Ammonia Emission BMP's for Livestock Feeding: Identifying Benefits and Barriers to Adoption

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Problem Statement and Relevance: Significant debate surrounds potential regulation of ammonia emissions from livestock feeding. Considered a source of nitrogen deposition in Rocky Mountain National Park and a hazard to human health, ammonia emissions (Figures 1&2) are now the focus of a Colorado Department of Public Health and the Environment sub-committee on air quality. At the same time, the USDA Natural Resources Conservation Service is beginning to develop air quality management practices for livestock owners including technical assistance and cost shares.

One approach to mitigating ammonia emissions is the use of specific livestock feeding, manure handling and land application practices. A number of best management practices (BMP's) will reduce ammonia emissions in livestock feeding. Primary data on the ammonia reduction potential of these practices is now being collected, but has not been published. Further, the cost of implementing these BMP's across heterogeneous livestock operations is not well known. Lastly, the adoption potential of these BMP's by livestock producers is not well researched in the economics literature.


Figure 1. US Ammonia NH3 Levels

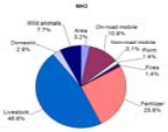
Figure 2. NH3 Emission Sources

Objectives: The overall objective of this study is to provide policymakers, industry professionals and scientists with more information regarding the costs, benefits and the potential success of BMP's for ammonia reduction. More specific objectives include:

1. *Quantify the ammonia emission reduction of 13 BMP's in terms of output measures (e.g. pounds of beef produced);*
2. *Calculate the costs of implementing BMPs individually or jointly, with particular attention to the demographic characteristic of livestock operation (e.g., size);*
3. *Reveal the barriers to adopting BMP's as self reported by livestock producers in a survey effort that includes manager and feeding operation characteristics;*
4. *Examine the potential for ammonia emissions reduction given the information of objectives (i)-(iii) with potential recommendation for NRCS assistance programs.*
5. *Provide recommendations to extension and livestock advocacy groups for targeting groups in BMP adoption efforts.*

The economic literature considering ammonia emission reduction is sparse. A study of dairy producers (Nunez and McCann, 2008) found that off-farm income, location, perceived profitability and perceived complexity were significant factors in determining adoption of four water quality manure BMPs in Iowa and Missouri. Prior to this research, Rahelizatovo (2002) found that adoption of dairy water quality BMPs was highly influenced by farm and operator characteristics, environmental perceptions as well as producer attitudes. The current research aims to extend this body of research to ammonia BMPs with particular attention to air quality.

Research Methodology An interdisciplinary approach addresses the research objectives. Pilot BMP experiments at feedlots in Colorado are used as primary data for ammonia emission reduction and as baseline cost information for implementing the program. Review of secondary data and an advisory group are used to further improve cost estimates of adoption and are used to inform calculation of emissions reduction in terms of output measures.

BMPs vary in simplicity, managerial time, effort and required financial capital, but may be boradly categorized into those that focus on feed intake and nutrition; BMP's that involve physical management of drylot pens and handling manure (Figure 5)

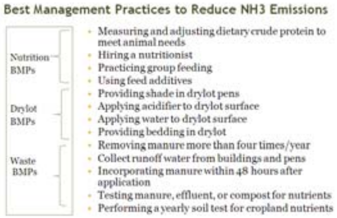

Figure 5. Ammonia Reducing BMP's

To learn more about these potential adoption barriers, a questionnaire was mailed to 1,998 dairy and feedlot producers in four states: Colorado, Kansas, Iowa and Nebraska. The survey requested information on producer adoption of thirteen BMPs listed in Table 1. These practices are known to reduce ammonia emissions (Marcillac et al., 2007) though producer knowledge of the practices' benefits may be limited. BMP adoption among the survey respondents is listed in Table 1's second column, and range from heavily adopted (e.g., using feed additives) to those that are seldom adopted (e.g., adding an acidifier to the surface of a dry lot).

Table 1. Current Adoption of NH3 BMP's Among Respondents

BMP	Adoption Rate
Use feed additives	96%
Measure and adjust crude protein to meet animal needs	93%
Practice group feeding (group by age, sex, etc)	88%
Perform yearly soil test for cropland nutrients	78%
Hire a nutritionist to formulate rations	77%
Collect runoff water from buildings and pens	67%
Remove manure more than four times per year	60%
Test manure, effluent, or compost for nutrients	59%
Provide bedding in drylot pens	52%
Incorporate manure within 48 hours after application	42%
Provide shade in drylot pens	34%
Apply water to the surface of drylot pens	28%
Apply an acidifier to the surface of drylot pens	3%

Factors Influencing Adoption Of the BMPs listed in Table 1, the respondents' cost perceptions of the BMP, its perceived profitability and the amount of technical expertise that is required are of particular note. These are the variables COST, PROFIT and TECHNICAL respectively in Table 2, and respondents were asked to rate their level of agreement using a Likert type scale (1= strongly disagree … 5 = strongly agree). Raw data are summarized in Table 3. As an example, measurement of crude protein (PROTEIN) is generally found to improve profitability (ranking of 4.4), requires technical assistance (4.0) and is not perceived to be costly (2.6).

The impact that Table 2's variables have on BMP adoption will vary by the practice; after all, BMP's vary in their requirements for capital, cash flow, technical expertise, etc.

Table 2. Respondents' Likert Agreement (1 to 5) with Practices as Being Profitable, Requiring Technical Assistance and Costly

	Do you think BMP is:		
BMP	Profitable	Technical[1]	Costly
PROTEIN	4.4	4.0	2.6
NUTRITION	4.1	4.2	3.1
ADD	4.3	3.7	3.2
GROUP	4.1	2.1	2.1
SHADE	3.4	2.2	3.4
SURFACE	2.9	2.1	3.4
ACID	2.5	3.0	3.4
CLEAN	3.7	2.1	3.5
BED	3.2	1.9	3.8
RUNOFF	3.0	3.2	3.9
INCORPORATE	3.4	2.2	3.5
TEST	3.8	4.0	3.4
SOIL	4.0	4.2	3.5

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Explaining and Forecasting Adoption A probit analysis estimated conditional probability of adoption given a set of attributes. Explanatory variables in the probit analysis include farm characteristics as well as operator perceptions of cost, profitability, ease of adoption, and environmental impact. The results from the probit model varied substantially across BMPs, with the most robust findings for hiring a nutritionist, implementing group feeding, testing soil for nutrients and providing shade in drylot pens. Practices involving high fixed costs are more likely to be adopted by large operations and by managers that perceive a practice as profit-enhancing.

Two exercises were conducted to determine how policy can feasibly impact adoption. Initially, values of policy-relevant variables were varied across the range of values found in this sample in order to determine how the probability of adoption varies for a given attribute, ceteris parabis. Specifically, the size of the operation, and perceptions of profitability were plotted against the probability of adoption, (Figure 6 and Figure 7).

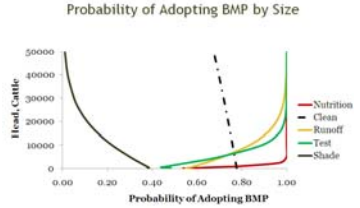

Figure 6. Influence of Size on Adoption

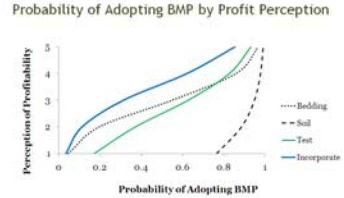

Figure 7. Influence of Perceived Profits on Adoption

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