Interest in feed additives will continue and will be influenced by new research results, advertising, and profit margins. In 2009, dairy nutritionists reported that some dairy managers removed all additives without considering the economic, production, and health impacts. An annual market survey conducted by Hoards Dairyman Magazine in January, 2010, is summarized in Table 1. Dairy managers were selected from Hoard's Dairyman subscribers based on the percent of their subscribers from each state.

Table 1. Percent of dairy managers reporting the inclusion of feed additive in their lactating dairy cow ration.

<table>
<thead>
<tr>
<th>Additive</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffers</td>
<td>41.4%</td>
</tr>
<tr>
<td>Yeast products</td>
<td>31.8%</td>
</tr>
<tr>
<td>Mycotoxin binders (flow agents)</td>
<td>23.1%</td>
</tr>
<tr>
<td>Ionophore (Rumensin--trademark)</td>
<td>21.4%</td>
</tr>
<tr>
<td>Probiotics/DFM</td>
<td>13.2%</td>
</tr>
<tr>
<td>Niacin</td>
<td>14.0%</td>
</tr>
<tr>
<td>Anionic products</td>
<td>4.4%</td>
</tr>
<tr>
<td>Feed bunk stabilizer</td>
<td>0.7%</td>
</tr>
<tr>
<td>No additives fed/included (not used)</td>
<td>8.1%</td>
</tr>
</tbody>
</table>

Feed additives are feed ingredients added for a non-nutrient role (for example sodium bicarbonate is added as a rumen buffering agent, not a source of sodium). Additives vary in cost from three cents to 30 cents a cow a day. The main reason to add a feed additive is to enhance cow performance based on farm conditions, research results, role of the feed additive, and economic returns.

Table 2 outlines additives in six categories that will assist dairy farmers, consultants, feed company nutritionists, and veterinarians in deciding if an additive should be included. The category, current status, is classified in the following ways.

* Recommended: Include as needed
* Experimental: Additional research is needed before recommending
* Evaluative: Monitor individual farm situation (variable responses)
* Not recommended: Currently lacks economic response
Table 2. Feed additive guidelines for dairy cows.

**Anionic salts and products**

1. **Function:** Cause the diet to be more acidic increasing blood calcium levels by stimulating bone mobilization of calcium and calcium absorption from the small intestine
2. **Level:** Reduce DCAD to zero to –50 meq/kg or 5 meq/100 grams using chloride sources (calcium chloride, ammonium chloride, Bio Chlor, Animate, Soy Chlor, Nutra Chlor, and hydrochloric acid treated feeds)
3. **Cost:** 40 to 75 cents per dry cow per day depending on product used
4. **Benefit to Cost Ratio:** 10:1
5. **Feeding strategy:** Feed to dry cows two to three weeks before calving. Adjust dietary calcium levels to 100 grams per day (30 grams inorganic). Raise dietary magnesium levels to 0.4 percent.
6. **Status:** Recommended

**Aspergillus oryzae**

1. **Function:** Stimulate fiber-digesting bacteria, stabilize rumen pH, and reduce heat stress.
2. **Level:** 3 g per day
3. **Cost:** 3 cents per cow per day
4. **Benefit to Cost Ratio:** 6:1
5. **Feeding Strategy:** High grain diets, low rumen pH conditions, and under heat stress (cows) and calves receiving a liquid diet
6. **Status:** Evaluative

**Biotin**

1. **Function:** Improve hooves by reducing heel warts, claw lesions, white line separations, sand cracks, and sole ulcers and increase milk yield through a metabolic routes
2. **Level:** 10 to 20 milligrams per cow per day for 6 months to one year
3. **Cost:** 8 to 10 cents per cow per day
4. **Benefit to Cost Ratio:** 4:1
5. **Feeding Strategy:** Herds with chronic foot problems, may require supplementation for 6 months before evaluation, and company recommends beginning supplementation at 15 months of age.
6. **Status:** Recommended

**Beta-carotene**

1. **Function:** Improve reproductive performance with higher ovarian levels, increase fiber digestion by rumen microbes, immune response, and mastitis control
2. **Level:** 300 mg per day (blood levels 1.5 to 3.5 micrograms/ml); 500 mg per day (blood levels < 1.5 micrograms per ml).
3. **Cost:** 30 cents to 50 cents per cow per day
4. **Benefit to Cost Ratio:** Not available
5. Feeding Strategy: In early lactation and during mastitis-prone time periods
6. Status: Experimental

**Calcium propionate**
1. Function: Increase blood glucose and calcium levels
2. Level: 120 to 225 grams
3. Cost: 80 cents per pound
4. Benefit to cost ratio: Not available
5. Feeding Strategy: Feed 7 days prepartum to 7 days postpartum or until appetite responds; unpalatable
6. Status: Recommended as a drench agent

**Choline (rumen protected)**
1. Function: A methyl donor used to minimize fatty liver formation and to improve fat mobilization leading to improved milk yield and reproductive performance
2. Level: 15 to 30 g per day
3. Cost: 30 cents per cow per day
4. Benefit to Cost Ratio: 2:1 (when protected)
5. Feeding Strategy: Feed two weeks prepartum to eight weeks postpartum to cows experiencing ketosis, weight loss, and high milk yield
6. Status: Recommended

**Enzymes (fibrolytic)**
1. Function: Increase fiber digestibility by reducing fiber (cellulase and xylanase enzymes) and DM intake.
2. Level: Not clearly defined (enzymatic units per unit of feed dry matter)
3. Cost: 15 to 30 cents per cow per day
4. Benefit to Cost Ratio: 2 to 3:1 (Canadian data)
5. Feeding Strategy: Increase fiber digestibility, treated 12 hours before feeding, spray on product more effective when applied to dry diets, and may be diet specific.
6. Status: Experimental

**Enzymes (starch-amylase)**
1. Function: Amylase based enzymes can improve total tract starch digestibility and improve milk yield and feed efficiency
2. Level: 300 kNU per kg dry matter intake. 1 kNU = approx 6 “Ceralpha Units” using the Megazyme International amylase assay
3. Cost: 15 cents per day
4. Benefit to Cost Ratio: 3:1 (U of WI data)
5. Feeding Strategy: Improve starch utilization reducing corn levels and replacing with lower cost rumen fermentable carbohydrate sources
6. Status: Experimental

**Essential oil compounds (cinnamon oil, clove oil, and/or garlic oil)**
1. Function: Improve rumen fermentation by reducing protein deamination, increase propionate production, increase feed efficiency, and/or improve hydrogen status
2. Level: 0.5 to 1.5 grams per cow per day (higher levels may have a negative impact)
3. Cost: Varies, six cents per cow per day
4. Benefit to Cost Ratio: 7:1 (Wisconsin data)
5. Feeding strategy: Increase propionate production in the rumen and feed efficiency
6. Status: Experimental

**Immune stimulation (OmniGen AF—brand name)**

1. Function: Impacting immune function as measured by changes in neutrophil activity including migration via L-selectin, phagocytosis, oxidative burst reactions leading to lower SCC and high milk yield related to immunity improvement. May be used to reduce HBS or bloody gut losses.
2. Level: 56 grams per day
3. Cost: 13 cents per day
4. Benefit to cost ratio: 7:1 early lactation; 3:1 for entire lactation
5. Time period: Dry off to 60 days postpartum
6. Status: Experimental

**Magnesium oxide**

1. Function: Alkalinizer (raises rumen pH) and increases uptake of blood metabolites by the mammary gland raising fat test
2. Level: 45 to 90 g per day
3. Cost: 21 cents per pound
4. Benefit to Cost Ratio: Not available
5. Feeding Strategy: With sodium-based buffers (ratio of 2 to 3 parts sodium bicarbonate to 1 part magnesium oxide)
6. Status: Recommended as a source of magnesium and buffer pack with bicarb

**Methionine hydroxy analog**

1. Function: Minimize fatty liver formation, control ketosis, and improve milk fat test
2. Level: 30 g
3. Cost: 10 cents per cow per day $1.60 per pound)
4. Benefit to Cost Ratio: 2:1
5. Feeding Strategy: Feed to cows in early lactation receiving high levels of concentrate and limited dietary protein
6. Status: Evaluative

**Monensin (Rumensin—brand name)**

1. Function: Improve feed efficiency for lactating cow, reduce ketosis and displaced abomasums in transition cows by shifting rumen fermentation and microbial selection. Milk yield may increase 2.2 pounds per day. Control coci in calves and heifers.
2. Level: 11 g to 22 g per ton of total ration dry matter consumed (250 to 400 mg / cow / day); lower levels in calves and heifers
3. Cost: 1 cent per 100 mg per day
4. Benefit to Cost Ratio: 5 to 1
5. Feeding Strategy: Feed to dry cows (reduce metabolic disorders) and lactating cow (feed efficiency) while monitoring milk components to evaluate optimal levels of monensin.
6. Status: Recommended

**Niacin (B₃, nicotinic acid, and nicotinamide)**

1. Function: Coenzyme systems in biological reactions, improve energy balance in early lactation cows, control ketosis, and stimulate rumen protozoa
2. Level: 6 g unprotected per cow (prepartum), 12 g unprotected per cow (postpartum), or 3 grams of rumen protected (one gram of rumen protected replaces 8 grams of unprotected niacin) and 3 grams of unprotected for rumen function
3. Cost: One cent per gram unprotected; ten cents rumen protected
4. Benefit to Cost Ratio: 3:1 (12 grams level)
5. Feeding Strategy: High producing cows in negative energy balance, heavy dry cows, and ketotic-prone cows fed two weeks prepartum to peak dry matter intake (10-12 weeks postpartum)
6. Status: Evaluative

**Prebiotics (Non-viable probiotics)**

1. Function: Stimulate bacterial growth or reduce bacteria growth that can reduce animal performance. Examples include inulin (stores carbohydrates), oligofructose, yeast cell wall products, MOS products, butyrate (0.16 g/liter of milk), lactoferrrin (2 mg/ml of colostrums)
2. Level: Varies by product and brand
3. Cost: 4 to 15 cents per day
4. Benefit to Cost Ratio: Not available
5. Feeding Strategies: Feed to calves and animal exposed to undesirable bacteria in the digestive tract
6. Status: Experimental

**Probiotics (Bacterial direct-fed microbes)**

1. Function: Produce metabolic compounds that destroy undesirable organism, provide enzymes improving nutrient availability, or detoxify harmful metabolites
2. Level: Not clearly defined
3. Cost: 5 to 15 cents per cow per day
4. Benefit to Cost Ratio: Not available
5. Feeding Strategy: Feed to calves on liquid diet, transition cows, high levels of rumen fermentable starch/carbohydrates, and during stress conditions
6. Status: Evaluative for cows; recommended for milk fed calves

**Propylene glycol**

1. Function: Source of blood glucose, stimulate an insulin response, and reducing fat mobilization
2. Level: 8 to 16 ounces per cow per day
3. Cost: $1.25 per pint or pound
4. Benefit to Cost Ratio: Not available
5. Feeding Strategy: Drench cow starting at one week prepartum (preventative role) or after calving when signs of ketosis are observed (treatment role). Feeding not as effective as drenching.
6. Status: Recommended

Silage bacterial inoculants
1. Function: To stimulate silage fermentation, reduce dry matter loss, decrease ensiling temperature, increase feed digestibility, improve forage surface stability, and increase VFA (lactate) production
2. Level: 100,000 colony forming units (CFU) per gram of wet silage. Recommended bacteria include Lactobacillus plantarium, Lactobacillus buchneri, Lactobacillus acidilacti, Pediococcus cerevisiae, Pediococcus pentacoccus, and/or Streptococcus faecium.
3. Cost: $0.60 to $2.00 per treated ton of silage
4. Benefit to Cost Ratio: 3:1 (feed recovery) to 7:1 (milk improvement)
5. Feeding Strategy: Apply to wet silage (over 60 percent moisture); corn silage, haylage, and high moisture corn; field conditions with low natural bacteria counts (first and last legume/grass silage and frost damaged corn silage); and under poor fermentation situations.
6. Status: Recommended

Sodium bentonite
1. Function: A clay mineral used as a binder, shifts VFA patterns, slows rate of passage, and exchanges mineral ions. Field claims to tie up mycotoxins have been reported (not legal claim via FDA)
2. Level: 450 to 700 g per day (rumen effect), 110 grams for mycotoxin effect
3. Cost: 15 cents per pound
4. Benefit to Cost Ratio: Not available
5. Feeding Strategy: With high grain diets, loose stool conditions, presence of mold, low fat test, and dirt eating
6. Status: Evaluative

Sodium bicarbonate/sodium sesquicarbonate (buffer)
1. Function: Increase dry matter intake and stabilize rumen pH.
2. Level: .75 percent of total ration dry matter intake
3. Cost: 6¢ per cow per day (bicarb = $0.19/lb; S Carb = $0.18/lb)
4. Benefit to Cost Ratio: 4:1 to 12:1
5. Feeding Strategy: Diets that are high in corn silage (over 60% of total forage intake), wet rations (over 55% moisture), lower fiber ration (<19% ADF), limited hay intake (<5 lb), finely chopped forage (over 50% in the bottom Penn State Particle Box, pelleted grain mixtures, slug feeding of concentrates, and under heat stress conditions.
6. Status: Recommended
**Yeast culture and yeast**
1. Function: Stimulate fiber-digesting bacteria, stabilize rumen environment, and utilize lactic acid.
2. Level: 10 to 120 g depending on yeast culture concentration
3. Cost: 4 to 6 cents per cow per day
4. Benefit to Cost Ratio: 4:1
5. Feeding Strategy: Two weeks prepartum to ten weeks postpartum, calf starter feeds, and during off-feed conditions and stress periods
6. Status: Recommended

**Yucca extract**
1. Function: Decrease urea nitrogen in plasma and milk by binding ammonia to the glycofraction extract of Yucca shidigera plant improving nitrogen efficiency in ruminant animals.
2. Level: 800 milligrams to 9 grams per day (depending on source)
3. Cost: 2 to 4 cents per cow per day ($1.28/ lb for Micro Aid 1X)
4. Benefit to Cost Ratio: Not available
5. Feeding strategy: To cows with high BUN and MUN levels
6. Status: Evaluative

**Zinc methionine**
1. Function: Improve immune response, harden hooves, and lower SCC.
2. Level: 9 g per day or 25% of added zinc supplemented
3. Cost: 2 to 3 cents per cow per day
4. Benefit to Cost Ratio: 14:1
5. Feeding Strategy: To herds experiencing foot disorders, high somatic cell counts, and wet environment
6. Status: Recommended