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Breeder Hen Nutrition for Improved Progeny Health and Performance

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In submitting this report, the researcher has agreed to the Poultry CRC publishing this material in its edited form.

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Introduction

This project was based on recent findings that the maternal environment can have profound effects on the development of the progeny with long-term consequences for its health and productivity. Whilst these epigenetic developmental effects have been well demonstrated in mammalian species including humans, they have been poorly studied in poultry species and yet it is the nature and structure of the broiler industry that lends itself to enormous benefits from manipulating the maternal environment. In poultry of course, the maternal 'environment' relates to the nature of the components of the egg (yolk, albumen, and chorioallantoic membrane). Whilst it may be feasible to manipulate these components through *in ovo* injection using Embrex technology, a more commercially-viable approach would be to let the hen change the egg environment by manipulating her diet and /or other maternal factors such as stress levels. We report here a series of experiment funded by the Poultry CRC and conducted at the HiChick broiler breeder hen facility in South Australia. This facility is unique in that it provided us with access to the unique genetic material coming from the USA, in the form of hens at the Great Grandparent level of the broiler breeding hierarchy. Having access to this facility and these birds is a unique opportunity and explains partly why no such research has been conducted previously in this space.

Virtually all of our results in targeted manipulations of the breeder hen diet have been positive for progeny outcomes including better growth rate, immunity and disease resilience/resistance. A summary of these results is provided in Table 1.

Hen manipulation	Hen effects	Progeny effects	Future
Betaine (1000 and 20000pppm inclusion rate)	↑egg production ↑fertility ↑hatchability ↑body weight of hens ↑yolk/albumen ratio	↑growth rate of males ↓FCR of females	Large scale trials of betaine inclusion in breeder hen diets is recommended
Arginine 1% and 1.5% inclusion rate	↑feed intake ↓egg production ↑yolk weight ↑shell weight	↑body weight of arginine progeny in finisher phase ↑ Breast muscle weight of females	Large scale trials of arginine supplementation of breeder hen diets recommended

	↑shell thickness ↑arginine conc. in eggs		
Putrescine (0.1 and 0.2% inclusion rate)	↓feed intake ↓egg production ↓egg length, weight and thickness	Not determined	No further work recommended
Omega-6/Omega-3 fatty acid ratio (5:1, 10:1, 15:1, 20:1)	20:1 ↓egg production	5:1 ↓growth rate 20:1 ↑disease rate; ↑ mortality	Large scale trials of omega-6 to omega-3 at 15:1 recommended

The results of our trials on breeder hen diet are very positive and warrant validation in commercial trials of large scale. The largely positive effects of supplementation of the hens diet with betaine, arginine and an optimum ratio of omega-6 to omega-3 fatty warrant large scale trials in commercial settings. These are very significant outcomes for the Poultry CRC.

1 and 2. Communicate results to industry and make industry recommendations for adoption of technology

We have regular and frequent meetings with our collaborators at HiChick to ensure that the outcomes of our research are well-understood and adopted where appropriate. ***Due to the hierarchical nature of the broiler breeder industry and the ownership of the majority of the genetic material by Baiada (HiChick), industry adoption is somewhat different to normal research extension/adoption models. We are dealing directly with some of the research adopters.*** We have regular meetings and discussions with HiChick to communicate our results directly. Our results have also been reported to the Poultry CRC for dissemination to the CRC participants and are also in the process of being published so that they are available for the wider poultry industry.

Our relationship with HiChick, and particularly Jan Meldrum and his staff, is such that we have submitted an ARC Linkage Grant to continue the research activities in this breeder hen nutrition field. HiChick have been very interested in our results and are incorporating our findings into their business. The extent to which they are involved in our research is demonstrated by the commitment of $400k cash plus $800k in kind commitment to the ARC grant**.** Lauckes Feedmill has also adopted our research findings on betaine into their diet

formulations. We are planning an article for the e-newsletter, Poultry Hub, summarising the outcomes of the entire project. We have been active in disseminating the results of our research at several industry workshops and conferences as below:

i. **Feedworks Conference (Sunshine Coast 2016)**
Prof Hynd was invited to speak at this conference this year and he presented the results of our CRC work in a 45 minute presentation. The presentation was well-received and raised considerable interest and discussion. (**Hynd** PI, Forder REA, Weaver S, Hughes R, Edwards NM, Heberle ND, Bowling M (2016). Developmental programming in the poultry industry)

ii. **Recent Advances in Animal Nutrition Conference (Armidale NSW 2015)**
Prof Hynd was invited to speak at this conference which attracts a large number of industry delegates, and particularly those involved in animal nutrition. He spoke on our CRC research findings, which also resulted in a publication in Animal Production Science (**Hynd PI**, Weaver S, Bowling M, Edwards NM and Heberle N (2015). Developmental programming- a new frontier for the poultry industry. **Anim Prod Sci 55: 1233-1238).** Again, the talk created significant interest and discussion

iii. **Australian Poultry Science Symposium (Sydney 2017)**
We have submitted a talk related to one of the outcomes of our CRC research, namely the importance of flock uniformity. This topic is of great industry relevance and one that can be tackled using the technology we developed in this project (ie via the breeder hen diet and management). Hughes RJ, Heberle ND, Barekatain R, Edwards NM and Hynd PI (2017). Flock uniformity- is it important and how is it assessed? **Australian Poultry Science Symposium**

3. Complete CRC reporting

We have completed all required CRC reporting milestones on time and in a format that will allow ready access for future reference. We have also published most of our findings in scientific journals as below.

4. Complete scientific paper reporting results

Our work in the CRC Project 2.1.12 has resulted in the publication of 3 papers to date with a fourth submitted and awaiting journal response. The publications are in journals most appropriate for the industry science.

1. **Hynd PI**, Weaver S, Bowling M, Edwards NM and Heberle N (2015). Developmental programming- a new frontier for the poultry industry. **Anim Prod Sci 55: 1233-1238**

2. Edwards NM, Heberle ND, Hynd PI (2016). The Effect of *In ovo* Administration of L-Arginine on the Hatchability and Embryological Development of Broiler Chicks**.**

Animal Production 2016; Proceedings of the 31st Biennial Conference of the Aust. Soc. of Anim. Prod.

3. Heberle ND, Edwards NM, Cadogan D, Wilkinson S, Hughes R and Hynd PI (2016). Effect of dietary natural betaine on broiler breeder hen performance and egg quality characteristics. **Animal Production 2016; Proceedings of the 31st Biennial Conference of the Aust. Soc. of Anim. Prod.**

4. Heberle N, Edwards NM, Cadogan D, Wilkinson S, Hughes R and Hynd P (submitted to Poultry Science) Effect of dietary betaine on broiler breeder hen performance, egg quality and progeny performance **Poultry Sci**.

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The researchers would like to thank the Board of the Poultry CRC for their support over the past 6 years. It was a gamble supporting a group with little previous experience in avian research but I think it has proved to be a very effective means of capturing new ideas from outside the prevailing paradigms. The support of the staff at HiChick is gratefully acknowledged. It would not have been possible to do this work without their support and facilities. Many thanks particularly to Jan Meldrum for his enthusiastic support.