FEEDING DILUTED DIETS TO BROILER BREEDER PULLETS

INTRODUCTION

Best practice flock management starts at placement, with an emphasis on sound stockmanship techniques. By giving pullets an ideal environment and enough feeding and drinking space during the rearing period, they can achieve their target body weight (BW) with a high level of uniformity and ensure optimal development to achieve sexual maturity. The ***Parent Stock Management Handbook*** contains details on optimal practices for managing broiler breeders. Regardless of the feeding system (track, pan or spin feeders), appropriate feed distribution is required to ensure uniform feed intake and BW gain. The modern broiler breeder is characterized by a developed appetite and feed utilization. A minimum feed volume must be established to guarantee adequate flock BW uniformity during rear. The allocation of adequate feed volume to flocks in rear provides better BW uniformity due to better feed distribution and prolonged feed access. Feed volumes can be increased by physical feed form, feed frequency and/or nutrient dilution.

Reducing the concentration of diets by including low-energy raw materials as diluents is a nutritional strategy to increase feed volume, improve uniformity, avoid abnormal behaviors and promote efficient digestion. These factors are essential to obtain successful biological performance and profitability for a broiler breeder operation. However, dilution and diluent inclusion have limits. It is important to know these limits and understand their reasons, so as not to compromise the benefits of diluting diets.

WHY DILUTE PULLET DIETS?

Diluting pullet diets is a strategy that permits increased daily feed allocation, which is an essential tool to promote the feeling of satiety, facilitate homogeneous feed distribution and extend feed clean-up times. This will result in more uniform access to the ration, preventing assertive birds from out-competing timid ones. Accordingly, feed dilution reduces BW variation, producing uniform flocks. The following are the advantages of good uniformity:

- Facilitates that energy and nutrient intake meet the requirements of a higher proportion of birds within flocks.
- Reduces the percentage of birds below the standard BW (light birds), which might also have experienced lower feed volume consumption resulting in exposure to nutritional deficiencies.
- Promotes correct and uniform body condition among the birds, resulting in better control of lean meat deposition and reducing the percentage of heavy birds.
- Birds arrive synchronized at sexual maturity; this supports a high production peak and egg production persistency and hatchability.

WHAT ARE DILUENTS?

Diluents are low-energy raw materials used to reduce the concentration of broiler breeder diets. They may be divided into fibrous and inert diluents; fibrous, in turn, may be divided into sources of insoluble and soluble fiber. **Table 1** shows the classification of some diluents which might be included in pullet diets.

TABLE 1: Diluents classified based on their characteristics.

FIBROUS		INERT
Source of insoluble fiber	Source of soluble fiber	
Wheat bran	Citrus pulp	Sand
Rice bran	Beet pulp	Vermiculite
Oat hulls		White kaolin
Alfafa hay		
Sawdust		

- **Fibrous diluents:** Wheat bran and rice bran, cereal co-products, are higher in energy (due to their high starch and crude fat content), while sawdust, a lignocellulosic raw material, has the lowest energy (due to its high crude fiber content) and a high lignin content.
- **Inert diluents:** These diluents do not contribute energy or nutrients to the diet. They include sand [silicon dioxide (SiO_2, silica)], vermiculite (a mineral from the micas group, whose main constituents are iron or magnesium silicates), and white kaolin, a thin clay, usually white in color, formed by the weathering of aluminous minerals. **Figure 1** shows vermiculite and white kaolin.

FIGURE 1: Vermiculite (top) and white kaolin (bottom).

ADVANTAGES AND DISADVANTAGES OF FIBROUS AND INERT DILUENTS

The lignin content of most insoluble fiber sources leads to a longer retention of the feed particles in the gizzard, improving its muscular development and, thus, its function (Hetland and Svihus, 2001; Hetland et al., 2003; Jiménez-Moreno et al., 2010). The poultry gastrointestinal tract does not produce the necessary enzymes to digest fiber; therefore, its particles enter into the cecum by anti-peristaltic movements. In this organ, a large bacterial community breaks down indigestible plant material. Plant materials produce volatile fatty acids (VFA), which may be used as a preferential source of energy by enterocytes. Increased VFA production from shifting the commensal microbiota to a more fiber-fermenting community will strengthen the mucosal barrier (Gomes et al., 2021).

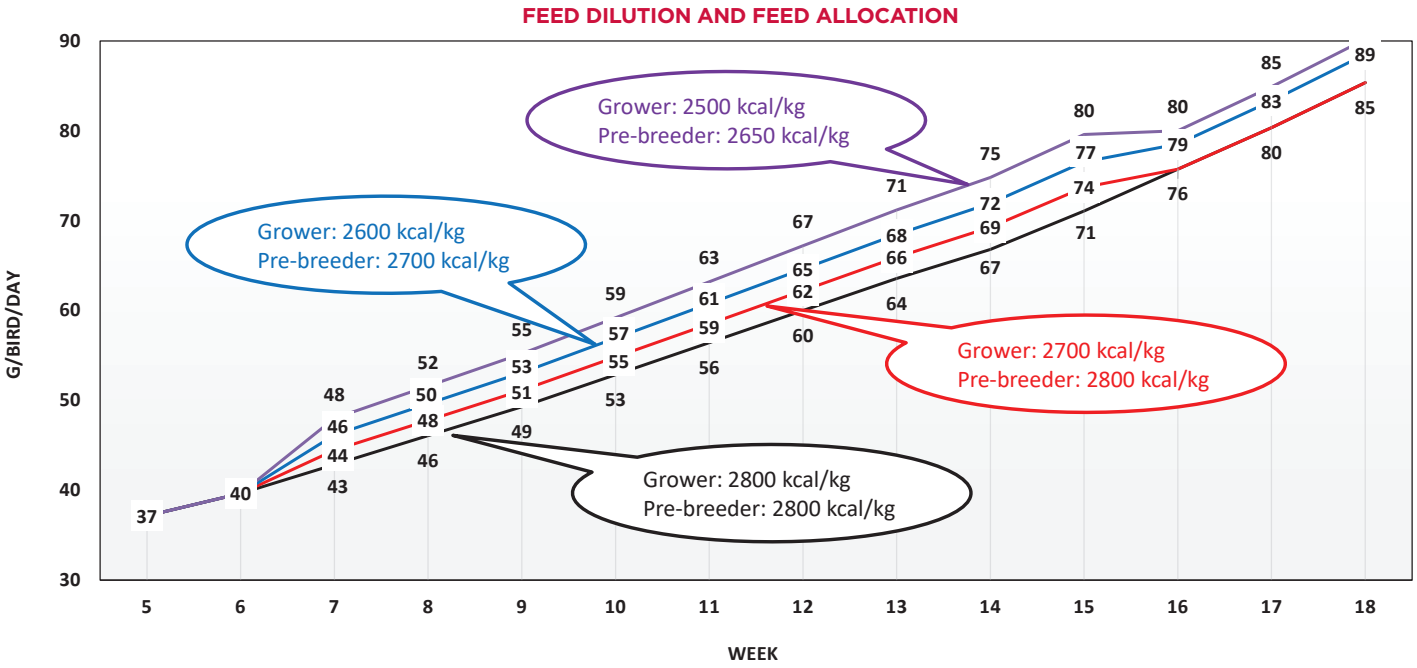
Additionally, diluting pullet diets with a raw material source of fiber may also improve satiety by increasing the time the feed is in the crop and gizzard; therefore, there may be opportunities to reduce abnormal behaviors by modifying the fiber content of the ration (Hocking et al., 2004). The quality of these ingredients is always an important consideration. For example, when using wheat milling co-products like wheat bran and wheat middlings as diluents, it is imperative to practice good quality control monitoring, including mycotoxin, fiber and protein contents. The energy content of these ingredients may vary from 1400 to 2200 kcal/kg. Therefore, the ingredient-nutrient matrix must be routinely updated based on quality control results.

Inert diluents do not have nutrients or energy value; this allows high dilution with low inclusion, as well as diluting the diets accurately. Additionally, vermiculite has a high water retention capacity, which is a great advantage as it increases satiety, thus reducing discomfort and the risk of abnormal behaviors. How inert diluents affect feed presentation must be considered. They may adversely affect pelletability, resulting in increased fine particles (< 1 mm). If a mash feed is used, a high content of fine particles may result in dusty feed. The consequence may be feed segregation, potentially resulting in poor flock uniformity through assertive, early-feeding birds selecting the coarse particles and leaving the fine particles to be consumed by the late feeders. This issue may worsen in the case of deficient feed distribution and/or high stocking density. Finally, it should be noted that some inert diluents, such as sand, are abrasive and may damage feed mill equipment (hammers, pellet die, pellet rolls, etc.).

ENERGY AND NUTRIENT DILUTION

During Grower and Pre-breeder phases, it is essential to control growth rate. To achieve the target, it is necessary to guarantee correct energy and nutrient allowances; therefore, throughout these phases, feed intake is controlled and distributed feed volume low. For these reasons, Grower and Pre-breeder diets are susceptible to being diluted to increase feed allocation (distributed feed volume) without increasing daily energy and nutrient intake. **Figure 2** shows how feed allocation would increase (g/bird/day) during Grower and Pre-breeder phases when the dietary energy is reduced from 2800 kcal/kg to 2500 kcal/kg.

FIGURE 2: Feed allocation (g/bird/day) depending on the energy of the Grower and Pre-breeder diets.



Daily feed intake (g/bird/day) is calculated using the daily energy intake (kcal/bird/day) provided in the ***Parent Stock Performance Objectives*** and the energy of the diets (kcal/kg). Example at 10 weeks:

- (148 kcal/bird/day x 1000) / 2800 kcal/kg = 53 g/bird/day
- (148 kcal/bird/day x 1000) / 2700 kcal/kg = 55 g/bird/day
- (148 kcal/bird/day x 1000) / 2600 kcal/kg = 57 g/bird/day
- (148 kcal/bird/day x 1000) / 2500 kcal/kg = 59 g/bird/day

In diluted diets, nutrient concentration must be calculated pro rata in accordance with energy dilution. Energy:nutrient ratios (calculated from the ***Parent Stock Nutrition Specifications***) have to be used to calculate the new and reduced nutrient values. **Table 2** shows an example: In Grower diets diluted to 2700, 2600 and 2500 Kcal/kg, dLys is reduced in accordance with energy reduction by using energy: dLys ratios (energy/ratio = dLys).

TABLE 2: Energy and digestible lysine (dLys) and their ratios in 2800, 2700, 2600 and 2500 kcal/kg Grower diets.

Grower. 2021 PS Nutrition Specs			Grower. Dilution to 2700 Kcal/kg			Grower. Dilution to 2600 Kcal/kg			Grower. Dilution to 2500 Kcal/kg		
Energy Kcal/kg	dLys %	Energy: dLys ratio	Energy Kcal/kg	Energy: dLys ratio	dLys %	Energy Kcal/kg	Energy: dLys ratio	dLys %	Energy Kcal/kg	Energy: dLys ratio	dLys %
2800	0.52	5385	2700	5385	0.50	2600	5385	0.48	2500	5385	0.46

DILUTION AND DILUENT INCLUSION

Dilution and diluent inclusion have limits that should be considered. When changing from a Grower diet to a Pre-breeder diet, daily feed allocation (g/bird/day) should never be reduced. Therefore, adjustments in the feed volume should be applied to at least the same feed amount when transitioning phases. Moderate dilution of the Pre-breeder phase is also possible since it does not compromise the feed increment strategy after the onset of lay. On the other hand, the dilution of the Breeder diet is also possible, but prolonged feed clean-up times should be avoided.

The dietary dilution will be limited by the local availability and quality of fibrous diluents. In particular, wheat milling co-products should not exceed 20% in the diet. As explained previously, they are quite variable. Therefore, limiting their inclusion helps to be accurate when formulating; feed composition and formulas should match as closely as possible. When available, including inert diluents (e.g., 5-10%) may help reduce the pressure of limited and/or inconsistent fibrous diluents. Likewise, high-quality fibrous diluents, such as oat hulls and purified lignocellulose, are useful to dilute the nutrient density safely. This is particularly relevant in corn/soya-based diets due to the higher energy of corn compared to wheat; these diets may require a higher inclusion of wheat milling co-products. Consequently, it might be more difficult not to exceed the recommended 20% limit of inclusion and achieve a consistent feed quality.

Ideally, the inclusion of inert diluents should not exceed 5%. If further dilution is required, inert diluents should be used in combination with fibrous ingredients. Maintaining fine particles as close as possible to a maximum of 15% should be a priority.

With regard to crude fiber, a maximum value of approximately 7% is advisable. Too much crude fiber may reduce the transit time of the digesta, resulting in less available time for enzymes to degrade nutrients and may lower the effectiveness of the digestion process (Morel et al., 2006). Additionally, the abrasive effect of the fiber on the intestinal mucosa may result in villus height reduction, and nutrients and endogenous cell losses to the lumen. It might also impair the efficiency of the digestion process and increase bird requirements.

Irrespective of the level of dilution, diets must be correctly balanced. The incorrect inclusion of diluents and/or excessive dilution may compromise nutrient supply to the birds. Deficiencies of essential and non-essential amino acids and minerals, can result in poor feather cover, leg health issues and abnormal behaviors. Episodes of feather-licking, feather-pecking and compromised feather development may be observed. Frequently, these issues are allegedly attributable to low nutrient density Grower and Pre-breeder diets. However, this may be hypothesized as one or a combination of the following factors:

- **Excessive dilution:** If a diet is diluted to energy levels below 2500 kcal/kg, it generally leads to a high inclusion of fibrous diluents. Thus, the bulkiness and potential water-holding capacity of these ingredients may lead to foregut compaction (constipation) if water supply is controlled. Compaction may cause behavioral disruption, inhibition of intake and poor absorption of nutrients.
- **Amino acid imbalance:** The desire to minimize dLys and crude protein in low-density Grower and Pre-breeder diets often leads to negligence in relation to the other amino acids. Often valine, isoleucine, arginine and tryptophan minimums are not met, which may lead to feathering issues and/or abnormal behaviors.

SUMMARY

- Dilution of feeds in rear is a strategy that permits increased feed allocation. This results in more uniform flocks and a lower risk of abnormal behaviors.
- Diluents are used to reduce the concentration of broiler breeder diets; they may be divided into fibrous and inert diluents.
- Fibrous diluted diets may benefit the digestion process, increasing the retention time of the feed in the crop and gizzard, and promoting the production of VFA in the ceca. Additionally, the high water retention capacity of some of these diluents promotes the feeling of satiety.
- Fibrous diluents, considered quite variable, must have their maximum levels of inclusion well determined to keep the formulation accuracy and feed consistency.
- Formulated crude fiber above the optimal 7% should be carefully managed, given that higher inclusion of fibrous material may impair gut functions.
- Inert diluents allow consistent dilution but should be limited to 5-10% inclusion; they may damage feed mill equipment and increase fine particles in the feed.
- An advisable range for the dilution of Grower and Pre-breeder diets with conventional diluents is 2500 - 2700 kcal/kg.

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