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FINANCIAL COSTS AND ENVIRONMENTAL OUTCOMES OF THE MICHIGAN AGRICULTURE ENVIRONMENTAL ASSURANCE PROGRAM (MAEAP)

By

Carrie Lynn Vollmer-Sanders

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ABSTRACT

FINANCIAL COSTS AND ENVIRONMENTAL OUTCOMES OF THE MICHIGAN AGRICULTURE ENVIRONMENTAL ASSURANCE PROGRAM (MAEAP)

By

Carrie Lynn Vollmer-Sanders

The Michigan Agriculture Environmental Assurance Program (MAEAP) is a voluntary program for all sizes and types of Michigan farms. The intent of MAEAP is to encourage producers to become better environmental stewards by providing producers tools to make and maintain changes that improve environmental stewardship. The focus of this study is the livestock system; all comments and conclusions are specific to that system. Livestock producers with MAEAP-verified operations were interviewed to verify costs incurred and environmental outcomes achieved as a result of MAEAP verification. In addition, producer motivations for participation in MAEAP were also examined.

The total cost to become MAEAP verified was $120,600 of which the average producer paid $104,423 or $14,709 annually. The average livestock producer received $16,177 through EQIP cost-share funds to lessen some of the financial burden. Livestock producers realized an annual cost savings of $2,792 through the use of less commercial fertilizers. The environmental outcomes were investigated using a cropland phosphorus mass balance and field phosphorus index. After becoming MAEAP verified, the average operation evaluated was in mass balance. The phosphorus index analysis indicated that the high risk fields of the high risk farms were, on average, below a risk threshold after becoming MAEAP verified. The major motivation to become MAEAP verified stemmed from environmental regulations directed at the producer's size or type of farm.

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My thesis is dedicated to my husband, sisters, and parents for their love and support and to those producers I admire, who dedicate their lives to being stewards of the land.

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My parents and husband have been extremely supportive of my career aspirations and motivated me when I was delirious from typing. One statement I have wanted to tell to my mother for the past 20 months "Yes, mom my paper is finally finished!" has come to fruition today. I truly appreciated your support, even if I did not always express it.

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KEY TO ACRONYMS

AFO	Animal Feeding Operation
A.U.	Animal Unit
CAFO	Concentrated Animal Feeding Operation
CNMP	Comprehensive Nutrient Management Plan
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CSP	Conservation Security Program
EBI	Environmental Benefits Index
ECOS	Environmental Council of the States
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
GAAMPs	Generally Accepted Agricultural and Management Practices
MAEAP	Michigan Agriculture Environmental Assurance Program
MARI	Manure Application Risk Index
MDA	Michigan Department of Agriculture
MDEQ	Michigan Department of Environmental Quality
MSU	Michigan State University
MSUE	Michigan State University Extension
N	Nitrogen
N	Sample Size
NASS	National Agriculture Statistics Service
NRCS	Natural Resources Conservation Service
NREPA	Natural Resources and Environmental Protection Act
NPDES	National Pollutant Discharge Elimination System
P	Phosphorus
PPI	Producer Price Index
r	Correlation
RUSLE	Revised Universal Soil Loss Equation, Version 1
RUSLE2	Revised Universal Soil Loss Equation, Version 2
TSP	Technical Service Provider
USDA	United States Department of Agriculture
USDL	United States Department of Labor [Bureau of Labor Statistics]

Chapter 1: Introduction

1.1 Problem Statement

Nutrient management has become increasingly important for Michigan livestock producers. During the last decade, animal feeding operations have become more consolidated, specialized, and regionally concentrated (Martinez, 1999). This consolidation and concentration has limited the availability of cropland on which to spread manure. Recent scientific studies (e.g., Butler & Coale, 2005 and Das, et al., 2004) have added to our understanding of the environmental impacts of erosion, runoff, leaching, and excess nutrients that can come from manure spreading on insufficient acreage. There are farm practices that can reduce these environmental impacts, but they all have associated costs. The challenge for producers is to reduce their operation's environmental impact and to manage farm nutrients in an environmentally sound manner, while at the same time maintaining economic viability.

In 1998, a voluntary program called the Michigan Agriculture Environmental Assurance Program (MAEAP) was created using the systems approach. The MAEAP livestock system (referred to in this document as MAEAP) was developed to assist livestock producers with their nutrient management. The main policy vehicle of the MAEAP has been the producers' development of a Comprehensive Nutrient Management Plan (CNMP). The CNMP describes how the management and production practices, equipment, and structures can be used on the farm operation for the production of livestock and crops in an environmentally sound way. The objectives of a CNMP are to protect soil and water quality, obtain beneficial use from animal manure and organic by-products, and minimize impacts to the environment and public health from animal feeding operations (MDEQ, 2005).

MAEAP verification occurs after the Michigan Department of Agriculture (MDA) verifies that the farm has an accurate and complete CNMP and that the producer has implemented or will implement on schedule the pollution prevention practices or improvements presented in the CNMP. To estimate the effectiveness of MAEAP in pollution prevention, it is necessary to determine the environmental changes that have resulted from MAEAP verification on specific operations. To determine the financial impacts, it is necessary to understand the magnitude and incidence of specific costs associated with record keeping, plan writing, managerial changes, and capital investments related to implementing and maintaining MAEAP verification.

Since the MAEAP's inception, there have been three studies that relate to an evaluation of the MAEAP or the cost of CNMP implementation. Patty Farrell of Michigan State University evaluated the Farm-A-Syst in a report entitled, "An evaluation of Michigan Groundwater Stewardship Program's Residential Program, 2002." Farm-A-Syst is a segment within the farmstead portion of MAEAP (Farrell, 2002). Farm-A-Syst addresses groundwater stewardship and farmstead verification, but not livestock and manure management.

Another study was conducted by the United States Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS, 2003). This study, "Costs Associated with Development and Implementation of Comprehensive Nutrient Management Plans" encompassed the entire United States (USDA-NRCS, 2003). Although the estimated costs of writing and implementing a CNMP were not specific to

Michigan, the study did give a baseline to compare where Michigan's costs are relative to the estimates of the Lake states (Michigan, Wisconsin, and Minnesota) and the rest of the country. Not all costs included in this research were included in the USDA-NRCS study.

In 2005, Dr. Allen Krizek conducted a mail-survey titled "A Decade of Change in Manure Management Practices in Michigan" (Krizek, 2005). Dr. Krizek's study was, in part, an updating of the Kevin Kirk (1995) study: "Manure Management Practices in Michigan." Krizek randomly selected dairy, swine, beef and poultry producers (N = 514); he surveyed them in the spring of 2005 to determine what manure management practices were used on their farms and what opinions they had about manure management issues (Krizek, 2005). Dr. Krizek used the same question set developed for the present study to observe his study participants' opinions. Thus, the Krizek study can be an important comparison for this present study's results. Of the 514 questionnaires mailed, 245 were completed and returned. Krizek's noted his survey responses were biased in that the sampling of non-respondents revealed they were producers that, on average, practiced less environmental stewardship than did the respondents. Also, Krizek's survey respondents may or may not be involved with MAEAP. It is beneficial to compare the opinion section of Allen Krizek's research to the present study's results to gain a better understanding of how MAEAP participants differ from Krizek's larger sample of livestock producers that, 1) practice average to above average environmental stewardship and, 2) who may or may not be involved with MAEAP.

This thesis research is original in that neither farm-level financial, nor environmental impacts associated with MAEAP verification were undertaken by previous evaluations. This thesis research should help to inform the agricultural industry and governmental agencies about what costs are incurred by verified operators, what environmental impact results from MAEAP participation, and what motivates livestock producers to become verified in a voluntary, education-based program.

To carefully design this study, several steps were taken to ensure the most important questions were asked during the personal interviews of the MAEAP-verified livestock producers. The certified CNMP plan writers in Michigan were surveyed in the fall of 2004, to capture more information on the changes a typical livestock producer would make to his/her operation to fully implement his/her CNMP. In addition, MAEAP program administrators were also consulted to obtain some background information on MAEAP, the process of verification, and common questions they received from livestock producers seeking verification.

Becoming MAEAP verified does several things for a livestock producer. First, it initiates closer examination by the producer of their manure management practices through the development of a CNMP. For example, when a CNMP is written for a farm, the plan accounts for issues the livestock producer may not have considered earlier, such as manure's nutrient content, keeping clean water clean, or maintaining records of applied manure. Second, after adopting the CNMP, those livestock producers who follow the pollution prevention strategies laid out in the CNMP and/or follow the advice of MAEAP's educational programs may be able to reduce the risk of pollution discharges, nuisance complaints, and lawsuits.

1.2 Objectives and Methods

The objectives of the present study were to identify costs and environmental outcomes associated with becoming MAEAP verified and implementing a CNMP. These objectives were accomplished by first personally interviewing 29 MAEAP-verified livestock producers on 31 operations. Then, the costs associated with becoming MAEAP verified were calculated directly from the interview data. These costs included writing the CNMP, capital investments[1], and management changes[2]. CNMP costs include the costs of the plan writer and the hours the producer spent collecting the information.

The costs involved with capital investments and management changes were reported by the livestock producer during the personal interview. These costs were then annualized or reported as an actual total cost[3], in 2004 dollars. The amount a producer paid out-of-pocket was reported separately from the cost associated with the taxpayer costs plus (+) private costs. The producer plus taxpayer costs included the costs that were cost-shared, plus the costs the livestock producer paid out-of-pocket.

Some changes made on an operation associated with fully implementing the CNMP have associated environmental outcomes such as less phosphorus runoff, keeping clean water clean, or lowering the phosphorus rate applied to a field. In assessing the environmental outcomes, several factors were considered including: the farm's proximity to cold water trout streams, specific field erosion potential, and field phosphorus (P) soil test results. The environmental outcomes were evaluated by considering the operation's cropland phosphorus mass balance and the P-Index score of fields. In addition, producers' motivations for becoming MAEAP verified as well as producers'

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[1] Capital investments include equipment to spread manure, machines to transport manure, manure storage, buildings, roofs, gutters, driveways/berms, drainage, buffers, and grass waterways.

[2] Management changes include crop consultant/Technical Service Provider (TSP), manure spreading hours, supervision hours, recordkeeping, commercial fertilizer purchased, equipment usage, fuel, energy/utilities, insurance, manure sold, manure testing, soil testing, and feed rations.

[3] The total management costs were reported as the present value of an annuity, while the capital investment costs were listed simply as the actual total cost.

environmental attitudes were identified. Several survey questions were focused on the barriers to implementing some of the CNMP strategies.

Ideally, evaluating MAEAP environmental outcomes and cost analysis should occur using a "with and without" framework rather than a "before and after" framework. The reason for using the "with and without" approach is that this framework holds constant those variables that might influence outcomes, whereas the "before and after" framework does not. For example, consider the phosphorus balance calculation, several variables that may have influenced the "before and after" phosphorus balance changes include regulation changes, additional education, input cost fluctuations (i.e., fuel, feed, or labor), Environmental Quality Incentive Program (EQIP[4]) cost-share funding, or technology advances. These variables are difficult to hold constant overtime for this study, yet they could have altered the producers' use of phosphorus or the phosphorus balance. In addition, a livestock producer could have decided to not purchase a feed additive because it is not cost shared, whereas manure storage can be cost shared. The lower out-of-pocket cost perhaps influenced the livestock producer to make a capital investment change instead of a managerial change. These decisions mean the financial costs calculated with a "with and without" accounting stance differs from the "before and after" one. Nevertheless, a "before and after" framework will be used to proxy the with-MAEAP verification and without-MAEAP verification context, because of difficulties of identifying and estimating these other variables.

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[4] The Environmental Quality Incentives Program (EQIP) was re-authorized by the 2002 Farm Bill to: 1) Promote agricultural production and environmental quality on private lands, on a voluntary basis using local, State, tribal, and Federal partnerships to provide flexible technical and financial assistance when complying with regulatory requirements. 2) Encourage environmental enhancement. 3) Stimulate innovative approaches to leveraging the Federal investment in environmental enhancement and protection, in conjunction with agricultural production through Conservation Innovation Grants. 4) Promote ground and surface water conservation on agricultural operations (USDA-NRCS:EQIP, 2005).

There are two methods that will be used to compare the environmental impact of MAEAP, a cropland phosphorus mass balance and the phosphorus index (P-Index). It will be assumed that all strategies laid out in the CNMP were fully implemented. On all surveyed operations in which a CNMP can be collected for this research, the phosphorus mass balance calculation will be used to evaluate its environmental impact from becoming MAEAP verified. The P-Index used for this research is a general P-Index, developed by several nutrient management professionals in Michigan. The P-Index has not been adopted by any Michigan governmental agency (i.e., MDA or NRCS) or MAEAP, but will be a useful tool in determining the change in phosphorus source (e.g., commercial or manure phosphorus) and transport (i.e., due to buffers, setbacks, or cover crops) within a field before and after implementing the CNMP recommendations.

1.3 Research Propositions

The producers interviewed for this research were those who voluntarily became MAEAP verified and voluntarily agreed to be interviewed. Because only producers who had sought MAEAP verification were interviewed, this study is not a representative sample of all Michigan livestock producers. However, the Krizek study does provide some comparisons of finding for MAEAP producers with his large group of respondents.

Each verified livestock farm had the same opportunity to become part of this study as all eligible operations received the same information packet and personal contact. At the time of the study, the total statistical universe of such producers was all producers that were verified by December of 2004 (40) plus those that were scheduled for 2005 verification (6).

Due to the small sample size, no formal hypothesis testing will occur. Therefore, this study was guided by several propositions. Below are nine propositions related to the motivation for becoming verified through the MAEAP, economics of becoming MAEAP verified, and the environmental impacts of MAEAP-verified farms. The propositions are accompanied by a brief explanation informing why each proposition is significant to this research.

Proposition 1: The earliest MAEAP adopters, (i.e., those operations verified in 2002 and 2003) were implementing many of the pollution prevention practices a CNMP requires prior to becoming verified, and thus are the low cost adopters.

This proposition assumes that there is a selection bias for voluntary programs. That is, if all else is held constant, the low-cost adopters will adopt first. It is much easier to become verified if the farm already is practicing a majority of the CNMP-based pollution prevention strategies.

A farm location with few changes might be more likely to become MAEAP verified earlier, as the producer has an easier implementation schedule and fewer costs associated with becoming MAEAP verified than the locations with many changes. Also, if an operation has many fixed assets that need to be altered, such as manure storage structure or production barn, it is less likely that operator will seek MAEAP verification, unless the producer assumes he or she will receive adequate technical assistance and cost-share by being a MAEAP participant.

Proposition 2: Liability risk and the potential for environmental regulation motivate livestock producers to become MAEAP verified.

Research has shown that livestock producers who have significant formal and informal pressures for pollution prevention from the community are more likely to pollute less (Alberini & Sergerson, 2002). Early adopters have more interaction with local and external resources [such as Michigan State University Extension (MSUE) or Michigan Farm Bureau employees], that strongly encourage the adoption of conservation practices (Habron, 2004). In the last decade, local community members and the Sierra Club have increasingly reported farms to the Michigan Department of Environmental Quality (MDEQ) when the farms have had manure spills or discharges. This monitoring and subsequent accountability has led to several livestock producers paying a fine for polluting ground or surface waters. Lawsuits and fines can be significant incentives for livestock producers to practice more pollution prevention (Srivastava, 2003).

If MAEAP's voluntary approach fails, the Michigan agricultural industry faces the threat of having only mandated regulation for environmental practices. Research suggests that the threat of regulation provokes more livestock producers to participate in abatement activities to ensure that the more costly mandatory policy is avoided (Alberini & Sergerson, 2002).

Proposition 3: The costs of becoming MAEAP verified are not proportional to the income of the farm.

Larger farms generally have been the more likely adopters of technology and better able to afford technologies that involve substantial initial capital investment, due to economies of scale (Feder et al., 1985). Farms with larger herds typically generate more gross revenue than small farms (Wittenberg & Wolf, 2004). The costs associated with implementing a CNMP in the USDA-NRCS study were greater for the large operations than for small operations; however, the costs were estimated to be lower on a per animal unit basis for the large operations (USDA-NRCS, 2003). Therefore, it is expected that a greater percentage of CAFOs become MAEAP verified at a lower proportional cost relative to the gross farm revenue of the AFOs.

Throughout this study, large and small/medium farms are delineated using definitions for Concentrated Animal Feeding Operation (CAFO)[5] and Animal Feeding Operation (AFO), respectively. A CAFO is considered a large operation that houses/produces more than 1,000 animal units[6] at one time. An AFO is defined as a small or medium operation that houses/produces less than a 1,000 animal units.

Proposition 4: When producers follow the implementation strategies in the CNMP the result is new fixed assets that are larger than without MAEAP verification or EQIP cost-share.

Livestock producers may expand their operations to spread the fixed costs over more animals. Permanent structures require a fixed capital investment that typically is not transferable in producing another product (species). If an operation did not have enough manure storage, given the local weather conditions and/or available land for

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[5] CAFO (Concentrated Animal Feeding Operation) is defined by the EPA as a livestock operation that has animals fed or maintained for a total of 45 or more days in any 12 month period within a place of confinement that does not sustain vegetation. To calculate 1,000 animal units, the following thresholds for different animal species is used: 1,000 slaughter or feeder cattle; or 700 mature dairy cattle (whether milking or dry cows); or 2,500 swine weighing over 55 pounds; or 500 horses; or 10,000 sheep or lambs; or 55,000 turkeys; or 100,000 laying hens or broilers when the facility has unlimited continuous flow watering systems; or 30,000 laying hens or broilers when facility has liquid manure handling system; or 1,000 animal units from a combination of slaughter steers and heifers, mature dairy cattle, swine over 55 pounds and sheep (MDEQ, 2005).

[6] One animal unit, for example, is the same as 1,000 chickens, 0.7 dairy cows, 1 beef steer, or 2.5 sows. See Appendix A for more details.

spreading manure, MAEAP verification required more manure storage. A general (not individual) NPDES permit did not allow any operation to have less than six months of manure storage. The individual NPDES permit allows flexibility to meet the standards established in the general NPDES permit. considering farm specific situations. See Appendix B for more details regarding the general NPDES permit (MIG440000). Anticipating future size needs. livestock producers that are contemplating future expansion would be expected to make capital investment improvements at a larger size than currently necessary. The expansion helps producers achieve economies of scale and avoid building another structure in the future, if they add animal units for production. EQIP cost-share funding will assist in financing manure storage. With the assistance of EQIP cost-share livestock producers can build a larger structure for less money, rather than implementing one smaller structure now and another smaller structure later in which they may not receive EQIP cost-share funding. Thus, if the CNMP calls for enhanced storage, a producer would be expected to build a larger than necessary manure storage given the operations current livestock numbers.

Proposition 5: The amount of financial assistance a livestock producer receives is correlated positively with the increased amount of capital investments implemented to prevent pollution.

Positive incentives from the government (i.e., EQIP cost-share funds for capital investments) are available on a competitive basis. Natural Resources Conservation Service (NRCS) requires a CNMP for producers to be eligible for cost-share; therefore MAEAP verification acts like certification for NRCS. Financial assistance, such as EQIP, motivates livestock producers to become MAEAP verified and implement capital investment for pollution prevention strategies. Cost-share reduces the private costs of abatement, thereby increasing the likelihood that private benefits exceed private costs. The more capital investments a farm needs to make, the more pressure is put on the operation's financial position. The financial consequences of becoming MAEAP verified may entice livestock producers to seek more cost-share money.

Proposition 6: As MAEAP becomes more established and additional details and regulations evolve, the average costs to become and maintain MAEAP verification increase.

When the MAEAP began in 1998, there were few qualified persons that could write Comprehensive Nutrient Management Plans (CNMPs) and agency staff had few materials in place to ease implementing required changes. As plan writers and MAEAP organizers gained experience, plans and implementation recommendations became more consistent (Wilford, personal communication, October 2005). When demand for a plan writer's services increased and EQIP cost-share for writing CNMPs became more frequent, CNMPs were no longer written for free and more standardized prices were set for similar plans. Over time, MAEAP has become more organized, more plan writers have experience, and the Environmental Protection Agency (EPA), NRCS, and MDEQ have implemented supplementary policies and regulations. Certain details add to the strength of the plan, but also increase the writing time, the price of a plan, and the promptness in implementing required changes.

The time it takes to write a plan also is dependent upon the environmental practices currently in place on the farm, records previously maintained by the livestock producer, and farm size. As more livestock producers have their farms MAEAP verified, there is a wider variety of operation sizes, detail of records, and environmental conditions of the operations participating. A broader range of costs associated with developing each farm's nutrient management plan and implementing various management and capital investment changes is expected.

Plan writers may increase their fees over time due to an increase in demand, increase in certification and education requirements, and additional liability insurance. However, it also is expected that the price of a CNMP will not deviate greatly from what EQIP will cost-share to have a plan written. The CNMP plan writer would be expected to reap the benefits of the cost-share dollars by charging at least the minimum price of what EQIP cost-share will pay. However, the livestock producer does have the option to seek another plan writer, ask the NRCS to write the CNMP as they contract the plans to a plan writer with a price cap, or the producers may do more work themselves.

Proposition 7: Most CNMP changes required for MAEAP verification are linked to management practices rather than capital investments.

Even with the broad range of farms becoming MAEAP verified, nearly all farms may need to make changes to management practices; only some farms may be required to make capital investments. The management changes, such as manure spreading method and location, recording manure nutrient composition, and manure and soil testing, changing rations, and commercial fertilizer applications likely outnumber the amount of capital investments an operator could establish. Research suggests that capital investment changes typically are easy to identify and thus, will be adopted first (Habron, 2004); however, altering an operations' management practices can increase the producer's knowledge of the farm, allowing him/her to capitalize on opportunities he/she might have otherwise overlooked (e.g., additional soil and manure testing could lead to proper nutrient application rates). Many of the requirements within the CNMP entail more time to manage the farm even though an operator cannot collect EQIP cost-share for these managerial changes.

Proposition 8: The largest barrier to becoming MAEAP verified is the proximity to suitable, available cropland to spread manure.

Due to the density of animal and human population, crop rotation, and distance to freshwater, it may be difficult to ensure enough cropland is available for Michigan livestock producers on which to spread manure. There are several factors that limit an operator's access to acreage acceptable for manure spreading.

1. Animal density. This factor, animal density, not only accounts for the animal density on a livestock producer's cropland, but also the animal density of that particular vicinity. Areas that have a large animal density have less cropland available for manure application as their farming neighbors are more likely to have animals themselves, leaving fewer extra acres available. The more manure that is spread on the cropland, *ceteris paribus*, the higher the nutrient content of the soil and the less manure a livestock producer can spread before it reaches the soil's carrying capacity. Exceeding this capacity increases the risk of pollution.

2. Population density. The denser the human population, the more acreage is unavailable for agriculture. A dense population also indicates that more agriculture land lies on the urban fringe, limiting the days and times to spread manure due to odor concerns. With a large population encroaching on the rural and suburban areas, there are more new homes located in or near fields that receive manure. The denser populated

rural areas may have more people unacquainted with livestock production that may have a larger concern for air quality and odor. Leaving more space around adjacent homes, free from manure spreading, creates less space and adds more time constraints for livestock producers to spread manure.

3. Soil testing over 150 pounds per acre (75 parts per million) of phosphorus. In Michigan, if an operator takes soil samples, P content will be expressed via lab analysis as Bray P1 or Mehlich-3 (results are in pounds of P, while recommendations are given in pounds of P_2O_5 per acre). According to GAAMPS, if a field has soil test results over 300 pounds of P per acre, (150 parts per million (ppm)), then phosphorus from any source cannot be spread on the field (MDA: Right to Farm, 2004). Fields with phosphorus levels between 150 and 299 pounds of P per acre (75 and 149 ppm) can have phosphorus applied equal to or less than crop removal rates. Fields with levels below 150 pounds of P per acre (75 ppm) can have manure spread based on nitrogen recommendations (Sharpley, et al., 2003).

The most common fields with an excess of phosphorus are likely to be those fields closest to the livestock housing and manure storage facilities and with a history of vegetables or root crops, such as peppers, potatoes, or sugar beets in the crop rotation. If livestock producers did not correctly account for manure's nutrient content, the fields closest to the livestock housing and storage facilities will become much higher in phosphorus than other fields on the farm. It costs less, and is less time consuming, to spread manure closest to the production site. Accounting for plant uptake of nutrients correctly is also a concern. When growing vegetables and root crops (e.g., potatoes) more phosphorus is applied than to say, corn, beans, and wheat because phosphorus enhances root growth and these crops require more P. If root crops are in the livestock producer's planting rotation, more inorganic and commercial phosphorus is likely to be over-applied relative to crop needs and more phosphorus will remain in the soil for either the next crop rotation or be displaced by soil erosion. When soil tests indicate higher phosphorus levels, the crop producer has more restrictions on where to spread manure in order to follow the agronomic rates described in a CNMP. Agronomic rates are set to reach a yield goal with the optimal amount of nutrients to prevent over-application and ultimately nutrient runoff and leaching.

4. Proximity to water. Michigan is surrounded by four of the five Great Lakes. With 37 watersheds in the Lower Peninsula, many Michigan farms have a river or lake near their farm (MDEQ, 2005). To become MAEAP verified, a setback or buffer strip along all bodies of water must be accounted for when surface spreading manure (injected manure does not need a setback). A setback or buffer strip may vary in depth and length depending on the erosion variables (e.g., proximity to ground water, field slope, and soil type) in the field, but a consequence is that the amount of available land to spread manure is decreased.

Proposition 9: More manure is spread according to agronomic needs after a farm becomes MAEAP verified than before verification.

Some livestock producers spread more manure in close proximity to the livestock production site, not using the manure for its nutrients, but spreading where it is most convenient. Applying fertilizer at a rate above that which is required is not an environmentally sound practice. After a farm becomes MAEAP verified, the livestock producer is required to follow the agronomic rates described by the farm's CNMP. The

CNMP is designed to follow scientific recommendations with regard to application rates, land conservation practices, and manure storage capacity.

* * *

To explore the validity of these nine propositions, data were analyzed from the producer interviews and the CNMPs collected from the producers. The financial analysis was conducted using primarily the interview data, while the environmental component was analyzed using the information within the CNMPs with help from both the Institute of Water Research at MSU and the MSU Extension in Calhoun County.

1.4 Thesis Organization

The thesis is divided into eight chapters. Chapter 2 provides a general background about the MAEAP's history and organization, and steps for verification, and an explanation of the CNMP. Chapter 3 presents the survey design and methods. The interview findings are within Chapter 4, which includes discussions on the type of operations and operators that became MAEAP verified, the opinion statement results, and what barriers the operator incurred when seeking verification. Chapter 5 gives details about the financial impacts and includes correlations and operator discussion. Chapter 6 explains the results from the phosphorus mass balance and the P-Index. Chapter 7 summarizes the data as they relate to the nine propositions. The last chapter discusses the financial, environmental, and policy implications of the MAEAP and also discusses the limitations of the study and further research that should be conducted.

Chapter 2: Michigan Agriculture Environmental Assurance Program

2.1 Introduction

An evaluation of MAEAP is assisted by an appreciation of the background, goals, and steps required of the livestock operators to become MAEAP verified. The Michigan Agriculture Environmental Assurance Program Livestock System is a voluntary program open to any Michigan livestock producer, regardless of size, who agrees to the adoption and verification of specific management practices as part of the CNMP. MAEAP requirements are designed so that a verified farm following the CNMP should be operating in accordance with the Right to Farm Act[7], Natural Resource and Environmental Protection Act (NREPA)[8], and the Michigan Groundwater Stewardship Program[9]. Also, the producer is required to have an Emergency Action Plan in the event of a manure spill. An important vehicle to accomplish these objectives is the CNMP. The intention of the MAEAP is to reduce environmental and legal risks for Michigan farm operations. An additional attribute is that MAEAP may give some animal feeding operation (AFO) owners an alternative to government required permits.

[7] The Michigan Right to Farm Act, P.A. 93, was enacted in 1981 to provide producers who follow its guidelines and practices with protection from nuisance lawsuits. This state statute authorizes the Michigan Commission of Agriculture to develop and adopt Generally Accepted Agricultural and Management Practices (GAAMPs) for farm operations in Michigan. (MDA: Right to Farm, 2004).

[8] Natural Resource and Environmental Protection Act (NREPA) has a dual purpose: to protect water quality and to regulate waste disposal, controlling pollution in any water, including ground and surface water (MDA: NREPA, 2004).

[9] Michigan Groundwater Stewardship Program's main objective is to provide information and assessment tools for pesticide and nitrogen fertilizer users help them identify risks to groundwater associated with their pesticide and nitrogen fertilizer use practices and to coordinate local, state, and federal resources to help individuals reduce those risks (MDA: Groundwater Stewardship Program, 2005).

2.2 Phosphorus in Manure, on Cropland, and in Water

The MAEAP should reduce a livestock producer's environmental and legal risks because the risk of a pollution discharge[10] should be decreased. Michigan livestock producers may be at risk of having an animal manure discharge into surface and ground waters, if manure is improperly stored or applied. To help alleviate improper manure management, the Right to Farm Act identifies and explains the Generally Accepted Agricultural Management Practices (GAAMPs). These voluntary practices provide uniform statewide standards and are supposed to be based on available technology and knowledge from scientific research to identify sound environmental stewardship. GAAMPs also are referenced in Michigan's Natural Resources and Environmental Protection Act (NREPA), Public Act 451 of 1994, as amended. NREPA is intended to protect the waters of the state from the release of pollutants in quantities and/or concentrations that violate established water quality standards (MDA: NREPA, 2004). The illegal release of pollutants into surface and ground waters from agriculture most commonly occurs through field runoff (Weld, et al., 2001).

Applying manure to fields for crop production and recycling of nutrients can be an important component of manure management. Agronomists have recognized manure's benefits for many years; in 1910, S. W. Fletcher published, "When incorporated with the soil, manure greatly improves the texture, loosening a heavy compact soil and binding together a light leachy one; making the soil more crumbly, warmer, more retentive of moisture, and more conducive to plant growth" (Fletcher, 1910). Nutrient

[10] A discharge is the release of nutrients, pathogens, manure or polluted storm water into surface waters of the state (MDEQ, 2005). Waters of the state include county drains, ditches, streams, creeks, rivers, wetlands, lakes and ponds.

recycling can be an agronomic and environmentally sound practice for both short and long term sustainability of the land.

Manure's composition, of all livestock species contains a greater amount of phosphorus, relative to nitrogen, than most plants require. Thus, phosphorus can build up in the soil, if manure application rates are based solely on the plant's nitrogen needs. The excess nitrogen and phosphorus in or on the soil are potential water pollutants. For example, to produce 140 bushel of corn per acre, the corn plants will use 126 pounds of nitrogen and 50.05 pounds of P_2O_5 (phosphate) or 22.02 pounds of elemental phosphorus (P) (Christenson, et al., 1992). If a producer uses liquid manure from a swine growing/finishing operation (hogs 40 to 250 pounds) as the nutrient source, the manure may have a ratio of N to P_2O_5 of 1.6 to 1.0 (Table 2.1). If the manure is spread according to the nitrogen needs, then an extra 28.7 pounds of phosphate, over the corn crop needs, will be spread on each acre.

Table 2.1: Average Nutrient Values of Grow-Finish (40-250 pounds) Swine Manure

Grow-Finish Swine	N	P_2O_5
	Pounds	
Pounds per day produced	0.08	0.05

*MWPS-18 Manure Management Systems Series, December 2000

If the soil tests indicate that the soil phosphorus level is below 150 pounds of P per acre (75 ppm), the crop can have manure applied in accordance to the nitrogen needs of the crop. If the soil tests indicate the soil phosphorus is at or above 150 pounds of P per acre (75 ppm), then to prevent phosphorus build up, the manure should be spread in accordance with the phosphorus needs of the plant (MDA: Right to Farm, 2004). Additional nitrogen can be applied to the corn crop using commercial fertilizers. This restriction is particularly important to reduce the risk of P runoff because phosphorus as a pollutant is a major problem in fresh water bodies (Sharpley, Gburek, Folmar, & Pionke, 1999).

With manure's extra phosphorus content relative to nitrogen for crop needs, the state's numerous watersheds, and farms' proximity to fresh water bodies, the primary nutrient of concern for water pollution in Michigan is phosphorus (P). Phosphorus generally is considered the limiting nutrient in freshwater systems because an increase of phosphorus increases the rate of eutrophication (Harper, 1992). Eutrophication is the process by which a body of water becomes enriched in dissolved nutrients that stimulate the growth of aquatic plant life, usually resulting in the depletion of dissolved oxygen (Merrium-Webster, 2000). Sufficient dissolved oxygen in fresh water is essential and critical for aquatic animals to live. Human and wildlife concerns associated with eutrophication include repulsive taste and odor in drinking water, impairment of waters for recreation and industry, and toxicity to humans, fish, and livestock (Gitau, Gburek, & Jarrett, 2005). Water bodies impaired due to excess phosphorus are costly and difficult to restore and may take many years to recover (Srivastava, 2003). The movement of phosphorus in runoff from agricultural land to surface water can cause and/or accelerate eutrophication.

2.3 Development of MAEAP

In 1998, the MAEAP was formally created from the Michigan Agricultural Pollution Prevention Strategy's[11] recommendation to assist agricultural producers with

[11] Michigan Agricultural Pollution Prevention Strategy was formulated by Michigan Department of Agriculture, Michigan Department of Environmental Quality, and Agricultural Industry Group representatives. They amended the Pollution Prevention Strategy for Michigan Agriculture in October 1997 to include provisions for identifying and implementing new agricultural pollution prevention activities.

nutrient management. The structure, guidelines, and goals of MAEAP were designed by multiple Michigan industry, university, and governmental agencies to assist livestock producers with their nutrient management. This partnership was to ensure that all viewpoints were considered in setting guidelines. Initially, there were 17 partners[12] in MAEAP. In the last several years, eight more industry partners have joined MAEAP.

The Environmental Protection Agency (EPA) and the Michigan Department of Environmental Quality (MDEQ) worked together to develop an innovative regulatory agreement that included the MDA. This agreement, often called the Environmental Council of the States (ECOS)[13] Agreement, gave the state of Michigan the opportunity to implement its own pollution prevention program from December 2002 until December 2007. The agreement still obliges the MDEQ to conduct proactive inspections on all CAFOs and pursue compliance and enforcement actions on all facilities with a discharge. Although MAEAP reduces environmental and legal risks for verified farm operations, a livestock producer must apply for a National Pollutant Discharge Elimination System (NPDES) permit from the MDEQ if 1) meet specific size criterion, or 2) are of any size and have had a regulated discharge since 2000, whether or not they are MAEAP verified.

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[12] Current MAEAP partners include: Institute of Water Research, Michigan Agri-Business Association, Michigan Allied Poultry Industries, Inc., Michigan Association of Conservation Districts, Michigan Aquaculture Association, Michigan Cattleman's Association, Michigan Cherry Marketing Institute, Michigan Corn Growers Association, Michigan Department of Agriculture, Michigan Department of Environmental Quality, Michigan Farm Bureau, Michigan Farm Radio Network, Michigan Integrated Food and Farming Systems, Michigan Milk Producers Association, Michigan Nursery and Landscape Association, Michigan Pork Producers Association, Michigan Potato Commission, Michigan State University, Michigan Soybean Promotion Committee, Michigan Township Association, Michigan United Conservation Clubs, MSU Extension, and USDA/Natural Resources Conservation Service.

[13] The Environmental Council of the States (ECOS) is the national non-profit, non-partisan association of state and territorial environmental agency leaders. The ECOS mission is to improve the US environment by advocating the role of states' environmental management, providing information exchange among states, fostering cooperation and coordination in environmental management, and articulating state positions to Congress, federal agencies, and the public on environmental issues. The agreement between the EPA and the Michigan Department of Environmental Quality (MDEQ) allows MAEAP to improve water quality without mandated permit through 2007.

2.4 Regulations Relevant to MAEAP

To alleviate some of the financial implications of developing and implementing a CNMP, the 2002 Farm Bill allowed the USDA-NRCS fewer restrictions when dispensing EQIP funded cost-share to livestock producers. EQIP cost-share funds required a CNMP for payment, but EQIP funds also assisted the producers in developing their farm-specific CNMP (USDA-NRCS, 2002). Michigan governmental and agency officials desired to have only one CNMP for consistency to meet EQIP, MAEAP, and permit standards. Therefore, Wickey, of USDA-NRCS comments repeatedly that Michigan's CNMP requirements often "meet or exceed regulatory requirements" of other states (Rector, personal communication, December, 2005).

Regulations enacted by the EPA in 2003, as well as state regulations, require all new CAFOs, livestock operations expanding by at least 1,000 animal units, or an operation of any size that has had a discharge, to meet new, more detailed and specific standards. By September 2005, existing (as opposed to new) Michigan CAFOs (over 1,000 animal units), who have not had a regulated discharge since 2000, had to have a signed letter of intent to either obtain MAEAP verification or a National Pollutant Discharge Elimination System (NPDES) permit within one year of receipt of the letter of intent. All CAFOs with MAEAP letters of intent must be verified by September 1, 2006. After July 1, 2007, all CAFOs will be required to have an NPDES permit regardless of a farm's past environmental history or prior MAEAP verification (MDEQ, 2005). Small and medium operations (less than 1,000 animal units) are not affected by the new regulations, if they have not had a discharge.

These new regulations assisted Michigan in reaching more livestock producers and helped to ensure that the largest operations were practicing pollution prevention. However, the EPA's NPDES permit system may be less attractive to livestock producers than MAEAP in the short run due to the permit's application and annual fees and publicly accessible CNMPs. In the long run given current regulations, CAFOs do not have a choice whether they will purchase an NPDES permit. MAEAP's voluntary approach generates a cost savings due to the absence of an application and annual fee, and is a viable, acceptable alternative to the NPDES permit system for all farms until July 1, 2007 and for AFOs perpetually, if the AFO does not have a reported pollution discharge (MDEQ, 2005), assuming no further changes in regulations. MAEAP also allows livestock producers to apply for special low interest loans, lower liability insurance premiums, and species specific scholarships that an NPDES permit does not offer.

2.5 Structure of MAEAP

MAEAP is a voluntary program designed to reduce producers' legal and environmental risks by increasing awareness of environmental regulation, knowledge of nutrient management, and ensuring documentation and implementation of nutrient management practices. The MAEAP-verified producers have an opportunity to take advantage of other farm managers', MAEAP agency staff's, and CNMP writer's expertise to help "minimize [manure] waste and maximize [nutrient] resource use" (Rector, personal communication, September 2005). The MAEAP's stated mission is: To develop and promote a recognized, voluntary, proactive environmental assurance program, targeted to the agricultural industry, which ensures that producers are engaging in cost-effective pollution prevention practices and are in compliance with environmental regulations ("Exec. Summary," 2005).

MAEAP is a three-system, three-phase program. Each system covers a different aspect of the farm: livestock, farmstead, and cropping. The livestock system was the first to be completed by MAEAP designers and will be the focus of this research. When all three systems are verified within a farm, the intent is to assure the entire farm has a reduced environmental pollution and legal risk ("Producers can minimize," 2001). MAEAP has attempted to achieve its seven goals on farms that are MAEAP verified. The seven goals MAEAP seeks to accomplish are the following:

1. Solving environmental pollution problems;
2. Preventing pollution at its source;
3. Maintaining and enhancing natural resources;
4. Monitoring and recording changes in producers management practices;
5. Providing incentives for participation;
6. Encouraging sharing of technological information;
7. Rewarding accomplishment through award recognition ("Exec. Summary," 2005).

The three phases of the MAEAP livestock system are: 1) education; 2) on-farm risk assessment through an operation-specific Comprehensive Nutrient Management Plan (CNMP); and, 3) third-party verification using an on-farm inspection. When a farm completes all three phases for a specific system, e.g., the livestock system, the farm is then a (livestock) verified MAEAP farm and an "environmentally assured" operation.

The education phase of MAEAP is to help raise the awareness of the diverse practices that may help prevent or reduce legal and environmental risks for the farm. There are educational meetings conducted jointly by MAEAP partners held throughout the state, multiple times a year. Producers are provided information about the three MAEAP systems, as well as state and federal environmental rules and regulations. Michigan's Right to Farm Act is briefly reviewed, emphasizing GAAMPs. Upon completion of the education phase, producers should be equipped with the necessary information to begin organizing their own CNMP.

The second phase includes the development of a Comprehensive Nutrient Management Plan (CNMP). The CNMP is a farm-specific planning tool that seeks to assure the livestock producer is complying with NRCS CNMP standards, MDEQ regulatory requirements, as well as the manure and nutrient management GAAMPs that were established by the MDA in 1988 and 1993. The compiling of information for the CNMP also assists livestock producers in documenting the conservation practices and management decisions made on the farm regarding the use of commercial fertilizers and manure nutrients. The CNMP allows livestock producers to work directly with qualified professionals certified by the USDA Natural Resource Conservation Service (NRCS), Technical Service Providers (TSP). These TSPs assist the producer in identifying high-risk areas on the farm and develop a plan to address the potential environmental issues.

Once the CNMP is written and the recommended changes are implemented, the farm has an on-farm inspection to become MAEAP verified. Third-party verification, conducted by the Michigan Department of Agriculture (MDA), occurs when the farm has developed a CNMP that has been approved by a technical service provider (TSP) and the operator states that he/she is implementing the pollution prevention practices or improvements according to the schedule of implementation specified in the CNMP.

Maintaining MAEAP verification is a part of the monitoring strategy. Livestock producers must have an updated CNMP and application records to continue MDA approval via an on-farm visit every three years. The first year for the MDA to conduct maintenance visits was 2005. The operator of the verified farm also needs to attend at least one MAEAP educational meeting over the course of the farm's verification.

2.6 Comprehensive Nutrient Management Plan

Developing and maintaining the CNMP is critical to MAEAP verification. Appendix E (Comprehensive Nutrient Management Plan Components of the Michigan Agriculture Environmental Assurance Program (MAEAP)) explains the necessary components of the CNMP with a detailed description of each component. However, the livestock producer does not need to personally write the plan in its entirety, or at all. If a producer personally writes the CNMP, a certified plan writer must, at a minimum, approve the CNMP. The plan writer's signature ensures the CNMP incorporated all the details of the necessary components.

The length of time it takes a TSP or livestock producer to write a Comprehensive Nutrient Management Plan is variable and depends on several factors. Information collected from a survey of plan writers (see Appendix C) indicated that the most common factors affecting the length of time it takes to write the CNMP is the number of operated acres, the number of animal units, and the livestock producer's past environmental (e.g., soil and manure testing), as well as record keeping practices. Some areas on the farm that pose an environmental risk and need to be changed may require an engineer's input.

Items such as manure storage design and/or evaluation and barnyard runoff frequently need an engineer's perspective, which prolongs the completion of the CNMP and increases the expense. In the past, most livestock producers have not kept records of the P content of the manure and the rates and location where each load of manure was spread. If these records and soil samples are up-to-date, the CNMP can be written more quickly.

After the CNMP is written, the livestock producer keeps the CNMP on the farm. The farmer is supposed to update the plan frequently with manure storage and spreading information. A plan writer needs to update the soil tests, manure tests and rates, and overall CNMP at least every three years.

2.7 MAEAP-Verified Farms

Once an operation becomes MAEAP verified, in any system, the producer receives an official certificate and the opportunity to purchase a sign to place near the farm entrance identifying the farm as a MAEAP-verified farm. A livestock producer that becomes MAEAP verified also has the opportunity to use the Small Business Pollution Prevention Loan Program, which provides loans at a rate of five percent or less ("Producers can minimize," 2001). In addition, a lower liability insurance premium may be available to those operations that have their liability insurance with some specific companies. For example, Michigan Farm Bureau Insurance gives livestock producers a 10 percent credit on a farm's base liability premium, if the operation has at least one system (Livestock, Farmstead, or Cropping) of the farm MAEAP verified (Wheaton & Atherton, 2005).

As of January 1, 2005, there were over 60 livestock MAEAP-verified farms, several thousand producers had attended a MAEAP Phase I meeting, and 51 CAFOs and 109 AFOs had begun the second and third phases of the 3-phase process. The total number of livestock MAEAP-verified farms more than tripled in 2004, increasing from 19 to 63. Many operations that began their CNMPs in 2002, took a few years to complete their CNMP and thus, many were completed during 2004. The increase in verified operations was also due to changes in regulations, requiring CAFOs to have either signed a letter of intent to begin MAEAP verification or obtain an NPDES permit by September 1, 2005.

2.8 Chapter Summary

MAEAP is designed to educate producers about nutrient management in order that they become better stewards of the land. Through verification of a farm, MAEAP enables the producer to understand changes needed to follow Michigan Right to Farm, the Michigan Groundwater Stewardship Program, and NREPA guidelines. As of January 1, 2005, MAEAP has assisted about 40 producers in complying with a multitude of state and federal regulations through the development of a CNMP representing 63 operations that have become MAEAP verified. The intent of MAEAP verification is to confirm that soil and water resource concerns have been appropriately addressed, that Right to Farm GAAMPs are being followed, and that practices comply with state and federal environmental regulations and until January 1, 2008 give some livestock producers who are CAFOs which have not had a manure discharge an alternative to the government permits (NPDES permits).

Chapter 3: Interview Methods

3.1 Introduction

The potential effectiveness of MAEAP to reduce the risk of environmental pollution depended on three factors: 1) the number of livestock producers that participated; 2) the level of pollution prevention practices undertaken by each livestock producer; and, 3) the impact that the adopted practices have on the environment. To determine MAEAP's value, 29 livestock producers involved in the MAEAP were personally interviewed and their CNMPs were collected. The interviews and the CNMP were used to assess: 1) producer's motivation for verification; 2) their attitudes towards the environment, MAEAP, and regulations; 3) the total number of animal units and acres used for manure application; 4) the costs associated with becoming MAEAP verified; 5) producer's perception of what environmental impacts occurred due to verification; 6) producer's farm's cropland phosphorus mass balance; and, 7) the farms' average phosphorus index.

3.2 Designing the Interview Instrument

Before beginning the interview process and finalizing the interview questionnaire, certified Michigan plan writers were surveyed, the producer questionnaire was pre-tested and peer-reviewed, and MAEAP administrators reviewed the document. The 26 certified CNMP plan writers were surveyed via a mail survey in the fall of 2004 with a 54 percent response rate. Useful information was obtained to evaluate what pricing schemes were often used to set the CNMP price, changes typically administered due to the MAEAP verification, and cost expenditures and savings realized from fully adopting the CNMP schedule of implementation. The information gathered from this plan writer survey added to the breadth and depth of questions asked of the livestock producers. A brief description of the plan writers' survey results, the cover letter, and the mail survey used, can be found in Appendix C.

After the plan writer's results were represented, the questionnaire was given to several MAEAP and non-MAEAP livestock producers as a pre-test, which resulted in an improved set of interview questions. Some MAEAP program administrators[14] also were consulted to determine the most accurate and understandable vocabulary, details of the CNMP, and particular cropping and spreading methods used by livestock producers. The finalized list of interview questions can be found in Appendix D "MAEAP Adoption Producer Interview Cover Letter, FAQ Page, and Questionnaire".

The interview questions included both closed and open-ended questions that encompassed seven subjects (farm status, the CNMP, farm characteristics and changes, managerial and capital changes, opinions, environmental impacts, and operator characteristics). The seven subjects reflected explanatory factors frequently identified in adoption rationale, costs of implementing and maintaining verification, and environmental impacts attained through voluntary programs. These subjects also addressed the nine propositions.

3.2.1 Design and Objectives

Each personal interview was designed to allow the livestock producers to expand on any issues they wanted, or to criticize or compliment MAEAP administrators and implementers. Each producer was given a copy of the interview questions so he/she could read, as well as listen to each question. The seven sections of the interview were

[14] Jan Wilford, MDA; Natalie Rector, MSUE; and Rhonda Wuycheck, MDEQ were the main administrators that gave input for the interview layout and question design.

strategically placed; the personal information and opinion questions were asked towards the end of the interview to allow time for trust to build between the livestock producer and the interviewer before replying to the more sensitive inquiries.

3.2.2 Population and Sampling Method

The final interview pool was determined by selecting all livestock producers that were MAEAP verified by September 1, 2004, and those farms awaiting verification through an on-farm visit in 2005. The pool was expanded to also include the operations that were verified in late fall of 2004. An information packet was mailed to each of the 46 producers, 36 on December 15, 2004 and a 10 on January 31, 2005. All 46 interview packets included a cover letter, a frequently-asked-questions page that outlined what was expected of the participants, what they would receive in return for their participation in the interview, and a letter of support from the Michigan Department of Agriculture (MDA) (Appendix D). MDA was deemed a respected agricultural organization that many livestock producers trust. MDA's letter of support was considered necessary to ensure the producer believed the interview was credible and that their conversation would be useful and necessary for the study. After the letters were mailed, personal phone calls were made to each livestock producer to set up an on-farm interview.

Personal interviews were conducted from late December 2004 through February 2005. The study focused on the nine research propositions discussed in Chapter 1 to draw policy, financial, educational, and risk implications for livestock producers involved with MAEAP. The interviews were informal and took place at the livestock producer's farm to ensure a convenient and comfortable atmosphere.

The interviews lasted from 1 to 3 hours and the livestock producers were paid $50 for their participation. The livestock producer received an additional $100 if they agreed to submit a copy of their CNMP to the interviewer. The copies of the CNMP were returned to the producer upon the completion of the research. Copies of the CNMPs were acquired from 25 producers, as some producers declined to offer their CNMP for further analysis. Information within the CNMP added to the detail and accuracy of the interview responses, while also providing data regarding field specific information, soil types, crop rotations, slopes, cover crops, and Manure Application Risk Index[15] (MARI) results.

3.3 Data Analysis

The information from the personal interviews was assembled and averages, standard deviations, ranges, and correlations were calculated using the Windows' Excel package. Statistical analysis was conducted to compare data between beef, dairy, poultry, and swine, CAFOs and AFOs, and in aggregate. The analysis used was appropriate as the objective of the research was to understand the pattern of relationships between the results, but not to explain the total variance. The small sampling size prevented significant regressions and formal hypothesis testing from being conducted.

3.3.1 Standardizing the Data

To better compare information between operation size and species, the animals units were standardized. Animal units are an accepted method used to compare size of operation between species. Following the Permit MIG 010000 (MDEQ, 2005)

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[15] MARI evaluates fields for winter spreading of manure using 12 weighted field factors, including soil groups, soil test P value, concentrated water flow, vegetative buffer width, and manure application rates and methods. MARI is a tool used by the NRCS that is required by MAEAP to ensure consistency between MAEAP and the NRCS. Recently, the MARI is referenced as an option in Michigan as a part of the state-recognized Generally Accepted Agricultural Management Practices (GAAMP). MARI assists in determining whether the level of environmental risk associated with manure applications is acceptable.

calculation, animal units were calculated for this study with a value based on the number of "noses counted within each animal category", instead of by earlier calculations of the estimated animal weight divided by 1,000. For example, a mature (milking or dry) dairy cow was given a standard weight of 1,400 pounds, which meant each dairy cow represented 1.4 animal units. Refer to Appendix A (Calculating Animal Units: Permit MIG 010000 Compared to General Permit MIG 440000) for a comparison of the two methods to calculate animal units. As both methods are currently used throughout the state, the CNMPs within this study reported animal units via both methods. Thus, all animal units on all CNMPs were converted to the method of calculating animal units used in the calculation set out in permit MIG 010000.

3.3.2 Changes Cost Calculations and Assumptions

Some of the financial information was calculated directly from the interview responses, but some costs were given in percentage terms with no baseline and thus, these costs were calculated using several methods. Soil and manure testing was calculated by multiplying the number of additional or fewer tests times the average cost of the test. There were several laboratories used to evaluate soil and manure samples; the average cost for a soil test was $7 per sample, and the average manure test cost was $32 per sample.

Equipment and machine use, manure spreading labor, and fuel were calculated using a computer spreadsheet developed at the University of Missouri (Massey, 1998). This spreadsheet has been used in manure cost studies and by producers to estimate the costs of spreading manure using different equipment, machinery, and distances from the storage area (Hadcock & Wright, 2002). The Excel spreadsheet assisted the researchers in estimating several variables relevant to this study. Fuel cost has changed substantially over the past three years, but $2.30 per gallon was used as the standard for the fuel cost input in the spreadsheet. The hourly wage for manure spreading labor was calculated at $10 per hour; this rate did not include benefits, bonus, or compensation (USDA-NASS, 2004). The Massey spreadsheet calculated an average of $2 per hour to account for the benefits, bonuses, and other compensation. The size and type of equipment was altered within the spreadsheet for each operation based on the size of the operation, the changes made, and the information provided in the CNMP.

The phosphorus and nitrogen savings or cost calculated was based on the 2001 Crops and Livestock Budgets Estimates for Michigan (Dartt & Schwab, 2001). These costs were then multiplied by the Producer Price Index (PPI)[16] (USDL, 2005) to obtain 2004 dollar costs.

Some swine and poultry operators supplemented rations with phytase. Phytase lowers the amount of phosphorus in the manure by assisting the animal in digesting more phosphorus. Poultry producers reported their estimated costs of adding phytase. To estimate the cost swine producers paid to add phytase, correspondence with several phytase suppliers was conducted. This study used $0.80 for an estimate of the average additional cost of phytase in a ton of total mixed feed. The number of tons of feed used on farm was then multiplied by the additional $0.80 each ton cost and then multiplied by the percent of feed that contained phytase.

Supervision and record keeping labor was calculated based on a labor fee of $16 per hour, as these jobs were primarily completed by the owner or manager. The change

[16] The PPI is an indicator of inflation published by the U.S. Bureau of Labor Statistics to evaluate wholesale prices in the economy.

in number of supervision hours and insurance premium rate as a result of MAEAP verification was not available for all farms. The average percent change in supervision hours was calculated based on information from producers that had similar operation size, who gave actual information. The average percent change in supervision hours on an AFO were applied to the AFOs that were not able to give an exact number of hours. The same technique was used for the CAFOs. The insurance premium was calculated in a similar way. The opportunity cost of the hours spent by the interviewed producer or farm operation staff collecting information to write the CNMP also was included in the initial CNMP price, at $16 per hour.

For the purposes of this research, the early verified operations were those operations that became verified between January 2002 and December 2003. The late verified operations were those operations that were verified after 2003. The early verified operations generally took longer to become verified and received special attention from both agency staff and the CNMP writer, because there were only a few producers volunteering for the program. Furthermore, they were considered a "pilot" project in which learning about the MAEAP implementation would take place (Wilford, personal communication, October 2005). When the program started, it was a learning experience for all participants: producers, plan writers, and MAEAP partner agencies. The program implementers also felt that it was critical that the initial producers had a positive experience, because landowners trust other landowners, as they can identify with one another's perceptions, opinions, and motivations (Wilford, personal communication, October 2005). Positive perceptions about the value of MAEAP were critical to the increase in livestock producer participants seeking MAEAP verification (Wilford, personal communication, October 2005). Only eight producers became MAEAP verified in the second year (2003). In 2004, however, the number of MAEAP-verified producers increased from a total of 19 to 63. This large increase in verified operations was probably due to the long completion time for developing a CNMP, MDEQ initiated deadline for compliance for CAFOs, more producers learning about MAEAP, an increase in available EQIP cost-share for producers, and the ECOS agreement that made it possible to become verified with MAEAP in lieu of purchasing an NPDES permit, if the operation had not previously had a discharge.

3.3.3 Environmental Calculations

The environmental data were analyzed for this research with the assistance of the MSU Institute of Water Research (IWR) and MSU Extension personnel in Calhoun County. For producers to comply with regulations, they must be able to quantify and adjust phosphorus imbalances that occur on the farm (VanDyke, Pease, Bosch, & Baker, 1999). When evaluating the environmental data, a cropland P mass balance and a phosphorus index were calculated as part of this research to examine the differences between the operation before and after MAEAP verification. The changes outlined in the CNMP and those explained during the interview were applied to the current environmental state of the operation. It was assumed the changes outlined in the CNMP were implemented fully. It was difficult to predict what changes an operation would have implemented on its own had MAEAP not required specific changes to be implemented. Therefore, this research only compares changes and costs before and after a farm become MAEAP verified.

The cropland phosphorus mass balance accounted for all input and output phosphorus in one year and was calculated for all operations in which a CNMP was collected. The CNMP specified values for most variables necessary to calculate the mass balance, the computed value was considered the "after" MAEAP verification phosphorus mass balance. To determine how much environmental change occurred within an operation due to becoming MAEAP verified, a "before" MAEAP verification phosphorus mass balance was calculated from information gathered during the interview. These questions addressed changes in manure sold, feed rations, cropland, number of animal units, and crop rotations.

To determine the environmental risk of a farm, CNMPs were evaluated to select the high risk farms based on: 1) proximity (within 1,320 feet or one quarter of a mile) to a cold water trout stream; and, 2) cropland P mass balance. If the operation was out of mass balance after becoming MAEAP verified, or a change in their mass balance score indicated that there was an increased amount of phosphorus on farm, but the condition was not necessarily putting the operation out of mass balance, the operation was placed in the high risk category. If one or more determinants of risk were met then the operation was characterized for this study as high risk, which meant the farm had a greater chance of phosphorus leaving the farm.

If a CNMP was not collected from an operation, it could not be determined if that operation would be considered high risk; thus, only the 25 operations in which a CNMP was collected were evaluated to place an operation in the high risk category. Twelve operations were considered high risk. The high risk fields of the high risk operations were then evaluated with the P-Index[17]. The assumption that the livestock producer had fully implemented all the recommended changes listed in the CNMP remained for this analysis.

Because the existing agronomic soil testing guidelines were developed to predict crop performance rather than for water quality protection, they must be re-interpreted to address environmental concerns (Sims & Sharpley, 1998). There is no single phosphorus index that is appropriate for every state, thus each state has developed an index specific to local topography, hydrology, management conditions, and policy decisions (Sharpley, Daniel, Sims, Lemunyon, Stevens, & Parry, 2003). The Michigan P-Index scored each field by applying a number, associated with the level of phosphorus runoff risk, to evaluate the level of phosphorus transport and the source of phosphorus. The phosphorus transport variables included the RUSLE2 score, proximity to surface water, number of intermittent streams, soil hydrology, and crop rotation. The sources of phosphorus included the following variables: soil test phosphorus, commercial fertilizer, manure spreading method, amount of manure, and cover crop when spreading manure. Generally, each variable could receive a score of zero, one, two, four, or eight, with a score of zero indicating a low risk and eight indicating a high risk. Each field could receive a P-Index score ranging from 0 to 68. A field that had a total score of less than 18 on the Michigan P-Index was considered to have low potential for phosphorus loss. The P-Index used is discussed in Appendix F (Phosphorus Index (Michigan Trial)).

Only the high risk fields of the high risk operations were scored with the P-Index in this research. It was assumed that if the fields with the highest risk of polluting surface

[17] Phosphorus index: This index is commonly used in many states but not in Michigan currently. The index used was not field tested in Michigan and may or may not be similar to the version Michigan ultimately adopts as its own.

water were evaluated and scored below the threshold, then the fields with less risk of polluting surface water would also score below the threshold. A high risk field was selected for evaluation based on: 1) proximity (within 300 feet) to surface water; 2) soil level of phosphorus was above 300 pounds per acre (150 ppm); or, 3) a high MARI score. The Manure Application Risk Index (MARI) identifies areas that may safely receive manure applications under specified weather conditions and during which seasons. A field with a high MARI rating cannot have any manure spread in the winter because application of manure would not be safe for the environment (Ouyang & Laboski, 2005). Fields that met one or more of the three criteria were compiled and then within this set, eight fields were randomly selected to conduct the P-Index. If an operation did not have eight fields that met at least one criterion, either six fields were tested or the set of tested fields were opened to those fields that had a soil phosphorus level between 150 to 300 pounds of P per acre (75 to 150 ppm) and/or a medium MARI score. Some operations may not have a change in the phosphorus mass balance or the phosphorus index depending on the operation's level of pollution prevention in place prior to MAEAP verification.

3.3.4 Reporting the Data

For the purposes of this research, each livestock producer was labeled with the corresponding primary enterprise. If a livestock producer raised more than one species, the largest number of animal units of a single species' category would be labeled the "primary enterprise." Several operations had dairy cows and beef cattle, but the dairy cattle out-numbered the beef cattle and thus, dairy was considered the primary enterprise; these operators were labeled as dairy producers.

Due to the large variety and small number of beef producers interviewed, this species' information was only discussed in averages. Again, this study was not representative of the general livestock operations in Michigan, only those operations that were MAEAP verified. Conclusions cannot be drawn regarding the costs of the average beef operation in Michigan due to the small sample size. Also, no minimums or maximums were listed for any group with a sample size (N) less than four.

In order to accurately compare costs across time, in this study all costs were adjusted to 2004 dollars using the Producer Price Index (USDL, 2005). Costs were defined using several methods. There were costs to the producer and costs to society, or private plus taxpayer costs. A producer's costs were only the costs in which the operator paid out-of-pocket. For example, the livestock producer's cost for the CNMP was the price for the written CNMP minus any cost-share or in-kind dollars received by the producer. Private plus taxpayer costs included the costs to the livestock producer plus any costs for which the livestock producer received from cost-share or in-kind dollars.

There also were total and annual costs related to implementing and maintaining MAEAP verification. The annual cost was not simply the total cost, annualized. The CNMP had a one time fee, considered to be a start-up cost. The cost to update the CNMP was considered to be an annual cost, but the two costs were different as the CNMP updating cost was typically not as expensive as the initial cost of the CNMP. The "total cost" of writing, implementing and maintaining MAEAP verification included the CNMP price, the costs of any change in managerial practices, and the costs of any change in or additional capital investments. The "annual cost" of implementing and maintaining MAEAP verification included the managerial costs, which included the TSP or crop consultant fees, annualized, and capital investment changes, annualized. All figures were reported in 2004 dollars, but did not account for inflation over the 2004 – 2008 time periods.

3.4 Chapter Summary

The style and design of the interview promoted producer and interviewer discussion. To evaluate MAEAP the livestock producers, who were already verified, were asked questions related to their motivation for becoming MAEAP verified, the costs associated with becoming MAEAP verified, and what management and capital changes they made for verification. The data were then compiled in a database with simple calculations and regressions used to determine the costs and categorized responses. To determine the environmental change that occurred on operations due to MAEAP verification, 25 operations were evaluated with the phosphorus mass balance. The farms that were determined to be at high risk of transporting phosphorus to surface water were evaluated with the phosphorus index. This index includes variables that evaluated the field's phosphorus source and transport potential.

Chapter 4: Summary of Interview Results

4.1 Introduction

Interviews were conducted between December 2004 and February 2005; 63 percent of all verified MAEAP producers who were verified as of January 1, 2005 were interviewed. Twenty-nine livestock producers discussed 31 operations, and 25 CNMPs were collected and examined to assess environmental impacts.

Of the 31 operations analyzed, 27 were previously MAEAP verified and four were awaiting third-party verification (Table 4.1). Throughout the research it was assumed that these four unverified operations would be verified during 2005. Large operations, CAFOs, made up 17 of the 31 operations and 14 operations were considered small or medium farms, or AFOs. Swine farm operators were the most frequently interviewed (13 operations, 92 percent of all verified swine producers) followed by dairy (10 operations, 43 percent of all verified dairy producers), poultry (5 operations, 57 percent of all verified poultry producers), and beef (3 operations, 50 percent of all verified beef producers).

Table 4.1: MAEAP-Verified Producers and Operation Statistics

	Beef	Dairy	Poultry	Swine	Total
Total Producers with MAEAP-verified operations	6	14	7	13	40
Total Operations MAEAP-verified	6	15	23	19	63
Producers interviewed	3	10	4	12	29
Operations surveyed	3	10	5	13	31
Producers interviewed verified as of 1-1-05	3	6	4	12	25
Operations surveyed verified as of 1-1-05	3	6	5	13	27
Early Verified Operations (Before 2004)	2	2	1	8	13
Late Verified Operations (After 2003)	1	8	4	5	18
CAFO (over 1,000 animal units)	1	7	4	5	17
AFO (under 1,000 animal units)	2	3	1	8	14

4.2 Operator Characteristics

The average manager that was interviewed was 50 years old and had slightly more than a technical education (2.2) plus 19 years of management experience at that farm location (Table 4.2). "Years in Management" was counted only at that particular farming operation. However, there were few managers that had switched from a different location, as most managers interviewed were owner/operators.

Table 4.2: Operator Characteristics (Age, Education, and Experience)

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
Age	Years						
Average	47	52	53	47	50	49	50
Standard Deviation	21	9	7	8	10	12	6
Minimum*		36	43	35	23	23	42
Maximum		66	59	69	69	69	62
N	3	10	4	12	29	17	12
Formal Education	1-4 scale						
Average	3.0	1.8	3.0	2.0	2.2	2.1	2.3
	Percent						
High School (1)	0	60	0	33	34	39	27
Technical Degree (2)	0	10	25	42	24	22	27
Bachelor's Degree (3)	100	20	50	17	31	28	36
Master's Degree (4)	0	10	25	8	10	11	9
N	3	10	4	12	29	17	12
Years Managing Operation	Years						
Average	21	19	18	18	19	17	21
Standard Deviation	17	13	7	8	10	12	8
Minimum		1	7	5	1	1	10
Maximum		45	25	34	45	45	38
N	3	10	5	13	31	17	14

*Minimum and maximum values are not reported if N is less than 4.

Overall, there was not much difference in the average age of the operator among all species and size of operations. CAFO operators however, varied the most in age, ranging from 23 to 69 years old. Beef and poultry managers had, on average, the most formal education – with no producer acquiring less than a technical degree. Dairy producers were, on average, the least formally educated (1.8 on a 4 point scale), but had many years of management experience at that farm location (19). One dairy producer had been managing the same operation for 45 years. Large operations had some of the most inexperienced managers; no small or medium operator had less than 10 years experience.

4.3 Farm Operation Characteristics

The sample in this research was a good representation of the livestock operations and operators that were MAEAP verified, as 43 percent of the operations and 63 percent of the operators that are MAEAP verified by January 1, 2005 were interviewed. Many of the livestock producers interviewed had contracts with or owned other farms that were also MAEAP verified, as can be seen from the difference in total operations verified and total producers with verified operations in Table 4.1. Of the 63 operations that have been MAEAP verified, there were 40 owners.

4.3.1 Land and Crops

Five of the 31 operations surveyed had no cropland acres, but even with these low values, the average farm in the interviewee database operated 1,138 acres (Table 4.3). The median operated acreage was 1,060 acres. If the operations with no cropland were excluded, the average operated acreage was 1,400 acres. Operated acre calculations only included the acreage used for crop production; facility and woodlot acres were omitted. It should be noted that the operated acre calculation does not imply that all of this land was available to spread manure. Spreadable acres included land that livestock producers owned, rented, or had verbal or written spreading agreements with the owners, excluding those acres with phosphorus content greater than 150 ppm, buffer strips, and grass waterways. Spreadable acres averaged 1,295 acres, approximately 160 acres more than the total operated acres (Table 4.3). The increase was due primarily to the additional agreements dairy and poultry operators had with other crop producers to spread the manure.

Table 4.3: Acreage* for Interviewed Operations

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
Owned acres				Acres			
Average	450	1,067	470	581	707	825	564
Standard Deviation	477	759	683	875	789	784	801
Minimum**		0	0	0	0	0	0
Maximum		3,000	1,500	3,000	3,000	3,000	3,000
Rented acres							
Average	273	746	40	378	432	602	226
Standard Deviation	414	620	89	343	487	578	231
Minimum		0	0	0	0	0	0
Maximum		1,957	200	1,180	1,957	1,957	800
Operated acres							
Average	723	1,813	510	957	1,138	1,427	789
Standard Deviation	891	990	760	1,020	1,044	1,096	891
Minimum		0	0	0	0	0	0
Maximum		3,300	1,700	3,200	3,300	3,300	3,200
Spreadable acres							
Average	526	2,387	1,103	708	1,295	1,871	597
Standard Deviation	649	1,618	1,685	519	1,382	1,568	651
Minimum		690	0	190	0	0	0
Maximum		6,258	3,813	2,227	6,258	6,258	2,610
N	3	10	5	13	31	17	14

* Owned, rented and operated acres include only cropped acreage, not facility and woodlot acres.
**Minimum and maximum values are not reported if N is less than 4.

In the aggregate, producers owned an average of 707 acres and rented an average of 432 acres. The average dairy operator farmed the most cropland (1,813 acres); he/she had 1,067 acres of owned cropland and 746 acres of rented cropland. Dairy producers also increased the average number of spreadable acres the most, by 574 acres through spreading agreements. The average swine operation could not spread manure on 250 of their total operated acres, and other agreements were not obtained to increase the amount of spreadable land available. The large number of acres unavailable for manure spreading at any given operation was typically due to the number of acres having a phosphorus soil test above 150 ppm.

This new information regarding the soil test and amount of manure that could be spread on specific fields decreased the number of acres an AFO could spread manure on compared to the total number of operated acres by approximately 190 acres. The amount of spreadable acres impacted the number and scope of the changes required in the CNMP. Because the fewer spreadable acres, the more land a producer needed to acquire, the more manure that must have been sold, the larger the amount of manure that must have been decreased with technologies, or the more animals that must have been sold.

Rented land was often obtained via rental agreements that were contracted for at least several years in length. Uncertainty is inherent in a one-year leasing agreement, which may reduce a tenant's ability and willingness to adopt new pollution prevention practices. Thirty-nine percent of the 29 producers interviewed (12) had land rental contracts that mentioned applying manure and/or nutrients to the land at agronomic rates or in accordance with GAAMPs. One producer that did not currently have nutrient management terms in his rental agreements thought he would need to add the manure management wording in future rental agreements due to an increase in his liability concerns for nutrient leaching and runoff in the past few years.

4.3.2 Animal Units and Manure Sold

Animal units (A.U.) were standardized for this research. The animal units used to calculate a farm's CNMP animal units was not necessarily the number of animal units used to calculate this study's averages. The calculations for this research were based on the EPA Permit (MIG 010000) method; that is, the number of noses was counted rather than total average weight divided by 1,000 to determine the number of animal units. For example, the new method counted the number of dairy cows on the farm and multiplied the total number by 1.4; the old method calculated the actual or estimated weight of all the cows and divided the total weight by 1,000. (Refer to Appendix A, "Calculating Animal Units: Permit MIG 010000 Compared to General Permit MIG 440000" for a comparison of the two methods, for calculating animal units.)

If an operation, such as swine, had multiple groups of animals being raised throughout the year, the average number of animals housed was used and then multiplied by the amount of time the animals were housed for manure collection. Thus, if the operation housed 1,000 animal units for 50 percent of the year, and if the production site was empty the other 50 percent of the time, the operation was considered to have 500 animal units annually.

Not surprisingly, the number of animal units varied significantly between and within species (Table 4.4). Poultry producers, on average, had the most animal units (7,808) per operation of all animal species. The 7,808 animal units equates to approximately 780,800,000 birds. The average poultry operation had nearly four times the number of animal units as the next largest species, dairy. The large number of animal units per poultry operation was more common due to the industry's consolidation; however, poultry producers also had the largest range from 405 to 17,873 animal units. Interestingly, every poultry producer interviewed sold at least 40 percent of his manure.

These operators sold off farm, on average, 83 percent of all manure generated on the verified operation.

When manure was sold off-farm, it decreased the amount of manure spread on operated land. This decrease in manure meant that a new figure of net animal units[18] needed to be calculated to determine the amount of animals units that must be considered when spreading manure. The net animal units indicated a lesser amount of manure that needed to be spread compared to the actual number of total animal units.

Table 4.4: Animal Units before Any Manure Sold and Net Animal Units

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
Animal units	Animal Units						
Average	417	1,994	7,808	1,146	2,424	3,999	510
Standard Deviation	592	1,299	7,058	1,003	3,685	4,420	310
Minimum*		309	405	160	47	1,100	47
Maximum		3,660	17,873	4,054	17,873	17,873	1,058
Percent manure sold	Percent						
Average	0	7	83	13	21	28	12
Standard Deviation	0	13	26	28	35	39	28
Minimum		0	40	0	0	0	0
Maximum		33	100	100	100	100	100
Net animal units	Animal Units						
Average	417	1,814	942	1,070	1,226	1,843	477
Standard Deviation	592	1,207	1,974	954	1,245	1,384	337
Minimum		309	0	0	0	0	0
Maximum		3,660	4,468	3,851	4,468	4,468	1,058
N	3	10	5	13	31	17	14

*Minimum and maximum values are not reported if N is less than 4.

As shown in Table 4.4, CAFOs on average had 3,999 A.U. and sold an average of 28 percent of the manure generated on the farm. By selling manure, CAFOs were able to

[18] Net animal units = total animal units – (animal units*percent manure sold). It is assumed the number of animal units on a farm represents the amount of manure produced. If the producer sells 83 percent of the operation's manure then only 83 percent of the total animal units will need to be used when calculating the pounds of phosphorus generated per animal unit or number of animal units per acre.

decrease the number of animal units germane to their manure management, by over 50 percent to 1,843, which ultimately decreased the manure applied to the operated acres. AFOs sold little manure on average (12 percent). Although AFOs sold some manure, they had 360 fewer acres for manure spreading on average, as compared to the number of acres they operated; thus, animal density was a concern on the small and medium farms.

4.3.3 Animal Density

Research has shown that to provide sufficient land base for using the nutrients in manure, a confined animal feeding operation (CAFO) requires approximately one acre of land per six animal units for nitrogen utilization and approximately one acre per one animal unit for phosphorus utilization (Glewen & Koelsch, 2001). Due to the large number of freshwater watersheds and lakes throughout and surrounding Michigan, phosphorus is the primary nutrient of concern. Phosphorus is a key nutrient pollutant of freshwater because excess phosphorus in the water stimulates eutrophication, which can diminish the value of water for human activities, aquatic life, and livestock. As a result, an animal density of approximately one acre per one animal unit was optimal to reduce the risk of phosphorus runoff.

Animal density could be calculated using several different methods, as seen in Table 4.5. Often, only the operation's animal units and the land that operation used for crop production determined animal density; this method was used in row one of Table 4.4. However, the cropland operators used to spread manure was not the same as operated acres, and some operators sell manure. In order to be precise, both the amount of manure sold off farm and only the cropland that manure could be spread determined the density calculated in row four of Table 4.4, *Net animal units per spreadable acre*.

This calculation was the most accurate animal unit density calculation as it included both the "spreadable acre" and total manure or "net animal unit" variables.

The importance of selling manure was most evident in the difference between rows three and four. Poultry producers sold the most animal units decreasing their animal density the most, from 5.8 to 1.3. However, all densities have large ranges among species. On the average, beef (0.6) and dairy (0.8) operations had a low animal density no matter how the density was calculated.

Table 4.5: Animal Density

		Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
1	**Animal units/ acres operated**	Animal Unit per Acre						
	Average	0.4	0.8	5.3	2.3	1.8	2.7	0.7
	Standard Deviation	0.2	0.5	7.4	4.5	3.6	4.7	0.6
	Minimum*		0.0		0.0	0.0	0.0	0.0
	Maximum		1.6		17.3	17.3	17.3	1.9
2	**Net A.U./ acres operated**							
	Average	0.4	0.7	1.3	1.9	1.2	1.8	0.6
	Standard Deviation	0.2	0.4	1.9	3.4	2.4	3.1	0.5
	Minimum		0.0		0.0	0.0	0.0	0.0
	Maximum		1.2		13.0	13.0	13.0	1.7
3	**Animal units/ spreadable ac.**							
	Average	0.6	0.9	5.8	1.7	1.6	2.0	1.2
	Standard Deviation	0.3	0.6	6.6	0.8	1.9	2.4	1.0
	Minimum		0.2		0.4	0.2	0.5	0.0
	Maximum		2.1		3.1	10.5	10.5	3.1
4	**Net A.U./ spreadable acres**							
	Average	0.6	0.8	1.3	1.6	1.2**	1.2	1.1
	Standard Deviation	0.3	0.4	1.9	0.8	0.8	0.7	1.0
	Minimum		0.2		0.0	0.0	0.0	0.0
	Maximum		1.5		3.1	3.1	2.6	3.1
	N	3	10	2	13	28	15	13

*Minimum and maximum values are not reported if N is less than 4.
**Rounding caused the Total and CAFO averages in row four to look equal, but there was a 0.05 unit difference.

Often past research indicating that livestock producers needed more cropland to spread manure, did not account for rented land, access agreements, and/or sold or composted manure (e.g., USDA-NRCS, 2003 and Gollehon, et al., 2001). All of these variables were considered in this research. The net animal units per spreadable acre showed that two species had an average density larger than 1.0 at 1.3 (poultry) and 1.6 (swine). An operation with an average density above 1.0 may be due to the method, in which the plan writer calculated the number of animal units initially, or the spreadable acres could have had a phosphorus level below 75 ppm and manure could be spread according to nitrogen, not phosphorus, recommendations of the crop (MDEQ, 2005). If a field had a soil test below 75 ppm, that field was limited only by nitrogen, not phosphorus, and the animal density could be higher - about six animal units per acre instead of one (Glewen & Koelsch, 2001). An animal density of approximately one was the goal of operations where the limiting nutrient on all fields was phosphorus. The average density across all species was 1.2, while CAFOs and AFOs were similar at 1.2 and 1.1 respectively.

4.3.4 Geographic Location

Many of the operations that have become MAEAP verified were in the same geographic area. Just under half (14 of 31) of the operations surveyed were from two 3-digit zip codes areas, 488 and 494 (Table 4.6). These two zip code areas were highly populated with both animals and people.

Five out of six operations surveyed in the 488 zip code area (parts of Clinton, Ionia, and Montcalm counties) and 75 percent of the operations (six) in the 494 zip code area (parts of Muskegon, Oceana, and Ottawa counties) sold some portion of the manure produced. However, the 490 zip code area (parts of Barry, Branch, and Kalamazoo counties) sold the most equivalent animal units of manure – 94 percent. If the livestock producers in these three zip codes did not sell any manure, the average animal density ratio would have been above 2.5. Due to manure sales, the average operation in these zip code areas had an animal density of 0.97.

Table 4.6: Operation Descriptors by First 3 Digits of the Zip Code, Averages

Zip Code Areas	N	Counties	Early Verify[19]	Late Verify[20]	CAFO	AFO	Total A.U.	Percent A.U. Sold
			Percent				Animal Unit	Percent
484	4	Huron, Newaygo, Sanilac	50	50	100	0	4,507	0
487	5	Huron, Sanilac, Tuscola	40	60	80	20	6,553	0
488	6	Clinton, Ionia, Montcalm	17	83	67	33	9,545	15
490	3	Barry, Branch, Kalamazoo	67	33	33	67	4,937	94
492	3	Calhoun, Hillsdale, Lenawee	67	33	0	100	2,848	0
493	1	Barry, Isabella, Mecosta	0	100	0	100	766	0
494	8	Muskegon, Oceana, Ottawa[21]	38	63	63	38	45,927	68
496	1	Lake, Missaukee, Osceola	100	0	0	100	47	0
		N	13	18	17	14		

The aggregation of livestock operations in the same area has been seen throughout Michigan; often the same species were located in the same 3-digit zip code. The economic benefits of vertical coordination in the animal sector, particularly for poultry and swine, led to both larger operations and a geographic concentration of animal production (Martinez, 1999). Four swine operations were located in the 487 area and four poultry operations were located in the 494 zip code area. However, the concentration of livestock operations poses challenges when spreading manure.

[19] "Early Verify" is defined as those operations that became MAEAP verified before 2004 (2002-2003).
[20] "Late Verify" is defined as those operations that became MAEAP verified after 2003 (2004-2005).
[21] The USDA-NRCS evaluated counties across the United States that had excess manure compared to the amount of spreadable land available. From the NRCS simulation, one county in Michigan (Ottawa County) was found to have more manure than the capacity of its crop and pasture land. This excess production of manure may be one reason why livestock producers in the 494 zip code area sold manure. It is not known in which county the manure was spread after it was sold, but some manure was sold outside the zip code area (USDA-NRCS, 2003).

4.4 Starting the Comprehensive Nutrient Management Plan

No operator had a Comprehensive Nutrient Management Plan developed prior to MAEAP verification, regardless of where the operation was located. Writing the CNMP was the second phase of the MAEAP verification process and required more time and money than MAEAP's first and third phases. The most recently developed CNMPs often had more information than earlier plans, because of changes in rules and regulations. Due to plan writer and operation heterogeneity, several different methods were used to calculate the animal units, manure quantity produced, and cost to have a CNMP written, as well as the variety of manure nutrient and land base details listed within a plan.

4.4.1 Motivation to become MAEAP Verified

Motivation to begin a CNMP came from many different sources. The early adopters had different motivations for becoming MAEAP verified than the later adopters. This difference was in large part due to regulatory changes. By 2006, more animal producers will need a CNMP to remain in business. By September 1, 2005, all CAFOs must have either signed a letter of intent to participate in MAEAP or purchase an NPDES permit; both programs require a CNMP (Wilford & Wuycheck, 2003). Regulations prompted seventy-one percent (12 of 17) of CAFO producers to become MAEAP verified (Table 4.7). The number of operations that have become MAEAP verified has increased; MAEAP verified its 100th farm in the summer of 2005 (Negal, 2005).

Fifty-eight percent of all producers (18) that became MAEAP verified did so due to current regulations or regulations they foresaw affecting their farm in the future. Seventy-one percent of CAFOs (12) and only forty-three percent of AFOs (six) listed regulations as a reason they became verified. There were fewer concerns from environmental groups directed at AFOs, where as CAFOs have received more concern from the community and have faced more regulations. Regulations motivated 100 percent of the four poultry producers interviewed to become MAEAP verified. The risk of lawsuits and fines motivated a total of six producers to become MAEAP verified.

Table 4.7: Producers Motivation to Become MAEAP Verified

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO	Early Verify	Late Verify
	Percent								
Environmental regulations directed at his/her farm	33	60	100	46	58	71	43	62	56
Someone asked him/her to become verified	33	40	0	62	42	35	50	54	33
To obtain technical and financial assistance	33	20	20	31	26	29	21	15	33
To decrease his/her lawsuit and fine risk	0	20	20	23	19	24	14	15	22
To obtain an increased community awareness	0	30	0	8	13	18	7	8	17
Insurance discounts	0	10	0	8	6	6	7	8	6
Had more time to manage the farm	33	0	0	0	3	6	0	0	6
N	3	10	5	13	31	17	14	13	18

*Producers could have chosen more than one motivation as to why they decided to have their operation become MAEAP verified.

As seen in Table 4.7, the operations verified before 2004, labeled *Early Verify* revealed that eight producers sought MAEAP verification predominately because of environmental regulations directed at their farms (62 percent). Also, seven became MAEAP verified because someone asked them to become verified (e.g., Michigan Farm Bureau or MSU Extension agent) (54 percent). As expected fewer "late verified" operators became MAEAP verified because someone asked them too (33 percent, (six)) as compared to 54 percent (seven) of the "early verified" operators. As MAEAP has evolved, motivation to become verified shifted towards technical and financial assistance a producer received for becoming verified (15 percent of the early (two) to 33 percent of later verified farms (six)). The interviewed producers could have responded with a multitude of reasons, which is why the columns listed do not sum to 100 percent.

More time to manage the farm motivated only one producer to become MAEAP verified. Community awareness motivated four producers, while insurance discounts motivate only two. Items that did not motivate any operator to become MAEAP verified included a concern about drinking water on the farm, awareness of a pollution problem on the farm, or a landlord or agricultural lender encouraging or requiring a CNMP.

Participation in voluntary programs may have been motivated by environmental stewardship, i.e., personal satisfaction gained from adopting activities, such as MAEAP, that protect the environment. Eight producers interviewed mentioned that they became verified because they felt it was the "right thing to do." This statement was often used to explain several different motivations. For some this statement meant setting a good example for other Michigan livestock producers, others mentioned this statement because they foresaw better crop returns, while others thought by becoming MAEAP verified they were "doing the right thing," whether it was for the environment or their neighbors.

4.4.2 Agency Assistance

Agricultural producers who voluntarily followed GAAMPs within MAEAP's guidelines or via the NPDES permit were provided protection from public or private nuisance litigation under Public Act 93 of 1981, as amended, The Michigan Right-to-Farm Act. MAEAP verification and the NPDES permit offered the same assurance against nuisance litigation, if a suit was filed. One of the major differences between the

MAEAP and the NPDES permit was the level of assistance the producer received to complete the CNMP and understand regulations affecting Michigan livestock producers.

To learn about the regulations, the CNMP, and information supplied to the plan writer, MAEAP livestock producers received support from many different agencies. Initially, many livestock producers were skeptical of any government intervention and how much activity the government would have on the farm. One poultry producer stated that the hardest part about volunteering [for MAEAP] was that the "government" was going to be on his farm and he feared that they might find something they did not like and penalize him. Working with the livestock producers during MAEAP's education phase helped to reduce producer anxiety about having governmental agency staff on the farm. The education MAEAP provided as part of its three-phase process also allowed livestock producers to learn from professionals in the field and from one another, rather than just purchasing and following an NPDES permit.

Another result of the program's education was that there were many agencies represented within the MAEAP partnership that livestock producers indicated they could work with and trust, throughout the MAEAP verification process. The average producer conversed with two different agencies for advice and assistance in writing the CNMP.

Of the governmental agencies that assisted the interviewed producers in writing their CNMP and becoming MAEAP verified, MSU Extension (MSUE) was a resource used by almost 50 percent of the producers; 35 percent used the NRCS (Table 4.8). The Michigan Department of Environmental Quality (MDEQ) was used the least as a resource. The plan provider was a resource used by 74 percent of all producers to seek advice, and particularly to ask questions about the contents of the producer's own plan.

Table 4.8: Resources Used to Write and/or Implement the CNMP

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
	Percent						
MSUE	67	30	20	69	48	29	71
NRCS	67	20	40	38	35	12	64
MDEQ	0	10	0	0	3	0	7
MDA	33	20	0	15	16	6	29
Private Plan Writer	67	80	100	62	74	88	57
Conservation District	0	10	0	23	13	6	21
Michigan Milk Producers	0	10	0	0	3	0	7
Pork Producers	0	0	0	15	6	6	7
Other	67	10	20	15	19	18	21
	Number Count						
Average Resources Used	3.0	1.9	1.8	2.4	2.2	1.6	2.9
N	3	10	5	13	31	17	14

* Producers listed all the resources they used, often listing more than one resource.

Often, before a livestock producer began writing the CNMP they sought the advice of various agency staff, the MAEAP educational seminars, and/or a CNMP plan writer to consider appropriate management changes. Management and capital investment changes involved with the CNMP could be simple (e.g., recording new information or having manure samples taken) or complex (e.g., building additional manure storage or changing the method used to spread manure).

4.5 Barriers to Implementing the CNMP

The largest barrier for MAEAP verification, affecting 41 percent of the 29 producers interviewed, was not financial, but rather available, spreadable cropland (Table 4.9). This concern about enough land to spread manure came from several different factors, highlighted in grey in Table 4.9: land base, using manure for its actual nutrient value (i.e., not using the book values for manure's nutrient value and not discounting manure's nutrient content), crop rotation, and hauling the manure further.

Table 4.9: Producer-Identified Barriers to Implementing Required CNMP Changes

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
	Percent						
Land components	100	30	50	33	41	50	31
Land base	33	30	50	33	34	50	15
Manure book values	67	0	25	17	17	13	23
Crop rotation	33	10	0	8	10	19	0
Driving distance to spread manure	0	0	25	8	7	13	0
Time (spreading manure and recordkeeping)	33	10	25	42	28	19	38
Inconsistencies among agencies	0	40	0	33	28	31	23
Adequate manure storage	0	20	50	17	21	25	15
Finding a qualified plan provider	33	0	0	25	14	13	15
Composting animals	0	0	0	17	7	0	15
Financial situation	0	10	0	0	3	0	8
N	3	10	4	12	29	17	12

One of the first barriers to complete the CNMP was finding enough cropland that had a soil phosphorus (P) level below 150 ppm. If the soil tested above this level of P then no manure could be spread on that land. Transporting manure could be costly to move relative to its nutrient value, which limits the owners' fields to which they can economically apply manure. Many operations across the US did not consider the nutrient value of manure when making livestock or cropping management decisions, thus treated manure as a waste. This situation has led to over-application of manure on land nearest to the facility relative to plant uptake across the US (Ribaudo et al., 2003), and is most likely what occurred on Michigan farms.

Different crop rotations require different amounts of phosphorus and can lead to more or less phosphorus uptake by the plant. However, before the agronomic level of P was established for a CNMP, many livestock producers spread excess phosphorus on the high value root crops; one vegetable field had a phosphorus level of 450 ppm. In many cases, acreage with these crops in past rotations had P levels above 150 ppm.

As a result of their CNMPs, two producers took entire crops out of the rotation because the crop did not remove enough phosphorus. Different crops take up and store different amounts of phosphorus from the soil (Table 4.10). For example, a soybean acre that yielded 40 bushel took 35.2 pounds of P_2O_5 from the soil while an average grain corn acre removed 42 pounds of P_2O_5 from the soil.

Table 4.10: Nutrient Removal (lb/unit of yield) by Several Michigan Field Crops

Crop		Unit	N	P_2O_5	K_2O
				----lb per unit----	
	Hay	ton	45*	10	45
Alfalfa	Haylage	ton	14	3.2	12
	Grain	bushel	0.88	0.38	0.25
Barley	Straw	ton	13	3.2	52
Birdsfoot Trefoil	Hay	ton	481	12	42
Brome grass	Hay	ton	33	13	51
	Grain	Bushel	1.9	0.91	0.46
Canola	Straw	Ton	15	5.3	25
Clover-grass	Hay	ton	41	13	39
	Grain	Bushel	0.9	0.35	0.27
	Grain**	Ton	26	12	6.5
	Stover	Ton	22	8.2	32
Corn	Silage	Ton	9.4	3.6	7.8
Dry Edible Beans	Grain	cwt	3.6	1.2	1.6
	Grain	Bushel	0.62	0.25	0.19
Oats	Straw	Ton	13	2.8	57
Orchard grass	Hay	ton	50	17	62
Potatoes	Tubers	cwt	0.33	0.13	0.63
Red Clover	Hay	ton	401	10	40
	Grain	Bushel	1.1	0.41	0.31
Rye	Straw	Ton	8.6	3.7	21
Sorghum –Sudan	Hay	Ton	40	15	58
grass (Sudax)	Haylage	Ton	12	4.6	18
Soybeans	Grain	bushel	3.8	0.88	1.4
Sugar Beets	Roots	ton	4	1.3	3.3
	Grain	Bushel	1.2	0.62	0.38
Wheat	Straw	Ton	13	3.3	23

*Legumes get most of their nitrogen from air. **High moisture grain.
Source: Fertilizer Recommendations for Field Crops in Michigan (Christenson et al., 1992)

Another method livestock producers used to increase spreading capabilities was to plant a winter cover crop. A winter cover crop, in some cases, reduced the effects of snowmelt and erosion, lowering a field's MARI score enough to allow winter spreading. Adding winter cover crops decreases erosion and nutrient surface runoff and increases organic matter. Similarly, some crop producers planted buffers around water bodies to decrease runoff. The acreage dedicated to buffers did not significantly impact the number of acres available for manure spreading; on average, only 3.5 acres of buffers or grass waterways were planted for MAEAP verification per farm.

Another barrier to acquiring enough land for the CNMP came from estimating manure's nutrient content. Testing manure for its nutrient content was a new concept for some livestock producers. Six producers had never tested manure for its phosphorus content prior to obtaining a farm specific CNMP. Thus, during the first few years, some verified farms lacked a manure nutrient history; therefore, to complete the CNMP with agronomic spreading rates, many used a mathematical calculation or the values listed in the Midwest Plan Service books to estimate manure's nutrient levels (Midwest Plan Service, 2000). One operation estimated his manure content initially, but after testing his manure he realized he could spread manure at a higher rate because the true nutrient value was less than the estimated. The actual characteristics of manure can vary ± 30 percent from table values (Bollinger, Rector, & Wilford, 2002).

As shown in Table 4.9, 17 percent of the producers interviewed saw the lack of manure nutrient history as a large barrier to implementing their CNMP. However, this perceived barrier may not be an actual barrier as a mass balance calculation based on phosphorus inputs and outputs to the farm could have been estimated. The underlying concern may have been that the previously unknown soil and or manure level of phosphorus may now be the limiting factor in spreading the manure on many fields.

Finding enough time to spread manure and keep records was mentioned by 38 percent of the livestock producers as a large barrier to implementing the CNMP (Table 4.9). Time more seriously affected the small and medium operators as 46 percent of the 13 producers listed it as a large barrier (six), while only 31 percent of the 16 CAFO operators mentioned it (five). One livestock producer replaced 200 acres of his grain corn with wheat, in order to be able to spread manure in the summer, when he had more time. Another producer explained that he could only spread a total of 11 days a year if weekends, holidays, and winter months were omitted, as well as taking into consideration forecasted weather conditions. Since it took him 20 days to empty his manure storage; thus, he hoped winter spreading would never be outlawed. Although 74 percent of the operations surveyed (23) had more than six-months of storage, it was still important that livestock producers have enough time, especially during strategic periods of the year to empty the manure storage.

Perhaps due to the infancy of the program, many livestock producers saw the inconsistency among different agencies' information as a large barrier (28 percent). Other barriers indicated by the respondent included manure storage (21 percent), finding a qualified CNMP provider (14 percent), composting of dead animals (seven percent), and financial situation (three percent).

4.6 Perceived Environmental Outcomes

Each producer interviewed mentioned their perceived environmental changes that occurred on the operation since completing the CNMP and/or becoming MAEAP verified. As indicated in Table 4.11, 38 percent of the 29 operators (11) described their operations as limited by phosphorus; by which they meant that there were multiple fields where they could not spread any phosphorus after they became MAEAP verified.

Table 4.11: Perceived Environmental Outcomes Due to MAEAP Verification

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
	Percent						
Limited by field phosphorus levels	0	50	75	25	38	44	31
Perceived a decrease in field phosphorus level	33	20	50	33	31	44	15
Increased H_2O quality	33	20	25	42	31	19	46
Increase in percent organic matter	0	20	25	42	28	31	23
Decreased soil erosion	33	20	25	33	28	25	31
Increased H_2O holding capacity	33	10	0	42	24	19	31
Increased wildlife habitat	33	0	0	42	21	13	31
N	3	10	4	12	29	17	12

CAFO managers perceived a decrease in the amount of phosphorus in the soil (44 percent) and an increase in percent organic matter (44 percent) following verification. AFO managers more often expected an increase in water quality (46 percent). There were not large differences in the perceived environmental effects across different species. These changes were the perceived changes, and may not be an accurate account of the farm after scientific testing.

4.7 Opinions

A producer's perceptions and personal experience can be influential in persuading other livestock producers to become MAEAP verified. MAEAP's education requirement, or Phase 1, set it apart from simply obtaining an NPDES permit. Through MAEAP's educational programs, producers learned about nutrient pollution prevention, the effects of new laws and regulations, and where to go to obtain nutrient management assistance. On average, the interviewed operators, on a scale of 1 (Strongly Agree), 2 (Agree), 3 (No Opinion), 4 (Disagree), and 5 (Strongly Disagree), agreed (1.8) with the statement, "MAEAP's educational programs have helped me become a better steward" (Table 4.12). When livestock producers are better environmental stewards, they achieved one of MAEAP's goals - preventing pollution at its source.

The governmental agencies assisting producers in becoming MAEAP verified were one of its unique aspects. Producers listed governmental agencies' helpfulness as 2.7. One producer said he hated government officials knowing everything about him and was glad MAEAP was not run solely by governmental agencies. Poultry producers thought the agencies were the most helpful as they assigned the lowest score of all the producers grouped by animal species (2.3). However, 17 percent of the 29 livestock producers (5) felt the MDEQ, MDA, and NRCS should have more interaction with each other so each of the three agencies would offer the same advice.

An important insight was how producers viewed the value of their CNMP. This measure foreshadowed whether the producer would continue to maintain the changes outlined in the CNMP, and/or periodically update it. As presented in Table 4.12, when asked how well they agree with the statement, "My CNMP is so valuable to my operation; it is my intent to maintain and update it in the future" producers responded in agreement with a score of 2.0 (agree). No producers gave the statement a score of less than a 3.0 (no opinion). The swine producers agreed the most (1.5), while the average dairy producer agreed the least (2.4). The positive feedback and desire to revise the CNMP suggested that producers should maintain the management scheme changes that already had been made and will update the CNMP to follow new laws and regulations.

Table 4.12: Opinion Statements

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO	Early Adopt	Late Adopt
MAEAP educational programs have helped me become a better steward.	2.0	2.2	1.3	1.6	1.8	1.9	1.6	1.8	1.8
Michigan governmental agencies are doing a good job helping producers reduce pollution without substantially hurting profits.	2.7	2.8	2.3	2.6	2.7	2.8	2.5	2.5	2.8
My CNMP is so valuable to my operation; it is my intention to maintain and update it in the future.	2.0	2.4	2.3	1.5	2.0	2.2	1.7	1.8	2.1
Liability and lawsuits are of little concern for the livestock industry in Michigan.	4.7	4.9	4.8	3.9	4.5	4.4	4.6	4.2	4.7
Trends in environmental regulation are clear enough to justify changing my environmental practices, even those that require permanent structure investments.	3.0	2.6	2.0	3.2	2.7	3.0	2.4	2.3	3.1
My farm operation can be profitable without causing or contributing to any significant water quality pollution.	1.0	1.3	1.0	1.0	1.1	1.2	1.0	1.0	1.2
The law requiring "no discharge" of polluted runoff over land or via tiles is adequate to counteract agricultural water pollution.	2.3	2.7	2.8	2.8	2.7	2.6	2.8	2.8	2.6
Even though clean water benefits the public, producers should pay for the majority of mandatory environmental practices to ensure pollution prevention.	4.0	3.5	4.8	3.7	3.8	3.9	3.7	4.0	3.7
Modern agriculture is a cause of environmental problems & needs continual, careful management to be environmentally sound.	3.7	3.3	3.3	2.7	3.0	3.3	2.8	2.8	3.2
N	3	10	4	12	29	16	13	13	16

1 = Strongly Agree, 2 = Agree, 3 = No Opinion, 4 = Disagree, and 5 = Strongly Disagree

*Solid grey: score of ≥1 but <2; Crosshatches: score ≥2 but <3; Diagonal strip: score ≥3 but < 4; White: score ≥4

The statement operators disagreed with the most (4.5) was "liability and lawsuits are of little concern for the livestock industry in Michigan" (Table 4.12). Several of the interviewed producers had litigation brought against them, or knew of a neighbor who had the same issue. Whether the allegations were factual or not, does not eliminate the frustrations and costs incurred. The chance of lawsuits prompted one producer to proclaim, "I'd tell my smaller neighbors to quit before they have to follow all these environmental regulations, because [writing and implementing] a CNMP takes a lot of money and causes a lot of headaches."

The size of an operation influenced how much a producer agreed with this statement: "Trends in environmental regulation are clear enough to justify changing my environmental practices, even those that require permanent structure investments." The CAFO managers, on average, were in the median (3.0, no opinion), while the AFO managers agreed more strongly (2.4). Over the past several years there have been many changes in regulations directed at CAFOs and some of this difference may have stemmed from the variable past.

The financing for pollution prevention also was addressed. The statement, "even though clean water benefits the public, producers should pay for the majority of mandatory environmental practices to ensure pollution prevention," was given on average a 3.8 on a 5 point scale. Poultry producers most strongly disagreed (4.8), while the dairy producers disagreed the least (3.5). Dairy producers had the most managerial and capital investment changes and received little cost-share per animal unit compared to the other animal species to make all their required changes.

4.8 Comparison to Allen Krizek's Study

In 2005, Allen Krizek conducted a mail-survey patterned closely with Kevin Kirk's earlier work in 1995 with regard to manure management. Dr. Krizek also asked the same opinion statements used in this study. Dr. Krizek's sample was much larger (254 respondents) than the present study (29 respondents). However, comparing the opinion section of Allen Krizek's research to this study's results helped gain a better understanding of how MAEAP participants differed from the Krizek's random sample population of Michigan livestock producers who practiced average to above average environmental stewardship.

Several statements received similar responses from both studies. The statement, "my farm can be profitable without causing significant water quality pollution" had more than 90 percent of both study participants giving the statement a strongly agree or agree score (Table 4.12). This parallel was understandable as all parties, including the respondents to Krizek's study, were categorized as practicing average or above average environmental stewardship. Another statement that received a similar response was "the law requiring "no discharge" of polluted runoff over land or via tiles is adequate to counteract agricultural water pollution." Both studies had a strongly agree or agree response rate between 52 and 55 percent. However, the number of respondents from this study that disagreed and strongly disagreed to the same question was nearly double the number compared to Dr. Krizek's study. A larger percentage of MAEAP-verified producers believed new or different regulations were necessary to lower water pollution from agricultural sources.

One of the statements that differed the most between the two studies was "MAEAP's educational programs have helped me become a better steward." The 31 percent difference between Krizek's (55 percent) and this study's (86 percent) agreement was expected as all MAEAP participants have attended meetings and adopted the practices taught through MAEAP. It is not known how many of Krizek's respondents were involved with MAEAP, but it was likely that if more livestock producers attended MAEAP's educational meetings, there would be less gap between the two groups' scores.

Another statement in which the two study participants disagreed was the financial statement, "Even though clean water benefits the public, producers should pay for the majority of mandatory environmental practices to ensure pollution prevention." More than 80 percent of Krizek's study participants disagreed or strongly disagreed, as compared to only 66 percent of this study's participants. It may be assumed that MAEAP participants believe that they cannot expect to get all their changes paid for through Environmental Quality Incentives Program (EQIP), Conservation Reserve Program (CRP), and Conservation Reserve Enhancement Program (CREP). Currently, these methods are the only way producers can receive cost-share assistance for new environmental stewardship enhancements.

4.9 Chapter Summary

The 29 operators that were interviewed have taken an important step in addressing pollution prevention by obtaining MAEAP verification for the 31 operations. Each operator may have decreased his/her lawsuit risk because of their increased environmental awareness and conservation of natural resources. MAEAP's educational phase likely has assisted operators in becoming better stewards of the land, as judged by the producers themselves as suggested by the opinion statement scores. Assistance to become MAEAP verified was provided to the interviewed operators primarily from the operator's plan writer and MSUE.

There were large differences in number of animal units and acreage that affected the amount of manure the operator sold, why the operator decided to become verified, and his/her opinions and barriers observed. Dairy producers had the most land, while poultry producers had the most animal units; thus, poultry producers sold more manure. Fifty-eight percent of the 29 producers interviewed (18) became verified due to regulations directed at his/her operation. However, the largest barrier to becoming verified was not related to rules, regulations, or financing, but rather available cropland to spread manure, listed by 41 percent of the 29 operators interviewed.

Chapter 5: Financial Consequences of Becoming MAEAP Verified

5.1 Introduction

With MAEAP's voluntary adoption, livestock producers would not be expected to participate unless their expected benefits (financial and/or non-financial) were greater than the expected costs, that is, the producer must have perceived some gain (or at least no net loss) from participation (Alberini & Sergerson, 2002). Positive incentives for voluntary abatement usually take the form of financial subsidies or cost-sharing. Many of the interviewed operators sought cost-sharing from the Natural Resource Conservation Service (NRCS). The NRCS executes a program called Environmental Quality Incentives Program (EQIP); EQIP cost-shares some of the private costs of pollution abatement, thereby increasing the likelihood that private benefits exceed private costs.

There were two main financial costs associated with MAEAP verification. One was the cost of writing the CNMP, and the second was implementing the changes required. To estimate the first year and annual costs of adopting MAEAP, capital investment changes were annualized. Machinery and equipment costs were annualized with a 7-year straight-line depreciation, while all other capital investments had a 20-year straight-line depreciation schedule. The management costs were incurred yearly, while the CNMP writing fee was incurred only in the first year. However, the fee to update the CNMP was considered an annual managerial cost. Managerial and other annual costs were calculated using the present value of an annuity, based on the ending year of 2008, at which time a permit may need to be adopted due to the new regulations.

To maintain the confidentiality of the three beef producers interviewed, there are no minimums or maximums listed for the beef operations or any category with an N less than four.

Throughout this chapter costs are described as either the producer costs or the producer plus taxpayer costs. The producer costs were those costs that the producer paid out-of-pocket. The producer plus taxpayer costs were the costs the producer incurred plus the costs that were cost-shared by tax payers.

5.2 Cost of Writing the CNMP

From Table 5.1, the average producer cost to write the CNMP for MAEAP verification was $2,531. This average includes the discounted price due to any EQIP cost-share the producer received and CNMPs that were written for free as a part of the plan writer's certification. The average private plus taxpayer cost to write the CNMP was $5,165, which included an assumed cost-share price for these CNMPs that were written for free for the livestock producers. For example, if the plan was written for free as part of certification, a small or medium operation's CNMP was given a value of $2,000 and a large operation's CNMP was given a value of $5,000. These two prices were the average costs associated with writing a CNMP for the prospective operation sizes of the other CAFO and AFO producers interviewed. This situation affected eight operations (26 percent).

Comparing individual species, the average dairy producer CNMP cost was over $2,500 more expensive than any other species at $4,082 (Table 5.1). Dairy farms had more production variables, which included milk house waste, silage leachate, and the most cropland to enter into the plan. Dairy producers also paid for 55 percent of their

CNMPs themselves. The average AFO operator paid approximately $1,900 less than the CAFO operators paid. CAFOs received a larger percentage (53 percent) of cost-share on average compared to AFOs (44 percent) to write the CNMP.

Table 5.1: Average Cost to Write the Comprehensive Nutrient Management Plan

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
Producer cost*: CNMP	2004 Dollars						
Average	1,992	4,082	2,160	1,605	2,531	3,382	1,498
Standard Deviation	2,649	3,101	3,268	1,420	2,609	3,085	1,380
Minimum**		800	320	165	165	165	166
Maximum		8,600	7,980	5,345	8,600	8,600	5,030
Producer + taxpayer cost*: CNMP**							
Average	3,054	7,507	4,835	3,978	5,165	6,538	3,499
Standard Deviation	3,535	4,369	2,557	2,142	3,488	3,906	1,963
Minimum		2,640	1,180	1,060	780	780	1,060
Maximum		14,646	7,980	7,141	14,646	14,646	7,126
Average percent producer paid	Percent						
	61	55	47	43	49	53	44
N	3	10	5	13	31	17	14

*Producer Cost = (Amount paid)
**Minimum and maximum values are not reported if N is less than 4.
***Producer + taxpayer Cost = (Producer cost) + (Cost-share dollars)

Producer plus taxpayer and producer costs for writing the CNMP have increased over time (Table 5.2), while the producer's cost increased only slightly. The early producers had about $1,900 less in costs compared to the later verified producers; and, the early adopters received more cost-share (52 percent compared to 45 percent). The earliest verified producers, those producers that were verified in 2002, paid the largest percentage out-of-pocket at 62 percent, possibly due to less available EQIP cost-share and perhaps the earliest plan writers tended to have higher prices (Rector, personal communication, December, 2005).

Producer plus taxpayer and producer costs for writing the CNMP were related positively to the number of animal units on the operation, both had a 0.77 correlation.

The more animal units on an operation, the more cropland or spreading agreements that was required within a CNMP. There was a negative correlation between the number of advisory resources used and the cost a producer paid for the CNMP (r = -0.40). When producers sought more assistance from various advisors, the producers gathered more information for the CNMP and knew in advance where and how to obtain financial assistance.

Table 5.2: Cost to Write the Comprehensive Nutrient Management Plan by Year

	Year the Farm became MAEAP Verified				Early Verified	Late Verified
	2002	2003	2004	2005		
Producer cost*: CNMP	2004 Dollars					
Average	2,985	1,142	3,021	2,108	2,134	2,818
Standard Deviation	2,464	1,181	3,292	977	2,129	2,934
Minimum	341	165	320	800	165	320
Maximum	6,162	3,302	8,600	3,030	6,162	8,600
Producer + taxpayer cost: CNMP**	2004 Dollars					
Average	4,231	3,904	6,047	5,608	4,080	5,949
Standard Deviation	2,055	2,478	4,366	3,363	2,167	4,075
Minimum	1,771	1,197	780	2,640	1,197	780
Maximum	7,126	6,914	14,646	9,030	7,126	14,646
Percent producer paid	Percent					
	62	25	54	47	45	52
N	7	6	14	4	13	18

*Producer Cost = (Amount paid out-of-pocket)
**Producer + taxpayer Cost = (Producer cost) + (Cost-share dollars)

The average hours a producer spent collecting information for writing the initial CNMP remained nearly constant over all years. Over the past four years of MAEAP's inception, however, it took less time for a producer to become MAEAP verified. The verification process took nearly nine fewer months for the producers that started their CNMP in 2003 or later (Table 5.3).

Table 5.3: Amount of Time to become MAEAP Verified

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO	Started CNMP Before 2003	Started CNMP After 2002
Number of years to become MAEAP verified					Years				
Average	1.2	1.9	0.8	1.1	1.3	1.3	1.4	1.6	0.9
Standard Deviation	0.3	1.1	0.3	0.7	0.8	0.8	0.9	0.9	0.4
Minimum*		0.3	0.5	0.5	0.3	0.3	0.5	0.5	0.3
Maximum		3.5	1.3	2.6	3.5	3.5	3.0	3.5	2.0
N	3	10	5	13	31	17	14	20	11

*Minimum and maximum values are not reported if N is less than 4.

In the early stages of MAEAP, there were not many qualified or experienced plan writers and many MAEAP partners were learning the best methods to assist producers. As the plan writers gained experience, it took them less time to write a CNMP. The shorter verification time for operations that began their CNMPs in 2003 and 2004 probably was due to the plan writers, MDA verifiers, and MAEAP partners' experience, which allowed for more accurate assistance. The shortened time frame did not, necessarily save the producer CNMP writing costs. The plan writers stated that the price of the CNMP included the time the plan writer spent writing the plan, but also depended on the number of animal units per farm, number of acres that the farm operated, and quality and amount of records kept prior to seeking verification.

5.3 Cost of Implementing the Required Management Changes

After the CNMP was written, the livestock producers implemented the required changes before becoming MAEAP verified; thus, a second set of costs included management and capital changes that a producer made to implement the CNMP. The management changes may have included additional recordkeeping, changing feeding programs, hiring a crop consultant, taking more manure and soil tests, hiring additional labor, increasing supervision hours, changing the insurance premium, hauling manure further, selling manure, using more energy to run fans or pumps required for the manure storage and spreading, or buying and spreading different amounts of commercial fertilizer.

The average producer needed to change 6.9 of these practices in his/her management routine (Table 5.4). The correlation between the number of management changes made and the cost of making the changes was weak (r = 0.26). Some management changes required a large expenditure, while other changes required minimal expenditure.

Table 5.4: Managerial Changes made due to MAEAP Verification

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
Managerial changes*	#						
Average	5.7	6.9	6.6	7.2	6.9	7.2	6.5
Standard deviation	1.2	2.1	3.0	3.0	2.5	2.7	2.4
Minimum**		3.0	2.0	2.0	2.0	2.0	3.0
Maximum		10.0	10.0	12.0	12.0	11.0	12.0
N	3	10	5	13	31	17	14

*Management changes included: crop consultant/TSP, manure spreading hours, supervision hours, recordkeeping, commercial fertilizer purchased, equipment usage, fuel, energy/utilities, insurance, manure sold, manure testing, soil testing, and feed rations

**Minimum and maximum values are not reported if N is less than 4.

The most common managerial changes made included hiring a crop consultant or a technical service provider (TSP) (100 percent), breadth of manure records kept (90 percent), and changing the amount of fertilizer bought (55 percent). A livestock producer may have had a crop consultant prior to becoming MAEAP verified, however due to the CNMP and updating this document, the crop consultant charges an additional fee. Most livestock producers kept records prior to MAEAP verification, but 90 percent of the producers interviewed needed to keep additional records or spend more time keeping more detailed records. A change in fertilizer costs did not necessarily mean the operator used less fertilizer. One operation had too high phosphorus levels and could not apply manure; thus, more nitrogen was purchased. However, 82 percent of the producers that changed the amount of commercial fertilizer applied, indicated that they observed a cost savings.

All but three livestock producers interviewed had an increase in the number of hours they spent keeping manure records. This outcome was expected due to the detail needed to account for all manure nutrients on the farm. Of the different records required for MAEAP-verified farms, 90 percent of the producers needed to add additional labor hours or keep additional records regarding one or more of the following: manure spreader calibrations (52 percent of all farms), freeboard height in the lagoon (48 percent), the soil conditions when spreading (48 percent), time of manure application (42 percent), the weather conditions when spreading manure (39 percent), and the level of manure nutrients (16 percent). Eleven producers claimed they spent at least double the time keeping records as they spent before becoming MAEAP verified.

Many management changes affected the way producers dealt with manure; they implemented or are still looking for alternative methods to use the manure. Some managers were investigating methane digesters, composting, changing bedding material, and/or marketing the manure at the time of the interview. Producers could decrease the total amount of manure needed to be spread by changing animal diets, decreasing the amount of wasted feed and water, and diverting rainwater to a separate storage unit (i.e., keeping clean water clean).

Diet changes most commonly occurred with the swine and poultry operations (15 and 20 percent respectively) as these operators took advantage of a feed additive, phytase. When phytase was added to poultry and swine feed mixtures, it improved phosphorus use efficiency, decreasing the amount of phosphorus in manure by up to 40 percent (USDA-NRCS, 2005). In dairy and beef, it was more difficult to decrease the phosphorus excreted, as the protein source needs to be changed; thus, the producer could not simply add a feed supplement.

If diet changes did not result in a decrease of the needed amount of phosphorus in the manure, the manure may have been applied or incorporated differently to decrease its runoff potential. Fifteen producers made this management change as part of their MAEAP verification. One dairy producer has fewer no-tilled fields after verification, because he needed to incorporate his manure. Incorporating manure decreased the potential for phosphorus to immediately run into a body of water; however exposed soil may have caused adverse erosion effects – depending on soil type and slope. Thus, the suitability of tillage after manure application was evaluated on individual fields by the plan writer prior to writing the CNMP.

Another dairy producer increased the amount of rain, wash water, and lot runoff collected and then irrigated, which decreased the amount of liquids that needed to be spread from the manure storage. Often the rain, wash water, and lot runoff contained little phosphorus nutrient value. If these liquids were to be mixed in the manure storage, they would only dilute the manure nutrient value, which would increase the cost per pound of nutrients it took to spread the manure. However, because of the increased quantities of water introduced through irrigation, the potential for runoff may also be greater in the irrigated areas (Gilley, Risse, & Eghball, 2002). Slope, crop residue, and soil type were also considered by the plan writer before additional irrigation was installed.

Some producers also spent more time and money to keep manure and soil nutrient records. MAEAP elevated a producer's awareness of the importance in testing manure and soil for their nutrient value; after implementing the CNMP, 74 percent of operations needed to increase the frequency of either the soil fertility test, manure nutrient test, or both. Until recently, it was common practice to spread manure more frequently on fields close to the manure production or storage site (barnyard), due to weather or time constraints. As animal production increased over time, this practice caused the fields closest to the barnyard to have a higher soil nutrient content. To curb this over-application problem, the CNMP matched the field's nutrient capacity with the phosphorus manure spreading rates.

The interviewed producers currently spread 73 percent of their manure less than two miles away from the barnyard, if the producer owned the acreage. If the land was rented, producers, on average, hauled 45 percent of their total manure further than two miles from the barnyard. Five producers traveled over eight miles away from the barnyard to ensure they were spreading at agronomic rates.

When manure and soil records were reviewed, it was critical that the manager apply the manure to the fields according to agronomic rates. Due to land constraints, ten of the 31 livestock operations surveyed have more than 25 percent of their manure sold off-farm. Those constraints were either due to lack of land base, or the land base they currently managed had a phosphorus level too high to be able to spread manure. If a field had a soil test phosphorus level above 150 ppm, the CNMP did not allow more manure to be spread, a requirement which is in accordance with the GAAMPs. If the field had a level below 75 ppm, the field could have manure spread according to nitrogen recommendations. The CNMP stipulated that, if soil tests that were between 75 and 150 ppm, they could only be spread according to the phosphorus recommendations.

Thirteen livestock producers did not need to sell any manure because they previously accounted for manure's phosphorus and nitrogen content when they applied nutrients to the soil. Forty-two percent of the livestock producers had applied no commercial phosphorus to the soil the past several years. During the past growing season only six crop producers spread any amount of commercial phosphorus. The decreased commercial phosphorus spreading was attributed to the additional soil and manure data producers acquired for their fields. After implementing the CNMP, 14 producers increased their frequency of manure testing. If the producer did not test his/her manure, he/she could estimate the amount of phosphorus excreted in the manure; this estimate was used to determine field manure-application rates.

Table 5.5 lists the average costs of managerial changes that resulted from implementing the CNMP. Due to commercial fertilizer savings that many livestock producers realized, a negative number may appear in Table 5.5 to convey a cost savings, while the expenses incurred due to following the CNMP were positive numbers; all amounts were in 2004 dollars. The costs or savings listed in Table 5.5 may be experienced each year.

Table 5.5: Average Managerial Change Costs

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
	2004 Dollars						
Recordkeeping labor	458	1,322	1,083	1,237	1,164	1,462	803
Standard deviation	184	1,933	355	1,229	1,344	1,628	804
Crop consultant/TSP	188	2,470	495	806	1,233	1,801	544
Standard deviation	105	3,011	338	632	1,920	2,434	525
Fertilizer bought (nitrogen)	-7,397	-5,550	11,000	-2,827	-1,918	-2,564	-1,132
Standard deviation	12,811	17,551	19,494	3,765	13,973	18,907	3,066
Fertilizer bought (phosphorus)	-2,940	-1,381	0	-343	-874	-1,554	-48
Standard deviation	5,092	3,753	0	828	2,644	3,463	179
Manure testing frequency	36	92	11	12	42	69	13
Standard deviation	52	153	25	16	97	128	27
Spreading labor	584	3,130	530	677	1,435	2,393	273
Standard deviation	1,012	7,795	7,583	1,393	5,306	7,078	815
Fuel use (hauling manure)	0	4,514	11,416	1,727	4,022	7,056	337
Standard deviation	0	7,987	24,399	3,155	10,751	13,863	1,882
Insurance premium	-13	-101	-60	-43	-62	-88	-29
Standard deviation	22	226	134	63	142	186	44
Soil testing frequency	0	602	308	142	304	453	122
Standard deviation	0	1,897	309	287	1,084	1,446	271
Equipment usage costs	87	1,341	4,006	92	1,126	2,043	12
Standard deviation	151	3,102	7,198	328	3,436	4,490	43
Supervision hours	0	451	432	231	312	482	106
Standard deviation	0	873	762	388	623	787	222
Manure sold	0	0	-4,500	0	-726	-1,324	0
Standard deviation	0	0	10,062	0	4,041	5,457	0
Feed additives or diet change	0	0	19,000	58	3,089	5,630	3
Standard deviation	0	0	42,485	196	17,058	23,031	12
Energy & utilities	0	0	10,000	0	1,613	2,941	0
Standard deviation	0	0	16,492	0	7,088	9,490	0
Producer's annual managerial change costs	-8,952	7,348	54,504	1,867	11,078	19,338	1,048
Standard deviation	16,878	11,562	96,131	4,926	41,129	54,868	3,589
N	3	10	5	13	31	17	14

The greatest average savings due to implementing the CNMP was a decrease in nitrogen fertilizer costs (-$1,918). The largest savings to a producer was -$55,000 while the largest increase in commercial fertilizer cost was $45,000. No producer saw a decrease in their crop yields due to the decreased amount of commercial fertilizer applied. Poultry producers were the only operators to add commercial fertilizer as a result of becoming MAEAP verified. These same producers needed to sell their manure due to field phosphorus levels and could not use the manure for its nitrogen content. All poultry producers were not applying commercial phosphorus before becoming MAEAP verified and thus, saw no savings from less phosphorus purchased. No operator increased the amount of purchased phosphorus due to MAEAP verification.

The producer's average overall costs were decreased as a result of additional manure sold (-$726), less commercial phosphorus fertilizer purchased (-$874), and lower insurance premiums (-$62). The largest average management change expenses, as listed in Table 5.5, were increased fuel usage ($4,022), feed additives ($3,089), and additional energy ($1,613). Fuel costs had a broad range, -$15,580 to $45,000, producers increased fuel usage because they needed to incorporate the manure after application and/or the manure needed to be hauled further. However, some producers saw a cost savings from using less fuel; these producers spread less commercial fertilizer, began irrigating the liquid layer off the top of the storage, or switched to a spreader that knifed in the manure instead of a broadcast application, which eliminated the extra tractor time to incorporate. The energy and utility fees increased due to the added cost of drying manure, specifically poultry. Drier manure could be hauled at a lower cost, with fewer trips causing less machine wear. As energy prices increase this added cost will most likely increase.

Soil testing did not always increase the cost of becoming MAEAP verified. If an operator tested the soil more often than once every two or three years, he/she no longer needed to soil test as much as before MAEAP verification. One operator saved $56 on soil tests. Another operator that had not tested his soils recently needed to have all his operated acres soil tested in order to accurately write his CNMP, which cost him $6,000.

Beef producers saved almost $9,000, on average, when they changed their management processes for MAEAP verification. The savings was primarily due to a decrease in the amount of fertilizer purchased. Poultry producers spent the most money on management changes ($54,504) to become MAEAP verified. The increase in costs came from four main sources: an increase in fertilizer purchased, adding phytase to diets, hauling manure further (equipment usage and fuel cost increases), and using more energy to dry manure.

CAFO managers spent more money, on average approximately $18,000 more, than AFOs to implement their CNMPs with only slightly more management changes (7.2 compared to 6.5). The more animal units a producer operated, the more likely he/she was to spend more money on management changes ($r = 0.78$).

5.4 Cost of Implementing the Required Capital Investment Changes

In addition to the management changes, a MAEAP-verified operation typically needed to make some capital investment changes. The capital investment costs included new machines (for manure transport, or spreading manure or water collected from the milk house, leachate, and roofs) and improvements or new construction (for manure storage, drainage, gutters, fences, buildings, roofs, grass waterways, buffers, and drives/berms).

The most common implementation change was additional or larger manure storage (39 percent) followed by more manure spreading (or irrigation) equipment (26 percent) (Table 5.6). Half of all the recorded manure storage investments were from dairy producers; six out of the ten dairy producers interviewed increased their manure storage for MAEAP verification. One swine producer stated, "It is cheaper to build another earthen lagoon than to spread the manure that is currently in my lagoon." If more storage was built, then the manure in the old storage would not have to be spread as frequently; as often in his situation, this operator needed to spread manure up to four miles away and had relatively small tanks, which meant many trips from the field to the manure storage.

Table 5.6: Percent of Producers to Make Each Capital Investment Change, Average

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
	Percent						
Manure storage	33	60	20	31	39	47	29
Equipment to spread manure	67	30	0	23	26	35	14
Drainage	67	20	0	8	16	18	14
Fences	0	30	0	15	16	29	0
Grass waterways	33	20	20	8	16	12	21
Gutters	67	20	0	8	16	18	14
Manure transportation	0	10	40	8	13	18	7
Buildings	33	10	0	15	13	6	21
Drives and berms	67	20	0	0	13	12	14
Buffers	0	10	0	15	10	0	21
Roofs	0	0	0	8	3	0	7
Capital investment changes	Number of changes adopted						
Average	3.7	2.5	0.8	1.5	1.9	2.2	1.6
Standard deviation	2.1	1.4	0.8	1.6	1.6	1.7	1.6
Minimum*		1.0	0.0	0.0	0.0	0.0	0.0
Maximum		5.0	2.0	5.0	6.0	5.0	6.0
N	3	10	5	13	31	17	14

*Minimum and maximum values are not reported if N is less than 4.

To become verified, manure storage must have accounted for freeboard height, as well as any extra water collected from lot runoff, silage leachate, and milk house or egg wash water. Prior to becoming MAEAP verified, only 48 percent of the operations' storage had at least six months of capacity or demonstrate that manure application could be managed at low risk if less than six months was available. On average, operations constructing new manure storage increased the operations' holding capacity by 10 months. These improvements were larger than necessary by current standards, but the expansion allowed the producer to achieve economies of scale and avoid rebuilding to meet more stringent standards or expansion needs should they emerge in the future.

The costs indicated in Table 5.7 were the costs in 2004 dollars that producers paid annually to implement their capital investments. Each capital investment change implemented was depreciated over time. The depreciation schedule varied with the type of capital investment. This depreciated amount was the amount that the item cost the producer each year. The capital investment costs were self reported during the interview, as was the amount of cost-share. The twelve operations that changed manure storage spent an average of $1,678 annually. Manure storage was the largest expense for CAFOs ($2,773), but the fourth largest expense for AFOs ($348). Although only four farms purchased additional machines to transport manure, this category had a large annual average cost ($943).

Large operations spent about twice the amount of money annually on capital investments as small and medium operations spent ($4,659 as compared to $2,382) and made nearly the same number of changes (2.2 as compared to 1.6). CAFOs made more capital investment changes that were not eligible for EQIP cost-share; MAEAP does not require new machines or equipment for verification. Producers that purchased equipment did so based on their own criteria. Additional equipment to spread manure and machines to transport manure were most commonly purchased by CAFOs. The type of investments large CAFOs made – as opposed to AFOs – raised the cost to the producers. Ten producers, seven of which were CAFO operators, purchased machines or equipment to handle the distance and amount of manure transported. Often the older equipment would take a long time to empty the storage or require additional trips back and forth from the barnyard to the field.

Table 5.7: Average Annual Producer Capital Investment Changes

Capital Investment Change	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
	2004 Dollars						
Manure storage	119	3,958	1,400	391	1,678	2,773	348
Equipment to spread manure	434	685	0	494	470	569	350
Drainage	211	250	0	21	110	163	45
Fences	0	76	0	191	105	191	0
Grass waterways	119	51	3	1	29	7	55
Gutters	126	33	0	1	23	18	29
Manure transportation	0	100	5,500	56	943	926	964
Buildings	91	4	0	460	203	3	447
Drives and berms	122	18	0	0	18	8	29
Buffers	0	150	0	6	51	1	112
Roofs	0	0	0	1	0	0	1
Producer's annual capital investment cost	2004 Dollars						
Average	1,222	5,326	6,903	1,625	3,631	4,659	2,382
Standard deviation	670	5,748	6,881	2,864	4,960	5,554	3,968
Minimum*		400	0	0	0	0	0
Maximum		16,500	14,000	8,227	16,500	16,500	13,515
N	3	10	5	13	31	17	14

*Minimum and maximum values are not reported if N is less than 4.

Becoming MAEAP verified prompted 27 of the 31 livestock operations surveyed to make capital investments. Poultry producers made the fewest capital investment changes (0.8), but spent the most money on average ($6,903). The number of changes an operation needed to make however, was not correlated (-0.01) with the annual producer cost of the capital investments.

The early verified operations, those operations that were verified before 2004, paid nearly $2,500 less out-of-pocket annually than the later adopters for their capital investment changes on average (Table 5.8). The operations that were verified before 2004 had, on average, fewer animal units, less costly required changes, and the more required changes that were eligible for EQIP cost-share funds.

Table 5.8: Annual Producer Capital Investment Changes Cost Over Time (year stated is year verified)

	2002	2003	2004	2005	Early Verify	Late Verify
	2004 Dollars					
Buffers	10	0	1	375	5	84
Manure storage	1,114	232	1,893	3,813	707	2,320
Equipment to spread manure	857	17	339	838	469	450
Drainage	71	55	0	625	64	139
Fences	321	2	46	25	174	42
Grass waterways	0	58	8	100	27	29
Gutters	36	66	1	0	50	1
Manure transportation	100	0	1,964	250	54	1,583
Buildings	250	667	0	11	442	2
Drives and berms	0	63	10	0	29	8
Roofs	0	0	1	0	0	1
Producer's annual cost	2004 Dollars					
Average	3,000	1,255	4,278	6,036	2,195	4,668
Standard deviation	3,290	1,948	5,728	7,347	2,795	5,931
Producer's annual cost per animal unit	2004 Dollars per Animal Unit					
Average	4.81	8.39	3.52	3.63	6.46	3.55
Standard deviation	5.99	13.14	8.88	2.08	9.66	7.82
Capital investment changes	Number of changes made					
Average	2.0	2.5	1.4	2.8	2.2	1.7
AFO N	5	3	4	2	8	6
CAFO N	2	3	10	2	5	12
Total N	7	6	14	4	13	18

Forty-eight percent of the changes the later producers made were eligible for cost-share as compared to 72 percent of the early producers' changes. In years 2002, 2004 and 2005, cost-share paid for approximately 15 percent of the total costs. However, in

2003 the average producer received nearly 50 percent of the total cost for implementing their capital investment changes. There were eight verified operations in 2003; six of those operations were surveyed for this research. Furthermore, EQIP cost-share funds available in Michigan increased from $6,811,000 in 2002 to $9,727,900 in 2003 (MacMaster, personal communication, November 2005); thus there was a large amount of EQIP funds available and fewer producers eligible to receive the funds as compared to other years.

The early verified operations on average spent the most capital investment on new manure storage ($707), equipment to spread manure ($469), new buildings ($442), and fences ($174) (see Table 5.9). Farm locations with minor changes appeared to have been more likely to become MAEAP verified earlier as the producer had an easier implementation schedule and fewer associated costs. Although the earlier producer spent less on average, they spent nearly double the money per animal unit to become verified ($6.46 compared to $3.55). More CAFOs became verified after January 1, 2004 as compared to before. The larger number of animal units also decreased the average cost per animal unit for the later producers as shown in Table 5.9.

The operations that became verified after 2003 made more costly investments in manure storage ($2,320), manure transporting equipment ($1,583), and equipment to spread manure ($450). AFO livestock producers implemented a larger portion of the capital investment changes themselves relative to the CAFOs to save on the costs. For example, one small dairy producer, because of an illness, was waiting to obtain MAEAP verification because he needed to do some of the work himself in order to afford the required changes.

The four producers that became MAEAP verified in 2005 had the most expensive capital investment changes to make on average, $6,036. These producers spent the least per animal unit at only $3.63, with a comparatively narrow range of $0.52 to $4.85. However, all the 2005 verified producers that were interviewed had been seeking MAEAP verification for at least two years, as they each began the MAEAP verification process before 2003. Some of the earliest costs may have been overlooked in the interview due to the long timeframe.

5.5 Cost-Share

Cost-share assisted livestock producers in paying for their CNMP and some of their capital investments. The producers seeking cost-share had to fill out an application to receive funds. Three livestock producers specifically mentioned the difficulty they had in applying for and receiving EQIP cost-share dollars. Some operators interviewed were hesitant to apply for capital investment EQIP money for two reasons: 1) The operator did not want to spend his time completing the lengthy application for the government money; and/or, 2) many livestock producers did not want to inform governmental agency staff about what changes they were making on the farm. While 23 producers received assistance to write the CNMP, only eight received EQIP cost-share for the capital investment changes. The cost-share total for these eight producers was $419,823. An application for capital investment cost-share dollars required a more detailed description and took longer to fill out. It should be noted that funds from EQIP could not be used for any of the management changes cost and they were available for only some of the capital investment changes cost. There were nine producers that were not eligible for any capital investment cost-share dollars due to the fact that the changes they needed to make on their operation (i.e., machinery, equipment, and management changes) were not eligible for cost-share.

From Table 5.9, many operators were eligible to obtain cost-share, but only a small percentage of the eligible cost-share was actually obtained. EQIP was a means of cost-share but did not pay for 100 percent of any capital investment. In Table 5.9, the investments eligible for EQIP cost-share (i.e., manure storage, drainage, fences, grass waterways, gutters, buildings, drives/berms, buffer strips, and roofs) totaled 61 percent of all capital investments costs. The difference between the amount of eligible cost-share and the amount of cost-share realized signified the amount a producer paid out-of-pocket for his/her capital investments to become MAEAP verified. While CAFOs could have received more cost-share, they only received eight percent of the total amount eligible for cost-share. The average AFO received approximately $11,000 more in EQIP cost-share funds than the average CAFO. Some of the operations that spent the most money did not receive any cost-share; however, these operations most likely did not apply for EQIP.

Table 5.9: Cost-Share Received Compared to Capital Investments Eligible for Cost-Share

	Total	CAFO	AFO
	2004 Dollars		
Total cost of eligible cost-share capital investments	57,895	66,162	44,805
	Percent		
Percent cost-share eligible	61	55	71
	2004 Dollars		
Amount of cost-share realized	13,543	9,325	20,221
	Percent		
Percent cost-share realized	14	8	23
N	31	17	14

The cost of the capital investments implemented ranged from $0 to $16,500 annually (Table 5.10). On average, producers paid about $3,631 annually for capital investments to become and remain MAEAP verified. In total, the poultry producers spent the most money, $6,903 out-of-pocket and, including cost-share, $8,303. The dairy, poultry, and swine producers paid over 90 percent of their capital investment costs out-of-pocket. The swine producers had the lowest average annual producer plus taxpayer capital costs ($2,125), and received the least in average EQIP cost-share ($333 annually). The small and medium operations spent almost half as much money out-of-pocket ($2,382) on average as compared to the large operations ($4,659).

Table 5.10: Annual Capital Investment Costs

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
Producer plus taxpayer* annual capital investment costs				2004 Dollars			
Average	3,235	5,823	8,303	2,125	4,422	5,368	3,272
Standard Deviation	3,491	5,842	7,582	3,407	5,381	6,076	4,333
Minimum**		704	0	0	0	0	0
Maximum		16,500	14,000	8,908	16,500	16,500	13,515
Producer* annual capital investment costs**							
Average	1,222	5,326	6,903	1,625	3,631	4,659	2,382
Standard Deviation	670	5,748	6,881	2,864	4,960	5,554	3,968
Minimum		400	0	0	0	0	0
Maximum		16,500	14,000	8,227	16,500	16,500	13,515
Percent producer paid				Percent			
Average	59	91	90	90	87	92	81
Standard Deviation	37	19	22	20	23	18	27
Minimum		50	50	40	28	50	28
Maximum		100	100	100	100	100	100
N	3	10	5	13	31	17	14

* Producer + taxpayer = Annual producer capital investment costs + capital cost-share dollars
**Minimum and maximum values are not reported if N is less than 4.
***Producer = Annual capital investment costs

From the interview data collected, the average AFO received about the same in cost-share as the average CAFO (Table 5.11). A larger cost-share amount was expected for the smaller operations as they had larger relative costs associated with becoming MAEAP verified. If evaluated on a per animal unit basis, however, AFOs received nearly 16 times more money per animal unit as the CAFOs received. AFOs typically did not have the resources to implement capital investments, thus EQIP cost-share was more sought after by the small and medium operations than the large operations. If an operation was a CAFO, there was a negative correlation to the amount of cost-share received per animal unit (r = -0.30).

Table 5.11: Total Cost-Share per Species, Operation Size, and Verification Categories

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO	Early Verify	Late Verify
Total cost-share	2004 Dollars								
Average	36,907	11,988	30,675	9,039	16,177	15,994	16,400	16,837	15,700
Standard Deviation	52,947	25,400	63,121	16,155	33,497	38,312	27,976	29,094	37,174
Total cost-share/A.U.	2004 Dollars per Animal Unit								
Average	405.98	9.26	9.22	26.69	54.96	7.10	113.07	119.06	8.66
Standard Deviation	481.66	19.98	14.76	69.43	176.79	17.02	255.23	264.76	16.33
Minimum*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum		65.08	34.47	251.09	938.19	65.08	938.19	938.19	65.08
N	3	10	5	13	31	17	14	13	18

*Minimum and maximum values are not reported if N is less than 4.

Swine producers received the lowest cost-share amount on average. Per animal unit, however the swine producers received $26.70 in cost-share, nearly three times the amount dairy and poultry producers received per animal unit. Beef producers on the other hand, received $406 per animal unit on average. Most of the money beef producers received was given to the small, pasture-based operators for winter manure storage, increasing the per animal unit average.

The total amount of cost-share given to early and late verified farms remained nearly the same. However, early producers received more cost-share per animal unit than did the later producers that became MAEAP verified ($119.06 compared to $8.66).

If a producer received cost-share, their reason for becoming MAEAP verified was more likely linked to the financial and technical support MAEAP offered (0.4 correlation). The incentive of financial and technical assistance motivated 26 percent of the interviewed producers to become MAEAP verified. There was also a correlation of 0.38 between the amount of EQIP funding and total producer plus taxpayer cost of implementing the capital changes, although weak, it indicated that the producers that received EQIP funding were those operators that had more costly investments. This correlation could also be amplified due to the producers that received cost-share, implemented capital investments of higher quality or larger scale than necessary. One operator that received cost-share put in larger manure storage than necessary simply because he received cost-share for the investments; thus, the cost producer plus taxpayer paid for the storage was increased, raising the producer's annual cost only slightly.

5.6 Total Cost to become MAEAP Verified

Total costs shown in Table 5.12 include the cost of writing the CNMP, plus implementing the management and capital investment changes to become MAEAP verified. Any cost-share received by a producer is not reflected in Table 5.12. The management changes incurred on each farm could have been negative, due to a cost savings through less fertilizer purchased, a lowered insurance liability fee, or less driving to spread or incorporate manure. The annual costs did not include the CNMP price, as the initial cost to write a CNMP was a one-time fee and the cost to update the CNMP was typically less than the initial CNMP writing cost. An annual fee associated with updating the CNMP was included in the managerial costs as the crop consultant/TSP cost.

Table 5.12: Total and Annual "Producer + Taxpayer" Costs to become MAEAP Verified

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
	2004 Dollars per Operation						
Total producer + taxpayer CNMP cost*	3,054	7,507	4,835	3,978	5,165	6,538	3,499
Standard deviation	3,535	4,369	2,557	2,142	3,488	3,906	1,963
Total managerial changes cost**	-31,140	32,962	201,236	7,715	43,312	75,300	4,470
Standard deviation	60,370	58,326	340,961	23,629	149,276	197,759	18,070
Total producer + taxpayer capital investment cost	55,949	107,223	111,060	33,877	72,122	91,141	49,028
Standard deviation	67,110	111,119	116,870	53,572	91,088	109,532	57,738
Total producer + taxpayer cost	27,862	147,693	317,131	45,571	120,600	172,979	56,996
Standard deviation	112,867	122,480	363,192	44,796	183,635	233,137	54,579
	2004 Dollars per Operation per Year						
Annual managerial cost	-8,952	7,348	54,504	1,867	11,078	19,338	1,048
Standard deviation	16,878	11,562	96,131	4,926	41,192	54,868	3,589
Annual producer + taxpayer capital investment cost†	3,235	5,823	8,303	2,125	4,422	5,368	3,272
Standard deviation	3,491	5,842	7,582	3,407	5,381	6,076	4,333
Annual producer + taxpayer cost	-5,171	13,171	62,807	3,991	15,499	24,706	4,320
Standard deviation	18,865	12,333	98,714	4,066	43,040	57,045	4,938
N	3	10	5	13	31	17	14

*Total Producer + taxpayer costs = CNMP writing cost + CNMP cost-share dollars + producer capital investment costs + capital cost-share dollars + present value of the managerial changes
**Managerial costs had a taxpayer cost of zero; only the producer cost was included.
†Annual Producer + taxpayer costs = Annual capital investment cost + annual capital cost-share dollars + managerial costs

The average total producer plus taxpayer cost to become MAEAP verified was $120,600 per farm, reflecting both the cost-shared money paid to producers as well as the producer's out-of-pocket costs (Table 5.12). However, not all the changes reported by producers were required by the MAEAP's CNMP, such as some equipment purchases or manure storage larger than necessary to meet GAAMPs. Thus, the $120,600 average per farm is biased upwards from the minimal necessary to be verified. The average annual producer plus taxpayer cost was $15,499. Swine operations had the lowest annual producer plus taxpayer cost at $3,991.

The average annual and total producer plus taxpayer cost for poultry producers to become MAEAP verified were the highest at $62,807, and $317,131, respectively. This figure seemed to be an outlier because it was so large, but upon reviewing several of the changes made on the five operations, three operations accounted for most of the large numbers. Managerial changes (e.g., soil and manure testing, commercial fertilizer purchased, feed additives, and supervision hours) were the main force in driving the poultry operation's cost higher than other farms. The operation with the most animal units had the highest cost to become and maintain MAEAP verification, but contrary to expectations the producer had nearly the largest cost per animal unit as well.

Table 5.13: Total and Annual Producer Average Costs to become MAEAP Verified

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
	2004 Dollars per Operation						
Total producer* CNMP cost	1,992	4,082	2,160	1,605	2,531	3,382	1,498
Standard deviation	2,649	3,101	3,268	1,420	2,609	3,085	1,380
Total producer managerial cost	-31,140	32,962	201,236	7,715	43,312	75,300	4,470
Standard deviation	60,370	58,326	340,961	23,629	149,276	197,759	18,070
Total producer capital investment cost	20,104	98,661	83,060	27,211	58,579	78,304	34,628
Standard deviation	14,456	108,139	75,847	46,054	79,671	95,792	47,199
Total producer cost	-9,044	135,704	286,456	36,531	104,423	156,985	40,597
Standard deviation	68,702	120,536	372,102	40,947	181,491	231,241	46,910
	2004 Dollars per Operation per Year						
Annual producer managerial cost	-8,952	7,348	54,504	1,867	11,078	19,338	1,048
Standard deviation	16,878	11,562	96,131	4,926	41,192	54,868	3,589
Annual producer capital investment cost	1,222	5,326	6,903	1,625	3,631	4,659	2,382
Standard deviation	670	5,748	6,881	2,864	4,960	5,554	3,968
Annual producer cost	-7,730	12,673	61,407	3,492	14,709	23,997	3,430
Standard deviation	16,885	12,345	99,596	4,381	43,182	57,204	5,089
N	3	10	5	13	31	17	14

*Total Producer costs = CNMP writing cost + producer capital investment costs + present value of the managerial costs

**Annual Producer costs = annual capital investment cost + managerial costs

Table 5.13 outlines the total and annual costs producer's paid; it is similar to that of Table 5.12 which describes the difference in total and annual producer plus taxpayer costs. Poultry producers spent the most both in total and annually. The large operations also spent more than the small and medium operations did on becoming MAEAP verified. The study conducted by NRCS did not conclude with these same findings[22].

Table 5.14: Average Annual Producer Cost per Animal Unit

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
Annual producer cost/ A.U.	2004 Dollars per Animal Unit						
Average	9.71	5.97	12.89	6.16	7.53	3.75	12.11
Standard Deviation	29.84	3.23	15.25	10.64	12.07	8.49	14.36
Minimum*		1.13	-0.31	-8.14	-24.74	-24.74	-8.14
Maximum		11.32	38.13	34.45	38.13	13.20	38.13
Annual producer + taxpayer cost/ A.U.							
Average	31.64	6.35	13.23	7.71	10.48	4.06	18.27
Standard Deviation	52.04	3.38	14.97	13.92	18.61	8.57	24.29
Minimum		1.13	-0.31	-4.53	-24.74	-24.74	-4.53
Maximum		11.44	38.13	49.40	77.82	13.20	77.82
N	3	10	5	13	31	17	14

*Minimum and maximum values are not reported if N is less than 4.

The average cost per farm does not explain the full picture. Upon examining the costs more closely, annual producer cost per animal unit was much easier to compare across size and species. The poultry producers had the largest average annual cost per animal unit to become MAEAP verified at $12.89 (Table 5.14). Dairy operations paid

[22] In a national study conducted by the USDA-NRCS, it was estimated that the annual average total cost of a Michigan livestock producer to develop and implement a CNMP would be $7,322 with a range of $212 to $73,160. The average annual total cost per animal unit was $35. These numbers can be contrasted with this thesis study's average, which was about $8,000 higher at $15,499, and which had a broader range of -$27,211 to $235,838. The average annual total cost per animal unit of this thesis research was $25 lower however, at $10 per animal unit. The USDA's estimate did not account for feed management changes, commercial fertilizer purchases, improved efficiencies, cost-share received, expanding the spreading radius, or machinery and equipment purchases. Thirty of the thirty-one operations surveyed in this thesis study fit the USDA criterion. The USDA study estimated the Lake Region (Michigan, Wisconsin, and Minnesota) as the cheapest region to develop and implement a CNMP. It should also be noted that the "costs associated with the assemblage of farms and ranches were as of December 31, 1997 and have not been adjusted for concentration and consolidation trends," which may also skew the cost figures (USDA-NRCS 2003). All data are reported in 2004 dollars.

the least per animal unit for verification at less than half of poultry producers ($5.97). Dairy also had the smallest standard deviation and range of costs.

CAFOs paid over a third of what AFOs paid annually for verification per animal unit, $3.75 compared to $12.11. The larger operations realized economies of size. The EQIP cost-share especially impacted AFOs as the cost-share assisted these operators in decreasing their cost per animal unit by $6.16. The beef producers that received cost-share funds were typically small but the added benefit lowered their cost by nearly $20.00 per animal unit.

The costs of writing the CNMP were much less than the costs associated with implementing the changes required for MAEAP verification. The mean cost to write a CNMP was two percent of the total cost of MAEAP verification (Table 5.15). The capital investment costs were larger than the managerial costs for the beef, dairy, and swine producers. The managerial and capital investments were similar for CAFOs, but the AFOs spent over seven times more on the capital investments than on managerial changes.

Table 5.15: Comparing Writing, Managerial, and Capital Costs of the Total Cost to Become MAEAP Verified, Averages

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
	Percent						
Total producer CNMP cost	22	3	1	4	2	2	4
Total producer managerial costs	-344	24	70	21	42	48	11
Total producer capital investment cost	222	73	29	75	56	50	85
	2004 Dollars						
Total producer cost	-9,044	135,704	286,456	36,531	104,423	156,985	40,597
N	3	10	5	13	31	17	14

5.7 Costs per Geographic Region

According to the National Agricultural Statistics Service, in 2002 there was 6,827,903 acres of harvested cropland in Michigan; 5,423,039 acres (79 percent) received commercial fertilizers, while 700,621 (10 percent) acres were spread with manure (USDA-NASS, 2004). This statistic suggests that Michigan livestock producers have enough available cropland to spread manure. However, livestock operations are not evenly spread across the state. Livestock populations have become more spatially concentrated in high production areas resulting in increased regional manure nutrient production relative to the assimilative capacity of the land (Kellogg, Lander, Moffitt, & Gollehon, 2000).

Allegan County, for example, sold over half of the total number of broilers and almost 20 percent of the hogs in the entire state of Michigan (USDA-NASS, 2004). Considering only the number of cropland acres and the number of animals produced there was not enough cropland in this county to spread all the manure; however, it is not known where the manure is spread or if it is used for other purposes such as methane digestion or composting. Other counties, such as Berrien, had thousands of acres in crop production, but few animals.

The 3-digit zip code areas 494 and 488 produced the most animal units in this study; however, the producers in these zip code areas did not pay the most on average, per animal unit, for the MAEAP verification process. As seen in Table 5.16, the producers in the 490 zip code area (Barry, Branch, and Kalamazoo counties) paid the most on average per animal unit to become verified ($272.17). The 494 zip code area

(Muskegon, Oceana and Ottawa counties) paid $124.55 per animal unit, and when compared to other areas, this average cost was large.

Table 5.16: MAEAP Verification Costs per Animal Unit Using the 3-Digit Zip Codes

3-digit zip code	N	Counties	Total producer cost/ A.U.	Annual producer cost/ A.U.
484	4	Huron, Newaygo, Sanilac	24.74	-3.81
487	5	Huron, Sanilac, Tuscola	39.10	7.28
488	6	Clinton, Ionia, Montcalm	78.16	5.69
490	3	Barry, Branch, Kalamazoo	272.17	17.61
492	3	Calhoun, Hillsdale, Lenawee	5.66	-1.02
493	1*	Barry, Isabella, Mecosta		
494	8	Muskegon, Oceana, Ottawa	124.55	12.15
496	1*	Lake, Missaukee, Osceola		

* Information exists on these zip code areas. However, to maintain the producer's confidentiality, these costs were omitted from this table.

The average operation in the 492 area (Calhoun, Hillsdale, and Lenawee counties) paid the least on a per animal unit basis ($5.66). Annually, however, the producers in the 484 zip code area (Huron, Newaygo and Sanilac counties) paid the least amount, saving $3.81 per animal unit[23].

5.8 Costs Compared to Gross Farm Revenue

The initial per farm cost to become MAEAP verified as a percent of gross farm revenue was examined. It was found that the larger was an operation's gross farm revenue the smaller was the percent costs (Table 5.17). It was observed that the operations with a gross farm revenue of less than $500,000 spent 2.77 percent of their gross revenue on MAEAP related managerial and capital investment changes each year. The producers with gross farm revenue greater than $2,000,000 paid the most for

[23] The total producer cost per animal unit is not simply the number of cost divided by the number of animal units because the initial cost of writing the CNMP was larger than the cost to update the CNMP.

verification in absolute terms; however, these costs constituted a small percentage of gross farm revenue (0.27%).

Table 5.17: Annual Producer Verification Costs as Related to Gross Farm Revenue

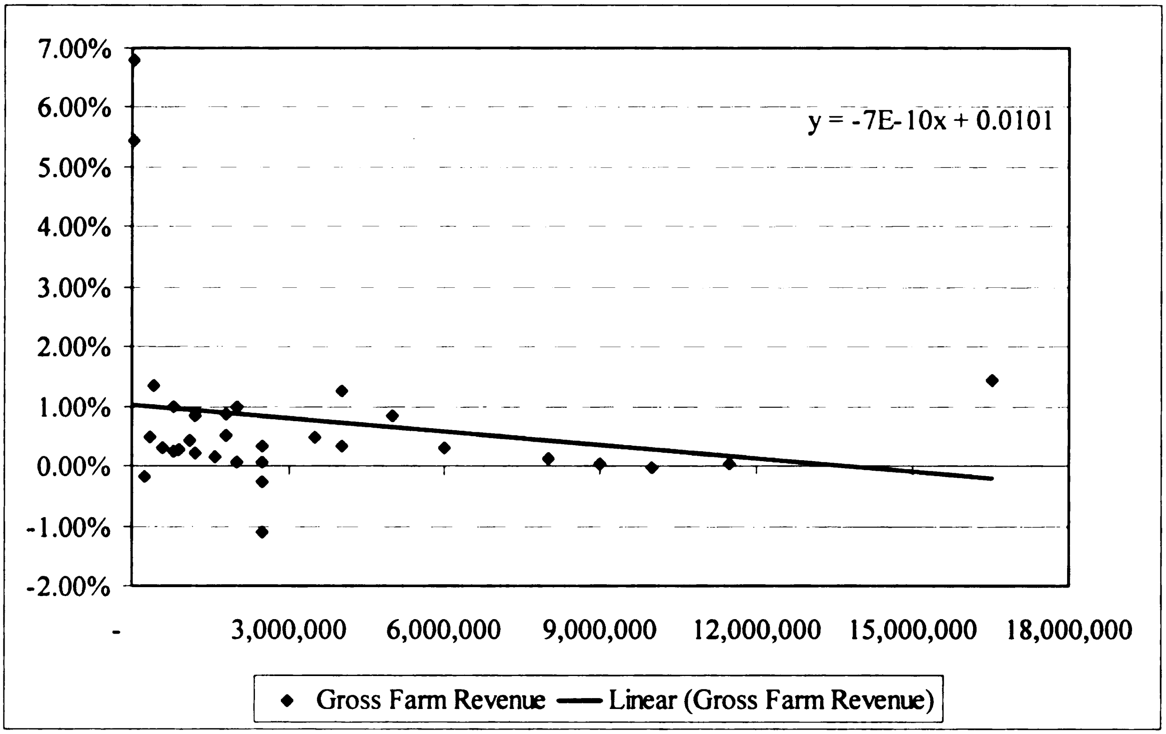
Gross farm revenue	N	Annual producer cost/ animal unit	Capital investment costs as a percentage	Managerial changes costs as a percentage	Annual producer cost as a percentage
		2004 Dollars per Animal Unit	Percent		
0 < 0.5 million	5	17.75	1.65	1.13	2.77
0.5 < 1 million	4	5.82	0.26	0.24	0.50
1 < 2 million	8	10.48	0.23	0.26	0.48
> 2 million	14	2.67	0.10	0.17	0.27

As revenue increased, the trend observed was a slight decrease in costs as a percentage of gross farm revenue. The correlation between gross farm revenue and producers' annual verification costs was positive (r = 0.63). However, previous research has shown that the link between environmental and financial performance appears to stem primarily from the effect of environmental performance on financial performance, rather than the reverse (Alberini & Sergerson, 2002). This link is most likely related to the amount of time the operator spends managing the details of the operation. An increased environmental stewardship and attention to details of the operations is more likely to lead to obtain a larger financial return on that operation compared to operations that do not practice environmental stewardship and spend less time on management of the operation.

The costs of adopting the management and capital investment changes seemed to increase at the same rate as the operation's income increased as the slope was small across all annual gross farm revenues (Figure 5.1[24]). The equation of the trend line was y = -7E-10x + 0.0101, where y is the cost of becoming MAEAP verified as a percent of gross farm revenue and x is gross farm revenue. One AFO operator spent 6.79 percent of his annual gross farm revenue on capital and managerial changes to become MAEAP verified, while another AFO operator saved 0.28 percent of his annual gross farm revenue by becoming MAEAP verified. On average, the CAFO operators spent 0.38 percent of their annual gross farm revenue on implementing the CNMP, while the AFO operators spent 1.58 percent. It was expected that a CAFO would spend a lesser percentage of his/her annual gross farm revenue than an AFO, due to more personnel available to implement the specific changes and the economies of scale a larger operation could realize.

[24] If the sample size were large and statistical analysis could be conducted, there would be two outliers omitted from the analysis as they were more than three standard deviations from the mean (greater than 5.35%). With the two outliers omitted, the linear relationship would slope slightly upward (y = 1E-10x + 0.0035). This relationship coupled with the relationship of Figure 5.1 indicates that the average producer's costs, as a percentage of annual gross farm revenue, decreased only slightly (less than 0.5 percent), if at all, for all revenue levels, regardless of species or size.

Figure 5.1: Annual Producer Cost as a Percent of Gross Farm Revenue



5.9 Summary

Overall, the larger operations had larger gross farm revenues and had more costs associated with MAEAP verification. The cost to become MAEAP verified ranged from 6.79 to -1.10 percent of the operator's annual gross farm revenue; the average was 0.76 percent. Because not all the changes reported by producers were required by the MAEAP's CNMP, such as some equipment purchases, the cost to become MAEAP verified was biased upwards from the minimal necessary to be verified. CAFOs received less in cost-share overall, but had more financial and capital resources available to implement some of the required changes. The management changes, specifically the commercial fertilizer reductions, impacted the AFOs more than the CAFOs relative to their total costs, but the reduced need for commercial fertilizer helped the average operator save money. The poultry operations had the highest cost to become MAEAP verified both for the producers and for the producer plus taxpayer groups.

Chapter 6: Environmental Outcomes from MAEAP Verification

6.1 Introduction

Although there are many methods[25] that could have been used to quantify the level of environmental improvement achieved on livestock operations, this study used the cropland phosphorus mass balance and the phosphorus index to calculate the environmental change on the livestock operation that the producer linked to MAEAP verification. Some of the alternative or additional methods available to calculate the environmental change would have added rigor to the research results.

6.2 Limitation of the Environmental Outcome Quantification Methods

Specific, measurable, and improved environmental outcomes on the 31 surveyed operations could be linked to the operations becoming verified through MAEAP; however, MAEAP cannot be held wholly responsible for the improved outcomes for several reasons. Specifically, since 2002 many changes have occurred in increased enforcement of CAFO regulations and increased availability of EQIP cost-share funds[26], both of which directly affect MAEAP. These changes came within the last few years of the MAEAP verification process. Therefore, it was impossible to determine whether some or all of the improved environmental outcomes were caused by the pursuit of MAEAP verification or to the new changes and regulations. For example, a livestock

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[25] The use of models such as Soil and Water Assessment Tool (SWAT) that model the transport of water from the land to receiving streams and routes flow downstream, the Soil Erosion and Sediment Assessment System (SESAS) that models soil erosion, sediment yield, and phosphorus loading, and the Erosion-Productivity Impact Calculator (EPIC) that uses a field-level physical process model to determine the effect of management strategies on agricultural production and soil and water resources were some of the models considered for the environmental evaluation of before and after livestock operations became MAEAP verified. However, these models were viewed as too data and analysis intensive as to be beyond the scope and timeframe of this thesis.

[26] The allotted EQIP funding for the state of Michigan increased from $6,811,000 in 2002 to $9,727,900 in 2003 (MacMaster, personal communication, November 2005).

producer may have needed to alter their management strategies or to purchase capital investments due to the regulation changes or their own business needs, but they asserted in the survey that their investments were due to their participation in MAEAP.

Also, this research did not include any environmental outcome studies on the animal production or manure storage area (a.k.a., barnyard) itself. This omission was due to the variability and complexity of barnyards as well as the lack of previous knowledge regarding the amount of barnyard phosphorus runoff that occurred prior to MAEAP verification. One of the largest problems in identifying the environmental outcomes relating to barnyard changes was that phosphorus contributions from non-field areas are poorly understood (Hively, Bryant, & Fahey, 2005).

With the exception of the barnyard area, environmental outcomes that stemmed from managerial and capital investment changes were examined for the entire farm with the cropland phosphorus mass balance, and on specific fields with the phosphorus index. Both methods were used to quantify an operation's environmental outcomes that occurred due to MAEAP verification.

The environmental outcomes were only examined on those operations in which a CNMP was collected, 81 percent of the 31 operations surveyed. Due to the variation among the CNMPs collected, some details were not able to be added to the phosphorus mass balance score (e.g., phosphorus in feed) that would have added to the precision of the score. The calculated phosphorus mass balance score signified the amount of excess or deficient phosphorus that was produced on the farm in a given year.

The P-Index used for this research was developed by a committee of nutrient management professionals in Michigan, but the index has not been adopted by any

Michigan governmental agency (i.e., MDA or NRCS) or MAEAP. The index used in this research may not be the same as the final version that Michigan state officials and industry experts agree to use. The P-Index estimated the potential for phosphorus runoff, but did not calculate the actual quantity of phosphorus, if runoff should occur.

6.3 Changes by Species: Number and Cost

Operators needed to adjust their management practices and purchase capital investments in accordance with the MAEAP CNMP to become verified. For this research, these management practices and purchases of capital investment were re-categorized to link the change with the area of the operation it affected; that is, some capital investment changes affect the field, while other changes affect the barnyard, animal manure, or the whole farm management. The examined categories included 1) field changes (i.e., related to machines to transport manure, equipment to spread manure, grass waterways, buffers, spreading labor, equipment usage, soil testing, commercial fertilizer, and fuel); 2) barnyard changes (i.e., related to manure storage, fence, buildings, gutters, drainage, roof, and driveway/berms); 3) animal manure changes (i.e., related to manure testing, manure sold, and feed additives); and, 4) whole farm changes (i.e., related to record keeping labor, crop consultant/TSP, energy and utility, supervision hours, and insurance premiums).

The effects of one change however, may have altered a decision related to a different category on the farm. For example, selling less animal manure may increase the need for additional manure storage (a barnyard change) and may also increase the distance manure was hauled to a field with a soil test phosphorus below 150 ppm (a field change). Also, five changes made on each specific operation affected many aspects of the entire operation, and thus were classified as whole farm changes. A change made in an operation did not necessarily translate into an environmental improvement. Also, a change that cost more than another change did not necessarily signify a larger environmental outcome.

In aggregate, whole farm and barnyard changes were the most expensive alterations that occurred on an average operation; $2.88 and $2.90 per animal unit, respectively (Table 6.1). Animal manure changes cost the least per animal unit, on average, at $0.22 per animal unit. Swine operators, on average, spent little ($0.07) per animal unit on animal manure changes, primarily due to the fact that swine producers did not sell much manure and the cost to add phytase, the feed additive, was only an additional $0.80 per ton of pre-mixed feed.

Table 6.1: Number of and Producer's Cost per Animal Unit per Category Change

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
	2004 Dollars per Animal Unit						
Whole farm costs*	7.76	2.21	1.69	2.72	2.88	1.85	4.13
Field costs**	-6.95	1.57	10.06	0.17	1.53	0.17	3.17
Animal manure costs†	0.43	0.06	0.81	0.07	0.22	0.31	0.11
Barnyard costs††	8.46	2.13	0.34	3.19	2.90	1.42	4.69
Total costs	9.71	5.97	12.89	6.16	7.53	3.75	12.11
	Number of changes made						
Whole farm changes	2.3	2.8	2.6	2.7	2.7	2.8	2.6
Field changes	2.7	2.7	3.4	3.2	3.0	3.2	2.7
Animal manure changes	0.7	0.8	0.8	0.5	0.7	0.9	0.4
Barnyard changes	2.7	1.6	0.2	0.8	1.2	1.3	1.0
N	3	10	5	13	31	17	14

*Whole farm changes and costs include: record keeping labor, crop consultant/TSP, energy and utility, supervision hours, and insurance premium

**Field changes and costs include: machines to transport manure, equipment to spread manure, grass waterways, buffers, spreading labor, equipment usage, soil testing, commercial fertilizer, and fuel

†Animal manure changes and costs include: manure testing, manure sold, and feed additives

††Barnyard changes and costs include: manure storage, fence, buildings, gutters, drainage, roof, and driveway/berms

The most changes occurred in the field category; however, this category did not have the largest costs ($1.53 for field changes). Although the number of changes categories varied across the different species, if the number of changes made could be examined statistically, it is probable that they would not be different from one species to another. However, there may have been a significant difference across species with respect to the cost per animal unit spent on different category changes.

6.4 Barnyard Management Changes

To evaluate the environmental impact from MAEAP, the barnyard management changes made on an operation and their environmental performance need to be quantified. However, an accurate assessment of the barnyard-related environmental outcomes due to MAEAP could not be completed, because the researchers were not able to inspect the barnyard before and after the changes were implemented, nor were secondary data available.

Upon examining the barnyard changes made on the surveyed operations (i.e., gutters, manure storage, fences, buildings, drainage, roofs, and driveways and berms), the average swine producer made few (0.8) changes but, spent nearly $3.19 per animal unit to obtain these changes (Table 6.1). However, as previously stated, due to the nature of the changes and the lack of scientific data available before the changes were implemented, there was no method available to calculate the amount of lowered environmental risk an operation achieved through implementing any changes. There were models available to assess the environmental benefits of keeping clean water clean; however, data for these models would have needed to be collected prior to any changes made on the barnyard to evaluate the amount of lowered risk.

Some evidence can be obtained from other studies. In a New York dairy study, nine variables were examined to evaluate the risk of phosphorus runoff; four types of pastures, the barnyard, cow paths, forest, and corn and hay fields (Hively et al., 2005). The barnyard and cow paths had the quickest phosphorus overland flow and they had the highest concentration of dissolved and particulate phosphorus in that runoff. This research suggested that the barnyard was a critical location for phosphorus loading (Hively et al., 2005). Many of the 31 operations surveyed for this thesis study lowered their risk of having a manure discharge into surface water by updating their manure storage, roofing and curbing the manure holding pads, or diverting water from an open lot to a lagoon. An MDA employee that verifies MAEAP operations explained that at least two of the thirty-one operations surveyed for this research altered the manure storage to eliminate a direct manure discharge into surface water (Appleby, personal communication, October 2005). If properly built and maintained, all changes made to the barnyard assisted in reducing potential transport of phosphorus to surface waters, because all these changes reduced runoff. However, quantification of pollution prevention benefits was beyond the scope of this study.

The barnyard changes made on the 31 operations accounted for, on average, approximately 38 percent of the producer's annual costs associated with maintaining verification ($2.90 per animal unit) (Table 6.1). If an operator made barnyard changes, the operator was more likely to receive more cost-share per animal unit ($r = 0.49$). A strong correlation was expected, as all of the MAEAP-required barnyard changes were eligible for EQIP cost-share. However, there was only a small negative correlation between the annual producer cost of becoming MAEAP verified and the number of barnyard management changes implemented (r = -0.19).

6.5 Cropland Phosphorus Mass Balance

Although the environmental impact of the barnyard could not be captured, the phosphorus mass balance on the operation's cropland was calculated. As phosphorus is the limiting nutrient in freshwater systems, such as Michigan, only the cropland phosphorus mass balance, not nitrogen, was calculated for this study.

A typical mass balance score would be calculated by subtracting the "exported" phosphorus from the amount "imported" on the operation. Due to the variability across CNMPs, the phosphorus mass balance calculation used in this study did not use the amount of phosphorus in the feed stuffs, by-products (e.g., grain, milk, meat, and manure) sold and retained on farm, and commercial fertilizer. The variables that were available in all CNMPs, and therefore used to calculate the cropland phosphorus mass balance in this thesis research, included: the amount of P in manure, the number of acres that could have manure spread and still be below 300 pounds per acre phosphorus, and the amount of P the crops on those spreadable acres would use during a growing season. Also, for this research, the application of commercial fertilizer was considered to be determined after the livestock producer knew the cropland phosphorus mass balance. Therefore, if a farm was out of cropland mass balance, according to the farm's CNMP calculations, no commercial fertilizer would be spread. Over-application of commercial fertilizer would therefore not be a concern.

Any operation will either be *in* cropland phosphorus mass balance or *out* of cropland phosphorus mass balance. For the purposes of this thesis research, a farm was in mass balance if the pounds of P_2O_5 per year applied via manure (import) were less than the pounds of P_2O_5 per year that a crop consumed from the soil (export). When imports were less than or equal to exports, the cropland P mass balance had a negative or zero score, respectively. If the cropland P mass balance score was negative, supplemental commercial P could have been spread on the crop to assist with crop production.

If the calculations from this research revealed an operation had a phosphorus mass balance score that was within plus or minus 20 percent of the initial pounds of P_2O_5 consumed by crops, that operation was considered to be in balance. The range was acceptable due to errors in calculating phosphorus in manure, soil phosphorus, and/or crop uptake (Appleby, personal communication, October 2005). If a farm was out of balance, it had a positive score, signifying that the crops could not consume all of the phosphorus that was applied via manure application and/or not enough manure had been sold off-farm.

The P mass balance score that was calculated using the information provided in the 25 collected CNMPs was considered the cropland P mass balance after the operation became MAEAP verified. To calculate the cropland phosphorus mass balance on these 25 operations before they became MAEAP verified, those variables that affected the quantity of manure, the level of phosphorus in the manure, or amount of phosphorus a crop consumed were evaluated. These variables included the amount of manure sold before MAEAP verification occurred, any change in crop rotation after a farm became MAEAP verified, and any animal unit, feed ration, or number of spreadable acres altered because the farm became MAEAP verified.

After the operations became MAEAP verified, excess generation of phosphorus occurred on four of the twenty-five farms. However, two of these operations were within the acceptable ±20 percent range and were deemed within mass balance. The other two operations did not have exports greater than imports and thus, were out of mass balance and they exceeded the acceptable range of ±20 by 3 and 19 percent.

From Table 6.1, of the data computed from the collected CNMPs, the operations with dairy as the primary species were the only species that had an average positive cropland phosphorus mass balance prior to becoming MAEAP verified. This result meant the average dairy farm was out of mass balance prior to implementation of the CNMP. However, each species category had at least one farm that had a high positive number prior to becoming MAEAP verified. After becoming MAEAP verified, all species had an average phosphorus mass balance score that was below zero.

There were three operations that remained in mass balance, but had an increase in their mass balance score after they became MAEAP verified compared to before verification. The increase in phosphorus mass balance was due to additional animal units and less manure sold. Additional animal units were brought on the farm because the livestock operator understood his cropland could use additional phosphorus. Some producers sold less manure due to the complexities that would occur with manifests in the future, and their cropland could use the extra nutrients.

After becoming MAEAP verified, CAFOs decreased their phosphorus mass balance by an average of 23,750 pounds of P_2O_5 (Table 6.2). AFOs had a smaller change in mass balance with an average decrease of 2,579 pounds of P_2O_5 after verification. Because spreadable acreage is a concern for many operations, the phosphorus balance allows the manager to evaluate how much manure needs to be moved off the farm to avoid over-application of nutrients (Nutrient Management Task Force, 1999). Many CAFO operators sold some of their animal, which aided these operations in bringing the operation into or below the phosphorus mass balance. The average operation made 7.0 changes and spent about $7.00 per animal unit annually on variables that affected the phosphorus mass balance score.

Table 6.2: Change in Phosphorus Cropland Balance on 25 Operations due to MAEAP Verification

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
P_2O_5 mass balance before verification	Pounds of P_2O_5 per year						
Average	-13,558	3,595	-15,171	-4,663	-4,744	-5,361	-4,075
Standard Deviation	15,797	57,837	127,178	19,179	55,515	76,077	20,234
Minimum		-58,335	-196,733	-29,467	-196,733	-196,733	-38,086
Maximum		97,689	95,271	44,641	97,689	97,689	40,780
P_2O_5 mass balance after verification							
Average	-12,675	-20,411	-41,341	-10,391	-18,332	-29,111	-6,654
Standard deviation	17,046	26,571	104,645	11,111	41,686	53,799	18,650
Minimum*		-63,751	-196,733	-29,467	-196,733	-196,733	-38,086
Maximum		13,448	31,369	8,206	31,369	180	31,369
Change in P_2O_5 balance							
Average	883	-24,006	-26,170	-5,728	-13,588	-23,750	-2,579
Standard deviation	1,249	40,443	46,280	14,271	29,605	38,369	7,208
Annual producer cost/ A.U.	2004 Dollars per Animal Unit						
Average	0.69	5.96	12.82	6.55	6.92	2.93	11.23
Standard deviation	35.96	3.01	17.61	11.02	12.65	9.16	14.78
Total number of changes made	Number of changes made						
Average	9.5	7.3	5.8	6.9	7.0	7.6	6.4
Standard deviation	0.7	2.2	2.5	3.2	2.7	3.0	2.4
N	2	7	4	12	25	14	12

*Minimum and maximum values are not reported if N is less than 4.

Producers can choose one or several methods to decrease their phosphorus mass balance score. Five of the seven surveyed operations that were not in mass balance prior to becoming MAEAP verified, achieved mass balance after becoming MAEAP verified. When these five farms moved towards becoming in mass balance, it would be expected that they will have reduced their operation's potential for soil phosphorus build-up and eventual runoff into surface water.

6.6 Phosphorus Index

In addition to the mass balance, the phosphorus index (P-Index) was another method used to estimate if MEAEP assisted in preventing surface water pollution. The P-Index differs from a mass balance calculation, because it evaluates specific fields and takes into consideration intermittent streams (a stream that holds water part of the year), field slope, and the field's hydrological group. The P-Index was not calculated as part of the CNMP, but was calculated using information within the CNMP. The P-Index was used to estimate the potential for phosphorus runoff, but did not calculate the quantity of phosphorus that would be contained in any runoff. The Michigan phosphorus index used in this study is discussed in Appendix F.

For purposes of this thesis research, several Michigan State University Extension personnel were asked to assist in comprehensively evaluating three to six high-risk fields on each of 12 high risk operations using the phosphorus index. Only 12 out of 25 operations were deemed high risk; this high risk categorization was based on their distance to a cold water trout stream (within a quarter of a mile) or the operation's mass balance score. An operation's mass balance score put the operation in the high risk category if the operation met one of two characteristics – either the operation was out of mass balance after becoming MAEAP verified, or the operation had a change in their mass balance score that indicated that there was an increased amount of phosphorus on farm, but the operation was not out of mass balance. If a CNMP was not collected from an operation, it could not be determined if the operation would be considered high risk; thus, only the 25 operations in which a CNMP was collected were evaluated as to whether they were in the high risk category or not.

Compared to a soil test or MARI calculation, the P-Index was more comprehensive in examining a field for pollution potential. The P-Index accounted for variables that affected the transport and source of phosphorus on each field. The variables included in the phosphorus index were placed in one of two categories, transport or source. The transport variables included RUSLE2[27], RCN (Runoff Curve Numbers), distance to surface water, subsurface drainage, and buffers, while the phosphorus source variables included soil test phosphorus, phosphorus fertilizer method, manure spreading method, and the P_2O_5 rate applied from all sources. Each of the nine variables received a score, ranging from zero to eight; the nine scores were totaled to determine the field's potential phosphorus runoff rating. A zero score indicated that there was a low potential of phosphorus runoff risk. If a particular category's score was closer to eight, that category was viewed to have a higher potential risk of phosphorus runoff. A field with a total score of 18 or higher indicated that the field had a high potential risk, and the operator needed to make management or capital changes to lower the score. A score

[27] RUSLE2 calculates the tons per year of soil loss on a field. RUSLE2 is calculated with the equation, A = R K LS C P, where A = Soil loss in tons per acre per year, R = Rainfall-runoff erosivity factor, K = Soil erodibility factor, S = Slope steepness factor, L = Slope length factor, C = Cover-management factor, P = Support practice factor. The 2 indicates that the calculation is the second version of RUSLE.

below 18[28] implied that a producer could spread more manure or commercial fertilizer, if he/she chose to do so. Eighteen was a threshold selected by the Michigan committee of manure nutrient specialists; however, P-Index scores can range from 0 to 68.

Not all fields were examined on the 12 high risk operations; this decision was made on the assumption that if the fields with the highest risk to pollute surface water were examined and had a score of less than 18, the fields that did not meet the high risk criteria on that farm would score below 18. Eight fields were randomly selected from the pool of fields on each of the 12 high risk operations that met one of the following three criteria: 1) soil test P was over 150 ppm; 2) a MARI score in the high category; or, 3) the field was within 300 feet of surface water. However, four of the high risk operations did not have any fields that met these three criteria. In those situations, the fields with the highest soil test phosphorus and MARI score were selected. As the RUSLE2 was the most laborious calculation to make, once the other eight P-Index variables[29] were evaluated, only those fields that scored above 18, or were the three highest scoring fields on the operation, whichever was greater, were evaluated with the last variable; RUSLE2.

From Table 6.3, prior to the 12 high risk operations becoming MAEAP verified, their fields had an average score of 18.5 on the P-Index, slightly above the 18 threshold. It should be noted however, that the P-Index score averages on the high risk operations ranged from 27.7 to 8.7 before the operations became MAEAP verified. After these operations became verified, the P-Index score on these same fields ranged from 20.5 to

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[28] Michigan's P-Index was considered a resource to be used in only two scenarios: 1) if the operator wanted to spread phosphorus on a field with a soil test above 150 ppm, the field must score below 18; or, 2) if the operator wanted to spread manure or commercial phosphorus fertilizer at a rate higher than the suggested two-year crop removal rate, the field must score below 18.

[29] The first eight factors to be calculated were the RCN, distance to surface water, amount of subsurface drainage, and width of buffers, the field's soil test phosphorus, the method used to incorporate phosphorus fertilizer, manure spreading method, and the P_2O_5 rate applied from all sources.

7.7. The smaller range and lower scores, after the high risk operations became MAEAP verified, indicated that environmentally beneficial practices were adopted to decrease phosphorus runoff. If no practices affecting the risk of phosphorus loss on fields were changed, the P-Index score would not have changed.

To lower the P-Index score of a field, the manager could have made several different management changes or planted a buffer strip or grass waterway. A change in the P-Index score usually resulted from decreasing P runoff potential through less soil erosion, (planting buffers or grass waterways, and observing setbacks), applying manure over a growing crop, incorporating manure, or applying less manure or commercial P.

Table 6.3: Average High Risk Operation P-Index Score

	Number of variables	Before MAEAP verification	After MAEAP verification	Change in Score
		P-Index Score		
Transport score	5	10.2	7.3	-2.8
Source score	4	8.3	7.1	-1.2
Total score	9	18.5	14.4	-4.0

The average change in the P-Index score from before to after MAEAP verification on the 12 high risk operations was -4.0. After the operations became MAEAP verified, a P-Index score of 14.4 was achieved, which signified a lowered potential for phosphorus runoff on the high risk fields. If the high risk fields scored below 18, it was assumed the lower risk fields on that same farm would also score below 18.

The transport score decreased more than the source score (-2.8 compared to -1.2) indicating that on average, more operators chose to implement buffer strips, change crop rotation, or alter tillage practices rather than change the method or amount of phosphorus that was applied to a field. The most common change in the transport category was adding buffers or setbacks, which also increased the distance to surface water. The source score was typically lowered by either not applying manure to a high risk field or altering the timing of application so that applications were on growing crops.

In this study, the costs associated with altering the P-Index in the fields were averaged to determine how much the producer and producer plus taxpayer spent on this environmental measure. All costs associated with managerial changes and capital investments were included, except those costs associated with energy and utility, insurance, and/or barnyard management changes. Not only were the costs associated with the field included, but also included were supervision hours, record keeping, manure testing, feed alterations, and the crop consultant fees. These costs were included as the relating variables assisted the operator in making managerial decisions about where to spread manure, determining what rates manure or commercial fertilizer should be spread, and supervising to ensure the CNMP was followed accurately.

About 44 percent of the producer's annual costs per animal unit incurred on the high risk operations were attributable to changes made that affected the P-Index ($3.42 of $7.76). Of the high risk operations, there were no CAFOs that received cost-share for any capital investments eligible for EQIP cost-share. The small and medium operators had nearly a $2.00 decrease in annual costs per animal unit that were related to altering the P-Index due to EQIP cost-share (Table 6.4).

Table 6.4: Average Costs Affecting the P-Index Score on 12 High Risk Operations

	Total	CAFO	AFO
	2004 Dollars per Animal Unit		
Annual taxpayer & private costs	4.23	3.41	5.39
Standard deviation	7.33	3.80	11.09
Annual producer costs	3.42	3.40	3.43
Standard deviation	5.64	3.80	8.12
N	12	7	5

If an operation was considered high risk according to this study's criteria, the operator was more likely to change the equipment he/she used to spread manure (r = 0.54), add more manure storage (r = 0.51), and put gutters on the buildings (r = 0.33) than if the operation was not labeled high risk. When the operators of the high risk operations were posed with the statement, "Even though clean water benefits the public, producers should pay for the majority of mandatory environmental practices to ensure pollution prevention," they gave the statement a score of 4.2 on a 5 point scale indicating disagreement. The operators of the high risk operations more strongly disagreed than the average operator 4.2 compared to 3.7.

The 12 high risk operation managers were, on average, four years older than the 13 other operations' managers in which a CNMP was collected (51 compared to 47 years old). Although the differences in ages found were not great and are probably not significant. Also, the more education the owner/operator achieved, the less likely the operation was considered one of the 12 high risk operations (r = -0.34). The 12 high risk operations also had a larger animal unit per acre density of 1.6 than did the 13 other operations in which a CNMP was collected (0.6).

6.7 Risk Level Effects on Changes Made

Although only the high risk operations were evaluated using the P-Index, the number of changes these operations made (8.8) outnumbered the quantity of changes made on all 31 of the operations (7.5) (Table 6.5). The number of changes an operation made were correlated with the amount of change in the operation's average P-Index score (0.57 correlation).

Table 6.5: Amount and Cost of Changes Made to Become MAEAP Verified

	High Risk Operations	CNMP Operations‡	All Operations
	2004 Dollars per Animal Unit per Year		
Whole farm costs*	2.57	2.54	2.88
Field costs**	0.95	1.50	1.53
Animal manure costs†	0.16	0.10	0.22
Barnyard costs††	2.83	2.78	2.90
Total costs	6.51	6.92	7.53
	Number of changes made		
Whole farm changes	2.8	2.6	2.7
Field changes	3.5	2.8	3.0
Animal manure changes	0.9	0.6	0.7
Barnyard changes	1.7	1.2	1.2
Total changes	8.8	7.2	7.5
	2004 Dollars per Animal Unit		
Cost-share received	91.17	56.78	54.96
N	12	25	31

‡CNMP operations include only those operations in which a CNMP was collected.
*Whole farm changes and costs include: record keeping labor, crop consultant/TSP, energy and utility, supervision hours, and insurance premium
**Field changes and costs include: machines to transport manure, equipment to spread manure, grass waterways, buffers, spreading labor, equipment usage, soil testing, commercial fertilizer, and fuel
†Animal manure changes and costs include: manure testing, manure sold, and feed additives
††Barnyard changes and costs include: manure storage, fence, buildings, gutters, drainage, roof, and driveway/berms.

Comparing the various costs (whole farm, field, animal manure, and barnyard), the high risk operators spent less than the aggregate on average and implemented more changes in each category per animal unit. It cost the managers of the high risk operations

$1.02 less per animal unit to implement all required changes than for all 31 operations. The lower cost per animal unit was due to the high risk operations having more animal units and more cost-share per animal unit.

The 12 high risk operations received more cost-share per animal unit on average than the aggregate (all 31 operations) average ($91.17/A.U. compared to $54.96/A.U.). These 12 operations had a P-Index score above 18 before they became MAEAP verified, and by implementing more agronomic management practices and decreasing the amount of field erosion, they reduced the potential of phosphorus runoff. On average, larger amounts of cost-share were given to the operations with the highest potential to pollute surface water from a field. Barnyard changes may have also decreased the amount of direct runoff into surface water. Because this research could not determine if an operation had a higher potential to pollute surface water from the barnyard than another operation, no linkages could be made between the amount of cost-share an operation received and the potential for the barnyard to pollute surface water.

6.8 Summary

MAEAP has affected environmental outcomes in a positive manner, as estimated by the lowered estimates of phosphorus mass balance on the farms and the P-Index calculations. Having an operation in mass balance suggests that excess nutrients are not accumulating in the soil and are less likely to be transported into surface water via runoff. Eliminating the excess nutrients in a field lowers the risk of phosphorus runoff. Although the phosphorus index is new, it provided valuable environmental information. The 12 high risk operations made changes to decrease the risk of field phosphorus runoff and erosion. This study did not however verify how much risk was reduced. The high risk operations that needed to make changes to their fields did so at a low cost per animal unit; this result suggests that improving the environmental stewardship of easily eroded or phosphorus-rich fields was not costly, given that the operators received cost-share.

Chapter 7: Proposition Analysis

7.1 Introduction

This study was a set of case studies of 46 percent of MAEAP-verified farms and is significant to the population of MAEAP participants, as 29 of the 46 producers that managed MAEAP-verified [or nearly verified] operations were interviewed. This study was useful in investigating several strongly held hypotheses, or propositions. Below are the nine propositions as stated in Chapter 1, that are related to the motivation to become verified through the MAEAP, economics of becoming MAEAP verified, and the environmental outcomes of MAEAP-verified farms. The nine propositions were supported or contradicted by the data collected from the livestock producer interviews and the CNMPs. These relevant data were the basis for support or opposition for the proposition. However, due to the small sample size, no formal hypothesis testing occurred.

7.2 Research Propositions

Proposition 1: The earliest MAEAP adopters (verified in 2002 and 2003) were already implementing many of the pollution prevention practices a CNMP required prior to becoming verified and thus, were the low-cost adopters.

Within the CNMP, there were many practices operators could implement to prevent pollution, including management or capital investment practices. The operations that were verified earlier (in 2002 and 2003) were different from the operations that were verified later (after 2003) in many respects; the earlier operations on average had older facilities (26 years older), more manure storage (85 percent had more than six months of manure storage as compared to 67 percent of the later adopters), and fewer animal units on average (1,442 A.U. compared to 3,133 A.U. for the later adopters).

The early verified operators also had more changes to make to their management system and capital investments to become verified, 9.5 compared to 8.3 for the later verified operations. However, there may be no statistical difference between the early and late verified operations in the number of changes they made. Although the earliest verified farms spent less annually on average, $8,855, they spent $5.86 more per animal unit per year compared to the later adopters in order to achieve and maintain MAEAP verification. The operations verified later had more than double the animal units which lowered their verification cost per animal unit. The earlier verified operations spent over one percent more of their annual gross farm revenue to become MAEAP verified (1.37 percent) compared to the later verified operations (0.32 percent).

Cost was only one side of the story, however. When evaluating the 25 CNMPs collected using the research calculated mass balance scores, the earlier operations were in mass balance before becoming MAEAP verified. These operations had a mass balance score of -12,291 pounds of P_2O_5, which meant that the earlier verified operations had the soil capacity to have 12,291 more pounds of P_2O_5 applied to meet crop removal requirements and still be considered in mass balance. The later verified operations were, on average, out of mass balance before they became MAEAP verified; they had a mass balance surplus of 1,187 pounds of P_2O_5. Both the early and late verified operations made changes in their P_2O_5 mass balance, which led to both types of operations to be in mass balance after becoming MAEAP verified.

The operations that were considered verified early, that is, those operations verified prior to 2004, spent more money per animal unit and decreased both their P_2O_5 mass balance (-15,015 compared to -12,467) and P-Index score (-5 compared to -2) more than did the later verified operations. The earlier verified operations were, however, in mass balance prior to MAEAP verification.

Looking only at the 12 high risk operations, half were verified early and half were verified late; the earlier verified operations had a larger average P-Index score prior to becoming MAEAP verified (20.7 compared to 16.7). However, the earlier verified operations lowered their P-Index score by 4.8 points compared to the later verified operations who lowered their scores by 2.0 points; all operations had an average P-Index score lower than the 18 score threshold after they became MAEAP verified.

This proposition, number one, that states the earliest MAEAP adopters were already implementing many of the pollution prevention practices a CNMP required prior to becoming verified and thus were the low-cost adopters, appears to be supported by the data collected from this study. The earliest MAEAP adopters were not already implementing most of the pollution prevention practices a CNMP required prior to becoming verified, as the number of changes made was similar to the number of changes the later operators made. Although the early adopters spent more per animal unit and a larger percentage of their gross farm revenue, in total they spent less money annually to become MAEAP verified than did the later adopters.

Proposition 2: Liability risk and the potential for environmental regulation motivated livestock producers to become MAEAP verified.

With increased environmental regulations on the forefront, more producers will need to have a CNMP in the future. Of the 29 producers that were interviewed, 58 percent became MAEAP verified due in part to the current or potential environmental regulations directed at his/her livestock operation. Although only 19 percent of the 31 operations (six) became verified to decrease the probability of lawsuit, on average the 29 producers disagreed strongly (4.5 out of 5) that liability and lawsuits were of little concern to the Michigan livestock industry.

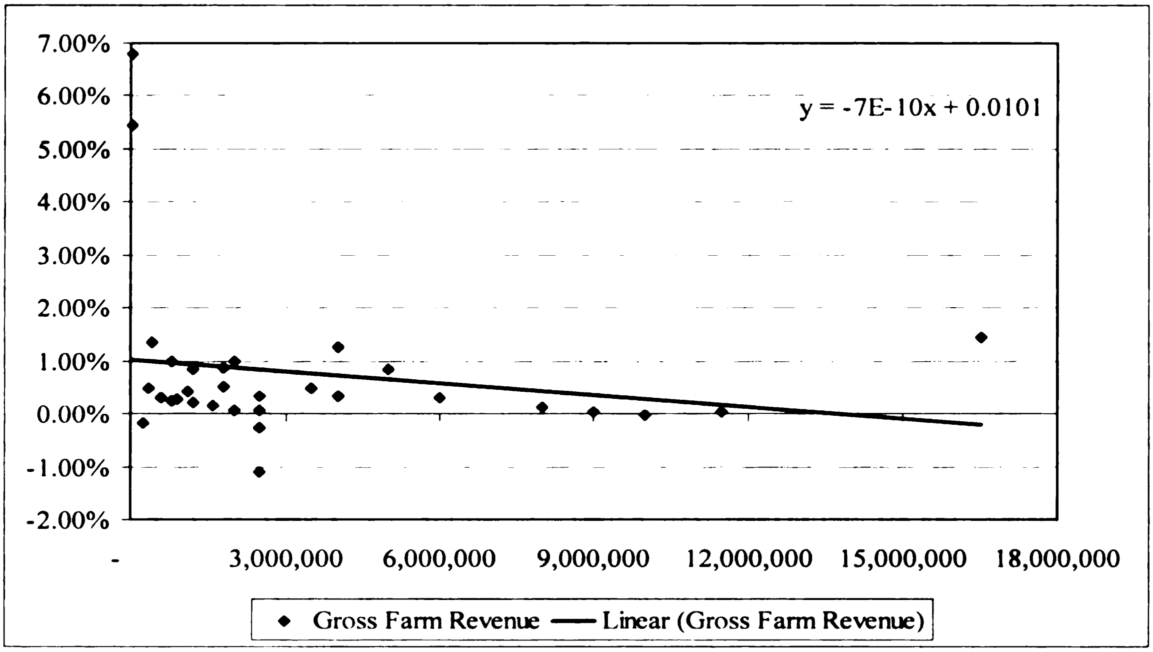
In 2004, four small and medium operations became MAEAP verified, while ten large operations became verified. Sixty percent of the CAFO operators that became verified in 2004 sought MAEAP verification in part, due to new regulations. It would appear that proposition number two is consistent with the motivation and opinion answers to questions asked during the interview. The increased interest in MAEAP verification was most likely influenced by the 2003 CAFO Final Rule (U.S. EPA, 2003) of the September 2005 deadline, requiring large livestock producers to be enrolled with MAEAP or have an NPDES permit. Proposition number two was supported by this research, as liability risk and the potential for environmental regulation did motivate livestock producers to become MAEAP verified.

Proposition 3: The costs of becoming MAEAP verified were not proportional to the income of the farm.

Gross farm revenue is the income of an operation before taxes, often called the gross profit and not the net farm income (i.e., profit). As revenue increases, the trend observed in this research was about a one percent decrease in annual producer costs to become MAEAP verified, as a percentage of annual gross farm revenue (Figure 7.1). However, the costs livestock operators incurred to become MAEAP verified may have changed over time.

If the sample size were large and formal hypothesis testing could be conducted, there would be two outliers omitted when evaluating the percentage of gross farm revenue. The two points, 6.45 and 5.44 percent, were more than three standard deviations from the mean (greater than 5.35 percent). With the two outliers omitted, the linear relationship would slope slightly upward (y = 1E-10x + 0.0035) from just below 0.4 percent to slightly more than 0.5 percent. This relationship coupled with the relationship of Figure 7.1 indicates that the average producer costs as a percentage of gross farm revenue may have remained nearly constant for all revenue levels, regardless of species or size. Data gathered from this study did not support proposition 3; the costs of becoming MAEAP verified *were* proportional to the gross farm revenue of the farm.

Figure7.1: Annual Producer Cost to Become MAEAP Verified as a Percent of Gross Farm Revenue



Proposition 4: When producers followed the implementation strategies in the CNMP the result was new fixed assets that were larger than without MAEAP verification or EQIP cost-share.

Fixed assets include buildings, manure storage, equipment, and real property. MAEAP verification does not require a minimum capacity of manure storage, as each farm has a unique situation. Each CNMP would have to justify that the manure storage currently in place is sufficient to allow for freeboard space and any extra lot, milkhouse, or roof runoff. A general NPDES permit, as opposed to an individual NPDES permit does not allow any operation to have less than six months of manure storage. Of the 12 MAEAP-verified operators who constructed new manure storage areas or altered their manure storage to decrease the potential for a discharge, nine built a new manure storage that increased at least one of their manure storage holding capacities by an average of 11 months. This increased capacity did not indicate that the operation added capacity in all types of manure storage. For example, there could have been three months of storage for the bedding/pen pack manure but 12 months of liquid manure storage. These new manure storage structures were larger than necessary by the current requirements in the GAAMPs or for MAEAP verification; however, the construction most likely allowed the producer to achieve economies of scale and avoid rebuilding to meet more stringent standards (i.e., permit regulations) or expansion needs that may occur in the future.

One producer's constructed a 24-month capacity manure storage structure to eliminate a direct manure discharge into surface water for a total cost of $240,000; 50 percent of this cost was EQIP cost-shared which lowered the producer's cost to $120,000. This producer "over-built" the building relative to MAEAP verification requirements; he stated his reason was so that manure storage capacity would not be an issue of future discussion with governmental officials. Perhaps if the project was not cost-shared, the livestock producer may not have spent $240,000 to construct a building of that magnitude. It could also be the case that the construction company may have capitalized the cost-share into the fee for building the structure, making the structure more expensive than if cost-share had been unavailable.

It should be noted however, that four of the 29 producers interviewed (14 percent) mentioned that less cost-share would have "made a difference" financially for them to become MAEAP verified. One operator pointed out that his operation was an AFO; and, if it were not for the EQIP program, he would not have become MAEAP verified because he could not have otherwise paid for some of the capital investment costs. Proposition number four appears to be supported by the data collected; following the implementation strategies in the CNMP resulted in new fixed assets being larger than without MAEAP or EQIP cost-share.

Proposition 5: The amount of financial assistance a livestock producer received was correlated positively with the increased amount of capital investments implemented to prevent pollution.

Neither new machinery, equipment, nor management changes were eligible for EQIP cost-share funds, but EQIP would cover a portion of nearly all other capital investment costs associated with becoming MAEAP verified. The correlation of the amount of cost-share received with the total costs of items that were eligible for cost-share was strong at 0.59. Of the producers that spent more than $1,000 on capital investment changes, 35 percent received EQIP cost-share funds. However, three operators – that spent over $1,000 in capital investments – did not apply for EQIP cost-share due to the paperwork required and for distaste of governmental involvement.

Some changes made on operations were small, 14 operations had capital investment expenditures that totaled less than $1,000; nine of the 14 operations had no eligible cost-share expenses. Of the eight operations that received EQIP cost-share for their capital investments, seven received a payment that covered at least 50 percent of their total capital investment costs. Proposition five was supported by the data; the amount of financial assistance a livestock producer received was associated with the increased cost and amount of capital pollution prevention investments implemented.

Proposition 6: As MAEAP became more established and additional details and regulations evolved, the average costs to become and maintain MAEAP verification increased.

The average costs associated with developing the CNMP increased slightly over time, from $4,231 in 2002 to $5,608 in 2005 (Table 7.1). The average cost to producers to write the CNMP remained nearly constant over the four-year period. The annual managerial and capital investment costs associated with becoming and maintaining MAEAP verification increased over time (Figure 7.2).

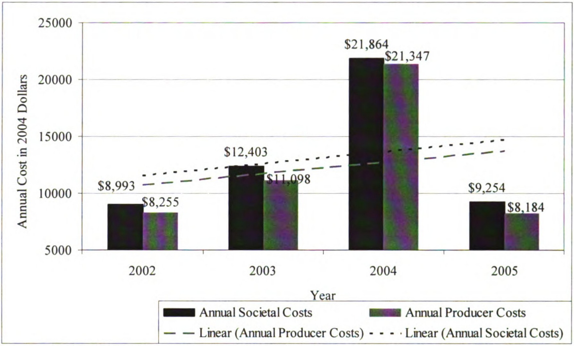
Table 7.1: Costs to Become and Maintain MAEAP Verification over Time

	2002	2003	2004	2005
	2004 Dollars per Year			
Total producer + taxpayer CNMP writing cost	4,231	3,904	6,047	5,608
Standard deviation	2,055	2,478	4,366	3,363
Total producer CNMP writing cost	2,985	1,142	3,021	2,108
Standard deviation	2,464	1,181	3,292	977
Annual producer + taxpayer cost	8,993	12,403	21,864	9,254
Standard deviation	15,158	19,060	62,692	8,314
Annual producer cost	8,255	11,098	21,347	8,184
Standard deviation	15,519	19,545	62,775	8,164
	2004 Dollars per Animal Unit per Year			
Annual producer cost per A.U.	9.36	12.76	4.92	5.60
Standard deviation	11.85	14.34	13.00	1.62

Although the average, annual costs livestock producers incurred increased over time, the size of the average operation also increased over time. For example, the operations verified in 2004 had the highest annual costs associated with MAEAP verification that the taxpayers + private ($21,864) and producers ($21,347) paid and at least double the number of animal units compared to the other years analyzed (Table 7.1).

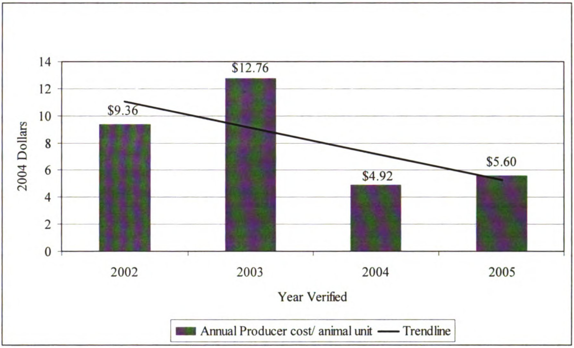
Thus, these operations had the lowest cost per animal unit ($4.92). Sixty-two percent of the operations verified in 2002 and 2003 were AFOs compared to only 33 percent of the operations verified in 2004 and 2005, which assisted the latter years' data in exhibiting a lower average cost per animal unit.

Figure 7.2: Annual Societal and Producer Cost to Become and Maintain MAEAP Verification over Time



The trend observed was a decreasing annual producer cost per animal unit (Figure 7.3) over time even though the trend of the average annual producer cost (Figure 7.2) was increasing over time. However, with more data a more compelling trend could have been established. Due to the small sample size and lack of subsequent years' data, it was not possible to gain much insight to conclusively dispute or support proposition number six which stated, as MAEAP became more established and additional details and regulations evolved, the average costs to become and maintain MAEAP verification increased.

Figure 7.3: Annual Producer Cost per Animal Unit to Become and Maintain MAEAP Verification over Time



Proposition 7: Most CNMP changes required for MAEAP verification were linked to management practices rather than capital investments.

Regularly, a variety of management changes and capital investments occurred before an operation was MAEAP verified. The average producer needed to make nearly 3.5 times more managerial changes than capital investments to become MAEAP verified, 7.2 and 2.1, respectively (Table 7.2). It did not matter what species was produced on the operation, whether the operation was labeled large or small, or whether the operator became verified early or late; the number of managerial changes always outweighed the number of capital investment changes on the average.

Although the average operation in total, spent three times more on managerial costs as compared to capital investments ($11,078 compared to $3,631), some managerial changes made did not cost much annually. Some changes assisted the livestock producer in decreasing the total cost of becoming MAEAP verified (e.g., less commercial fertilizer was purchased on some farms). Additionally, the more management changes an operation made did not necessarily lower the potential for pollution of surface water more than that of another operation that made fewer managerial changes. The same statement was also true for capital investment changes. The research collected supports proposition seven; most changes required for MAEAP verification were linked to management practices rather than capital investments.

Table 7.2: Producer's Annual Changes and Costs made to Become MAEAP Verified

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO	Early Verify	Late Verify
Managerial changes*	5.7	6.9	6.6	7.2	6.9	7.2	6.5	7.3	6.6
Capital investment changes**	3.7	2.5	0.8	1.5	1.9	2.1	1.6	2.2	1.7
Total number of changes made	9.3	9.4	7.4	8.7	8.8	9.3	8.1	9.5	8.3
	2004 Dollars per Year								
Annual managerial costs	-8,952	7,348	54,504	1,867	11,078	19,338	1,048	7,373	13,753
Annual capital investment costs	1,222	5,326	6,903	1,625	3,631	4,659	2,382	2,195	4,668
Annual cost of changes made	-7,730	12,673	61,407	3,492	14,709	23,997	3,430	9,567	18,422
N	3	10	5	13	31	17	14	13	18

*Managerial changes include: crop consultant/TSP, manure spreading hours, supervision hours, recordkeeping hours, commercial fertilizer purchased, equipment usage, fuel, energy/utilities, insurance, manure sold, manure testing, soil testing, and feed rations.
**Capital investment changes include: machines to transport manure, equipment to spread manure, manure storage, buffers, fence, drainage, buildings, roofs, gutters, grass waterways, and driveways/berms.

Proposition 8: The largest barrier to become MAEAP verified was the proximity to suitable, available cropland to spread manure.

When posed with the question, "What were the largest barriers to implementing your CNMP changes on your farm?" the most common response was "land" (41 percent).

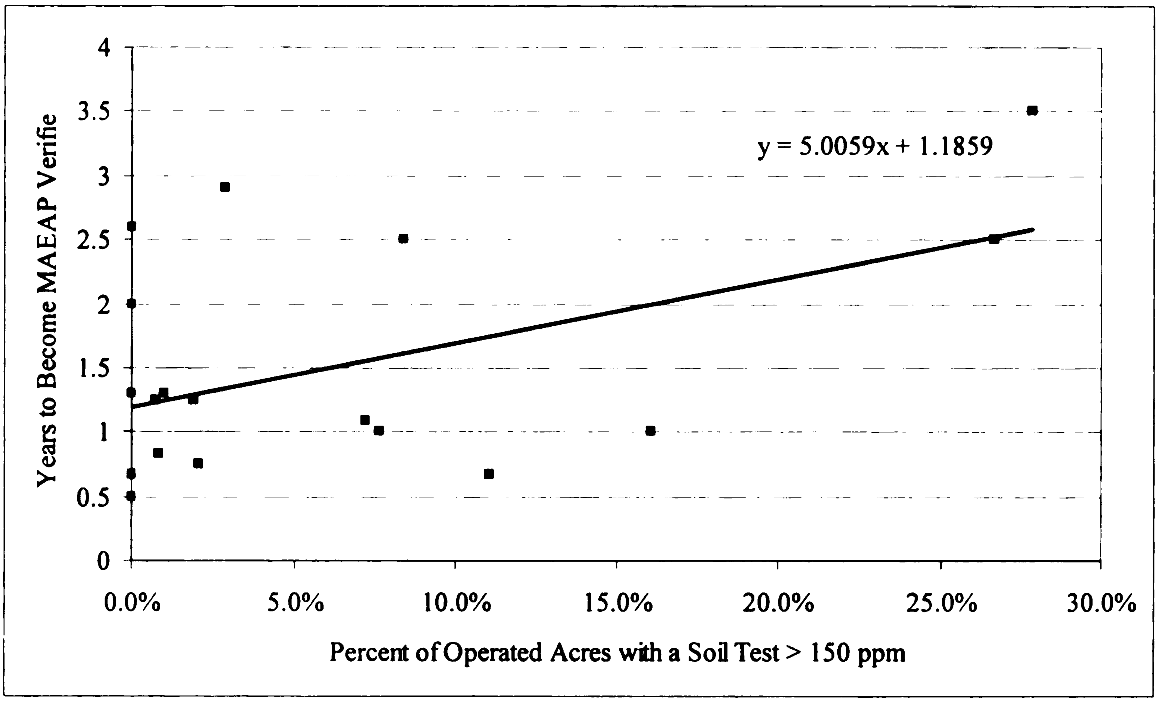
Other responses included time (28 percent), inconsistency among agency staff (28 percent), and the need for more manure storage (14 percent). The different land components are explained in section 4.5, *Barriers to Implementing the CNMP*, and can be identified in more detail in shaded section of Table 7.3. Of the four components, available land base to spread manure was most often mentioned when listing the barriers to implementing the CNMP. Often, previous to MAEAP verification, the operator did not consider manure's nutrient composition when spreading manure; this omission allowed the livestock producers to spread manure repeatedly on the same fields. Spreading manure on a growing crop was also a difficulty for many operations. Crop rotation, time restraints, and location of the field were many of the reasons that limited this practice.

Table 7.3: Percent of Producers that Identified Elements of Land Components as a Barrier to Implementing the CNMP

	Beef	Dairy	Poultry	Swine	Total	CAFO	AFO
	Percent						
Land components	100	30	50	33	41	50	31
Land base	33	30	50	33	34	50	15
Manure book values	67	0	25	17	17	13	23
Crop rotation	33	10	0	8	10	19	0
Driving distance to spread manure	0	0	25	8	7	13	0
N	3	10	4	12	29	17	12

After examining 19 of the 25 CNMPs that had soil analysis available for all operated acres, there were only seven operations that had five percent or more of their operated acres that tested above 300 pounds of phosphorus per acre (Figure 7.4). As the percentage of acres unavailable for manure application due to high soil phosphorus test levels increased, the length of time it took the operation to become MAEAP verified was lengthened.

Figure 7.4: Number of Years to Become MAEAP Verified in Relation to the Percent of Acres with a Soil Test Value Above 300 Pounds of Phosphorus per Acre



Upon examining the number of livestock producers that must travel further to spread manure as a result of following their CNMP, ten of the 31 operations needed to have manure spread from one to 12 miles further to ensure manure was spread at agronomic rates. This increased distance often added to the operators' fuel, equipment usage, and labor costs. The largest barrier to becoming MAEAP verified was perceived to be the proximity to suitable, available cropland to spread manure. After interviewing 29 livestock producers that were MAEAP verified, proposition number eight, which states the largest barrier to become MAEAP verified was the proximity to suitable, available cropland to spread manure, was supported by the data.

Proposition 9: More manure was spread according to agronomic needs after a farm became MAEAP verified than before verification.

Many producers did not have enough information before writing their CNMP to understand they were over-applying manure in some fields. Twenty producers increased the amount of soil and/or manure tests they have taken regularly as part of verification. With the increase in soil and manure nutrient tests, producers were more informed about the nutrient details of their farm.

Eighty-six percent of the 31 MAEAP-verified producers interviewed agreed that becoming verified through MAEAP helped them become better stewards of the land. For example, producers have decreased the potential for phosphorus runoff from fields by not spreading manure on soil that tests above 300 pounds of phosphorus per acre (150 ppm), which was a requirement in the CNMP for MAEAP verification.

The P-Index score, which relates directly to the source and transport of phosphorus on each field, was also decreased due to the changes made for MAEAP verification. The 12 high risk operations decreased their P-Index score by an average of 4.0. Additionally, 11 producers spread less commercial phosphorus and/or nitrogen. Data support proposition number nine; more manure was spread according to agronomic needs after a farm became MAEAP verified.

7.3 Summary

Although no formal hypothesis tested occurred in this thesis research due to the small sample size, several propositions were supported or refuted by the data. It was found that liability and regulatory risk was the largest motivator to initiate livestock producers to become MAEAP verified. The largest barrier to implement the CNMP was not a specific capital investment, but rather the amount and proximity of available cropland to spread manure. Additionally, MAEAP-verified operations were spreading more manure according to agronomic needs, after attending a MAEAP educational seminar and implementing the changes required for verification.

An operation seeking MAEAP verification made more changes linked to management rather than capital investments. The producer plus taxpayer and the producer cost of the managerial changes were greater than the costs related to capital investment changes, although no management changes were eligible for EQIP cost-share funds. The amount of financial assistance (i.e., EQIP cost-share) an operation received was associated ($r = 0.59$) with the increased cost of capital investments implemented for pollution prevention.

It was expected that the costs associated with MAEAP verification were not proportional to the gross farm revenue of the operation. However, it was determined, through producer-reported data that, in fact, the producer's costs were proportional to the operation's gross farm revenue. This proportionality included the EQIP cost-share operators received. On a per animal unit basis, the average annual cost a producer paid to become and maintain MAEAP verification has decreased over time. The producer cost to have the CNMP written has remained nearly the same over the four-year timeframe.

Chapter 8: Summary and Conclusions

8.1 Summary

Nutrient management has become increasingly important for Michigan livestock producers. The challenge for producers has been to reduce their operation's environmental impact and to manage farm nutrients in an environmentally sound manner, while at the same time maintaining economic viability. In 1998, a voluntary program, the Michigan Agriculture Environmental Assurance Program (MAEAP), was created by multiple Michigan industry, university, and governmental agencies to assist livestock producers with their nutrient management. MAEAP verification occurs after the Michigan Department of Agriculture (MDA) verifies that the farm has an accurate and complete Comprehensive Nutrient Management Plan (CNMP) and that the producer has or will implement the pollution prevention practices or improvements presented in the CNMP.

To determine the effectiveness of MAEAP, interviews were conducted with MAEAP-verified farm operators. These operations were not representative of all Michigan farms, as this set only included livestock producers that were MAEAP verified, or nearly MAEAP verified, as of January 1, 2005. The 29 livestock operators interviewed in this research represented 63 percent of all MAEAP-verified livestock operators. The interviews gave researchers a better understanding of the magnitude and incidence of specific costs associated with the record keeping, plan writing, managerial changes, and capital investments required to implement and maintain MAEAP verification. Farm-specific CNMPs were collected and analyzed to determine the environmental changes that resulted from MAEAP verification on specific operations.

This thesis research examined three questions. First, what were the barriers faced by and motivations of the livestock producers who became verified in the voluntary, education-based program? Second, what costs were incurred by those operators who had become verified under MAEAP? Finally, what environmental impact did MAEAP verification have on the phosphorus mass balance and phosphorus index of those MAEAP-verified operations? This thesis research was original in that neither farm-level financial, nor environmental impacts associated with MAEAP verification were undertaken by previous evaluations (Farrell, 2002 and USDA-NRCS, 2003).

8.2 Review of Research Findings

The first research question examined the barriers and motivations livestock producers faced when becoming MAEAP verified. The largest barrier for the majority of operations (41 percent) was the availability of land for manure spreading, whether it was associated with the amount of cropland, phosphorus levels on the land, crop rotations, or driving distance. Financial stress was not identified as a strong barrier. It should be noted, however, that 74 percent of the producers interviewed received cost-share funds to help pay for their CNMP, and 28 percent received cost-share funds to help pay for their capital investments.

While 58 percent of producers interviewed in this research became verified because of their expectations with respect to regulations affecting their size or type of farm, all of the 29 producers agreed that they would maintain and update their CNMP. The positive feedback and desire to maintain and update their farm-specific CNMP suggested that producers should maintain the management scheme changes that already had been made and will update the CNMP to follow new laws and regulations. Neither a concern about the drinking water on the farm nor a landlord or agricultural lender encouraging or requiring a CNMP motivated livestock producers (N = 0) to become MAEAP verified. It was surprising that 1) more time dedicated to farm management, 2) insurance discounts, and 3) community awareness motivated few producers (3, 6, and 13 percent respectively).

The second research question examined the costs incurred by livestock operators to achieve MAEAP verification. Results indicated by the average producer spent $104,423 in total or $14,709 annually on capital investments and managerial changes to maintain MAEAP verification. At the same time, some producers revealed that verification resulted in a modest savings that offset these costs. The savings were realized through the use of less commercial fertilizers ($2,792 annually) and insurance discounts ($61 annually), but the savings did not, on average, exceed the annual cost of the capital investment and management changes ($14,709). The largest average cost incurred was for the addition of phytase to swine and poultry diets (phytase enables swine and poultry to digest phosphorus more efficiently, excreting less phosphorus in the manure), at an average annual cost of $4,022.

Livestock producers who applied for MAEAP verification were eligible for cost-share assistance through the Environmental Quality Incentive Program (EQIP), distributed by the Natural Resources Conservation Services (NRCS). The average total cost-share funds given to the interviewed operators through EQIP, including the opportunity cost of free CNMPs was $16,177 or $790 each year. Eighty-five percent of the small and medium operations, AFOs[30], received some form of cost-share to assist

[30] An AFO produces fewer than 1,000 animal units annually, while a CAFO produces more than 1,000 animal units. One animal unit is the same as: 1 feeder calf, heifer, or steer; or .7 mature dairy cow (whether

with the cost of writing the CNMP or adding specific capital investment changes[31]. On average, AFOs received $113.07 per animal unit to assist with the costs, while CAFOs received an average of $7.10 per animal unit. Even with the substantial amount of cost-share received per animal unit, AFOs on average, paid $12.11 per animal unit per year to become and maintain MAEAP verification. CAFOs paid only $3.75 per animal unit per year for verification.

The average producer spent $7.53 per animal unit annually, and used 0.76 percent of their annual gross farm revenue to become MAEAP verified. Poultry operators spent the most money per animal unit annually ($12.89) to become MAEAP verified followed by the beef producers ($9.71), swine producers ($6.16), and dairy producers ($5.97).

The third research question regarding the environmental impact of MAEAP on the phosphorus mass balance and phosphorus index of MAEAP-verified operations revealed that verified operations did reduce their phosphorus pollution potential. Ninety-two percent of 25 operations surveyed were in mass balance after they became MAEAP verified. With operations in mass balance, the potential phosphorus build up in the soil on these farms was diminished. The 12 high risk operations had a P-Index score above the threshold (18) before they became MAEAP verified. As a result of implementing additional agronomic field management practices and reducing the amount of field erosion, these high-risk livestock operations reduced their field P-Index score average to below 15. The P-Index score of these operations, after becoming MAEAP verified, was

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a milking or dry cow); or 25 swine weighing over 55 pounds; or .5 horse; or 10 sheep or lambs; or 55 turkeys; or 100 laying hens or broilers when the facility has unlimited continuous flow watering systems; or 30 laying hens or broilers when facility has liquid manure handling system (MDEQ, 2005).

[31] Capital investments that were eligible for EQIP cost-share funds included: manure storage, drainage, gutters, fences, buildings, roofs, grass waterways, buffers, and drives/berms.

below the threshold, which indicated that a low risk of phosphorus runoff potential from a field had been achieved.

Interviews with livestock producers who implemented the CNMP also provided some additional noteworthy insights. The impression gained by the interviewer from the producers was that the producers believed there were some intangible benefits that accompanied MAEAP verification. For example, several producers felt that they were making a difference in their community, in the environment, and across the state by becoming MAEAP verified. Many producers wanted to help their colleagues understand the benefits to environmental stewardship. Nearly all producers (86 percent) stated that they would have become MAEAP verified without EQIP cost-share funds, but the "money certainly helped lower the financial strain." Some producers stated that they were more motivated by how they could make their operation more efficient and productive due to MAEAP verification. Many of the operators began the MAEAP verification process before the current regulations were in place, however, some were disgruntled with the "moving target" they were required to attain. A few operators thought a legislative change would be appropriate so that, if a lawsuit was filed against a MAEAP-verified livestock producer, the person bringing the suit would be responsible for paying for legal fees, should the livestock producer win the case.

8.2 MAEAP's Effectiveness

MAEAP has not been growing rapidly in numbers of verified producers. There are 53,315 farms (USDA-NASS, 2002) in the state and over than 200 MAEAP-verified operations (Wilford, personal communication, January 2006). However, the first phase of MAEAP verification, the education portion, has had over 4,500 participants since

2001. Many of the changes implemented on an operation were due to an increased knowledge and understanding of agronomy, water flow, record keeping, animal management, and environmental regulations. It is possible that environmental stewardship could be increasing all over the state regardless of the number of verified operations, because of the number of livestock operators attending the informational sessions. MAEAP's additional verification phases increases the probability that the knowledge gained from the informational sessions is implemented.

Also, there was a decreased risk of phosphorus runoff on the high risk operations and nearly all operations were in cropland mass balance after they became MAEAP verified. Environmentally, MAEAP has had an impact, but on a small scale. Perhaps the addition of the Progressive Planning[32] initiative will involve more livestock producers in pollution prevention. As of December 31, 2005, there were 218 livestock producers that had signed up for this new initiative (Wilford, personal communication, January 2006).

8.3 Policy Enhancement and Development Influencing MAEAP

Increasing environmental quality can be stimulated via larger benefits for pollution prevention accruing to the participants or by increased mandatory regulations. From the information collected from the MAEAP-verified livestock producers, CNMP plan writers, and MAEAP administrators, it was found that some regulations and policies affecting the CNMP organization and MAEAP effectiveness could be improved.

[32] MAEAP Progressive Planning was introduced January 1, 2004 as a formal method to "enroll" in MAEAP, or begin the process of MAEAP verification. Each producer works with a partner to help act as a clearinghouse of information, assist in any resource needs, and answer any questions that arise during the verification process. A schedule is developed by the producer and his/her partner to assist the livestock producer in reaching specific goals to complete his/her CNMP and with the ultimate goal of becoming MAEAP verified.

8.3.1 Comprehensive Nutrient Management Plan Order and Calculations

If the CNMP is to be a producer-friendly document, referred to for daily or weekly nutrient management assistance, then the format of the CNMP needs to be adapted slightly to meet livestock producer needs. The CNMP has a list that easily identifies what information should be included under each topic area, (Appendix E). A livestock producer should be familiar with all the information in their farm-specific CNMP; however, much of the practical information that livestock producers need is obscured by the technical information. A more accessible document would have the practical information commonly used by livestock producers, such as field data and spreading recommendations, could have its own separate binder for on-farm use or a specific section at the beginning of the CNMP. The CNMP components could remain the same following the producer-specific section.

If enforcement or impact research is to be accurate, both from an NPDES permit and MAEAP prospective, then the CNMPs need to evaluate animal units, soil tests, MARI, and RUSLE2 calculations using consistent methods. Currently, animal units can be measured using actual weights, noses, or an older version of book values. One method should be chosen based on scientific research and accuracy. Also, the Bray P-1 test has been proven to give inaccurately low P values on many calcareous soils (Sawyer & Mallarino, 1999). The imprecision of the Bray P-1, on Michigan's calcareous soils could lead to inaccurate agronomic advice. To eliminate inaccuracy in determining the soil phosphorus level and P-Index variables the Mehlich-3 test could be used (Appleby, personal communication, October 2005).

8.3.2 Increased Benefits for MAEAP Verification

In 2008, there will be no regulations motivating CAFO operators to become MAEAP verified because permits will be mandatory. If MAEAP wants more small and medium operations to become verified, then there may be need to increase the benefits received after an operation becomes MAEAP verified or an increase in costs for those operations that do not become MAEAP verified, unless these producers feel they can avert future regulation by being proactive. Under a voluntary approach, economic theory suggests that a livestock producer will not participate unless his/her payoff is at least as high as it would be without participation, i.e., the producer must perceive some gain (or at least no net loss) from participation (Alberini & Sergerson, 2002). Increased benefits could include an increased preference to MAEAP-verified operations for EQIP cost-share funding or additional nuisance litigation protection. Increased costs for those operations not becoming verified could be linked to increased membership dues for species-specific trade organizations (i.e., Beef Producers Council and Michigan Milk Producers Association) or lenders requiring a CNMP for agricultural loans.

8.3.3 Targeting Finances to Critical Source Areas

"Overall phosphorus management strategies will reduce phosphorus export [from fields] most effectively when targeted to critical source areas in a watershed that are most vulnerable to phosphorus loss" (Sharpley et al., p. 2, 1999). Targeting money to the operations with direct and/or chronic pollution discharges to increase environmental stewardship would be more cost effective, than widely spreading money among the many operations that need assistance for pollution prevention activities. A cost effective method of targeting would be to focus MAEAP on priority areas and then priority farms within those areas (Batie, 1994). If MAEAP and EQIP were to target higher animal density areas, polluted watersheds, or critical watersheds then, more cost effective pollution prevention could result. Currently, MAEAP does not target operations and the NPDES permit is targeted only at those operations that have above a specific number of animal units or which have previously had a discharge. CAFOs may offer a larger potential pollution problem due to their size; however, any size of operation could have a chronic and/or acute discharge into surface water. Given a pool of willing participants, information on the operation (i.e., soil quality in fields to be enrolled and farms' proximity to surface water) could be used to assess potential environmental benefits if the operation became MAEAP verified. Environmental indices, like the Environmental Benefits Index (EBI) or phosphorus index, could then be used to efficiently rank the operations (Catteneo, Claassen, Johansson, & Weinberg, 2005).

8.3.4 Environmental Quality Incentive Program Portfolio

If EQIP cost-share is going to affect cash flow and improve environmental quality, then the NRCS needs to evaluate the portfolio of capital and managerial investments covered through EQIP cost-share funds. The largest annual expenses livestock producers incurred, according to this research were fuel to haul manure further or incorporate manure ($4,022), feed additives ($3,089), and manure storage ($1,678). Manure storage was the only cost, of the three mentioned, that was eligible for EQIP cost-share. To assist more livestock producers in saving money, it would be ideal if cost-sharing also covered some managerial changes. Equipment to incorporate manure along with feed additives and diet changes could assist the producer in becoming more efficient and increase environmental stewardship. Phytase and other feed rations that reduce the amount of phosphorus in manure also help the producer in possibly lowering the fuel and equipment use as a larger amount of manure could be applied to a field, while still maintaining the same P_2O_5 rate per acre. NRCS evaluates its portfolio of EQIP-eligible investments each year but, currently financial assistance supports only those operations that implement one of the few eligible capital investments rather than changing the management practices.

8.3.5 Manifests

Animal density is a huge concern in several counties throughout Michigan. The increasing trend towards intensive animal operations on relatively small area of land could lead to nutrient applications on cropland in excess of crop requirements and the subsequent buildup of phosphorus in the soils (Maguire & Sims, 2002). If manure application was limited to not exceed the soil nutrient capacity of the acres within a geographic area, then all sizes of livestock operations in that area must indicate where their manure would be spread. If the manure is sold off-farm, then the manure buyer must indicate what he/she will do with the manure. This increased transparency as to the fate of animal wastes would help eliminate any geographic areas that exceeded its nutrient capacity. This policy would be similar to the "manifest" that will be required, beginning in 2007, by all operations with a general NPDES permit. MAEAP could apply the "manifest" to farms within a targeted geographic area. The end use of manure is vital to ensuring agronomic applications are being adhered to throughout the state, irregardless of the size of operation that produced the manure.

8.4 Limitations of this Study

Although this study examined many variables linked to the effectiveness of MAEAP, there were some calculations that that were limited in size, scope, and detail, several variables that were not captured, and variables that could have been misrepresented by the interviewee. The number of livestock producers that met the sample criteria was few, only 46. A larger sample size over a longer period of time would have allowed more statistical analysis to be conducted. The infancy of the program also limited the amount and integrity of trend analysis.

There were some environmental outcomes not captured well or at all in this research, such as barnyard management, field drain tiles, habitat management, and the trade off between incorporating and knifing manure. As indicated by the 2005 Hively study, barnyard management can be a large contributor of phosphorus runoff on an operation, but the calculation of this contribution was beyond this study.

One measure of environmental change that was captured in this research was the field specific phosphorus index. However, the phosphorus index used in this study is still being developed for the state of Michigan. Thus, the acceptable P-Index threshold, 18, may not be accurate, as the index has not been formally field tested yet. This P-Index may have overlooked several variables such as irrigation, spreading setbacks observed, or manure texture and may not weight variables appropriately as some contribute to a larger vulnerability to phosphorus transport than others. Additionally, if a field had a soil phosphorus level above 150 ppm, but had a transport score of zero, the transport of excess phosphorus into surface water would be severely limited. However, due to the organization of the P-Index the field may still exceed the threshold and thus the implication is that no additional phosphorus should be applied. Although the index used in this study may not be the index adopted by Michigan, it was the best agreed upon P-Index by a group of Michigan manure management specialists, soil scientists, and CNMP plan providers.

The research was conducted via personal interviews; humans are limited in their ability to process all relative information. Thus, some costs could be the perceived or remembered amounts instead of actual costs incurred. Some operations took three years to become verified and within those years many changes occurred. Some history may have been lost as an operator may not have been able to sum up all changes made due to MAEAP verification during the sometimes long verification process. Operators may have made investment or managerial changes based on education they received through MAEAP, but these changes may not have been required for verification. Much of the information collected was not documented on paper by the livestock producer; thus, the livestock producer's estimates were used. Any information collected during the interview was taken as truth; therefore, some of the information used in this research could have been exaggerated or discounted.

Evaluating MAEAP environmental outcomes and cost analysis should have occurred using a "with and without" framework rather than a "before and after" framework. The "with and without" framework would have held constant variables that may have influenced the phosphorus balance outcomes, whereas the "before and after" could not. Several variables that may have influenced the "before and after" phosphorus balance changes included regulation changes, additional education, input cost fluctuations (i.e., fuel, feed, or labor), EQIP cost-share funding, or technology advances.

These variables would have been difficult to hold constant overtime for this study, yet they could have altered the producers' decision making process regarding MAEAP, as well as the producer's capital investment or managerial practices. These variables could have caused correlation between two other variables (i.e., spurious correlation) (Burns, 1997). Evaluating a program using the "before and after" framework lends itself to spurious correlation, because the statistical relation could have been initiated by a third unrelated variable (Burns, 1997). Nevertheless, a "before and after" framework was used to proxy the "with and without" MAEAP verification context because the unknown variables that could have caused some of the changes or encouraged verification could not be pinpointed and/or estimated. Due to the proxy, the changes that would have occurred if the regulations, education level, inputs, cost-share, or technology would not have changed were not captured.

8.5 Recommended Future Research

From the research conducted in this study and the limitations drawn, there are several studies that would add to the evaluation of MAEAP in the future. Additional research focusing on the education and environmental implications of MAEAP could help determine what level of benefit MAEAP has compared to the NPDES permit or no CNMP. The environmental impacts of the barnyard would add greatly to the risk assessment of an operation and the amount of runoff reduced due to MAEAP-required changes. Identifying who should receive financial benefits for cost-effectiveness could assist MAEAP administrators in using resources more accurately.

Three types of operations: 1) operations seeking MAEAP verification; 2) operations seeking an NPDES permit; and, 3) operations seeking neither (i.e., the control group), would need to be evaluated to accurately assess the level of environmental stewardship change over time, the affect of the educational phase MAEAP requires, and motivation for choosing the environmental path. This type of analysis would indicate what level of environmental stewardship the MAEAP-verified operations had in place before any CNMP changes were implemented. It could then be determined how the operation's environmental stewardship changed and how the education affected the three types of operations. Those livestock participants not becoming verified could give more insight about the level of change in environmental stewardship, benefits, perceived costs, and barriers. The livestock producers that chose not to participate in MAEAP would offer a different perspective about the perceived benefits or lack of benefits that prevent producers from becoming MAEAP verified. This sample population could also indicate what areas MAEAP could improve to increase the number of MAEAP-verified operations and ultimately its effectiveness.

Evaluating several farms in the process of seeking MAEAP verification with more detail, beginning with before an operation became MAEAP verified and ending several years after the operation acquired MAEAP verification, would increase the accuracy of the environmental benefits, costs incurred, and efficiencies gained due to MAEAP verification. Analyzing an operation on a field by field basis would lead to a detailed assessment of the field and whole-farm phosphorus runoff potential. The impact of incorporating or surface applying manure; observing set-backs; planting grass waterways, cover crops, buffers, and filter strips could add depth to an evaluation of MAEAP's environmental outcomes, as well.

Currently, there is no widely accepted method to calculate the environmental change of the barnyard (i.e., lagoons, driveways, roofs) (Hively et al., 2005). Capturing the environmental outcomes of the barnyard management changes made for MAEAP verification would add depth to this research and any other research focusing on the environmental impact of programs such as MAEAP or the NPDES permit. An index or model used to measure the risk of pollution from the barnyard would increase the exactness of this environmental analysis on an operation that implemented barnyard changes.

Financial and technical incentives were not mentioned as a strong motivator to become MAEAP verified. If MAEAP administrators want to know to whom to target the financial incentives and benefits then, the characteristics of those operators that obtain EQIP cost-share funds, insurance discounts, low interest loans, and other financial opportunities due to MAEAP verification need to be examined. Some characteristics that might need to be considered include geography, income level, age, number of animal units, number of acres, previous enrollment in environmental programs (e.g., Pork Producers Environmental Assurance Program, CSP, or CRP), type of species produced, insurance carrier, changes made due to MAEAP verification, and total cost of verification. After identifying the need for and desire to seek financial assistance, additional incentives should be implemented.

One such example of financial assistance that is linked to the adoption of a voluntary program exists in Switzerland. In order for the Swiss livestock producers to receive their government payments, they must cross-comply with the country's environmental program. They can choose to not adopt the program, but if the environmental program is not adopted, the Swiss livestock producers do not receive any form of government payments. It would be interesting to link a voluntary environmental program, such as MAEAP, to state or federal programs (i.e., CRP, CSP, CREP, crop payments). MAEAP could be linked with the Conservation Security Program (CSP) for example. Livestock producers that have completed MAEAP verification could receive an extra payment, if the farm operation was in the CSP watershed. CSP payments are based on the number of points an operation accumulates; MAEAP verification could be considered as one or several points. Payments designed to reward producers who are already good environmental stewards will limit the cost-effectiveness of achieving new environmental benefits (Catteneo et al., 2005), but may complement other programs, such as CSP, that target regions or producers with a high potential for environmental improvement. Increased payments could also be given to those operations that have multiple systems verified with MAEAP (i.e., cropping, homestead, and livestock).

APPENDIX A: Calculating Animal Units: Following Criteria from Permit MIG 010000
Compared to those criteria of the General Permit MIG 440000 (MDEQ, 2005)

The following table explains the methods used to calculate the number of animal units on an operation. Column A is used to calculate animal units for the general CAFO permit on existing farms from December 2002 through December 2007. This column uses the average body weight of a group, if the weight is not estimated or known, then the number of animals in that group can be multiplied times the number indicated. If the total number of animal units from the entire column sum to over 1,000 the operation is considered a CAFO (see the example at the bottom of Column A).

Operators that are building new operations between February 2004 and April 2009 should calculate the number of animal units according to Column B, using the permit MIG010000 standards. This method of calculating animal units does not sum the entire column, but if one group (e.g., cattle or mature dairy cattle) has a total number of head that sums to more than the indicated number then that operation is considered a CAFO (see the example at the bottom of Column B). This column is based on number of head rather than average or estimated weight. Under the new permit, MIG010000, one animal unit is the same as: 1 feeder calf, heifer, or steer; or .7 mature dairy cow (whether a milking or dry cow); or 25 swine weighing over 55 pounds; or .5 horse; or 10 sheep or lambs; or 55 turkeys; or 100 laying hens or broilers when the facility has unlimited continuous flow watering systems; or 30 laying hens or broilers when facility has liquid manure handling system. (MDEQ, 2004)

Animal Sector	Column A:	Column B:
	ECOS MAEAP option and General Permit MIG440000	**Permit MIG010000: New source and Large CAFO**
	Dec. 2002- Dec. 2007	**Feb. 2004 – Apr. 2009**
	The threshold number of head it takes based on animal units, to be at 1000.	**Calculated based on head, not animal units, and groups are not added.**
	Blank columns indicate a group is not defined for that permit.	
Beef: mature or feeder	1,000; each animal = 1	
Cattle: heifers, steers, bulls, cow/calf pair		1,000
Veal		1,000
Mature Dairy Cattle	700; each animal = 1.4	700
Swine over 55lbs.	2,500; each animal = 0.4	2,500
Swine under 55 lbs.		10,000
Horses	500; each animal = 2	500
Sheep and lambs	10,000; each animal = 0.1	10,000
Turkeys	55,000; each animal = 0.02	55,000
Laying hens or broilers (continuous overflow watering)	100,000; each animal = 0.01	
Laying hens or broilers (liquid manure)	30,000; each animal = 0.03	
Laying hens or broilers (liquid manure handling)		30,000
Chickens other than laying hens, includes pullets (other than liquid manure)		125,000
Laying hens (other than liquid manure)		82,000
Ducks	5,000; each animal = 0.2	
Ducks (other than liquid manure)		30,000
Ducks (liquid manure)		5,000
All other (e.g., pullets, heifers, veal)	1 lb of body weight = 1 A.U.	

	Total animal groups, <1,000 not a CAFO, >1,000 is a CAFO	Groups are not additive. If any group is > its specified number, it is a large CAFO
Example: 600 mature dairy cows and 600 replacements averaging 850 lbs.	600 young stock x 850 lbs. ÷ 1000 = 510 A.U. + 600 mature x 1.4 = 840 A.U. = 1350 A.U. YES, a large CAFO.	600 young stock is less than 1000. 600 mature cows is less than 700, these groups are NOT added. NOT a large CAFO.

APPENDIX B: NPDES General Permit (MIG440000)
(MDEQ, 2005)

PERMIT NO. MIG440000

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
GENERAL PERMIT

CONCENTRATED ANIMAL FEEDING OPERATION

PART I

Section A. Water Pollution Control Requirements and Limitations

3. Manure and Wastewater Storage Structures
The permittee shall have large CAFO waste storage structures in place and operational that are designed, constructed, maintained and operated to contain the total combined volume of all of the following:

a. All process wastewater, production area wastewater and manure resulting from the operation of the CAFO generated in a six-month time period or other time period as defined by the United States Department of Agricultural Natural Resources Conservation Service (NRCS) standards (including normal precipitation and runoff in the production area during the same time period);
b. All production area waste from a 25-year 24-hour rainfall event. The magnitude of the 25-year 24-hour storm event will be specified in the certificate of coverage; and,
c. In addition to a. and b. above, manure and wastewater storage structures shall include additional design capacity equal to the freeboard requirements in NRCS Conservation Practice Standard N. 313, Waste Storage Facility.

The discharges in Part I.A.1.a. are not authorized unless the permittee is in full compliance with the requirements of this Part, Part I.A.3.

APPENDIX C: Plan Writer Cover Letter, Survey, and Results

Plan Writer Cover Letter

October 22, 2004

Dear Comprehensive Nutrient Management Plan (CNMP) provider,

You were identified as being a certified CNMP writer by the Michigan Department of Agriculture. We would like to enlist your support in a Michigan Agriculture Environmental Assurance Program (MAEAP) survey we are conducting to learn more about livestock producer experience with nutrient management. This study is designed to gain knowledge from your experience with writing CNMPs for livestock producers.

The information gathered in this survey will be used to help design livestock producer surveys relating to CNMPs. We want to ensure the questions we ask livestock producers are both relevant and necessary to learn about the financial and environmental implications of nutrient balancing using MAEAP, NRCS and/or DEQ CNMPs.

Your voluntary participation in this survey will take less than thirty minutes. To consent to participation you need only complete and return this three-page survey in the accompanying postage paid envelope. Please note you are free to decline to answer the questionnaire or specific questions without penalty, if you choose. If you wish to comment on any questions, please feel free to use the space in the margins. We will keep your responses from this survey in strict confidence. Your privacy will be protected by the maximum amount allowable by law.

If you have questions about the study, contact Christopher Wolf at 517-353-3974 or wolfch@msu.edu. If you have any questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact - anonymously, if you wish - Peter Vasilenko, Ph.D., Chair of the University Committee on Research Involving Human Subjects (UCRIHS) by phone: (517) 355-2180, fax: (517) 432-4503, email address: ucrihs@msu.edu, or regular mail: 202 Olds Hall, East Lansing, MI 48824.

Thank you for considering this request.

Sincerely,

Dr. Christopher A. Wolf

Department of Agricultural Economics

Michigan State University

(517) 353-3974

Plan Writer Survey

From your experience in writing Comprehensive Nutrient Management Plans (CNMPs), we would like to gain insight to your and producers' difficulties, attitudes and costs when writing and implementing a CNMP. This information will be applied to producer surveys and interviews to ensure these are more accurate and complete. All of the information you share will be confidential. Thank you for your help in answering the following questions.

1. How long have you been writing CNMPs? _______
2. How many CNMPs have you written and signed? _______
    a. How many are started that are not complete? _______
    b. How many resulted in MAEAP verification? _______
    c. How many are in process that are not yet signed? _______
3. Do you specialize in a specific type of farm? _______ If yes, which type(s)? _______
4. What other services do you provide (i.e., rental agreements, soil testing)? _________
5. Who have you called with questions regarding CNMPs? ____________________
6. Who have you called with questions regarding MAEAP? ____________________
7. What, in general, are the most common areas of increased cost to a livestock producer after implementing all phases of a CNMP? ______________________________
8. What, in general, are the most common areas of savings to a livestock producer after implementing all phases of a CNMP? ______________________________
9. What commonalities (i.e., age, number of acres, and type of farm) do you see in the livestock farms or producers you write CNMPs for? ______________________________

10. Please rank the importance of issues a typical livestock producer needs to address to have an approved CNMP? (1 very important to 4 not important)

	1	**2**	**3**	**4**
Adding eves to barns	□	□	□	□
Installing a catch area for silage leachate	□	□	□	□
Proper winter manure spreading	□	□	□	□
More accurate and comprehensive soil testing	□	□	□	□
Implementing manure testing	□	□	□	□
Properly disposing of parlor wastewater	□	□	□	□
Changing/adding manure storage	□	□	□	□
Adding land to spread manure on (high animal density)	□	□	□	□
Changing their attitude towards advice and advisors	□	□	□	□
Changing their attitude towards the environment	□	□	□	□
Informing their neighbors of spreading times	□	□	□	□
Informing their neighbors of environmental stewardship	□	□	□	□
Paying for the CNMP implementation	□	□	□	□
Other________________________	□	□	□	□

11. What percent of the livestock farms that you have written (are writing) CNMPs for involve the following changes?

	100-75%	**74-50%**	**49-25%**	**24-0%**
Record keeping	□	□	□	□
Manure testing	□	□	□	□
Water testing upstream	□	□	□	□

Spreading				
Less winter manure spreading	☐	☐	☐	☐
Inject manure	☐	☐	☐	☐
Incorporate manure	☐	☐	☐	☐
Calibrating spreaders	☐	☐	☐	☐
Observe setbacks – using buffers	☐	☐	☐	☐
Haul manure further (even spread on fields)	☐	☐	☐	☐
Spreading agreement with local land owner	☐	☐	☐	☐
Storage				
Add manure storage	☐	☐	☐	☐
Account for freeboard	☐	☐	☐	☐
Manage leachate with holding tanks	☐	☐	☐	☐
Fields				
Reduce commercial fertilizer	☐	☐	☐	☐
More frequent soil testing	☐	☐	☐	☐
More accurate soil testing	☐	☐	☐	☐
Monitor tiled fields' drainage	☐	☐	☐	☐
Test tiled field drainage (at end of pipe)	☐	☐	☐	☐
Manage leachate with filter strips	☐	☐	☐	☐
Increase acreage – rent more land	☐	☐	☐	☐
Increase acreage – buy more land	☐	☐	☐	☐
Lots/Pasture				
Add grass to qualify as pasture	☐	☐	☐	☐

Add drains to collect runoff	□	□	□	□
Roof over a lot to deter runoff	□	□	□	□
Roof water kept clean	□	□	□	□
Other changes________________________	□	□	□	□

12. What is the cost to a livestock producer for (a range is adequate)

Reducing commercial fertilizer $______________

Changing feed ration $______________

Having a plan written $______________

Implementing a plan $______________

13. What does the price you charge for a CNMP depend on? Check all that apply.

□ Farm size (acreage)

□ Farm size (number of animals)

□ Your time

□ Number of tests needed

□ Number of existing, potential water quality problems

□ Adequate farm records

□ Animal species

□ Other ________________

14. What records does the typical livestock producer keep before he/she has a CNMP?

____

15. What records does the livestock producer keep after a CNMP is implemented?

____

16. According to the type and size of the livestock farm and type of CNMP how much time does it take you to write a plan?

	Acres - crops	Livestock number & species	NPDES Permit	MAEAP	Time to write
Size of farm	400, grain/veg	1500 swine		X	30 hrs
Size of farm					
Size of farm					

17. Is there anything else you would like to share with us regarding the writing and/or implementation of a CNMP, your opinions on MAEAP or other information you think would be valuable to us as we interview producers in the next six months?

___

Plan Writer Results

Introduction

All Comprehensive Nutrient Management Plan (CNMP) plan writers that were certified in Michigan (26) as of September 1, 2004 were surveyed in the fall of 2004 to determine what questions should be asked of the MAEAP-verified livestock producers. The survey indicated how the cost of a CNMP was calculated, what changes typically needed to be made on an operation, any commonalities among MAEAP participants, and what cost savings the livestock producers might realize after they become MAEAP verified. This survey aided in the development of a larger survey targeted towards MAEAP-verified operations that took place in January and February of 2005.

Methods and Procedures

The CNMP Plan Writer Survey was conducted through a mail survey of 26 plan writers throughout the state of Michigan. All certified plan writers were selected for the survey since the number of plan writers was limited. The 2004 study did not include plan writers from other states that may have written a CNMP in Michigan, nor did it include any MAEAP program administers or committee members.

The survey questions were chosen to increase the researcher's knowledge about MAEAP-verified operations. The questions selected also addressed the changes an operator needed to adopt for the CNMP and what the costs and saving an operator might realize after fully implementing their farm-specific CNMP. Several Michigan State University faculty and MAEAP program administrators reviewed the questionnaire. Suggested changes were incorporated in the final version. Since the survey was designed to educate the researchers regarding livestock producers and the sample size was small, it was not field tested prior to use.

All 26 plan writers selected for the study were mailed a cover letter explaining the need for the study, the three-page survey, and a postage paid return mailer during the month of October. Of the 26 questionnaires mailed, 14 or 54 percent were completed and returned. This high response rate provided an accurate measure to ensure the questions asked of the livestock producers were relevant and necessary.

Results

The average plan writer surveyed had less than three years of experience writing CNMPs (Table 1). The few years of experience was expected, as certification requirements to write CNMPs was also recent. However, plan writers wrote plans for more operations than those operations seeking MAEAP verification. About one in three CNMPs written were for an operation seeking MAEAP verification. When asked about the average time it took to write a CNMP, the 14 respondents gave several scenarios, but the average was about 70 hours to write. These scenarios also revealed that the average farm seeking a CNMP, whether for MAEAP verification or not, had about 1194 acres. The average number of animal units could not be determined based on the varied answers reported.

Table 1: Plan Writers Average Experience (Years and Number of CNMPs)

	Years
Years of Experience	2.6
	Number of CNMPs
Number of CNMPs completed	9.4
Number of MAEAP CNMPs completed	2.7
Number of CNMPs currently writing	4.1

The time it took to write a CNMP and the acres an operator owned were the two largest variables that influenced the cost of the CNMP the most, 71 and 50, percent respectively (Table 2). The number of soil and manure tests that an operation needed to make also influenced the price of the CNMP (43 percent). To a lesser extent, the number of animal units, farm records, and existing or potential water quality issues also influenced the cost of the CNMP (36 percent). The number of operated acres on a farm may be correlated with the number of animal units, which may mean that both variables significantly impacted the price of the CNMP. The plan writers indicated that a CNMP could range in costs from $1,500 to $25,000; this range assisted in determining if a price noted by a livestock producer was on target with what the plan writers were charging.

Table 2: Percent of Plan Writers that Used Each Variable to Calculate the CNMP Price

	Percent
Your time	71
Farm size (acreage)	50
Number of tests needed	43
Farm size (number of animals)	36
Adequate farm records	36
Number of existing, potential water quality problems	36
Animal species	29

The CNMP cost only included the writing portion and did not include the costs of implementing the CNMP. Many of the changes listed in Table 3 required financial expenditure and while some required more management time. The plan writers surveyed indicated that implementing a CNMP could cost between $0 and $400,000, in total. As seen in Table 3, accounting for freeboard and additional recordkeeping occurred on over 75 percent of the CNMPs that the plan writers wrote. Manure needed to be hauled further from the manure production and storage site (barnyard) than before the operator implemented his/her CNMP (71 percent). Interestingly, more operations developed a spreading agreement with their local land owner (57 percent) than changed their manure application method to incorporation (45 percent) or injection (25 percent). These questions helped develop several cost questions to decipher what costs a producer incurred to become MAEAP verified.

Table 3: Percent of CNMPs that the Plan Writer Wrote that Implemented the Following Changes

	Percent
Account for freeboard	78
Record keeping	75
Haul manure further (to spread on fields)	71
Calibrating spreaders	69
Observe setbacks – using buffers	68
Manure testing	68
Reduce commercial fertilizer	64
Monitor tiled fields' drainage	62
More frequent soil testing	60
More accurate soil testing	59
Spreading agreement with local land owner	57
Manage leachate with holding tanks	53
Add manure storage	53
Roof water kept clean	50
Add drains to collect runoff	48
Incorporate manure	45
Less winter manure spreading	40
Increase acreage – rent more land	38
Roof over a lot to deter runoff	33
Increase acreage – buy more land	27
Inject manure	25
Manage leachate with filter strips	25
Add grass to qualify as pasture	23
Water testing upstream	16
Test tiled field drainage (at end of pipe)	14

The most important issues a plan writer believed a livestock producer needed to address to have his/her CNMP approved were also captured (Table 4). The plan writer rated the importance on a likert scale, 1 = very important, 2 = important, 3 = semi-important, 4 = not important. No issue received less than a 2.6; leading the researchers to believe that all topics were important for CNMP approval. The most important issues regarding soil testing and manure storage were also implemented by more than 50 percent of the operations, as explained in Table 3. The least important issue from the plan writers' perspective was informing the operation's neighbors of their environmental stewardship. One plan writer even commented that producers do not want publicity on their farm, thus the MAEAP sign signifying the operation was MAEAP verified was unnecessary and possibly not a large motivator. Different geographic areas may feel differently about the neighbor relations, also.

Table 4: Important Issues Typically Addressed for CNMP Approval (1 = very important, 2 = important, 3 = semi-important, 4 = not important)

	Score
More accurate and comprehensive soil testing	1.7
Changing/adding manure storage	1.7
Installing a catch area for silage leachate	1.9
Adding land to spread manure on (high animal density)	1.9
Proper winter manure spreading	1.9
Implementing manure testing	2.1
Changing their attitude towards advice and advisors	2.1
Adding eves to barns	2.1
Paying for the CNMP implementation	2.1
Properly disposing of parlor wastewater	2.3
Changing their attitude towards the environment	2.3
Informing their neighbors of spreading times	2.4
Informing their neighbors of environmental stewardship	2.6

All of the changes made on an operation had financial or time repercussions. When the plan writers were asked what were the most common areas of increased costs or savings a livestock operator incurred after fully implementing the CNMP, they responded succinctly. From Table 5, 57 percent of the plan writers saw manure and runoff storage as very common cost. It was not determined how much each variable listed would cost the producer. However, 71 percent or ten plan writers commonly saw a cost saving in commercial fertilizer due to implementing the CNMP. The amount of savings operators obtained from less commercial fertilizer ranged from $3,000 to $50,000. One plan writer thought producers could achieve a savings of about five dollars per acre.

Table 5: Costs Producers May Incur that are Associated with Implementing a CNMP

	Percent
Increased costs	
Manure and runoff storage	57
Reduced and/or applying runoff	29
Controlling silage leachate	21
Controlling milkhouse waste water	14
Decreased costs	
Commercial fertilizer	71

Conclusions

Developing and implementing the CNMP has a large cost range. It should cost the operator between $1,500 and $425,000 to develop and implement his/her CNMP. There could be a cost savings of up to $50,000 occurring from following the CNMP requirements and applying less commercial fertilizer. Two plan writers mentioned that EQIP cost-share money took a long time or was difficult to obtain to assist livestock producers in paying for some of their costs associated with their farm-specific CNMP.

The plan writers commented that additional manure tests, manure spreading, and soil testing records need to be kept up-to-date on the operation; the process of writing a CNMP would be much smoother with the added documentation. Plan writers felt that all producers need to receive more education on the items necessary and rules involved with CNMPs.

The CNMP plan writers that were surveyed provided valid and necessary information to develop the livestock producer survey. These responses along with additional field testing will be used to further develop the MAEAP-verified Producer Interview Questionnaire.

APPENDIX D: MAEAP Adoption Producer Interview Cover Letter, FAQ Page, and Questionnaire

MAEAP Adoption Producer Interview Cover Letter

February 1, 2005

Dear livestock producer,

I am Carrie Vollmer Sanders, a graduate student at Michigan State University. I grew up on a swine and cash crop farm in Ohio and am currently working on my thesis for my master's degree. I'm asking for your assistance in completing my thesis.

You were identified as having a verified Comprehensive Nutrient Management Plan (CNMP) for your farm. I would like to enlist your participation in a personal interview to learn more about your concerns about the MAEAP program, the costs of implementing a CNMP and the environmental improvements you anticipate once you have fully implemented your CNMP. My objective is to assess how the state of Michigan can improve MAEAP and other agricultural environmental policy development and implementation. These results will be shared with industry, policy makers in Michigan and Washington as well as other producers. This study will publish information in summary form so that findings will not be traceable to you or your operation.

Cash payment for your participation will be $50, upon completing the interview. If you will allow me to make a reference copy of your CNMP, which will be returned to you at the completion of the study, you will receive an additional payment of $100. Temporarily having a copy of your CNMP will help me analyze your operation's unique situation, make the interview move much more quickly and enable me to quantify MAEAP's environmental effects. The information gathered and your CNMP will be held in strict confidence.

I will contact you within the next week to set up a time to conduct the interview. Another colleague will take notes during our conversation to ensure I don't misconstrue your responses. When I meet you, there will be a participation consent form for you to sign to ensure confidentiality. Please note that during the interview you are free to decline to answer any specific questions of your choosing. As previously mentioned, we will keep your responses from this interview survey in strict confidence. Your privacy will be protected by the maximum amount allowable by law.

If you have questions about the study, contact either Dr. Christopher Wolf at (517) 353-3974 or wolfch@msu.edu; Dr. Sandra Batie at (517) 355-4705 or batie@msu.edu; or Carrie Vollmer Sanders at (419) 553-0622 or vollmer3@msu.edu.

Thank you for considering this request.

Sincerely,

Carrie Vollmer Sanders

Department of Agricultural Economics

Michigan State University

If you have any questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact - anonymously, if you wish - Peter Vasilenko, Ph.D., Chair of the University Committee on Research Involving Human Subjects (UCRIHS) by phone: (517) 355-2180, fax: (517) 432-4503, email address: ucrihs@msu.edu, or regular mail: 202 Olds Hall, E. Lansing, MI 48824.

MAEAP Adoption Producer Interview Frequently Asked Questions

1. What is this interview for?
    - To help Carrie Vollmer Sanders with her agricultural economics thesis research
    - To learn more about your concerns with MAEAP
    - To understand the full costs of implementing a CNMP
    - To identify the environmental implications once the CNMP is fully implemented
    - To recognize how Michigan can improve MAEAP for future applicants
    - To influence agricultural environmental policy development and implementation
2. When will I be interviewed?
    - We will set up an appointment at your convenience during February
3. How long will the interview last?
    - About an hour and fifteen minutes
4. Do I have to answer all the questions?
    - No – you are free to decline to answer any specific questions of your choosing
5. What happens with my CNMP?
    - A copy will be made of it
    - The original will be returned to you via priority mail or in person
    - The copy will be mailed to you once the research is completed
6. Is all the information confidential?
    - Yes –published information will not be able to be traced back to you or your operation
    - All documentation will be destroyed upon completion of the research
7. How were you selected?

- You have a verified farm through MAEAP

8. If I agree what and when will I be paid?

    - You will receive $50 for your interviewing
    - You will receive $100 for allowing me to make a reference copy of your CNMP – the CNMP copy will be given back to you
    - Cash payment will be given to you upon completing the interview and making a copy of your CNMP

MAEAP Adoption Producer Interview Questionnaire

I. Farm Status	***Yes***	***No***
1. Do you have a NPDES CAFO permit with MDEQ?	□	□
2. Do you have a CNMP that is verified through MDA?	□	□
3. Is your farm enrolled with the Pork Producers' Environmental Assurance Program?	□	□
If you answered no above and own swine, do you plan to register with the Pork Producers' Environmental Assurance Program in the next 2 years?	□	□

II. Comprehensive Nutrient Management Plan – Now, we would like to know a little bit about how you manage the nutrients on your farm. Your answers will help enhance nutrient management education and financial assistance programs.

1. When was your CNMP started? _________

2. When was your CNMP completed? __________

3. When was your CNMP approved?__________

4. Is your CNMP verified by MDA? __________

   If yes, when was it verified? _________

5. What encouraged you to have a CNMP? **Check all that apply**.

   □ a. Someone asked you to adopt (Who)_______________________

   □ b. Insurance discounts

   □ c. Environmental regulations directed at your size and type of farm

   □ d. Mandated currently by regulation or you foresee it being mandatory

   □ e. Have a reduced risk of governmental fines

   □ f. Increased concern about drinking water on your farm

□ g. Have a reduced risk of lawsuits

□ h. Became aware of a pollution problem on your farm

□ i. Received technical and financial assistance

□ j. Mandatory for EQIP money

□ k. Had more time to devote to managing your farm

□ l. Your landlord encouraged/required it

□ m. Your agricultural lender encouraged/required it

□ n. Want the community to be aware of your stewardship effort

□ o. Other ________________________________

6. Which resources have you used in writing or implementing your CNMP? **Check all that apply**.

□ MSU Extension - Michigan State University Extension

□ NRCS – Natural Resource Conservation Service

□ MDEQ – Michigan Department of Environmental Quality

□ MDA – Michigan Department of Agriculture

□ Private consultant

□ Conservation District Employee

□ Michigan Milk Producers

□ Other ________________________________

7. List the percent effort each of the following provided in writing your farm's CNMP?

a. Yourself ______%

b. Plan writer/consultant that signed your plan ______%

c. An MSU Extension agent ______%

d. A family member or employee ______%

e. NRCS or Con. District ______%

f. Michigan Milk Producers ______%

g. Co-op or elevator ______%

h. Other ___________________ ______%

TOTAL 100 %

8. Approximately how many hours of your personal time did you spend to get your CNMP written (including consultation with the writer, information gathering, etc.)?

___________ hrs.

9. How many hours do you spend annually to keep your CNMP updated? ______ hrs.

10. How much did or will you pay the plan writer(s) to write your CNMP? $______

11. To have a verified CNMP, what tests did you complete and what was the cost? If the fees are covered in the cost of question #5 then simply check the tests you had completed and how often you will have to update them in the future. How often…

- □ Soil test $________ _______________
- □ Manure test $________ _______________
- □ Water test $________ _______________
- □ Engineering consultant $________ _______________
- □ Other ___________ $________ _______________

12. What were the largest barriers to implementing your CNMP (or other environmental assurance program) changes on your farm? __________________________________

13. What advice would you give your neighbor if (s) he was beginning to write his/her CNMP? ____

14. Would you be interested in ever exchanging information with other similar producers also implementing CNMPs? Why or why not? ______________________________

15. Is there anything else you'd like to share with us about your nutrient management plans? i.e., frustrations or things you wished you had done differently.

____

III. Farm Characteristics – Next we'd like to ask you a few questions specifically about your farm, to get an idea about size and scope of your operation. This will allow us to better estimate the costs of implementing a CNMP.

Livestock Inventory

a. What have been the changes in livestock in the last two years?

Type of Enterprise	**Average Number per year**		**Reason For Change**
Weight, #, meat, breeding	**Before CNMP**	**After CNMP**	

b. What was your annual production last year? For example if you have laying hens, number of eggs sold or if milking cows, pounds of milk sold. ___________________

Land, Crops & Facilities

1. Of the land you farm, how many acres do you **own**? ______ acres
2. Of the land you farm, how many acres do you **rent from others**? ______ acres
3. Of your owned land, how many acres do you **rent to others**? ______ acres
4. What percent of the land you farm do you use the following tilling practices?

	Before	**After**
a. No-till	_____%	_____%
b. Minimal till	_____%	_____%
c. Conventional till	_____%	_____%

TOTAL	100 %	100%

5. How many acres of the land you operate are… **Before CNMP** **After CNMP**

	Before CNMP	**After CNMP**
a. Tillable cropland in production	_______ acres	_______ acres
b. Animal pasture/grazing	_______ acres	_______ acres
c. In government programs (CRP, filter strip)	_______ acres	_______ acres
d. Woodlot, unable to be tilled	_______ acres	_______ acres
e. Wetlands, unable to be tilled	_______ acres	_______ acres
Total	_______ **acres**	_______ **acres**

6. On average, how many acres of the crops below do you plant and what are the average yields?

a. Corn – Grain	_________ acres	_______bu./ac.
b. Corn - Silage	_________ acres	_______ton /ac.
c. Soybeans	_________ acres	_______bu./ac.
d. Wheat	_________ acres	_______bu./ac.
e. Alfalfa & grass hay	_________ acres	_______tons/ac
f. Dry Beans	_________ acres	_______bu./ac.
g. Sugar beets	_________ acres	_______unit _____/ac.
h. Other _______________	_________ acres	_______unit _____/ac.

7. How much fertilizer do you purchase to spread on your crops since you implemented the CNMP?

	Nitrogen	**Phosphorous**	**Potassium**
a. Corn – Grain	_______ lbs/ac	_______ lbs/ac	_______ lbs/ac
b. Corn - Silage	_______ lbs/ac	_______ lbs/ac	_______ lbs/ac
c. Soybeans	_______ lbs/ac	_______ lbs/ac	_______ lbs/ac

d. Wheat _______ lbs/ac _______ lbs/ac _______ lbs/ac

e. Alfalfa & grass hay _______ lbs/ac _______ lbs/ac _______ lbs/ac

f. Dry Beans _______ lbs/ac _______ lbs/ac _______ lbs/ac

g. Sugar beets _______ lbs/ac _______ lbs/ac _______ lbs/ac

h. Other_____________ _______ lbs/ac _______ lbs/ac _______ lbs/ac

8. Have you changed the number of acres you plant to specific crops since you implemented the CNMP and how much has the average yield changed?

	Increase	Decrease	Yield Change
a. Corn – Grain	_______ acres	_______ acres	_______bu./ac.
b. Corn - Silage	_______ acres	_______ acres	_______tons/ac.
c. Soybeans	_______ acres	_______ acres	_______bu./ac.
d. Wheat	_______ acres	_______ acres	_______bu./ac.
e. Alfalfa & grass hay	_______ acres	_______ acres	_______tons/ac
f. Dry Beans	_______ acres	_______ acres	_______bu./ac.
g. Sugar beets	_______ acres	_______ acres	_____unit _____/ac.
h. Other ______________	_______ acres	_______ acres	_____unit _____/ac.

IV. Management and Capital Changes

A. Management

1. What type(s) of manure storage do you currently have?

a. ____________________________

b. ____________________________

c. ____________________________

2. Which describes your manure holding capacity before and after your CNMP? **Check all that apply**.

Before	After
□	□ a. Daily haul to field, no appreciable storage
□	□ b. Short-term storage, (0-3months)
□	□ c. Intermediate storage, (3-5 months storage)
□	□ d. Long-term storage, (at least six months)
□	□ e. Other storage_______________________________

3. If you put in new manure storage, what kind of storage did you put in? ____________

4. Why did you change your manure storage facility? **Check all that apply.**

- □ To reduce winter spreading
- □ To account for freeboard
- □ To account for the 24hr – 25yr event
- □ Other ______________________________

5. Has need for winter spreading changed your operation by

- □ Adding more storage
- □ Finding more land
- □ Traveling farther to haul manure
- □ Other_______________________________________

6. What manure records do you keep?	**Before**	**After**	**How often?**
a. Freeboard height	□	□	__________
b. Weather conditions when spreading	□	□	__________
c. Manure nutrient levels	□	□	__________

d. Manure application time ☐ ☐ __________

e. Soil conditions you are spreading the manure on ☐ ☐ __________

f. Spreader calibrations ☐ ☐ __________

7. Before writing your CNMP, how would you answer the following questions and does the answer change after the CNMP has been implemented?

	Yes	No	Δ
a. I know the rate at which I apply manure nutrients to the soil	☐	☐	☐
b. I know the nutrient value of manure I apply to the soil	☐	☐	☐
c. I change the amount of manure nutrients I apply based on proximity to water sources & slope	☐	☐	☐
d. I have the flexibility to not apply manure nutrients when the ground is frozen	☐	☐	☐
e. When I know the manure nutrient value, I Δ the amount of manure I spread	☐	☐	☐

8. Do you have a method in place to control the odor emitted from your manure storage? **Yes** **No**

If yes, what method do you use? ________________________________

Is this method new because of your CNMP? **Yes** ☐ **No** ☐

9. How far is the closest manure storage area (in ft.) from the following before and after your CNMP?

	Before	**After**
a. From a creek, river, lake	________ feet	________ feet
b. From a wetland	________ feet	________ feet
c. From a well	________ feet	________ feet
d. From a pond	________ feet	________ feet

10. What setback is observed (in ft.) from where you spread manure before and after your CNMP?

	Before	**After**
a. From a creek, river, lake	________ feet	________ feet
b. From a wetland	________ feet	________ feet
c. From a well	________ feet	________ feet
d. From a pond	________ feet	________ feet

11. What manure application method do you use (in %) before and after your CNMP?

	Before	**After**
a. Liquid injection	____%	____%
b. Liquid surface applied, no incorporation	____%	____%
c. Liquid surface applied, with incorporation	____%	____%
d. Solid, no incorporation	____%	____%
e. Solid, with incorporation	____%	____%
f. Irrigation	____%	____%

12. Where does your milk house and parlor wastewater drain?______________________

Will/has this change/d because of your CNMP? **Yes** □ **No** □

How did it change? ____

13. Where does your feedlot rainwater drain?__________________________________

Will/has this change/d because of your CNMP? **Yes** □ **No** □

How did it change? ____

14. How do you control silage leachate? ______________________________________

Is this method new because of your CNMP? **Yes** □ **No** □

Before **After CNMP**

15. How many acres of cropland that you operate have tiled or drained fields? _____acres _____acres

16. How many acres of cropland that **you own**, are applied with manure? _____acres _____acres

17. How many acres of cropland that **you do not own** are applied with manure? _____acres _____acres

18. What percent of your farm's manure do you sell to others? _____% _____%

19. Is there a:

	Yes	No	Written	$	Share%
a. Manure contract for land you rent **from others**?	□	□	□	___	___
b. Manure contract for land you rent **to others**?	□	□	□	___	___

20. If you rent land **from/to others**, are there nutrients application terms? YES NO

    If there are terms, what are they? ______________________________________

21. If you spread manure on land but **do not own or rent** the land, is there any contract terms regarding the nutrients applied to the soil? YES NO

    If there are terms, what are they? ______________________________________

22. What is the distance (in road miles) to the cropland you spread manure on?

Owned	**Rented**	
_____%	_____%	0 - 1 Mile
_____%	_____%	1 - 2 Miles
_____%	_____%	2 - 4 Miles
_____%	_____%	4 - 8 Miles
_____%	_____%	> 8 Miles

23. Do you anticipate the need to seek alternative arrangements for manure application within the next five years? **Yes or No** What?(i.e., location, equipment, technologies) Why? ____________________

24. Did you add any new technologies to decrease the amount of manure needed to be spread? What do they allow you to do differently? ____________________

25. What other changes did or do you plan to make in your farm operation to follow your CNMP? ____________________

B. Financial

1. What are the changes in production volume and/or costs made solely for the CNMP? (If you have not implemented the CNMP, what are your anticipated changes?)

Changes in Costs - %	**Increase**	**0**	**Decrease**	**Remarks**
Revenue from livestock				
Animal density				
Manure sales				
Crop consultant/CNMP TSP				
Soil tests (frequency and cost)				
Manure tests (frequency & cost)				
Equipment usage				
Fertilizer bought: Phosphorous				
Fertilizer bought: Nitrogen				
Feed additives: diet changes				
Feed bought off farm				
Energy and utility costs				
Fuel costs				
Labor for manure spreading				
Labor for manure storage				
Labor for crop production				

Labor for record keeping				
Composting/Methane digesters				
Supervision hours				
Insurance premium				
Other				

2. Which of the following did you have to purchase or lease in whole or part to comply with your CNMP? How much did it cost and what percent was cost shared?

	Yes	No	Cost	%Cost Shared
a. Additional Machines/Equipment				
1. For production	□	□	$______	______%
2. Transport manure	□	□	$______	______%
3. Spreading manure	□	□	$______	______%
4. Calibrating manure	□	□	$______	______%
5. GPS/GIS technology	□	□	$______	______%
6. Other ____________	□	□	$______	______%
b. Improvements/New construction				
1. Manure Storage	□	□	$______	______%
2. Drainage	□	□	$______	______%
3. Gutters	□	□	$______	______%
4. Fences	□	□	$______	______%
5. Buildings	□	□	$______	______%
6. Roofed lots	□	□	$______	______%
7. Feed Storage	□	□	$______	______%

8. Grass waterways	□	□	$______	______%
9. Buffers	□	□	$______	______%
10. Other ____________	□	□	$______	______%
c. Additional land to spread manure				
1. Purchased	□	□	$______	______%
2. Rented	□	□	$______	______%
d. Additional labor	□	□	$______	______%
e. Other________________	□	□	$______	______%

V. Opinions – This next section is solely your opinions; there is no correct answer. From this section we will be able to better educate policy makers about your concerns regarding the environment.

1. How serious are the following problems in your locality? Chose between 1 and 5, 1 = not serious and 5 = very serious. **Not --------- Very serious**

a. Animal manure polluting ground and surface water 1 2 3 4 5

b. Ag fertilizer polluting ground and surface water 1 2 3 4 5

c. Ag pesticides & herbicides polluting ground/surface water 1 2 3 4 5

d. Municipalities polluting ground/surface water 1 2 3 4 5

2. In your county (several county area), if an agricultural producer were to pollute water, which would be the most likely to cause a water problem?

□ Beef cattle production

□ Dairy production

□ Swine production

□ Poultry production

- ☐ Crop production
- ☐ Horticultural Production
- ☐ Other ____________________

3. What are the most serious opportunities and threats to your farm operation in the next 5 years?

	Threats	Opportunities
a. Changing commodity prices	____	____
b. Variable profit margins	____	____
c. Vertical integration and contracting	____	____
d. Government regulations on the environment	____	____
e. Possible lawsuits or liability issues	____	____
f. Fluctuating interest rates	____	____
g. Urbanization	____	____
h. Exotic pests	____	____
i. Technology advances	____	____
j. Diversification/specialization of enterprises	____	____
k. Other __________________________	____	____

4. Do you think, given the cost of the CNMP, it was a worthwhile investment for the environmental state of your farm? Please explain. ________________________________

5. How would your attitude change towards CNMP and MAEAP if you were offered more or less cost sharing to complete the plan? _________________________________

6. If a farm has had a spill, do you think the owners should still be eligible for cost share money? Why or why not. ____

7. Do you think the CNMP is the appropriate solution to eliminate any environmental problem that may exist on a farm? Please explain. ______________________________

8. Below are statements, please select the one of the following 1 = strongly agree 2 = agree 3 = no opinion 4 = disagree 5 = strongly disagree **SA A N D SD**

My farm operation can be profitable without causing or contributing to any significant water quality pollution.	1	2	3	4	5
My CNMP is so valuable to my operation; it is my intent to maintain and update it in the future.	1	2	3	4	5
Modern agriculture is a cause of environmental problems & needs continual, careful management to be environmentally sound.	1	2	3	4	5
Even though clean water benefits the public, producers should pay for the majority of mandatory environmental practices to ensure pollution prevention.	1	2	3	4	5
Trends in environmental regulation are clear enough to justify changing my environmental practices, even those that require permanent structure investments.	1	2	3	4	5
The law requiring "no discharge" of polluted runoff over land or via tiles is adequate to counteract agricultural water pollution.	1	2	3	4	5
MAEAP educational programs have helped me become a better steward.	1	2	3	4	5
Liability and law suits are of <u>little</u> concern for the livestock industry in Michigan.	1	2	3	4	5
Michigan governmental agencies are doing a good job helping producers reduce pollution without substantially hurting profits.	1	2	3	4	5

VI. Environmental Effects – Due to changes that have taken place over the past few years on your farm, we would like to see if there has been some immediate environmental advantages for your participation in MAEAP.

1. What are the soil changes on your farm since you implemented CNMP? What are your long-term goals for the farm?

	Change	Long-term Goal
a. Phosphorus soil level	____________	____________
b. Heavy metals	____________	____________

c. Water holding capacity ____________ ____________

d. Percent organic matter ____________ ____________

e. Soil erosion ____________ ____________

2. Is there an increase in wildlife habitat due to the changes you've made with the CNMP? Explain.____

3. Is your farm limited in the phosphorus it can spread? **Yes** □ **No** □

How close is the farm to reaching mass balance (inflows = outflows)? _______________

4. Do you feel the water quality on or near your farm has improved (will improve) do to the changes you made (will make) by implementing your CNMP? __________________

VII. Operator Characteristics – Finally, in this last section we would like to know more about you, the operator. This information will give me better background information about your situation and help explain how much technical and financial assistance generally a producer might need. Keep in mind this is strictly confidential and will not be able to be traced back to your farming operation.

	Primary	**1st Partner**	**2nd Partner**	**3rd Partner**
1. Age as of January 1, 2004	______	______	______	_______
2. Farm operator's education level:				
Less than 12 years	□	□	□	□
High school graduate	□	□	□	□
Training past high school	□	□	□	□
College graduate	□	□	□	□
Post-graduate	□	□	□	□

3. How many years have you been in agriculture? ______ yrs.

4. How many years have you worked in this operation? ______ yrs.

5. How many years have you managed this operation? ______ yrs.

6. How many years has this farm been in the family? _______ yrs.

7. What was your family's income (before taxes) last year?

- □ a. Less than $50,000
- □ b. $50,001 - $100,000
- □ c. $100,001 - $150,000
- □ d. $150,001 - $250,000
- □ e. $250,001 - $400,000
- □ f. More than $400,000

8. What was your family's expenses (both on and off the farm) last year?

- □ a. Less than $50,000
- □ b. $50,001 - $100,000
- □ c. $100,001 - $150,000
- □ d. $150,001 - $250,000
- □ e. $250,001 - $400,000
- □ f. More than $400,000

9. What percentage of your 2003 family income was from off-farm work ________%

10. What was the total farm revenue for your farm last year (crops, livestock, livestock products and government payments)? $________________

11. What percent of this total cash value came from:

    a. Animal sales _______%

    b. Milk sales _______%

c. Crop Sales _______%

d. Government Payments _______%

e. Co-op dividends _______%

f. Tourism _______%

h. Other specify __________ _______%

TOTAL 100 %

12. What is the total value of all farm **liabilities**?

- ☐ a. Less than $500,000
- ☐ b. $500,000 - $1,000,000
- ☐ c. $1,000,001 - $2,000,000
- ☐ d. $2,000,001 - $5,000,000
- ☐ e. $5,000,001 - $7,500,000
- ☐ f. $7,500,001 - $10,000,000
- ☐ g. More than $10,000,000

13. What is the total value of all farm **assets**?

- ☐ a. Less than $500,000
- ☐ b. $500,000 - $1,000,000
- ☐ c. $1,000,001 - $2,000,000
- ☐ d. $2,000,001 - $5,000,000
- ☐ e. $5,000,001 - $7,500,000
- ☐ f. $7,500,001 - $10,000,000
- ☐ g. More than $10,000,000

14. What are your plans for the farm? **Check all that apply**

- ☐ Increase in size
- ☐ Decrease in size
- ☐ Maintain size
- ☐ Diversify
- ☐ Specialize
- ☐ Sell, if price is right
- ☐ Transfer it to the next generation
- ☐ Transition to niche markets
- ☐ Other, specify________________

Is there anything else you'd like share with us?

____

APPENDIX E: Comprehensive Nutrient Management Plan Components of the Michigan Agriculture Environmental Assurance Program (MAEAP) (MAEAP Steering Committee, 2000)

Comprehensive Nutrient Management Plan Components of the Michigan Agriculture Environmental Assurance Program (MAEAP)
Approved August 10th 2000

MAEAP Steering Committee Meeting

Introduction

The Michigan Agriculture Environmental Assurance Program is a voluntary program for agricultural producers enabling them to develop management plans and implement practices that are protective of the environment while maintaining the economic viability of their farm operations.

The MAEAP has developed a three-phase approach: 1) education; 2) operation-specific action plan development and implementation; and, 3) verification of the plan to obtain certification as an environmentally assured farm operation.

The development and implementation of a farm-specific Comprehensive Nutrient Management Plan (CNMP) is an integral part of the program. The objectives of a CNMP include: protecting water quality, obtaining beneficial use from animal manure and organic by-products of the operation, and minimizing impacts to the environment and public health from animal feeding operations.

A Comprehensive Nutrient Management Plan (CNMP) describes the production practices, equipment, and structure(s) that the owner/operator of an agricultural operation now uses and/or will implement to sustain livestock and/or crop production in a manner that is both environmentally and financially sound. It combines conservation practices and management activities into a system that addresses animal production operations from feed inputs through use of animal manure and other organic by-products. The CNMP is a planning tool as well as a record of decisions in that it details the activities that the landowner/operator implements. The CNMP also assists the producer in maintaining records to document where manure or organic by-products will be generated, handled, or applied.

The CNMP, as outlined in this document, is consistent with the Generally Accepted Agricultural and Management Practices (GAAMPs) developed and adopted under the Michigan Right to Farm Act, including the GAAMPs for Manure Management and Utilization, and Site Selection and Odor Controls for New and Expanding Livestock Production Facilities. In addition, the CNMP conforms to USDA Natural Resources Conservation Service Technical Guidance for developing CNMPs which includes meeting NRCS technical standards for structural conservation practices proposed and all management activities in the CNMP.

CNMP Process Overview

The CNMP concepts are introduced to the landowner/operator through the education phase of the MAEAP. The data and records needed to complete a CNMP are presented along with the components and purpose of CNMP. A good plan should help the landowner/operator see the "big picture" and trends in their operation. It should also provide a more comprehensive view of the operation that enables better decision-making and day to day management.

The CNMP is developed in conjunction with the landowner/operator. For small and straightforward farm operations, the landowner/operator may be able to complete a CNMP with technical assistance. However, particularly for complex and/or larger operations, a professional planner can help the landowner/operator understand his/her site-specific resource needs and develop a plan.

CNMP Components

The major components of a CNMP are listed here, and detailed on the following pages:

- Overview
- Farm Headquarters Map
- Animal Outputs
- Conservation Practices on Fields Used for Land Application
- Land Application Management
- Record of CNMP Implementation
- Inputs to Animals—Feed Management (where applicable)
- Alternative Utilization Activities (where applicable)
- Inspection, Operation and Maintenance, Training
- Schedule of Implementation
- Emergency Action Plan
- References
- Appendices

Overview

A brief statement describing the farm operation including enterprises, goals, and long-term plans for resource management is in this section.

Farm Headquarters Map

A site map showing locations of farm buildings, animal housing, manure storage structures, other sources of manure and wastewater, feed storage, farm house(s) and any other relevant physical features.

Animal Outputs

This section should include information regarding the total animal units, amount of manure produced, approximate nutrient levels of the manure (i.e., the amount of nitrogen, phosphorus, and potassium). The method the operator will use on the operation to collect, store, treat, and transfer or spread the manure produced on the operation should also be detailed in this section.

Production

- Identify species, weight, production level, etc. of livestock (herd/flock inventory)
- Identify the total amount, location and characteristics of manure, wastewater and other organic by-products generated, including method(s) of calculation:
  - Manure and wastewater nutrient content and volume
  - Milk house and parlor wastewater
  - Water from plate coolers/supplemental cooling
  - Runoff from feedlot/barnyard, stored manure, or stored feed areas
  - Silage leachate
  - Spoiled feed
- Identify water control devices (e.g., diversions, roof gutters, etc.) to reduce amount of polluted water
- Identify the management of animal mortality (i.e., compost, render, burial, etc.)
- Identify the management of animal veterinary wastes

Collection

- Manure and waste water collection method(s)
- Location of collection points at facility

- Schedule of collection
- Equipment and/or structural facilities needed

Storage

- Type, location and size (dimensions) of storage facility(s)
- Storage capacity:
  - Volume
  - Duration of storage time based on waste production
- Assess volume and site suitability for storage (existing and planned)
- Means to measure freeboard, where applicable, and fill rate

Treatment (where applicable)

- Type, function, capacity and location of any treatment facility or equipment

Transfer

- Method, frequency/schedule and structures or equipment needed for movement of manure and wastewater from or between collection, storage, treatment and utilization locations.

Conservation Practices on Fields Used for Manure Application

This section should evaluate each field to determine the erosion potential (RUSLE(2) score), sensitive areas, conservation/management practices, and winter application (MARI score). Maps should indicate the above mentioned areas or practices within each field operated.

- Evaluation of potential for nitrogen or phosphorus transport off-site (i.e., to surface and/or ground water) includes such factors as:
  - Soil

    - Soil Hydrologic Group
    - Soil Management Group
    - Percent Slope
    - Topography
    - Soil Test P. Value (Bray P 1 in lbs/ac)
    - Nitrogen Leaching Index for Soil Hydrologic Group
  - Water Quality
    - Concentrated Water Flow or Surface Inlet
    - Tile drainage system
    - Setbacks from Surface Water
  - Surface Cover
    - Residue Cover/Cover Crops
    - Vegetative Buffer Width
  - Manure
    - Manure P. Application
    - Manure N. Application
    - Manure application method(s)
- Identification of sensitive areas such as sinkholes, streams, water bodies, wells, gullies/swales, surface inlets, drinking water sources and property boundaries
- Identification of conservation and management practices needed for erosion control and water management in order to control offsite transport of nitrogen and phosphorus
- Identification, by field, if winter application of manure is acceptable

- Develop maps showing sensitive areas, setbacks and locations of practices/activities

Land Application Management

This section outlines the nutrients available on cropland, crop rotation, equipment calibrations, and on which fields, at what rates, and via which method manure will be spread.

- Nutrient budget for nitrogen, phosphorus, and potassium from all sources (include form, source, amount, timing and method of application)
- Calibration of application equipment
- Application schedule (planned dates of application – i.e., month)
- Determine application rates, by fields, based on:
  - Crops to be grown
  - Realistic crop yield goals
  - Crop nutrient needs
  - Soil test results (within last three years)
  - Previous crops grown, including residual nutrient credits
  - Manure and wastewater nutrient content
  - Nitrogen or phosphorus limiting nutrient
  - Winter spreading requires special provisions to control runoff and erosion
- At time of application, consider field-specific conditions (wet, dry, frozen, etc.) and adjust application rate, accordingly.

Record of CNMP Implementation

A record of the animal outputs, conservation practices, and land application management practices that were in fact observed should be kept in this section.

- Records to be kept by field:
  - Soil test reports
  - Date(s) of manure/wastewater applications(s)
  - Source and rate of manure/wastewater applied
  - Date and rate(s) of other nutrients applied
  - Date(s) of incorporation (where applicable)
  - Method of application (e.g., surface applied, injected, irrigated)
  - Acres and area of field applied
  - Weather conditions during application of manure
  - Field conditions during application of manure (wet, dry, frozen, etc.)
  - Recommended nutrient application rates
  - Previous crops grown and yields
  - Plant tissue sampling and testing reports (where applicable)
  - Pre-Sidedress Nitrate Test (PSNT) reports (where applicable)
- Other records:
  - Manure/wastewater quantities produced and nutrient analysis results
  - Inspection and maintenance records
  - Records of rental agreements or other agreements for application of manure/wastewater on land not owned by the producer

- Record of manure/wastewater sold or given away to other landowners (where applicable)

Inputs to Animals – Feed Management (where applicable)

This section should outline any change or future plan to change the feed ratio.

- The management of animal diets that results in:
  - optimum production and/or animal body maintenance
  - best economical use of feed materials
  - minimize the amount of (recoverable) nutrients contained in manure

Alternative Utilization Activities (where applicable)

This section explains where manure was transported or for what it was used, if all manure was not spread on the operated acres.

- Transport and environmentally sound off-site utilization
- Power generation (e.g., methane production, combustion for energy)
- Conversion to value-added products (e.g., compost)

Inspections, Operation & Maintenance, Training

A plan to inspect or review practices and equipment and how the operator will train their employees to follow the CNMP is in this section.

- Schedule for inspection of structural and vegetative practices and equipment
- Operation and maintenance practices/activities
- Schedule for review of management practices/activities to ensure implementation of plan
- Plan for training employees how to follow CNMP, including when training will be provided, such as:

- New employees hired
- New processes, procedures or equipment
- Employee responsibilities

Schedule of Implementation

A plan to implement any new components and when the entire CNMP will be reviewed and updated in this section.

- New components that are planned and the implementation schedule for each new component
- Annual review and update of plan, as necessary

Emergency Action Plan

A plan to be implemented should manure or other wastes from the operation leak, overflow, or run off the site.

- Actions to take in the event of a spill, discharge or failure of a collection, storage, treatment of transfer component.
- Telephone numbers to report and seek assistance in the event of an emergency
- Anticipated flow paths in the event o f a spill, discharge or failure. Show on a site map.

References

This section includes sources of information that were cited in the plan.

Appendices

Copies of documents cited in the plan or additional material that adds to the explanation of the plan.

- Copies of pertinent references cited in the plan

- Environmental documentation, as appropriate
- Other appropriate supporting documents not included in other parts of the plan (i.e., worksheets, forms, etc.)

APPENDIX F: Phosphorus Index (Michigan Trial)

The Michigan phosphorus index (P-Index) used in this study is still being field tested prior to it being adopted by any governmental agency, university, or MAEAP. A separate matrix, like the one below, is completed for each field to be scored with the P-Index. A score above 18 signifies that the field has a high potential risk of phosphorus runoff entering surface water. The total P-Index score is the sum of the transport and source scores.

The transport score consists of the RUSLE2, RCN, distance to surface water, subsurface drainage, and buffer score. This score can range from zero to 36. The most accurate method to determine the distance to surface water, subsurface drainage, and buffers is to examine the field in person. Maps can be used, but often the aerial photographs are out-of-date and do not portray the entire picture as an on-site view can. The RUSLE2 and RCN scores are calculated based on information from the operator and field soil data. Altering the crop rotation can affect both of these numbers.

The source score consists of the soil test P, P fertilizer method, manure method, and P_2O_5 rate from all sources. This score can range from zero to 32. A scientific soil test determines the soil test P, while the producer controls the other three variables with his/her management practices chosen for each field.

Each variable is given a score based upon which text box it most closely follows. For example, if a field had a RUSLE2 score of 5.8 then that field would receive four points for the transport score of RUSLE2. If an operator surface applied commercial fertilizer two days before planting but never incorporated the fertilizer, then the source score for P fertilizer method would be eight. After all variable scores are determined, they are totaled for the field's P-Index score.

Michigan P-Index	Matrix	Version 0.5	Landowner:			
September 2005	County:	Field:	Soil Map Unit:			
	Township:	Section:	Developed by:			
Transport	0	1	2	4	8	Total
RUSLE2	< 1 ton/acre-yr	1 - 2 tons/acre-yr	2.1 - 4 tons/acre-yr	4.1 - 6 tons/acre-yr	> 6 tons/acre-yr	
RCN	< 75	75 – 78	79 - 82	83 - 86	> 86	
Distance to surface water	> 300 feet	150 - 300 feet	100 - 149 feet	50 - 99 feet	< 50 feet	
Subsurface drainage	no subsurface drainage or surface inlets, or > 300 ft from surface water	random or patterned subsurface drainage present, no surface inlets	random or patterned subsurface drainage present or 1 - 2 surface inlets	random or patterned subsurface drainage present, or 3 or more surface inlets		
Buffers	buffer is permanent vegetation > 35 ft width, or > 300 ft from surface water	buffer is permanent vegetation 26 - 35 feet width	buffer is permanent vegetation 20 - 25 feet width	buffer is permanent vegetation < 20 feet width	no vegetative buffer	
					transport total	0
Source	0	1	2	4	8	
Soil Test P	< 20 ppm	20 - 40 ppm	41 - 74 ppm	75 - 150 ppm	> 150 ppm	
P fertilizer method	no P fertilizer applied	P fertilizer injected or surface applied and incorporated < 2 days before planting	P fertilizer surface applied and incorporated 3 - 7 days before planting	P fertilizer surface applied or incorporated 8 - 15 days before planting	P fertilizer surface applied; incorporate > 15 days before planting; no incorp.	
Manure method	no manure applied	inject or incorporate manure within 2 days of application	incorporate manure 3 - 7 days after apply; surface apply on growing crops	incorporate manure 8 - 30 days after application	incorporate manure >30 days after application, or no incorporation	
P_2O_5 rate all sources	0 to 1 year P_2O_5 crop removal	2 year P_2O_5 crop removal	3 year P_2O_5 crop removal	4 year P_2O_5 crop removal	> 4 year P_2O_5 crop removal	
M. Gangwer	USDA-NRCS	East Lansing, MI	September 2005		source total	0

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