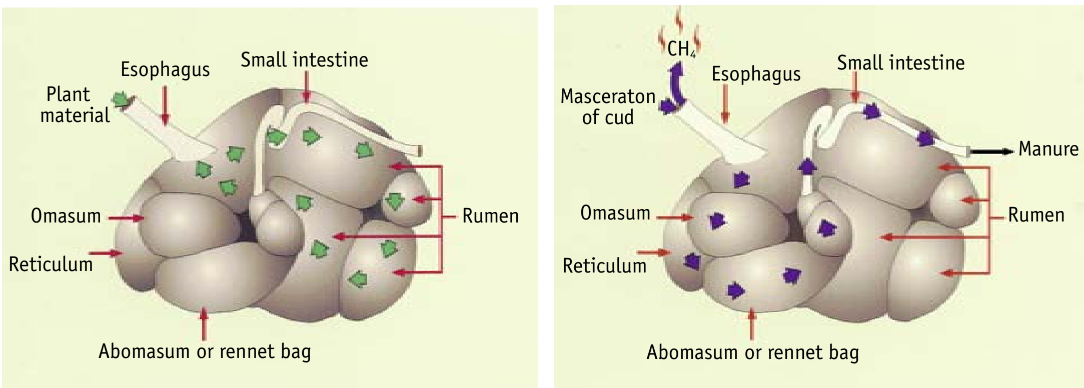
NUTRITION AND WATER

Less waste and improved feed conversion to marketable livestock product means lower emissions per animal from the cattle industry.

Diet and feeding strategies are of critical importance to livestock and poultry health, performance and product quality. Reduced feed wastage and improved performance can be attained with careful attention to the principles of animal nutrition, feed analysis, ration formulation and feeding strategy.

Animal digestion and excreted feces/urine are the main sources of greenhouse gases and potential water pollutants from livestock agriculture. Obviously, practices that improve performance and reduce nutrient wastes will help reduce emissions.

PRINCIPLES



Ruminant livestock convert fibrous plant materials into food, thanks to a four-part stomach that includes the rumen, reticulum, omasum and abomasum. The rumen accounts for 80% of the total stomach volume. The rumen's function is to house microbes that break down and ferment the plant material into energy. Energy compounds are used for maintenance and production functions. Methane is a by-product of this process.

Technology that reduces feed loss translates to lower manure volumes and lower emissions.

The prime sources of greenhouse gases from livestock are rumen-sourced methane, methane from stored manure, and nitrous oxides and ammonia from manure. The nature and extent of these emissions relate directly or indirectly to animal nutrition.

Methane emissions from ruminants and non-ruminants can be reduced with better nutrition management – improving roughage quality and balancing with grains.

Meeting the requirements for essential amino acids can reduce nitrogen excretion. Use rumen-undegradable protein supplements such as roasted soybeans or corn gluten meal to minimize excesses of non-essential amino acids.

As you consider diet changes to reduce greenhouse gas emissions, re-orient yourself to the principles of nutrients and feeds. Start by analyzing your current feed materials. Whenever practical, seek assistance from a livestock nutritionist or feed company representative. They can help to formulate rations with available feeds – and supplements where necessary – to meet nutrition requirements, as well as to reduce emissions and meet production goals for your livestock or poultry operation.

For further information regarding the nutritional requirements of swine, beef, dairy, sheep and poultry, visit: www.nap.edu/browse.html

4 STEPS TO PRODUCTIVITY, REDUCED NUTRIENT WASTE, AND REDUCED GREENHOUSE GAS EMISSIONS

1. Determine animals' requirements. Match feed to nutritional requirements and waste less feed.
2. Evaluate feeds. Test feedstuffs so that you know nutrient levels fed. This can help reduce nutrient levels in excreted wastes.
3. Feed only what they need. By meeting needs, you improve efficiency and waste less.
4. Manage nutrient waste and manure. Manage manure materials so that feed crops can use manure nutrients efficiently.

DIGESTION

Digestion is a complex metabolic process. Digested feed is used for:

▶ maintenance – respiration, normal biological processes
▶ growth and production requirements – meat, eggs, milk
▶ reproduction.

Nutritional requirements are directly related to growth stage and type of production.

Excretion rates are also related to nutrient availability. Excretion is related to:

▶ feed and nutrients consumed
▶ efficiency of uptake
▶ normal metabolic excretions (e.g., tissue breakdown).

Properly formulated diets that precisely meet requirements for maximum efficient growth will also reduce excessive N and P excretion.

Better nutrition means that more of the feed is assimilated for production and proportionally less is used for maintenance.

Evaluate feeds. Test feedstuffs so that you know nutrient levels being fed. This can help reduce nutrient levels in excreted wastes.

Monogastric (non-ruminant) animals, such as poultry, pigs, dogs and humans, are not able to digest cellulose efficiently.

Methane is a by-product of enteric digestion by microbes called methanogens. Methane is released mostly by belching. It represents a loss of dietary energy and feed inefficiency. CH_4 is proportional to feed components: high fibre = high methane.

Feeding a high-fibre diet leads to higher rates of methane generation.

Microbial digestion of fibres from roughages (cellulose) and starch (from grains) results in the production of energy for the animal. Rumen microbe species are specialized in their ability to break down either starch or cellulose. When the diet is high in roughages, the fibre-digesting microbes multiply and dominate. In a high-grain diet, the number of starch-digesting microbes increases.

Changes in the composition of a ration should be made gradually to allow time (about two weeks) for the rumen microbe population to adapt. Any practices that speed up the rate of passage of roughage through the digestive system will reduce the rate of enteric fermentation.

DIGESTION IN RUMINANTS

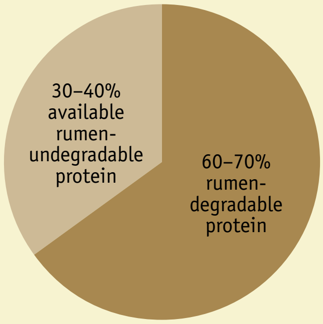
Ruminants generate 80% of the methane from livestock agriculture. They convert fibrous plant materials into food, thanks to a four-part stomach that includes the rumen, reticulum, omasum and abomasum. The rumen accounts for 80% of the total stomach volume.

The rumen's function is to house microbes such as bacteria, protozoa and fungi. These microbes break down and ferment the plant material into energy. Energy compounds are used for maintenance and production functions.

Ruminants can utilize two types of nitrogen compounds in their diet: true protein and non-protein nitrogen (npN). The digestion of a particular protein depends to a large extent on its degradability.

Non-protein N (e.g., urea, ammonium) is soluble and easily used by rumen microbes, as are some readily digestible proteins. The amount assimilated relates to the energy intake – much like the C:N ratio found in soils. If there is insufficient energy or excess protein, most of the npN will be excreted as urine.

Eventually the microbes become a source of protein as they pass into the small intestine.



Optimum diets usually contain 30–40% available rumen-undegradable protein and 60–70% rumen-degradable protein.

N-use efficiency is related to two factors:

- ▶ the balance of protein types and N-sources fed, and
- ▶ the balance of N-sources and energy "fed" to the rumen bacteria.

Optimum diets usually contain 30–40% available rumen-undegradable protein and 60–70% rumen-degradable protein. Less than 30% of total protein should be in the form of npN.

FEEDING MANAGEMENT FACTORS

FACTOR	DESCRIPTIONS
GROUPING	• Group animals for feeding by stage, age, weights
GENDER	• Group animals by sex for non-ruminants
ENVIRONMENT	• Change the diet to meet requirements as affected by season, local weather conditions, housing conditions
FEEDING STRATEGY	• Plan and adjust diets by growth stages (phase-feeding)
WASTE	• Use BMPs to reduce wastage and spillage
FEED PROCESSING	• Modify feedstuffs to make them more palatable and the nutrients more available

Group animals by growth stage, age, and weight to improve efficiency and reduce emissions.

FACTOR	DESCRIPTIONS
NUTRIENT CONTENT AVAILABILITY	• Use feed analysis results to determine availability and to formulate diets
GENETICS	• Adjust diet for genetic potential for growth rates, feed-conversion, etc.
FEED EFFICIENCY	• Adjust balances and use promoters to improve intake efficiency
SPECIAL FEEDS	• Use special amino acid feeds, feeds with specific enzymes
WATER SUPPLIES	• Ensure proper quality, safety and mineral content

NUTRITIONAL BALANCE AND EXCRETION

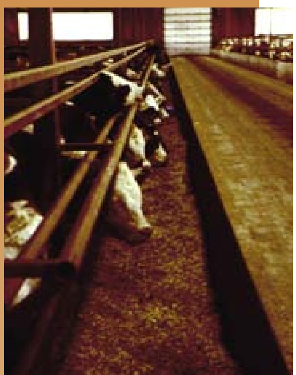
A properly formulated ration supplies adequate amounts of all nutrients to allow animals to achieve a desired level of production. Accurate ration formulation requires:

- allowance for animal characteristics – sex, weight, frame size, body condition, desired rate of gain, stage of production
- feed analysis
- consideration of other feeding management practices, e.g., feed additives.

Precision nutrition is a means of ensuring that livestock and poultry are fed the right quantity of nutrients in an ideal ratio to maintain optimum efficiency.

The ratio of amino acids AAs required for growth is fixed – a deficiency in one amino acid will affect the overall growth of all AAs.

AAs that are absorbed and not used for growth and production are used as an energy source. As a consequence, ammonia is produced. The ammonia is detoxified in the liver to produce urea, which is excreted in urine. Urea can volatilize (as ammonia) when mixed with feces.



Lacombe Research Centre estimates a 14% reduction in GHG emissions from feedlot cattle with properly balanced rations.

NUTRITION AND METHANE REDUCTION

Methane production by ruminants is a function of:

- feed characteristics
- feeding portions and schedule
- nutritional balance, e.g., high N in manure = more methane loss
- additives, and
- health and fitness of animal.

Dairy cattle methane emissions have dropped by 15% over 30 years, largely due to improvements in nutrition and production efficiencies. There are now 41% fewer dairy cows. Today's cows produce more milk per cow and 20% more milk overall.

DIET MANIPULATION BMPs

✔ **Determine nutrient content** to understand the bioavailability.

✔ **Adjust diets to ensure nutrient balance,** less nutrient waste and better performance (e.g., amino acid balance for methane reduction in swine).

✔ **Select feed materials for improved production.** Consider type, bioavailability and quality. In ruminants, high-quality forage consumption leads to less methane production; more grains, with less roughage and more available nutrients, lead to less methane.

✔ **Use speciality feeds.** Feeds with special ingredients can help improve feed efficiency (e.g., legumes with enzymes for non-ruminants).

✔ **Use additives where useful.** Copper and zinc balance can act as growth promotants for increased productivity.

Analyze feeds to determine bioavailability of nutrients.

Use high quality feeds. High quality forages will reduce methane emissions.

FEEDING MANAGEMENT BMPs

- ✔ **Group by sex, age and stage of production** to help target feeding to diet requirements (split-sex feeding).
- ✔ **Consider how feeds are processed.** Ground or pelleted feed can reduce methane by 20–40%.
- ✔ **Ensure proper feeder design and presentation.** These can reduce losses during feeding and wasted feed.
- ✔ **Adjust feeding to weather conditions.** Weather conditions can impact feeding programs. For example, under hot summer conditions, pigs eat less but require more energy for heat dissipation, requiring a nutrient-dense diet with a lower protein-to-energy ratio.

Reduce feed losses with improved technology.

Adjust feeding to weather conditions to reduce manure nitrogen content.

High digestibility of ingredients via technological treatments (particle size reduction, pelletting, expanding) or through the addition of enzymes can reduce excess wastes and nutrient losses. For example, with pelletization, feed efficiency has improved by 8.5% and protein digestibility by 3.7%.

Improving feed efficiency will reduce nutrient excretion.

NUTRITION AND REDUCTION OF NITROUS OXIDE FROM LIVESTOCK MANURE BMPs

- ✔ **Reduce crude protein in diets.** All nutrients should be balanced. For ruminants, high N diets = great loss of N in urine. For example, researchers have documented 80% of N loss when consumption of N for swine exceeds 500 g/day. Urinary N excretion increases exponentially to N intake.
- ✔ **Reduce crude protein in ruminant diets.** Nitrogen plus high crude protein = high N excretion in dairy cattle.

- ✔ **Provide a better AA balance.** In swine, this could make for 40% less methane and ammonia (N). In poultry, with a 40% adoption rate, a 15% reduction in the protein intake by poultry would help meet Kyoto protocols.
- ✔ **Improve performance potential.** Improving productivity and feed efficiency is the most obvious strategy for reducing nutrient excretion and increasing profitability.
- ✔ **Enhance nutrient availability.** Treat feeds for non-ruminants with enzymes and eliminate anti-nutritional factors from feed materials (e.g, tannins, polyphenols).
- ✔ **Practise phase feeding.** Different diets can be fed so as to more closely match the nutrient requirements of the separate sexes while limiting excesses and reducing excretion. For grower-finisher pigs, this will help balance AAs in the diet to the requirements of the animal so less N is excreted. Meeting the N needs more precisely would reduce N in manure by 13%.
- ✔ **Use supplemental AAs to produce a protein with a near-perfect AA balance.** A 15-kg pig can convert 87% of its absorbed nitrogen above maintenance to carcass protein. For poultry, supplement methionine and lysine to reduce crude protein content. (AA levels depend on ratio of digestible lysine to other AAs.)
- ✔ **Follow feeding guidelines to reduce ammonia emissions.** Formulate rations that meet requirements and reduce ammonia emissions.

Reduce nitrogen levels in manure with better AA balances in rations.

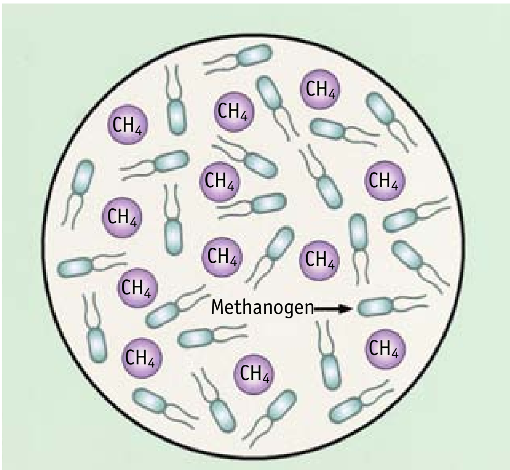
Practise phase-feeding to reduce excretion of nitrogen.

IONOPHORE SUPPLEMENTS

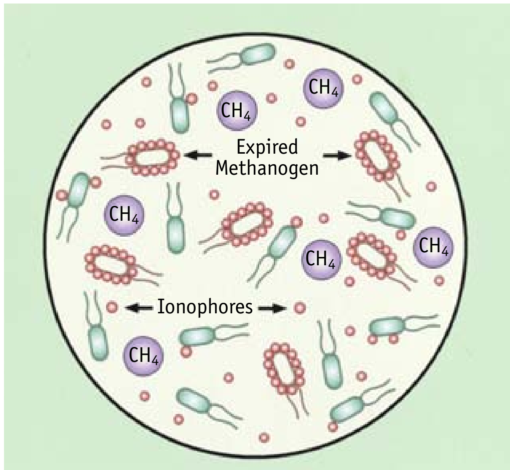
Ionophores reduce methane production from rumen fermentation and improve performance and gain. Use ionophores to:

- improve efficiency of energy metabolism by increasing the ratio of acetate to propionate (volatile fatty acids or VFAs) and decreasing energy lost during feed fermentation
- decrease breakdown of feed protein and bacterial protein synthesis, which makes high-roughage feeding more efficient
- reduce incidence of acidosis, coccidiosis and grain bloat.

Ionophores may reduce methane by up to 24%.



Ionophores reduce methane production from rumen fermentation.



Ionophores inhibit methanogenesis and can reduce methane emissions by up to 24%.

LIVESTOCK DRINKING WATER

Clean water in sufficient quantity is a necessity for animal health and production efficiency. Again, the link to greenhouse gas emission reduction is making your operation as efficient as possible. Limitations on water intake can affect performance through dehydration, sight and hearing impairment, and urinary problems. Factors that can affect water intake include these:

- ▶ water temperature – ideally 4.0–18.0°C (40–65°F)
- ▶ access – preferably free
- ▶ nutrients in diet – increases in salts or protein levels stimulates increased intake
- ▶ stress – can reduce consumption
- ▶ water quality – including but not limited to presence of salinity, dissolved solids, nitrates, pH, microbiologic properties, and other chemicals.

✔ To protect water quality:

- ▶ **get it tested regularly**
- ▶ **interpret results** to determine if there is an ongoing water safety or quality problem
- ▶ **take corrective measures** for well protection, repair, water treatment or well abandonment.

Nitrates, bacteria, organic materials and suspended solids are the most common substances that can contaminate on-farm water supplies, which in turn can adversely affect livestock and poultry.

Test drinking water quality regularly and take corrective measures if water test results indicate a water safety problem.