An examination of pollution prevention in Montana secondary agricultural education laboratories
by Thomas Martin Bass

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Agricultural Education
Montana State University


Abstract:
The purpose of this study is to determine what practices, in the area of pollution prevention and waste management, are being applied by Montana agricultural educators in the classroom, laboratory and field settings. When certain defined practices are not applied, barriers to implementation will be examined. Data will also be collected and analyzed regarding Montana agricultural educators' perceptions and knowledge base-concerning pollution prevention, waste management and hazardous material management.

A survey titled "Pollution Prevention in Agricultural Education Laboratories and Field Areas'' was administered to 73 Montana Agricultural Education Programs, which appeared on a statewide agricultural education program directory. This study was a census of the population of Montana Agricultural Education programs. .

Subject areas examined in this study are divided into ten sections: 1) Demographic data, 2) Program information, 3) Agricultural and power mechanics laboratory, 4) Green house and farm plot, 5) Wood laboratory, 6) Metals/welding laboratory , 7) Animal confinement area, 8) Curriculum and classroom management, 9) Perceptions, 10) Barriers to Pollution Prevention.

Results of the study found that deficiencies were identified with current practices in pollution prevention and waste management by Montana agricultural educators. Lack of knowledge, or need for further education was the primary barrier to practice and improvement of pollution prevention identified by survey respondents. Agricultural educators in Montana, had positive perceptions of pollution prevention. Most agreed that agriculturalists are responsible for their own actions concerning the environment and that the actions of few can have a wide effect. It was documented that Montana agricultural educators do have a basic knowledge or awareness of pollution prevention and proper waste management.

The participants in this study indicated a need for education in pollution prevention specific to agricultural teaching laboratories and field areas. Agricultural educators in Montana are interested in pursuing this issue. Data obtained through this study may also be pertinent in other areas of vocational education were similar teaching or research facilities are maintained. Such research can also contribute to that which has already been done in other areas such as chemistry and biology education.

It is recommended that a pollution prevention education or training program, specific for agricultural education, should be developed as soon as possible. It should focus on source reduction of waste, management of unavoidable waste and consideration to proper facilities planning and management. Agricultural educators themselves should be as involved as possible in the development of pollution prevention training and education. Such information should become part of a holistic pollution prevention resource for educational institutions including all traditional, academic and vocational (agriculture included) teaching areas.

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by

Thomas Martin Bass

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APPROVAL

of a thesis submitted by

Thomas Martin Bass

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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# ABSTRACT


The purpose of this study is to determine what practices, in the area of pollution prevention and waste management, are being applied by Montana agricultural educators in the classroom, laboratory and field settings. When certain defined practices are not applied, barriers to implementation will be examined. Data will also be collected and analyzed regarding Montana agricultural educators' perceptions and knowledge base concerning pollution prevention, waste management and hazardous material management.

A survey titled "Pollution Prevention in Agricultural Education Laboratories and Field Areas" was administered to 73 Montana Agricultural Education Programs, which appeared on a statewide agricultural education program directory. This study was a census of the population of Montana Agricultural Education programs.

Subject areas examined in this study are divided into ten sections: 1) Demographic data, 2) Program information, 3) Agricultural and power mechanics laboratory , 4) Green house and farm plot, 5) Wood laboratory , 6) Metals/welding laboratory , 7) Animal confinement area, 8) Curriculum and classroom management, 9) Perceptions, 10) Barriers to Pollution Prevention.

Results of the study found that deficiencies were identified with current practices in pollution prevention and waste management by Montana agricultural educators. Lack of knowledge, or need for further education was the primary barrier to practice and improvement of pollution prevention identified by survey respondents. Agricultural educators in Montana, had positive perceptions of pollution prevention. Most agreed that agriculturalists are responsible for their own actions concerning the environment and that the actions of few can have a wide effect. It was documented that Montana agricultural educators do have a basic knowledge or awareness of pollution prevention and proper waste management.

The participants in this study indicated a need for education in pollution prevention specific to agricultural teaching laboratories and field areas. Agricultural educators in Montana are interested in pursuing this issue. Data obtained through this study may also be pertinent in other areas of vocational education were similar teaching or research facilities are maintained. Such research can also contribute to that which has already been done in other areas such as chemistry and biology education.

It is recommended that a pollution prevention education or training program, specific for agricultural education, should be developed as soon as possible. It should focus on source reduction of waste, management of unavoidable waste and consideration to proper facilities planning and management. Agricultural educators themselves should be as involved as possible in the development of pollution prevention training and education. Such information should become part of a holistic pollution prevention resource for educational institutions including all traditional, academic and vocational (agriculture included) teaching areas.

# CHAPTER 1

# THE PROBLEM

## Introduction

Environmental concern seems to be rising in our society. A quick scan of our media sources reveals that the environment is certainly a topic receiving much attention. New fields of study are dedicated to this area, and environmental issues are finding their way into our traditional subjects of study and research. All segments of society need to become more responsible in the way that they utilize resources and manage waste and potentially hazardous materials.

An important concept in the arena of environmental issues is pollution prevention, conceived in the early 1980's. This idea was born into national policy with the passing of the Pollution Prevention Act of 1990. The pure concept of pollution prevention (P2) deals with source reduction of waste, use of alternate (better for human health and the environment) products, methods and processes as well as conservation of resources. The passing of this act helped create resources for research, education, technical assistance and development of policy and legislation.

The movement to act more responsibly where issues of pollution are concerned continues. It is important that all segments of society and industry recognize their responsibility in helping solve these problems. Through education and increased awareness, society can make pro-active decisions regarding these issues before regulatory agencies force change all at once. Williams recognized agriculture's involvement in this arena, when he stated, "Production agriculture and agribusiness industries face, as well as contribute to, environmental concerns" (1993, p. 5).

Institutions such as schools and colleges can potentially be incredible generators of waste and pollution. Many schools have begun to examine their practices and take action in acting more responsibly as a whole institution in the areas of waste reduction, waste management and hazardous material management. Educators in science, especially chemistry, are examining the way they teach and conduct laboratory experiments. They are taking steps towards decreasing health risk to students, instructors and the environment by more effective management of chemicals, potential hazards and waste.

As a part of a larger institution agricultural educators have a responsibility to do their part in improving the environmental management practices of their programs and in promoting practices that can have a great deal of influence on the very thing agriculture relies on: productive, safe, non-polluted land, water and air. Williams supported the integration of sound environmental practices and education with agricultural education in 1993 when he stated:

> If agricultural educators recognize these {environmental} concerns and teach their students how to develop solutions to these problems through the application of scientific principles, then the students, the agricultural industry, and the profession of agricultural education will all benefit (p. 5).

Helping agricultural educators in Montana become better environmental stewards will first require an assessment of the perceptions about, and knowledge of pollution prevention, as well as current practices in dealing with waste and hazardous materials.

An examination of these points will allow for the development of educational programs to help agricultural educators make responsible decisions prior to regulatory government intervention, implement new waste and resource management tools, increase their personal safety and the safety of their students, pass on responsible behaviors to their students, and ultimately protect the resources upon which the entire agricultural industry is reliant. Bogo (1999), quoted former Tufts University dean, Anthony Cortese as saying, "If the students are learning in class about the environment and how to act responsibly, and the university through its buildings, its operations and investments is unsustainable, then they are sending a very subtle but effective message that says 'do what I say, not what I do', practicing what they preach is extremely important" (p. 39). This idea also holds true in the high school setting, especially for agricultural education.

## Statement of Purpose

The purpose of this study was to determine what practices, in the area of pollution prevention, are being applied by Montana agricultural educators in the classroom, laboratory and field settings. When certain defined practices were not applied, barriers to implementation were examined. Data was collected and analyzed regarding Montana agricultural educators' perceptions and knowledge base concerning pollution prevention, waste management and hazardous material management.

## Need for Study

The following statement, published by the United States Environmental Protection Agency (EPA, 1990), sums up the multifaceted importance of practicing and teaching pollution prevention in educational settings.

> Reduction of pollutant emissions associated with research and educational activities is an important objective consistent with traditional environmental policy. More significantly, however, the adoption of waste minimization by the research and educational community carries with it a tremendous potential for designing pollution out of future industrial (or agricultural) processes right in the lab. Waste minimization awareness can also be instilled and propagated by educational institutions, so that today's students and tomorrow's professionals can apply pollution prevention in their endeavors. Hence the importance of instituting pollution prevention within research and educational organizations cannot be overstated (p. 1).

The previous quote gives reasons why implementation of these concepts are important, but does not convey the need for research. Research is needed. Implementation or further development of practices cannot occur without an assessment of current practices, barriers to implementation and general knowledge about the subject.

The role of agricultural educators in the area of pollution prevention, waste management and hazardous material management has not been examined well at all. Of 853 articles published in the Journal of Agricultural Education and papers presented at the National Agricultural Education Research Meetings from 1986 to 1996, only 18 dealt with what was categorized as “environmental” issues (Radhakrishna and Xu, 1997). That means only two percent of published research in these two venues were dedicated to environmental issues. Within this two percent, many papers dealt with sustainable agriculture and organic farming. Research on pollution prevention within the realm of agricultural education is non existent. Radhakrishna and Xu described environmental and sustainable agriculture topics as “emerging topics” (1997). Researching issues in pollution prevention as it pertains to agricultural education and agricultural teaching laboratories will fill a current void. A baseline of pollution prevention information gathered from agricultural educators will provide a platform from which future research and education can be developed. An initial area of priority can be identified and efficient progress can be made toward improving the perceptions, level of knowledge and practices of pollution prevention by agricultural educators.

## Objectives

The following objectives are put forth, in order to fulfill the purpose of this study:

(1) To determine Montana agricultural educators’ current practices in pollution prevention;

(2) To identify barriers to implementation of practices in pollution prevention by Montana agricultural educators;

(3) To determine Montana agricultural educators’ perceptions of pollution prevention;

(4) To determine Montana agricultural educators’ level of knowledge of pollution prevention.

## Definitions

Pollution Prevention (P2) - an activity that relies on source reduction of pollutants. P2 stands above recycling, treatment, and disposal in a waste management hierarchy. P2 is not limited to, but may include the following concepts: waste reduction, reuse and in-house recycling of materials, water conservation, energy conservation and hazardous material substitution. Under P2 one waste stream cannot be turned into another (Peaks to Prairies P2 Information Center 1999). In the context of this study, pollution prevention is used as an umbrella term, including waste management and recycling. This was done for the sake of brevity in the survey instrument and to keep new terms and concepts as simple as possible for the study population. It should be realized that there is a distinct difference between pollution prevention, waste management, and issues regarding environmental compliance.

Waste - surplus, unusable or byproduct materials.

Waste Management - methods of recycling, treating or disposing of waste and surplus materials after they are generated or accrued.

Hazardous Materials - materials which may possess personal health or environmental hazards; material requiring special management to prevent danger to persons, animals or the environment.

## Assumptions

Pollution prevention is necessary to provide a safe learning environment and to sustain and protect natural resources involved in agriculture. The researcher's beliefs account for the following assumptions:

1) Waste and potential pollutants result from certain activities in agricultural education;
2) Increased awareness of concepts in pollution prevention by educators will contribute to increased awareness in students;
3) Proper management of waste and hazardous materials will provide a safer learning environment for educators and students;
4) Pollution prevention in the setting of agricultural education laboratories and other facilities can impact the environment outside of that setting;

## Limitations

The following limitations exist for this study:

1) The survey population will be limited to agricultural educators in the state of Montana's Public School System employed during the 1999-2000 school year;
2) Pollution prevention was primarily examined in laboratory and field activity settings, curriculum only received brief attention;
3) The survey was administered in the month of October 1999.

# CHAPTER 2

## REVIEW OF LITERATURE

While there is little to no research on pollution prevention, waste management and hazardous material management related to agricultural education in secondary schools, there are resources from parallel fields that provide insight into how these topics are pertinent to agricultural education. Traditional science education, predominantly chemistry and biology, has begun to recognize the need to control wastes that result from the educational process of conducting laboratory experiments and demonstrations. On an industrial scale, the activities that make up most of agricultural education's laboratory and field projects have been studied in relation to their human health and environmental impacts.

Collins (1995) introduced the need for pollution prevention and waste management in the field of chemistry education and research when he stated that, "concern for the environment has become an important factor in developments in science and technology (p. 965)." The term "green chemistry" has been used for several years now. This term, or related terms such as "primary prevention" and "environmentally benign chemistry" deal with the idea that activities in chemistry education and research that are potentially harmful to the environment can be substituted with less polluting or non-polluting alternatives (Collins, 1995). Collins stated that green chemistry is the most widely used, and offers the strongest description of the concepts involved (1995).

Comparisons can be made between the defense of green chemistry offered by Collins and the need for pollution prevention and waste management in agricultural education. Collins (1995) stated that:

> The idea of green chemistry has an energy that properly belongs in university research laboratories and classrooms where it can be nurtured in the most positive way. It presents academic chemists with an opportunity to develop a new and optimistic way of looking at chemistry and planning to contribute to it's future (p. 965).

Integrating practices of pollution prevention into agricultural education allows educators and students alike to look at agriculture with a new perspective and contribute to its future.

One could argue that pollution prevention should be easier to integrate in agricultural education than other fields. Swan and Spiro (1995) stated that, "environmental issues and standard chemistry curriculum do not always map onto one another exactly" (p. 967). The authors describe difficulty experienced by chemistry educators in meshing the two topics. Agriculture and the environment are very integrated. Agricultural educators and students already have an idea of how the two are related. In a survey conducted on the impacts of sustainable agriculture, agricultural educators and students recognized that sustainable agricultural practices involved or contributed to the following: better conservation of soil, greater management requirements, reduced use of chemicals, protection of groundwater, safer food and protection of wildlife and woodlands (Williams and Wise, 1997). Such realistic associations between agriculture and the environment by educators and students are a positive sign that barriers experienced in chemistry environmental education may not be as heavily encountered.

Disappointed by low awareness of agriculture and the food and fiber systems by elementary students, several entities in the state of Ohio developed AgVenture Magazine, a teaching tool for use in elementary education (primarily fourth grade) (Swortzel, 1997). The purpose of AgVenture Magazine was to provide a tool to be used across all subject matters that would increase the awareness of agriculture and the methods by which we get our food, clothes and many raw materials by elementary students. Swortzel examined how elementary teachers integrated this magazine into other subject areas; he found that while the most use of AgVenture Magazine was in social studies, the second most popular use of the magazine was in education on environmental issues (1997). The margin of environmental issues over third placing general science was 11%; social studies led environmental issues by 13% (Swortzel, 1997). When left to their own recognizance, non-ag elementary teachers recognized the important relation between agriculture and the environment.

Agricultural educators maintain a variety of teaching laboratories to help fulfill the objectives set forth in their curriculums. Some areas of study defined in the Montana Agricultural Education Curriculum that may contain laboratory sections include the following: animal husbandry, metallurgy, crop production, horticulture, internal combustion engines, hydraulics (transmission of power), material fabrication and repair, equipment maintenance and management and agricultural construction (MSU-AgEd, 1994). The labs associated with the previously listed areas of study can produce the same wastes that their larger scale counterparts in industry and production agriculture. Along with many other subject areas, agricultural education has already been identified as producing hazardous waste through its teaching activities (EPA, 1990).

The United States EPA published a Pollution Prevention guide for research and educational institutions in 1990. Within this document waste streams from a variety of educational activities were identified. Subjects, which may commonly be included in an agricultural education curriculum, that were recognized as potentially producing waste or hazardous materials included the following: (broad) agriculture, horticulture/landscaping, woodworking, metalworking, welding, auto mechanics, masonry and machine shop (EPA, 1990). Although not an exhaustive list of potential problem materials, the following wastes were identified as coming from the previously mentioned subject activities: pesticides, fertilizers, stains, solvents, wood preservatives, paints, metal dust, metal waste, de-greasing solvents, oil, grease, batteries, acids, alkaline wastes, and stripping and cleaning solutions (EPA, 1990).

Many wastes pose an immediate personal health threat through poor handling before their disposal or spillage may cause an environmental one. Rein stated, "Perhaps more than any other occupational group, agricultural workers are exposed to a tremendous variety of environmental hazards that are potentially harmful to their health and well being" (1992, p. 1). The environment referred to here is the work environment; within this environment potential hazards include: respiratory hazards, noise, skin disorders, cancers, chemical hazards and heat stress (Rein, 1992). Chemical and noise hazards in the work environment not only pose threats to human health, but to the greater environment as well. Respiratory hazards, skin disorders, cancers and chemical hazards can all be related to how waste and hazardous materials are managed, stored, handled and transported.

The most widely recommended method in dealing with pollutants, waste and hazardous materials is source reduction. This is a means of reducing the amount of waste and surplus material generated, limiting possession of hazardous materials to minimum amounts needed. In its plan for waste management in schools, the Massachusetts Department of Environmental Management (MDEM) recommended examining an institution's or program's purchasing strategies (MDEM, 1988). Amounts of material that are hazardous or may be difficult to dispose of should be purchased only as needed and gross surplus avoided. MDEM (1988) continued by also recommending the practice of maintaining detailed inventories of chemicals and stored waste, proper storage facilities that comply with regulation, and utilizing disposal or transportation methods that are most economical, such as "milk-run" shipments. A "milk-run" shipment utilizes small collections from several sources in an area, all of which share shipping costs. Also related, periodic community collections of certain materials may also prove to be cost effective. Continuous disposal and recycling options exist for many common wastes.

The automotive repair and maintenance industry and day to day machinery operation in agricultural production can generate a great deal waste. Engine fluid wastes such as engine oil, transmission fluid, gasoline, diesel, solvents and cleaners, brake fluid and hydraulic oil can be generated. The importance of proper management of used engine fluids is supported by the following statements:

1) One gallon of used oil, the oil from a single oil change, can render 1 million gallons of water undrinkable;
2) Oil concentrations as small as 50 to 100 parts per million in a sewage treatment system can fowl the treatment process;
3) Concentrations as low as 310 parts per million of oil can cause serious long term effects to freshwater fish species (EPA 1994, p. 4).

A great need exists for proper engine fluid management along the entire spectrum of waste generators, from the "do-it-your-selfer", to the mechanics teaching lab, and finally large agricultural operations and commercial auto repair businesses.

Many agricultural education programs maintain greenhouses and small farm plots. These teaching labs raise the same concerns one would find with their respective larger industries of horticulture and major crop production. Latimer et al. (1996) reported the nursery industry is the second greatest consumer of insecticides, and runoff water from greenhouses and nurseries has been the subject of discussion on new regulations. Two impediments to pollution prevention, with respect to conventional pesticide use in the horticulture industry, stated by Latimer, et. al. (1996) were "lack of sufficient educational or resource information for users on potential or available alternatives, and lack of funding for educating the users on the implementation of alternatives" (p.121-122).

Risse (1998) reported that "the most common environmental pollutants from crop production are sediment, nutrients and pesticides" (p. 37). These pollutants are produced on incredible scales in production agriculture, but management in smaller scale operations, such as teaching labs, is just as important. The University of Florida has been involved in a study that assessed pesticide contamination at agricultural research universities (Thomas, 1994). In the study, 49 pesticide mixing and loading sites at research universities were tested for pesticide contamination. Thomas (1994) reported that, "seventy-eight percent of these sites were found to have soil or ground water pesticide levels which exceed one or more recommended action levels. Many also exceeded allowable levels under federal and or state hazardous waste regulations" (p. 203). In the case of agricultural chemical contamination, the problem has already been identified in the teaching/research arena.

The residential construction industry in America is making efforts to become more environmentally responsible with initiatives in waste reduction and resource management. McStain Enterprises, a Denver based construction firm promotes practices that reduce the impact on diminishing wood and other natural resources (Fanjoy, 1999). "Much of the program [McStain's Built Green Program] involves the use of recycled and engineered building products" (Fanjoy, 1999, p. 87). Concepts of wood resource conservation should also be understood in the agricultural and vocational wood/construction laboratory setting.

Pollution prevention is also needed wherever agricultural animals are maintained; large scale animal confinement operations undergo a great deal of scrutiny concerning environmental impact. Risse (1995) stated that, "Although problems associated with small scale, agricultural livestock production do not receive as much attention as larger operations, small operations can have a substantial impact on rural environmental quality" (p. 1). Even maintaining a few animals in the teaching field area or laboratory carries with it responsibilities related to environmental concerns.

Agricultural teaching laboratories mimic different activities and components of the previously mentioned industrial and production agricultural situations. The same environmental concerns raised there, should also remain in the scaled down activities associated with agricultural and vocational education. It has already been shown that the chemistry and biology teaching laboratories are potential sources of hazardous waste and pollutants. All of this information may be used to facilitate environmental assessment of agricultural teaching laboratories and field areas.

# CHAPTER 3

# METHODOLOGY

The following methods were used to meet the objectives of this study. They are described within this chapter in four sections: 1) Population Description, 2) Instrument Design, 3) Data Collection Methods, and 4) Data Analysis Procedures.

This was a descriptive research study to determine the current practices in pollution prevention conducted by Montana agricultural educators in secondary schools, as well as to determine barriers preventing these educators from engaging in pollution prevention. Measurements related to perceptions and knowledge on the subject possessed by agricultural educators were also made.

## Population Description

Potential individuals for the study population were identified through the Directory of Montana Agricultural Educators, maintained by the Agricultural Education Program at Montana State University. Seventy-three programs were listed in the roster updated fall of 1999. For programs with multiple teachers, all were included on the address. Potential participants were contacted by postcard prior to inclusion in the survey mailing. Every program on the roster was included in the mailing, therefore this was a census and all agricultural education programs at secondary schools in Montana could participate. A study proposal was sent to the president of the Montana Vocational Agriculture Teachers Association. As a representative of many of the agricultural educators in Montana, this person was considered by the researcher to possess valid opinions concerning the proposed research population. Positive comments were received concerning the general project idea as well as the speculated acceptance by agricultural educators in Montana. The population included in the study was limited to individuals meeting the following criteria:

1. Those employed as agricultural educators in Montana secondary schools in the school year 1999-2000.
2. Those educators listed, by their program/school name on the Directory of Montana Agricultural Educators updated fall of 1999.

## Instrument Design

The research instrument was a survey constructed with partial adherence to the Total Design Method (TDM) published by Dillman (1978). The survey instrument is a collection of questions which were developed from review of related literature, expert advice and prior use in other related surveys or audits. A brief demographic questionnaire, one question on curriculum and a single question related to the EcoStar award program sponsored by the Montana State University Extension Service made up a small portion of the survey. The remainder of the survey deals directly with this study's objectives. Other than demographic information, anonymity was protected. There were no distinguishing features on the survey instruments which could lead to identification of participants upon return. Identification of participants by name was solely voluntary.

The survey was constructed with a combination of questions using three and five point Likert-type scales, nominal scale and open ended format. Question format was chosen on appropriateness for the type of answer desired and to maintain the highest instrument validity. Further comments were encouraged at the end of the survey on any related topic or issue. These comments are provided in Appendix D.

A pilot test of the survey was conducted. Twenty surveys were sent out to technology education instructors in Montana secondary schools. While this audience did not maintain all of the same teaching laboratories, many similarities did exist. This audience was encouraged to evaluate the survey for content and face validity. A survey draft was also administered to an expert panel, composed of a subject matter specialists, and two agricultural education professors (university level). Appropriate adjustments were made to the instrument in accordance with comments made by pilot audience and expert panel.

A Cronbach's Alpha-Reliability Analysis was conducted using all Likert-type scale questions in the survey instrument on the final data. "For research purposes, a useful rule of thumb is that reliability should be at least .70 and preferably higher" (Franken and Wallen, 1996 p. 163). The Cronbach's Alpha-Reliability coefficient rating for this instrument was .78, therefore the overall reliability of the survey was acceptable.

## Data Collection Methods

The data for this study was collected using a mailed survey instrument. Dillman's TDM was considered while designing the following mailing timetable:

1) October 12, 1999-pre-survey postcard sent (Appendix A);

2) October 15, 1999-1st cover letter and survey sent (Appendix B);

3) October 22, 1999- reminder announcement at Montana Vocational Agriculture Educators Conference made; and

4) November 2, 1999- reminder postcard sent and electronic reminder on Met-Net made (Appendix C).

As stated earlier, a total of 73 surveys were mailed to agricultural educators in Montana secondary schools. A cover letter accompanied the survey instrument (Appendix B). The survey was designed to be a self mailer for return. Postage was provided for the respondent. Data from returned surveys was manually entered into Microsoft® Excel®. Comments and answers to open ended questions were typed in Corel® Word Perfect® and are available in Appendix D. All spreadsheets were prepared for presentation in table form.

A final response rate of 56.2% was obtained, a full explanation of this data is available in Chapter 4 and also described in Table 1. Two additional surveys were received after data analysis was complete and narration was near final draft. They are not included in the data reported here. Dillman (1978) finds that, "there is almost no difference in response rates for various lengths below 12 pages, or about 125 items. However beyond that length, the response rates decline to an average of 65%" (p.27).

The length of this survey hovered around this barrier and it may or may not have been a factor in response rate. It is believed that surveys within special audiences should receive higher response rates (Dillman,1978). However, other factors may contribute to reduced rate. It was the researcher's belief that sensitive subject matter and fear of self-incrimination was a contributing factor to a response rate less than that projected by Dillman. Time constraints upon the researcher, as well as financial limitations contributed to the need to modify Dillman's method and ability to do further follow-up.

## Data Analysis Procedures

Data analysis was conducted using Microsoft® Excel® and SPSS® statistical software. Expert guidance was sought during statistical analysis of the data. Early and late respondents were examined for statistical difference by a t-test and Mann-Whitney U test. Gall, Borg, and Gall (1996) stated that, "If you are concerned about score distributions of your data, you should consider doing both a t-test and its non-parametric counterpart, either the Mann-Whitney U test or the Wilcoxon signed rank test" (p. 390). The hypothesis that there would be no difference between the two groups was accepted, as no significant differences were found at the .05 level. Late responders were combined with early responders for the remaining data analysis. Response frequencies for all survey questions were calculated in Excel® spreadsheets, tables and figures were prepared in Corel® Word Perfect®, and statistical analysis on early and late respondents was done in SPSS®.

# CHAPTER 4

## RESULTS OF THE STUDY

The study was designed to identify Montana agricultural educators' level of awareness and level of knowledge of pollution prevention, as well as to measure the frequency of certain practices in pollution prevention. The study hoped to also identify barriers to implementation of practices in pollution prevention and measure the perceptions of pollution prevention and the environment held by Montana agricultural educators. The results of this study are divided into ten sections: 1) Demographic data, 2) Program information, 3) Agricultural and power mechanics laboratory , 4) Green house and farm plot, 5) Wood laboratory , 6) Metals/welding laboratory , 7) Animal confinement area, 8) Curriculum and classroom management, 9) Perceptions, and 10) Barriers to Pollution Prevention.

Since not all total respondents answered each section of the survey, percentages throughout the results are representative only of the frequencies of a response to that single question alone. The total number of responses for each question is listed under "Frequency, Total" for that question in the table, or below the table when indicated by an asterisk. In Table 5, these responses to a question in a section exceed the frequency listed for that section; it is assumed that some teaching activities may take place although a full laboratory for such activities may not exist. Due to the sensitive nature of this survey, and the perception by the population that some answers may be incriminating, anonymity was protected. This issue also may have led respondents to omit certain demographic data which they felt may lead to their identification. All respondents' answers to open ended questions are available in Appendix D.

## Demographic Data

Seventy-three surveys were mailed to agricultural education programs identified in Directory of Montana Agricultural Educators. All surveys were assumed to be delivered correctly; none were returned due to postal problems. Three requests were made to receive second copies because the original survey was lost by the potential respondent.

Table 1 represents the return rate of surveys over the study period. Eighteen surveys were returned within a week of the initial mailing, for a response rate of 24.7%. A verbal reminder was given at the MVATA meeting in Butte, Montana on October 22, 1999. Approximately 40 teachers were present at this meeting. The eight surveys returned between the MVATA meeting and the mailing of the reminder postcard on November 2, 1999, represent 10.9% of the total returned. Consideration was made in the return period for the occurrence of the National FFA Convention in Louisville, Kentucky October 25-31, 1999. A large majority of the survey population attended this event, therefore disrupting the survey period. On November 2, 1999 a reminder postcard was mailed to encourage those who had not returned their survey to do so. Four surveys were returned between the mailing of the postcard and the cut-off date of November 9, 1999.

They represent 5.5% of the total return. Eleven more surveys, representing 15.1% of the total were returned after November 9, 1999. Late responses were not found to be statistically different from the original responses, by a t-test and Mann Whitney U test, and all were grouped together for a final response rate of 56.2%.

Table 1. Survey responses over time.

| | Date | n | Returned | Percent |
|---|---|---|---|---|
| After 1st mailing | 10/15/99 | 73 | 18 | 24.7 |
| After MVATA reminder | 10/22/99 | --- | 8 | 10.9 |
| After reminder postcard | 11/02/99 | --- | 4 | 5.5 |
| After late response date | 11/09/99 | --- | 11 | 15.1 |
| Total | | | 41 | 56.2 |

Data in Table 2, and Figure 1 depict the age and gender of survey respondents. Seven (17.1%) respondents were within the age range 21-25, 1 (2.4%) respondent 26-30, 5 (12.2%) in the range 31-35, 8 (19.5%) in 36-40, five (12.2%) in 41-45, 10 (24.4%) in 46-50, 4 (9.8%) indicated to be between 51and 55, no respondents were above 55, and 1 (2.4%) respondent did not indicate his age or gender. Thirty-seven (90.2%) respondents indicated they were male, 3 (7.3%) indicated they were female, and 1 (2.5%) did not answer this question.

Table 2. Age group distribution of survey respondents.

| Age group (years) | Frequency | Percent |
|---|---|---|
| 21-25 | 7 | 17.1 |
| 26-30 | 1 | 2.4 |
| 31-35 | 5 | 12.2 |
| 36-40 | 8 | 19.5 |
| 41-45 | 5 | 12.2 |
| 46-50 | 10 | 24.4 |
| 51-55 | 4 | 9.8 |
| 56+ | 0 | 0.0 |
| No response | 1 | 2.4 |
| Total | 41 | 100.00 |

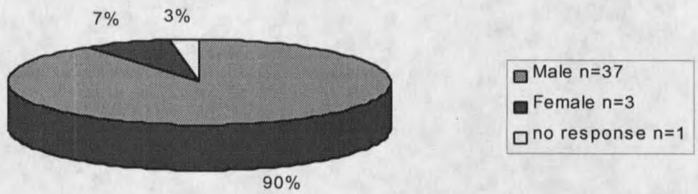


Figure 1.

Gender composition of survey respondents.

The level of education attained by survey respondents was collected and reported in Figure 2. Twenty (48.8%) respondents have acquired a bachelors degree. Eleven (26.8%) have completed some graduate work and 10 (24.4%), have completed studies to the masters level. No respondents (0.0%) have completed doctoral studies.