How are enzymes used in the feed formulation?
Two options:
1. Reformulate the feed – to reduce feed costs and at least maintain animal growth, egg production and feed conversion.
   For example replace some wheat, barley or corn with lower cost high fibre by-products and/or reduce the added fat level in the diet.
2. Add to the standard feed formulation – for improved animal growth, egg production and feed conversion giving improved costs of production.

Which enzymes are used in animal nutrition?
Enzymes are categorized according to the substrates they act upon. Some of the most common include:

<table>
<thead>
<tr>
<th>Enzyme</th>
<th>Substrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xylanase</td>
<td>arabinoxylans in plant fibre</td>
</tr>
<tr>
<td>Amylase</td>
<td>starch in feed</td>
</tr>
<tr>
<td>Protease</td>
<td>proteins in feed</td>
</tr>
<tr>
<td>Beta-glucanase</td>
<td>mixed linked beta-glucans in plant fibre</td>
</tr>
<tr>
<td>Phytase</td>
<td>phytate in plant material</td>
</tr>
</tbody>
</table>

What are the requirements for enzymes used in feed?
Enzymes used in animal feed have to be:
- active and effective in the animal
- stable during storage
- compatible with minerals, vitamins and other feed ingredients
- stable at high temperatures reached during feed manufacture
- safe and easy to handle
- free-flowing, to ensure thorough mixing throughout the feed

Want to know more?
Danisco Animal Nutrition
info.animalnutrition@dupont.com
www.animalnutrition.dupont.com

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What are enzymes?
Enzymes are proteins, composed of amino-acids, which are produced by all living organisms. Enzymes are responsible for many reactions and biological activities in plants, animals, human beings and microorganisms. Enzymes are essential for all metabolic processes, but are not themselves living materials. They are distinguishable from other proteins because enzymes are involved in a reaction but not used up. Enzymes have catalytic activity - increasing the rate of a reaction.

How is an industrial enzyme produced?
Enzymes are selected from nature and can be further enhanced in a laboratory to improve their performance. The enzyme production takes place in a fermentation vessel under controlled conditions. After this fermentation process, the enzymes are isolated and further processed for industrial use.

Which industries use enzymes?
Enzymes are widely used in many different industries, including food, beverages, detergents and textiles. They are also used in animal nutrition where enzymes are supplemented in finished feed. During animal feed digestion the enzymes break down feed molecules into smaller components, enabling these nutrients to be more easily absorbed by the gut. This allows the pig and poultry producer to lower feed costs, improve the nutritive uniformity of the feed, help maintain optimal gut balance and reduce environmental outputs of phosphorus and nitrogen.

Are feed enzymes safe?
Yes, they are natural, biodegradable ingredients. Feed enzymes are digested as normal proteins, so they do not leave any residues in animal produce.

How do feed enzymes work?
Enzymes have an active site of a specific size and form that will fit only one substrate (e.g. arabinoxylan) in a specific reaction. The enzyme and substrate form an enzyme-substrate complex, where a reaction occurs breaking down the substrate and releasing different products. This allows the enzyme to work again and form a new substrate complex.

Why use enzymes in animal feed?
The challenge
- Feed is often the single biggest cost in animal production. Pigs and poultry do not digest around 15-25% of the feed they eat.
- Feed ingredients contain “anti-nutritional factors” and pigs and poultry do not produce the enzymes to break down these anti-nutrients.
- Young animals have an immature digestive system so enzyme production may be inadequate.

The solution
- Improve efficiency and reduce cost – break down anti-nutrients, allowing the animal to digest its feed more efficiently.
- For a better environment – phytase reduces phosphorus excretion, and carbohydrases and proteases can help reduce nitrogen output.
- Improved consistency – reduce the nutritional variation in feed ingredients resulting in more consistent feed for more consistent animal performance.
- Helps to maintain optimal gut balance – by improving nutrient digestibility, fewer nutrients are available in the animal’s gut for the growth of undesirable bacteria.

Feed enzyme guide

<table>
<thead>
<tr>
<th>Enzyme</th>
<th>Substrate</th>
<th>Enzyme-substrate complex</th>
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Reaction occurs releasing products A and B
Product A
Product B