

ANIMAL NUTRITION TECHNOLOGY EXCHANGE

January 20, 2000

A Conference Developed by the Agricultural Nutrient Reduction Workgroup
of the
Chesapeake Bay Program's
Nutrient Subcommittee

This document is a summary of the Animal Nutrition Technology Exchange.

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INTRODUCTION

During the past several years, considerable attention has been directed at the potential environmental impacts of agriculture in the Chesapeake Bay Watershed. A primary focus has been on the potential nutrient loadings to surface and groundwater resulting from animal agriculture sources. In this context, a wide array of alternative practices and uses have been suggested to reduce the effects of current manure management practices.

There is an emerging body of science-based information on the formulation of animal rations that have the potential to cost-effectively achieve the objectives of producers and also result in potential reductions in the nutrient content of manures at the point of excrement. These reductions can be achieved in a number of ways. One example is the incorporation of enzymes into rations (required in Maryland beginning in 2001) in order to improve the ability of animals to utilize a greater proportion of the nutrients that are ingested.

The Chesapeake Bay Program's Agricultural Nutrient Reduction Workgroup (AgNRWG) planned a technology exchange in the Winter of 2000 to serve as a mechanism to begin to develop a broader understanding of the latest advances in animal nutrition and the ability of these advances to provide cost-effective tools to reduce the nutrient content of animal waste at the point of excrement.

The technology exchange involved individuals from each of the jurisdictions representing:

- state lead agencies
- state associations of swine, livestock, dairy and poultry producers
- state environmental organizations
- state agribusiness associations that represent processors and suppliers
- Agricultural Experiment Stations
- state Cooperative Extension
- state conservation agencies, and
- state offices of the Natural Resource Conservation Service and the Farm Service Agency

The objectives of the Animal Nutrition Technology Exchange were to engage participants in discussions to:

- Assess the current science-based technology available to produce cost-effective animal feeds that minimize the nutrient content of animal manures at the point of excrement
- Assess the current level of adoption of these technologies by feed producers
- Identify and assess the barriers to adoption of these feed technologies by feed producers
- Identify and assess the barriers to adoption and utilization of nutrient reduction feeding strategies by farmers; and
- Identify the technology needs required to accelerate the adoption and utilization of appropriate reduction strategies in animal agriculture in the Chesapeake Bay Watershed.

PROGRAM

January 20, 2000

Moderator: Roydan Powell, Assistant Secretary Maryland Department of Agriculture.

9:00 AM - **Welcome** - Dr. Thomas Simpson, Chair, Chesapeake Bay Program, Nutrient Subcommittee

9:10 AM - **Watershed and Regional Nutrient Balance Issues** - Dr. Les Lanyon, Professor of Soil Fertility, Penn State University

9:55 AM - **Managing the Nutrient Content of Rations to Achieve Animal Production Goals and also Minimize Environmental Consequences** - Dr. William B. Roush, Associate Professor of Poultry Science, Penn State University

10:55 AM - **Panel 1: Optimizing Nutrient Levels in Feed Through Balanced Mixes While Minimizing Nutrient Outputs"**
Dairy - Dr. Charles Stallings, Professor and Extension Dairy Scientist, Virginia Tech
Swine - Dr. Ken Kephart, Associate Professor of Animal Science, Penn State University.
Poultry - Dr. William B. Roush, Associate Professor of Poultry Science, Penn State University

12:45 PM - **Economics of Enzyme Technology and Cost/Benefits** – Dr. Darrell Bosch, Professor Agricultural and Applied Economics, Virginia Tech

1:25 PM - **Panel 2: "The Status and Progress of Implemented Feeding Strategies"**
Poultry - Winston Turner, Broiler Production Manager, Tyson Foods
Dairy – Dr. Rick Kohn, Associate Professor of Animal Science, University of Maryland
Swine & Poultry - Joe Garber, Nutritional and Analytical Services Coordinator, Wenger Feed, Inc.,

2:35 PM - **Breakout Groups.**

Breakout Group discussion topics include:

1. **Identify barriers to adoption and ways to increase adoption.**
2. **What practices can work now - economically and environmentally?**
3. **Identify knowledge gaps and future research needs.**

3:35 PM - **Report from Breakout Groups and discussion.** Chaired by Royden Powell

4:00 PM - **Closing Remarks and Adjournment.** Royden Powell.

ABSTRACTS

Watershed and Regional Nutrient Balance Issues – Dr. Les Lanyon, Professor of Soil Fertility, Penn State University

Introduction

Changes in the amount of nutrients available to agriculture have made possible changes in the organization of agriculture at field, farm, watershed, and regional levels. The new patterns of organization in agriculture have resulted in new consequences from the production methods. Reactions by various interest groups to these consequences are contributing to new expectations for agriculture. Because each action in agriculture has many consequences, the new expectations and the means to achieve them must be sensitive to the factors that have contributed to the specialization in agriculture and not just a reaction to a subset of the consequences.

Increased Nutrient Availability

Unease about the ability of agriculture to sustain itself because of nutrient scarcity continued from the 19th century into the 20th century. As we begin the new millennium, concerns about nutrient scarcity have been replaced by concerns about the consequences of nutrient excesses. This dramatic change was based on the ability to fix nitrogen from the atmosphere by industrial processes that were pioneered to ensure the ability of nations to fight world wars. The nitrates so commonly used in agriculture can be, under the right conditions, explosives. It was the military dependence on the explosive character of nitrates that led many nations to build nitrogen fixation plants. These plants were later converted from military to agricultural purposes. Phosphorus is currently mined from geologic deposits rather than recaptured from biological sources such as animal and human bones. We no longer scour battlefields for bones, nor rely on recapturing the nutrients in the wastes from slaughtered animals to sustain agricultural production.

Changes in the Organization of Agriculture

Although those who advocated for increased nutrient availability envisioned the need to offset nutrient deficiencies in crop production, changes in organization of agriculture were made possible by the continuous supply of nutrients from new sources. Because fertilizer could replace the nutrients exported from farms in harvested crops, recycling nutrients in manure from animals on the farm was no longer an essential tactic to sustain the productivity of farms. Fertilizer made it possible for some farms to specialize in crop production and other farms to specialize in animal production. In addition to the production advantages that are often due to specialization, the result was a new pattern of nutrient flow. Nutrients from primary sources such as the atmosphere and geologic deposits were processed into fertilizer and shipped to cash crop farms. The nutrients built soil reserves and were taken up into harvested crops that were transported to specialized animal production facilities. Although there are some nutrient balance issues related to crop production, they are mostly related to the efficiency of nutrient recovery by crop plants. Nutrient balance in animal agriculture is another issue. Animals naturally excrete a large proportion of the feed nutrients they consume as "waste." Ecologically this excretion is critical to the functioning of natural systems. So, unlike crop production in which improved efficiency can reduce the nutrients required for production, animal agriculture will always have a large part of the nutrients consumed by the animals end up in the waste because the biology of animals defines the limits.

Consequences of New Patterns of Organization

The concentration of animal agriculture has contributed to the accumulation of nutrients in some areas in excess of the crop utilization potential of nearby fields. These excesses can be lost as nitrate leaching into groundwater or as phosphorus being lost in runoff from agricultural landscapes. The degradation of water resources has attracted attention in many locations and

stimulated calls for cleaning up the sources of pollution. At the same time, the associated economies of scale and advantages of size in agriculture have created a widely distributed and very powerful system of production. Instead of being constrained by the local crop production for feeding animals, this new system is able to access feed and other production inputs from many locations. Thus, the concentrated animal production units can be fueled with the lowest cost feeds that are available in the market. These units also have power in marketing products for processing or may actually be integrated with the processing units. Local, small scale production that can not take advantage of "low-cost" inputs, nor negotiate with processors is at a disadvantage in comparison to the concentrated and integrated operations.

Reacting to the Consequences of Agricultural Production

Although many programs are underway to reduce the loss of excess nutrients from agriculture, these often address symptoms of the organization of agriculture as perceived by special interest groups. For instance, those interested in water quality in a particular area may not realize that the concentration of animals is based on very rational business principles and a host of factors that encourage the organizations involved. Furthermore, there may be social advantages for the farmers involved because intensive animal agriculture may be the most viable of the agricultural alternatives available to them in an intensely competitive agricultural economy. Responses by governments to those concerned about the consequences of agriculture will also have their own collateral consequences in addition to the intended impacts on water quality improvement. Future actions must take into account the full spectrum of consequences, not focus solely on the intended outcomes. Decision-makers must factor into their decisions the implications of their actions for the next iteration in the evolution of agriculture. They will be creating a new set of conditions and factors to which businesses and farmers will react. As the seemingly simple introduction of fertilizer to offset nutrient deficiencies in agriculture made entirely new patterns of organization possible, the new business environments they create will stimulate new relationships and organization.

Reacting to the consequences of watershed and regional nutrient balances is not like fixing a broken food producing machine. It involves the setting of parameters for a dynamic, evolving system whose managers will explore the possibilities of those parameters and fashion new patterns of organization. Those in agriculture and those affected by the consequences of agriculture have stakes in the outcomes of the new patterns. It is likely to be in the best interest of all to respond with this in mind.

Managing the Nutrient Content of Rations to Achieve Animal Production Goals and Also Minimize Environmental Consequences –

Dr. William B. Roush, Associate Professor of Poultry Science, Penn State University

Feed formulation management has the potential to reduce nitrogen and phosphorus pollution at the nutrient input stage. This management strategy includes: (1) the development of analytical, physical and nutritional enhancements for ingredients, (2) the accurate determination of the nutritional requirements of animals, and (3) examination of alternatives to linear programming to more accurately meet requested nutrient levels.

Analytical, physical and nutritional enhancement of ingredients includes the improvement of the availability and digestibility of nutrients and the determination (prediction) of nutrient levels and their variance in ingredients. Artificial neural networks have been shown to be an effective alternative to regression analysis for predicting amino acid levels in ingredients based on proximate analysis values.

Treatments and additives that reduce excess concentrations of nitrogen include supplementing the diet with commercially available amino acids and feed formulation based on digestible amino acid values and ideal amino acid profiles. Phosphorus pollution can be reduced by formulating on the basis of available phosphorus and by adding enzymes to the diet that will release phosphorus from phytate. Also, nutrient pollution can be reduced by phase-feeding diets to match the changing nutrient needs of the animal.

Multivariate experimental designs (response surface methodology) can efficiently and effectively define the requirements of animals for nitrogen and phosphorus and their interaction with other nutrients and energy factors. Computer modeling for ruminants, swine and poultry holds promise for defining nutrient requirements under varying environmental conditions.

Algorithm alternatives to linear programming are being investigated for more effective formulation of rations to meet nutritional and economic goals. These computer algorithms provide a framework upon which the analytical, physical and nutritional enhancements of ingredients can be effectively balanced to reduce nutrient pollution while meeting economic goals. Stochastic programming, goal programming and genetic algorithms are being compared to linear programming (with a margin of safety). Stochastic programming involves the formulation of rations based on nutrient variability at a specified level of probability. Goal programming is an approach that allows more than one objective (e.g., minimizing cost and nutrient variance) to be met in the formulation process. Genetic algorithm formulation of rations is based on the principles of genetic selection. The variables of the ration are evolved into an optimal solution.

In summary, research is being conducted on analytical, physical, and nutritional enhancement of ingredients. Stochastic programming, goal programming and genetic algorithms, as alternatives to linear programming, are being investigated for feed formulation. These nutrient management developments promise to more accurately meet animal nutritional requirements and reduce the consequences of nutrient pollution in the environment.

PANEL 1

“Optimizing Nutrient Levels in Feed Through Balanced Mixes While Minimizing Nutrient Outputs”

Dairy - Dr. Charles Stallings, Professor and Extension Dairy Scientist - Nutrition, Virginia Tech

Dairy cattle nutritionists and milk producers have been pushing for higher milk production in order to remain competitive in a challenging economic environment. In the process, cattle are many times over-supplemented with nutrients, especially protein (nitrogen, N) and phosphorus (P). This excess will be excreted in the feces (N and P) and urine (primarily N). In addition, many times farms with herd sizes of less than 130 cows do not have facilities to group and feed cows by production, a practice commonly encountered in larger herds. The majority of Virginia herds are less than 130 lactating cows. Feeding only one group contributes to over supplementation because the ration is balanced to challenge higher producers but will supply excessive amounts to lower producers. A fairly typical one group ration balanced to supply 17% protein (2.72% nitrogen) and .77 Mcals net energy/lb. of dry matter would contain 20 lbs. alfalfa silage, 50 lbs. corn silage, 4.5 lbs. whole cottonseeds, 1 lb. fish meal, 5.5 lbs. soybean meal, and 12 lbs. shelled corn. At milk yields ranging from 30 to 100 lbs./cow/day the following demonstrates the degree of overfeeding.

<u>Lbs./cow/day</u>	<u>30#</u>	<u>40#</u>	<u>50#</u>	<u>60#</u>	<u>70#</u>	<u>80#</u>	<u>90#</u>	<u>100#</u>
Dry matter intake	33	37	39	43	46	49	52	55
Protein consumed	5.5	6.2	6.6	7.3	7.8	8.3	8.8	9.3
Protein required	3.4	4.2	5.1	5.9	6.8	7.6	8.4	9.3
Excess	2.1	2.0	1.5	1.4	1.0	.07	.04	0
(% excess)	(38)	(32)	(23)	(19)	(13)	(8)	(5)	(0)
Phosphorus consumed	.14	.16	.17	.19	.20	.21	.22	.24
Phosphorus required	.09	.11	.13	.15	.17	.18	.20	.22
Excess	.05	.05	.04	.04	.03	.03	.02	.02
(% excess)	(36)	(31)	(24)	(21)	(15)	(14)	(9)	(8)

The ration above had no supplemental P but still contained .43% P on a dry basis. Approximately two-thirds of the P came from whole cottonseeds, fish meal, soybean meal, and corn. These are feeds usually imported onto the farm. The alfalfa and corn silage usually grown on the farm supplied only about one-third of the P. Only about 30% of consumed P is captured in milk and exported off the farm, so typically, there is a net importation of P onto a dairy farm. To further confound the problem P is normally supplemented in inorganic form. For instance adding a pound of 4:1 mineral (calcium:phosphorus ratio) supplement to the ration increases the P content to .55%. Research has documented that this high level is not needed and lower levels are recommended. In conclusion, N and P excretion can be reduced by grouping and feeding by production and reducing or eliminating supplemental P when amount in feeds are adequate.

Swine - Dr. Ken Kephart, Associate Professor of Animal Science, Penn State University

Overview of Swine Production Systems

Nearly two-thirds of all nutrients consumed by the pig are excreted in the manure, but it has only been in the last decade that animal agriculture has recognized the importance of nutrient excretion. Recently, more precise feed formulation and the use of feed additives have helped to reduce nutrient excretion. But important challenges remain in animal production systems and the land application of manure.

Today, the vast majority of swine producers operate an all-in-all-out system – grouping pigs closely by age and weight. This has important implications for nutrient excretion. Since body weights are fairly precise within a group, we can formulate diets to exacting specifications— saving both dollars, and nutrients.

But in the last 20 years, swine farms have increased in size to help offset diminishing profit margins. In addition, many units are now operated under contract. Both trends mean that all feed nutrients are now imported to the farm.

For contract grower-finisher units, most or all of the manure produced is applied on the home farm. Large sow units, however, usually produce an excess of manure causing the application of manure to sometimes become a disposal issue. As a result, manure is surface-applied to increase nitrogen volatilization, and crop yields are projected at the upper limit, in order to maximize manure application rates. Since the P:N ratio in manure is already higher than is required by most crops, these high manure application rates increase the deposition of P in the soil.

Partial Solutions to Nutrient Imbalance and Nutrient Excretion

The use of lysine and other amino acids in swine diets enable the feed manufacturer to decrease the amount of protein, and therefore the nitrogen, in the diet. This practice can reduce nitrogen excretion by more than 20%; unfortunately this practice increases the P:N ratio in the manure even further. The use of dietary phytase, an enzyme that enhances the digestion of plant-borne phosphorus, can reduce phosphorus excretion by at least 20%. Furthermore, with the recent edition of the Nutrient Requirement of Swine (1998), and an awareness of nutrient excretion, nutritionists follow recommended guidelines fairly closely.

Future Needs for Swine Production Systems

The use of phytase is a sound tool for reducing phosphorus excretion, but methods are needed for further reductions, or for extracting P from the manure. Equipment is needed to provide fast and economical injection or incorporation of manure without destroying conservation practices. Water waste has been reduced in swine production, but further improvements are needed to decrease the cost of hauling swine manure long distances.

Economics of Enzyme Technology and Cost/Benefits – Dr. Darrell J. Bosch, Professor, Agricultural and Applied Economics, Virginia Tech

Runoff from soils which are very high in phosphorus (P) can be detrimental to surface water quality. High soil P may result from repeated applications of manure with higher P content than can be used by crops. Genetically engineered microbial phytase can improve swine and poultry utilization of natural P in feedstuffs, reduce the need for supplemental feed P, and lower P content in animal manure. Producers must weigh phytase costs against its potential economic benefits. Costs include purchasing the enzyme formulation, adapting the feed system to accommodate the enzyme formulation, management time to learn to manage the new feed ration, and risk. Benefits include lower feed P supplement costs, lower manure disposal costs, and lower costs of commercial fertilizer. Case studies of a Virginia turkey operation and a North Carolina swine operation were conducted to evaluate the farm-level costs and benefits of microbial phytase under a P-standard where manure applications cannot exceed crop P recommendations.

Potential net returns from microbial phytase for turkeys were estimated as savings in supplemental feed P costs plus savings in commercial fertilizer costs, plus increased prices of litter sold off the farm, minus costs of microbial phytase. Estimated costs of phytase formulation to reduce P content in litter by 35 percent were \$2,500. Phytase reduced supplemental P feed costs by an estimated \$1,431. When the P content of litter was reduced, more litter could be applied on farm and the cost of supplemental commercial fertilizer was reduced by \$390. Reduced P content of litter would reduce the amounts of excess litter exported by poultry producers, increase the amounts that non-poultry farms could import, and enhance prices of litter sold off the farm. When the litter price enhancement effect is included, it is likely that economic benefits of phytase would exceed its cost.

Potential net returns from microbial phytase for swine were estimated as savings in swine lagoon liquid application costs plus savings in supplemental feed P costs minus costs of microbial phytase. Estimated costs of phytase formulation to reduce litter P content by 28% were \$4,735. Savings in supplemental feed P formulation were estimated as \$2,713. Savings in lagoon liquid application were \$9,356 when lagoon liquid was applied to bermudagrass hay, resulting in a \$7,334 net return to phytase. When lagoon liquid was applied to corn, savings in lagoon liquid application to corn were \$1,686 resulting in a negative net return of \$-336 to phytase.

Phytase can lower but not eliminate the cost to poultry and swine farmers of limiting manure applications to crop P requirements. The more widely the P standard is applied, the greater the potential cost savings from phytase use. Effective phytase use requires cooperation between integrators and contracting producers and development of ways to manage production risks.

PANEL 2

“The Status and Progress of Implemented Feeding Strategies”

Poultry – Winston Turner, Broiler Production Manager, Tyson Foods

The concept of using phytase in feed has been used in Europe for some period of time. In the USA it was tested by E.T. Kornegay for six years at Virginia Tech.

Much of the phosphorus in poultry and swine feed is a form that is poorly digested by these monogastric animals, including humans. Phytase improves digestion of the phosphorus and is better balanced for plant needs.

Phytase is organic and sensitive to heat and must be applied after the pelleting process. BASF came up with a fluid form of phytase that uses 1.5 gallons of water with .12 pounds of natuphos per one ton of feed. A computer controlled Doppler Radar Unit measures the flow into the spray unit. The cost of installation for the feed mill was \$140,000. The state grant for installation and natuphos was \$84,000.

Starting in mid February 1998, Tyson Foods ran extensive tests to be sure phytase would work in the poultry world. This test concluded there was no difference in bird performance between phytase and control. The big advantage was the DeFlour phosphate was reduced from 17 pounds per ton to 6 pounds per ton of finished feed. Manure test results during the performance testing period indicated that phytase in 85% of our feed would reduce P205 by 28.30%. When used in 100% of the feed the reduction should be 33.30%.

Dr. Paul Ruszler of Virginia Tech recently summarized Virginia's annual poultry manure production at 469,312 tons at 30% moisture or 438,008 tons at 25% moisture. Using the Department of Conservation and Recreation (DCR) default of 62 pounds per ton; 13,578 pounds of phosphorus is produced. Using Tyson Foods of Harrisonburg projection at 100% implementation of 46 pounds per ton; 10,074 tons of phosphate is produced, the reduction will be 3,503 tons. Tyson continues to run tests with Virginia Tech to continue improving the reduction of phosphorus.

Dairy – Dr. Rick Kohn, Associate Professor of Animal Science, University of Maryland

Milk urea nitrogen (MUN) is a means to evaluate nutritional status in lactating dairy cows because it is an indirect measure of protein utilization. With adequate energy in the diet, MUN is indicative of protein status. Variation in MUN has also been suggested to be related to the protein to energy ratio of the diet consumed.

Nitrogen (in the form of protein and non-protein nitrogen, NPN) consumed by the dairy cow has three ultimate fates. Part of the N is undigested and excreted in the feces. The remaining N is absorbed into the blood stream from diffusion of ammonia across the rumen wall and transport of amino acids and peptides from the small intestine. Ammonia is toxic to the animal and is therefore rapidly converted to urea in the liver. Some of the absorbed amino acids and peptides are utilized for milk synthesis. Excess absorbed amino acids and peptides are deaminated in the liver for energy and N is converted to urea.

The urea is filtered from the blood by the kidney and is excreted from the body in urine. Blood flow through the kidney is constant within an animal, which ensures a constant urea filtration rate (milliliters of blood filtered per minute) regardless of urine volume. Because urea is a small neutral molecule, it readily diffuses across cellular membranes. As milk is secreted in the mammary gland, urea diffuses into and out of the mammary gland, equilibrates with urea in the blood. Because of this process, MUN equilibrates with and is proportional to blood urea N. A mathematical model based on these principles was developed to predict urinary N excretion from MUN.

When excess N is consumed by a dairy cow, urea in the blood increases. Subsequently an increase in MUN and urinary excretion of N occur. Conversely when little excess N is consumed, urea in the blood is low and lower MUN and urinary excretion of N result. Therefore high MUN concentrations indicate excess protein in the diet while low MUN levels show protein may be deficient. Furthermore, high MUN indicates high levels of urinary N excretion. However, a definitive method for determining target MUN concentrations has been lacking.

The objectives of our study are: 1) to establish target MUN concentrations for cows fed according to National Research Council recommendations throughout a 305-d lactations, 2) to compare target values with correct MUN concentrations from Lancaster Dairy Herd Improvement Association, and 3) to examine the environmental and economic impact of overfeeding protein in the Chesapeake Bay drainage basin.

**Swine and Poultry – Joe Garber, Nutritional and Analytical Services
Coordinator, Wenger Feed, Inc.**

New feeding strategies for swine and poultry have been successfully implemented at Wenger Feed Mill, Inc. For phosphorus, the strategies include reduced dietary levels, supplemental phytase and source of inorganic phosphorus. During 1993, the reduction of phosphorus levels in swine feed was initiated going from 0.63% to 0.51%. Currently, efforts are underway to include phytase and approach the 0.40% levels recommended by the National Research Council. The phytase enzyme liberates phytate bound phosphorus and is heat unstable, so it must be post-pellet applied. In addition, it provides amino acid and energy benefits. However, phytase application may impact manufacturing efficiency. Inorganic phosphorus availability values were analyzed. Trace mineral "tie-up" of phosphorus and using extra clean sources were found to be important factors. Feed nitrogen reduction was also achieved using synthetic amino acids and digestible amino acid formulations. These methods reduce total nitrogen levels needed to satisfy amino acid requirements and currently focus on lysine and methionine. Activities include using ingredients at its true digestible value, increasing efficiency of nitrogen utilization and altering the previous "value" for ingredients. Similar reductions and efficiencies have occurred in poultry feeding operations. Use of phytase in poultry feed started in 1996. These efforts have lowered feed costs and increased nutrient efficiency, while meeting animal nutrition requirements.

SUMMARY FROM THE BREAKOUT SESSIONS

Introduction

This portion of the meeting was devoted to breakout groups that were charged with discussing the three specific topics identified below. Each of the three groups discussed all three of the topics, but were tasked to concentrate on a specific one. Participants were assigned to each of the three breakout groups randomly in order to ensure a mixture of backgrounds and viewpoints. The structure of the breakout groups was a "brainstorming session" facilitated by a moderator, and recorded by a note taker. This section summarizes the ideas put forth by the breakout groups.

Barriers to the Adoption of New Animal Nutrition Technology in Environmental, Agricultural and Governmental Sectors, and Ways to Increase Adoption

Barriers

- Lack of a clear understanding, on the part of the farmers, millers and processors, of the costs and effects of feed additives and high phytase corn to more efficiently utilize nutrients in feed
- Uncertainty across the animal industry about the nature and amount of risk associated with new methods for managing nutrients in feed
- Lack of cost-share programs to off-set capital investment costs
- Current inability to produce feed with more precise and consistent nutrient content
- Lack of a common understanding among the animal agriculture industry, environmental community and governmental agencies on the role and implications of managing nutrients in animal feeds as a tool for reducing nutrients in manure
- Lack of clear, consistent management recommendations to farmers by animal nutritionists, animal health care professionals, millers and proprietary industry interests

Opportunities to Increase Adoption

- Strengthen education/technology transfer programs for the animal agriculture industry (farmers, millers, animal health professionals, processors) on appropriate technology, costs and benefits of adoption, animal health implications, and environmental consequences
- Develop new and strengthen current mechanisms for communication between the animal agriculture industry, the environmental community and governmental agencies
- Initiate consistent, and where appropriate, collaborative responses in the implementation and use of the technology across jurisdictions, e.g. Cost-share/incentive programs that are consistent, science based education and technology transfer programs, technology development and consistent regulations

Practices that can Work Now

- Utilize Milk Urea Nitrogen (MUN) screening as a nutrition guide for formulating rations in lactating dairy cows
- Use of high phytase corn in formulating rations for the appropriate segments of the animal production industry
- Improving on-farm nutrient efficiency by increasing the adoption of animal grouping practices
- Incorporating phytase as a feed additive to increase phosphorus utilization
- Utilize amino acid supplements in feed formulations to increase the efficiency of nutrient utilization

Knowledge Gaps and Research Needs

- Current National Research Council (NRC) nutritional standards for many animals are not current, and in some instances are based upon data from animal genotypes that are no longer used in production. More precise nutrition standards that are designed for current genotypes and production practices should be established
- Improve the technology in the production of feed to ensure a more consistent and uniform nutrient content
- Develop science based assessments of the economic, animal health, and environmental benefits and risks of utilizing formulated feeds that more precisely meet animal nutrition needs
- Improve the technology for the cost-effective incorporation of additives into feeds to enhance nutrient utilization
- Develop science based assessments of the influence of feed additives on changes in the potential fate and transport of excreted nutrients
- Develop a science based definition of the role of cost-effective, environmentally sound animal nutrition management as an element of a watershed wide sustainable animal agriculture

ADDITIONAL DISCUSSION ITEMS

There were a number of items that participants discussed that they recognized were indirectly related to animal nutrition. However, there was general agreement that these issues were of sufficient importance and should be identified and enumerated in these proceedings. Most of the topics arose during discussions of knowledge gaps and research needs. They include:

- A very real need to develop science based estimates of the spatial and temporal distribution of ammonia emissions from animal agriculture
- A need for cost-effective management practices to reduce odors from animal agriculture for farms across the entire watershed
- Farmers need manure management alternatives to composting and land application that include the economics of implementation and sound market development practices, especially for those farms with existing high soil phosphorus levels
- A need for wastewater treatment technology/practices for animal agriculture. A high priority should be given to systems that recycle wastewater on-farm
- A continuing need exists to develop practices that allow for incorporation of all types of manure without disturbing conservation practices

SUMMARY OF PROCEEDINGS

The technology exchange provided a forum for broadening the understanding of current and potential animal nutrition practices and their effects on animal agriculture in the Chesapeake Bay Watershed. The participants represented a diverse array of stakeholders from across the watershed. Examples of current progress in the science of animal nutrition and the adoption of new nutrition management practices were examined and discussed. Barriers to accelerated adoption were identified and explored. Participants concurred that significant opportunities do exist to incorporate into the major animal production systems, practices and technologies that can improve the efficiency with which animals utilize nutrients in feed, and feeds that can be produced to more precisely meet the nutritional needs of animals. There was general agreement that substantial reductions in the nutrient content of manure at the point of excrement are possible through the adoption of these practices and technologies. However, participants agreed that before wide-scale adoption of these practices and technologies could take place, substantive improvements must be made in the quality and extensiveness of the science available to support them. There are concerns about the currency of data on nutrient requirements that support animal nutrition data bases used for formulating feeds. It was recognized that a more definitive understanding of animal nutrition requirements coupled with the ability to more precisely formulate feeds to meet those needs could substantially reduce the excess nutrients currently in feeds. Participants also noted that the widespread adoption, in this watershed, of animal nutrition practices that would minimize nutrients in manure at the point of excrement, could only be achieved with a sustained education and technical assistance program to teach farmers, millers, processors, and animal health professionals how to adapt and use the practices.

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