

# Mixing Considerations when Pelleting Livestock Feeds

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**T**he nutritionist puts together a formula to meet the target animal requirements for growth, maintenance, reproduction and general health. It is therefore, very important that the ingredients be proportioned and mixed to obtain a homogeneous blend. Most of the ingredients in the feed formulation are in mash form and are added to the mixer according to a pre-set sequence that ensures a homogeneous blend.

In order to ensure that the mixing is done properly, the major dry ingredients are added first, from largest to smallest. The last dry ingredients to be added are the minors—composed of the premixes, which are usually vitamins, minerals and other additives. After all dry ingredients are added and allowed to mix, the operator proceeds to add the liquid ingredients. Understandably, mixing is then one of the most critical steps in feed manufacturing process and, if not done correctly, it can have adverse effects on the nutritional and physical quality of the finished product or pellet.

Improper mixing can also adversely affect the pelleting efficiency because of stoppages of the pellet mill. This can occur if excessive ingredients (in most cases, liquids) are added resulting in lumps that can cause the die to plug up.

## Poor mixing

A complete homogeneous mix will produce uniform pellets. Poor mixing can have an adverse effect on the pellet quality. If pelleting aids, such as a binder, are not added in the correct sequence, their

distribution in the meal will be inadequate to produce pellets with the desired hardness or durability. In this case, the additive will be lost and excess fines will be produced in the process.

Excessive fines will also have a direct impact on costs, as they increase the shrink and re-process costs. The fines that are recovered in the process increase cost because they need to be re-processed. Most of the time, the fines are recycled back to the pellet surge bin; however, if excessive fines are put into the pellet mill, the pellet quality will continue to deteriorate as the fines tend to lose their binding capacity.

## Moisture

It is common to add liquids in any feed formula. One of the most important liquids is water. Water helps reconstitute the moisture loss during grinding of some ingredients. It also helps to raise the moisture content in the meal that, in turn, can improve the pelleting process. Adding 1-2% water in the mixer can help improve pellet quality. The moisture added in the mixer should be sprayed so it can be well distributed in the meal. The water added in the mixer has ample time to be internalized prior to the conditioning process, and this can help achieve the desired conditioned mash moisture and temperature.

This can be explained in the following example: Target mash moisture prior to pelleting should be at around 17%. The initial mash moisture is 11%, and the meal temperature is 22°C and we need to reach 17% moisture in the conditioner. This means that

with low-pressure steam the meal should gain 6% moisture. This amount of moisture can be partially achieved via water in the mixer or via condensed steam added during the conditioning process. If no water was added in the mixer to achieve the target moisture prior to pelleting, it would mean that the meal temperature will need to be raised from 22°C to 97°C (12.5°C for every 1% moisture added via steam). This high temperature, although not impossible, is very difficult to achieve unless the pellet mill is equipped with double-, triple-, or twin-shell conditioners. However, if 2% water was added in the mixer, the amount of moisture added via steam condensation in the conditioner will be reduced to only 4%; this translates to final meal temperature of 77°C—which is more reasonable.

Other liquids are added in the mixer to meet formulation requirements. These include liquid amino acids, molasses and fat/oils. In any case, it is important that the liquids be sprayed and not poured into the mix. Sprayed liquid ingredients are better distributed in the meal. Poor liquid distribution will result in pellets that do not meet the specifications of the formula and, worst of all, will not meet the requirements of the target animal.

In order to increase liquid distribution in the mix, it is important to have spray nozzles that can fan out the liquid properly. This can be achieved if the atomizer heads are placed as far as possible from the mash. Poor liquid distribution can affect pellet physical quality as liquids not properly distributed in the mixer can result in lumps of material. These lumps can produce spotted pellets and pellets of uneven color, texture and hardness.

When applying liquids in the mixer it is important to also take into account their physical properties. Liquids that are highly viscous will need to be applied at temperatures that reduce the viscosity and ensure their distribution in the meal. If a highly-viscous liquid is added cold it will not disperse well in the meal, and this can result in poor pelleting performance, as well as nutritional imbalances in the finished feed. It is also important to take into account how liquids are added in the meal. It is recommended that liquids high in water content be added first, followed by the more hydrophobic ones

(i.e., fats and oils). If a fat or oil is added first, this can result in a meal that is coated with a hydrophobic layer that will repel water and prevent its absorption. It is important that aqueous fluids be applied first and allowed some mixing time to improve water uptake. The water that is internalized will improve the starch gelatinization and produce pellets that are harder.

### **Ensuring proper mixing**

Any imbalance in the nutritional profile will have adverse effects on the growth of the target species. Fast-growing animals are the most susceptible to any imbalance in the nutritional profile of the feed. Therefore, every pellet should be a representative sample of the formula for the target species it was designed for. Nutritional imbalances can occur if minor ingredients (vitamins, minerals, antibiotics, pelleting aids and other additives) are not homogeneously distributed in the mixed meal. The imbalances can be in both directions—one of nutrient deficiency if some ingredients are not mixed, and one of excess or even toxicity (minerals, vitamins, antibiotics) if ingredients are in excess.

To ensure proper mixing quality, the mixer should be tested at least every 6 months (McCoy, 1992). The mixer test measures the coefficient of variation (CV)—which is the standard deviation ( $\sigma$ ) divided by the mean ( $\mu$ ) multiplied by 100. The mixer is optimized at different time intervals, and the one with the least amount of mixing time that is below 10% CV should be selected. The mixing time can vary with formulation type. Therefore, it is important that a mixer test be performed for each formula type.

Mixer efficiency can be affected by the amount of build-up on the paddles and ribbons. The ingredient physical properties (density, particle size, hygroscopicity and electrostatic charges) can build-up in the discharge gates that prevent them from tightly closing, and cause wear of the paddles and ribbons. It is therefore important to ensure that the mixer is kept clean and properly functioning to ensure a homogeneous blend and optimum pellet quality.

**References**

McCoy, R.A., 1992. Effect of mixing uniformity on broiler chick performance. Master's thesis, Kansas State University, Manhattan, Kansas, USA.

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