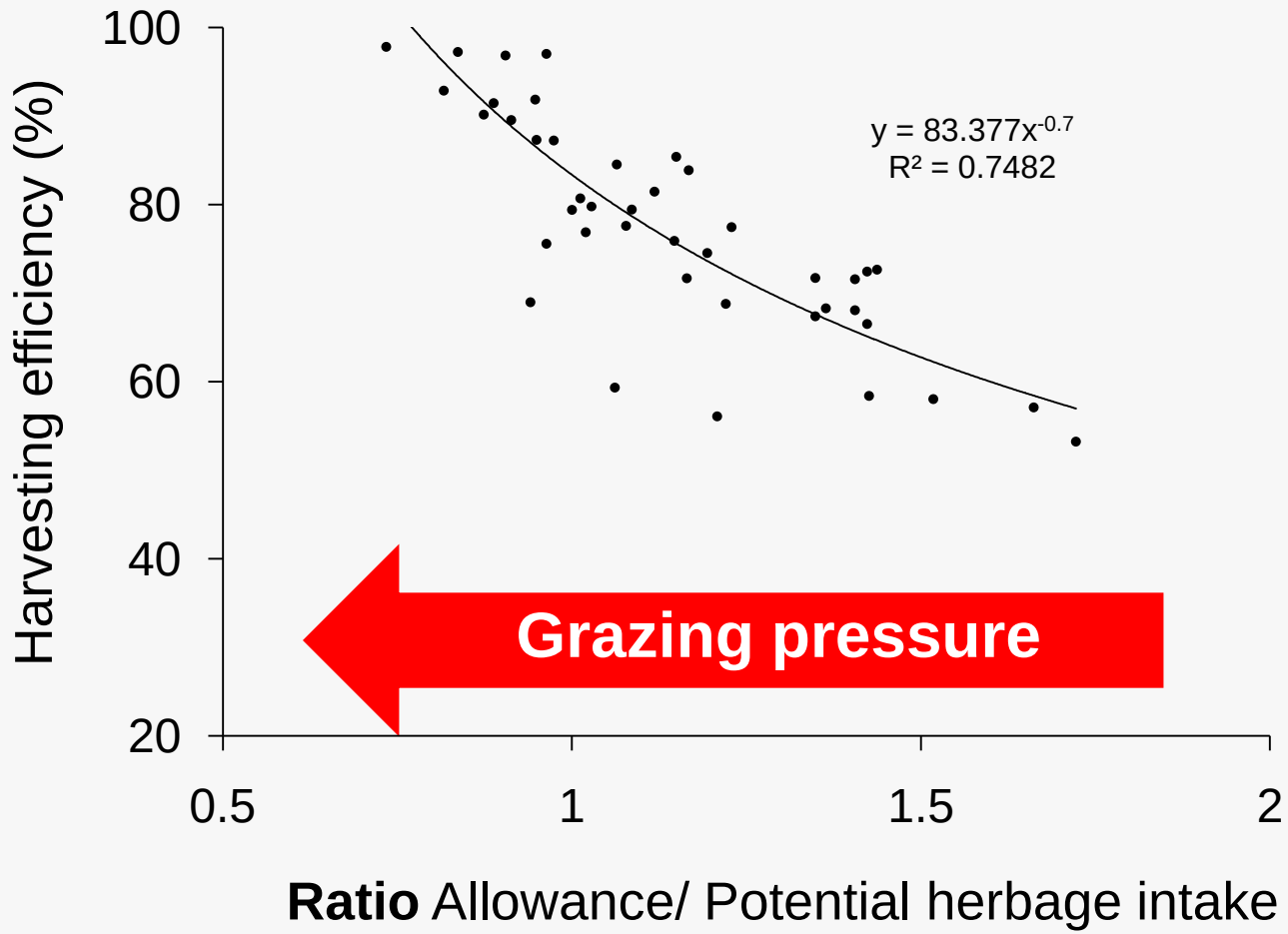
Herbage Allowance x Harvesting efficiency

↓ Input

↓ Empirical equation

From Potential to actual herbage intake

Non supplemented treatments of 13 studies



Substitution rate

If supplements are used, then:

Final herbage DM intake =

Herbage DM intake – (SR x kg supplements)

Substitution rate

(Stockdale *et al.*, 2000)

Results:

Model validation

Dataset for validation

3 Holstein Friesian strains (Irish strain trial):

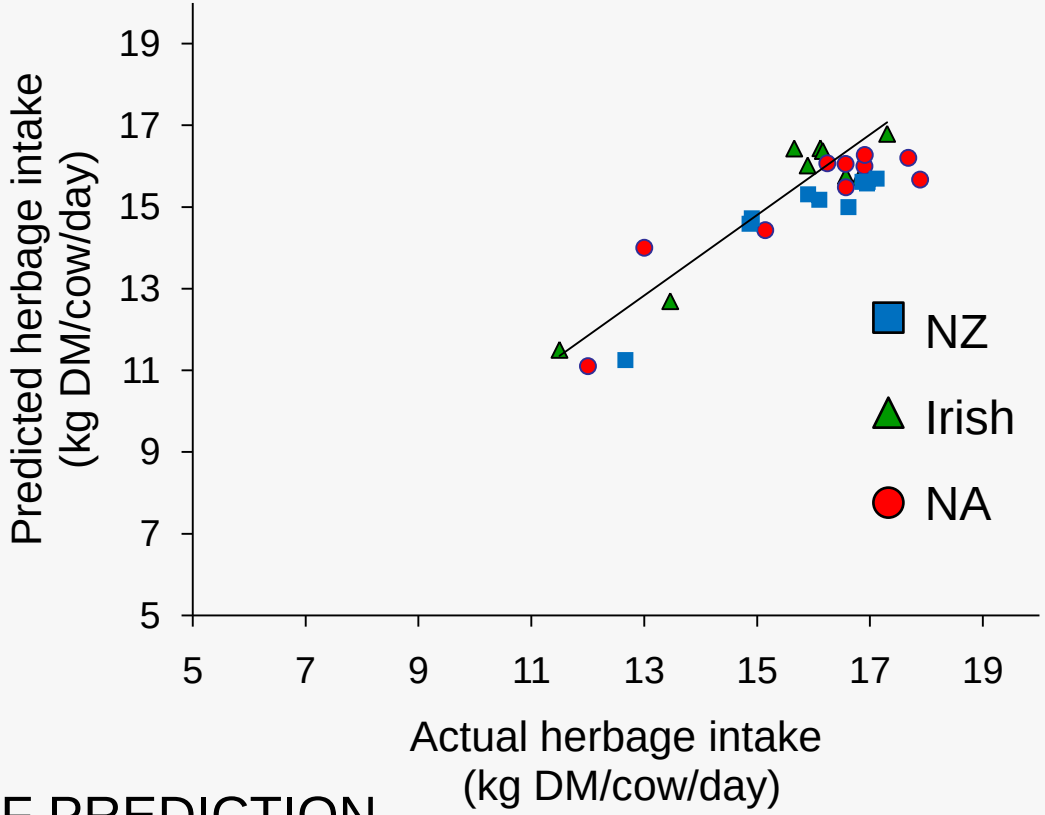
North American (NA)	> 90% NA genetics
Irish	≤ 80% NA genetics
New Zealand (NZ)	≤ 13% NA genetics

Herbage dry matter intake measurements:

With n-alkane, 858 observations, 3 lactations

Data averaged across month of lactation (per strain)

Model validation



ACCURACY OF PREDICTION

Relative prediction error (RPE): $\sqrt{\overline{MSPE}}$ / mean actual intake

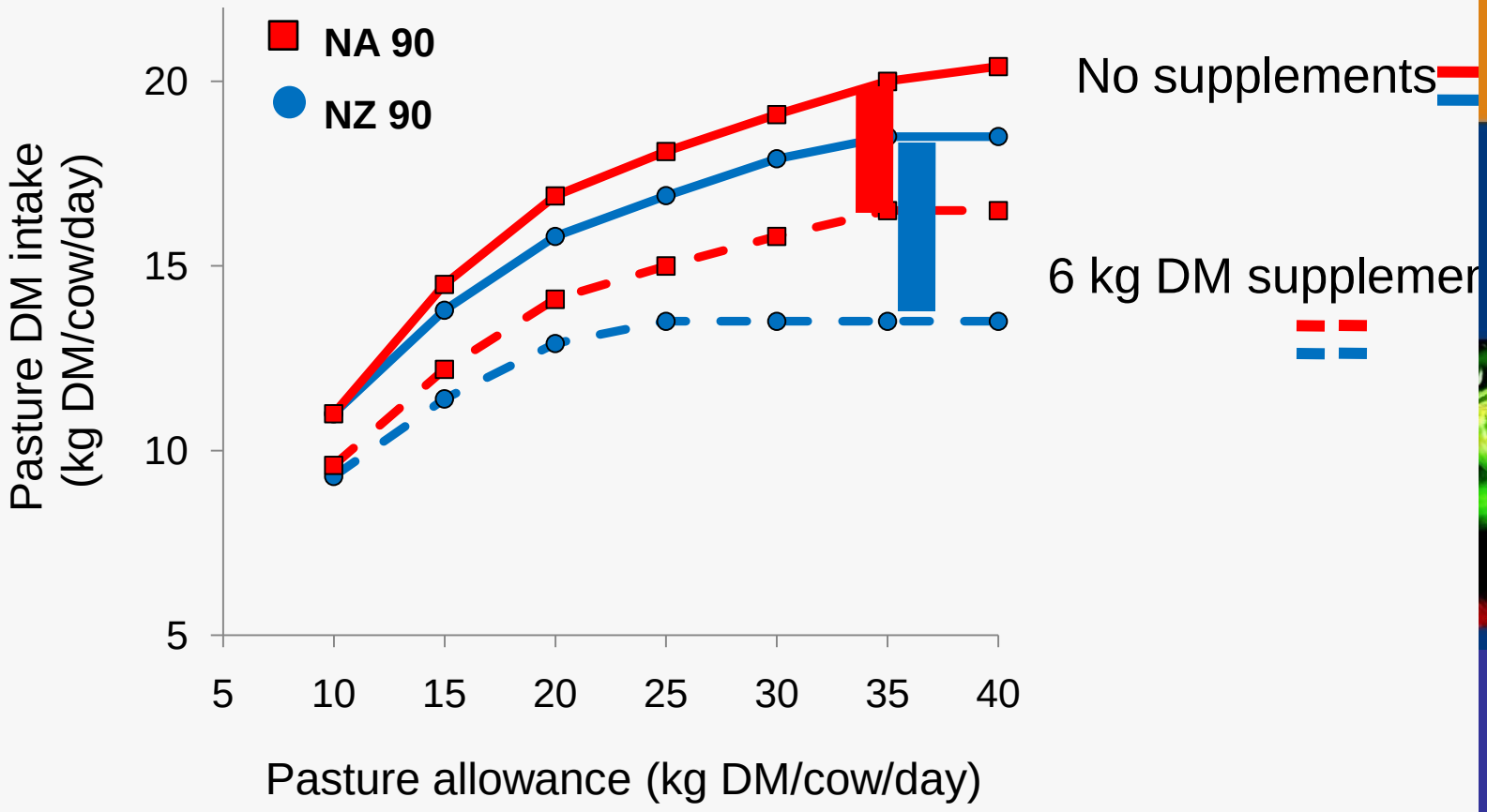
RPE = 6.4% ➔ Satisfactory prediction when: RPE < 10%

Concordance correlation coefficient = 0.87

Results:

Model simulations

MODEL SIMULATIONS



	Pasture Allowance	
	10 kg/cow	35 kg/cow
Substitution rates New Zealand	0.28	0.83
North American	0.23	0.59

Conclusions

Conclusions

The model requires a simple set of inputs:

- Potential milk yield and live weight
- Days in milk & days from conception
- Herbage allowance and quality (NDF and ME)
- Supplements consumption and quality

Conclusions

- The model is sensitive to nutritional, physiological and genetic variables

- The model accurately predicts herbage intake under grazing conditions.

When validated against actual intake values:

RPE= 6.4% and a CCC= 0.87

Thank you

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Agriculture and Food Development Authority

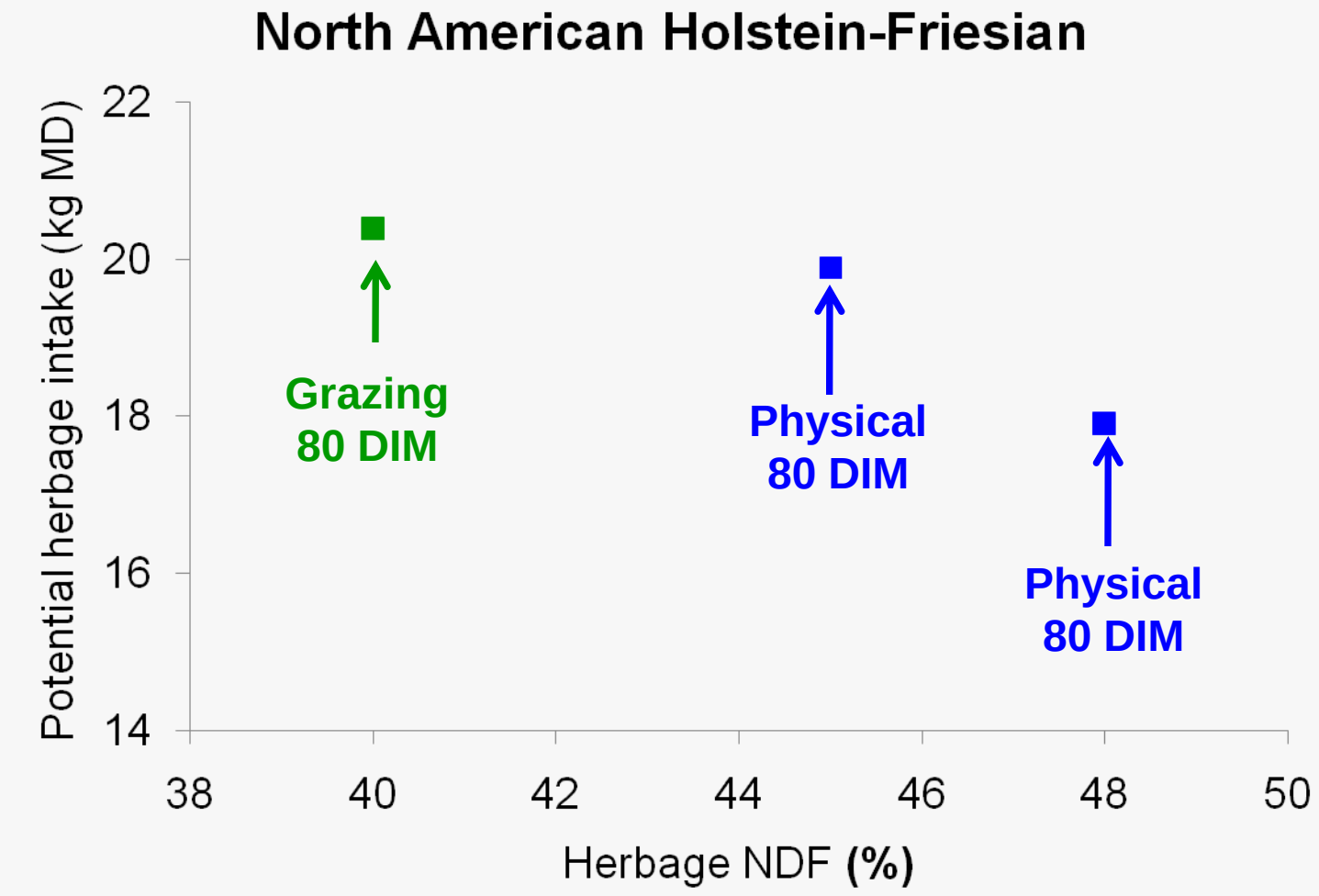
Extra slides

Experiments used to find relationship Herbage Allowance – Harvesting Efficiency

Reference	Cutting height (cm > ground level)	Allowance (kg DM/cow/day)
Maher et al. 2003	3.5	16-25
Stakelum et al. 2007	3.5	17-24
Burke et al. 2008	4	15-20
Kennedy et al. 2003	4	20-25
Kennedy et al. 2007a	4	17-31
Kennedy et al. 2008	4	13-20
Kennedy et al. 2007b	4	13-19
Kennedy et al. 2009	4	15
McEvoy et al. 2008	4	14-18
McEvoy et al. 2009	4	17-21
Meijs & Hoekstra 1984	4	18-25
Morrison & Patterson 2007	4	20
Delagarde et al. 1997	5	22-24
O'Donovan & Delaby 2008	5	13-22

Details
Back

Model predictions: What limits intake ?



METHODOLOGY: POTENTIAL HERBAGE INTAKE

- **METABOLIC LIMIT**

Potential intake (kg DM/cow/day)= $\frac{\text{ME Requirements (MJ)}}{\text{ME content herbage (MJ)}}$

ME Requirements (MJ ME)= $ME_m + ME_p + (ME_l \times \text{Potential milk yield})$

Potential milk yield = Mammary gland model (Vetharaniam *et al.* 2003),

with parameters of cows fed TMR (no nutritional limitations)

North American HF = 10,097 kg milk/lactation

New Zealand HF = 7,304 kg milk/lactation

METHODOLOGY: POTENTIAL HERBAGE INTAKE

- **METABOLIC LIMIT**

Potential intake (kg DM/cow/day)= $\frac{\text{Energy requirements}}{\text{Energy content of herbage}}$

Energy requirements (MJ ME)=

$$ME_m + ME_p + (ME_l \times \text{Potential milk yield})$$

Potential milk yield:

Mammary gland model (Vetharaniam *et al.* 2003)

METHODOLOGY: POTENTIAL HERBAGE INTAKE

- **PHYSICAL LIMIT** = $\frac{\text{Rumen capacity (kg NDF)}}{\text{Fill effect (\% NDF herbage)}}$

Potential intake (kg DM/cow/day)= $\frac{0.0165 \times LW}{\text{\% Herbage NDF}} \times SOL$

Vazquez and Smith (2000)

Hulmes *et al.* 1986

METHODOLOGY: POTENTIAL HERBAGE INTAKE

- **GRAZING LIMIT** =

Potential intake (kg DM/cow/day)= 0.0375 x LW x SOL

from Kolver and Muller (1998); McGilloway and Mayne (1996)

It is selected as a limit in cases of:

- High yielding cows
- Herbage with low NDF

METHODOLOGY: SUBSTITUTION RATE

If supplements are used, then:

Final herbage DM intake =

Herbage DM intake – (SR x kg supplements)

SR = 0.21 herbage DMI – 0.18 (Stockdale *et al.*, 2000)

Australian Journal of Experimental Agriculture, 2000, **40**, 913–921

Levels of pasture substitution when concentrates are fed to grazing dairy cows in northern Victoria

C. R. Stockdale

METHODOLOGY: SUBSTITUTION RATE

Substitution rate (SR) is the reduction in herbage DM Intake per kg of supplement consumed

SR = 0.21 herbage DMI – 0.18 (Stockdale *et al.*, 2000)

Herbage DMI = kg DM herbage/100 kg Live weight

If supplements are used, then:

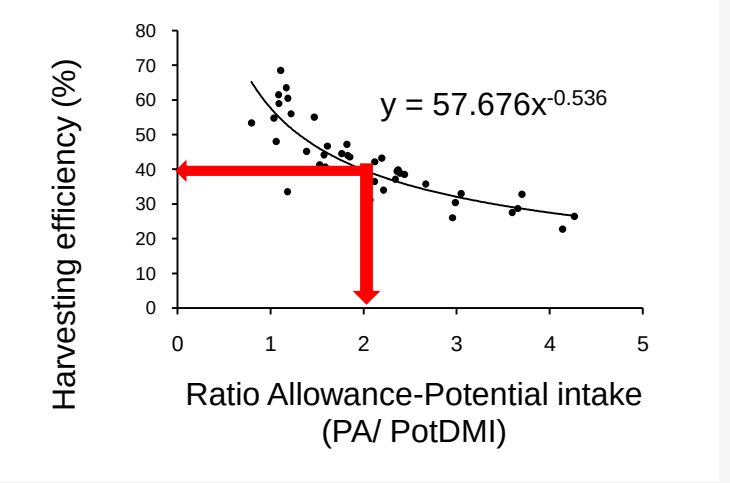
Final herbage DM intake =

Herbage DM intake – (SR x kg supplements)

How to convert potential intake into actual intake?

Example:

- 40 kg DM allowance
- 20 kg potential herbage DM intake



Harvesting efficiency (%) =

$$57.676 \left(PA/(PotDMI)^{\wedge(-0.536)} \right) = 40\ \%$$

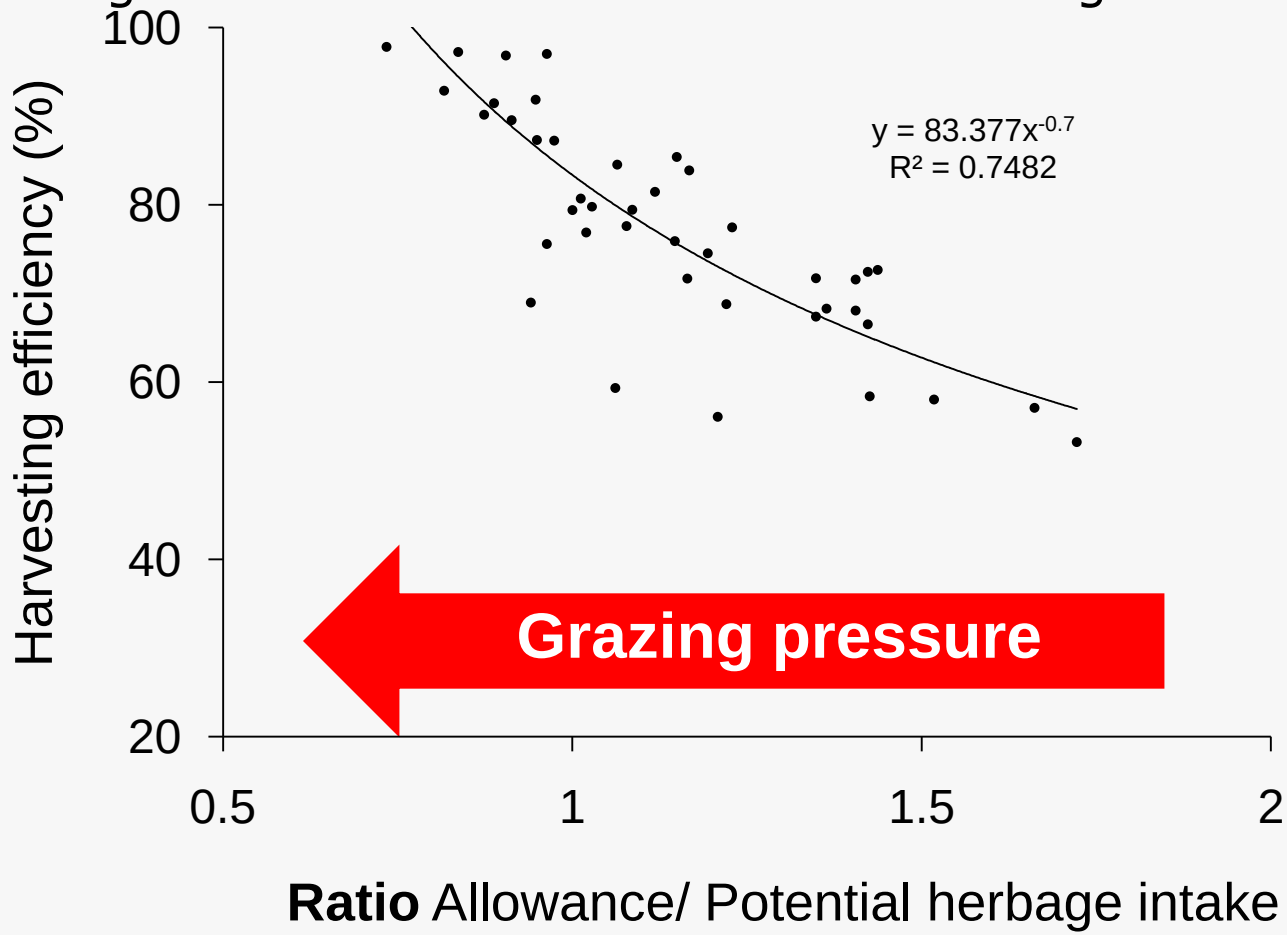
Herbage DM intake =

$$\text{Allowance x Harvest efficiency} = \frac{40 \times 40}{100} = 16 \text{ kg DM/day}$$

From Potential to actual herbage intake

Non supplemented treatments of 13 studies

Herbage allowance measured >3 cm above ground level



Stage of lactation coefficient

$$SOL = 0.67 + (4.0401 \times \text{Log}(w) - 0.095 \times w) \times 0.0972$$

SOL= stage of lactation coefficient

W= week of lactation

Hulme *et al.* 1986