

## **Connecting Broiler Breeder Microbiota to Performance in Commercial Conditions**

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The intestinal microbiota plays a crucial role in chicken health and production performance. The maturation of microbiota of chickens includes rapid successional changes, developing from a simple to a more complex and diverse composition based on gradual colonization with microbiota in the intestinal tract. Large scale field trials have demonstrated that good performing broiler flocks have a more stable and mature microbiota at an earlier age. Also, their microbiota is characterized by a lower abundance of *Proteobacteria* and a more balanced ratio between lactate-producing and lactate-utilizing bacteria, resulting in a higher production of short chain fatty acids. Delaying or disrupting this development pattern caused by poor chick quality, for example, results in a lower performance and increased pathogen and food safety risks. Different interventions such as probiotics, prebiotics, postbiotics, phytogetic compounds, organic acids, and appropriate dietary fiber sources, and low levels of fermentable protein have been shown to promote early microbiota maturation in broiler chickens. They can also result in a better ratio between lactate-producing and lactate-consuming bacteria in the hindgut, resulting in increased production of short-chain fatty acids.

Unraveling the interaction between environmental and host factors and the impact on chickens' gut microbiota is a complex task. There is more than  $10^9$  bacteria/gram ileal content and more than  $10^{11}$  bacterial/gram cecal content. Analysis of the gut microbiota by molecular approaches has identified bacterial populations of over 600 species from more than 100 genera. Furthermore, the relation between different bacteria and between bacteria and other factors impacting them may also be non-linear in nature. In Cargill, we worked for more than 10 years on the development of a practical non-invasive microbiota analysis platform called Galleon™ to extract actionable insights from such big microbiome data. Chicken cloaca samples are collected with swabs in the field; the microbiota is quantified using a microarray chip with pre-selected DNA populations (biomarkers), which are then analyzed using statistics and non-linear AI (artificial intelligence) models. With this combination of technologies, Cargill's Galleon Microbiome Intelligence platform provides poultry producers with practical and

actionable insights on the gut microbiome status of their flocks, to help improve animal health, performance, preharvest food safety, and ultimately return on investment.

Recent work with Galleon in broiler breeders showed that their gut microbiota composition is also linked to performance; these specific concepts that are related to the performance of broilers may also be important in breeders. In the presented field case, Galleon was used to investigate the difference in microbiota composition of high- and low-performing broiler breeder flocks – 153 vs. 140 saleable chicks/hen – both receiving the same feed and raised with similar management practices. The low-performing breeder flocks were associated with higher presence of *Lactobacillus*, *Enterococcus*, and *Clostridium perfringens*. The AI model also confirmed *Lactobacillus* as being the most important biomarker to distinguish between high- and low-performing breeder flocks (Figure 1), with a significantly higher abundance of *Lactobacillus* species in low-performing farms (Figure 2). This may indicate an imbalance between lactate-producing and lactate-consuming bacteria in the hindgut of broiler breeders, which may result in reduced performance, similar to what is often seen with Galleon in the field in low-performing broiler farms.

Fig 1: Top ten biomarkers, in order of importance, for the model to distinguish good from bad performing breeder flocks.

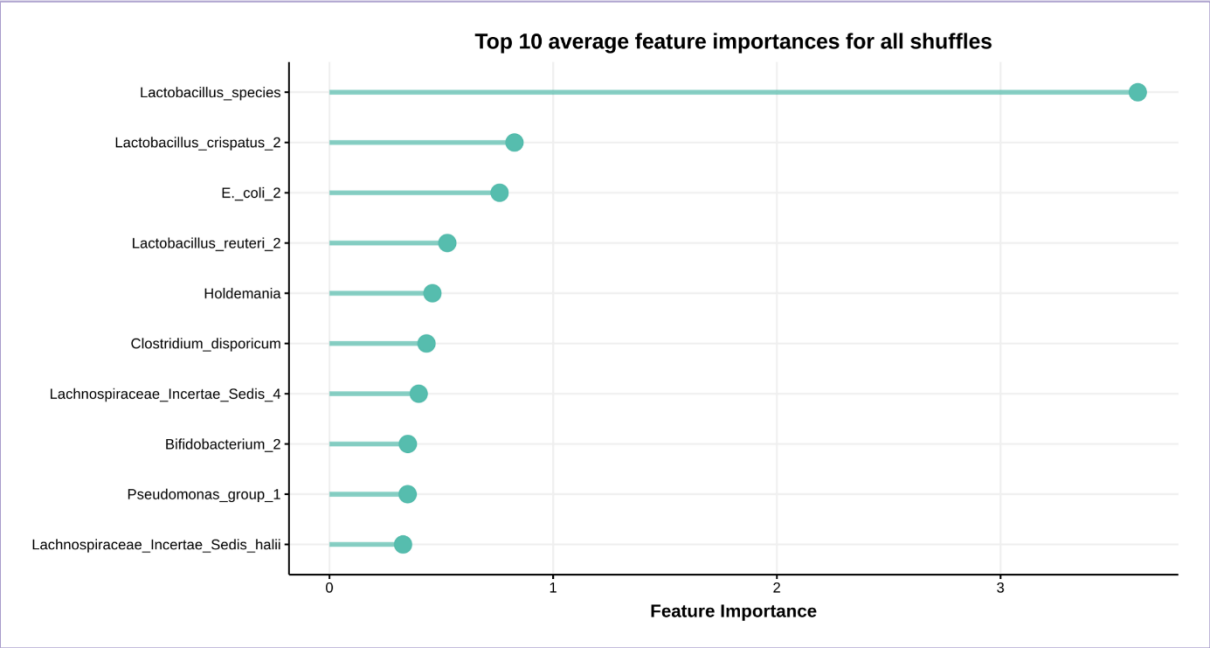
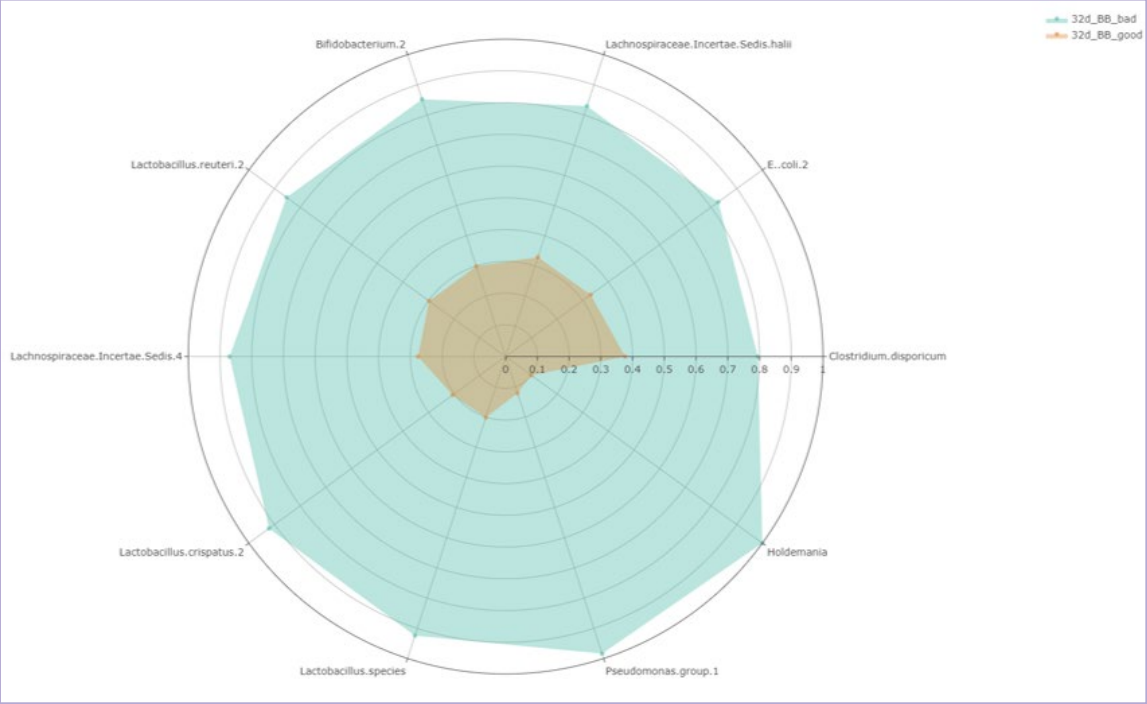


Fig 2: Radar plot of standardized fluorescence signal showing a microbiota profile of good and bad microbiota profile using the top ten biomarkers for the AI model.



Since broiler breeders are adult animals, their intestinal microbiota is expected to be mature and stable, and more resilient to different stressors. However, an unstable and less mature intestinal microbiota is more sensitive to stressors and disruption of normal developmental patterns. This may result in higher pathogen risk and an imbalanced ratio between lactate-producing and lactate-utilizing bacteria with too high a presence of *Lactobacillus* species. This may lead to accumulation of lactate in ceca, which is detrimental to several butyrate-producing bacteria. Specific dietary interventions can restore this microbiome balance and improve performance.

More work is planned to unravel the link between gut microbiota of broiler breeders and their offspring performance and to evaluate nutrition and additive strategies to optimize microbiota in broiler breeders to achieve better overall performance.

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