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## Use of Computer Spreadsheets and Paper-Based Workbooks to Teach Comprehensive Nutrient Management Planning

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## **USE OF COMPUTER SPREADSHEETS AND PAPER-BASED WORKBOOKS TO TEACH COMPREHENSIVE NUTRIENT MANAGEMENT PLANNING**

**C. A. Shapiro R. L. DeLoughery, R. K. Koelsch, M. J. Kucera, and C. S. Wortmann**

### **ABSTRACT**

The objective of this program was to provide producers and ag advisors the skills needed to apply for and maintain the non-engineering components of a Nebraska permit to operate a livestock waste control facility. This includes a Comprehensive Nutrient Management Plan (CNMP). Eighty six producers and advisors participated in an intensive three-session hands-on class with a total of nine contact hours at four sites in eastern Nebraska in the spring of 2002. The workshop included lecture and participant use of spreadsheet tools to assist with performing the necessary calculations. With an average of 68 % responses per session, 58% rated the sessions easy to understand, and only 4% rated them difficult. The classes helped participants develop eight specific skills required to complete and maintain a livestock waste storage operation permit application. These skills were: estimate total land requirements, calculate manure credits, calculate crop nitrogen need, develop a nutrient management plan, write an annual manure application plan, identify key records needed to maintain a permit, and prepare required maps. Over 60% reported they could do these tasks after the workshop, and an additional 30% reported they could accomplish these tasks with some help. Overall, 62% thought they could complete the land application part of the permit. Comments from the evaluation stressed the benefits of using computer-based tools in conjunction with explanations by various presenters.

**KEYWORDS.** Manure management, CNMP

### **INTRODUCTION**

Nebraska Title 130 regulations were promulgated in 2000 in response to changes in state law. The Title 130 regulations increased the level of involvement necessary for managing land application of manure from livestock facilities. In the past, the focus of the permitting process was on the physical facilities for containing the manure produced, and not on the specifics of where and at

what rate the manure was to be applied. The results of these changes were that most producers had to apply for an inspection by the Nebraska Department of Environmental Quality (NDEQ) to determine if a permit would be required. Depending on the findings and the size of the operation, many existing operations had to submit a permit application for review by NDEQ. All proposed new operations and expansions also had to go through this process.

The Nebraska regulations specific to manure application and nutrient management require that a producer submit an application that contains an estimate of annual manure nitrogen produced, nitrogen losses due to storage and application, and the net manure nitrogen available for land application. This estimate is compared to the sum of the crop nitrogen removal for all fields available. If sufficient land is not available to receive this manure then manure application agreements with other landowners must be included in the application. Alternatives such as sale of manure or alternative uses of manure and/or its byproducts may be accepted with sufficient documentation. In addition, the permit application needs to address plans for manure and soil sampling, manure application equipment inventory and calibration, emergency response, land application site inventories and maps, and other planning issues.

Once a permit is approved, the livestock producer must keep annual records to maintain the permit. The producer is responsible and required to have available for inspection a five-year record of nutrient budget procedures, soil sample analysis, manure analysis, crop production, manure and fertilizer application records, and other relevant information.

At the time of the introduction of these new rules, it was unknown what the NDEQ would accept for the many components of the plan. Although NDEQ released guidance documents there was no place to find all the relevant information. Applications were often returned for more information. Only the few consultants, who had experience with several permit applications, had an idea of what was acceptable. Small and medium sized producers did not have the financial resources or the desire to hire consultants for the land application part of the permit application. Thus, there was a need for an educational program and workbooks that combined all the needed information in one instrument. Producers were requesting a workbook that would guide them through development of a permit with assurance of its acceptance during the regulatory review process.

Recent producer adoption of computers (73% own them and 45% use spreadsheets for financial record keeping) meant that spreadsheets could be a useful tool to make permit writing easier (Breazeale and Hill. 2002). Others have used spreadsheets to illustrate complex subjects with success in the agricultural community (Falconer and Parker. 2001).

The objective of this program was to develop spreadsheet tools, along with a set of forms for calculating manure rates and recording notes by hand, and provide training on their use so that a Nebraska CNMP could be completed. A secondary objective was to teach the underlying scientific principles that are the basis for the calculations and regulations. The authors also felt that Best Management Practices and concepts could be promoted at the same time. These tools also

facilitate increased profitability, improve protection of the environment, and ensure regulatory compliance when followed.

## **METHODOLOGY**

### Tool Development

Representatives of NDEQ, NRCS, the University of Nebraska, the animal industry, consultants, educators, and producers met several times in 2000 to provide guidance about how to accomplish the general goal of communicating the needed information and skills that enable livestock producers to comply with the new NDEQ rules. The concluding guidance to the core group, which included the authors of this paper, was the following: the educational effort was to be focused on the non-engineering aspects of regulatory compliance, materials were to be complete, easy to understand, and accompanied with training. The goal was that participants could complete that part of the permit application that applies to land application of manure. In addition, there would be assistance available to answer questions after training was completed.

The underlying framework that the educational effort was to be organized around is shown in figure 1. This flow diagram organizes the material needed into logical groups. The Inventory and Strategic Plan sections are needed in an application to obtain a permit. The Annual Plan, Record Keeping and Review are needed to implement and maintain the permit.

Based on these criteria, the Nebraska CNMP workbook series was developed that combined all the needed information and calculations into a series of forms for major animal species. Due to the size of this document, which was discouraging to the first-year participants, the one large workbook was divided into three smaller workbooks that focused on separate aspects of the planning process: manure application, manure storage, and odor management (Koelsch et al., 2003a; Koelsch et al., 2003b; and Koelsch et al. 2003c). The CNMP class was then focused on the manure application aspect of the regulations. The Manure Application Workbook (2003a) was the primary text used for these workshops.

The workshops were structured as three afternoon sessions given one week apart. The rationale for this approach was a combination of practical considerations: producers prefer mid-day meetings with early dismissal so that they can return to do chores, attention spans for regulatory issues are limited, learning computer programs is challenging, and producers indicated a willingness to attend several shorter sessions instead of a one- or two-day intensive workshop. From the instructor's view, the advantage of several sessions included the opportunity to have producers complete some of the worksheets and spreadsheets at home, reinforce important points at several meetings, allow time for questions to surface, and to give attendees time in class to work through worksheets and spreadsheets with their own data.

Evaluations of the 2001 workshops indicated that the mechanics of doing the arithmetic calculations impeded the learning and understanding of the broader issues related to managing manure and land application. Two long-term planning spreadsheet tools were available for the 2001 pilot session, Nutrient Inventory and Whole Farm Balance (Koelsch, Web Access). Based on producer feedback, the Manure Use Plan spreadsheet was developed to address the annual nitrogen planning needs of producers. This allows producers to focus on the nitrogen management principles underlying land application and record keeping, and not the mechanics of the calculations.

### Additional Tools

Dr. Richard Koelsch developed an Excel® spreadsheet, Nutrient Inventory, which calculates the nutrients excreted by livestock for the producer using accepted 'book' values of nutrient content of manure. Nitrogen use by each crop is based on removal by the crop for the average yield of the field. This spreadsheet is used by NDEQ in their evaluation of livestock waste control facility permits. Alternatively, the producer can input actual feed used and weight gains into the spreadsheet. This spreadsheet will calculate manure nitrogen and phosphorus excretion based on these numbers. These calculations are considered more accurate than using book values since actual feeding and nutrient retention values are used.

A second Excel® spreadsheet, Whole Farm Balance, which calculates the nutrient balance for nitrogen and phosphorus on the farm, was also developed by Dr. Richard Koelsch to provide livestock producers a tool to determine whether their production systems import more nutrients than they export.

A third Excel® spreadsheet, Manure Use Plan, was developed that combined the University of Nebraska nitrogen and phosphorus recommendations for the major Nebraska crops (Ferguson and DeGroot, 2001) and manure application recommendations (Koelsch and Shapiro, 1997a; Koelsch and Shapiro, 1997b) to determine how much manure and fertilizer would be needed for each field. The spreadsheet keeps records for 25 fields for 25 years. It has not been released to the public as of June 2003.

PowerPoint® presentations were developed to help teach participants about manure regulations, nutrient management, and introduce them to the workbooks and spreadsheets. In addition, a case study was developed for a swine operation that shows a completed permit application, and the beginning of a record keeping system needed to stay in compliance after the permit is granted. . The case study information was included in the spreadsheet as an example and to simplify learning to use the spreadsheets. Each participant learned the spreadsheets on a computer during the class.

All materials used in class were distributed to participants via CD-ROM, except the PowerPoint® presentations. The workbooks included reference tables with all the relevant nutrient recommendations needed to complete the crop nutrient related aspects of the CNMP. The workbook is available electronically in two formats: as a Word® document in 'Form Field' mode

where a user can fill in the blanks, but not edit the text in the headings, and also as a Acrobat Reader® version for printing and filling in by hand. Individual forms are also available in both formats as separate files for easier selection of the needed form.

### Evaluations

Each topic of each session was evaluated for ease of use and understanding. At the beginning of the class the participants were asked about their practices. Their self-reported use of best management practices is higher than for the general livestock industry, indicating our participant population was more motivated and more advanced in best management adoption (Table 1). For example, in a study of Kansas swine producers only 10.6% tested their manure for nitrogen and phosphorus compared to 73% reported in Table 1 (Richart et al., 2002).

**Table 1. Use of Best Management Practices by Participants at the CNMP Land Application Workshops. Nebraska. 2002.**

Use of specific practices	Number	(%)Yes	(%)No
Do you calibrate your manure application equipment?	44	55	45
Have you analyzed manure in the last 3 years?	45	73	27
Do you calculate a nitrogen or phosphorus credit for manure application?	44	61	39
Do you perform deep soil sampling for nitrate credit?	44	61	39
Do you perform soil sampling for phosphorus credit?	45	80	20
Do you take into account soil phosphorus levels when choosing manure application sites?	44	68	32
Do you incorporate manure within 24 hours of application?	44	45	55
Do you maintain a written plan for manure application?	45	49	51
Do you maintain a record of past manure applications?	45	73	27
Do you use soil conservation measures at manure application sites?	44	89	11

Alternatively, they knew what the appropriate answers should be and reported the 'correct' answers. The latter seems to be the case since, when asked about specific numbers for the credits and application rates, a different picture emerges. While those reporting taking nitrogen credits averaged 84 lbs N per acre, 56% did not know how much credit they were taking (Table 2). Similarly, those giving phosphorus credits were in the minority and probably were low, 72 % did not have a number to report. The population of producers at the meetings was mostly beef cattle (65%) and swine (25%). This follows the type of manure applied with 52 % spreading manure from box type spreaders, generally scraped from lots, 25 % with liquid applications with tank spreaders, and 13 % using some sort of sprinkler application system. Interestingly, most of the producers either had a permit (44 %) or did not need one (31%). While we did not ask why they were at the meeting in the evaluation, it was clear from the discussions that the producers' main motivation was to learn how to do a better job managing the manure. The 44 % who had a permit and the 10 % who were in the process of obtaining one needed to learn how to make the calculations and keep the appropriate records.

After the three classes, the participants were asked whether they could complete individual components of the permit application and the maintenance of necessary records, as well as put a complete land application permit together. For the individual components, most felt they could do that on their own. On their own implies with the spreadsheet tools that they now had in their possession. Only when asked if they could put all the pieces together in a complete application did more than 50% of participants indicate they needed help doing the task (Table 3).

Of concern to our team was the ability of producers to use spreadsheet type tools to complete long term and cropping season planning activities. The workshop training focused almost exclusively on using computer based tools for determining land requirements (question 2 of table 3), calculating a nitrogen credit and crop nitrogen requirement (questions 5 and 6 of table 3), and preparing an annual action plan (question 7 of table 3). Producer estimation of their skills was high to questions 2, 5, and 6 and moderately high to question 7. These responses and skills exhibited by producers suggested that computer-based tools provide a desirable approach for the majority of producers. Considering the complexity of the calculations and the negative response during our first year pilot test when paper tools were the primary focus, there may not be a good paper-based alternative to some nutrient planning needs.

**Table 2. Quantitative reporting of practices used by participants in the CNMP Land Application Workshops. Nebraska. 2002.**

Use of specific practices	Quantity	(%) Don't know
Pounds of nitrogen credited for first year manure application?	84 lbs N per acre	56%
Pounds of nitrogen credit for previous year's application?	33 lbs N per acre	61%
Pounds of phosphorus credit for manure application?	53 lbs P <sub>2</sub> O <sub>5</sub> per acre	72 %
How is manure spread on your operation?		
Dry spreader	52 (%)	
Irrigation system	13 (%)	
Honey wagon	25 (%)	
Other	7 (%)	
How much manure do you apply on average?		53 %
Tons per acre	23	
Inches per acre (irrigated on)	2.5	
1000 gal/acre	4.5	
Current status in regard to a Nebraska Operating Permit		
Exempt from permit	21 (%)	
Inspected, but permit not needed	10 (%)	
Not inspected	8 (%)	
Construction permit applied for (new facility, Means in the middle of permitting process)	4 (%)	
Operating permit applied for	4 (%)	
Operating with a permit	44 (%)	
Need to submit a permit	2 (%)	
Other	6 (%)	
Species of livestock on your operation?		

Beef cattle	65 (%)	
Dairy cattle	10 (%)	
Hogs	25 (%)	

**Table 3. Ability to accomplish critical tasks related to maintain compliance with Nebraska Title 130 Land Application of Manure Regulations by participants at CNMP Land Application Workshops, Nebraska, 2002.**

Specific task or skill	Number	Yes	Yes, with some help (%)	Unsure (%)
1. Can you prepare a CNMP application?	58	36	58	5
2. Can you estimate total land requirements for manure	58	71	25	4
3. Can you develop a nutrient management activities plan	58	65	33	2
4. Can you prepare maps for a permit application?	58	69	25	5
5. Can you calculate nitrogen credit from manure?	58	65	29	5
6. Can you calculate nitrogen needed by a crop?	58	72	26	2
7. Can you write an annual action plan?	58	56	38	5
8. Can you identify key records for maintaining a permit?	58	58	36	5

The ratings of individual topics were consistently very high. Each topic was evaluated as 'easy to follow', 'somewhat easy to follow', and 'difficult to follow'. The 'difficult to follow' category was never above 7% and usually under 5%. Although no specific questions were asked in our evaluations about implementation of permits among producers with existing permits, multiple comments suggested a rather strong disconnect between regulatory approval of a permit and producers awareness and implementation of the nutrient management and record keeping requirements of the permit. Our team has observed the apparent "boiler plate" CNMP portions of permit applications, which are not specific to individual farms and have not involved the producer in developing the ongoing nutrient management aspects of the permit. Many producers indicated a lack of awareness of procedures they had agreed to implement in the permit application. The development of a permit application by a third party advisor, and the limited follow through by the advisor and producer after regulatory permit approval, suggests real problems in the implementation of management components of the permit. These responses have caused us to place greater emphasis in our training program on Annual Planning and Record Keeping as well as stressing the need for a more active producer role in preparation of the management components of an approved permit.

**Table 3. Ability to accomplish critical tasks related to maintain compliance with Nebraska Title 130 Land Application of Manure Regulations by participants at CNMP Land Application Workshops, Nebraska, 2002.**

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8. Can you identify key records for maintaining a permit?	58	58	36	5

## CONCLUSION

Spreadsheet-based nutrient planning tools were acceptable to the majority of livestock producers involved in the pilot. Paper-based alternatives may not be acceptable for some nutrient planning tasks because of the complexity of those processes.

Planning tools that facilitate producer involvement in development and implementation of management plans are essential. Such tools must remove the mystery of this process for the producer and integrate the producer into the management planning process.

### Acknowledgements

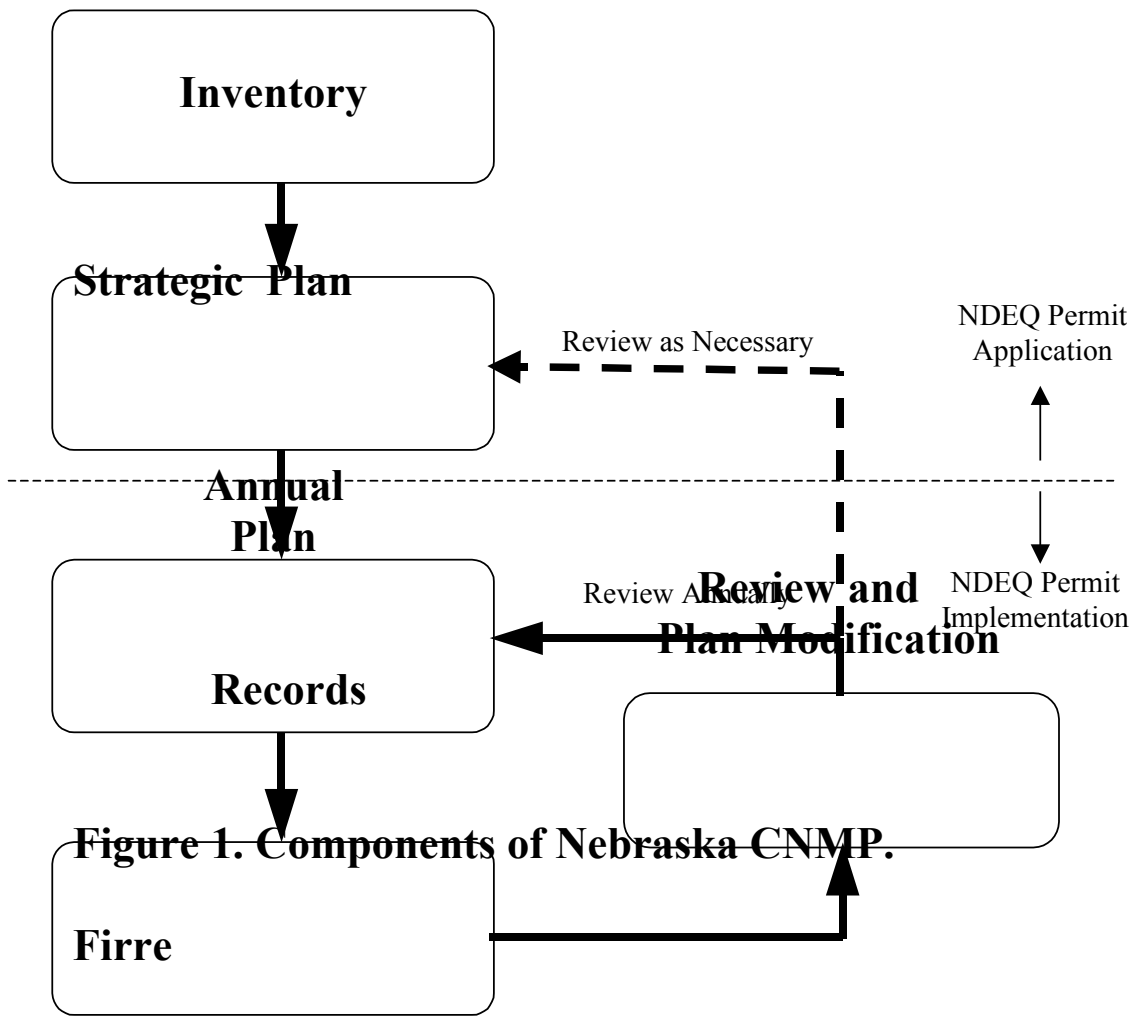
The authors thank the USDA CSREES program for partially funding the pilot program that developed the workshops and workbooks. All the people who reviewed the workbook, the Extension Educators who organized the workshops at specific locations, and the workshop participants who gave us comments and found numerous areas where the materials could be improved.

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## **APPENDIX**



**Figure 1. Components of Nebraska CNMP.**

Figure 1. Components of Nebraska CNMP.