Nutritional Strategies to Minimize Nutrient Excretion in Dairy Cows
降低奶牛粪污中养分排泄的营养策略

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Feed is the most expensive cost on the farm 饲料是牧场最贵的成本

- Feed costs comprise ≥25% of production cost 饲料成本占生产成本的25%以上
- Makes sense to minimize waste
- 把浪费降至最低是有意义的
  - Avoid overfeeding costly nutrients 避免过量的营养
  - Minimize refused feed 剩料最小化
  - Both without compromising performance
  - 两种方式都不影响性能
    - Optimal performance 最优的性能

Grouping animals 奶牛分群

- If feeding all animals in one group, tend to feed the animal with the greatest nutrient needs
- 如果以一个群来饲喂所有的奶牛，往往会以最大的营养需求来饲喂奶牛
  - Therefore, overfeed nutrients to most of the group
  - 因此，大部分群的营养都过多
  - Costly to waste those nutrients when not needed by the animal
  - 当这些奶牛不需要这些营养时，这些营养都被浪费了

Grouping strategies 分群策略

- By parity 按胎次
  - Growth and maintenance requirements for 1st and 2nd lactation animals 头胎和二胎牛的生长和维持需求
- By production 按产量
  - Milk yield (MY) or days in milk (DIM)
  - 产奶量或泌乳天数
- For young stock, dry, and lactating animals
- 后备牛、干奶牛和泌乳牛
  - Close-up and far-off dry cows 产前和干奶前期牛
  - Bred and unbred heifers 带胎小母牛和不带胎青年母牛

Grouping 分群

- Feeding in 3 groups vs. 2 groups
- 三群饲喂vs. 两群饲喂
  - Higher income over feed costs (Williams, 2002)
  - 收入比饲料成本要高
- Feeding 3 groups vs. 1 group TMR
- 三群饲喂vs. 一群TMR日粮
  - Reduced N excretion by 15% (Castillo, 2000)
  - 氮排泄量减少15%

Why not group feed? 为什么不分组饲料

- Need ability to make groups within housing
- 需要在牛舍内分组
- More rations to formulate 更多的配方日粮
- Feed composition changes by load and throughout storage
- 装载和贮存中的饲料成分变化

Precision feeding 精确饲喂

- Diet formulation 日粮配方
  - Builds on grouping strategies 基于分群策略
  - Reducing nitrogen excretion 减少氮的排泄
  - Reducing phosphorus excretion减少磷的排泄

Reducing nitrogen excretion
降低氮的排泄

- Maximize microbial protein synthesis
- 最大化微生物蛋白合成
  - Requires soluble N and fermentable carbohydrates 需要可溶性氮和可发酵碳水化合物
- Formulate on RUP/RDP
- 瘤胃非降解蛋白/瘤胃降解蛋白的形成
- Supplement with methionine (Met) and lysine (Lys) for further reductions in excreted nitrogen
- 补充蛋氨酸和赖氨酸以进一步降低氮的排泄

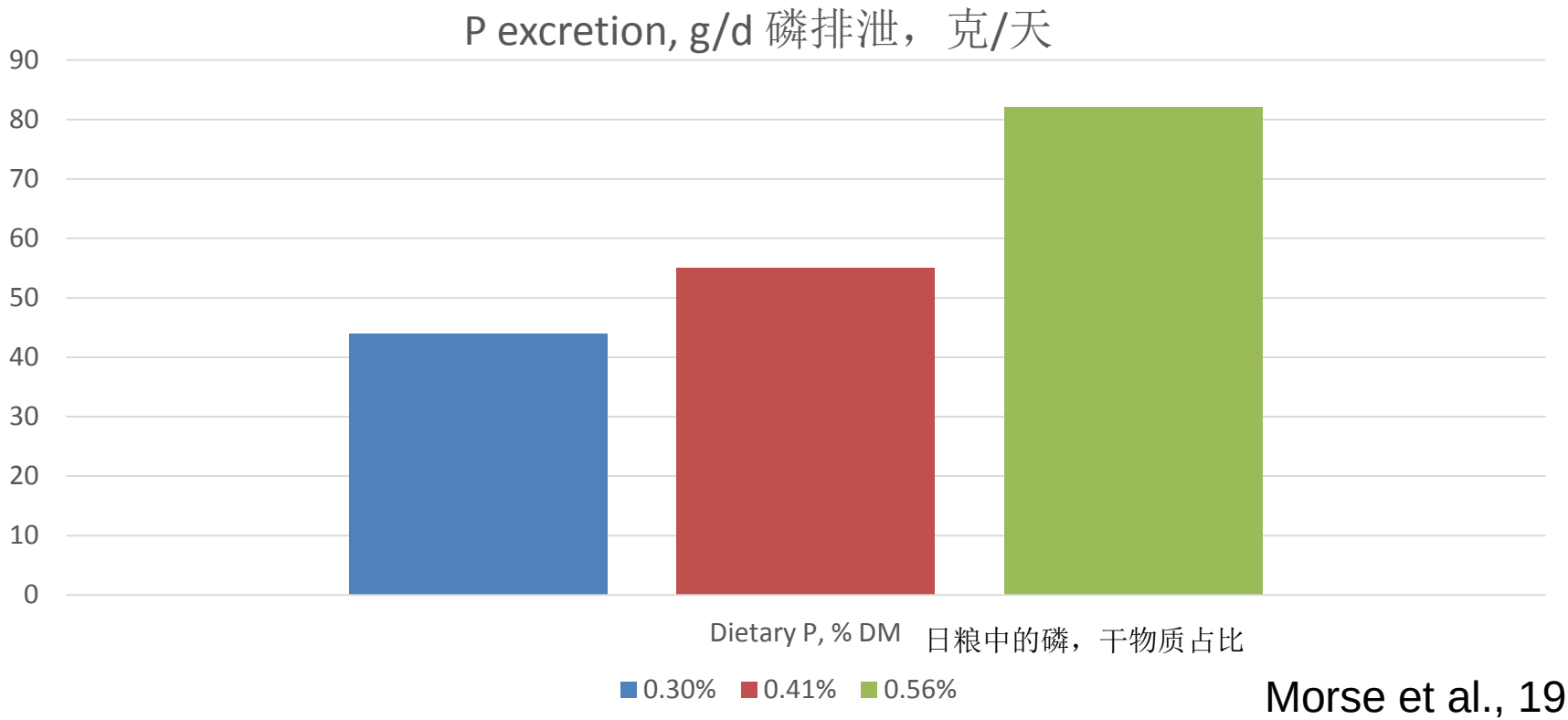
Reducing nitrogen excretion
减少氮的排泄

- Reducing diet CP from 17.8% to 17.0% reduced fecal N by 5% and urinary N by 17.3% (Harrison et al., 2002)
- 日粮中粗蛋白从17.8%降至17%时，粪氮下降5%，尿氮下降17.3%。（哈里森等，2002年）
- Wattiaux and Kang (2004) observed a 16% drop in urinary N when diet CP was reduced from 18% CP to 16.5% CP
- Wattiaux 和 Kang (2004) 研究表明当日粮中粗蛋白从18%降至16.5%时，尿氮下降16%
- No impact on MY in either study
- 两个研究表明对牛奶产量都没有影响
- IOFC increased in the Harrison study
- 在哈里森的研究中收入大于成本

Reducing phosphorus excretion
降低磷的排泄

- Phosphorus (P) believed to improve reproductive performance
- 磷被认为可提高繁殖性能
- One of most expensive nutrients in the diet
- 是日粮中最贵的营养成分之一
- Cows overfed P used P less efficiently because excess P is not converted to milk or stored in bones or tissue
- 奶牛吃过多的磷或磷的使用效率较低，那是因为过量的磷没有转换为牛奶或储存在骨骼或组织
- Grouping strategies, alone, can reduce P excretion by 9%
- 分群策略可以使磷的排泄降低9%

What happens when you overfeed P to cows?当你给奶牛饲喂过多磷时会发生什么？



Morse et al., 1992

日粮中磷含量 Dietary P content				
	.40	.45	.50	.55
Acres required for land application[1]				
100 cows	91	108	126	143
Maximum cow numbers[2]				
100 acres, 50% corn, 50% alfalfa	93	78	68	60
100 acres, 50% corn, 25% alfalfa, 25% grass hay	86	73	63	56

[1]Assumes cropping program of 50% corn, 50% alfalfa. DMI predicted from NRC, 2001, and crop nutrient values as in Van Horn (1992).
[2]Milk yield of 60 lb/d.

Acreage needed for crop removal of P increases almost 60% when diet P content increases from 0.40% to 0.55%.
当日粮中磷的含量从0.40%上升至0.55%时，每英亩作物需移走的磷增长近60%

P needs in the dairy cow diet
奶牛日粮中磷的需求

- NRC does not recommend P as a percent of the diet dry matter
- NRC没有关于磷占日粮干物质比例的建议值
- But, roughly speaking, 0.4 is adequate
- 但是，大体来说，在日粮干物质占比0.40－0.41% 是足够的

Precision feeding 精确饲喂

- 3 diets 3种日粮
  - What is formulated by the nutritionist
  - 营养师配制的日粮？
  - What is mixed on the farm 牧场自身混合的日粮？
  - What is consumed by the animal 奶牛采食的日粮？

What is formulated by the nutritionist
营养师配制的日粮

- Of the 3 diets, this is likely most reflective of nutrient needs
- 在这三种日粮中，营养师配制的日粮最能反应营养需求
- Safety margins added in for some nutrients?
- 某些增加的营养成分是否在安全边际量范围？
- Does the ingredient list match what is available on-farm?
- 配方上的原料表是否与牧场现有的原料匹配？

What is mixed on the farm
牧场混合的日粮

- Do on-farm ingredient compositions match values used in formulation?
- 确保牧场的原料组成与配方上使用的值一致
- Feed composition varies by load and throughout storage 在装载和贮存过程中，饲料成分变化
- Errors associated with mixing 日粮混合过程中的错误
  - Scale errors 称重的错误
  - Personnel errors 人为的错误

What is consumed by the animal
什么是奶牛采食的日粮？

- Sorting of ingredients 挑食原料
  - Overcome through proper particle size and mixing
  - 通过合适的颗粒和混合来解决
- Feed refusal 剩料
  - Feed often 饲喂过多
  - Keep feed within reach 保持饲料触手可及
  - Track feed refusal to minimize overfeeding
  - 监测剩料，以将过量降至最低

Impact of 3 diets on nutrient management 三种日粮对养分管理的影响

- The combination of above factors can lead to as much as 30% extra nitrogen and phosphorus in the manure
- 上述所有的因素可导致粪污中多出30%的氮和磷
  - Could also be a shortage of nutrients
  - 也可能是营养不足的
  - May not see the effect until manure sampling
  - 在粪污采样前不会看到效果

Precision feeding
精确饲喂

- Ingredient sampling
- 原料采样
  - Necessary for formulation 需要配方
- TMR sampling TMR 取样
- Particle sizing efficiency assessment 效率评估

Forage nutrient content changes over time
随着时间的推移，粗饲料养分含量的变化

- Forage P content varies 粗饲料中磷含量的变化
  - 20-25% over 1 year (NE DHIA laboratory); field effect
  - 1年后，20-25%；田间效应
  - More variable in grasses than in legumes
  - 草比豆科植物变化更大
  - Thus, need to sample at least by field or load
  - 因此，至少需要在田间或装载时采样
- Mechanical losses during forage harvest (leaf shatter) influence energy and nitrogen content
- 收获牧草期间，机械损失（叶片粉碎）影响能量和氮的含量
- Excess moisture at baling leads to heating and decreased nutrient digestibility 打捆时，过多的水分导致过热并且降低养分的消化率

Other changes to forage content
粗饲料的其他变化

- Weather 天气
  - Rain on growing forages can lead to leaching of nutrients; more important in early stages of growth
  - 牧草生长时的降雨可导致养分流失；生长的早期阶段更重要
  - Poor drying conditions leads to lower quality forages due to length of drying time 由于干燥时间，干燥条件差可导致粗饲料质量低。
- Composition changes during ensiling
- 青贮过程中的成分变化
  - Particularly if ensiled wet or poorly 特别是如果青贮时太湿或质量较差
- You can’ t sample too much! 你不能取太多样本！

Sampling concentrates 精料取样

- Assume each load coming onto the farm is from a single source 假设到牧场的每车精料都来自于一个单一的来源
  - Sample each load
  - 每个都取样

Feed waste 饲料的浪费

- Fresh feed 新鲜的饲料
- Accessible 容易获取
- Recycle to replacements
- 饲喂给后备牛

Keep feed fresh 保持饲料的新鲜

- Ingredients and mixed rations 原料和混合日粮
- Feeding frequency is important 饲喂频率是重要的
- Mold growth inhibits dry matter intake, increasing refusals 霉菌的生长抑制干物质采食量，会增加剩料

Face management 青贮窖横截面管理

- Good silage management is key to minimizing nutrients managed as waste 良好的青贮管理是将养分浪费降至最低的关键

Keep feed accessible 保证饲料容易获得

- If they can’ t reach it, they can’ t eat it 如果她们够不着，他们就不会吃
  - Feed more frequently 更频繁的饲喂
  - Push up feed between feedings
  - 在饲喂之间推料

Recycling feed to replacements
剩料饲喂后备牛

- Reduces feed waste and excess nutrients to manage 减少饲料浪费及营养过量管理
  - If you know what it contains and that it fits in the formulation for replacement heifers 如果你知道它包括什么，以及它适合后备牛的日粮配方
  - If it is actually consumed and refusal isn’t just delayed another day 如果它是实际消耗并按并且剩料不只是延迟了一天
- Still best to avoid excess from the milking herd
- 仍然是最好的方式避免泌乳牛群营养过量的方式

Feeding DDGs 饲喂DDGs

- DDGs included at DDGs包括
  - >20% for lactating animals
  - 泌乳牛日粮中 大于20%
  - 15% for replacement heifers 后备牛日粮中15%
- Good source of RUP and energy是过瘤胃蛋白和能量的良好来源
- Watch the diet P content 监控日粮中磷的含量
  - Less likely to contribute to excess P when fed to lactating animals compared to other dairy or other species 与其他的品种相比，饲喂泌乳牛DDGS时，不太可能出现过量的磷。
    - P exported in milk 磷转化为牛奶

Conclusions 结论

- Feeding to minimize nutrient excretion makes economic sense
- 最小化养分的排泄，具有经济意义
  - N and P are expensive in the diet 氮和磷在日粮中是昂贵的
  - Spoiled or refused feed adds feed cost
  - 变质的饲料或剩料增加了饲料成本
  - Wasted nutrients and feed mass add to what has to be managed as part of a nutrient management plan
  - 浪费的营养和饲料必须成为养分管理计划的一部分
- Feed management plan - encompasses housing strategy, ration formulation, herd management, feed handling 饲料管理计划包括牛舍策略、日粮配方、牛群管理和饲料处理