You can’t have it all – unless you feed appropriately

Ibrahim Akinci*, Olivier Hanotte*,† and Nick Sparks‡

University of Nottingham*, ILRI†, SRUC‡
Background

• Highly productive birds perform well if fed and protected, but underperform in semi-scavenging systems – this matters

• Evidence that indigenous birds are more resistant/resilient to endemic disease (and less prone to predation)

• Mechanism?
  a more appropriate immune responses; adequate nutrition for an equally efficacious immune response or a combination of the two – if the last, where does the balance sit?

• Lots of anecdotal health information, far less biologically or system relevant information – new tools will help address this
Why may nutrients be limited?

• Sources of feed to be scavenged will change with season
• Quantitative and qualitative restrictions
• Larger poultry less effective scavengers
• Supplementary feeding may be fixed
• Birds that produce more require more feed - ‘mature’ broiler, layer, dual purpose, indigenous bird eat 220g, 110g, 210g, <100g respectively
• Is it easier for indigenous birds to meet their nutrient requirement in the field and/or are nutrients partitioned more equally?

What evidence is there for nutrients being partitioned
• Ruminant and monogastric mammals - disease challenge in pregnancy
• In poultry cage layer fatigue
• Many breeding and research programmes use *ad libitum* feeding programmes
  • Fast growing broilers and high producing layers, in the absence of antibiotics, achieve <5% livability across the World.
  • Has selection for productivity driven partition in favour of productivity at expense of health when *nutrients are limiting*?

![Graph showing nematode egg excretion](image)

*Fig. 4. Daily nematode egg excretion (eggs/d with 95% CI) of twin-rearing Blackface (BF) and Mule (MU) ewes, trickle infected with *Teladorsagia circumcincta* and fed at either 0:8 (low protein, LP) or 1:3 (high protein, HP) times their assumed metabolisable protein requirement during late pregnancy and lactation. --O-- LP-MU; --O-- HP-MU; --O-- LP-BF; --O-- HP-BF.*

Kidane et al. (2010)
Hypotheses

when nutrients are limited immune response will be restricted in animals selected for productivity and the greater the selection pressure for ‘product’ the greater the compromise
Approach

- Proof-of principal studies in UK and Ethiopia
- Birds subject to varying degrees of partition pressure (i.e., nutrients to product)
  - Most extreme – broiler and sexual mature laying hen
  - Least extreme – sexual immature laying hen (proxy for indigenous bird)
  - Intermediate – dual-purpose bird
- Feed constraint
  - Quantitative reduction of 10% of breed recommendation
    How best to replicate scavenging environment reproducibly in pen study? Quantitative, qualitative, mix of the two?
• Sub-clinical Disease challenge
  • *Eimeria tenella* – lesions scored 0 – 4 (no, mild, moderate, severe, v severe)
  • Relevant and reproducible (experimental and welfare)
  • Gavaged at 21 days of age
• Replicated pen studies - typically 96 birds/type and four birds/pen and 6 replicates
Initial findings

_Eimeria_ lesion score at day 29, 8 days PI

- Broiler 1
  - Ad libitum
  - Restricted
  - *P* < 0.05

- Broiler 2
  - Ad libitum
  - Restricted
  - *P* < 0.05

- Dual-purpose
  - Ad libitum
  - Restricted
  - *P* > 0.05
Interleukin 10 (anti-inflammatory cytokine) (pg/ml)

Feed type
- adlib: 313 pg/ml
- restricted: 293 pg/ml

E. tenella challenge
- no: 173 pg/ml
- yes: 433 pg/ml

P = 0.818
P = 0.01
Body weight (kg) at day 29, 8 days PI

Broiler 1

Broiler 2

Dual-purpose

- **Broiler 1**: No-challenge, $P < 0.001$; Challenge, $P > 0.05$
- **Broiler 2**: No-challenge, $P > 0.05$; Challenge, $P < 0.001$
- **Dual-purpose**: No-challenge, $P < 0.01$; Challenge, $P < 0.01$
Conclusions

Challenge models

• Quantitative feed achieved modest weight loss and no treatment mortality – acceptable proxy for semi-scavenging systems

• Gavaging Eimeria oocyst achieved reproducible sub-clinical infection and no treatment mortality – acceptable model for enteric disease but consider using *E. acervulina*

Outcomes - sub-optimal nutrition

• Significantly increased likelihood of enteric damage from *Eimeria* in broilers

• Numerical increased enteric damage in dual-purpose birds

• Reduced body weight gain (and, from other studies, egg mass)
Outcomes – immune response

- Clear IL 10 response in challenged vs unchallenged birds, overlaying nutritional treatments gave inconclusive results – indicative of other mechanisms or confounders?

Initial findings support the hypotheses – nutrient scarcity and selection for growth were associated with poorer health outcomes.

Mechanisms to be elucidated but consistent with studies in other species.

This pilot study established procedures and baselines – extending now to pullets, adult dual purpose and indigenous birds – those most relevant to semi-scavenging systems.

**Most breeding programmes assume optimum nutrition to drive productivity**

Suboptimal nutrition does not only mean slower growth rates or less egg mass – there may be a health trade-off
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