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IMPROVED CATTLE GROWTH BY METHIONINE-BALANCED DIETS DOES NOT RESULT FROM LOWER PROTEIN DEGRADATION

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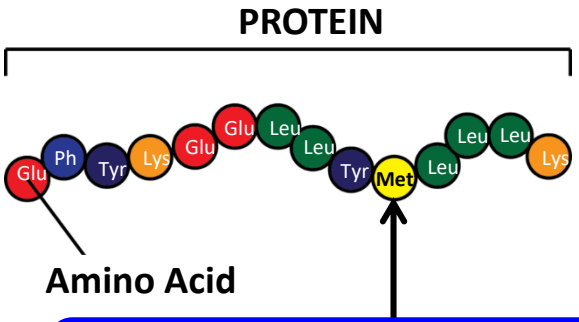
INRA SCIENCE & IMPACT

Dubrovnik, 29/ 08 / 2018

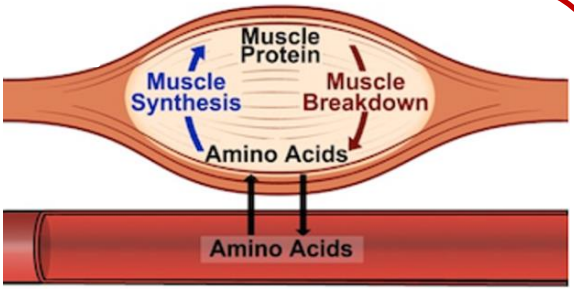
INTRODUCTION

- **Improving N use efficiency (NUE) is currently an important issue in animal production**
- **From a metabolic point of view both the amount and nature of protein may impact NUE**
- **The dietary AA profile should be formulated according to animal requirements**
  - **Methionine is believed to be the first limiting AA in growing cattle fed forage-diets** ***(Titgemeyer and Merche, 1990)***
  - **Diets well balanced for Met improve performances of growing beef cattle** ***(Veira et al., 1991; Bahloul et al., 2018)***
  - **However, controversy exists about the metabolic pathways involved in this improvement**

PROTEIN TURNOVER



IF THIS AMINO ACID LACKS:
1) PROTEIN SYNTHESIS MAY BE REDUCED
2) PROTEIN DEGRADATION MAY INCREASE

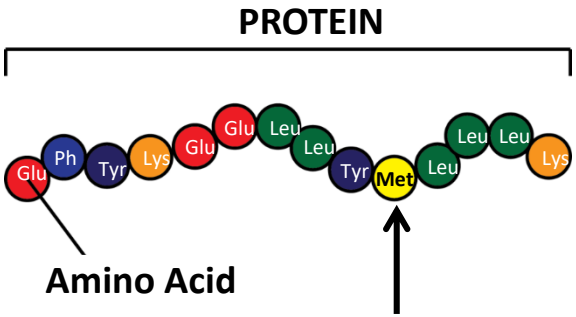


EXAMPLE OF PROTEIN TURNOVER

(Lobley, 2003)

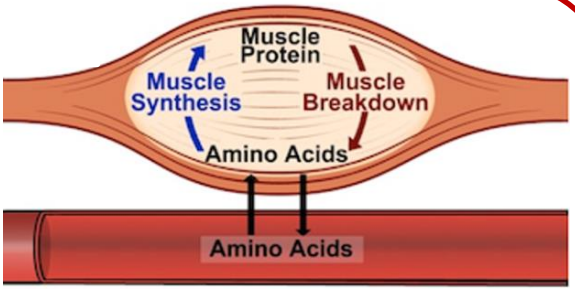
- Protein intake = 1500 g/d
- Protein synthesis = 3000 g/d
- Protein degradation = 2750 g/d
- Protein gain = 250 g/d

PROTEIN TURNOVER: H1



IF THIS AMINO ACID IS SUPPLEMENTED THE PROTEIN DEPOSITION MAY INCREASE THROUGH:

Salter et al., 1990; Wessels et al., 1997; Saggau et al., 2000; Ren et al., 2007 Robinson et al., 2016



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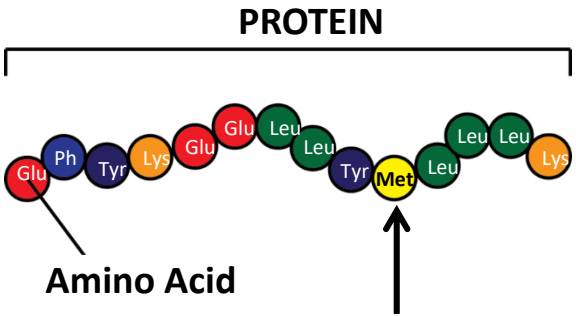
PROTEIN TURNOVER: H2



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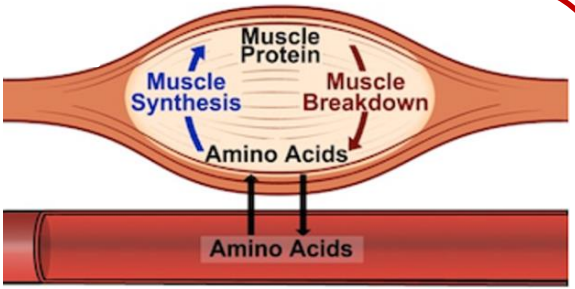
Nieto et al., 1994; Tesseraud et al., 1996
De la Higuera et al., 1998; Schadereit et al., 1999
Löhrke et al., 2001



EXAMPLE OF PROTEIN TURNOVER

(Lobley, 2003)

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Mechanisms responsible for the effect of Met (synthesis vs degradation) are not elucidated.

Available studies:

- ✓ **monogastrics only (pigs, broilers, rats, fish)**
- ✓ **measurement of protein synthesis using a reference method (infusion or flooding dose of a labelled amino acid)**
- ✓ **but no measurement of protein degradation (→ calculated).**

OBJECTIVE

To analyse the whole-body protein turnover rate of fattening young bulls fed diets balanced or unbalanced for methionine, at two dietary levels of metabolizable protein, using a new methodology to quantively assess protein degradation rate in vivo.

MATERIAL AND METHODS

- 36 Charolais young bulls (320 kg BW and 266 d old on average)
- 4 experimental diets, all based on grass silage (60%) and concentrate (40%)

2 x 2 Factorial design

[Normal *vs* High MP] x [Without *vs* with Smartamine®]

100 *vs* 120% requirements x 1.9 *vs* 2.4 %Met (Lys/Met ~ 4 vs 3)

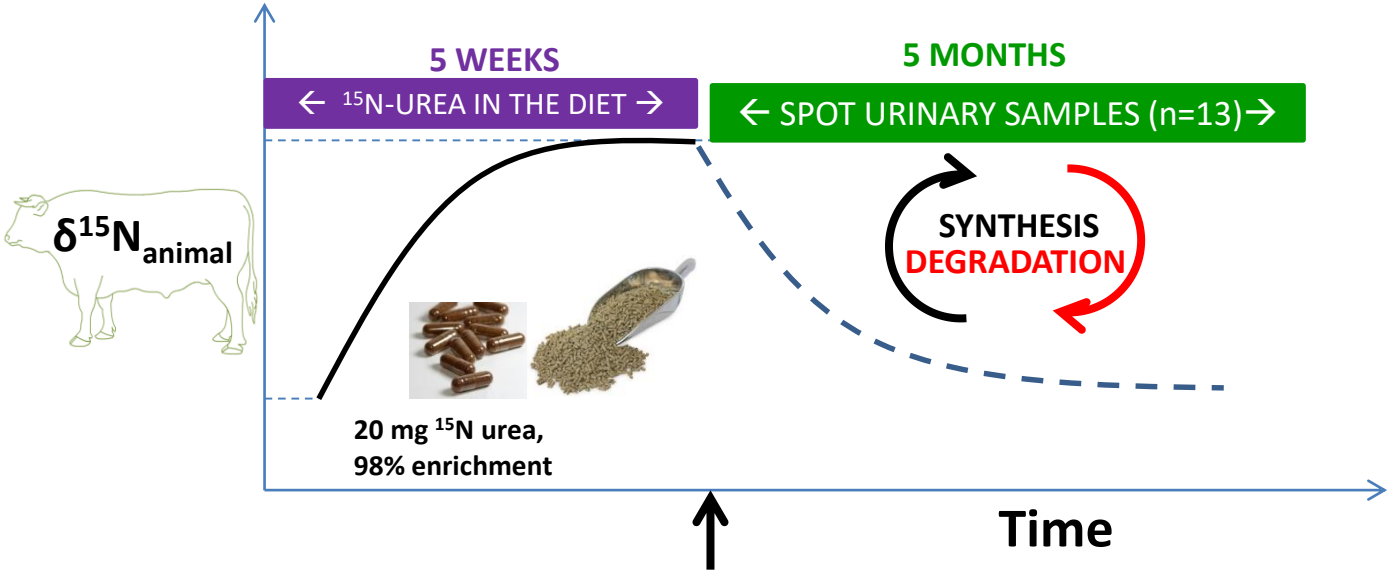
The 2 experimental factors (MP and Met)
significantly increased ADG (+16 and 9%, respectively) (*Bahloul et al., 2018)*
and thus were supposed to impact the protein metabolism

Measurement of isotopic (^{15}N) turnover

- ✓ ***After tissue enrichment in ^{15}N, the rate of release of ^{15}N from the whole body reflects WB protein degradation***
- ✓ ***≠ reference methods which target protein synthesis using tracers***

ISOTOPIC ^{15}N TURNOVER RATE

Measurement in urine following an isotopic diet switch



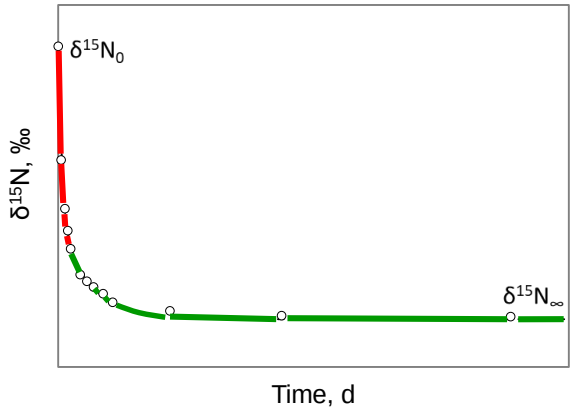
The rate at which WB proteins release ^{15}N after accumulation reflects WB protein degradation rate.

Protein synthesis rate evaluated by difference from ADG and protein degradation rate.

MODELING of ISOTOPIC TURNOVER RATE

$$\delta^{15}N(t) = \delta^{15}N_{\infty} + (\delta^{15}N_0 - \delta^{15}N_{\infty}) \times [p \times \exp^{-k1 \times t} + (1-p) \times \exp^{-k2 \times t}]$$

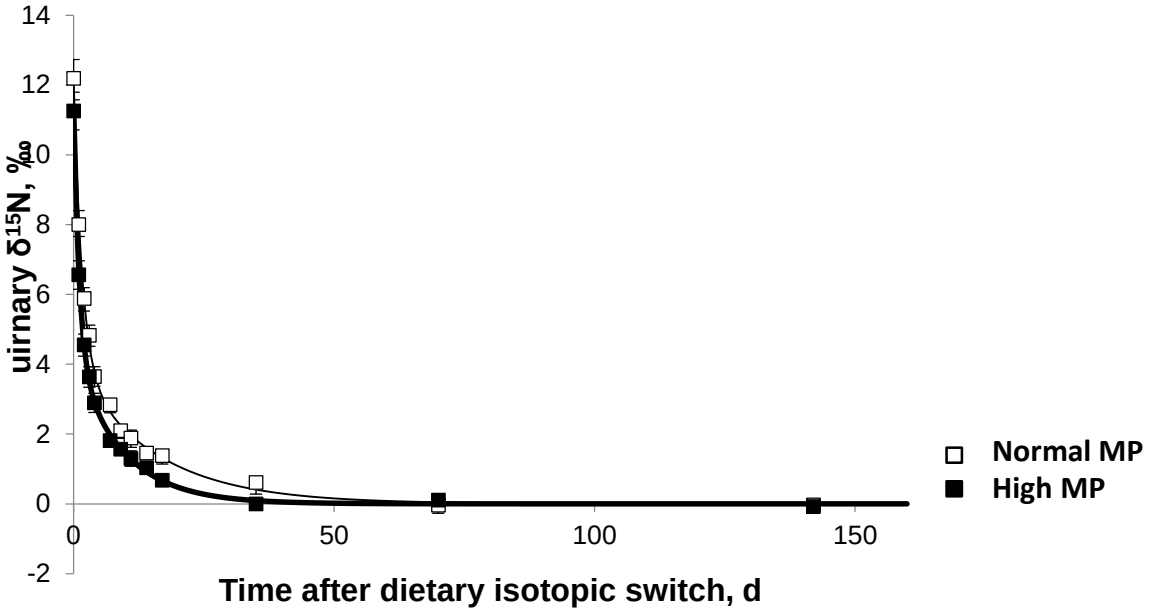
Slope k1 = degradation rate of pool 1 (fast)
Slope k2 = degradation rate of pool 2 (slow)



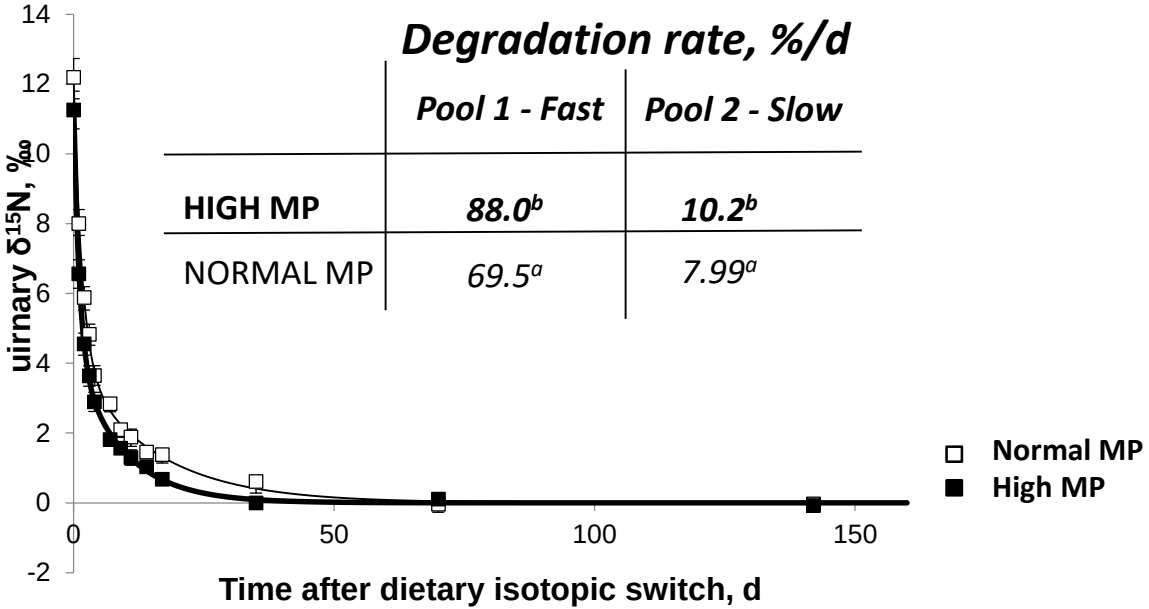
- **All individual data are used to adjust a non linear mixed-effect model (nlme in R)**
  Mono or bi-exponential
- **Fixed effects : MP level, Methionine content and their interaction**
- **Random effect: Animal**

RESULTS

Effect of DIETARY PROTEIN LEVEL



Effect of DIETARY PROTEIN LEVEL
High MP increases the whole body protein degradation rate



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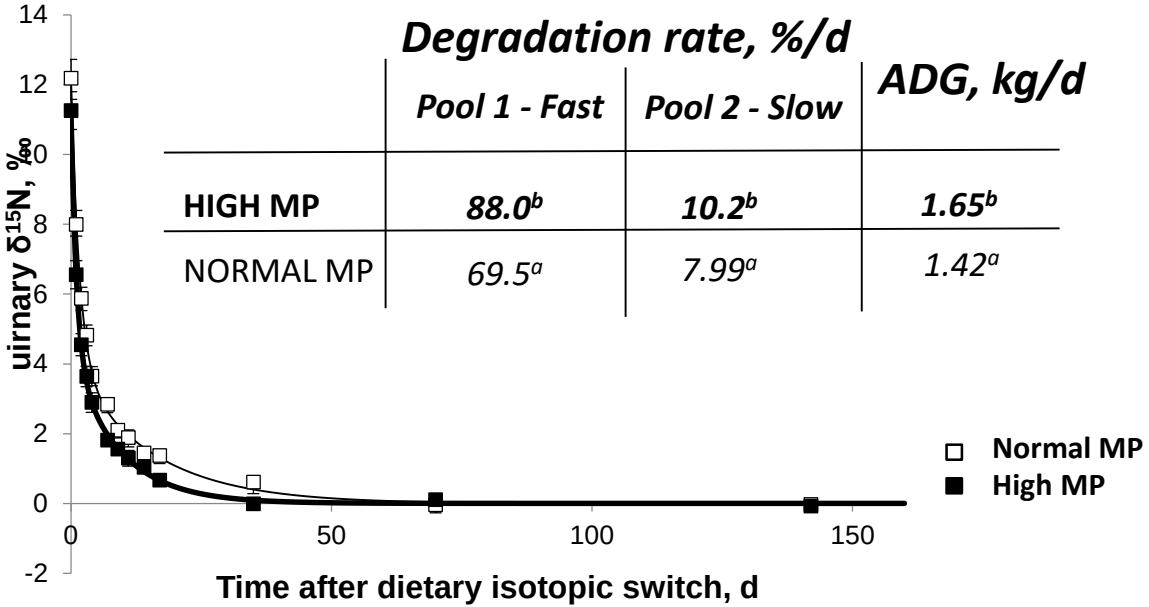

	Degradation rate, %/d		ADG, kg/d
	Pool 1 - Fast	Pool 2 - Slow	
HIGH MP	***88.0^{b}***	***10.2^{b}***	***1.65^{b}***
NORMAL MP	*69.5^{a}*	*7.99^{a}*	*1.42^{a}*

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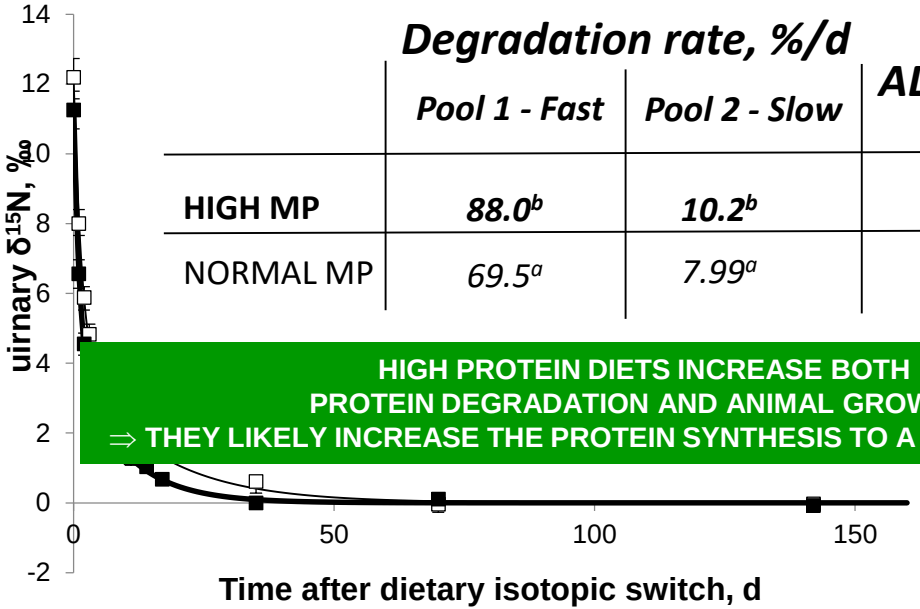

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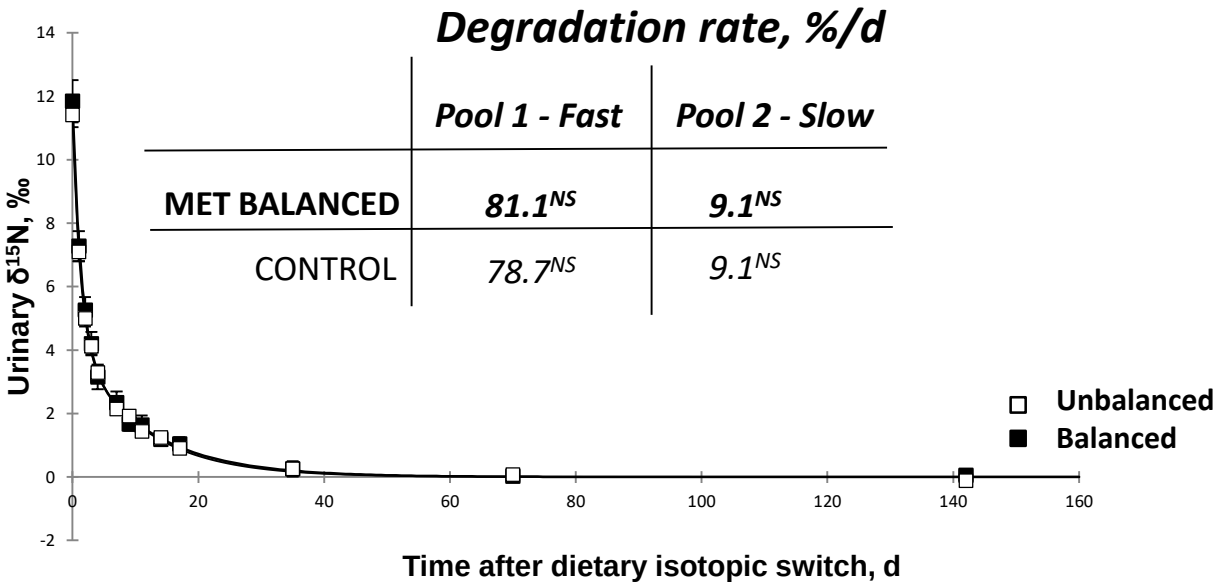
HIGH PROTEIN DIETS INCREASE BOTH PROTEIN DEGRADATION AND ANIMAL GROWTH,
⇒ THEY LIKELY INCREASE THE PROTEIN SYNTHESIS TO A GREATER EXTENT

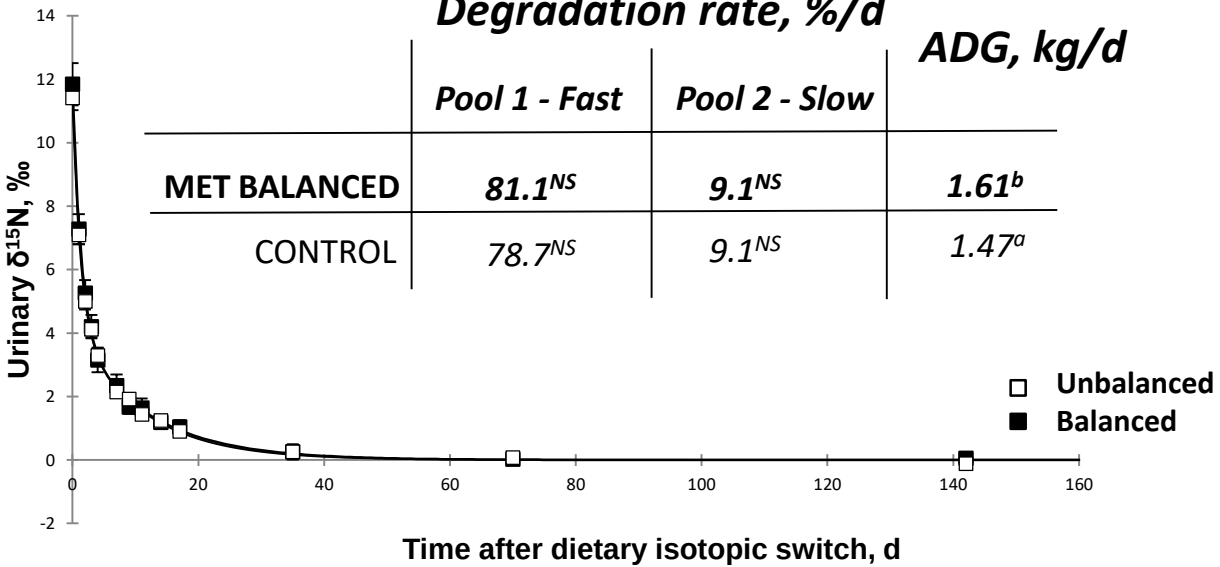
Effect of DIETARY METHIONINE LEVEL

Effect of DIETARY METHIONINE LEVEL
No impact on whole body protein degradation



Effect of DIETARY METHIONINE LEVEL
No impact on whole body protein degradation

	Degradation rate, %/d		ADG, kg/d
	Pool 1 - Fast	Pool 2 - Slow	
MET BALANCED	81.1^{NS}	9.1^{NS}	1.61^{b}
CONTROL	78.7^{NS}	9.1^{NS}	1.47^{a}



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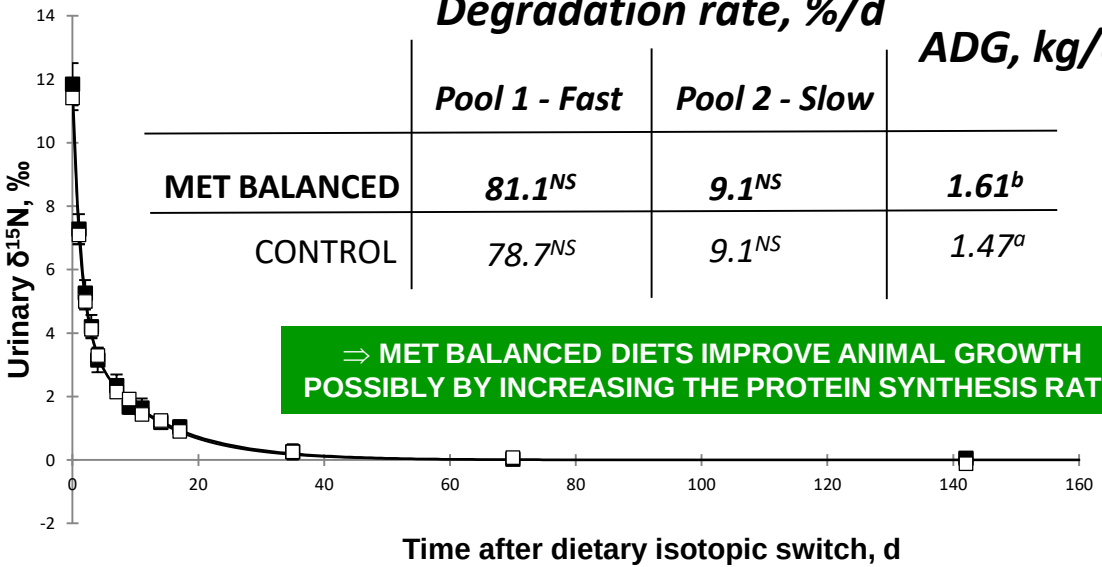

⇒ MET BALANCED DIETS IMPROVE ANIMAL GROWTH POSSIBLY BY INCREASING THE PROTEIN SYNTHESIS RATE

□ Unbalanced
■ Balanced

CONCLUSIONS

The improvement of animal growth with methionine balanced diets is not due to a decrease in whole-body protein degradation rate but more likely to an increase in protein synthesis.

As expected, increasing the protein content of diets increased the whole-body protein degradation rate, and may also have increased the protein synthesis rate.