

# Broiler-Breeder Ration Formulation Strategies to Improve Offspring Performance

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**World's Poultry Science Association – Bangladesh Branch 11th International Poultry Seminar 2019**  
**Le Meridian Hotel, Airport Road, Dhaka**

**5 - 6 March 2019**

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**Sr. Nutritionist, Cobb-Vantress, Inc., USA**



# Scope of this Presentation

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- The focus of this presentation will be on the nutritional aspects of parents that affects their offspring positively
- This presentation does not discuss the transfer of antibodies to the progeny or the immunological benefits
- Another subject not covered in this presentation is how nutritional deficiencies in maternal feed can hurt their offspring.



## Reason to Invest in Parents to Influence Offspring: Cost Effective

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A reasonable investment in broiler-breeder hen feeds to improve offspring performance makes economic sense in a vertically integrated broiler production system because the impact of the increased hen feed cost on the end product (per kg of live progeny broiler or processed meat) cost is minimal.

Maternal feed interventions are shown to influence progeny in

- transfer of antibodies,
- embryo livability,
- embryo skeletal development,
- immunocompetence,
- broiler live production performance (livability, FCR),
- carcass meat yield and meat quality



**It may make sense to invest in parent feed even in a non-integrated system if a higher value for their hatching egg can be proven**

## Reason to invest in Parents to influence offspring: cost effective

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➤ A \$5 (US) (417.5 BD Taka, BDT) investment in a metric ton (MT) of parent breeder hen feed would increase live broiler meat price associated with feed by \$0.0004/kg (approx. 0.0317 BDT)

➤ However, a US \$5 investment in their progeny broiler feed would increase feed cost associated with a Kg of live broiler by \$0.008 (approx. BDT 0.6683), which is a 21 times higher investment, a much larger hurdle to offset in the market place.

### Assumption:

- 160 hatching eggs/hen housed (HE/HH),
- 133 chicks/HH, and
- 121 G feed/HE
- Offspring (broilers): Marketed at 2 kg.



# Challenge is to Identify Proper Nutrient Candidates for the Parent Feeds and to Work Across Different Departments

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There are several challenges in achieving a successful return on breeder hen feed investment.

- **Time:** It takes carefully, planned, expensive, and sometimes long-term (6 months to a year) controlled studies (if you consider data collection in parent hens and their offspring) to evaluate products that work.
- **Team Work:** These studies must be collaborated across several teams (departments) such as the HE production team, the hatchery team, the broiler production team and finally a trained meat processing team. Multi-group collaborations that are spread over a relatively long period of time is prone to errors in any of the steps of the process flow during the study and may bring up experimental design flaws.
- **Positive Skepticism:** From a nutritionist's point of view, positive skepticism and persistency are necessary to gradually build additive and synergistic nutrients / feed additive combination for the parent hen feeds to improve progeny performance.



# The Reason for Maternal Nutrition Affect on Offspring is Complex: Direct Effect of Nutrition, Feeding Plan & Role of Epigenetics

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## Epigenetics

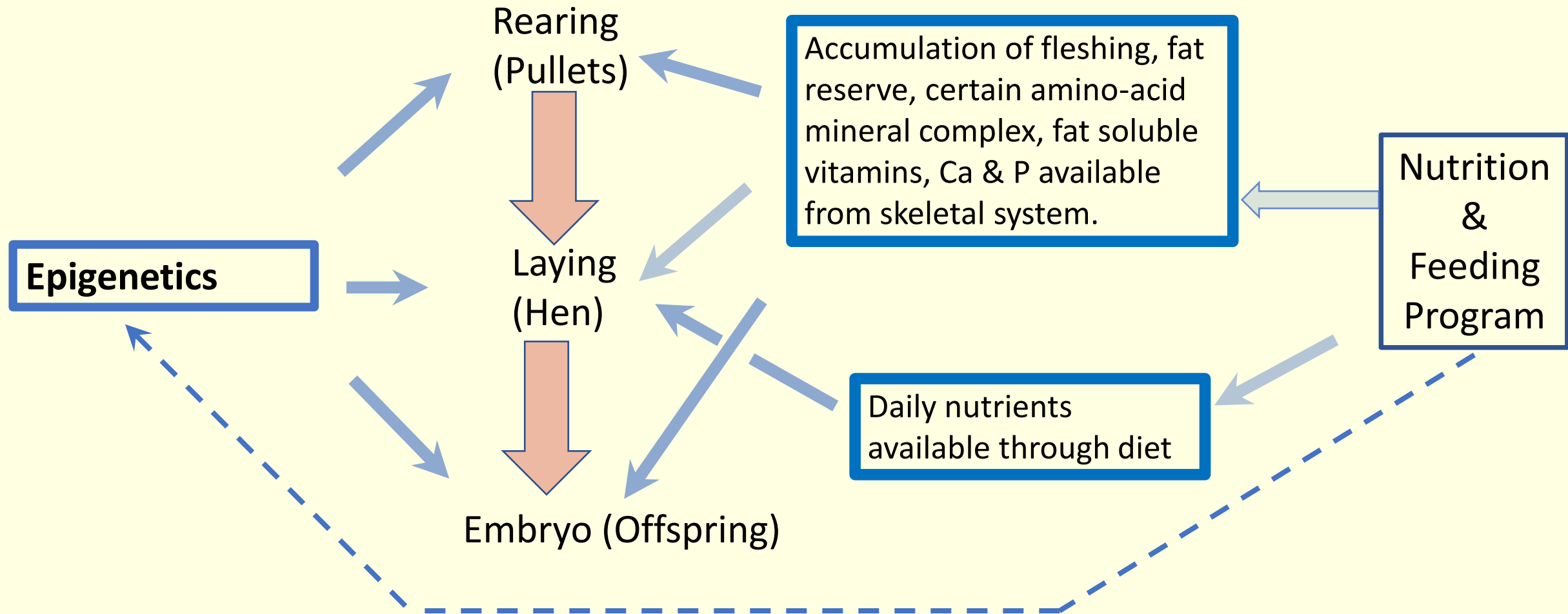
“Known or suspected epigenetic agents include heavy metals, pesticides, diesel exhaust, tobacco smoke, polycyclic aromatic hydrocarbons, hormones, radioactivity, viruses, bacteria, and **basic nutrients**.”

These environmental and random effects influence the genetic code defined by the genotype; not by altering the gene sequence, but by modifying nucleotide characteristics within a gene sequence (the Epigenotype) to produce various phenotypes. In other words, an epigenetic gene sequence is as a font of text: the letters are the same, but they may be interpreted differently”

Peter Ferket, 2012



# The Reasons for Maternal Nutrition Affect on Offspring are Complex



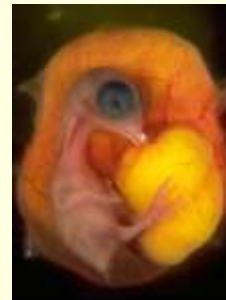
- **Epigenetics or nutrient availability at time of egg formation?**
- **More research needed.**
- **Difficult to determine how much of results are due to nutrition vs epigenetics.**

## Formulation / Investment Strategy: First, try to Recover Investment in the Parent Hens

Keep the Parents Healthy so That You Have Healthy Embryos and Healthy broiler chicks

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- Helping offspring through parent nutrition is a long-term continuous project
- Initially, focus on the nutrients / additives which help parents & provide ROI in the hatching egg production itself (improvement in life of flock mortality more hatching eggs, improved fertility, more chicks per hen)
- Later, or along the way, begin testing / using nutrients or products that may exclusively benefit offspring (during incubation, during chick transportation to the farm and offspring in the field)





# Feed Formulation Point of View: How to Prioritize Investment?

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(Options are listed below and will be discussed in the “Summary” slide at end)

- Protein (Ideal Amino Acid Ratio), Energy, Energy to Protein Ratio (in pullets & Hens)
- Attention of digestible Lysine and Isoleucine
- Antioxidants (synthetic & natural = Vitamin E & Se)
- Vitamin D3 and 25-OH-D3 (HyD, Bio-D)
- Zn, Mn, Cu
- Male BW and male feed allocation considerations



# Maternal feed formulation considerations for Dietary Protein & Amino Acids; Energy Protein Ratio



## Pullet & Hen Feeds: Optimum Dietary Protein / Ideal Proportion of AA

(This Author's summary is based on several articles and field experience)

- Optimum Protein for Pullets & Hens: 14 to 15.5% Range
  - 16% and higher seem to have a negative effect on fertility & hatchability
  - 14 to 15% protein diets during rearing and laying periods seem to help male broiler BW gain and BMY
- Optimum Digestive Lysine during rearing (6 to 21 WOA) = 0.6 to 0.63%
- Optimum Digestible Lysine = 0.6 to 0.62% in Hen diets
- Low or Medium Calorie in pullets: (2,640 to 2,820 Kcal/Kg)
- Higher Calorie in Hens: 2,850 to 2,915 Kcal/kg
- Make sure that hens **do not** become over-weight and produce large eggs because eggs heavier than (larger than) 66 grams may lead to
  - Increased microbial contamination in the hatchery
  - Increased embryo mortality, lower hatchability
  - Lower BW profile resulted in increased fertility and higher broiler BW @ 42 days of age



## We are Managing a Moving Target with Pullets and Hens



As broilers are changing, their parents are changing as well. Nutritionists should be willing to fine-tune their feeds with respect to CP, digestible Lys and ideal AA, ME)



Age (in Weeks)	1	2	3	4	5
12 P2	X X				
14 P2		XX			
16 P3		X	X		
17 P3			XX		
18 P3			XX		
19 P3			XX		
20 P3			X	X	
21 P3				XX	

**Fleshing (Muscle Growth)**

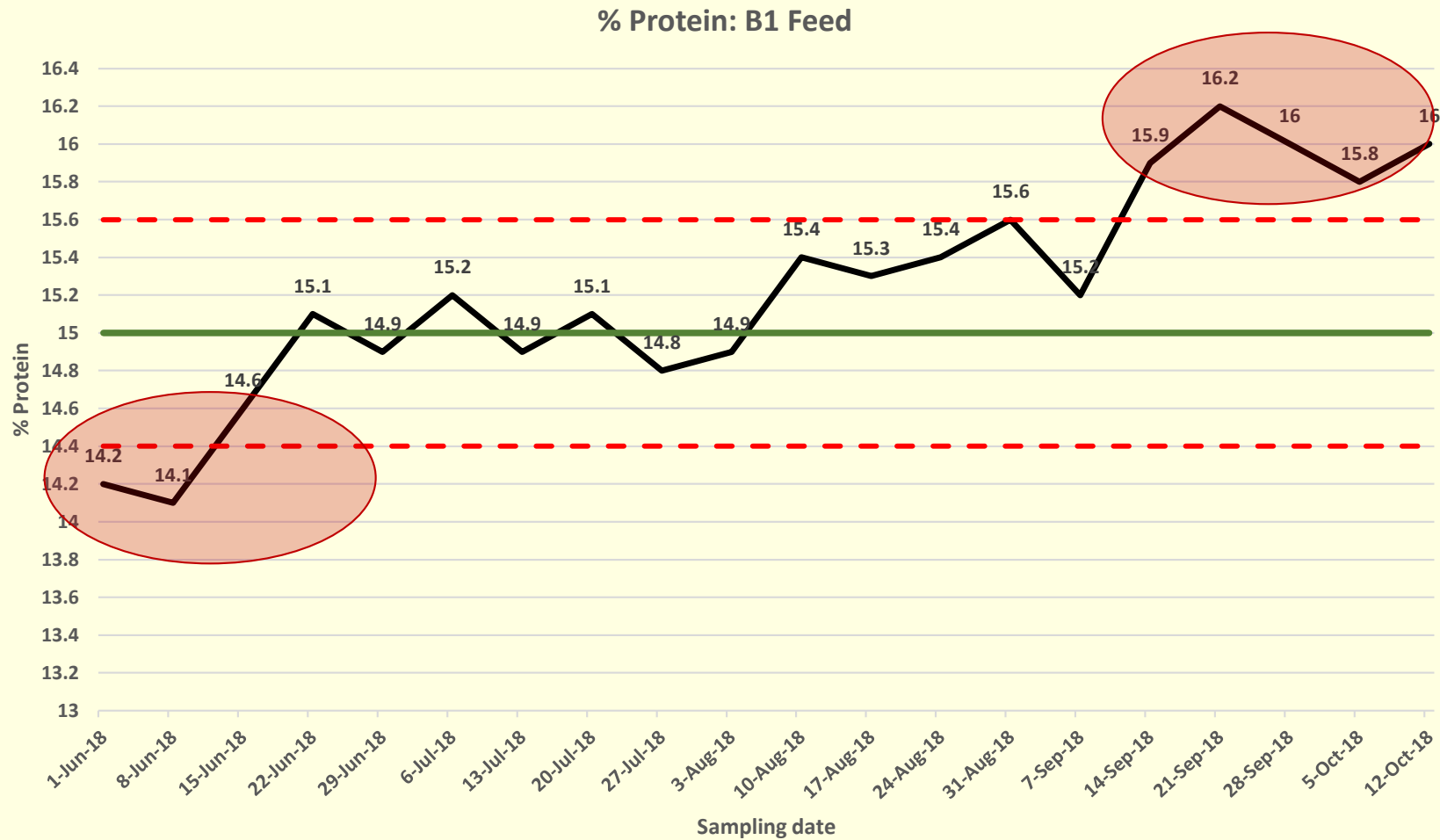
Age (in Weeks)	1	2	3	4	5
12 P2	X X				
14 P2		XX			
16 P3		X	X		
17 P3			XX		
18 P3			XX		
19 P3			XX		
20 P3			X	X	
21 P3				XX	

**Fat Accretion**

**Routinely evaluate fleshing and fat reserve just prior to photo-stimulation and based on your observation, continually fine-tune pullet & hen nutrition plans (Calorie to Protein ratio)**

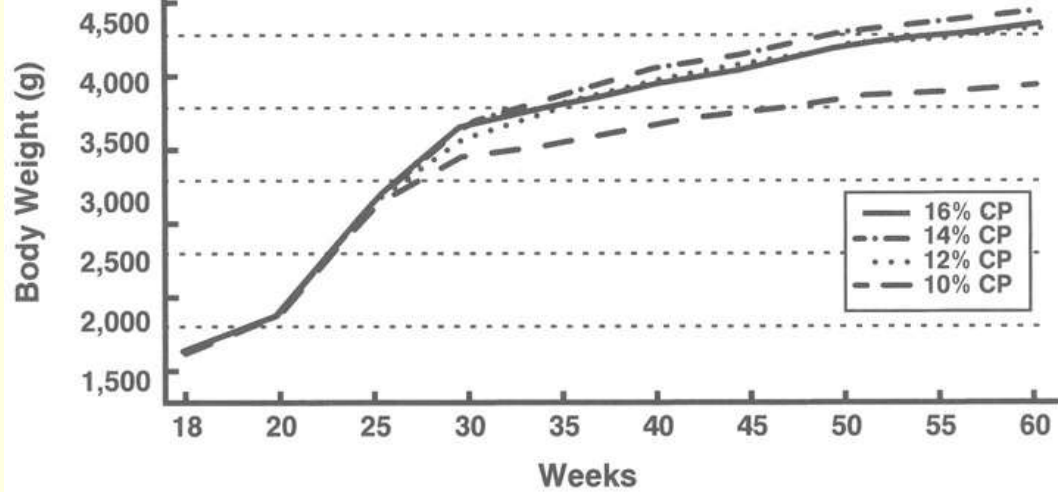


# Setup Ingredient & Finished Feed QC Programs to Avoid Excess and low Protein Feeds.

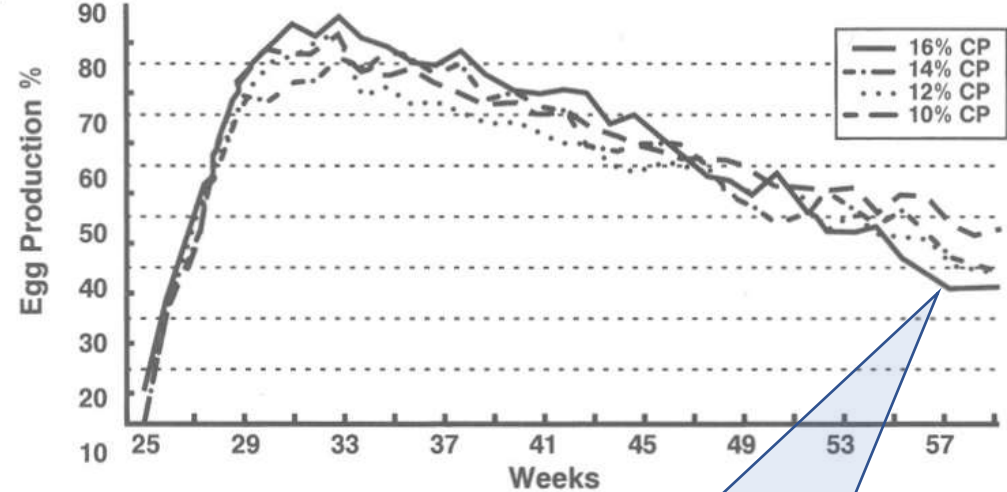


# Excess Dietary Protein /Amino Acids have Adverse Influence on Parents and Offspring

BW broiler breeder hens (From Lopez and Leeson, 1993).

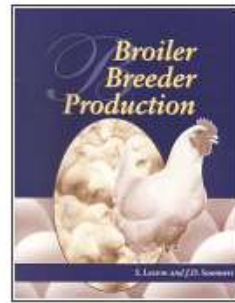


EP% broiler breeder hens (18 to 60 WOA)



Dr. Steve Leeson

“ Studies with 10, 12, 14 or 16% CP diets. All diets contained the same level of energy; and levels of methionine + cystine and lysine are kept constant. Diets were formulated at 0.82% lysine and 0.59% methionine + cystine in and all other nutrients, and quantities fed daily were as suggested by the primary breeder. Breeders fed 10% CP performed remarkably well, and although they did not have the highest peak, their better persistency meant no difference in overall egg production”



**High Protein Diets are not necessarily ideal for broiler breeders. We need to strive for optimum protein level**

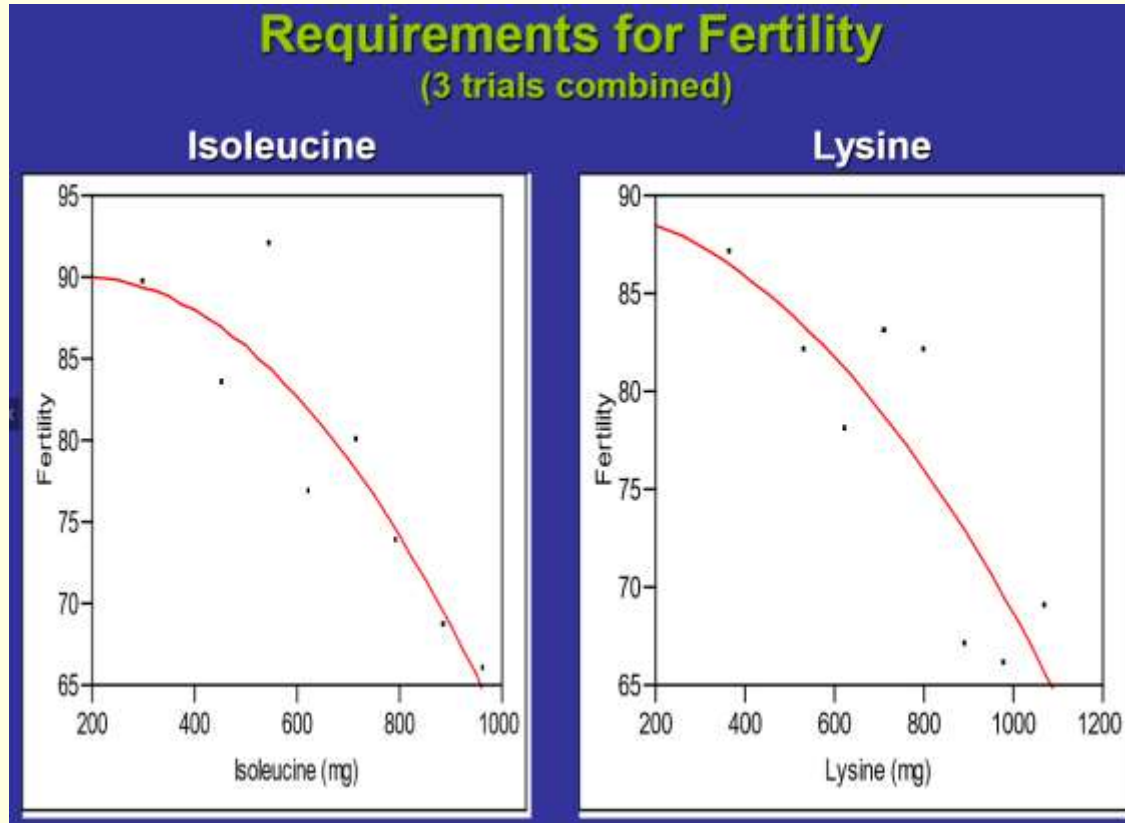
“One of the most surprising results from the study, was **better fertility with the lower protein diets**. For example, overall fertility to 64 weeks for birds fed 10 vs 16% CP was 95.4 vs 90.6%” Dr. Steve Leeson

\* We at Cobb do not recommend 10 or 12% protein diets. Dr. Steve Leeson's research is presented here to explain the concept



## Excess Digestible Lysine and Digestible Isoleucine may decrease fertility

Keep dig. Lys around 900 to 950 mg/day



- Use optimum levels of digestible Lysine and Isoleucine because excess could reduce fertility and hatchability.
- Excess in these two amino acids lowers urine pH significantly (abnormal) and negatively affect sperm storage in hens

Dr. Coon (Univ. Arkansas)

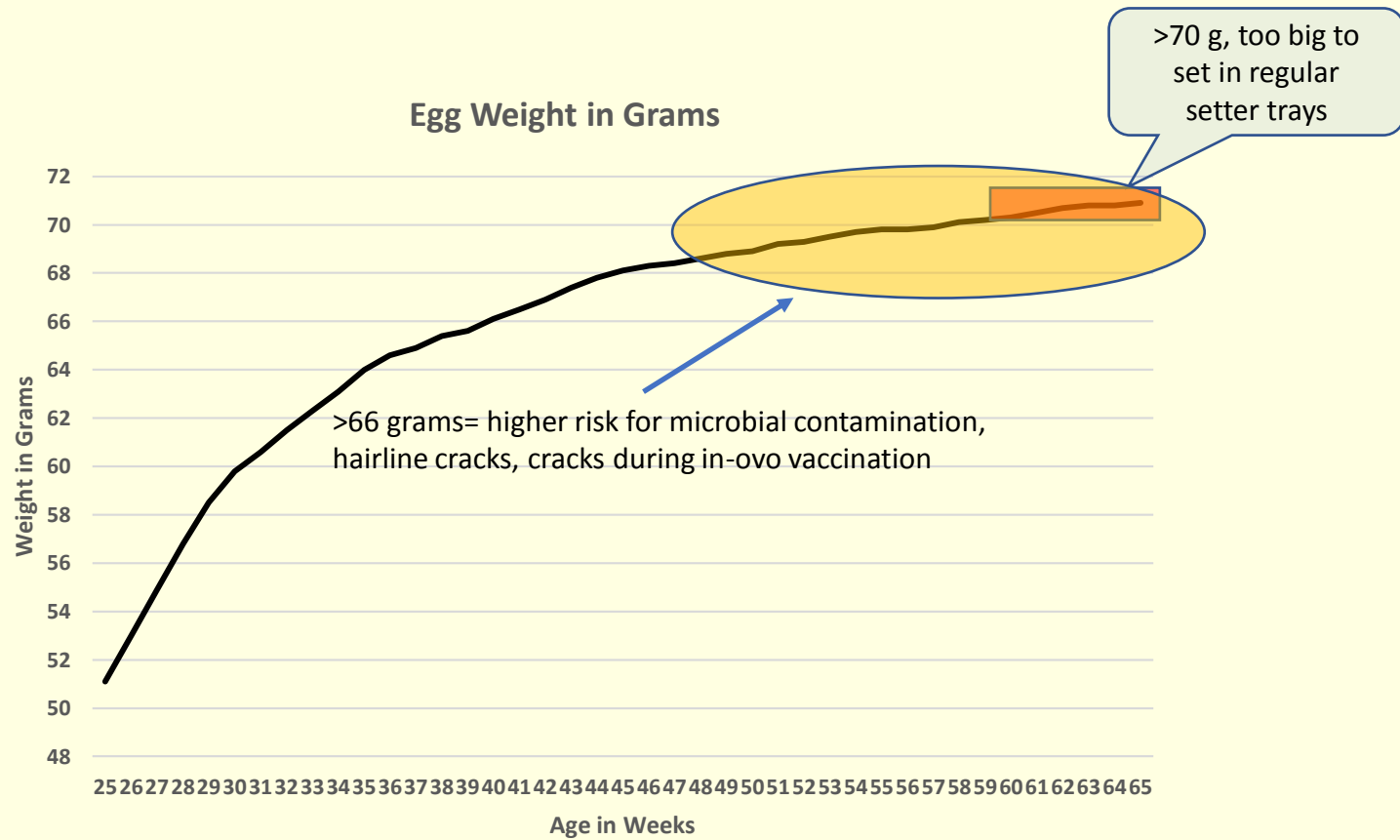
- Are these effects due to a more unsuitable environment for sperm storage?
- Both Isoleucine and Lysine are ketogenic







# Eggs larger than 66 grams tend to have thinner shells, prone to microbial contamination, higher embryo mortality & low hatch



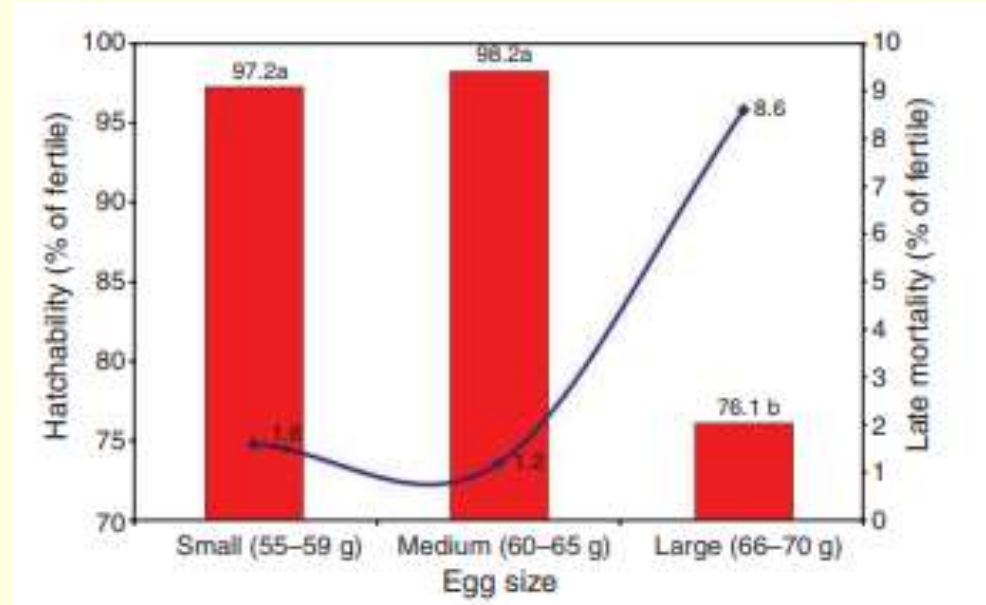
CSIRO PUBLISHING  
*Animal Production Science*  
<https://doi.org/10.1071/AN15381> Review

**Can feeding the broiler breeder improve chick quality and offspring performance?**

A. Chang<sup>AB</sup>, J. Halley<sup>A</sup> and M. Silva<sup>A</sup>

<sup>A</sup>Aviagen Group, 920 Explorer Boulevard NW, Huntsville, Alabama 35896, USA.  
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Received 14 July 2015, accepted 12 October 2015, published online 22 March 2016



**Fig. 3.** Effect of egg size on hatchability and late mortality (adapted from Shafey 2002).

# Breeder 2 Feed: A Tool to Control Egg Size

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- As a tool to control egg size past 40 weeks of age
- 13.5 to 14% with 0.58 to 0.62% Digestible Lysine
- Same or slightly higher energy level than B1 feed
- Slightly higher calcium level to help eggshell quality



# Maternal Dietary Protein / Ideal AA Ratio on Offspring FCR and BW

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- Several studies looked into these two KPI's in broilers as influenced by maternal dietary Protein / Ideal AA
  - No conclusive data
- Some publications are old
- More studies needed



# Balance Dietary Protein / AA – Effect on Progeny Meat Yield

## Effect of maternal dietary energy and protein on live performance and yield dynamics of broiler progeny from young breeders

T. G. V. Moraes, A. Pishnamazi, E. T. Mba, I. I. Wenger, R. A. Renema, M. J. Zuidhof

Poultry Science, Volume 93, Issue 11, 1 November 2014, Pages 2818–2826, <https://doi.org/10.3382/ps.2014-03928>

Published: 01 November 2014 Article history

Rearing Phase (Pullets)			Laying Phase (Hens)		
Kcal/ Kg	Kcal/ Lb	% Protein (Balanced)	Kcal/ Kg	Kcal/ Lb	% Protein (Balanced)
2,650	1,205	14	2,900	1,318	15.0

Rearing Phase (Pullets)			Laying Phase (Hens)		
Kcal/ Kg	Kcal/ Lb	% Protein (Balanced)	Kcal/ Kg	Kcal/ Lb	% Protein (Balanced)
2,736	1,244	15.3	2,900	1,318	15.0

Pullets reared under low CP and energy when switched to 15% CP & 2960 Kcal/kg hen diet improved progeny meat yield

Resulted in best carcass and breast meat yield in male broilers (females no difference)



## Energy and protein dilution in broiler breeder pullet diets reduced offspring body weight and yield

T. G. V. Moraes, A. Pishnamazi, I. I. Wenger, R. A. Renema, M. J. Zuidhof

Poultry Science, pey603, <https://doi.org/10.3382/ps/pey603>

Published: 25 January 2019 Article history



# Balanced Dietary Protein Effect on Progeny Meat Yield (Continued)

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Effects of growth patterns and dietary protein levels during rearing of broiler breeders on fertility, hatchability, embryonic mortality, and offspring performance <sup>FREE</sup>

R. A. van Emous, R. P. Kwakkel, M. M. van Krimpen, H. van den Brand, W. H. Hendriks

*Poultry Science*, Volume 94, Issue 4, 1 April 2015, Pages 681–691, <https://doi.org/10.3382/ps/pev024>

- Offspring of breeders fed the medium and low crude-protein diet showed a higher feed intake between Days 18 and 27 and during the total growth period than did offspring of high crude protein breeders.
- Male broilers of low crude-protein breeders had higher breast-meat yield than did male broilers of high crude-protein breeders, whereas breast-meat yield of female broilers was not affected by dietary protein concentrations



# Antioxidants

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## Synthetic:

- Ethoxyquin
- BHT,
- BHA

**Usually Less Expensive to supplement in feeds, could be stored for a few months at room temperature**

## Natural:

- Selenium
- Vitamin E,
- Pigments
- Many other natural compounds

**Usually more expensive to supplement in feeds & storage limitations**



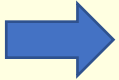
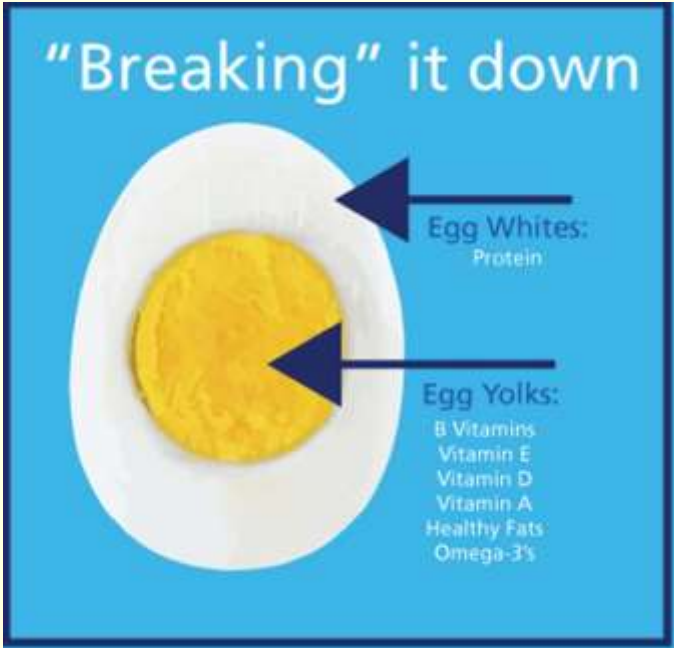
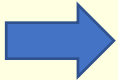
# Benefits of Antioxidants

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- Preservation of energy value
- Protection of heat labile proteins
- Vitamin stability
- Prevents losses of palatability
- Prevent formation of degradation by-products



# Antioxidants Added to Parent Feeds Help Parents and Offspring (embryo stage & possibly first few days broiler-chick's life)





# **Synthetic Antioxidants are Less Expensive: A Good Strategy to Use in Pullet and Hen Feeds**

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- **Sparing effect on other more expensive natural antioxidants present in feed**
- **Fat soluble vitamin sparing effect**



# Results of a Field Study

(Dr. Omar Gutierrez), Director of Tech Service, HuvePharma)

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Ethoxyquin in breeders resulted in increased levels of :

- Vitamin A ▪ 25% relative to control group ▪ 10% -68% relative to Baseline
- Vitamin E ▪ 77% relative to control group ▪ 52% -78% relative to Baseline
- Vitamin D ▪ 68% relative to control group ▪ 91% -200% relative to Baseline
- Improvement in 7-d mortality rate from 2.4% to 1.2%



# Vitamin E

- Increased immunity: improve adaptive antibody transfer from parent to offspring
- Vitamins E, K and B were supplemented at 20% above Aviagen breeder recommendation: 2.2% lower mortality than that of the control birds, with a yield advantage of 0.2% at 2-kg bodyweight
- Egg yolk vitamin E: 50% increase in a-tocopherol in the supplemented birds.
- Additionally, candling clears at 60 and 64 weeks of age were 12.2% vs 17.3% and 17.9% vs 26.9% for the higher supplementation group

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*Animal Production Science*  
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Review

## Can feeding the broiler breeder improve chick quality and offspring performance?

A. Chang<sup>A,B</sup>, J. Halley<sup>A</sup> and M. Silva<sup>A</sup>

<sup>A</sup>Aviagen Group, 920 Explorer Boulevard NW, Huntsville, Alabama 35806, USA.

<sup>B</sup>Corresponding author. Email: [achang@aviagen.com](mailto:achang@aviagen.com)



# Selenium (Se)

- Organic Se: Potent antioxidant, supplementation leads to increased Se in the egg, and in the tissues of offspring
- 0.5 mg/kg in hen feed results in increased Se in broiler chick tissue up to 14 days of age
- Improved FCR in broilers

CSIRO PUBLISHING  
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<http://dx.doi.org/10.1071/AN15381> **Review**

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<sup>B</sup>Corresponding author. Email: [achang@aviagen.com](mailto:achang@aviagen.com)



# Minerals: Zinc, Manganese & Copper Affect on Embryo

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- Feeding high levels of most minerals in inorganic form to hens has little or no effect on the egg mineral concentration ([Naber, 1979](#); [Angel, 2007](#))
- A mix of inorganic trace minerals (**ITM**) and organic trace mineral (**OTM**) sources or OTM by itself have been shown to increase the amount of minerals in the egg components ([Hudson et al., 2004](#); [Dobrzanski et al., 2008](#)).

Development of bone in chick embryos from Cobb 500 breeder hens fed diets supplemented with zinc, manganese, and copper from inorganic and amino acid-complexed sources 

[A. Favero, S. L. Vieira, C. R. Angel, A. Bos-Mikich, N. Lothhammer ...](#)

*Poultry Science*, Volume 92, Issue 2, 1 February 2013, Pages 402–411, <https://doi.org/10.3382/ps.2012-02670>

**Broiler breeder hens consuming a mixture of organic & inorganic sources of Zn, Mn & Cu produced embryos & hatching chicks with improvements in selected bone mineralization parameters**



# Minerals: Zinc & Manganese Affect on Broiler Chick (up to D34)

Immune System and Cardiac Functions of Progeny Chicks from Dams Fed Diets Differing in Zinc and Manganese Level and Source , 

W. S. Virden, J. B. Yeatman, S. J. Barber, K. O. Willeford, T. L. Ward ...

*Poultry Science*, Volume 83, Issue 3, 1 March 2004, Pages 344–351, <https://doi.org/10.1093/ps/83.3.344>

- **Breeder hens fed supplemental Zn and Mn as a mixture of organic and inorganic sources produced progeny with improved cardiac functional capacity and some improvements in immunity.**
- **Together with organic zinc, supplementation of manganese in organic form in maternal diets has been found to improve progeny livability from hatching to Day 34**



# ZN and Mn: Breast Meat Yield and Immune Functions in Offspring

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- Progeny from hens fed organic manganese and zinc tended to have improved breast-meat yield over that of the progeny from hens fed inorganic forms of these trace minerals.
- Immune function and livability of offspring may substantially improve if dietary Se, Zn & Mn are fed from a combination of organic and inorganic sources at a substantially higher level than typical to maternal hens

**Hocking PM (2007) Optimum feed composition of broiler breeder diets to maximize progeny performance. In 'Proceedings of the 16th European symposium of poultry nutrition'. pp. 101–108. (World Poultry Science Association: Strasbourg, France)**



# Vitamins / Metabolites: Vitamin D3

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- Progeny weight gain was the greatest when broiler breeders were fed the highest maternal dietary concentrations of 2000 or 4000 IU of vitamin D3/kg
- The incidence of tibial dyschondroplasia in progeny was improved in the offspring of young (30, 37 week) but not older (45, 57 week) broiler breeders.
- Vitamin D3 supplements in the concentration of 2800 IU/kg were recommended (Atencio et al. 2006).

Atencio A, Edwards HM Jr, Pesti GM(2005a) Effects of vitamin D3 dietary supplementation of broiler breeder hens on the performance and bone abnormalities of the progeny. Poultry Science 84, 1058–1068. doi:10.1093/ps/84.7.1058

Atencio A, Edwards HM, Pesti GM, Ware GO (2006) The vitamin D3 requirement of broiler breeders. Poultry Science 85, 674–692. doi:10.1093/ps/85.4.674





# Vitamins / Metabolites: 25-OH-D3

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- 25-OH-D3 (25-hydroxycholecalciferol), has been shown to have better biological value in maternal diets than vitamin D3 has for embryo mortality and bone ash has for progeny
- Improved fertility in hens, roosters, and has improved hatchability
- Widely accepted by nutritionists and veterinarians



# Male BW at Hen Peak Production & Male Feed Allocation post-peak affects hen fertility Male Progeny BW

Experiment	Breeder		Fertility (%)	Broiler	
	Flock (Wks)	Age Treatment		42 d BW (g)	Sex
1	29	Low BW <sup>1</sup>	97.6 <sup>s</sup>	2766 <sup>s</sup>	Male
		High BW	96.2 <sup>t</sup>	2669 <sup>t</sup>	Male
2	48	Constant <sup>2</sup>	92.9 <sup>b</sup>	2546 <sup>b</sup>	Mixed
		Increase	95.2 <sup>a</sup>	2604 <sup>a</sup>	Mixed

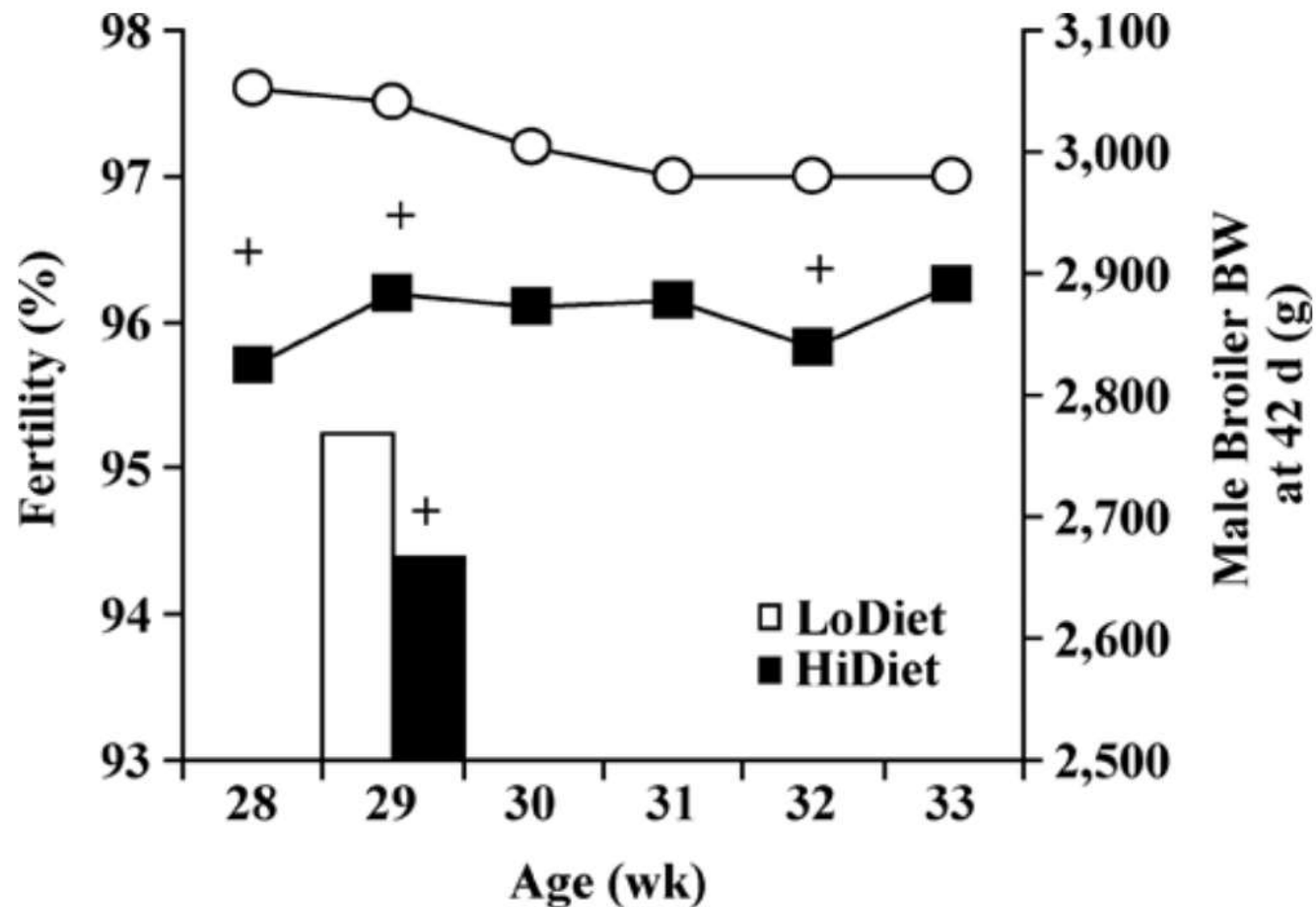
<sup>1</sup> Means with no common superscripts differ at P< 0.10.

<sup>2</sup> Means with no common superscripts differ at P<0.05.

Rooster BW & Feeding affects offspring



Brake & Romero-Sanchez, 2008



# Summary





# Investment & Payback

(Author's Best Guess)!



	Parent Nutritional / Feed Intervention	Payback Expectations
1	Protein (Ideal Amino Acid Ratio), Energy, Energy to Protein Ratio (in pullets & Hens)	ROI through lower feed cost & improved parent performance
2	Attention of digestible Lysine and Isoleucine	ROI immediate through improved fertility & hatchability
3	Antioxidants (synthetic & natural – Vitamin E & Se)	Reasonable to high ROI with minimum investment Sparing effect on vitamin E & Se
4	Vitamin D3 and 25-OH-D3 (HyD, Bio-D)	ROI through improved hen performance, slow down eggshell quality deterioration with high probability of improving embryo livability
5	Organic / Inorganic Mix of Zn, Mn, Cu	Slightly expensive but ROI only if you can clearly identify improved hen performance in your production system for hatchability, broiler 7-day mortality etc. (live or processing KPI's)
6	Male BW and male feed allocation considerations	Almost No Investment: Test it. If helps then implement

# Investing in Parent Hen Feeds to Improve Offspring: Positive Skepticism & Team Effort

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- Not an overnight project! Need companywide and/or customer support
- A positive skepticism and persistency are necessary to gradually build additive and synergistic nutrients / feed additives combinations for the parent hen feeds to improve progeny performance





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Le Meridian Hotel, Airport Road, Dhaka

5 - 6 March 2019



**Thank you**

**Shivi Rao**

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