Dairy Management

WISCONSIN
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Nutritional Considerations in Robotic Herds

UW-Dairy Management Decision Support TOOLS

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Rationale

Cows in conventional milking parlors:

- Kept structured, consistent, and social milking and feeding routine
- Obtain all their nutrients from a TMR

Cows in automatic milking systems (AMS):

- Obtain a fraction of their nutrients during milking and through a partial mixed ration (PMR)
- Their milking frequency and time of milking vary across time

AMS

Challenges: milking frequency not only dependent on **concentrates at the AMS**, but

- the social structure of the herd,
- the farm layout design,
- the type of traffic imposed to cows,
- the type of flooring,
- the health condition of the cow

Opportunities

- manipulate the number of cows per AMS
- milking more frequently
- feeding more precisely

Overcome challenges and capture opport

- Behavioral Considerations
- Nutritional Considerations
- Economic Considerations

Bach & Cabrera, 2017

Behavioral Considerations

Maximum AMS return on investment → full utilization of the AMS with little or no human intervention

Crucial → maximizing milking frequency and minimizing fetching

Challenge → consistent milking frequency throughout time

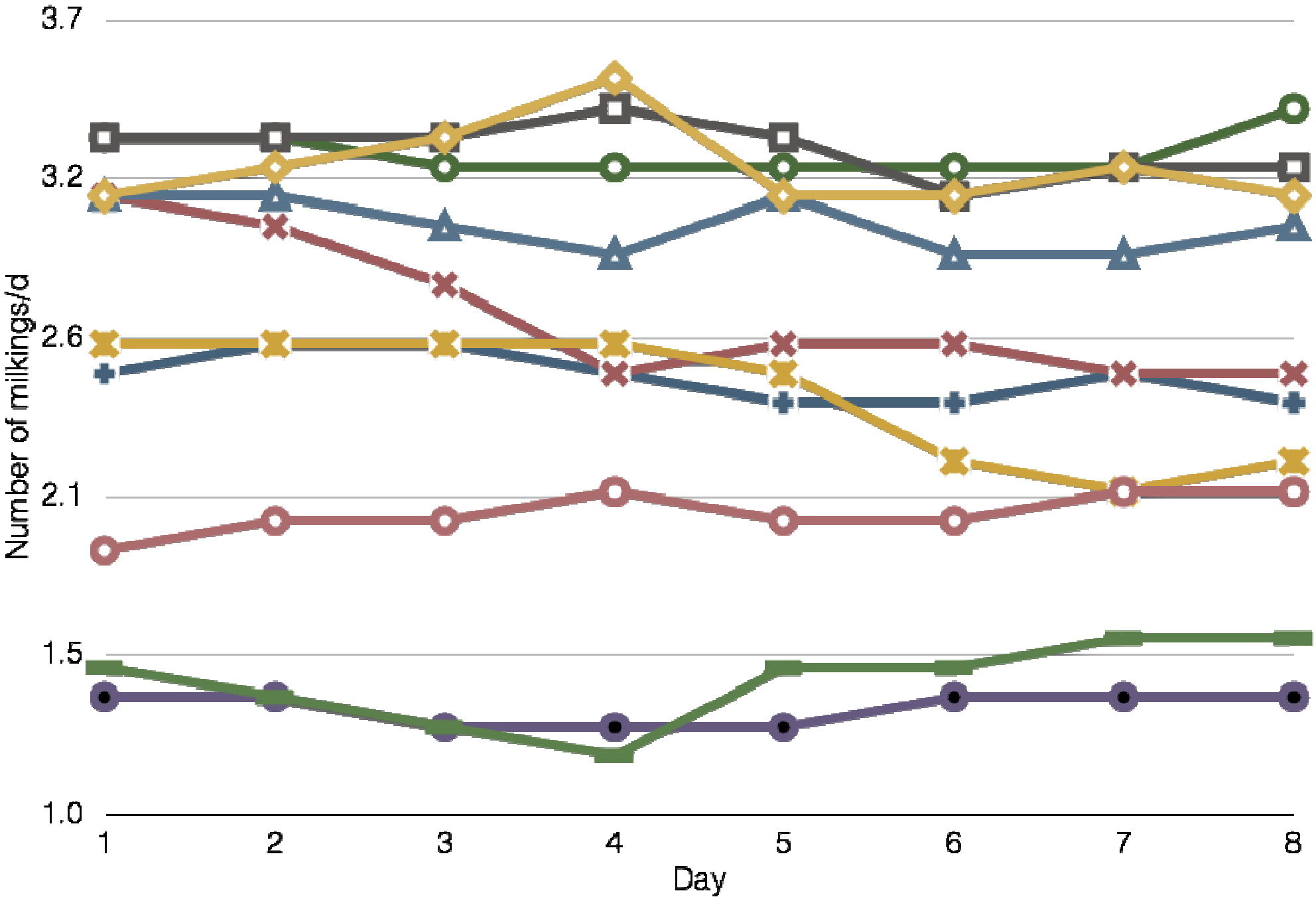
Behavioral Considerations

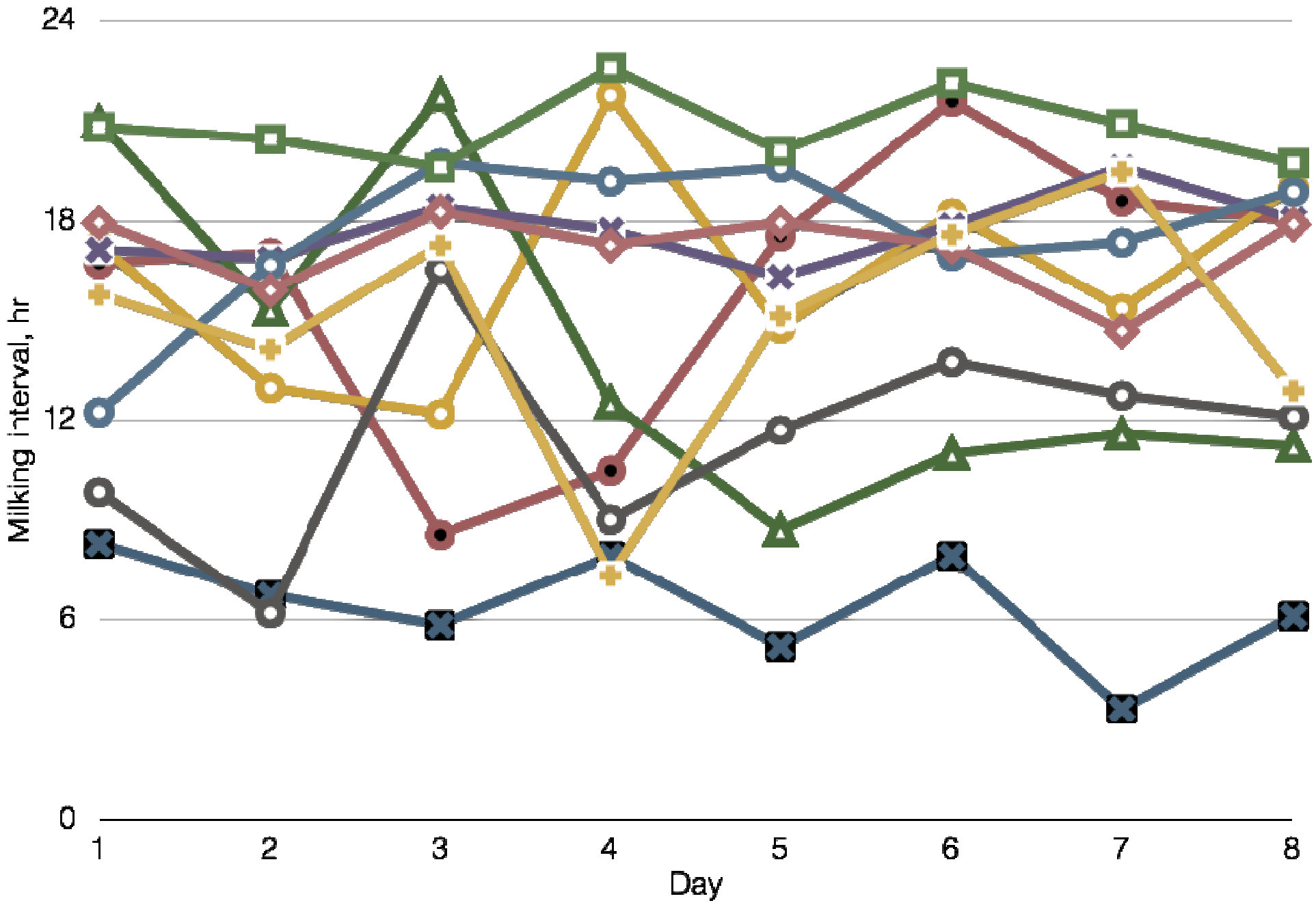
Common → ~2.5 average milkings

Wagner-Storch et al., 2003; Bach et al. 2009; Deming et al., 2013

Variation → can be high

Change frequency of milkings → change in the AMS DMI


3.7
3.2
2.6
2.1
1.5
1.0
Number of milkings/d
1
2
3
4
5
6
7
8
Day


24
18
12
6
0
Milking interval, hr
1
2
3
4
5
6
7
8
Day

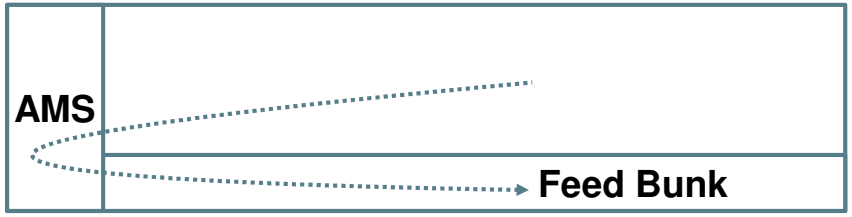
Behavioral Considerations

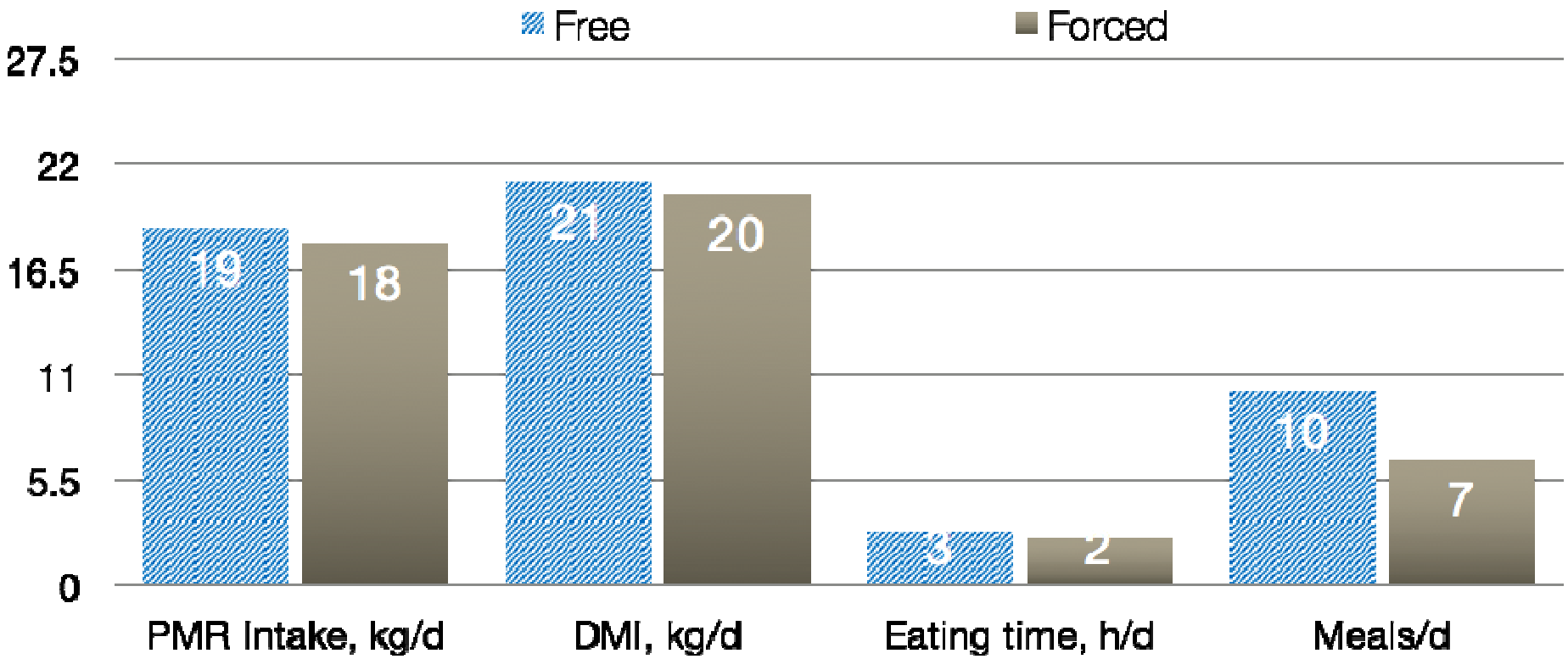
↑AMS visits & ↓variability

→

Palatable feed

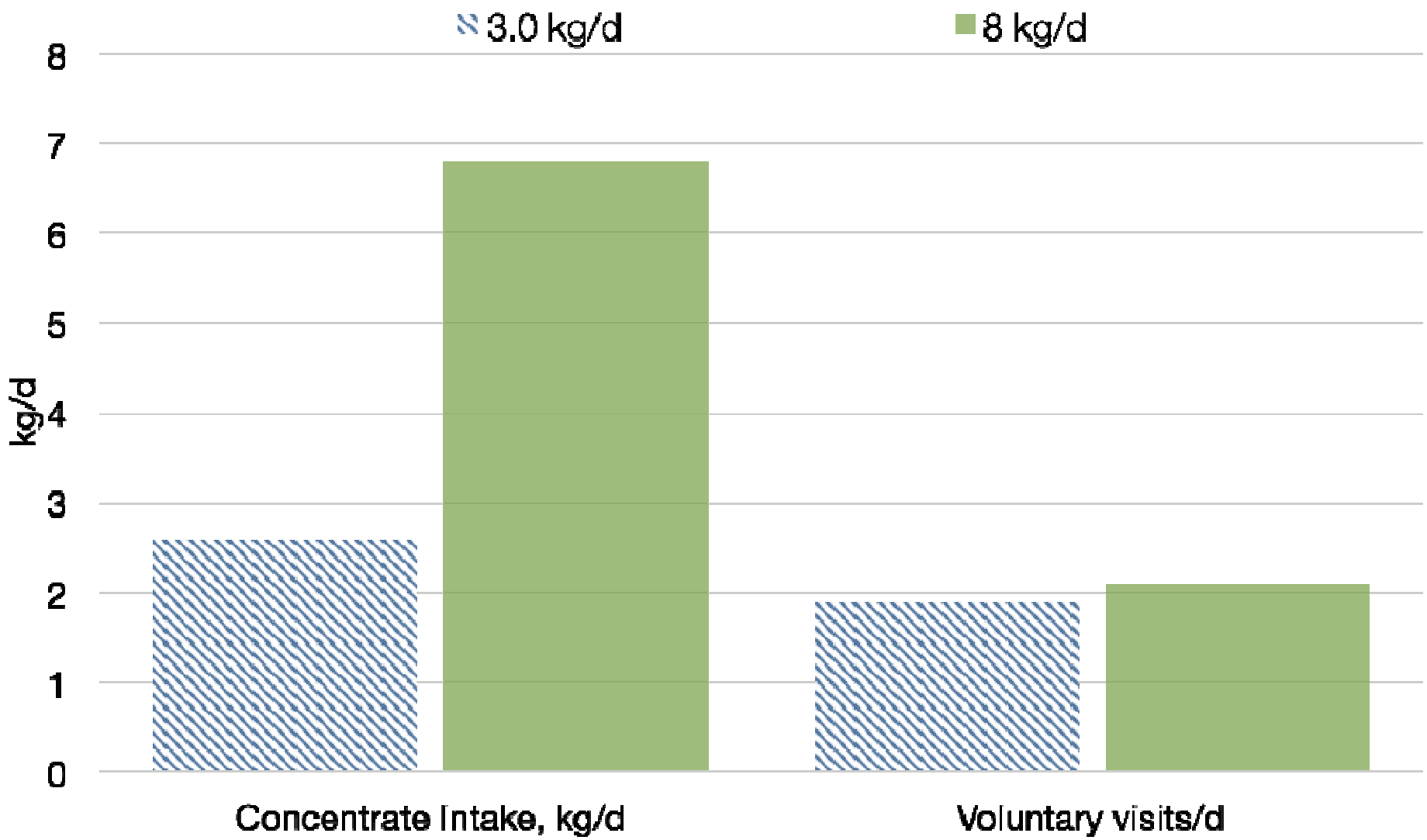
Forced (guided) traffic





Bach et al., 2009

- Forced traffic reduces PMR intake Bach et al., 2009
- Forced traffic decreases milk yield Tremblay et al., 2016



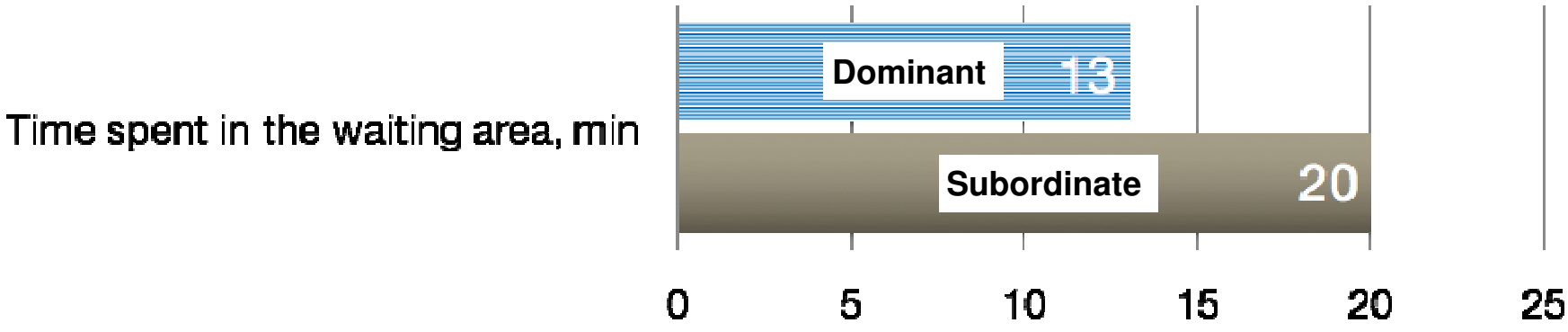
Bach et al., 2007

- ⬆feed allowance does not ⬆visits Bach et al., 2007
- 300 g/visit attracts grazing cows Scott et al., 2014

Behavioral Considerations

Cows are gregarious →
Sync behaviors
Benham, 1992

AMS force individualism
→ unnatural



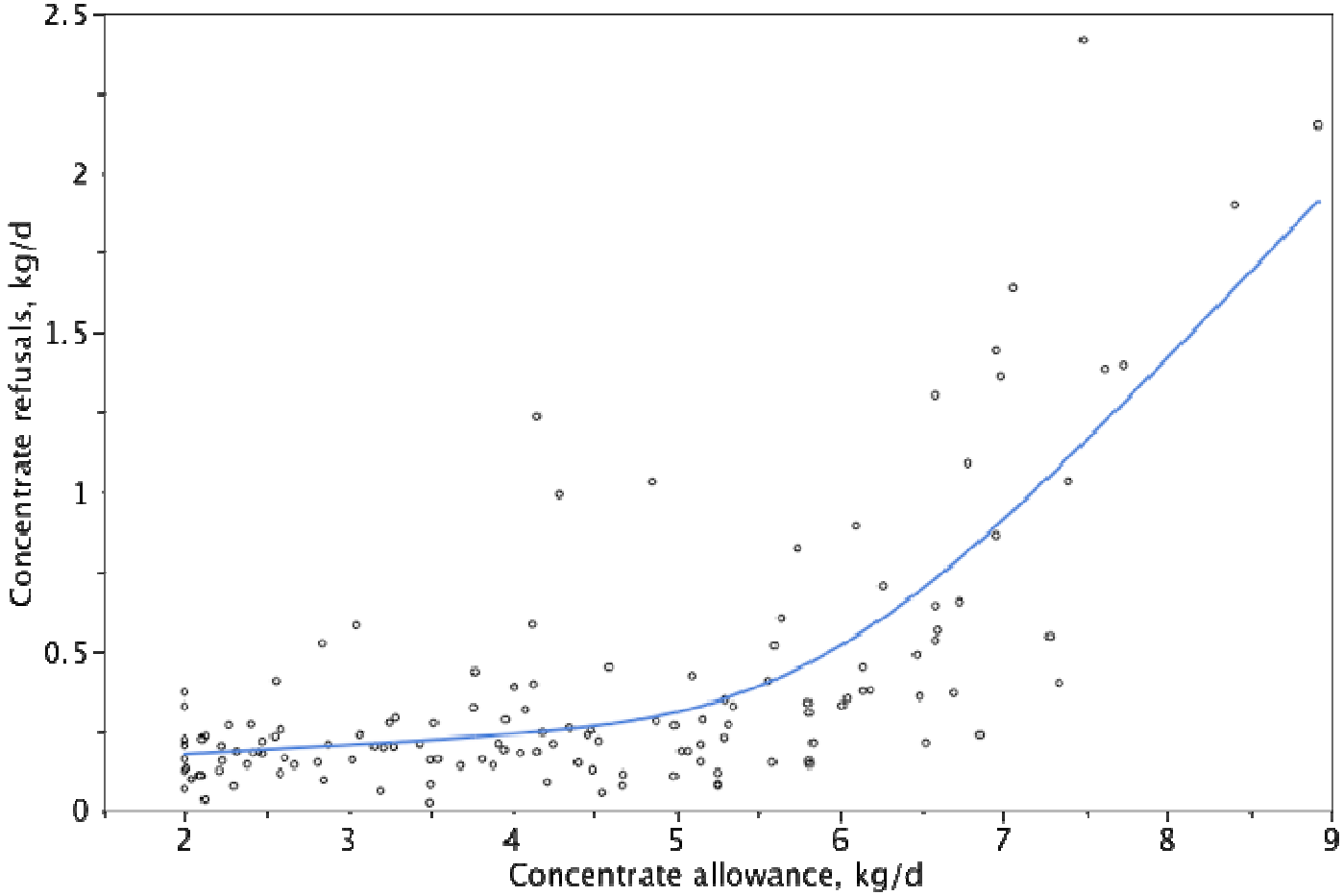
Dominant cows → less time in waiting area
Halachmi, 2009

Nutritional Considerations

AMS concentrate feeding ➞ main attraction to milking

Prescott et al, 1998

Cows do not consume all concentrate ➞ > 4 kg/d



Nutritional Considerations

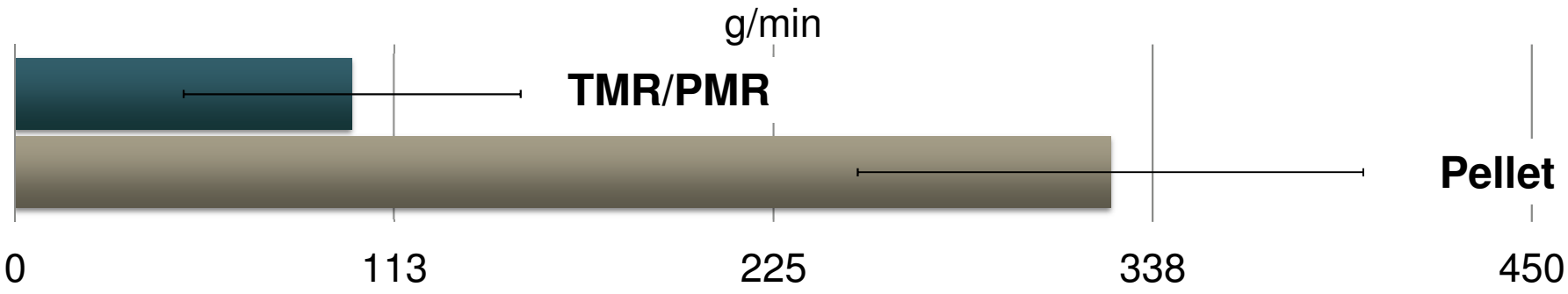
Inconsistent nutrient supply→ affects negatively milk yield

MacBeth et al., 2013

> AMS concentrate allowance → < density PMR

Milk yield decreased→ > AMS concentrate allowance

Tremblay et al., 2016



AMS time/milking ➞ 7 min

Castro et al. 2012

A cow can consume ➞ < 2.8 kg/milking

Theoretically, a cow can consume ➞ < **8.4 kg**/3 milkings per d

To avoid variation ➞ better an allowance of 4 kg/d

Nutritional Considerations

25 vs. 49% starch for 3 kg/d allowance➞ no change in milk yield, composition, or visits

Halachmi et al., 2006

Minerals and vitamins➞ normally not provided in AMS➞ **becomes an issue when cows rely more in concentrate**

Flavoring agents➞ in general no positive effects

Harper et al., 2016

Precision feeding opportunity

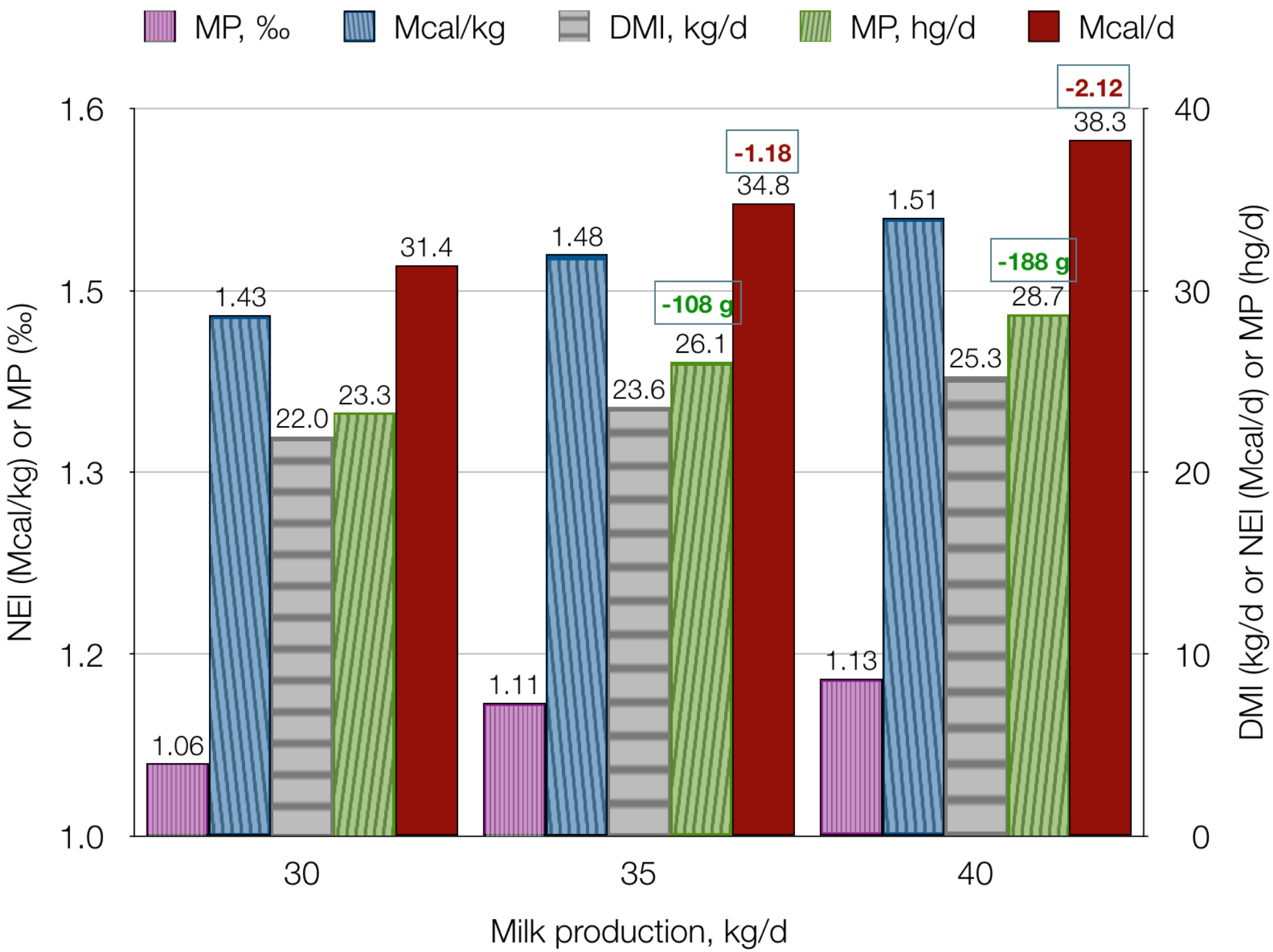
TMR or PMR inefficiencies→
improved by AMS supplementation

Cows sort
Leonardi and Armentano, 2007

Composition changes
Kononoff and Heinrichs, 2003

Intake is variable→
between cows and within cows

Balanced diet for a cow→
unbalanced diet for another cow


MP, ‰
Mcal/kg
DMI, kg/d
MP, hg/d
Mcal/d
NEI (Mcal/kg) or MP (‰)
DMI (kg/d or NEI (Mcal/d) or MP (hg/d)
Milk production, kg/d
1.6
1.5
1.3
1.2
1.0
40
30
20
10
0
30
35
40
1.06
1.43
22.0
23.3
31.4
1.11
1.48
23.6
26.1
-108 g
34.8
-1.18
1.13
1.51
25.3
28.7
-188 g
38.3
-2.12

Precision feeding opportunity

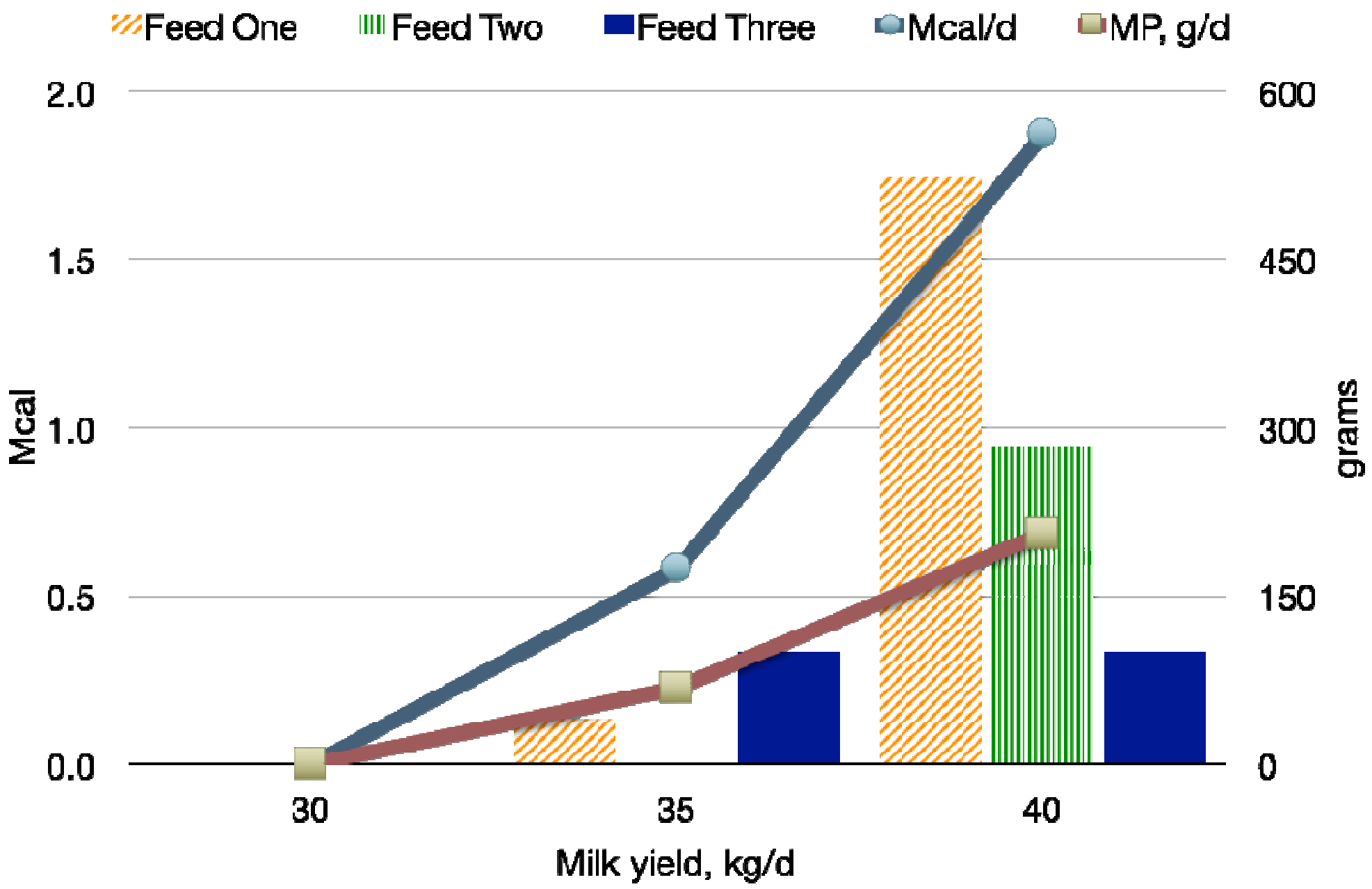
Decrease imbalance→ AMS concentrate

Most AMS only have single bin to deliver concentrates

Imbalance→ will remain and progressively increase

How to overcome it→ provide a custom-made cow-specific concentrate

On the basis of milk, BW, state, components, etc.


Feed One
Feed Two
Feed Three
Mcal/d
MP, g/d
2.0
1.5
1.0
0.5
0.0
Mcal
600
450
300
150
0
grams
30
35
40
Milk yield, kg/d

Economic considerations

Maximizing milk production per AMS proposed as goal for economic efficiency

Sonck & Donkers, 1995

More cows per AMS -> milkings reduced and time AMS used by cows increased

Tremblay et al., 2016

Maximizing milking frequency -> should be the main goal of AMS

Economic analyses

Data from a North Catalonian farm

AMS 1

- 64 cows
  - Primiparous (PMC)
- AMS concentrate
  - **3.84** kg/d
  - [0.98 - 7.42]
- Milk yield
  - **32.6** kg/d
  - [15.6 - 46.0]

AMS 2

- 70 cows
  - Multiparous (MPC)
- AMS concentrate
  - **4.70** kg/d
  - [1.60 - 9.04]
- Milk yield
  - **41.3** kg/d
  - [17.3 - 59.6]

Dataset

AMS concentrate

- 2.07 Mcal of NEl/kg
- 22.4% CP
- €274/MT

PMR feed

- 1.62 Mcal of NEl/kg
- 15.6% CP
- €92.5/MT

Cow consumption

- **DMI:** NRC (2001)
- **NEl & CP**: milk yield

Income over feed cost (IOFC)

- Milk price at **€0.32/kg**

1 - Change number of cows per AMS

70 to 65 MPC

Total milk harvested per AMS remained constant

Tremblay et al., 2016

2,892 kg milk AMS/d

- 70 MPC = 41.3 kg/cow.d
- 65 MPC = **44.5** kg/cow.d

Extra 3.2 kg/cow.d

- Required ~2.5 Mcal NEl/cow.d

Additional **PMR**

- Maintaining AMS concentrate allowance equal

1 - Change number of cows per AMS

70 to 65 MPC

↑€**2,453**/AMS.yr
↑€**6.72**/d

IOFC

- 70 MPC = €720.8/AMS.d
- 65 MPC = €727.5/AMS.d

65 MPC increased IOFC

- Less feed for maintenance

2 - Limit amount of AMS concentrate

Less allowance of AMS concentrate

- minimize variability in concentrate consumption
- reducing feed costs
  - lower cost per unit of nutrient with PMR

PMC

- 3.74 to **2 kg/cow.d**

MPC

- 4.70 to **3 kg/cow.d**

2 - Limit amount of AMS concentrate

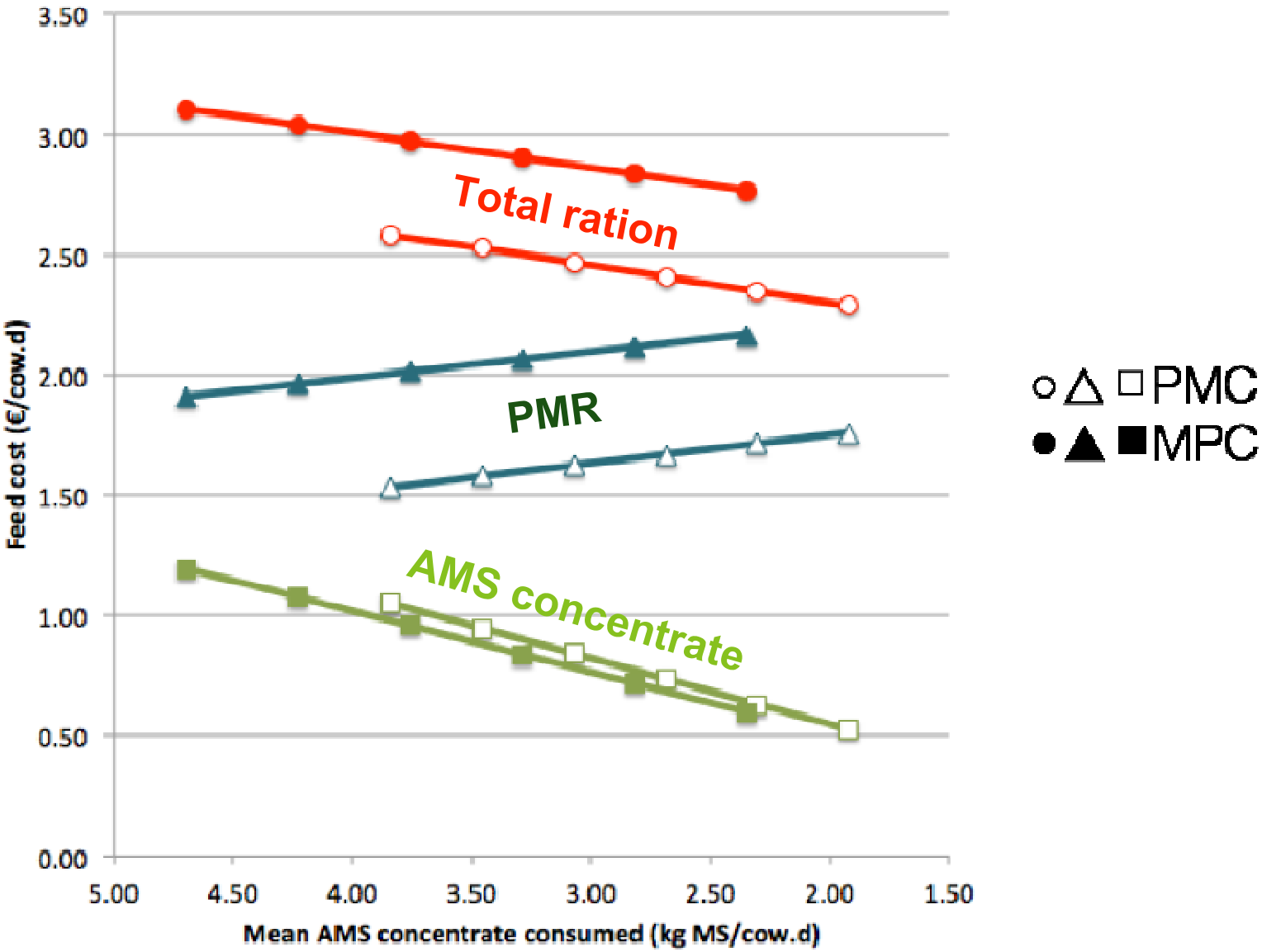
PMC

- 3.74 to **2 kg/cow.d**
- €7.9 to €8.1/cow.d
- ↑**€6,710/AMS.yr**

MPC

- 4.70 to **3 kg/cow.d**
- €10.0 to €10.3/cow.d
- ↑**€6,748/AMS.yr**

2 - Limit amount of AMS concentrate



3 - Precision feeding

AMS concentrate

- normally same density of nutrients for all animals
- ideally, it could be formulated individually

AMS concentrate

- 2 kg/cow.d PMC
- 3 kg/cow.d MPC

3 - Precision feeding

PMC IOFC

- ↑€1.30/cow.d

MPC IOFC

- ↑€1.56/cow.d

Whole farm

- ↑€192/d
- ↑€70,080/yr

Conclusions economic considerations

Reducing number of animals per AMS could **improve IOFC** if production does not decline

Precision feeding to meet cow-specific nutrient requirements may **greatly improve IOFC**

Restricting concentrate allowance to kg/cow.d **3** (PMC) and **4** (MPC) **improves IOFC** and minimizes variation nutrient intake

DairyMGT.info

Thanks

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