

A System-Level Approach to Maximizing Broiler Response through Feed Form

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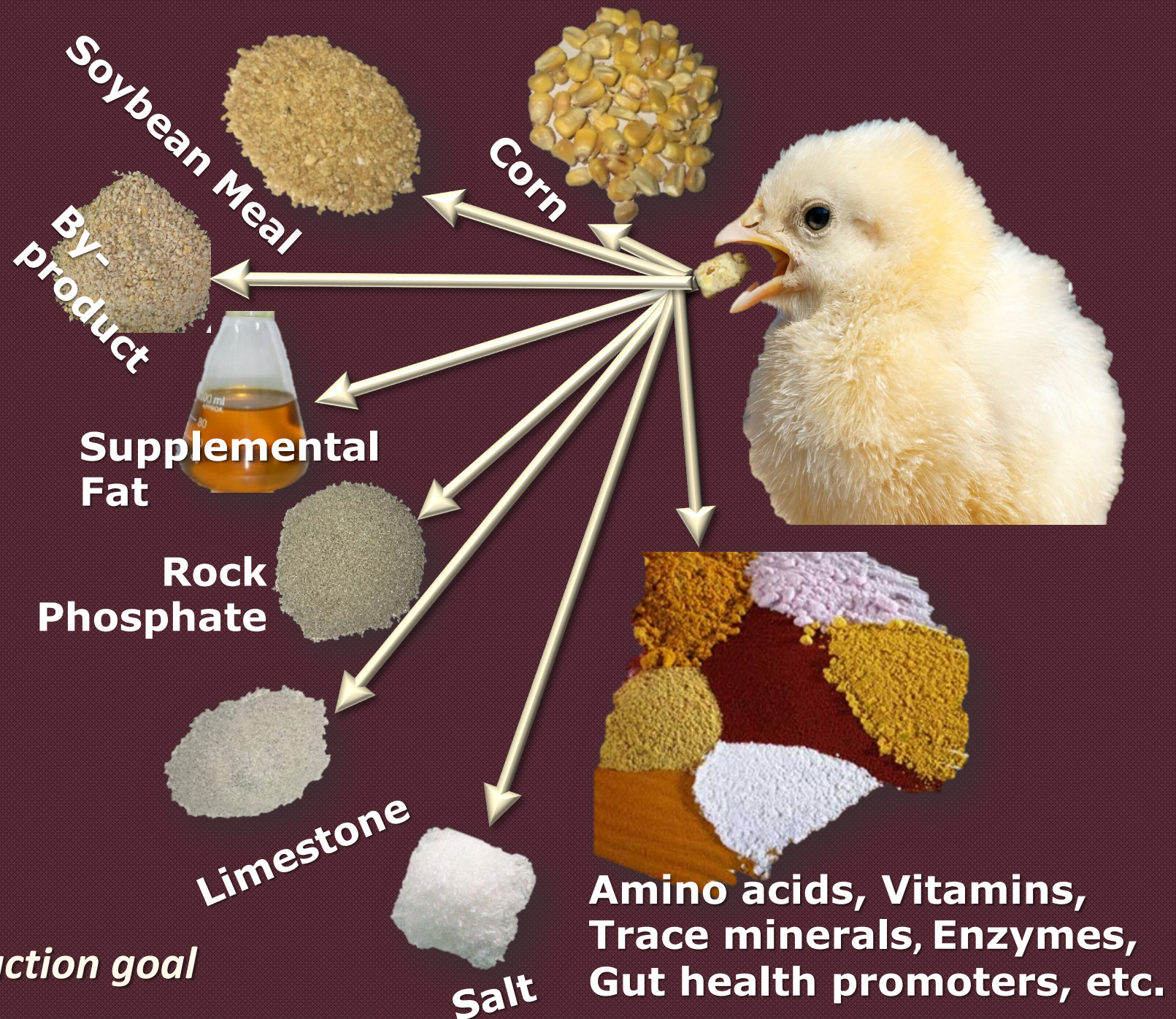
Maximizing Growth Potential



The Goal...

To supply the bird
with a complete,
nutritionally
balanced serving
with each peck

**Regardless of age, strain, production goal*

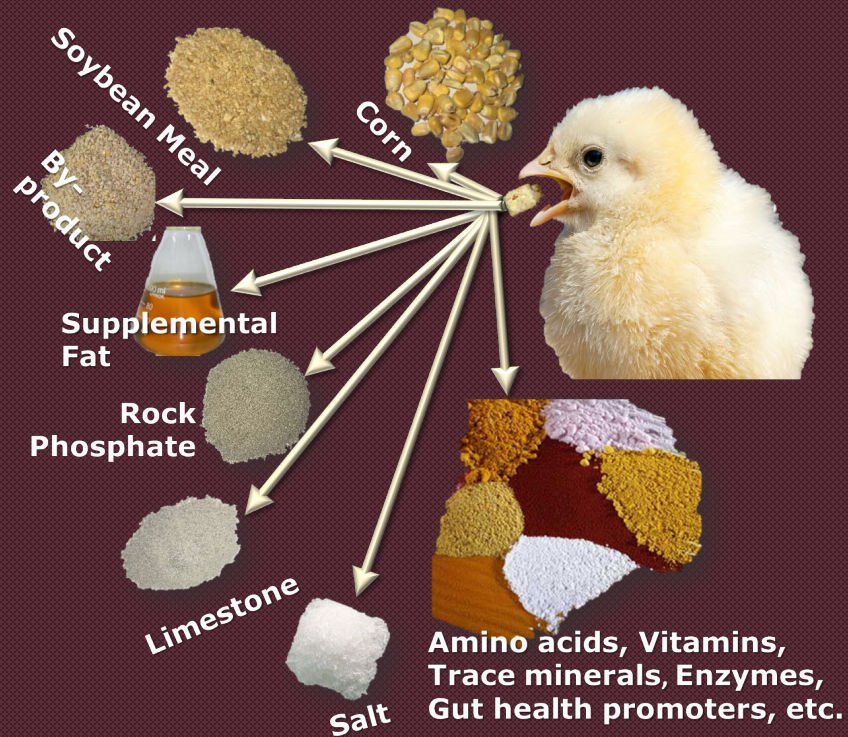


Phase-Specific Feed Optimization



Goal vs. Reality

Formulate for nutrients



Birds eat what structure allow them to consume





Feed is more than just nutrients



Microstructure defined as “particle size within the pellet” (or feed form)⁴

- **Corn main energy source in US poultry diets**
→ **Gring size can impact digestibility, gut health, feed manufacture variables¹⁻⁴**
 - **Absorption of nutrients**
 - **Feed quality**



Macrostructure → “diameter and length of the pellet”¹ (feed form)

- **Benefits w/ improved feed form^{1-5,7,8}**
- **Majority research focus on single phase**
 - **Quality presented in each dietary phase may influence overall broiler performance – independently and interactively⁵**

Benefits of Feeding Pelleted Diets

Decrease:

- Prehension time and energy^{2,3}
- Feed wastage^{2,3}
- Ingredient segregation^{2,3}
- Pathogens^{2,3}

Increase:

- Feed intake⁵⁻⁷
- Live weight gain^{1,4-7}
- Carcass weight^{1,4-7}
- Economic return^{1,4-7}



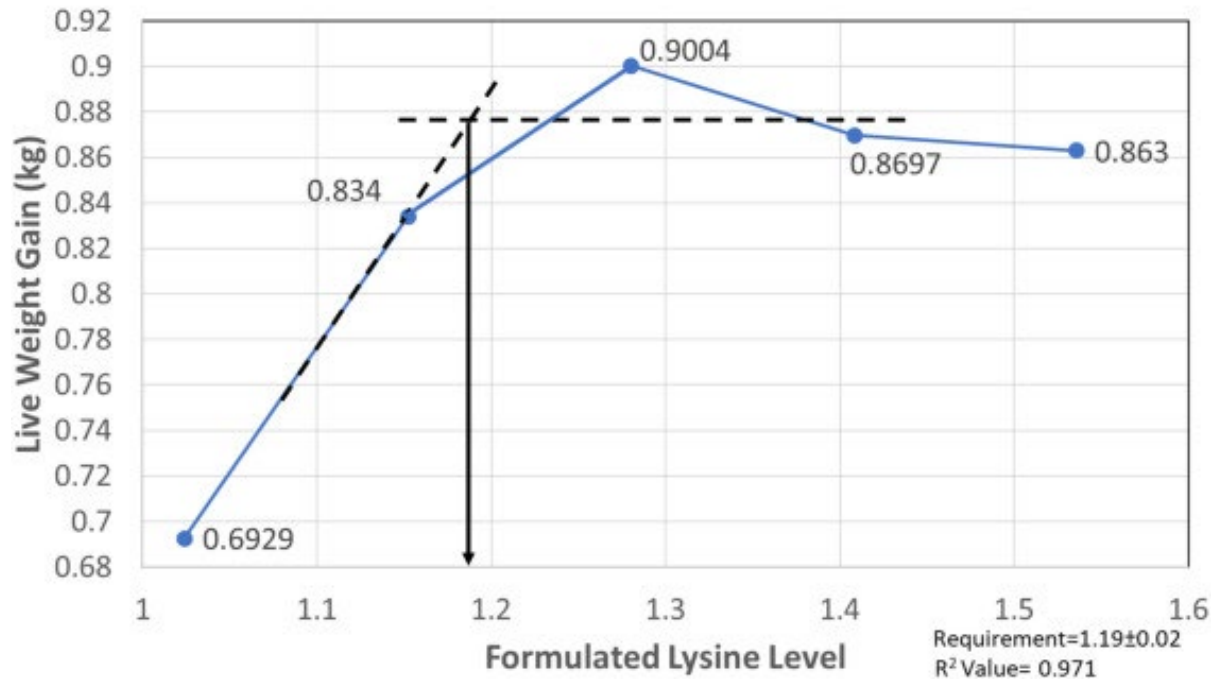
Context Matters – Feed Mill Decisions are Nutrition Decisions

Maximizing physical feed quality through feed manufacturing techniques can negatively impact the nutritional quality of diet

- **Lynch et al., 2023**
- **Loar et al., 2014**
- **Corey et al., 2014**
- **Wamsley et al., 2013**
- **Beaman et al., 2012**
- **Loop et al., 2012**
- **Gehring et al., 2011**

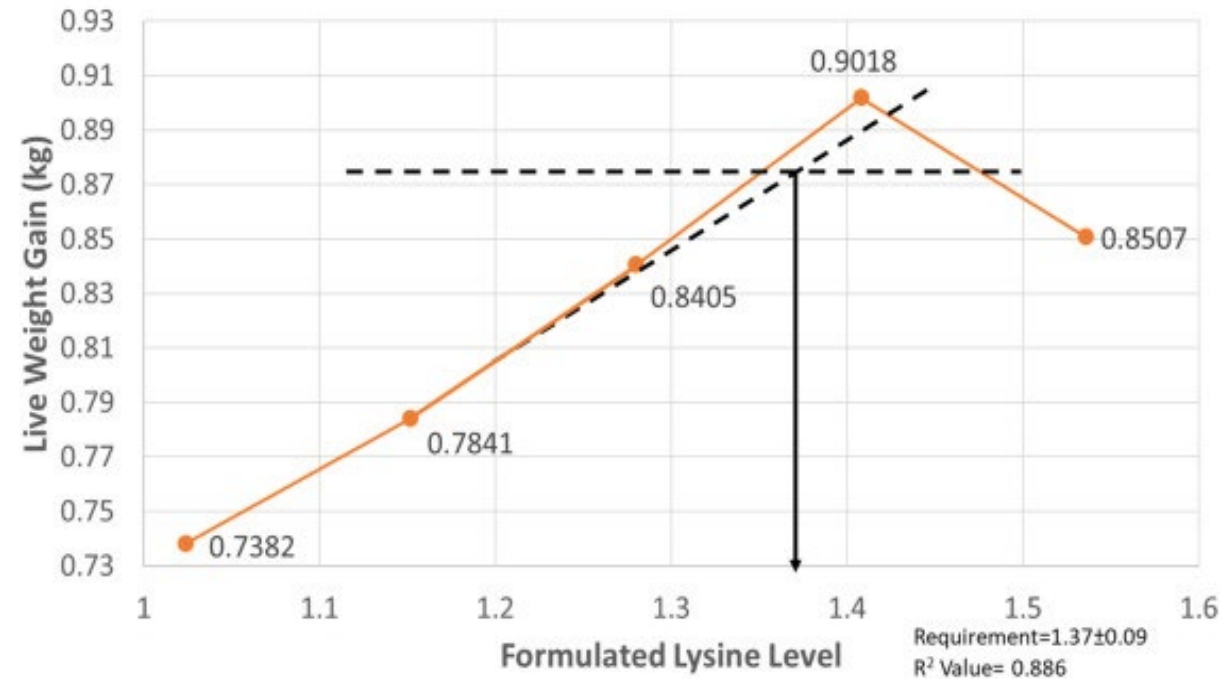
Context Matters

d0-21 Live Weight Gain (Standard Pelleting)



Standard Pelleting Lys Req - 1.19%

d0-21 Live Weight Gain (Hygienic Pelleting)



Hygienic Pelleting Lys Req - 1.37%

Potential Influence of Feed Structure & Performance



Feed structure driving performance

intake/intake behavior

nutrient access

GIT development/function

ingredient distribution/selection

Modest improvements in structure ➔ *Measurable economic return*

40 vs 70% Pellets

- Lemons and Moritz, 2016
 - Hubbard x Cobb 500 from 23-38 d
 - 70% pellet → 2 pt ↓ FCR; 100 g ↑ BW

50 vs 70% Pellets

- Glover et al., 2016
 - Hubbard x Cobb 500 from 22-38 d
 - 70% pellet → 6 pt ↓ FCR

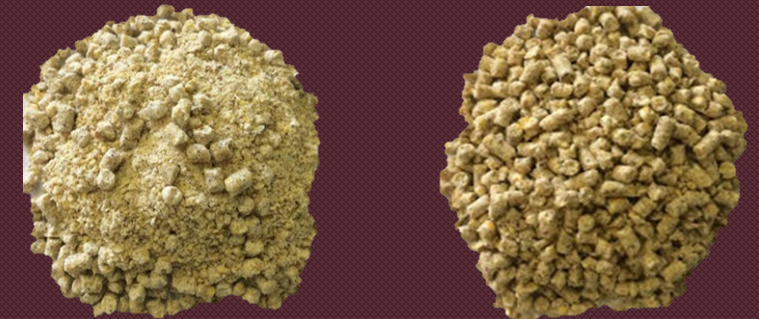
50 vs 80% Pellets

- Sellers et al., 2017
 - Fast Growing and High Yielding males from 28-42 d
 - 80% pellet → 8 pt ↓ FCR; 0.82 g ↑ BW

80% maximized breast yield for both strains, though an <80% pellets –consideration

55 vs 75% Pellets

- Sellers et al., 2020
 - Ross 708 males from 28-42 d
 - 75% pellet → 3 pt ↓ FCR; 9 g ↑ BW



Phase-Specific Feed Optimization



Interactive Effects of Feed Form and Phase of Feeding on Performance

Overall Conclusions

Starter Phase

- Crumbles (0-14) → ↓ FCR by 2 pts; ↑ BW by 9 g

Grower Phase

- 80% pellets (14-28 d) → ↑ BW by 25 g

Starter and finisher FF
interactively affected overall
bird performance

Starter (0-14 d) x Finisher (28-46 d) FF

- Ground crumbles and 80% pellets or crumbles and 50% pellets

Maximize Growth Potential from the Start

Shorter grow-outs =
added pressure to
this phase



Previous Wamsley Lab Starter Feed Form Research



1174 μm
4:4:74:17



1423 μm
12:14:61:13



1883 μm
15:18:64:3



2049 μm
23:17:58:2



2257 μm
32:19:46:3



2800 μm
42:34:24:0



3456 μm
61:31:8:0



3736 μm
72:23:5:0

**U.S. dime
for size
reference

Previous Wamsley Lab Starter Feed Form Research

- d 0-14 performance maximized by feeding an average feed particle size of $\geq 2,800 \mu\text{m}$



2800 μm
42:34:24:0

- Largest feed size (3,736 μm) had no negative effect on performance



3736 μm
72:23:5:0

- Increased APS improved 0-14 d BW, BWG, and FCR
- No negative effects feeding higher APS

Follow up Study – Starter Phase Study



2210 μm

Low



3010 μm

Medium



3388 μm

High

Crumbles



1703 μm



2112 μm



3411 μm

Pellets

Feed Structure & Distribution

Average feed particle size is similar



2210 μm



2112 μm

BUT...distribution of particle sizes varies greatly

Follow up Study - Feed Consumed & Performance

- d 0-6 feed consumed: 1600 – 2800 μm

5:10:79:6 - 42:34:24:0

- d 0-18 feed consumed: 1700 – 3200 μm

8:18:69:5 - 61:23:16:0



3200 μm
61:23:16:0

- Relationships towards increased feed particle size consumed and improved crop fill, BW, FCR, and BWG during the starter phase
- No significant differences in carryover performance → contrary to other Wamsley lab research

Starter Phase Research Follow Up – Practical Application

Starter Phase Goal: Maximize Feed Intake (FI)

- Common industry practice to reach target FI/bird
- Optimizing FI = cost savings



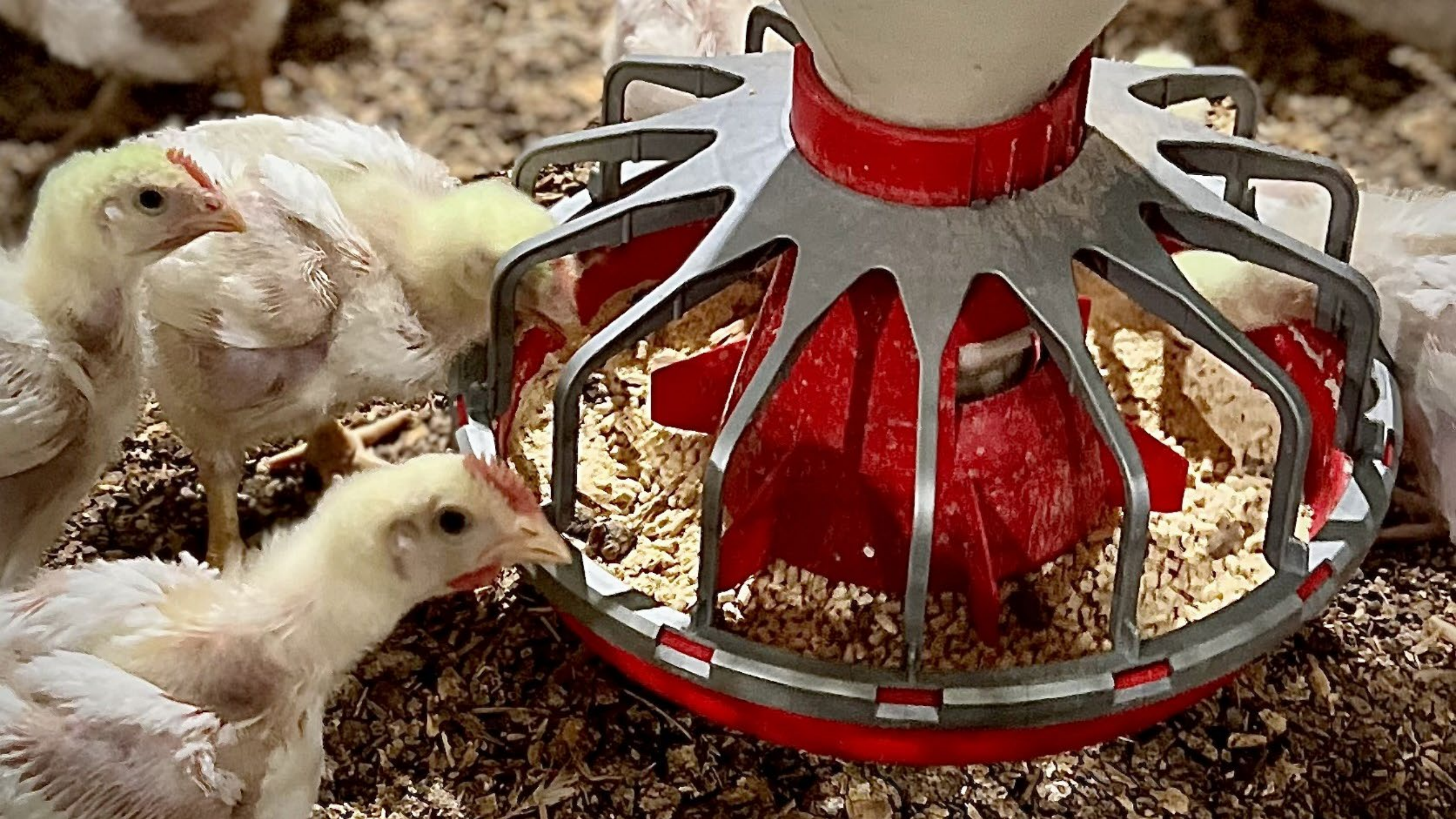
Prediction modeling methods

- **Current - Linear, Quadratic, Cubic¹ may not perform well with**
 - Unknown data distributions
 - Highly variable → differences in feed form, quality, or bird-to-bird variation
 - Risk of overfitting or underfitting → reducing predictive accuracy
- **Newer – non parametric alternative models^{1,2} - Smoothing spline; Kernel smoother**
 - Potential improved accuracy/robustness w/ variable conditions

Metric	Cubic Prediction (20 d)	Smoothing Spline Prediction (14 d)	Validation (16 d)
FI per bird (g)	1,010	515	650
Total Feed Required (tons)	1,010	515	650
Feed Cost (\$/tons)	\$335.00	\$335.00	\$335.00
Total Cost (\$)	\$338,350.00	\$172,525.00	\$217,750.00
Cubic VS. Spline	\$165,825.00		
Cubic VS. Validation	\$120,600.00		

Starter Phase Research Follow Up – Practical Application

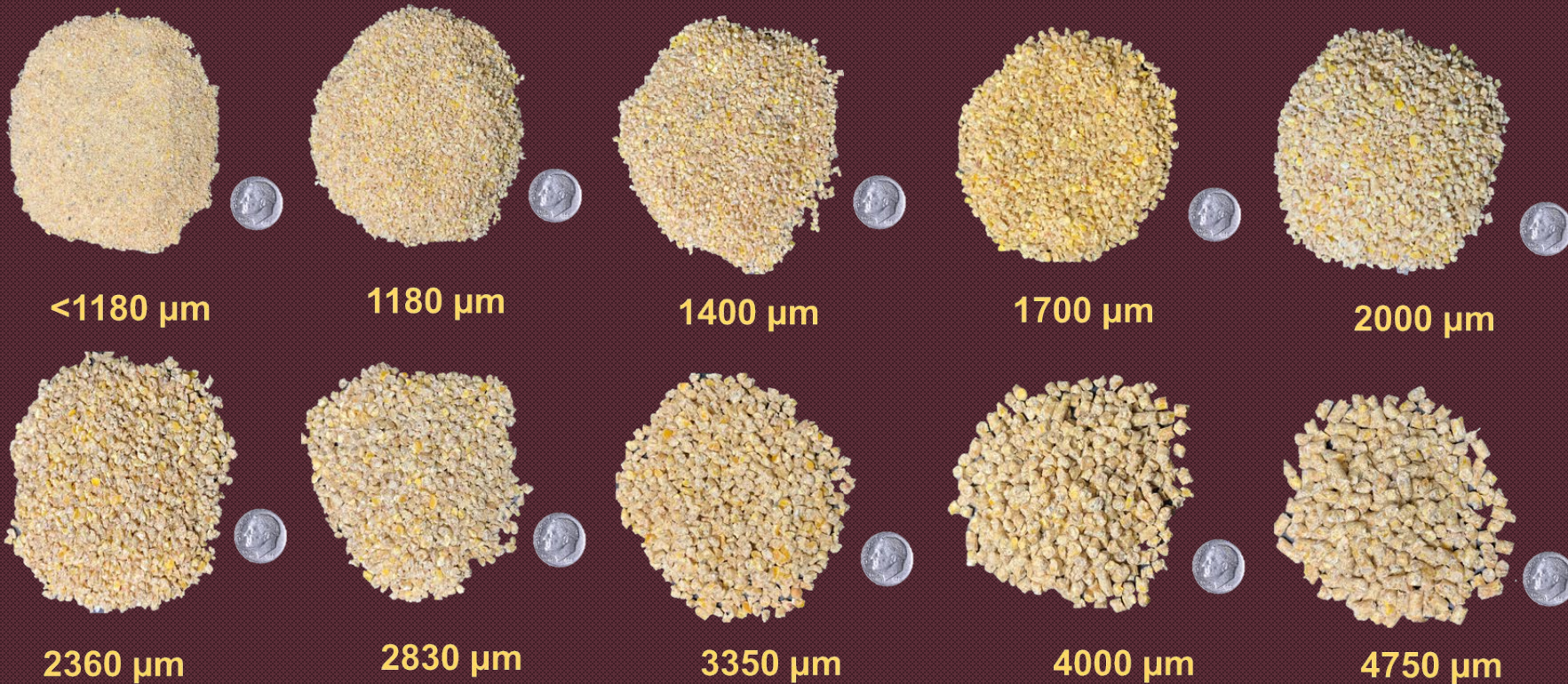
- **Dataset used from Lemons et al., 2021**
 - Prediction data → d0-14 (predicting outside the given range of data)
 - Validation data → d0-18 (full dataset utilized)
- **Implications**
 - **Utilize Caution:**
 - Predicting outside the dataset range → requires caution
 - More accurate predictions → decision-making in poultry industry applications
 - **Interactive effects on performance:**
 - By adjusting feed strategies (particle size and distribution), producers can accelerate target feed intake, improve growth outcomes, and lower production costs



Starter Feeding Strategy and Bird Beak Study

2 Feeding Strategies:

1. Choice of particle sizes (Feed retained from 1 of 10 different sieves)
2. No Choice (Common crumble) ~1200 μm
 - Based on survey feed mill managers southeastern US (1200 -1400 μm)



~No Choice Distribution %	
	1200 μm
>3mm	4
2-3 mm	4
1-2 mm	74
<1 mm	18

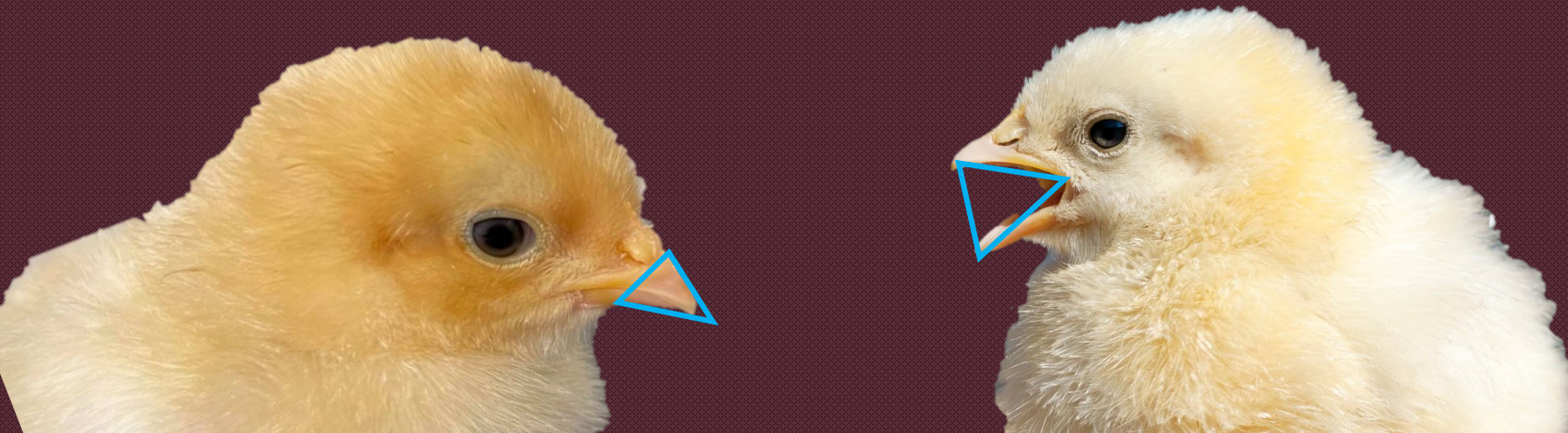


Starter Feeding Strategy and Bird Beak Study

Offspring from 2 Breeder Flock Ages to force two chick sizes:

1. Pullet (27±1 wk)
2. Late (51±1 wk)

- **Beak capacity measured every 2 d, from 0-14 d**
 - **Beak size only influenced by BFA (chick size; $P < 0.0001$)**
 - **No indication to limit feed particle size consumed**



Determination of Optimal Starter Feed Particle Size for Broilers

Data supports feeding increased feed particle size in starter	Smallest		Largest		
	Tested ¹	Consumed ^{3,4}	Tested ¹	Consumed	
				0-6 d ³	0-18 d ³
				0-14 d ⁴	
Particle Size of Feed (Dgw, microns)	1200	1600	3736	2800	3200
>3 mm (%)	4	5	72	42	61
2-3 mm (%)	4	10	23	34	23
1-2 mm (%)	74	79	5	24	16
<1 mm (%)	17	6	0	0	0

5 studies → fast growing and high yielding¹, commercial feed¹⁻⁴

- Increased particle size → improved crop fill, body wt & gain, FCR
- Carryover performance (up to 62 days) – no difference or improved

Feed preference w/ beak measurements

- Beak size → no influence on feed particle size consumed
- Chicks preferred larger feed particles

Industry Reference	
>3 mm	<20
1-3 mm	70%
<1 mm	<10%

¹Lemons et al., 2019; ²Lemons et al., 2021; ³Brown, et al., 2023; ⁴Alvarenga et al., 2023

Take Home Message

- **Modern broilers respond to improved feed form (macrostructure)**
 - **Improved intake and performance** *as long as nutrition isn't compromised*

- **Bird beak capacity & feed intake**
 - **Smaller particles likely more limiting**
 - **Defining distribution**

Opportunities to maximize nutrition through optimized feed structure



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Thank you!



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