Nutritional Considerations in Robotic Herds

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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 opportunities

- 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
Behavioral Considerations

↑ AMS visits & ↓ variability

→

Palatable feed

Forced (guided) traffic

 AMS

Feed Bunk
Forced traffic reduces PMR intake

Forced traffic decreases milk yield
Feed allowance does not increase visits

$300 \text{ g/visit}$ attracts grazing cows

Bach et al., 2007

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

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

Prescott et al, 1998
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 $\rightarrow$ improved by AMS supplementation

Cows sort
Leonardi and Armentano, 2007

Composition changes
Kononoff and Heinrichs, 2003

Intake is variable $\rightarrow$ between cows and within cows

Balanced diet for a cow $\rightarrow$ unbalanced diet for another cow
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.
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 Catalanian 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 NEI/kg
- 22.4% CP
- €274/MT

PMR feed
- 1.62 Mcal of NEI/kg
- 15.6% CP
- €92.5/MT

Cow consumption
- DMI: NRC (2001)
- NEI & 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 NEI/cow.d

Additional PMR
• Maintaining AMS concentrate allowance equal
1 - Change number of cows per AMS

70 to 65 MPC

IOFC

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

€2,453/AMS.yr
€6.72/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
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

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

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