Factors Influencing Best Management Practice Implementation in Virginia's Chesapeake Bay Drainage Basin

by

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Major Report Submitted to the Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

MASTER OF ENGINEERING
in
BIOLOGICAL SYSTEMS ENGINEERING

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June, 1996
Blacksburg, Virginia

Keywords: Agriculture, Best Management Practices, Cost-Share, Nonpoint Source Pollution, Survey

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(ABSTRACT)

A survey of farmers was conducted to determine the extent of cost-share and non-cost-share BMP implementation and to evaluate the impact of socio-economic variables of the adoption of BMPs in Virginia's Chesapeake Bay drainage basin. Farmers in 67 counties in Virginia were randomly selected using VirGIS land use data and GRASS 4.1. All of the counties included in the study had at least 90 percent of their total land in the Chesapeake Bay drainage basin. Surveys were mailed to approximately 5,850 farm operators and 1,377 responses were returned, with approximately 1,099 estimated to farm in the Chesapeake Bay basin.

A concern for pollution in the Chesapeake Bay was evident by farmers throughout the Bay basin, as 80 percent of the respondents indicated being concerned about water pollution in the Chesapeake Bay. However, only 33 percent believed that their farm contributed to water quality problems. The most often indicated perceived causes of pollution were runoff from urban or paved areas, industrial waste or factory discharge, sewer systems, and litter or garbage.

Hay and beef cattle were the commodities produced by the largest numbers of farmers, as over 70 percent of the farmers grow hay and about 67 percent raise beef cattle. Corn, soybeans, and small grains are the other predominant crops grown in the Chesapeake Bay basin. Accordingly beef cattle, hay, corn, soybeans, and small grains were most often

indicated as the major sources of income. Overall, 81 percent of the farmers implemented a BMP, regardless of the funding, 31 percent implemented a BMP with cost-share funds, and 75 percent implemented a BMP without cost-share assistance. The major cost-share BMPs implemented were hayland or pasture management, permanent vegetative cover, grassed waterways, cover crops, and surface sampling/analysis. The predominant BMPs implemented without cost-share funds were hayland or pasture management, conservation or reduced tillage, cover crops, surface soil sampling/analysis, permanent vegetative cover, and field scouting.

Several regression models were developed to determine the influence of farming characteristics, personal characteristics, farming considerations, and information sources on a farmer's decision to implement BMPs. The most prominent factors in predicting cost-share BMP implementation were the availability of cost-share funds, having a farm conservation plan, and farm size. The production of corn, small grains, or soybeans, and farm size were the major factors in the model used to predict non-cost-share BMP implementation. The model constructed to predict BMP implementation, regardless of the funding, had similar influences as the non-cost-share model. The adoption of a conservation plan also played an important role in BMP implementation. Approximately 55 percent of the farmers had a conservation plan, of which 91 percent implemented a BMP. Of the 45 percent that did not have a conservation plan, only 64 percent implemented a BMP. Farm magazines, extension agents/specialists, ASCS, and NRCS offices were indicated as the major sources of information on BMPs.

Comparisons of the survey results with VDACS-VASS data showed that crop production and land use in Virginia's Chesapeake Bay drainage basin was accurately represented by the survey. DSWC and NRCS databases were used to verify the BMP implementation results. The results of the survey on cost-share BMP implementation were found to be accurate when compared to the DSWC and NRCS databases.

AKNOWLEDGEMENTS

The completion of this research has been possible only with the assistance and encouragement of many people. I wish to express my deepest thanks to Dr. Mostaghimi for his guidance during the course of my graduate studies and research, and for allowing me to be a part of such an interesting and educational project. I am also very appreciative of his keen assistance during the writing of this paper. I would also like to thank Dr. Blake Ross and Ram Gupta for their critique and advice during the final stages of my research. I am especially appreciative of the advice, instruction, and support of Phillip McClellan. Without his help and thorough analysis, many facets of this project could not have been achieved.

I would also like to express my gratitude to Dr. John Perumpral for the financial support afforded me by the department, and to the Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation for funding they provided for this research. Many thanks are certainly due to Michelle Persinger, Mariana Gardner, Rene Sewell, Ron Sheffield, and Nicole Herbert for traveling throughout Virginia with me to gather names and addresses of farmers. I would also like to thank everyone, especially Chris Sims and Nathan Snyder, who assisted in the preparation of the mailings of the survey and data entry.

I would finally like to express my love and thanks to my wife, Leia for her love, patience, support, and assistance during my research, and to my parents and family for their love and support.

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1 Introduction

The deposition of excess sediment and nutrients, primarily nitrogen and phosphorus, originating from nonpoint source (NPS) areas, into Virginia's surface waters is contributing to the degradation and decline of the beneficial uses of the Chesapeake Bay and its tributaries (Crafton, 1985). NPS pollution differs from point source pollution since it does not come from a single identifiable source, and therefore is not conducive to the same types of pollution control practices as point source pollution. NPS pollution is generally affiliated with agricultural and urban runoff, construction sites, forestry operations, and yard care chemicals. NPS pollution in rural areas is often more diffuse than that in urban areas. Runoff from these areas may flow directly into an adjacent stream or river after a rainfall event.

NPS pollution was first addressed at the national level in 1987 when the Water Quality Act Amendment to the Clean Water Act of 1972 was passed. This act required states to develop strategies for information collection and problem assessment, and for program implementation. It has been estimated that 50-70 percent of surface waters, classified as impaired or threatened, are affected by NPS pollution from agricultural activities (Wolf, 1995). The U.S. Environmental Protection Agency reported that NPS pollution is the most significant cause of water pollution in the United States today (Maine Department of Environmental Protection, 1994). Erosion contributes almost 5 trillion kilograms of soil

into the oceans and the nation's rivers and lakes (Napier and Forster, 1982.). Since 1988, the United States Environmental Protection Agency has funded NPS pollution programs totaling over $40 million throughout the United States (Wolf, 1995). The Chesapeake Bay's nine largest tributaries contributed approximately 273 million kg of nitrogen and 14 million kg of phosphorus from 1990 to 1992. About 97 percent of all of the nitrogen and 90 percent of the phosphorus enters the Bay through its three largest tributaries, the Susquehanna, the James, and the Potomac Rivers (USGS, 1995). A model developed by the Chesapeake Bay Program in 1985 estimated that nonpoint sources of pollution contributed approximately 51% of the total nitrogen and 61% of the total phosphorus load into the Chesapeake Bay (EPA, 1992).

The major problem caused by the inflow of these nutrients is that they accelerate the natural eutrophication processes by enhancing excessive algae growth in the Bay which consequently causes other problems within the aquatic environment. The algae growth inhibits sunlight from reaching submerged aquatic vegetation in shallow areas of the Bay, reducing their growth. This lack of growth eventually causes the loss of grass beds which provide food for waterfowl and critical habitat for many Bay creatures. As the algae die and sink towards the bottom, their decomposition causes the consumption of oxygen in deeper portions of the Bay. Dissolved oxygen can be depleted in the warm summer months, and bottom dwelling organisms (both producers and consumers) cannot survive such prolonged periods with excessively low oxygen concentrations (EPA, 1992).

Reducing the nitrogen and phosphorus entering the Bay from agricultural and urban NPS areas is an important action necessary to prevent further water quality degradation of the Chesapeake Bay and it's major tributaries.

Implementation of best management practices (BMPs) on agricultural land is encouraged for control of the NPS pollutants entering adjacent streams and rivers. The Virginia Department of Conservation and Recreation - Division of Soil and Water Conservation (DCR-DSWC) has developed a cost-share program which encourages the voluntary adoption of BMPs to reduce pollution problems and help reach one of the goals of the Chesapeake Bay Act by reducing the flow of nitrogen and phosphorus into the Bay by 40%. The DSWC promotes an incentive program for the adoption of BMPs in order to assist farmers and landowners reduce sediment and nutrient losses into Virginia's waters. The goal of the BMP program in Virginia is to encourage farmers to voluntarily implement BMPs on their land without cost-share assistance.

Data regarding the type and number of BMPs that are implemented through the cost-share program in each Soil and Water Conservation District, as well as in the individual hydrologic units in Virginia, are available through the DSWC records. However there are no official records available pertaining to the amount of BMPs implemented without cost-share assistance. There is also very little information available regarding the factors that impact the farmer's decision to implement a new BMP or continue using an existing

BMPs. Such information would prove to be useful to the DSWC in assessing the effectiveness of their educational and technical assistance programs, and in developing improved strategies to persuade farmers to voluntarily implement BMPs without using the limited cost-share funds.

Objectives

The overall goals of this study were to estimate the amount of cost-share and non-cost-share BMP implementation in Virginia's Chesapeake Bay drainage basin and to determine the major factors that influence farmers to implement cost-share and non-cost-share BMPs. The specific objectives of the study were to:

- Establish estimates of the levels of cost-share and non-cost-share BMPs implemented in Virginia's Chesapeake Bay drainage basin by conducting a statistically designed survey.
- Determine those factors that influence BMP implementation on a cost-share and non-cost-share basis.
- Compare the results of the survey between the five major river basins and the six DSWC regions covered by the survey.
- Verify the survey results regarding the BMP implementation with cost-share funds by comparing the results with the actual data available through the Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation; Virginia Department of Agriculture and Consumer Services; and the Natural Resource Conservation Service in the Chesapeake Bay drainage basin.

2 Literature Review

Factors Influencing Farmers' Decision to Adopt Conservation Practices

Agricultural researchers and rural sociologists have been attempting to understand the factors that influence farmers to implement practices that reduce soil erosion and NPS pollution. Most researchers believe that farmers' lack of awareness of environmental problems, in their county or community is not a major factor in their decision not to implement a conservation practice. Bultena and Hoiberg (1986) state that farmers do, however, underestimate the severity of their own contribution to environmental problems. This phenomenon is called the "proximity effect." In a survey of approximately 3,200 farm operators in erosion prone areas of 13 states, Bultena and Hoiberg (1986) found that 92 percent of the farmers perceived soil erosion as a problem in their home counties, 78 percent in their local communities, but only 66 percent on their own farms. Hoban and Wimberley (1992) also found similar results in a study of farmers that participated in the Rural Clean Water Program and farmers which were eligible but did not participate.

Another factor influencing a farm operator's decision to implement conservation practices is the farmer's economic resources. Farmers who try to maximize short-term profits usually must do so at the expense of long-term productivity and land resource

protection (Swanson et al, 1986). Swanson et al. (1986) presented a recent history of agricultural economics and stated that farmers must continue to increase their scale of operation to remain efficient. During the 1960's and 1970's the scale of agriculture increased due to market pressures, technological growth, and low real interest rates. Even with the high inflation, it was possible to expand land holdings during the 1970's because of the low interest rates. During the 1980's interest rates rose and those farmers with high debt to asset ratios encountered economic difficulties. Over-supply of agricultural products lowered prices, causing reduced farm incomes. The loss of income caused farmers to maximize production by discontinuing practices that did not contribute to short-run profitability and ignoring soil erosion control practices in order to survive in the short-term. Tax policies that encourage investment in production technologies and price support programs that establish a minimum price also contribute to the agricultural pollution problems. The combination of these two factors encourage farmers to invest capital in production technologies and maximize production rather than invest in conservation practices (Swanson, et al., 1986). A study of Missouri farmers concluded that those farmers that adopted conservation practices were motivated by a "perception of profitability" with these practices (Ervin, 1981). Swanson et al. believe that the elimination of incentives to keep marginal land in production, revision of tax policies to reward farmers that implement soil conservation practices, and more careful targeting of incentives to the most erodible areas would decrease erosion problems.

Sources of information and personal attitudes also influence the decision making process of implementing a conservation practice. The adoption/diffusion model is the most prominent model developed to help understand the role of information in farmers' decision-making process (Bultena and Hoiberg, 1986). This model asserts that failure to adopt any object, practice, or technology is a partial function of being denied access to information, which in turn prevents individuals from being aware of potential solutions to perceived problems (Swanson et al., 1986). In general, farmers initially receive information on specific practices from farm magazines and other mass media sources. These sources are gradually replaced by other farm operators, government agencies, and personal experiences as the trial stages of decision making progresses (Bultena and Hoiberg, 1986). Once farmers develop positive attitudes towards conservation alternatives, they will act on the basis of adopting practices that they believe will solve perceived problems (Napier et al., 1988). Four attitudes that have an impact on a farmer's willingness to adopt conservation practices were discussed by Napier and Forster (1982). Attitudes toward land controls, vested-interest perspectives, attitudes toward land stewardship, and agrarianism all effect a farmers decision to implement a BMP.

- Farmers tend to strongly oppose land use controls in which government intervention affects their rights to determine how to use their own land.
- Farmers, however, favor government involvement when it is to their advantage, such as cost-share funding and technical assistance. Thus, they tend to resist any program that does not benefit them directly.

- Farmers perceive themselves as stewards of the land and such a belief should be a motivating factor in the adoption of conservation practices.
- Agrarianism also would motivate a farmer to implement conservation practices that protect land resources.

Survey Methodologies and Results

Numerous surveys have been conducted in order to determine the factors involved in a farmer's decision to adopt conservation practices. These studies have used descriptive and multivariate statistics to determine farmer's characteristics and attitudes. They have also attempted to predict such variables as "willingness to participate in a tenant buy-down program", "willingness to sell row-cropping rights to erosion prone land", the effect of personal and farm characteristics, favorability toward conservation compliance, adoption of selected farm practices, and attitudes toward groundwater pollution (Napier, et al., 1988, Swanson et al., 1986, Napier and Brown, 1993, Napier and Napier, 1991, and Cameron-Howell, 1992)

Swanson et al. (1986) conducted a survey of 918 Ohio farmers in order to determine what types of conservation practices the farmers were using and to build predictive models using personal and farm characteristics to explain frequency of conservation practice use. Ten conservation practices were studied to determine the frequency of their use by farm operators. Multivariate analyses were used to build the predictive models. Farm

characteristics were the best predictors of the frequency of conservation practice use. Farmers with higher levels of education, increased exposure to information sources, and environmental concerns tended to adopt more conservation practices. Age, years of farming experience, and size of farm were not significant factors in predicting the use of these conservation practices.

A study of the Oakwood Lakes/ Poinsett Rural Clean Water Program (RCWP) participants was conducted to determine the influence of the program on them, the reasons they signed up for the program, and if a change in farming methods resulted from participation in the program (Cameron-Howell, 1992). Ninety-five surveys were mailed to former participants in the RCWP, of which 49 were completed and returned. Descriptive statistics, chi-square, and frequency analyses were used to describe the farmers' attitudes and farming practices. About 59 percent of the respondents indicated a change in tillage methods from plowing to conservation tillage as a result of their participation in the RCWP. Fifty-five percent thought that their crop productivity increased, mainly because of an increase in soil moisture. The primary sources of information on the RCWP were neighbors, and the SCS and ASCS offices. Most of the farmers (76 percent) felt that participation in the RCWP improved water quality in Oakwood Lakes or Lake Poinsett. The primary motivation to join the program was the cost-share incentives, however 82 percent of the farmers continued conservation tillage after the program benefits ceased (Cameron-Howell, 1992).

Napier et al. (1988) collected data from 552 land-operators in erosion prone areas of central and western Ohio to determine their "willingness to participate in a tenant buy-down program" and "willingness to sell row-cropping rights to erosion prone land". The study participants were selected using a systematic sampling technique in which every other occupied farmstead in the study area was chosen. Descriptive and multivariate statistics were used to analyze the data. These descriptive analyses showed that the respondents believed soil erosion control practices can produce profits for landowners who use them, are relevant to their farming operation, and are useful and that farmers should have absolute rights to farm land they own but should not be free to abuse land resources. The multivariate analyses revealed that the respondents who were more favorable toward participation in the interest buy-down program believed that farmers who wish to adopt erosion control practices should not be required to pay the costs of adoption; farmers should not have absolute rights to land; farmers should not be permitted to abuse land resources; erosion control practices could increase profits; erosion control practices were relevant to their farming operations; and soil erosion was a problem on their farm. Those farmers who were more willing to sell row-cropping rights believed that farmers do not have absolute rights to land and that they should be forced to use soil conservation practices on highly erosive land. They also believed that farmers who adopt soil erosion control practices should not have to pay the costs of adoption. These farmers owned more acres being damaged by soil erosion, and derived higher percentage of their gross farm income from non-grain farm products. Both predictive

models explained approximately 22 percent of the variability of the dependent variable.

Napier and Napier (1991) conducted a survey of 371 land-owner operators in central Ohio to assess their attitudes toward conservation compliance. Farmers were selected using the systematic sampling technique previously discussed. Multivariate statistics were used to measure the favorability toward conservation compliance using farm characteristics, attitudes of the owner-operators, and perceptions of compliance as independent variables. A zero-order correlation coefficient was used to examine the relationship between the dependent and independent variables. These analyses revealed that those farmers who were most favorable toward conservation compliance perceived that conservation compliance will produce benefits for their farming operation; believed that farmers do not have absolute rights to land; reported greater awareness of agriculturally induced pollution; had greater knowledge of conservation compliance; believed that conservation compliance will not change production costs substantially; and participated in more federal farm programs. Regression analysis were used to assess the relative explanatory power of the independent variables. Increased favorability towards conservation compliance was explained by increased benefits of conservation compliance, less absolute rights of farmers, more knowledge of conservation compliance, awareness of agriculturally induced pollution, and little impact of conservation compliance on production costs. This model explained 55.3 percent of the variance in the dependent variable.

Napier and Camboni (1993) collected data from 1,305 farm operators in the Scioto River watershed in Ohio to examine the use of conventional and conservation farming practices. The sample size of each county was determined based on the number of farmers in each county. The sample population was selected using the systematic sampling techniques through which they conducted interviews with occupants of every other farmstead. The survey contained questions concerning the types of agricultural practices used; concern for groundwater pollution; perceived knowledge of groundwater pollution; perceived threat of groundwater pollution to their health; perceived impact of conservation farming on production costs; use of well water for household consumption; and farm and personal characteristics. Regression analyses were used to determine the significant factors involved in adopting different farm practices. The model used to predict use of soil testing had an adjusted coefficient of determination of 0.16, and showed that those farmers that used soil testing tended to have more knowledge of groundwater pollution in their county of residence; reported higher gross farm income; used well water for household purposes; reported a higher proportion of gross farm income from grain production; used more sources of information about groundwater pollution; and participated in numerous farm programs. The model used to predict winter application of manure explained about 29 percent of the variance and demonstrated that those farmers most likely to apply manure in the winter were more knowledgeable of groundwater pollution; were younger; reported higher gross farm income; used well water for household purposes; reported lower percentages of gross income from grain farming;

higher percentages of gross income from animal production; reported less concern about groundwater pollution; and participated in more government farm programs. Models were developed to predict use of ten different practices, however eight of these models had an adjusted coefficient of determination of less than 0.10 and were not discussed because they did not successfully explain the variability regarding the use of the farm practices. Napier and Napier (1991) concluded that until good predictive models are developed concerning the adoption of soil and water conservation practices, billions of dollars and a tremendous amount of human effort will be spent on conservation programs that will produce relatively little effect.

Napier and Brown (1993) used the data collected from the study discussed previously to determine the factors affecting attitudes toward groundwater pollution. A Groundwater Pollution Index was developed and used as the dependent variable in a multivariate regression model by using the perceived importance of groundwater pollution as an environmental problem and action options needed to prevent groundwater pollution. Respondents who believed that their families were threatened by fertilizers and pesticides in the groundwater; and used well water for household consumption were more willing to change production practices to protect groundwater resources. Those farmers who were more knowledgeable of groundwater pollution in their county, had higher debt to asset ratios, and more specialized in grain production were less concerned about groundwater pollution and less willing to change farming practices to protect groundwater resources.

Those farmers that farmed more acreage believed that production costs would increase if they implemented practices to protect groundwater resources. The regression model explained about 33.8 percent of the variation in the groundwater pollution index score.

Hoban and Wimberley (1992) conducted a study of farmers participating in the Rural Clean Water Program (RCWP) and farmers who were eligible, but chose not to participate. Twenty-one RCWP project areas were used in the study and the appropriate number of farmers were selected at random from each of these areas based on the cubic root of farm operators from a given area participating in the RCWP. This procedure was taken in order to achieve a compromise between selecting a proportionate number of farmers based on the population of farm operators in each area and selecting an equal number of farmers from each project area regardless of the number of farm operators. An advisory committee consisting of RCWP officials, project personnel, social scientists, and others who had experience with RCWP was established to provide advice on sampling design and survey content. Telephone interviews were conducted and a response rate of almost 85 percent was achieved. The response rate was higher for those farm operators that participated in the RCWP compared to those that did not participate. The study attempted to describe the results in terms of water quality awareness and information; attitudes about water quality problems; adoption of BMPs; participation in the RCWP; and attitudes about public policies and programs. Farm magazines were the most

frequently cited sources of information followed by government agricultural and conservation agencies. About 57 percent of the respondents believed that water pollution was either a "serious problem" or "somewhat of a problem" in their area, whereas only 21 percent felt that water pollution was either a "serious problem" or "somewhat of a problem" on their farms. Approximately two-thirds of the respondents were concerned about pollution of their own drinking water. Over one-third of the respondents indicated runoff from cropland as a cause of water pollution (which was the most frequently mentioned cause). About 25 percent mentioned pesticides and 20 percent mentioned fertilizers as causes of water pollution.

Non-agrarian causes of pollution, such as industrial and municipal discharge, septic tanks, litter or garbage, and urban runoff constituted 45 percent of the reported causes of pollution. Forty-six percent of the farmers believed that the farming practices used had no significant impact on water quality, and over 75 percent felt that agriculture is being unfairly blamed as a cause of water quality problems. Soil testing, pesticide management, conservation tillage, grass waterways, and cover crops were reported as being used by over 70 percent of the farmers responding to the survey. In general, BMPs that tended to be more management oriented, rather than structural were the most frequently implemented practices. The major factors influencing the adoption of BMPs were the cost of the practice; potential to improve water quality; the practice's effect on profits; the ease of use; and labor and time required. All of these factors were indicated by at least 50

percent of the respondents as a very important consideration (Hoban and Wimberley, 1992)

Hoban and Wimberley (1992) also attempted to determine what factors influenced the 680 farmers who participated in the RCWP. The major reasons were their concern for pollution and availability of cost-share funds. The major reasons given by the 481 farmers that chose not to participate in the RCWP were no pollution problem, either on their farm or in general, resistant to change because the farmer's current practices work well or that changing practices would involve too much trouble, and a dislike of government programs because of too much red tape or complicated procedures. Most farmers seem to support the voluntary approach taken by the RCWP and 96 percent believed that "water pollution can best be controlled through educational programs that encourage farmers to use BMPs." About 89 percent felt that "if farm operators don't do more to protect water quality on their own, the government will force them to protect water quality through regulations" and 69 percent agreed that the government should help pay more for water pollution control on farms.

Virginia's Cost-Share Program

The Virginia cost-share program provides state and federal funding to farmers, and local Soil and Water Conservation Districts (SWCD) administer the implementation of the

BMPs. The SWCD seek farmer participation in this program based on need as determined from the use of major agricultural activities that influence water quality, soil properties, and animal unit numbers. These factors are analyzed to determine relative water quality degradation for individual hydrologic units. Funding is allocated to the hydrologic units with the potential for the most significant water quality problems. The Districts recruit those farmers from within the most critical hydrologic units which have both the willingness to voluntarily participate in the cost-share programs and have the potential to make substantial improvements in protecting water quality (DSWC, 1995).

There are three major requirements for participation in the cost-share program (DSWC, 1995):

- Participants must have lands that are classified as either 1/3 highly erodible land (HEL) or have a water quality index (WQI) category rating of 5 or greater or have an erosion index (EI) value of 8 or greater. The WQI rating is determined using the VirGIS overlay maps.
- Priority consideration must be given to those candidates in the highest ranked hydrologic unit for water quality degradation potential.
- No practice may be installed with cost-share funds unless a conservation plan exists for the field in question.

Some possible exceptions to the first requirement are the implementation of animal waste control facilities, loafing lot management systems, composter facilities, permanent vegetative cover on critical areas, stream protection, vegetation stabilization of marsh

fringe area, water table control structures, and woodland erosion stabilization. Sod waterways, small grain cover crop for nutrient management, grazing land protection, grass filter strips, and sediment retention, erosion or water control structures can also be accepted practices under appropriate conditions.

The 1995 Virginia Agricultural BMP Cost Share Manual outlines the description, purpose, cost-sharing authorization/eligibility requirements, specifications, cost-sharing rates, and technical responsibility of the farmer for 22 BMPs (DSWC, 1995). Although most of the BMPs are designed to control erosion or surface runoff from cropland, there are several that are intended for animal waste and pasture management, and conservation practices using forest management techniques. A list of BMPs eligible for Virginia SWCD cost-share funds, a brief description and purpose of the practices, and the rate of cost-sharing available for each is listed in Table 2.1 (DSWC, 1995).

The cost-share funding limits are maintained by the SWCD so that specific identified water quality problems can be addressed. As described in the Virginia Agricultural BMP Cost-Share Program Manual (DSWC, 1995):

- The individual cost-share funds limit is between $2,000 and $7,500 for all crop and pasture land BMPs per applicant per year depending on the Soil and Water Conservation District. This limit is established by each District board, with the same limit being applied to all participants throughout the District.
- For the animal waste control facilities and the loafing lot management

systems, a limit of either $7,500 or $20,000 per applicant per year is imposed. The $7,500 limit is used for the construction of an animal waste storage structure, such as a lagoon or pond, and the associated components that are a part of the planned animal waste management system. The $20,000 limit is used for the construction of a fabricated liquid waste storage structure and associated components that are a part of the planned animal waste management system. The $20,000 limit can only be applied when a fabricated structure is the only acceptable structural alternative based on site limitations, such as high water table or karst topography, for liquid waste management.

- Applicants may receive the sum of these two limits for the implementation of both animal waste storage facilities and cropland/pastureland BMPs.

State sponsored cost-share funds do not apply to all lands in order to avoid overlap or conflict with federal cost-sharing programs. Lands that have been identified as being in violation of "sodbuster" provisions are not eligible if not carrying out an approved plan to return to sod condition or not eligible if used on converted woodland. Other lands not eligible for state cost-sharing are those identified as being in violation of "swampbuster" provisions, those lands enrolled under the Conservation Reserve Program (CRP), and those lands under the Wetlands Reserve Program (WRP). Lands identified as highly erodible (HEL) are eligible, as well as land enrolled under CFSA-ACP program, as long as CFSA policies and procedures are met.

Table 2.1. Best Management Practices Eligible for Virginia DSWC Cost-Share Funding.

BMP	Description and Purpose	Rate of Cost-Sharing
Animal Waste Control Facilities	A planned system designed to manage liquid and solid waste from areas where livestock and poultry are concentrated to improve water quality by storing and spreading waste at the proper time, rate, and location.	75% of total eligible cost
Loafing Lot Management Systems	Lots used for herd exercise and loafing to prevent those areas exposed to heavy livestock traffic from experiencing excessive manure and soil losses due to the destruction of ground cover.	75% of total eligible cost
Composter Facilities	A planned system designed to manage treatment and disposal of poultry carcasses resulting from normal mortality, thus improving water quality by composting the carcasses and spreading the composted material at the proper time, rate, and location.	75% of total eligible cost
Buffer Stripcropping	A series of narrow permanent protective strips of sod alternating with wider strips of row or close growing crops to reduce erosion and surface runoff and improve water quality.	$15/acre
Diversions	A channel with a supporting ridge on the lower side constructed across the general land slope to improve water quality by directing nutrient and sediment laden water from large areas to sites where it can be used or disposed of safely.	75% of total eligible cost

Table 2.1. Continued.

BMP	Description and Purpose	Rate of Cost-Sharing
Grass Filter Strips	Vegetative buffers located along the banks of water courses to filter runoff, anchor soil particles, and protect banks against scour and erosion, thus improving water quality by filtering fertilizers, pesticides, sediment, and microorganisms that otherwise may reach waterways.	$175/acre
Grazing Land Protection	A structural and/or management practice that will enhance or protect vegetative cover to reduce runoff of sediment and nutrients from existing pasture land and reduce NPS pollution associated with grazing livestock.	75% of total eligible cost
Legume Cover Crop	Establishment of a cover crop to utilize an adequate legume mulch residue as a natural source of nitrogen to reduce applied soil amendment nitrogen and improve water quality by preventing erosion and serve as a desirable mulch for no-till cultivation.	$25/acre
No-Till Pasture-Land and Hayland	Re-establishment of pastures and hayland with no-till grasses and legumes to reduce soil erosion, enhance water quality, and improve sod cover.	$25/acre
Permanent Vegetative Cover on Critical Areas	Land shaping and planting of a permanent vegetative cover on critically eroding areas to improve water quality by stabilizing soil, thus reducing the movement of sediment and nutrients from the site.	75% of total eligible cost
Protective Cover for Specialty Cropland	Establishment of a vegetative cover on specialty cropland to provide an incentive to keep a cover on cropland when it is not being used after harvest of the specialty crop, such as tobacco and vegetables.	$10/acre

Table 2.1. Continued.

BMP	Description and Purpose	Rate of Cost-Sharing
Reforestation of Erodible Crop and Pasture land	Tree planting on cropland and pasture land to provide an incentive to change land use to one that will more effectively control the soil and nutrient loss from surface runoff.	$75/acre
Sediment Retention, Erosion or Water Control Structure	Structures that will collect and store debris or control the grade of drainage ways to improve water quality by reducing the movement of sediment and materials from agricultural land to receiving streams.	75% of total eligible cost
Sod Waterways	A natural or constructed waterway, shaped or graded and established in suitable vegetation, to safely convey water across areas of concentrated flow and improve water quality by reducing the movement of sediment and nutrients from agricultural nonpoint sources.	75% of total eligible cost
Stream Protection	Protection methods, such as fencing or shrubs and grasses, along streams to reduce erosion, sedimentation, and the pollution of water from agricultural nonpoint sources.	75% of total eligible cost
Stripcropping Systems	Growing crops in a systematic arrangement of strips or bands across the general land slope to reduce water erosion and nutrient loss.	$30/acre + 75% of total eligible component cost
Terrace Systems	An earth embankment, channel, or a combination ridge and channel constructed across the slope to improve water quality by reducing slope and slope length to one that will slow the movement of sediment and nutrients from cropland.	75% of total eligible cost

Table 2.1. Continued.

BMP	Description and Purpose	Rate of Cost-Sharing
Vegetative Stabilization of Marsh Fringe Area	Establishment of a fringe marsh buffer area for tidal shoreline stabilization so that the establishment of a natural and environmentally acceptable fringe buffer of selected marsh grasses will provide to stabilization protection on tidal waters.	50% of total eligible cost
Water Table Control Structure	A water control structure for the management of drainage water to regulate and manage drainage water to improve water quality by trapping sediment and managing dissolved or suspended nutrients.	75% of total eligible cost
Woodland Buffer Filter Area	Establishment of a forest buffer to provide streambank protection and to control soil erosion, sedimentation, and nutrient loss from surface runoff of agricultural nonpoint sources.	$100/acre
Woodland Erosion Stabilization	Land shaping and planting permanent vegetation on critically eroding areas on forest harvesting sites to improve water quality by stabilizing soil.	75% of total eligible cost
Small Grain Cover Crop for Nutrient Management	Establishment of vegetative cover on cropland for protection from erosion and the reduction of nutrient losses to groundwater.	$10/acre or $15/acre depending on the type of cover planted

Source: Virginia Agricultural BMP Cost-Share Program Manual, (DSWC,1995).

3 Methodology

Survey Development

Many sources were consulted in the initial development of the survey. Ideas and suggestions from the staff of the Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, (DSWC), a sociologist, an economist, and faculty and staff of the Virginia Tech Biological Systems Engineering Department were combined to develop an original draft of the survey. The first draft contained 67 questions dealing with agricultural production, fertilizer and pesticide use, extent of BMP implementation, factors influencing BMP implementation, and personal opinions and information. Surveys conducted by the Maryland Farm Bureau and by North Carolina State University were used as guides for the initial development of this survey. Due to the many considerations of the size and medium of implementation, the survey was revised several more times. The survey was finally reduced to 35 questions (Appendix A). Once the survey was near completion, staff of the Virginia Farm Bureau Federation were invited to make any suggestions which would improve the quality of the survey or make the survey more easily completed by the farm operator. The Center for Survey Research at Virginia Tech was then contacted to improve the overall quality of the survey. A cover letter, cosigned by the Director of the DSWC, and the President of the Virginia Farm Bureau Federation, was sent to the farm operators. The cover letter explained the goal of

the survey and ensured confidentiality of the farmers' responses.

Sample Population Determination and Sampling Procedures

In order to successfully and accurately gain information pertaining the farming practices and implementation of BMPs throughout Virginia's Chesapeake Bay drainage basin, several steps were undertaken. Sixty-seven counties located in the Chesapeake Bay region of Virginia were surveyed. The criteria for choosing whether a county would be included in the study was based on the percentage of land area in a given county which drains to the Chesapeake Bay. Any county which had less than ten percent of its area in the Chesapeake Bay drainage basin was not included in the survey. Once the counties had been selected, the number of surveys needed to reach the established statistical criteria was calculated. Farm operators were chosen as the survey unit and all of the following procedures deal with the farm operator, rather than a particular farm. It was estimated that approximately 24,000 farmers exist in the Chesapeake Bay basin in Virginia. Procedures suggested by Thompson (1992) were used to determine the sample size needed to obtain a 95% confidence level with 3% error. Based on these procedures it was determined that 1,341 completed surveys were needed for the study.

The number of surveys required from each county was determined by the following formula:

$$1{,}341 \; X \; \frac{\textit{No. of Farmers within the County}}{\textit{No. of Farmers within the Chesapeake Bay Basin}}$$

Any calculations with a remainder were rounded up to the nearest integer in order to determine the number of surveys required for each county. After these calculations for individual counties were completed, an estimated 1,478 completed surveys were required for our analysis in order to obtain the established statistical criteria of a 95% confidence interval with 3% error for each county. The required number of completed surveys was multiplied by four, based on an estimated 25% response rate, to determine the number of surveys to mail for each county. Table 3.1 lists the number of surveys necessary to reach the statistical criteria set for each county, and the number of surveys mailed to and received from each county.

VirGIS landuse data was used for most counties, with GRASS 4.1, to randomly select the agricultural landuse parcels. The random selection of locations was performed by the random subroutine within GRASS 4.1. The number of agricultural landuse parcels randomly selected was calculated by multiplying the number of surveys to be mailed by 1.75 to account for duplication of farm operators in the random selection. The random selection of locations in the counties of Accomack, Alleghany, Amherst, Bath, Craig,

Table 3.1. Summary of Surveys Mailed and Received.

COUNTY	# FARMS	# OF SAMPLES NEEDED	# OF SURVEYS RECEIVED	% OF SURVEYS RECEIVED
Accomack	323	19	17	92
Albemarle	772	44	43	98
Alleghany	150	12	8	67
Amelia	322	19	21	100
Amherst	408	23	23	99
Appomattox	358	21	18	88
Augusta	1536	86	90	100
Bath	135	12	8	67
Bedford	1240	70	71	100
Botetourt	532	30	34	100
Buckingham	346	20	15	76
Campbell	628	36	31	87
Caroline	220	13	14	100
Charles City	47	12	8	67
Chesapeake	223	13	11	85
Chesterfield	169	12	12	100
Clarke	315	18	15	83
Craig	177	12	8	67
Culpeper	492	28	20	71
Cumberland	277	16	14	87
Dinwiddie	373	21	21	98
Essex	142	12	11	92
Fairfax	198	12	15	100
Fauquier	978	55	44	80
Fluvanna	261	15	16	100
Frederick	555	32	28	89
Gloucester	130	12	9	75
Goochland	253	15	10	68
Greene	225	13	9	69
Hanover	554	32	33	100
Henrico	158	12	6	50
Highland	303	17	22	100
Isle of Wight	245	14	10	70
James City	68	12	7	58
King and Queen	157	12	7	58
King George	141	12	9	75
King William	121	12	6	50
Lancaster	84	12	7	58
Loudoun	934	53	41	78
Louisa	397	23	27	100
Madison	441	25	25	99
Mathews	77	12	6	50
Middlesex	83	12	11	92

Table 3.1. Continued.

COUNTY	# FARMS	# OF SAMPLES NEEDED	# OF SURVEYS RECEIVED	% OF SURVEYS RECEIVED
Nelson	365	21	17	81
New Kent	72	12	10	83
Northampton	180	12	9	75
Northumberland	159	12	10	83
Nottoway	302	17	15	86
Orange	424	24	21	87
Page	489	28	29	100
Powhatan	212	12	15	100
Prince Edward	353	20	21	100
Prince George	167	12	12	100
Prince William	272	16	14	89
Rappahannock	288	17	17	100
Richmond	148	12	13	100
Rockbridge	682	39	47	100
Rockingham	1895	107	116	100
Shenandoah	830	47	49	100
Spotsylvania	305	18	24	100
Stafford	197	12	14	100
Suffolk	314	18	16	89
Surry	126	12	12	100
Va. Beach	165	12	5	42
Warren	223	13	17	100
Westmoreland	181	12	7	58
York	66	12	6	50
Ches. Bay Basin	23963	1341	1377	100

BOLD names indicate the number of responses received were greater than the nu

Cumberland, Dinwiddie, Highland and Surry was accomplished by choosing locations from within the entire county boundary, since no land use data was available for these counties. Because the selection of random locations in these counties was not based on the agricultural land use of the county, many more points were chosen due to the increased probability that the selected locations may not be in an agrarian portion of the county. Once the appropriate number of points were selected, maps containing agricultural land use cells and road networks were created for each county.

The names and addresses of the farm operators, corresponding to the random locations, were obtained using primarily the information available in county USDA-ASCS offices. Their aerial photographs closely agreed with the maps generated from the VirGIS land use data. The selection of farmers in those counties for which VirGIS land use data was not available was more difficult because the random locations were not based on agricultural areas. Therefore, the nearest farm operation to the randomly-selected point was chosen. However, the name and address of the farm operator for many of the locations selected could not be found in the ASCS records and investigation into the county tax maps was needed in order to determine the owner of the land. After the names and addresses had been obtained, they were entered into a database format of Quattro Pro and sorted so that a farmer with operations in more than one county would not receive more than one survey.

Implementation of the Survey

The first mailing of the survey was sent during the first week of October, 1994. Approximately 5,850 surveys were mailed. A reminder card was sent in mid-November to remind the recipients of the surveys to promptly complete the survey and return it to Virginia Tech. The second mailing of the survey, approximately 4,800 surveys, occurred during the third week of December, 1994. The difference in the number of surveys mailed between October and December mailings (approximately 1,050 surveys) were not all due to completed responses; many were returned to indicate that the recipient no longer had a farming operation and others were returned due to address problems. A second reminder card was mailed during the second week of January 1995 to encourage farmers to complete and return their survey.

Data Entry

Procedures in dBASE were developed for the entry of the survey information from each county. The survey was separated into four portions and the information for each portion was entered into three separate files. The first dBASE file contains the first and last portions of the survey (Questions #1 - #5 and #24 - #35, Appendix A) which mainly dealt with the personal opinions and information of the responding farm operator. The second file contains information concerning the agricultural production, extent and type of BMPs implemented, and satisfaction of those BMPs used (Questions #6 - #11, Appendix A).

The third file contains a variety of questions dealing with many factors which have influenced the implementation or non-implementation of BMPs and future adoption of BMPs and the perceived effects of BMPs on production, farm income, labor demand and general knowledge of water quality (Questions #12 - #23, Appendix A).

Data Analysis

Summaries of each of the three files were produced. A summary of the three files was produced for each individual county, the five major drainage basins, the six Division of Soil and Water Conservation (DSWC) Field Offices, and the entire Chesapeake Bay drainage basin in Virginia. The five major drainage basins are the Potomac River, Rappahannock River, York River, James River, and Chesapeake Bay Coastal basins. The six DSWC Field Offices surveyed were the Central Tidewater, Central Virginia, Northern Piedmont, Shenandoah Valley, and portions of the Southeast Virgnina, and Southside Virginia Field Offices. The percentage of the farmland in each county that lies in the major river basins is indicated in Table 3.2. Table 3.3 lists the counties that comprise the DSWC Field Office regions. The error associated with a 95 percent confidence level for the major river basins and the DSWC regions is listed in Table 3.4.

Table 3.2. Percentage of Agricultural Land in the Major River Basins.

County	Potomac Basin	Rappahannock Basin	York Basin	James Basin	Coastal Basin	Ches. Bay Basin
Accomack	0	0	0	0	56	56
Albemarle	0	0	2	98	0	100
Alleghany	0	0	0	100	0	100
Amelia	0	0	0	100	0	100
Amherst	0	0	0	100	0	100
Appomattox	0	0	0	74	0	74
Augusta	90	0	0	10	0	100
Bath	0	0	0	100	0	100
Bedford	0	0	0	11	0	11
Botetourt	0	0	0	92	0	92
Buckingham	0	0	0	100	0	100
Campbell	0	0	0	3	0	3
Caroline	0	25	75	0	0	100
Charles City	0	0	0	100	0	100
Chesapeake	0	0	0	6	0	6
Chesterfield	0	0	0	100	0	100
Clarke	100	0	0	0	0	100
Craig	0	0	0	85	0	85
Culpeper	0	100	0	0	0	100
Cumberland	0	0	0	100	0	100
Dinwiddie	0	0	0	13	0	13
Essex	0	90	0	0	10	100
Fairfax	100	0	0	0	0	100
Fauquier	51	49	0	0	0	100
Fluvanna	0	0	0	100	0	100
Frederick	100	0	0	0	0	100
Gloucester	0	0	39	0	61	100
Goochland	0	0	4	96	0	100
Greene	0	44	0	56	0	100
Hanover	0	0	90	10	0	100
Henrico	0	0	0	100	0	100
Highland	34	0	0	66	0	100
Isle of Wight	0	0	0	57	0	57
James City	0	0	23	77	0	100
King and Queen	0	0	77	0	23	100
King George	25	75	0	0	0	100
King William	0	0	100	0	0	100
Lancaster	0	97	0	0	3	100
Loudoun	100	0	0	0	0	100
Louisa	0	0	98	2	0	100
Madison	0	100	0	0	0	100
Mathews	0	0	0	0	100	100
Middlesex	0	58	0	0	42	100

Table 3.2. Continued.

County	Potomac Basin	Rappahannock Basin	York Basin	James Basin	Coastal Basin	Ches. Bay Basin
Nelson	0	0	0	100	0	100
New Kent	0	0	42	58	0	100
Northampton	0	0	0	0	64	64
Northumberland	59	1	0	0	40	100
Nottoway	0	0	0	62	0	62
Orange	0	52	46	1	0	100
Page	100	0	0	0	0	100
Powhatan	0	0	0	100	0	100
Prince Edward	0	0	0	94	0	94
Prince George	0	0	0	35	0	35
Prince William	100	0	0	0	0	100
Rappahannock	0	100	0	0	0	100
Richmond	0	100	0	0	0	100
Rockbridge	0	0	0	100	0	100
Rockingham	100	0	0	0	0	100
Shenandoah	100	0	0	0	0	100
Spotsylvania	0	17	83	0	0	100
Stafford	49	51	0	0	0	100
Suffolk	0	0	0	43	0	43
Surry	0	0	0	43	0	43
Va. Beach	0	0	0	0	1	1
Warren	100	0	0	0	0	100
Westmoreland	59	41	0	0	0	100
York	0	0	75	1	24	100

Table 3.3. DSWC Field Offices Regions and the Counties the Comprise each Region.

DSWC Field Office	Counties
Central Tidewater	Caroline, Charles City, Essex, Gloucester, Hanover, James City, King and Queen, King George, King William, Lancaster, Mathews, Middlesex, New Kent, Northumberland, Richmond, Spotsylvania, Stafford, Westmoreland, York
Central Virginia	Albemarle, Amherst, Appomattox, Buckingham, Campbell, Chesterfield, Cumberland, Fluvanna, Goochland, Henrico, Louisa, Nelson, Powhatan, Prince George
Northern Piedmont	Culpeper, Fairfax, Fauquier, Greene, Loudoun, Madison, Orange, Prince William, Rappahannock
Shenandoah Valley	Alleghany, Augusta, Bath, Botetourt, Clarke, Craig, Frederick, Highland, Page, Rockbridge, Rockingham, Shenandoah, Warren
Southeast Virginia*	Accomack, Isle of Wight, Northampton, Surry, Chesapeake, Suffolk, Virginia Beach
Southside Virginia*	Amelia, Bedford, Dinwiddie, Nottoway, Prince Edward

* These DSWC Field Offices have other counties under their jurisdiction that were not covered by the survey.

Table 3.4. Sample Size and Error Values with a 95% Confidences Level for the Major River Basins, the DSWC Field Office Regions and the Chesapeake Bay Drainage Basin.

	Sample Size	Total # of Farmers	% of Total Farmers	Error with 95% C.L.*
Potomac River Basin	423	8035	5 %	±6 %
Rappahannock River Basin	150	2813	5 %	±9 %
York River Basin	117	1918	6 %	±11 %
James River Basin	373	7198	5 %	±6 %
Coastal Rivers Basin	36	622	6 %	±19 %
Central Tidewater	198	2932	7 %	±8 %
Central Virginia	222	4771	5 %	±8 %
Northern Piedmont	195	4252	5 %	±8 %
Shenandoah Valley	434	7822	6 %	±6 %
Southeast Virginia	77	1576	5 %	±13 %
Southside Virginia	135	2590	5 %	±10 %
Chesapeake Bay Basin	1099	20585	5 %	±4 %

* Expected error values associated with the survey results.

Descriptive Analyses

Descriptive analyses were performed using Statistical Analysis Software (SAS) on each of the major river basins, the DSWC Field Offices, and the Chesapeake Bay drainage basin. This information was used to compare the farmers' attitudes, and personal and farm characteristics, throughout different regions in the Chesapeake Bay drainage basin, as well as attempting to describe and characterize the farmers throughout the Bay drainage basin.

Multivariate Analyses

Multiple regression analyses were used within SAS to determine the factors involved in a farmer's decision to implement a cost-share BMP, a non-cost-share BMP, or either type of BMP. To perform this type of multiple regression analysis a large random sample should be gathered so that one can achieve the statistical significance desired when determining which factors independently influence the dependent variable. The number of cost-share practices, non-cost-share practices and either type of practice implemented were summed and an index was developed using the number of practices adopted to obtain three separate dependent variables. The cost-share index was the sum of cost-share practices implemented with a maximum index score of five. The non-cost-share index and any BMP index were calculated similar to the cost-share index by summing the appropriate number of practices adopted. The maximum index score for both the non-cost-share

index and any BMP index was ten. For example, if a farmer implemented four different cost-share practices the cost-share index would equal four. However, if another farmer adopted seven different cost-share practices the cost-share index would equal five.

The regression analyses were used to determine the factors influencing the use of BMPs for farmers in the Chesapeake Bay drainage basin, therefore the entire sample population was used in these analyses. The models were developed so that farming characteristics, personal characteristics, including water quality concerns, farming considerations, information sources, factors that were prominent in a farmer's decision to implement any previously adopted BMPs, factors that were prominent in a farmer's decision to implement new BMPs, and several opinion statements could be separately analyzed. From the regression analyses one can determine the relative importance of independent factors involved in a farmer's decision to implement BMPs. The significant factors from the separate models were grouped into a single model for each BMP index to attempt to predict the number of BMPs implemented.

Verification of the Survey Results

Several different data sources were assembled to assess the reliability of the information collected by the survey. The verification primarily focused on the production of various commodities and BMP implementation. Comparative information concerning the BMP implementation were available from several different sources. Those sources used in the

verification process included:

- The 1992 Virginia Agriculture Statistics Summary (VDACS-VASS). Virginia Department of Agriculture and Consumer Services. Richmond, VA.
- 1984-94 DCR-DSWC cost-share data. Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation. Richmond, VA.
- 1993-94 Natural Resource Conservation Service (NRCS) assistance data. Natural Resource Conservation Service. Richmond, VA and Blacksburg, VA.
- 1992 National Resource Inventory (NRI) data. Natural Resource Conservation Service. Richmond, VA.
- 1994 Conservation Tillage Information Center data.
- 1995 Animal Waste Storage Facility data for Augusta, Page, and Rockingham counties. Virginia Cooperative Extension, Rockingham County.

The VDACS-VASS data were used to compare actual production levels of agricultural commodities in the Chesapeake Bay basin with those obtained by the survey. The other sources of information pertained to BMP implementation in various areas within the Chesapeake Bay basin. The 1993-94 DCR-DSWC data were used to compare the number of cost-share management practices implemented (using DCR-DSWC funds), with those indicated by the survey. Furthermore, the 1984-1994 DCR-DSWC data were used to compare the actual number of animal waste facilities implemented with those predicted by the survey. The 10-year period for the data on animal waste storage facilities

was used because many of those cost-share facilities indicated in the survey were probably constructed several years ago and are, therefore, reported by DCR-DSWC during the year they were constructed. The NRCS database incorporated information on any BMPs the NRCS had knowledge of, including BMPs implemented using federal monetary assistance and those implemented with NRCS technical assistance, though no cost-share funds may have been given to the farmer. The Natural Resource Inventory (NRI) data for the Chesapeake Bay basin was used to compare specific management practices adopted, and the data from the CTIC were used to verify the information on implementation of conservation tillage obtained by the survey.

4 Results and Discussion

In this chapter, information collected from the survey and a summary of the results for the entire Chesapeake Bay drainage basin are presented. The results of the regression analyses performed to determine the significant factors that influence BMP implementation are also included. Summaries and comparisons of the data collected for the major river basins as well as the Division of Soil and Water Conservation Field Office Regions are also presented.

Chesapeake Bay Drainage Basin

The Chesapeake Bay drainage basin in Virginia consists of the Chesapeake Bay Coastal, James River, Potomac River, Rappahannock River, and York River Basins. The area comprises most of Virginia, excluding Southside and Southwest Virginia. The VirGIS land use and VASS (VDACS, 1992) data show that the total farmland in the study area is 3,629,677 acres, which is farmed by 20,585 farmers.

Response and Acreage Represented

The information presented in this section is based on the 1,377 responses which cover 474,772 acres of farmland (13% of the basin's farmland). An estimated 1,099 of the respondents farmed in the Chesapeake Bay drainage basin. This estimation is less than

the 1,377 figure because several counties had only a portion of their agricultural land in the Chesapeake Bay drainage basin. For such counties, the number of respondents from each county was multiplied by the ratio of agricultural land in the county that is in the Chesapeake Bay basin to the total amount of agricultural land in that county. The 1,099 farmers corresponds to approximately 6 percent of the farmers in the Bay basin.

Personal and Farming Characteristics

Overall, the respondents were 58 years of age and had 31 years of farming experience. The average farm size was approximately 436 acres, with 51 percent of the farms less than 250 acres, about 19 percent between 250 and 500 acres, and 30 percent greater than 500 acres. Sixty percent of the farmers owned a majority of the land they farm rather than renting the land. About 84 percent of the respondents lived on their farm and approximately 40 percent of the family income is derived from the farming operation. An average of two full-time and three part-time employees are hired at peak season. Approximately 41 percent of the farmers are members of some type of farm or environmental organization. Seventy-eight percent of the respondents have completed high school, 22 percent have received an associate's or bachelor's degree, and 10 percent have an advanced or graduate degree. A summary of this information is presented in Table 4.1.

Table 4.1. Characteristics of Respondents in the Chesapeake Bay Basin.

Characteristics	Descriptive Data
Average years of farming	31 (Range: 1-88)
Average age of farm operator (years)	58 (Range: 19-92)
% of net family income from the	
(a) Farm source	40
(b) Off-farm source	60
Average number of employees hired at peak season -	
(a) Full-time	2 (Range: 0-200)
(b) Part-time	3 (Range: 0-200)
(c) Total	4 (Range: 0-230)
Education level -	
(a) First to sixth grade	37 (3%)[1]
(b) Seventh to eleventh grade	145 (12%)
(c) High School graduate/GED	397 (32%)
(d) Some college - No degree	245 (20%)
(e) Associates degree	40 (3%)
(f) Bachelor's degree	174 (14%)
(g) Some graduate school - No degree	76 (6%)
(h) Advanced degree	139 (11%)
Membership in a farm or environmental organization -	570 (41%)
Membership in Virginia Farm Bureau Federation	452 (33%)
Memberships in other farm or environmental organizations[2] -	
(a) One organization	161 (12%)
(b) Two organizations	65 (5%)
(c) Three organizations	38 (3%)
(d) Four organizations	24 (2%)
(e) Five or more organizations	17 (1%)

[1] - Number in parenthesis is the percentage of respondents.

[2] - Does not include membership in Virginia Farm Bureau

Increasing yield was denoted by 87 percent of the respondents as either a very important or somewhat important consideration in their farming operation. Eighty-nine percent indicated decreasing production costs as an important consideration. This can be attributed to the desire to maximize yield and minimize costs in order to remain economically viable. Reducing fertilizer and pesticide use were important considerations given by 81 percent and 77 percent of the farmers, respectively. Complying with government regulations and avoiding regulatory programs were stated as important considerations by 83 percent and 77 percent of the farmers, respectively.

Several statements were listed and the farmers were asked to indicate if they agreed or disagreed with these statements. Sixty-seven percent of the respondents agreed that farm practices that protect water quality usually require more labor. About 31 percent agreed with the statement "the best way to control pollution is through the enforcement of strict regulations", whereas 90 percent agreed that water pollution can best be controlled through educational programs that encourage farm operators to use BMPs. Sixty percent of the respondents believed that the government should help by paying more for water pollution control on farms. About 73 percent of the respondents agreed with the statement "farm operators do not have the right to farm in ways that damage water quality" and 35 percent believed that farm practices that protect water quality mean lower profits.

Attitudes towards Pollution and Water Quality

The "proximity effect" of the Chesapeake Bay was evident as 85 percent of the respondents indicated that they were either somewhat or very concerned about pollution in the Chesapeake Bay. Sixty percent responded that water quality was either a serious or somewhat of a problem in their county, whereas only 35 percent believed that their own farm contributes to the water quality problems. The information concerning water pollution concerns and water quality problems is presented in Table 4.2.

Table 4.2. Respondents Attitudes and Concerns with Water Pollution.

Characteristics	Descriptive data
Respondents believing their farm contributes to water quality problems -	
(a) Significantly	10 (1%)[1]
(b) Small amounts	448 (34%)
(c) Does not contribute	775 (59%)
(d) Do not know	82 (6%)
Seriousness of water quality problems in the county -	
(a) Not a problem	344 (27%)
(b) Somewhat problem	646 (50%)
(c) Serious problem	126 (10%)
(d) Do not know	171 (13%)
Concerns about pollution in the Chesapeake Bay -	
(a) Very concerned	472 (36%)
(b) Somewhat concerned	641 (49%)
(c) Not concerned	91 (7%)
(d) Do not know	107 (8%)

[1] - Number in parenthesis is the percentage of respondents.

The perception of farm operators regarding causes of pollution in their county were evaluated (Figures 4.1a and 4.1b). Runoff from urban or paved areas, and industrial waste/factory discharge were denoted as a serious or moderate cause of pollution by 54 percent, and 52 percent of the farm operators, respectively. Pesticides, fertilizers, and runoff from cropland were perceived as a serious or moderate cause of pollution by 32 percent, 30 percent, and 28 percent of the farmers, respectively.

Crop Production

Results of the survey indicated that crop production is the primary land use on 63 percent of farmland covered in the survey. Approximately 57 percent of farmland is owned by farmers and the remaining 43 percent is farmed on the rent-basis. Fifty-five percent of the farmers have conservation plans for their lands. Due to the variability in soil, topography, and climatic factors in the various drainage basins extending from the coastal plain to the mountainous areas of the Chesapeake Bay drainage basin, farmers produce a variety of agricultural commodities. Over 70 percent grow some type of hay on approximately 15 percent of the total farmland; 41 percent grow corn on 13 percent of the farmland; 29 percent grow small grains on 10 percent of the farmland; and 21 percent grow soybeans on 14 percent of the farmland. The percentage of farmers producing several different agricultural commodities is listed in Table 4.3. Comparisons of the percentage of farmers who produce crops are given in Figure 4.2. The commodities indicated as major sources of income were beef cattle, hay, corn, small grains, and soybeans.

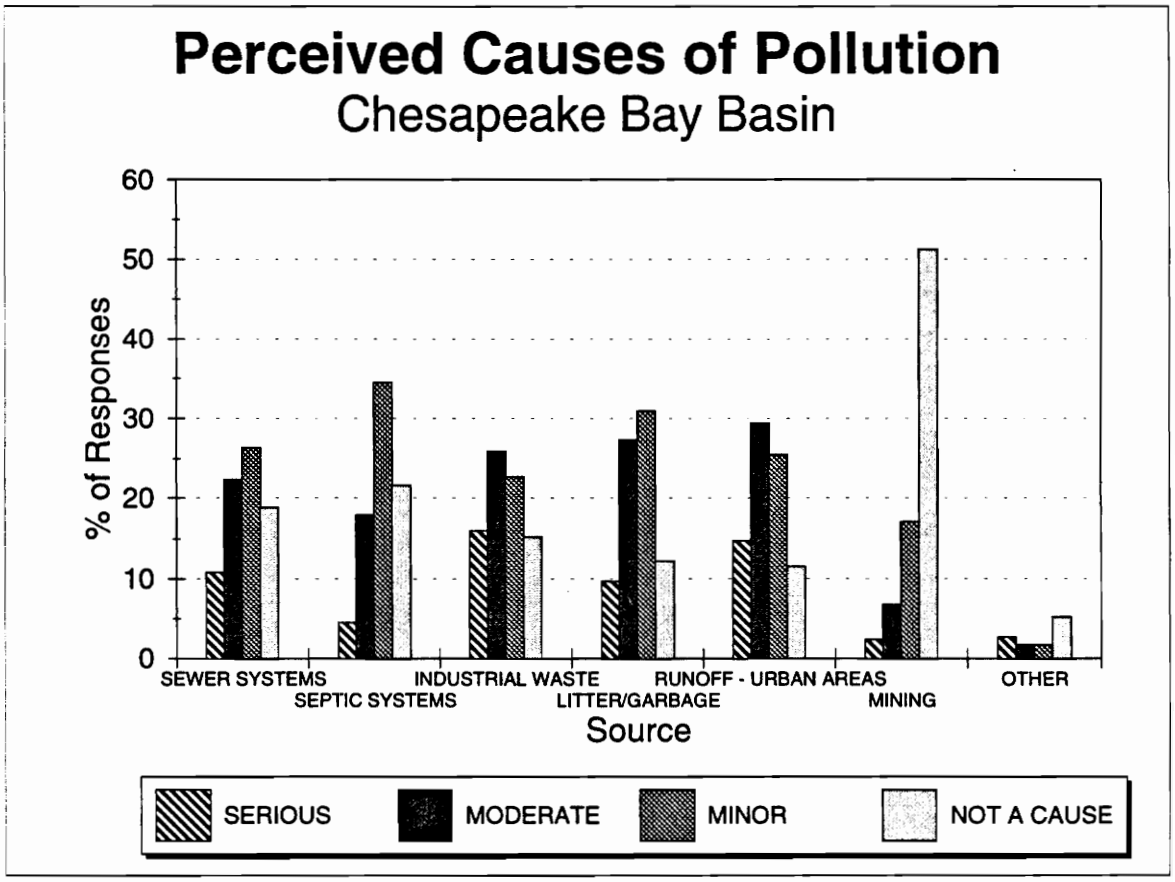


Figure 4.1a. Perceived Causes of Pollution in the Chesapeake Bay Basin.

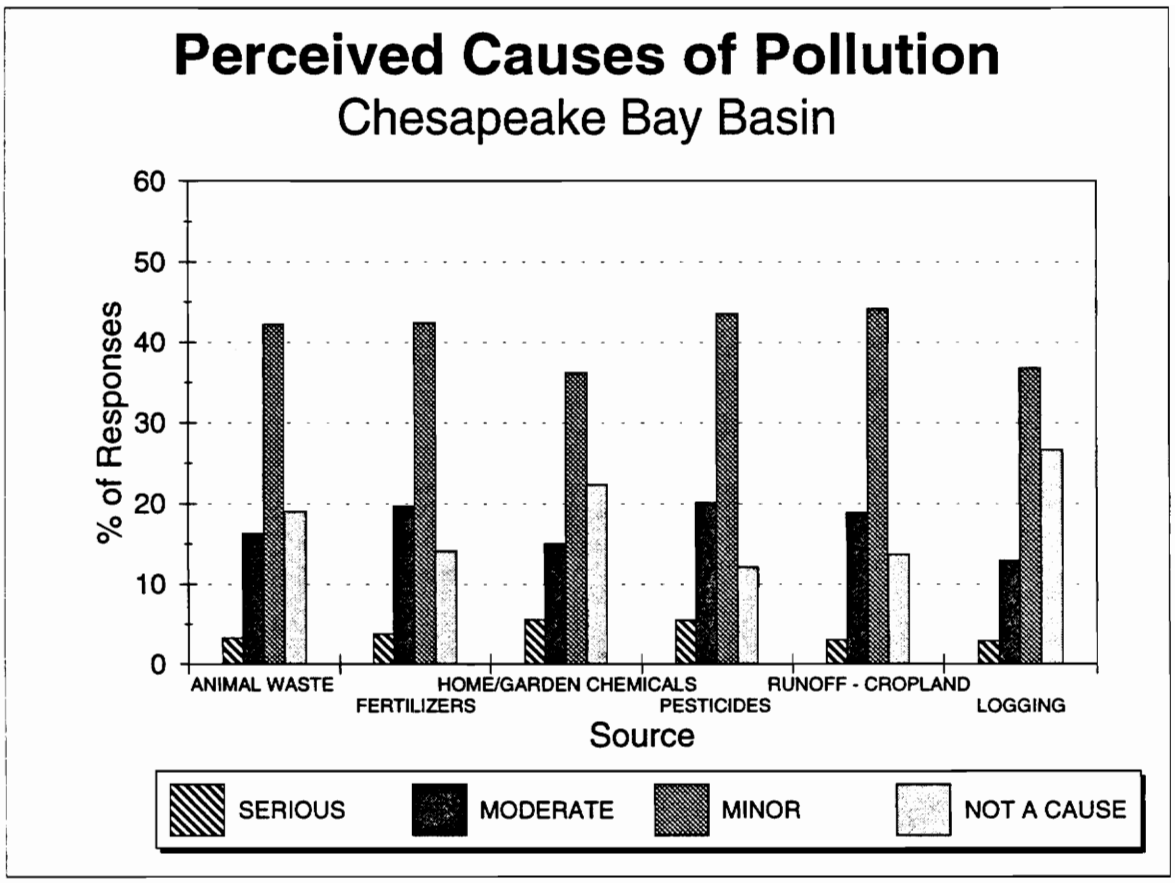


Figure 4.1b. Perceived Causes of Pollution in the Chesapeake Bay Basin.

Table 4.3. Livestock and Crop Production in the Chesapeake Bay Basin

Livestock Production		
Livestock	**% Farmers raising**	**# per 100 acre of surveyed land**
Aquaculture (lbs. of fish)	1	27
Beef cattle	67	17
Dairy cattle	9	2
Horses	13	<1
Poultry	8	2065
Sheep	6	1
Swine	5	5
Other livestock	3	506
Crop Production		
Crops	**% of Farmers growing**	**% of Total acreage**
Alfalfa	27	2
Other hay	71	14
Corn	41	13
Cotton	1	<1
Fruits, orchards & vineyards	4	1
Peanuts	2	1
Small grains	29	10
Soybeans	21	14
Tobacco	2	1
Vegetables	7	1
Other crops	10	5

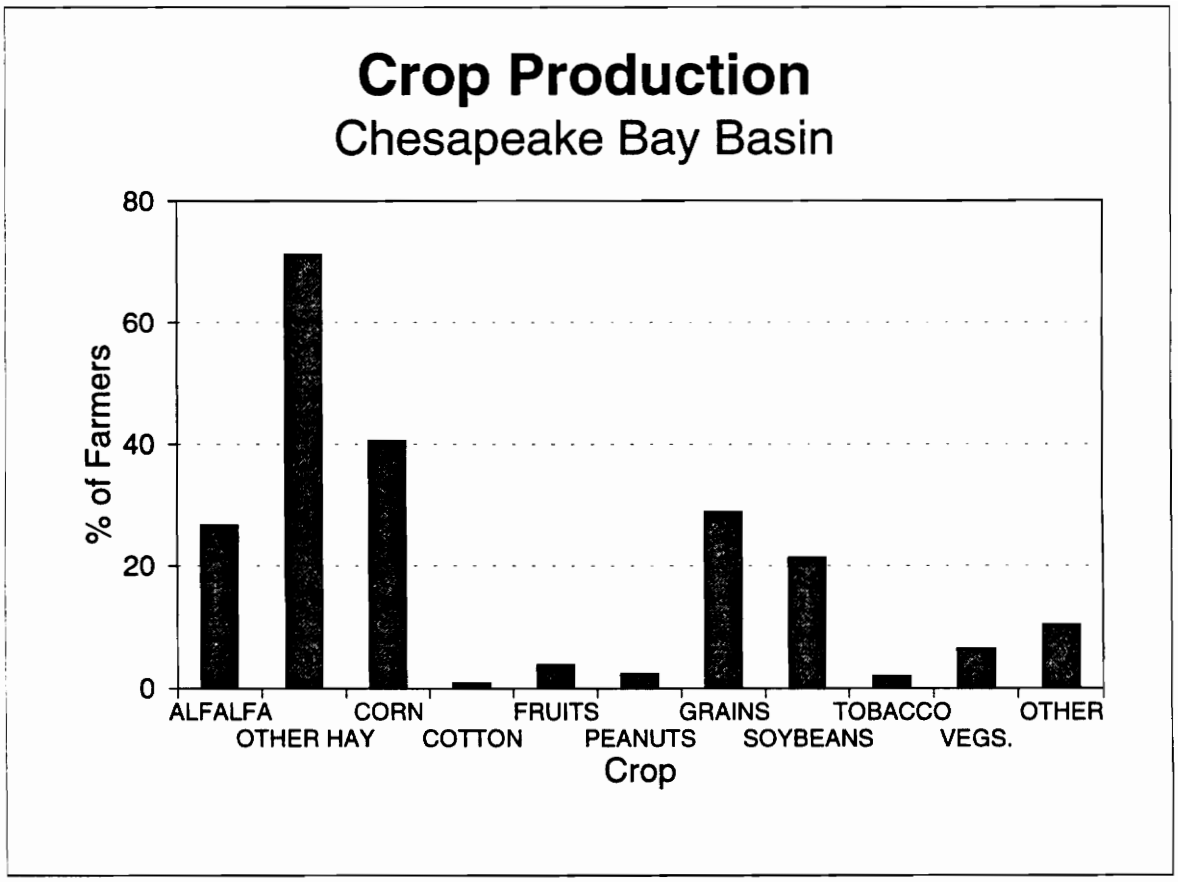


Figure 4.2. Crop Production in the Chesapeake Bay Basin.

Livestock Production

Beef cattle is the most commonly raised livestock in the Chesapeake Bay basin. Over 67 percent of the farmers surveyed raised beef cattle, compared to 13 percent raising horses, and 9 percent raising dairy cattle. There are an estimated 17 head of beef cattle per 100 acres of farmland throughout the basin. The large number of farmers raising beef cattle is perhaps one of the major reasons for the large number of farmers growing hay. Nineteen percent of the respondents reported they produce poultry, sheep, and swine. Comparisons of the percentage of farmers who raise livestock are given in Figure 4.3.

Best Management Practice Implementation

The BMPs implemented to reduce sediment and chemical losses from agricultural lands varied considerably for various land uses. Several different cost-share and non-cost-share BMPs are used in the Bay basin. The major BMPs implemented on a cost-share basis were hayland or pasture management (implemented by 9 percent of the farmers on 2 percent of the total farmland in the Chesapeake Bay basin); permanent vegetative cover (implemented by 7 percent of the farmers on 1 percent of the total farmland); grassed waterways (implemented by 6 percent of the farmers on a minimal percentage of the total farmland); cover crops (implemented by 5 percent of the farmers on 1 percent of the total farmland); and surface soil sampling/analysis (conducted for 5 percent of the farmers on a small fraction of the total farmland). The predominant BMPs implemented without using

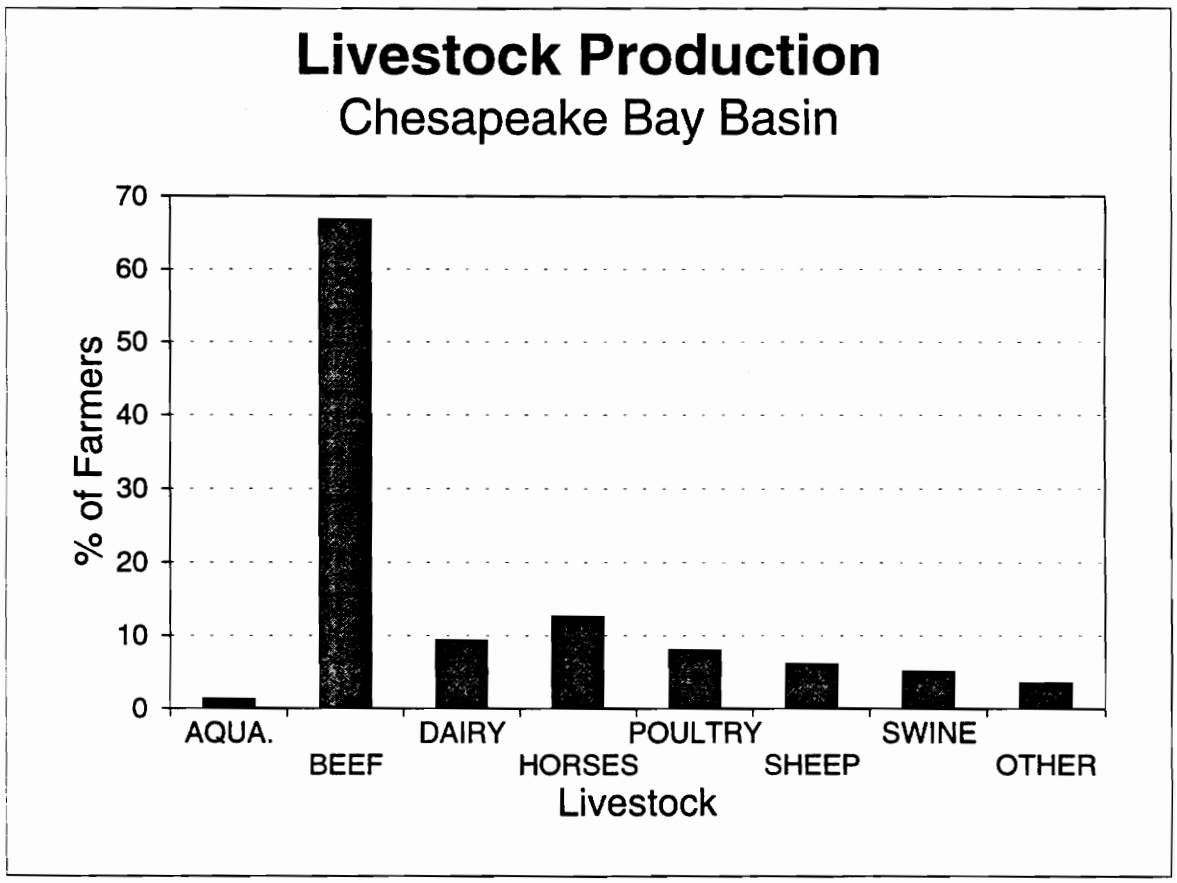


Figure 4.3. Livestock Production in the Chesapeake Bay Basin.

cost-share funds were hayland or pasture management (implemented by 43 percent of the farmers on 9 percent of the total farmland); conservation or reduced tillage (implemented by 42 percent of the farmers on 15 percent of the total farmland); cover crops (implemented by 35 percent of the farms on 5 percent of the total farmland); surface soil sampling/analysis (conducted for 35 percent of the farmers on a small fraction of the total farmland); permanent vegetative cover (implemented by 33 percent of the farmers on 8 percent of the total farmland); and field scouting (implemented by 28 percent of the farmers on 15 percent of the total farmland). The percentage of farmers implementing any BMP and the extent of implementation on both a cost-share and non-cost-share basis listed in the survey is presented in Table 4.4. Figures 4.4a and 4.4b show a comparison of the percent of farmers implementing BMPs using cost-share funds with those implementing BMPs without cost-share assistance. Figure 4.4c illustrates the difference in acreage on which cost-share BMPs are implemented, compared to non-cost-share BMPs for all of the relevant BMPs. Overall, 81 percent of the farmers implemented a BMP, 31 percent implemented a BMP with cost-share funds, and 75 percent adopted a BMP without cost-share assistance. The adoption of a conservation plan was a major factor influencing the use of BMPs. Of the 55 percent of the farmers that had a conservation plan, 42 percent implemented a BMP with cost-share funds, 84 percent implemented a BMP on a non-cost-share basis, and 91 percent implemented a BMP, either with or without cost-share assistance. Whereas, of the 45 percent of the farmers that did not have a conservation plan, only 15 percent implemented a BMP on a cost-

Table 4.4. BMP Implementation in the Chesapeake Bay Basin.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Biological pest controls, BPC -		
(a) Cost-Share	11 (1%)[1]	460 (<1%)[2]
(b) Non-Cost-Share	72 (6%)	6,603 (1%)
(c) Ratio (b)/(a)	7	14
Contour strip cropping, CS -		
(a) Cost-Share	35 (3%)	3,163 (1%)
(b) Non-Cost-Share	160 (13%)	9,278 (2%)
(c) Ratio (b)/(a)	5	3
Conservation tillage, CT -		
(a) Cost-Share	47 (4%)	9,011 (2%)
(b) Non-Cost-Share	465 (39%)	70,659 (15%)
(c) Ratio (b)/(a)	10	8
Cover crops, CC -		
(a) Cost-Share	58 (5%)	3,971 (1%)
(b) Non-Cost-Share	383 (32%)	25,117 (5%)
(c) Ratio (b)/(a)	7	6
Field scouting, FS -		
(a) Cost-Share	23 (2%)	7,386 (2%)
(b) Non-Cost-Share	304 (25%)	73,055 (15%)
(c) Ratio (b)/(a)	13	10
Grass or legume in rotation, GL -		
(a) Cost-Share	28 (2%)	1,534 (<1%)
(b) Non-Cost-Share	334 (28%)	25,298 (5%)
(c) Ratio (b)/(a)	12	16
Hayland or pasture management, HY-		
(a) Cost-Share	101 (8%)	7,145 (2%)
(b) Non-Cost-Share	476 (40%)	44,095 (9%)
(c) Ratio (b)/(a)	5	6
Irrigation improvement, IR -		
(a) Cost-Share	5 (<1%)	390 (<1%)
(b) Non-Cost-Share	76 (6%)	5,876 (1%)
(c) Ratio (b)/(a)	15	15

Table 4.4. Continued.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Permanent vegetation cover, VE -		
(a) Cost-share	73 (6%)	4,863 (1%)
(b) Non-Cost-Share	364 (30%)	36,582 (8%)
(c) Ratio (b)/(a)	5	8
Rotational grazing, RG -		
(a) Cost-share	39 (3%)	4,148 (1%)
(b) Non-Cost-Share	308 (26%)	37,559 (8%)
(c) Ratio (b)/(a)	8	9
Split fertilizer applications, SFA -		
(a) Cost-Share	36 (3%)	7,178 (2%)
(b) Non-Cost-Share	341 (28%)	50,710 (11%)
(c) Ratio (b)/(a)	9	7
Tissue analysis, TA -		
(a) Cost-Share	8 (1%)	646 (<1%)
(b) Non-Cost-Share	120 (10%)	13,782 (3%)
(c) Ratio (b)/(a)	15	21
BMPs	**Number of Farmers Implementing BMP**	**BMP Implementation**
Animal waste storage facilities, WSF -		
(a) Cost-Share	49 (4%)	65 facilities
(b) Non-Cost-Share	71 (6%)	90 facilities
(c) Ratio (b)/(a)	1	1
Animal waste sampling/analysis, AWS -		
(a) Cost-Share	19 (2%)	122 analyses/year
(b) Non-Cost-Share	79 (7%)	362 analyses/year
(c) Ratio (b)/(a)	4	3
Deep soil sampling/analysis, DSS -		
(a) Cost-Share	6 (1%)	2 samples/acre/farmer
(b) Non-Cost-Share	40 (3%)	1 sample/acre/farmer
(c) Ratio (b)/(a)	7	0.5

Table 4.4. Continued.

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Surface soil sampling/analysis, SSS -		
(a) Cost-Share	51 (4%)	1 sample/acre/farmer
(b) Non-Cost-Share	384 (32%)	1 sample/acre/farmer
(c) Ratio (b)/(a)	8	1
Diversions (acres affected), DIV -		
(a) Cost-Share	4 (<1%)	141 acres (<1%)
(b) Non-Cost-Share	30 (3%)	2,423 acres (1%)
(c) Ratio (b)/(a)	8	17
Filter/buffer strips (acres affected), FBS -		
(a) Cost-Share	48 (4%)	3,955 acres (1%)
(b) Non-Cost-Share	200 (17%)	15,181 acres (3%)
(c) Ratio (b)/(a)	4	4
Grass waterways (acres affected), GW -		
(a) Cost-Share	68 (6%)	4,011 acres (1%)
(b) Non-Cost-Share	254 (23%)	22,057 acres (5%)
(c) Ratio (b)/(a)	4	5
Terraces (acres affected), TER -		
(a) Cost-Share	0 (0%)	0 acres (0%)
(b) Non-Cost-Share	25 (2%)	966 acres (<1%)
(c) Ratio (b)/(a)	-----	-----
Sediment traps/basin (acres affected), ST-		
(a) Cost-Share	10 (1%)	434 acres (<1%)
(b) Non-Cost-Share	56 (5%)	2,527 acres (1%)
(c) Ratio (b)/(a)	6	6
Stream protection or fencing, SP -		
(a) Cost-Share	38 (3%)	53,363 ft
(b) Non-Cost-Share	119 (10%)	323,727 ft
(c) Ratio (b)/(a)	3	6
Sprayer calibration checks, SC -		
(a) Cost-Share	13 (1%)	108 checks/year
(b) Non-Cost-Share	187 (16%)	1,347 checks/year
(c) Ratio (b)/(a)	14	12

[1] - Values in parenthesis are the percentage of respondents using the BMPs.
[2] - Values in parenthesis are the percentage of acres farmed.

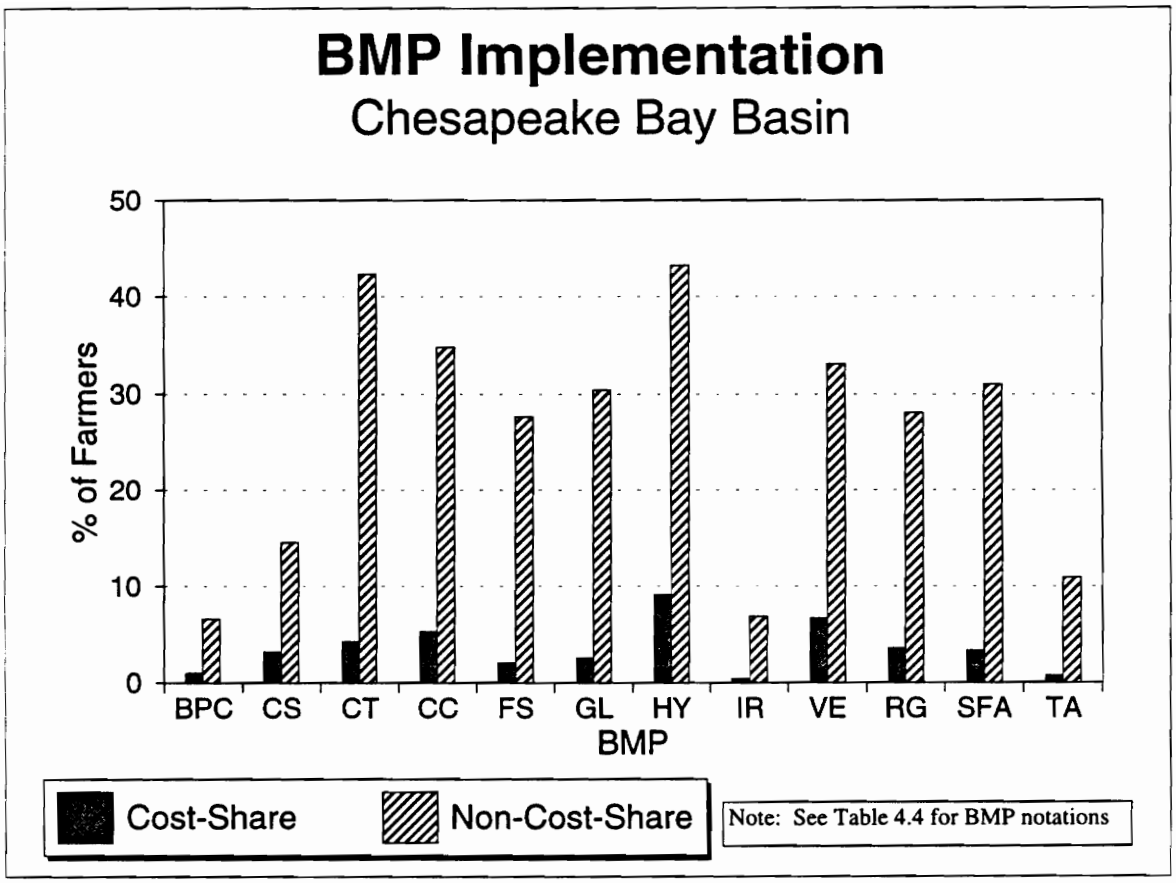


Figure 4.4a. BMP Implementation in the Chesapeake Bay Basin.

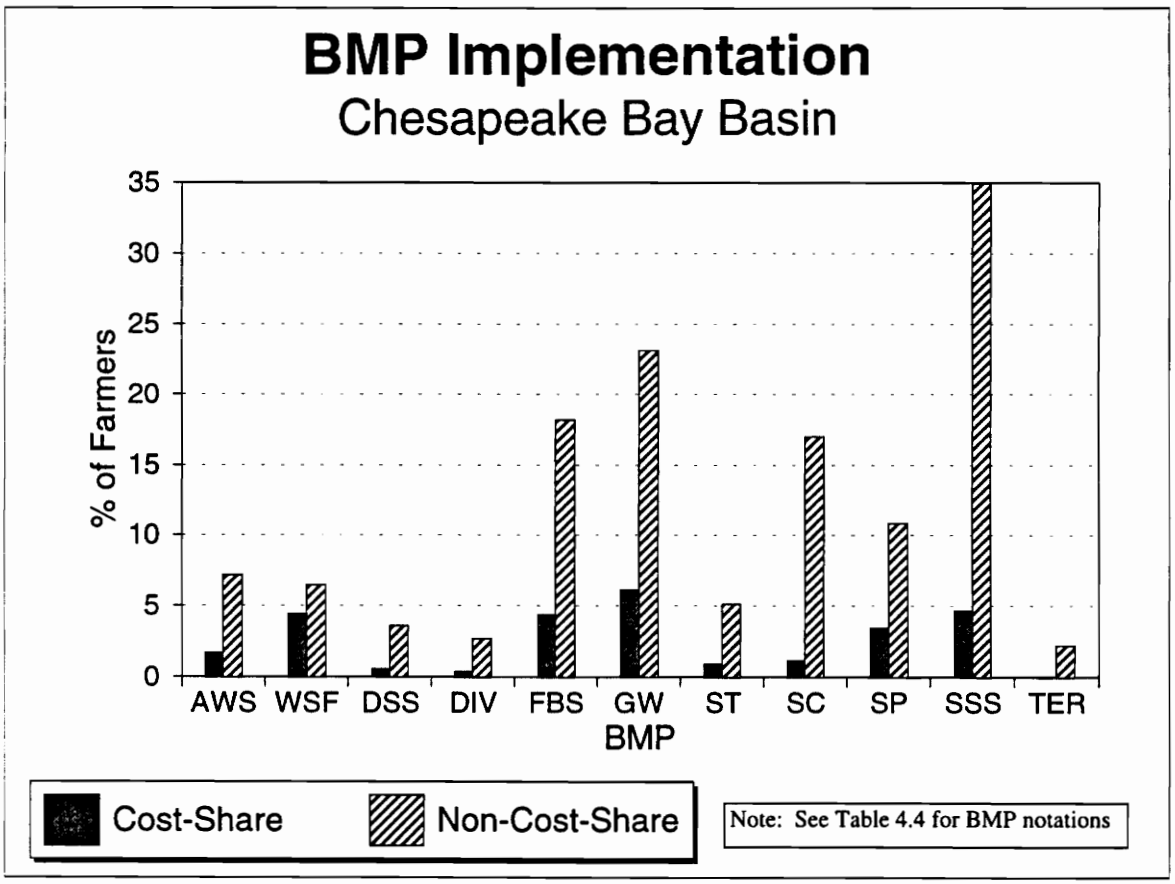


Figure 4.4b. BMP Implementation in the Chesapeake Bay Basin.

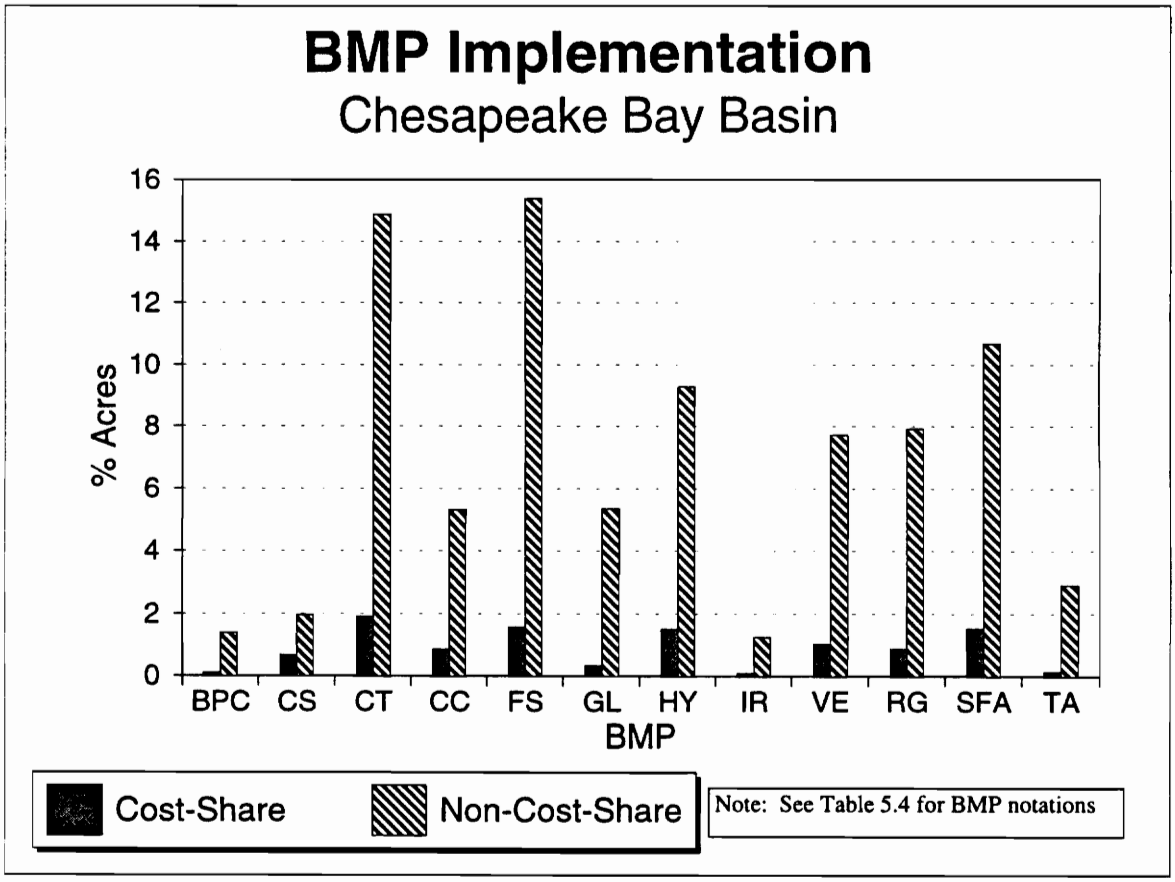


Figure 4.4c. BMP Implementation in the Chesapeake Bay Basin.

share basis, 60 percent implemented a BMP without cost-share funds, and 64 percent implemented a BMP, either with or without cost-share assistance.

Information Sources

State and Federal agencies conduct educational and technical programs to promote the use of BMPs, and offer cost-share assistance to farmers as an incentive to install or implement BMPs on their lands. The educational and technical programs would also encourage implementation of BMPs by farmers on a non-cost-share basis. The major information sources used by farmers in learning about BMPs are farm magazines (indicated by 69 percent of the farmers); extension agents/specialists (60 percent); American Stabilization and Conservation Service (ASCS) offices (58 percent); Natural Resource Conservation Service (NRCS) offices (47 percent); Virginia Division of Soil and Water Conservation Districts (45 percent); and other farm operators (44 percent). An average of 5 information sources were used by farmers to obtain information on BMPs. The influence these information sources have on BMP implementation will be discussed later with the multivariate regression analyses.

Factors Influencing the Implementation of Best Management Practices

The survey data were analyzed using multiple regression techniques to determine what factors affect a farmer's decision to adopt BMPs. The dependent variables used were an index of the number of cost-share practices implemented, an index of the number of non-

cost-share practices implemented, and an index of the number of either type of BMPs implemented. Seven models were initially developed for each dependent variable. These models were constructed to enable the analysis of data collected on farming characteristics; personal characteristics and water quality concerns; farming considerations; information sources; factors that were prominent in a farmer's decision to implement any previously adopted BMPs; factors that were prominent in a farmer's decision to implement new BMPs; and several opinion statements. Many factors were significant at the 5% level of analysis for each of the dependent variables.

The farm and personal characteristics that were significant for all three dependent variables were farm size, farm conservation plan, membership in farm organizations, perceived pollution from cropland, and their farm's contribution to water quality problems. Others that had a positive impact on BMP implementation in at least two of the three models were the production of corn, small grains, or soybeans, production of grazing livestock, production of confined livestock, concern for pollution in the Chesapeake Bay, and the farmer's residence (on or off farm). The DSWC Districts and NRCS were the only sources of information significant for each dependent variable. However, conferences, exhibitions or fairs, farm magazines, nutrient management specialists, and pesticide or fertilizer dealers were also positive significant sources of information on the implementation of non-cost-share BMPs. Surprisingly, the Virginia Farm Bureau Federation, as a source of information of BMPs, had a significantly negative

impact on the implementation of BMPs adopted without cost-share assistance. Availability of technical assistance, decreasing production costs, and trying new crops were significant farming considerations in predicting the number of BMPs implemented. Several of the opinion statements were also significant for each dependent variable. Therefore, those farmers who were more aware and concerned with pollution were more likely to implement a BMP, regardless of the funding source. Those farmers willing to try new crops also suggested that they may be more likely to experiment with conservation techniques and implement BMPs. Economic considerations also impacted the farmer's decision to implement BMPs. Decreasing production costs and farm size were significant factors affecting BMP implementation. Age of the farm operator had a significantly negative impact on the implementation of non-cost-share BMPs (older farmers were less likely to implement BMPs without cost-share assistance), however it was not significant in predicting the cost-share BMP implementation level. Table 4.5 lists all the factors analyzed for each model and indicates their significance at the 5% level. Table 4.5 also indicates if the variable had a positive or negative influence on implementing BMPs.

The significant factors from each of the seven models (Table 4.5) were combined into a three separate models using the cost-share index, the non-cost-share index, and the any

Table 4.5. Multivariate Analysis on Cost-Share, Non-Cost-Share, and Any BMP Implementation in the Chesapeake Bay Basin.

Dependent Variables	Effect of Variables		
	Cost-Share BMPs	Non-Cost-Share BMPs	Any BMP*
Farm Characteristics			
Farm size (Increasing in size)	+	+	+
Land owned/rented	NS	NS	NS
Percent of income from the farm	NS	NS	NS
Production of corn, small grains or soybeans	NS	+	+
Raise beef cattle, horses, or sheep	NS	+	+
Raise dairy cattle, swine, or poultry	NS	+	+
Farm conservation plan	+	+	+
Personal Characteristics			
Membership in farm organizations	+	+	+
Age (Increasing in age)	NS	-	-
Seriousness of water pollution in their county	NS	NS	NS
Pollution from fertilizers	NS	-	-
Pollution from livestock/animal waste	NS	NS	NS
Pollution from pesticides	NS	NS	NS
Pollution from cropland	NS	+	+
Farm's contribution to water quality problems	+	+	+
Concern for pollution in the Chesapeake Bay	+	NS	+
Farmer's living on farm	NS	+	+
Level of education	NS	NS	NS
Considerations for the Farm Operation			
Increasing yield	NS	NS	NS
Decreasing production costs	+	+	+
Trying new crops	+	+	+
Reducing fertilizer use	NS	+	+
Reducing pesticide use	NS	NS	NS
Access to markets	NS	NS	NS
Credit	NS	NS	NS
Complying with government regulations	NS	NS	NS
Avoiding regulatory problems	NS	NS	NS

Table 4.5. Continued.

Dependent Variables	Effect of Variables		
	Cost-Share BMPs	Non-Cost-Share BMPs	Any BMP
Considerations in Implementing Previous BMPs			
Assistance from farm organizations	NS	-	-
Assistance from government	NS	NS	NS
Assistance from other farm operators	-	NS	NS
Availability of cost-share funds	+	-	NS
Concern for water pollution	NS	NS	+
Concern for future regulation	NS	NS	NS
Conservation ethic	NS	+	+
Demonstrations/meetings sponsored by the Virginia BMP Program	NS	NS	NS
Increased farm production	NS	+	+
Regulatory compliance	NS	NS	NS
Information Sources			
Conferences	NS	+	+
Extension agents	NS	NS	NS
Extension bulletins	NS	NS	NS
Field trips	NS	NS	NS
Exhibitions or fairs	NS	NS	NS
Farm magazines	NS	+	+
Meetings or workshops	NS	+	NS
Newspapers	NS	NS	NS
Nutrient management specialists	NS	+	+
Other farm operators	-	+	NS
Pesticide or fertilizer dealers	NS	+	+
Private consultants	NS	NS	NS
Radio	NS	NS	NS
Television	NS	NS	NS
Tours or demonstrations	NS	NS	NS
Virginia Farm Bureau	NS	-	-
Virginia DSWC	+	+	+
U.S. ASCS	+	NS	NS
U.S. NRCS	+	+	+

Table 4.5. Continued.

Dependent Variables	Effect of Variables		
	Cost-Share BMPs	Non-Cost-Share BMPs	Any BMP
Considerations of Adopting New BMPS			
Availability of government cost-sharing	+	-	NS
Availability of technical assistance	+	+	+
Cost of the practice	NS	NS	NS
Difficulty of implementation	NS	NS	NS
Effects of practice on profits	NS	+	+
Experience of other farm operators	-	NS	NS
Information from agribusinesses	NS	NS	NS
Information from government	NS	NS	NS
Labor or time required	NS	NS	NS
Potential to improve water quality	NS	+	+
Tax credits	NS	NS	NS
Opinion Statements			
Farm practices that protect water quality usually require more labor.	NS	NS	NS
The best way to control pollution is through the enforcement of strict regulations.	-	-	-
The government should help by paying more for water pollution control on farms.	+	+	+
Farm operators do not have the right to farm in ways that damage water quality.	+	NS	NS
Farm practices that protect water quality mean lower profits.	NS	NS	NS
Water pollution can best be controlled through educational programs that encourage farm operators to use BMPs.	+	+	+

* BMP implemented regardless of the funding source.

\+ The variable is significant at the 5% level of analysis and has a positive regression parameter.

\- The variable is significant at the 5% level of analysis and has a negative regression parameter.

NS - The variable is not significant at the 5% level of analysis.

BMP index as dependent variables to determine the interaction among various factors that influence a farmer's decision to implement BMPs. Tables 4.6, 4.8, and 4.10 list the variables included in each of the models developed, the intercept and regression coefficients, and the possible numerical responses of the variables. Tables 4.7, 4.9, and 4.11 list the variables included in the respective models and the cumulative coefficient of determination (R^2) as parameters are added to the models. A seven parameter model was developed for the BMPs implemented with cost-share assistance (Table 4.6). The availability of cost-share funds was the most important factor, followed by having a conservation plan, and farm size. This model explains approximately 18 percent of the total variance (Table 4.7). An eight parameter model was constructed for the non-cost-share BMPs (Table 4.8). The major factors in this model were production of corn, soybeans, or small grains and farm size. Together these two parameters explained approximately two-thirds of the variance in the model (Table 4.9). The factors included in this model explained 34 percent of the variance with regard to implementing BMPs using non-cost-share funds (Table 4.9). A ten parameter model was developed to predict the implementation of a BMP, regardless of the funding source. Similar to the non-cost-share model, farm size and production of corn, soybeans, or small grains were the major factors (Table 4.10). These two variables and conservation ethic as an important consideration when implementing BMPs, explained over 31 percent of the variation in this model. The complete model had a coefficient of determination (R^2) of 42 percent (Table 4.11). The models developed for the non-cost-share and any BMPs have a large

Table 4.6. Model Developed for Predicting Cost-Share BMP Implementation.

Independent Variable	Regression Coefficient	Independent Variable Options
Farm Size	0.1370	$X_1 = 1$; farms less than 250 acres $X_1 = 2$; farms between 250-500 acres $X_1 = 3$; farms greater than 500 acres
Farm's Perceived Contribution to Water Quality Problems	0.1404	$X_2 = 1$; Does not contribute $X_2 = 2$; Contributes a small amount $X_2 = 3$; Contributes significantly
Virginia DSWC Districts as a source of information on BMPs	0.2016	$X_3 = 0$; Not a source of information $X_3 = 1$; A source of information
Other Farm Operators as a source of information on BMPs	-0.2587	$X_4 = 0$; Not a source of information $X_4 = 1$; A source of information
Importance of the Availability of Cost-Share Funds when implementing BMPs	0.4093	$X_5 = 1$; Not important $X_5 = 2$; Somewhat important $X_5 = 3$; Very important
"Farm operators do not have the right to farm in ways that damage water quality"	0.0951	$X_6 = 1$; Strongly disagree $X_6 = 2$; Somewhat disagree $X_6 = 3$; Somewhat agree $X_6 = 4$; Strongly agree
Farm Conservation Plan	0.3276	$X_7 = 1$; Do not have a conservation plan $X_7 = 2$; Have a conservation plan
Intercept	-1.129	

Table 4.7. Adjusted Coefficient of Determination of the Model Developed for Predicting Cost-Share BMP Implementation.

Independent Variable	Adjusted Coefficient of Determination (R^2)
Availability of Cost-Share Funds	11 %
Farm Conservation Plan	14 %
Farm Size	15 %
Virginia DSWC Districts	16 %
Other Farm Operators	17 %
Farm's Contribution to Water Quality Problems	17 %
"Farm operators do not have the right to farm in ways that damage water quality"	18 %

Table 4.8. Model Developed for Predicting Non-Cost-Share BMP Implementation.

Independent Variable	Regression Coefficient	Independent Variable Options
Farm Size	0.6326	$X_1 = 1$; farms less than 250 acres $X_1 = 2$; farms between 250-500 acres $X_1 = 3$; farms greater than 500 acres
Production of Corn, Small Grains, or Soybeans	1.5565	$X_2 = 0$; Do not produce commodities $X_2 = 1$; Does produce commodities
Age	-0.0375	X_3 = Actual age of farm operator
Importance of Decreasing Production Costs as a consideration for the farm operation	0.5311	$X_4 = 1$; Not important $X_4 = 2$; Somewhat important $X_4 = 3$; Very important
Pesticide or Fertilizer Dealers as a source of information on BMPs	0.6527	$X_5 = 0$; Not a source of information $X_5 = 1$; A source of information
Importance of Conservation Ethic when implementing BMPs	0.8652	$X_6 = 1$; Not important $X_6 = 2$; Somewhat important $X_6 = 3$; Very important
"The best way to control pollution is through the enforcement of strict regulations"	-0.4283	$X_7 = 1$; Strongly disagree $X_7 = 2$; Somewhat disagree $X_7 = 3$; Somewhat agree $X_7 = 4$; Strongly agree
Farm Magazines as a source of information on BMPs	0.8988	$X_8 = 0$; Not a source of information $X_8 = 1$; A source of information
Intercept	1.1927	

Table 4.9. Adjusted Coefficient of Determination of the Model Developed for Predicting Non-Cost-Share BMP Implementation.

Independent Variable	Adjusted Coefficient of Determination (R^2)
Production of Corn, Small Grains, or Soybeans	18 %
Farm Size	23 %
"The best way to control pollution is through the enforcement of strict regulations"	26 %
Importance of Conservation Ethic when implementing BMPs	28 %
Farm Magazines as a source of information on BMPs	30 %
Age	32 %
Pesticide or Fertilizer Dealers as a source of information on BMPs	33 %
Importance of Decreasing Production Costs as a consideration for the farm operation	34 %

Table 4.10. Model Developed for Predicting Any BMP Implementation.

Independent Variable	Regression Coefficient	Independent Variable Options
Farm Size	0.7532	$X_1 = 1$; farms less than 250 acres $X_1 = 2$; farms between 250-500 acres $X_1 = 3$; farms greater than 500 acres
Production of Corn, Small Grains, or Soybeans	1.2734	$X_2 = 0$; Do not produce commodities $X_2 = 1$; Does produce commodities
Production of Dairy Cattle, Swine, or Poultry	0.7204	$X_3 = 0$; Do not produce commodities $X_3 = 1$; Does produce commodities
Age	-0.0288	X_4 = Actual age of farm operator
Runoff from Cropland as a perceived cause of pollution	0.4709	$X_5 = 1$; Minor cause of pollution $X_5 = 2$; Moderate cause of pollution $X_5 = 3$; Major cause of pollution
Importance of Decreasing Production Costs as a consideration for the farm operation	0.8003	$X_6 = 1$; Not important $X_6 = 2$; Somewhat important $X_6 = 3$; Very important
Farm Magazines as a source of information on BMPs	0.8121	$X_7 = 0$; Not a source of information $X_7 = 1$; A source of information
Virginia DSWC Districts as a source of information on BMPs	0.9090	$X_8 = 0$; Not a source of information $X_8 = 1$; A source of information
"The best way to control pollution is through the enforcement of strict regulations"	-0.5345	$X_9 = 1$; Strongly disagree $X_9 = 2$; Somewhat disagree $X_9 = 3$; Somewhat agree $X_9 = 4$; Strongly agree
Importance of Conservation Ethic when implementing BMPs	0.7278	$X_{10} = 1$; Not important $X_{10} = 2$; Somewhat important $X_{10} = 3$; Very important
Intercept	0.2032	

Table 4.11. Adjusted Coefficient of Determination of the Model Developed for Predicting Any BMP Implementation.

Independent Variable	Adjusted Coefficient of Determination (R^2)
Farm Size	20 %
Production of Corn, Small Grains, or Soybeans	28 %
Conservation Ethic	31 %
Farm Magazines	34 %
"The best way to control pollution is through the enforcement of strict regulations"	36 %
Virginia DSWC Districts	38 %
Age	40 %
Decreasing Production Costs	41 %
Runoff from Cropland	41 %
Production of Dairy Cattle, Swine, or Poultry	42 %

enough coefficients of determination to be considered good models for predicting BMP implementation. As discussed in the Literature Review Chapter, Napier et al. (1988) developed models to predict "willingness to participate in a tenant buy-down program" and "willingness to sell row-cropping rights to erosion prone land". These models were developed from 552 responses and both had a coefficient of determination of approximately 22 percent. Napier and Napier (1991) constructed a model from 371 land-owners concerning favorability towards conservation compliance. Approximately 55 percent of the variance was explained by the model. Napier and Camboni (1993) built models from 1,305 farm operators to determine the significant factors involved in adopting ten different farm practices. The greatest amount of variance explained for any of the models was 29 percent, for the model used to predict winter application of manure, and only two of the ten models had a coefficient of determination greater than 10 percent.

Effect of Conservation Plans on BMP Implementation

The adoption of a farm conservation plan was considered to be a major factor influencing a farmer's decision to implement BMPs. This is evident from the large difference in the percentage of farmers implementing BMPs who had and did not have conservation plans (91 percent of the farmers with a conservation plan implemented a BMP, whereas only 64 percent of the farmers without a conservation plan implemented a BMP). Regression models similar to those developed for the entire sample population were used to determine the significant factors influencing farmers to implement the three types of

BMPs discussed earlier.

However those farmers that indicated the adoption of a farm conservation plan were separated from those farmers that did not have a conservation plan. Table 4.12 lists the variables in the models and indicates which factors are significant for the farmers with a conservation plan. For those farmers, farm size, production of beef cattle, horses, or sheep, the perception of the farm's contribution to water quality problems, NRCS as an information source, and the statement "the government should help by paying more for water pollution control on farms" were significant as independent variables for all three dependent variables. Similar to the entire sample population, production of corn, small grains, or soybeans, and raising confined livestock were significant in the non-cost-share and any BMP models. The farmer's living on the farm and membership in farm organizations, decreasing production costs, conservation ethic, farm magazines, nutrient management specialists, pesticide and fertilizer dealers, and the effect of the practice on profits were also positively significant in the non-cost-share and any BMP models. Table 4.13 lists the variables in the models and indicates which factors are significant for the farmers without a conservation plan. Those variables that were significant in the models constructed to predict BMP implementation by farmers without a conservation plan were membership in farm organizations, trying new crops, and availability of technical assistance. Other factors that were significant influences in implementing non-cost-share

Table 4.12. Multivariate Analysis on Cost-Share, Non-Cost-Share, and Any BMP Implementation for Farmers with a Conservation Plan.

Dependent Variables	Effect of Variables		
	Cost-Share BMPs	Non-Cost-Share BMPs	Any BMP*
Farm Characteristics			
Farm size (increasing in size)	+	+	+
Land owned/rented	NS	NS	NS
Percent of income from farm	NS	NS	NS
Production of corn, small grains, or soybeans	NS	+	+
Raise beef cattle, horses, or sheep	+	+	+
Raise dairy cattle, swine, or poultry	NS	+	+
Personal Characteristics			
Membership in farm organizations	NS	+	+
Age (increasing in age)	NS	-	-
Seriousness of water pollution in their county	NS	NS	NS
Pollution from fertilizers	NS	NS	NS
Pollution from livestock/animal waste	NS	NS	NS
Pollution from pesticides	NS	NS	NS
Pollution from cropland	NS	NS	NS
Farm's contribution to water quality problems	+	+	+
Concern for pollution in the Chesapeake Bay	NS	NS	NS
Farmer's living on farm	NS	+	+
Considerations for the Farm Operation			
Increasing yield	NS	NS	NS
Decreasing production costs	NS	+	+
Trying new crops	NS	NS	NS
Reducing fertilizer use	NS	NS	NS
Reducing pesticide use	NS	NS	NS
Access to markets	NS	NS	NS
Credit	NS	NS	NS
Complying with government regulations	NS	NS	NS
Avoiding regulatory problems	NS	NS	NS

Table 4.12. Continued.

Dependent Variables	Effect of Variables		
	Cost-Share BMPs	Non-Cost-Share BMPs	Any BMP
Considerations in Implementing Previous BMPs			
Assistance from farm organizations	NS	NS	NS
Assistance from government	NS	NS	NS
Assistance from other farm operators	NS	NS	NS
Availability of cost-share funds	+	-	NS
Concern for water pollution	NS	NS	NS
Concern for future regulation	NS	NS	NS
Conservation ethic	NS	+	+
Demonstrations/meetings sponsored by Virginia BMP Program	NS	NS	NS
Increased farm production	NS	+	+
Regulatory compliance	NS	+	NS
Information Sources			
Conferences	NS	NS	NS
Extension agents	NS	NS	NS
Extension bulletins	NS	NS	NS
Field trips	NS	NS	NS
Exhibitions or fairs	NS	NS	NS
Farm magazines	NS	+	+
Meetings or workshops	NS	NS	NS
Newspapers	NS	NS	NS
Nutrient management specialists	NS	+	+
Other farm operators	-	+	NS
Pesticide or fertilizer dealers	NS	+	+
Private consultants	NS	NS	NS
Radio	NS	NS	NS
Television	NS	NS	NS
Tours or demonstrations	NS	NS	NS
Virginia Farm Bureau	NS	-	-
Virginia DSWC	NS	NS	NS
U.S. ASCS	+	NS	NS
U.S. NRCS	+	+	+

Table 4.12. Continued.

Dependent Variables	Effect of Variables		
	Cost-Share BMPs	Non-Cost-Share BMPs	Any BMP
Considerations of Adopting New BMPS			
Availability of government cost-sharing	+	-	NS
Availability of technical assistance	NS	NS	NS
Cost of the practice	NS	NS	NS
Difficulty of implementation	NS	+	NS
Effects of practice on profits	NS	+	+
Experience of other farm operators	NS	NS	NS
Information from agribusinesses	NS	NS	NS
Information from government	NS	NS	NS
Labor or time required	NS	NS	NS
Potential to improve water quality	NS	NS	NS
Tax credits	NS	NS	NS
Opinion Statements			
Farm practices that protect water quality usually require more labor.	NS	NS	NS
The best way to control pollution is through the enforcement of strict regulations.	NS	-	-
The government should help by paying more for water pollution control on farms.	+	+	+
Farm operators do not have the right to farm in ways that damage water quality.	+	NS	NS
Farm practices that protect water quality mean lower profits.	NS	NS	NS
Water pollution can best be controlled through educational programs that encourage farm operators to use BMPs	NS	+	+

* BMP implemented regardless of the funding source.

\+ The variable is significant at the 5% level of analysis and has a positive regression parameter.

\- The variable is significant at the 5% level of analysis and has a negative regression parameter.

NS - The variable is not significant at the 5% level of analysis.

Table 4.13. Multivariate Analysis on Cost-Share, Non-Cost-Share, and Any BMP Implementation for Farmers without a Conservation Plan.

Dependent Variables	Effect of Variables		
	Cost-Share BMPs	Non-Cost-Share BMPs	Any BMP*
Farm Characteristics			
Farm size (increasing in size)	NS	+	+
Land owned/rented	NS	NS	NS
Percent of income from farm	+	NS	NS
Production of corn, small grains, or	NS	+	+
soybeans	NS	NS	NS
Raise beef cattle, horses, or sheep	NS	+	NS
Raise dairy cattle, swine, or poultry			
Personal Characteristics			
Membership in farm organizations	+	+	+
Age (increasing in age)	NS	-	-
Seriousness of water pollution in			
their county	NS	NS	NS
Pollution from fertilizers	NS	-	-
Pollution from livestock/animal waste	NS	NS	NS
pollution from pesticides	NS	NS	NS
Pollution from cropland	NS	+	+
Farm's contribution to water quality			
problems	NS	NS	+
Concern for pollution in the			
Chesapeake Bay	NS	NS	+
Farmer's living on farm	NS	+	+
Considerations for the Farm Operation			
Increasing yield	NS	NS	NS
Decreasing production costs	NS	+	+
Trying new crops	+	+	+
Reducing fertilizer use	NS	+	+
Reducing pesticide use	NS	NS	NS
Access to markets	NS	NS	NS
Credit	NS	NS	NS
Complying with government regulations	NS	NS	NS
Avoiding regulatory problems	NS	NS	NS

Table 4.13. Continued.

Dependent Variables	Effect of Variables		
	Cost-Share BMPs	Non-Cost-Share BMPs	Any BMP
Considerations in Implementing Previous BMPs			
Assistance from farm organizations	NS	NS	NS
Assistance from government	NS	NS	-
Assistance from other farm operators	-	NS	NS
Availability of cost-share funds	+	NS	NS
Concern for water pollution	NS	+	+
Concern for future regulation	NS	NS	NS
Conservation ethic	NS	+	+
Demonstrations/meetings sponsored by Virginia BMP Program	NS	NS	NS
Increased farm production	NS	+	+
Regulatory compliance	NS	NS	NS
Information Sources			
Conferences	+	NS	NS
Extension agents	NS	NS	NS
Extension bulletins	NS	NS	NS
Field trips	NS	NS	NS
Exhibitions or fairs	NS	NS	+
Farm magazines	NS	+	+
Meetings or workshops	NS	+	+
Newspapers	NS	NS	NS
Nutrient management specialists	NS	NS	NS
Other farm operators	NS	NS	NS
Pesticide or fertilizer dealers	NS	NS	NS
Private consultants	+	NS	NS
Radio	NS	NS	NS
Television	NS	NS	NS
Tours or demonstrations	NS	NS	NS
Virginia Farm Bureau	NS	NS	NS
Virginia DSWC	NS	+	+
U.S. ASCS	NS	NS	NS
U.S. NRCS	NS	NS	NS

Table 4.13. Continued.

Dependent Variables	Effect of Variables		
	Cost-Share BMPs	Non-Cost-Share BMPs	Any BMP
Considerations of Adopting New BMPS			
Availability of government cost-sharing	+	-	+
Availability of technical assistance	+	+	+
Cost of the practice	-	NS	NS
Difficulty of implementation	NS	NS	NS
Effects of practice on profits	NS	+	+
Experience of other farm operators	NS	NS	NS
Information from agribusinesses	NS	NS	NS
Information from government	NS	NS	NS
Labor or time required	NS	NS	NS
Potential to improve water quality	NS	+	+
Tax credits	NS	NS	NS
Opinion Statements			
Farm practices that protect water quality usually require more labor.	NS	NS	NS
The best way to control pollution is through the enforcement of strict regulations.	NS	+	-
The government should help by paying more for water pollution control on farms.	NS	NS	NS
Farm operators do not have the right to farm in ways that damage water quality.	NS	NS	NS
Farm practices that protect water quality mean lower profits.	NS	NS	NS
Water pollution can best be controlled through educational programs that encourage farm operators to use BMPs.	NS	NS	+

* BMP is implemented regardless of the funding source.

\+ The variable is significant at the 5% level of analysis and has a positive regression parameter.

\- The variable is significant at the 5% level of analysis and has a negative regression parameter.

NS - The variable is not significant at the 5% level of analysis.

and any BMPs for farmers not having conservation plans were production of corn, soybeans, or small grains, farm size, perceived pollution from cropland, decreasing production costs, reducing fertilizer use, concern for water pollution, conservation ethic, increasing farm production, farm magazines, meetings or workshops, DSWC Districts, the effect of the practice on profits, and the potential to improve water quality. In general, the factors significant for the any BMP model were also significant in the non-cost-share BMP index models regardless of the adoption of a conservation plan.

Major River Basins

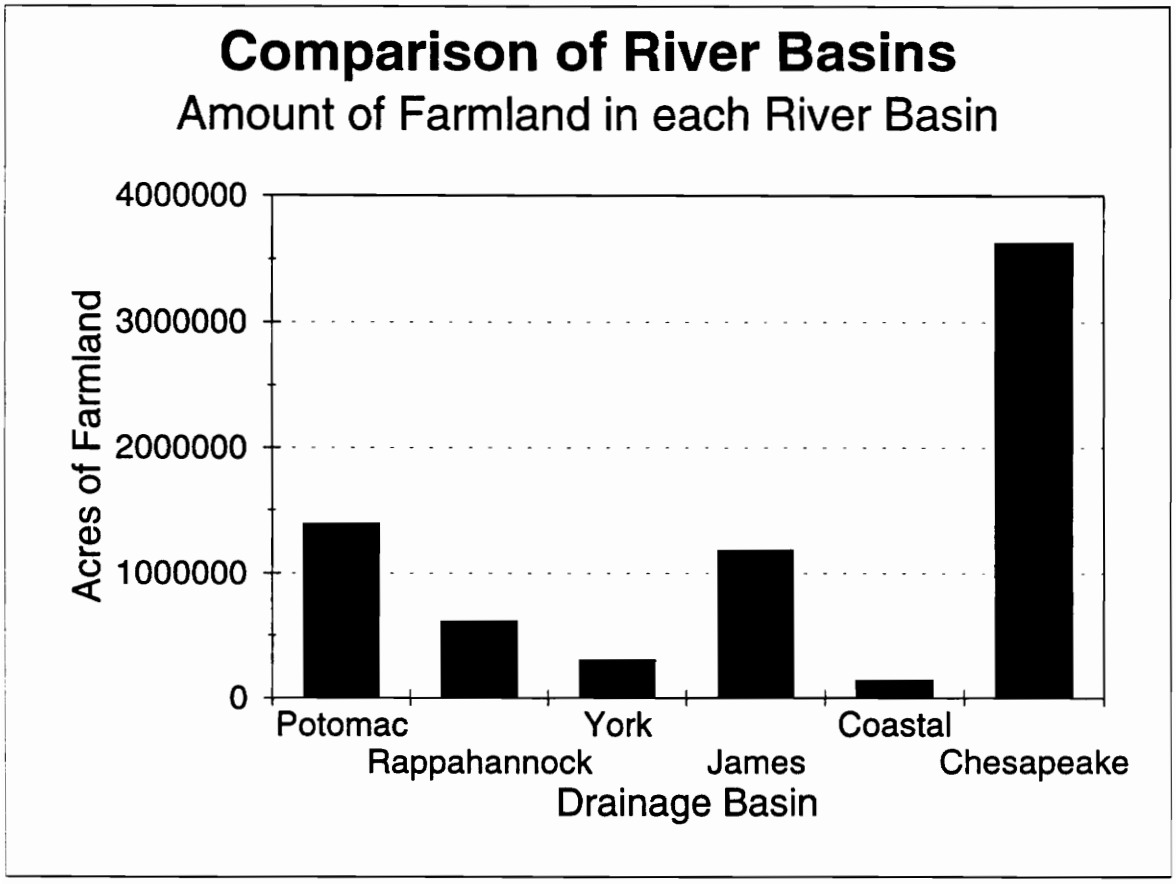
The major drainage basins in Virginia which flow into the Chesapeake Bay are the Potomac River, Rappahannock River, York River, James River, and the Coastal Rivers Basins. The Potomac River Basin consists of the Lower and Upper Potomac River Basins and the Shenandoah River Basin in Northern Virginia. The VirGIS land use and VDACS data show that the total agricultural land in the basin is 1,392,058 acres and is farmed by 8,035 farmers. The Rappahannock River Basin is bounded by the Blue Ridge Mountains to the west, the Potomac River Basin to the north and the York River Basin to the south. The total farmland in the basin is 612,942 acres and is farmed by 2,813 farmers. The York River Basin consists primarily of the Mattaponi and Pamunkey River Sub-basins and the York River Sub-basin below the confluence of the Mattaponi and Pamunkey Rivers. The basin is bounded by the Rappahannock River Basin to the north and the James River Basin to the south. The total farmland in the basin is 301,864 acres and is farmed by 1,918 farmers. The James River Basin consists of the Sub-basins of the Maury River, Rivanna River, Appomattox River, Hampton Roads, Nansemond River, and Elizabeth River. The total farmland in the basin is 1,181,671 acres and is farmed by 7,198 farmers. The Chesapeake Bay Coastal Rivers Basin consists of the area of Virginia flowing into the Chesapeake Bay without first flowing through one of the major rivers. It includes many tributaries from the eastern and western shore such as Cherrystone Inlet, Messongo Creek, Pungoteague Creek, Onancock Creek, Nassawaddox Creek, Great

Wicomico River, Piankatank River, Ware River, Mobjack Bay, Poquoson River, Back River, and Lynnhaven River. The total farmland in the basin is 141,141 acres and is farmed by 622 farmers. Figure 4.5 summarizes the amount of farmland in the major drainage basins, and Figure 4.6 compares the number of farmers in the major drainage basins. Table 3.2 lists the counties and the percentage of agricultural land of the counties in each basin.

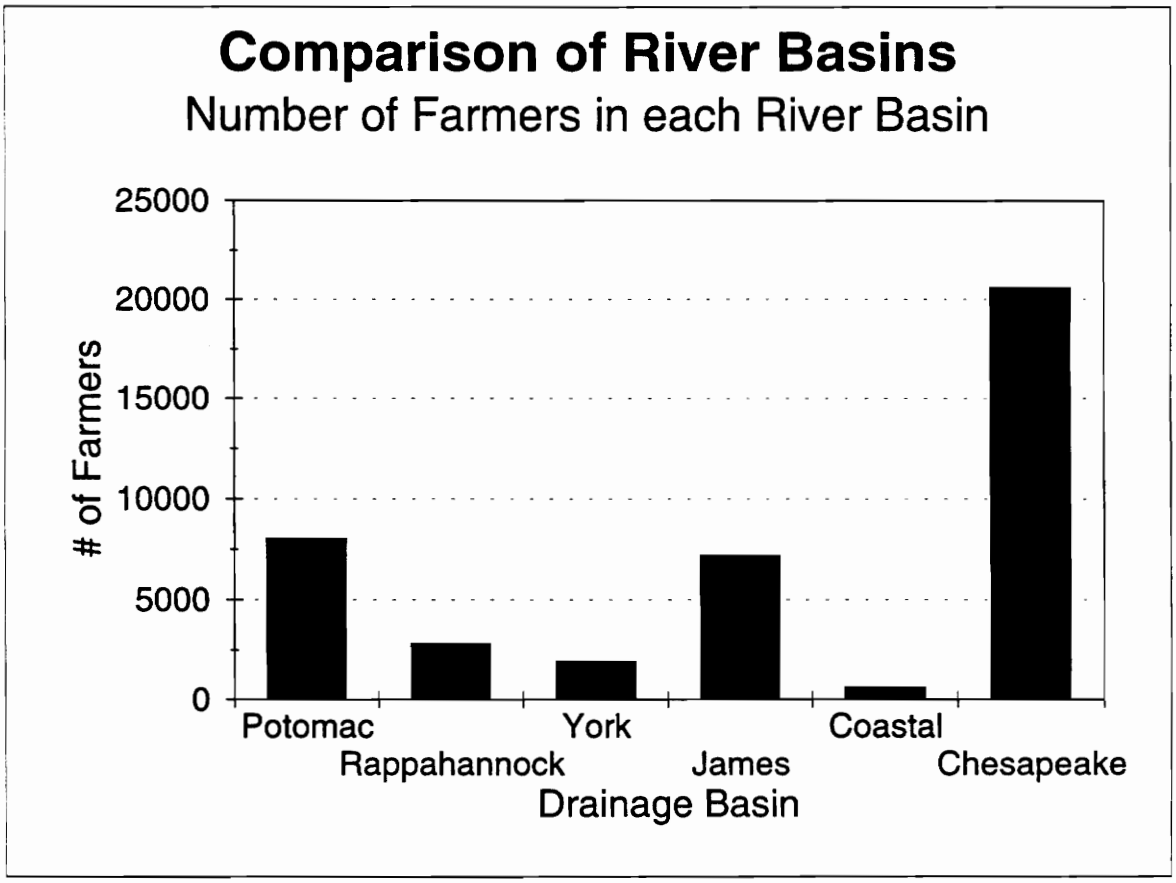
Potomac River Basin

The information presented in this section is based on 455 responses (6 percent of the total number of farmers in the basin) and covers 154,783 acres of farmland (11 percent of total farmland in the basin). Data show that crop production is practiced on 47 percent of farmland. Approximately 61 percent of farmland is owned by farmers and the remaining 39 percent is rented. About 51 percent of the farmers have conservation plans for their farms.

The survey results indicate that the farm operators are of highly varied characteristics. On average, respondents were 58 years of age with 29 years of farming experience and earn 40 percent of their family income from farming operations. The average farm size is approximately 406 acres, and an average of three full-time and four part-time employees are hired at peak season. About 76 percent of the respondents have completed high school, 17 percent have received an associate's or bachelor's degree, and 11 percent have



Graph 4.5. Amount of Farmland in the Major River Basins.



Graph 4.6. Number of Farmers in the Major River Basins.

an advanced or graduate degree. About 37 percent of the respondents were members of a farm or environmental organization.

The considerations for the farming operation most commonly indicated as either very or somewhat important were decreasing production costs (77 percent of the farmers), complying with government regulations (75 percent), and increasing yield (73 percent). The "proximity effect" was evident in the Potomac River Basin, as 79 percent of the farmers indicated they were somewhat or very concerned with pollution in the Chesapeake Bay; 64 percent think water pollution in their county is a problem; but only 36 percent believe that their farm contributes to water quality. Runoff from urban areas (50 percent of the farmers), industrial waste or factory discharge (46 percent), city or town sewer systems (39 percent), and litter/garbage (39 percent) were most commonly indicated as perceived serious or moderate sources of pollution. Fertilizers, pesticides, animal waste, and runoff from cropland were perceived to be either a serious or moderate cause of pollution by 31, 31, 26, and 27 percent of the respondents, respectively.

Beef cattle, dairy cattle, and horses are the primary livestock raised by farmers in the Potomac River basin. Seventy-one percent of the surveyed farmers raise beef cattle, 15 percent raise dairy cattle, and 15 percent raise horses. The average number of beef cattle raised by each farmer is 126 head. A total of 27 percent of the farmers raise poultry, sheep, or swine. Because of the large number of farmers producing beef and dairy cattle,

the majority of the farmers grow hay (76 percent of farmers). Corn (42 percent of farmers), and small grains (22 percent of farmers) were the major crops produced. These were produced on 11 and 5 percent of the farmland, respectively. Table 4.14 presents livestock and crop production in the Potomac River Basin. Beef cattle and hay are the major sources of farm income in this basin.

The survey data indicate that most of the farmers implemented a combination of different BMPs on their farms. An average of 1 cost-share BMP and 4 non-cost share BMPs are implemented by farmers in the Potomac River Basin. Thirty-two percent of the farmers implemented cost-share BMPs on their farms, 71 percent of the farmers implemented non-cost-share BMPs, and 78 percent implemented a BMP, regardless of the funding source. Animal waste storage facilities (8 percent of the farmers) and hayland or pasture management (8 percent) were the most commonly implemented cost-share BMPs. Several other cost-share BMPs were implemented by a slightly fewer number of farmers. Permanent vegetative cover was used by 6 percent of the farmers, rotational grazing (5 percent), grassed waterways (4 percent), stream protection (4 percent), and surface soil sampling (4 percent) comprised the remainder of the major cost-share BMPs implemented. The most often implemented non-cost-share BMPs were hayland or pasture management (42 percent on 11 percent of the farmland) and conservation tillage (39 percent of the farmers on 12 percent of the farmland). Other non-cost-share BMPs commonly implemented were surface soil sampling (35 percent of the farmers); cover

Table 4.14. Livestock and Crop Production in the Potomac River Basin.

Livestock Production		
Livestock	**% of Farmers Raising**	**# per 100 Acres of Surveyed Land**
Aquaculture (lbs. of fish)	1	1
Beef cattle	71	24
Dairy cattle	15	4
Horses	15	<1
Poultry	12	5297
Sheep	10	3
Swine	5	2
Crop Production		
Crops	**% of Farmers growing**	**% of Total acreage**
Alfalfa	36	4
Other hay	76	16
Corn	43	11
Cotton	1	<1
Fruits, orchards & vineyards	2	3
Peanuts	1	<1
Small grains	22	5
Soybeans	11	5
Tobacco	0	0
Vegetables	4	<1

crops (34 percent of the farmers on 6 percent of the farmland); grasses or legumes in rotation (33 percent of the farmers on 7 percent of the farmland); permanent vegetative cover (31 percent of the farmers on 9 percent of the farmland); and rotational grazing (29 percent of the farmers on 11 percent of the farmland). A complete list of cost-share and non-cost-share BMP implementation is provided in Table 4.15 The most commonly indicated sources of information on BMPs for farmers in the Potomac River Basin were extension agents, extension bulletins, farm magazines, other farm operators, DSWC Districts, ASCS, and NRCS. The major reasons given for not implementing BMPs were lack of a problem, operation is too small, and too much paperwork or red tape.

Rappahannock River Basin

The information presented in this section is based on 160 responses (6 percent of the total number of farmers in the basin) that cover 95,280 acres of farmland (16 percent of total farmland of the basin). Data show that crop production is practiced on 63 percent of farmland covered by the survey. Approximately 58 percent of farmland is owned by farmers and the remaining 42 percent of the farmland in rented. Sixty-eight percent of the farmers have conservation plans for their farms.

The survey results indicate that the farm operators are of highly varied characteristics. On the average, respondents were 58 years of age with 30 years of farming experience and earned 44 percent of their family income from farming operations. The average farm size

Table 4.15. BMP Implementation in the Potomac River Basin.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Biological pest controls -		
(a) Cost-Share	6 (1%)[1]	369 (<1%)[2]
(b) Non-Cost-Share	24 (5%)	3,001 (2%)
(c) Ratio (b)/(a)	4	8
Contour strip cropping -		
(a) Cost-Share	13 (3%)	685 (<1%)
(b) Non-Cost-Share	67 (15%)	5,981 (4%)
(c) Ratio (b)/(a)	5	9
Conservation tillage -		
(a) Cost-Share	13 (3%)	1,062 (1%)
(b) Non-Cost-Share	166 (36%)	19,188 (12%)
(c) Ratio (b)/(a)	13	18
Cover crops -		
(a) Cost-Share	14 (3%)	461 (<1%)
(b) Non-Cost-Share	142 (31%)	9,163 (6%)
(c) Ratio (b)/(a)	10	20
Field scouting -		
(a) Cost-Share	6 (1%)	209 (<1%)
(b) Non-Cost-Share	100 (22%)	17,988 (12%)
(c) Ratio (b)/(a)	17	86
Grass or legume in rotation -		
(a) Cost-Share	11 (2%)	374 (<1%)
(b) Non-Cost-Share	140 (31%)	10,301 (7%)
(c) Ratio (b)/(a)	13	28
Hayland or pasture management-		
(a) Cost-Share	35 (8%)	2,316 (2%)
(b) Non-Cost-Share	179 (39%)	16,501 (11%)
(c) Ratio (b)/(a)	5	7
Irrigation improvement -		
(a) Cost-Share	1 (<1%)	100 (<1%)
(b) Non-Cost-Share	26 (6%)	1,591 (1%)
(c) Ratio (b)/(a)	26	16

Table 4.15. Continued.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Permanent vegetation cover -		
(a) Cost-share	27 (6%)	1,755 (1%)
(b) Non-Cost-Share	122 (27%)	14,305 (9%)
(c) Ratio (b)/(a)	5	8
Rotational grazing -		
(a) Cost-share	21 (5%)	1,905 (1%)
(b) Non-Cost-Share	124 (27%)	17,514 (11%)
(c) Ratio (b)/(a)	6	9
Split fertilizer applications -		
(a) Cost-Share	10 (2%)	1,098 (1%)
(b) Non-Cost-Share	109 (24%)	8,661 (6%)
(c) Ratio (b)/(a)	11	8
Tissue analysis -		
(a) Cost-Share	0 (<1%)	0 (<1%)
(b) Non-Cost-Share	36 (8%)	3,543 (2%)
(c) Ratio (b)/(a)	-----	-----

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Animal waste storage facilities -		
(a) Cost-Share	34 (7%)	43 facilities
(b) Non-Cost-Share	40 (9%)	49 facilities
(c) Ratio (b)/(a)	1	1
Animal waste sampling/analysis -		
(a) Cost-Share	14 (3%)	38 analyses/year
(b) Non-Cost-Share	41 (9%)	253 analyses/year
(c) Ratio (b)/(a)	2	7
Deep soil sampling/analysis-		
(a) Cost-Share	3 (1%)	2 samples/acre/farmer
(b) Non-Cost-Share	19 (4%)	1 sample/acre/farmer
(c) Ratio (b)/(a)	6	0.5

Table 4.15. Continued.

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Surface soil sampling/analysis-		
(a) Cost-Share	15 (3%)	1 sample/acre/farmer
(b) Non-Cost-Share	147 (32%)	1 sample/acre/farmer
(c) Ratio (b)/(a)	10	1
Diversions (acres affected) -		
(a) Cost-Share	0 (0%)	0 acres (0%)
(b) Non-Cost-Share	8 (2%)	465 acres (<1%)
(c) Ratio (b)/(a)	-----	-----
Filter/buffer strips (acres affected) -		
(a) Cost-Share	8 (2%)	229 acres (<1%)
(b) Non-Cost-Share	60 (13%)	3,906 acres (3%)
(c) Ratio (b)/(a)	8	17
Grass waterways (acres affected) -		
(a) Cost-Share	16 (4%)	1,002 acres (1%)
(b) Non-Cost-Share	92 (20%)	9,825 acres (6%)
(c) Ratio (b)/(a)	6	10
Terraces (acres affected) -		
(a) Cost-Share	0 (0%)	0 acres (0%)
(b) Non-Cost-Share	6 (1%)	345 acres (<1%)
(c) Ratio (b)/(a)	-----	-----
Sediment traps/basin (acres affected) -		
(a) Cost-Share	4 (1%)	100 acres (<1%)
(b) Non-Cost-Share	17 (4%)	656 acres (<1%)
(c) Ratio (b)/(a)	4	7
Stream protection or fencing -		
(a) Cost-Share	18 (4%)	21,958 ft
(b) Non-Cost-Share	43 (9%)	121,394 ft
(c) Ratio (b)/(a)	2	6
Sprayer calibration checks-		
(a) Cost-Share	6 (1%)	15 checks/year
(b) Non-Cost-Share	59 (13%)	157 checks/year
(c) Ratio (b)/(a)	10	10

[1] - Values in parenthesis are the percentage of respondents using the BMPs.

[2] - Values in parenthesis are the percentage of acres farmed.

is approximately 572 acres, and an average of one full-time and two part-time employees are hired at peak season. About 79 percent of the respondents have completed high school, 18 percent have received an associate's or bachelor's degree, and 12 percent have an advanced or graduate degree. About 48 percent of the respondents were members of a farm or environmental organization.

The considerations for the farming operation most commonly indicated as either very or somewhat important were decreasing production costs (85 percent of the farmers), increasing yield (82 percent), and reducing fertilizer use (76 percent). The "proximity effect" was also evident in the Rappahannock River Basin, as 84 percent of the farmers indicated they were somewhat or very concerned with pollution in the Chesapeake Bay; 58 percent think water pollution in their county is a problem; however only 40 percent believe that their farm contributes to water quality. Runoff from urban areas (40 percent of the farmers), city or town sewer systems (39 percent), industrial waste or factory discharge (36 percent), and litter/garbage (35 percent) were most commonly indicated as perceived serious or moderate sources of pollution. Fertilizers, pesticides, animal waste, and runoff from cropland were perceived to be either a serious or moderate cause of pollution by 25, 26, 19, and 27 percent of the respondents, respectively.

Beef cattle, horses, and dairy cattle are the primary livestock raised by farmers in the Rappahannock River basin. Sixty-five percent of the surveyed farmers raise beef cattle,

11 percent raise horses, and 9 percent raise dairy cattle. The average number of beef cattle raised by each farmer is 158 head. A total of 12 percent of the farmers raise poultry, sheep, or swine. Most of the farmers surveyed grow hay or grain crops. The majority of the farmers grow hay (68 percent of farmers on 13 percent of the farmland), corn (51 percent of the farmers on 16 percent of the farmland), small grains (40 percent of the farmers on 12 percent of the farmland), and soybeans (37 percent of the farmers on 16 percent of the farmland). Table 4.16 presents livestock and crop production in the Rappahannock River Basin. Beef cattle, corn, small grains, and soybeans are the major sources of farm income.

As with the other river basins, a variety of different BMPs are implemented on the farms in the Rappahannock River Basin. Results of the study showed that 36 percent of the farmers implemented cost-share BMPs on their farms, 79 percent of the farmers implemented non-cost-share BMPs, and 88 percent implemented any type of BMP. The average farmer adopts 1 cost-share BMP and 5 non-cost-share BMPs. Grassed waterways (11 percent of the farmers), filter or buffer strips (10 percent), and permanent vegetative cover (10 percent) were the most commonly implemented cost-share BMPs. Conservation tillage (8 percent), cover crops (8 percent), grasses or legumes in rotation (7 percent), and hayland or pasture management (9 percent) were other cost-share BMPs implemented by a slightly fewer number of farmers. The most often implemented non-cost-share BMPs were conservation tillage (49 percent of the farmers on 13 percent of the

Table 4.16. Livestock and Crop Production in the Rappahannock River Basin.

Livestock Production		
Livestock	**% of Farmers Raising**	**# per 100 Acres of Surveyed Land**
Aquaculture (lbs. of fish)	2	11
Beef cattle	65	16
Dairy cattle	9	1
Horses	11	<1
Poultry	2	33
Sheep	3	1
Swine	7	5
Crop Production		
Crops	**% of Farmers Growing**	**% of Total Acreage**
Alfalfa	29	2
Other hay	68	13
Corn	51	16
Cotton	<1	<1
Fruits, orchards & vineyards	4	1
Peanuts	2	<1
Small grains	40	12
Soybeans	37	16
Tobacco	1	<1
Vegetables	4	<1

farmland) and hayland or pasture management (47 percent of the farmers on 10 percent of the farmland). Other non-cost-share BMPs commonly implemented were cover crops (36 percent of the farmers on 3 percent of the farmland), field scouting (38 percent of the farmers on 11 percent of the farmland), permanent vegetative cover (37 percent of the farmers on 8 percent of the farmland), and split fertilizer applications (35 percent of the farmers on percent of the farmland). A complete list of cost-share and non-cost-share BMP implementation is provided in Table 4.17. The most commonly indicated sources of information on BMPs for farmers in the Rappahannock River Basin were extension agents, extension bulletins, farm magazines, DSWC Districts, ASCS, and NRCS. The major reasons given for not implementing BMPs were operation is too small, lack of a problem, and too much paperwork or red tape.

York River Basin

The information presented in this section is based on 123 responses (6 percent of the total number of farmers in the basin) that cover 60,680 acres of farmland (20 percent of total farmland in the basin). Data show that crop production is practiced on 88 percent of farmland covered by the survey. Approximately 47 percent of farmland is owned by farmers and the remaining 53 percent of the farmland in rented. Sixty-eight percent of the farmers have conservation plans for their farms.

Table 4.17. BMP Implementation in the Rappahannock River Basin.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Biological pest controls -		
(a) Cost-Share	2 (1%)[1]	60 (<1%)[2]
(b) Non-Cost-Share	15 (9%)	835 (1%)
(c) Ratio (b)/(a)	8	14
Contour strip cropping -		
(a) Cost-Share	6 (4%)	473 (<1%)
(b) Non-Cost-Share	23 (14 %)	1,060 (1%)
(c) Ratio (b)/(a)	4	2
Conservation tillage -		
(a) Cost-Share	12 (8%)	1,664 (2%)
(b) Non-Cost-Share	74 (46%)	12,570 (13%)
(c) Ratio (b)/(a)	6	8
Cover crops -		
(a) Cost-Share	11 (7%)	607 (1%)
(b) Non-Cost-Share	55 (34%)	2,701 (3%)
(c) Ratio (b)/(a)	5	4
Field scouting -		
(a) Cost-Share	8 (5%)	769 (1%)
(b) Non-Cost-Share	57 (36%)	10,498 (11%)
(c) Ratio (b)/(a)	7	14
Grass or legume in rotation -		
(a) Cost-Share	10 (6%)	431 (<1%)
(b) Non-Cost-Share	46 (29%)	3,167 (3%)
(c) Ratio (b)/(a)	5	7
Hayland or pasture management-		
(a) Cost-Share	14 (9%)	765 (1%)
(b) Non-Cost-Share	70 (44%)	9,355 (10%)
(c) Ratio (b)/(a)	5	12
Irrigation improvement -		
(a) Cost-Share	2 (1%)	275 (<1%)
(b) Non-Cost-Share	8 (5%)	646 (1%)
(c) Ratio (b)/(a)	4	2

Table 4.17. Continued.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Permanent vegetation cover -		
(a) Cost-share	15 (9%)	634 (1%)
(b) Non-Cost-Share	56 (35%)	7,166 (8%)
(c) Ratio (b)/(a)	4	11
Rotational grazing -		
(a) Cost-share	4 (3%)	125 (<1%)
(b) Non-Cost-Share	45 (28%)	8,310 (9%)
(c) Ratio (b)/(a)	11	66
Split fertilizer applications -		
(a) Cost-Share	5 (3%)	1,302 (1%)
(b) Non-Cost-Share	53 (33%)	8,661 (9%)
(c) Ratio (b)/(a)	11	7
Tissue analysis -		
(a) Cost-Share	3 (2 %)	94 (<1%)
(b) Non-Cost-Share	25 (16%)	2,617 (3%)
(c) Ratio (b)/(a)	8	28

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Animal waste storage facilities -		
(a) Cost-Share	0 (0%)	7 facilities
(b) Non-Cost-Share	14 (9%)	12 facilities
(c) Ratio (b)/(a)	-----	2
Animal waste sampling/analysis -		
(a) Cost-Share	4 (3%)	0 analyses/year
(b) Non-Cost-Share	11 (7%)	43 analyses/year
(c) Ratio (b)/(a)	3	-----
Deep soil sampling/analysis-		
(a) Cost-Share	1 (1%)	1 sample/acre/farmer
(b) Non-Cost-Share	4 (3%)	1 sample/acre/farmer
(c) Ratio (b)/(a)	4	1

Table 4.17. Continued.

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Surface soil sampling/analysis-		
(a) Cost-Share	9 (6%)	1 sample/acre/farmer
(b) Non-Cost-Share	62 (39%)	1 sample/acre/farmer
(c) Ratio (b)/(a)	7	1
Diversions (acres affected) -		
(a) Cost-Share	2 (1%)	16 acres (<1%)
(b) Non-Cost-Share	5 (3%)	415 acres (<1%)
(c) Ratio (b)/(a)	3	26
Filter/buffer strips (acres affected) -		
(a) Cost-Share	15 (9%)	1,523 acres (2%)
(b) Non-Cost-Share	41 (26%)	2,579 acres (3%)
(c) Ratio (b)/(a)	3	2
Grass waterways (acres affected) -		
(a) Cost-Share	16 (10%)	1,568 acres (2%)
(b) Non-Cost-Share	42 (26%)	3,719 acres (4%)
(c) Ratio (b)/(a)	3	2
Terraces (acres affected) -		
(a) Cost-Share	0 (0%)	0 acres (0%)
(b) Non-Cost-Share	2 (1%)	38 acres (<1%)
(c) Ratio (b)/(a)	-----	-----
Sediment traps/basin (acres affected) -		
(a) Cost-Share	1 (1%)	57 acres (< 1%)
(b) Non-Cost-Share	13 (8%)	642 acres (1%)
(c) Ratio (b)/(a)	13	11
Stream protection or fencing -		
(a) Cost-Share	7 (4%)	17,926 ft
(b) Non-Cost-Share	19 (12%)	73,086 ft
(c) Ratio (b)/(a)	3	4
Sprayer calibration checks-		
(a) Cost-Share	2 (1%)	9 checks/year
(b) Non-Cost-Share	34 (21%)	120 checks/year
(c) Ratio (b)/(a)	17	13

[1] - Values in parenthesis are the percentage of respondents using the BMPs.
[2] - Values in parenthesis are the percentage of acres farmed.

On average, respondents were 58 years of age with 30 years of farming experience and earned 39 percent of their family income from farming operations. The average farm size is approximately 502 acres, and an average of one full-time and two part-time employees are hired at peak season. About 84 percent of the respondents have completed high school, 16 percent have received an associate's or bachelor's degree, and 11 percent have an advanced or graduate degree. About 54 percent of the respondents were members of a farm or environmental organization.

The major considerations indicated as somewhat or very important for the farming operation were decreasing production costs (82 percent of the farmers), increasing yield (81 percent), reducing fertilizer use (75 percent), and access to markets (75 percent). The "proximity effect" was also evident in the York River Basin, as 82 percent of the farmers indicated they were somewhat or very concerned with pollution in the Chesapeake Bay; 52 percent think water pollution in their county is a problem; but only 31 percent believe that their farm contributes to water quality. Runoff from urban areas (47 percent of the farmers), industrial waste or factory discharge (43 percent), litter/garbage (35 percent), and city or town sewer systems (34 percent), were most commonly indicated as perceived serious or moderate sources of pollution. Fertilizers, pesticides, animal waste, and runoff from cropland were perceived to be either a serious or moderate cause of pollution by 21, 21, 14, and 19 percent of the respondents, respectively.

Beef cattle, horses, dairy cattle, and poultry are the primary livestock raised by farmers in the York River basin. Fifty-eight percent of the surveyed farmers raise beef cattle, 9 percent raise horses, 7 percent raise dairy cattle, and 7 percent raise poultry. The average number of beef cattle raised by each farmer is 108 head. A total of 10 percent of the farmers indicate raising sheep or swine. As with the Rappahannock River Basin, most of the farmers surveyed grow hay or grain crops. The majority of the farmers grow hay (68 percent of farmers on 12 percent of the farmland), corn (50 percent of the farmers on 19 percent of the farmland), small grains (49 percent of the farmers on 20 percent of the farmland), and soybeans (42 percent of the farmers on 29 percent of the farmland). Table 4.18 presents a summary of livestock and crop production in the York River Basin. Beef cattle, corn, small grains, soybeans, and hay are the major sources of farm income in this basin.

As with the other river basins, a variety of different BMPs are implemented on the farms in the York River Basin. Results of the study showed that 34 percent of the farmers implemented cost-share BMPs on their farms, 83 percent of the farmers implemented non-cost-share BMPs, and 90 percent implemented any type of BMP. The average farmer adopts 1 cost-share BMP and 5 non-cost-share BMPs. Hayland or pasture management (14 percent of the farmers), and grassed waterways (9 percent of the farmers) were the most commonly implemented cost-share BMPs. Contour strip-cropping (5 percent), conservation tillage (4 percent), cover crops (5 percent), permanent

Table 4.18. Livestock and Crop Production in the York River Basin.

Livestock Production		
Livestock	**% of Farmers Raising**	**# per 100 Acres of Surveyed Land**
Aquaculture (lbs. of fish)	2	<1
Beef cattle	58	12
Dairy cattle	7	1
Horses	9	<1
Poultry	7	211
Sheep	5	<1
Swine	5	3
Crop Production		
Crops	**% of Farmers Growing**	**% of Total Acreage**
Alfalfa	24	2
Other hay	68	12
Corn	50	19
Cotton	0	0
Fruits, orchards & vineyards	5	<1
Peanuts	1	<1
Small grains	49	20
Soybeans	42	29
Tobacco	2	2
Vegetables	10	<1

vegetative cover (4 percent), split fertilizer applications (5 percent), filter of buffer strips (5 percent), and surface soil sampling (4 percent) were other frequently implemented cost-share BMPs. The most often implemented non-cost-share BMPs were conservation tillage (54 percent of the farmers on 22 percent of the farmland), split fertilizer applications (45 percent of the farmers on 25 percent of the farmland), and hayland or pasture management (43 percent of the farmers on 7 percent of the farmland). Other non-cost-share BMPs commonly implemented were cover crops (42 percent of the farmers on 4 percent of the farmland), field scouting (41 percent of the farmers on 32 percent of the farmland), permanent vegetative cover (41 percent of the farmers on 7 percent of the farmland), and surface soil sampling (40 percent of the farmers) A complete list of cost-share and non-cost-share BMP implementation in the York River basin is provided in Table 4.19. Similarly to the other river basins, the most commonly indicated sources of information on BMPs for farmers in the York River Basin were extension agents, extension bulletins, farm magazines, DSWC Districts, ASCS, and NRCS. The major reasons given for not implementing BMPs were operation is too small, lack of a problem, and too much paperwork or red tape.

Table 4.19. BMP Implementation in the York River Basin.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Biological pest controls -		
(a) Cost-Share	1 (0%)[1]	2 (<1%)[2]
(b) Non-Cost-Share	6 (13%)	553 (1%)
(c) Ratio (b)/(a)	6	277
Contour strip cropping -		
(a) Cost-Share	5 (0%)	1,742 (3%)
(b) Non-Cost-Share	16 (3%)	438 (1%)
(c) Ratio (b)/(a)	3	0.25
Conservation tillage -		
(a) Cost-Share	4 (3%)	3,330 (5%)
(b) Non-Cost-Share	64 (52%)	13,358 (22%)
(c) Ratio (b)/(a)	16	4
Cover crops -		
(a) Cost-Share	6 (5%)	679 (1%)
(b) Non-Cost-Share	49 (40%)	2,594 (4%)
(c) Ratio (b)/(a)	8	4
Field scouting -		
(a) Cost-Share	3 (2%)	4,296 (7%)
(b) Non-Cost-Share	48 (39%)	19,338 (32%)
(c) Ratio (b)/(a)	16	5
Grass or legume in rotation -		
(a) Cost-Share	3 (2%)	500 (1%)
(b) Non-Cost-Share	41 (33%)	3,195 (5%)
(c) Ratio (b)/(a)	14	6
Hayland or pasture management-		
(a) Cost-Share	16 (13%)	1,047 (2%)
(b) Non-Cost-Share	50 (41%)	4,169 (7%)
(c) Ratio (b)/(a)	3	4
Irrigation improvement -		
(a) Cost-Share	0 (0%)	0 (0%)
(b) Non-Cost-Share	11 (9%)	1,012 (2%)
(c) Ratio (b)/(a)	-----	-----

Table 4.19. Continued.

BMPs	Number of Farmers Implementing BMPs	Acreage under BMPs
Permanent vegetation cover -		
(a) Cost-share	5 (4%)	133 (<1%)
(b) Non-Cost-Share	48 (39%)	4,122 (7%)
(c) Ratio (b)/(a)	10	31
Rotational grazing -		
(a) Cost-share	3 (2%)	147 (<1%)
(b) Non-Cost-Share	33 (27%)	2,202 (4%)
(c) Ratio (b)/(a)	11	15
Split fertilizer applications -		
(a) Cost-Share	5 (4%)	1,877 (3%)
(b) Non-Cost-Share	52 (42%)	15,249 (25%)
(c) Ratio (b)/(a)	10	8
Tissue analysis -		
(a) Cost-Share	3 (2%)	386 (1%)
(b) Non-Cost-Share	25 (20%)	3,248 (5%)
(c) Ratio (b)/(a)	8	8

BMP	Number of Farmers Implementing BMP	BMP Implementation
Animal waste storage facilities -		
(a) Cost-Share	0 (0%)	5 facilities
(b) Non-Cost-Share	7 (6%)	4 facilities
(c) Ratio (b)/(a)	-----	1
Animal waste sampling/analysis -		
(a) Cost-Share	4 (3%)	0 analyses/year
(b) Non-Cost-Share	4 (3%)	9 analyses/year
(c) Ratio (b)/(a)	1	-----
Deep soil sampling/analysis-		
(a) Cost-Share	1 (1%)	1 sample/acre/farmer
(b) Non-Cost-Share	3 (2%)	1 sample/acre/farmer
(c) Ratio (b)/(a)	3	1

Table 4.19. Continued.

BMP	Number of Farmers Implementing BMP	BMP Implementation
Surface soil sampling/analysis-		
(a) Cost-Share	5 (4%)	1 sample/acre/farmer
(b) Non-Cost-Share	47 (38%)	1 sample/acre/farmer
(c) Ratio (b)/(a)	9	1
Diversions (acres affected) -		
(a) Cost-Share	1 (1%)	3 acres (<1%)
(b) Non-Cost-Share	3 (2%)	281 acres (<1%)
(c) Ratio (b)/(a)	3	94
Filter/buffer strips (acres affected) -		
(a) Cost-Share	6 (5%)	346 acres (1%)
(b) Non-Cost-Share	33 (27%)	2,049 acres (3%)
(c) Ratio (b)/(a)	6	6
Grass waterways (acres affected) -		
(a) Cost-Share	10 (8%)	439 acres (1%)
(b) Non-Cost-Share	39 (32%)	3,207 acres (5%)
(c) Ratio (b)/(a)	4	7
Terraces (acres affected) -		
(a) Cost-Share	0 (0%)	0 acres (0%)
(b) Non-Cost-Share	4 (3%)	31 acres (<1%)
(c) Ratio (b)/(a)	-----	-----
Sediment traps/basin (acres affected) -		
(a) Cost-Share	1 (1%)	50 acres (<1%)
(b) Non-Cost-Share	6 (5%)	117 acres (<1%)
(c) Ratio (b)/(a)	6	2
Stream protection or fencing -		
(a) Cost-Share	3 (2%)	4,688 ft
(b) Non-Cost-Share	14 (11%)	52,190 ft
(c) Ratio (b)/(a)	5	11
Sprayer calibration checks-		
(a) Cost-Share	1 (1%)	2 checks/year
(b) Non-Cost-Share	34 (28%)	190 checks/year
(c) Ratio (b)/(a)	34	95

[1] - Values in parenthesis are the percentage of respondents using the BMPs.
[2] - Values in parenthesis are the percentage of acres farmed.

James River Basin

The information presented in this section is based on 420 responses (6 percent of the total number of farmers in the basin) that cover 142,570 acres of farmland (12 percent of total farmland in the basin). The survey data show that crop production is practiced on 61 percent of farmland. Approximately 59 percent of farmland is owned by farmers and the remaining 41 percent of the farmland in rented. Fifty percent of the farmers have conservation plans for their farms.

The survey results indicate that the farm operators, on the average, were 59 years of age with 31 years of farming experience and earned 36 percent of their family income from farming operations. The average farm size is approximately 376 acres, and an average of one full-time and two part-time employees are hired at peak season. About 79 percent of the respondents have completed high school, 15 percent have received an associate's or bachelor's degree, and 9 percent have an advanced or graduate degree. About 42 percent of the respondents were members of a farm or environmental organization.

The major factors indicated as somewhat or very important considerations for the farming operation were decreasing production costs (74 percent of the farmers), increasing yield (73 percent), and access to markets (67 percent). The "proximity effect" was also evident in the James River Basin, as 78 percent of the farmers indicated they were somewhat or very concerned with pollution in the Chesapeake Bay; 49 percent think water pollution in

their county is a problem; but only 29 percent believe that their farm contributes to water quality. Industrial waste or factory discharge (41 percent of the farmers), runoff from urban areas (40 percent), and litter/garbage (36 percent) were most commonly indicated as perceived serious or moderate sources of pollution. Fertilizers, pesticides, animal waste, and runoff from cropland were perceived to be either a serious or moderate cause of pollution by 20, 22, 17, and 19 percent of the respondents, respectively.

Beef cattle and horses are the primary livestock raised by farmers in the James River basin. Sixty-nine percent of the farmers surveyed raise beef cattle and 12 percent raise horses. The average number of beef cattle raised by each farmer is 91 head. A total of 19 percent of the farmers indicate raising beef cattle, poultry, sheep and swine. As with the other river basins, most of the farmers surveyed grow hay or grain crops. The majority of the farmers grow hay (73 percent of farmers on 16 percent of the farmland), corn (30 percent of the farmers on 9 percent of the farmland), small grains (23 percent of the farmers on 8 percent of the farmland), and soybeans (15 percent of the farmers on 9 percent of the farmland). Table 4.20 presents livestock and crop production data for the James River Basin. Beef cattle, corn, small grains, soybeans, and hay are the major sources of farm income.

A number of different BMPs are implemented in the James River Basin. Results of the study showed that 27 percent of the farmers implemented cost-share BMPs on their

Table 4.20. Livestock and Crop Production in the James River Basin.

Livestock Production		
Livestock	**% of Farmers Raising**	**# per 100 Acres of Surveyed Land**
Aquaculture (lbs. of fish)	2	82
Beef cattle	69	17
Dairy cattle	6	2
Horses	12	<1
Poultry	6	374
Sheep	3	<1
Swine	4	8
Crop Production		
Crops	**% of Farmers Growing**	**% of Total Acreage**
Alfalfa	18	1
Other hay	74	16
Corn	30	9
Cotton	2	1
Fruits, orchards & vineyards	5	1
Peanuts	5	3
Small grains	23	8
Soybeans	15	9
Tobacco	5	1
Vegetables	7	<1

farms, 74 percent of the farmers implemented non-cost-share BMPs, and 79 percent implemented any type of BMP. The average farmer adopts 1 cost-share BMP and 4 non-cost-share BMPs. Hayland or pasture management (9 percent of the farmers), grassed waterways (6 percent of the farmers), permanent vegetative cover (6 percent) and cover crops (6 percent of the farmers) were the most commonly implemented cost-share BMPs. Conservation tillage (4 percent), split fertilizer applications (4 percent), filter or buffer strips (4 percent), and surface soil sampling (5 percent) were other frequently implemented cost-share BMPs. The most commonly implemented non-cost-share BMPs were hayland and pasture management (45 percent of the farmers on 10 percent of the farmed land) and conservation tillage (38 percent of the farmers on 12 percent of the farmland). Other non-cost-share BMPs commonly implemented were cover crops (32 percent of the farmers on 6 percent of the farmland); permanent vegetative cover (33 percent of the farmers on 8 percent of the farmland); split fertilizer applications (30 percent of the farmers on 9 percent of the farmed land); surface soil sampling (30 percent of the farmers); and rotational grazing (28 percent of the farmers on 7 percent of the farmed land). A complete list of cost-share and non-cost-share BMP implementation is provided in Table 4.21. Similar to the other river basins, the most commonly indicated sources of information on BMPs for farmers in the James River Basin were extension agents, extension bulletins, farm magazines, DSWC Districts, ASCS, and NRCS. The major reasons given for not implementing BMPs were operation is too small, lack of a problem, and too much paperwork or red tape.

Table 4.21. BMP Implementation in the James River Basin.

BMPs	Number of Farmers Implementing BMPs	Acreage under BMPs
Biological pest controls -		
(a) Cost-Share	2 (1%)[1]	30 (<1%)[2]
(b) Non-Cost-Share	22 (5%)	1,629 (1%)
(c) Ratio (b)/(a)	11	54
Contour strip cropping -		
(a) Cost-Share	10 (2%)	259 (<1%)
(b) Non-Cost-Share	52 (12%)	1,859 (<1%)
(c) Ratio (b)/(a)	5	7
Conservation tillage -		
(a) Cost-Share	13 (3%)	1,074 (1%)
(b) Non-Cost-Share	142 (34%)	17,544 (12%)
(c) Ratio (b)/(a)	11	16
Cover crops -		
(a) Cost-Share	22 (3%)	1,819 (1%)
(b) Non-Cost-Share	121 (29%)	8,701 (6%)
(c) Ratio (b)/(a)	6	5
Field scouting -		
(a) Cost-Share	5 (1%)	1,187 (1%)
(b) Non-Cost-Share	81 (19%)	15,667 (11%)
(c) Ratio (b)/(a)	16	13
Grass or legume in rotation -		
(a) Cost-Share	3 (<1%)	230 (<1%)
(b) Non-Cost-Share	101 (24%)	7,365 (5%)
(c) Ratio (b)/(a)	34	32
Hayland or pasture management-		
(a) Cost-Share	34 (8%)	2,984 (2%)
(b) Non-Cost-Share	166 (40%)	13,809 (10%)
(c) Ratio (b)/(a)	5	5
Irrigation improvement -		
(a) Cost-Share	2 (<1%)	15 (<1%)
(b) Non-Cost-Share	24 (6%)	690 (<1%)
(c) Ratio (b)/(a)	12	46

Table 4.21. Continued.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Permanent vegetation cover -		
(a) Cost-share	22 (5%)	2,201 (2%)
(b) Non-Cost-Share	122 (29%)	10,938 (8%)
(c) Ratio (b)/(a)	6	5
Rotational grazing -		
(a) Cost-share	11 (3%)	1,957 (1%)
(b) Non-Cost-Share	103 (25%)	9,468 (7%)
(c) Ratio (b)/(a)	9	5
Split fertilizer applications -		
(a) Cost-Share	15 (4%)	1,851 (1%)
(b) Non-Cost-Share	110 (26%)	12,817 (9%)
(c) Ratio (b)/(a)	7	7
Tissue analysis -		
(a) Cost-Share	1 (<1%)	40 (<1%)
(b) Non-Cost-Share	28 (7%)	1,703 (1%)
(c) Ratio (b)/(a)	28	43

BMP	Number of Farmers Implementing BMP	BMP Implementation
Animal waste storage facilities -		
(a) Cost-Share	5 (1%)	6 facilities
(b) Non-Cost-Share	16 (4%)	25 facilities
(c) Ratio (b)/(a)	3	4
Animal waste sampling/analysis -		
(a) Cost-Share	4 (1%)	84 analyses/year
(b) Non-Cost-Share	15 (4%)	47 analyses/year
(c) Ratio (b)/(a)	4	0.6
Deep soil sampling/analysis-		
(a) Cost-Share	1 (<1%)	2 samples/acre/farmer
(b) Non-Cost-Share	11 (3%)	1 sample/acre/farmer
(c) Ratio (b)/(a)	11	0.5

Table 4.21. Continued.

BMP	Number of Farmers Implementing BMP	BMP Implementation
Surface soil sampling/analysis-		
(a) Cost-Share	19 (5%)	1 sample/acre/farmer
(b) Non-Cost-Share	112 (27%)	1 sample/acre/farmer
(c) Ratio (b)/(a)	6	1
Diversions (acres affected) -		
(a) Cost-Share	2 (<1%)	123 acres (<1%)
(b) Non-Cost-Share	12 (3%)	487 acres (<1%)
(c) Ratio (b)/(a)	6	4
Filter/buffer strips (acres affected) -		
(a) Cost-Share	14 (3%)	863 acres (1%)
(b) Non-Cost-Share	52 (12%)	4,954 acres (3%)
(c) Ratio (b)/(a)	4	6
Grass waterways (acres affected) -		
(a) Cost-Share	23 (5%)	965 acres (1%)
(b) Non-Cost-Share	73 (17%)	4,863 acres (3%)
(c) Ratio (b)/(a)	3	5
Terraces (acres affected) -		
(a) Cost-Share	0 (0%)	0 acres (0%)
(b) Non-Cost-Share	13 (3%)	551 acres (<1%)
(c) Ratio (b)/(a)	-----	-----
Sediment traps/basin (acres affected) -		
(a) Cost-Share	4 (1%)	190 acres (<1%)
(b) Non-Cost-Share	14 (3%)	476 acres (<1%)
(c) Ratio (b)/(a)	4	3
Stream protection or fencing -		
(a) Cost-Share	10 (2%)	5,437 ft
(b) Non-Cost-Share	40 (10%)	73,555 ft
(c) Ratio (b)/(a)	4	14
Sprayer calibration checks-		
(a) Cost-Share	3 (1%)	24 checks/year
(b) Non-Cost-Share	45 (11%)	649 checks/year
(c) Ratio (b)/(a)	15	27

[1] - Values in parenthesis are the percentage of respondents using the BMPs.
[2] - Values in parenthesis are the percentage of acres farmed.

Coastal Rivers Basin

The information presented in this section is based on 40 responses (6 percent of the total number of farmers in the basin) that cover 21,460 acres of farmland (15 percent of total farmland of the basin). Data show that cropland is the major agricultural land use. Approximately 28 percent of farmland is owned by farmers and the remaining 72 percent of the farmland in rented. Sixty-six percent of the farmers have conservation plans for their farms.

The survey results indicate that the farm operators, on the average, were 57 years of age with 32 years of farming experience and earned 56 percent of their family income from farming operations. The average farm size is approximately 679 acres, and an average of three full-time and four part-time employees are hired at peak season. About 85 percent of the respondents have completed high school, 16 percent have received an associate's or bachelor's degree, and 7 percent have an advanced or graduate degree. About 52 percent of the respondents were members of a farm or environmental organization.

The major factors indicated as somewhat or very important considerations for the farming operation were decreasing production costs (93 percent of the farmers), increasing yield (90 percent), reducing fertilizer use (87 percent), access to markets (85 percent), and complying with government regulations (85 percent). The "proximity effect" was evident in the Coastal Rivers Basin, as 89 percent of the farmers indicated they were somewhat or

very concerned with pollution in the Chesapeake Bay; 73 percent think water pollution in their county is a problem; but only 43 percent believe that their farm contributes to water quality problems. Runoff from urban areas (51 percent of the farmers), litter/garbage (40 percent), city or town sewer systems (39 percent), and industrial waste or factory discharge (38 percent) were most commonly indicated as perceived serious or moderate sources of pollution. Fertilizers, pesticides, animal waste, and runoff from cropland were perceived to be either a serious or moderate cause of pollution by 26, 24, 8, and 24 percent of the respondents, respectively.

Beef cattle and poultry are the primary livestock raised by farmers in the Coastal Rivers basin. Twenty-five percent of the farmers surveyed raise beef cattle and 12 percent raise poultry. The average number of beef cattle raised by each farmer is 38 head. A total of 15 percent of the farmers indicate raising horses, sheep and swine. Most of the farmers surveyed grow grain crops, and unlike the other basins, vegetables. The majority of the farmers grow soybeans (83 percent of farmers on 56 percent of the farmland), small grains (60 percent of the farmers on 29 percent of the farmland), corn (55 percent of the farmers on 24 percent of the farmland) and vegetables (33 percent of the farmers on 11 percent of the farmland). Table 4.22 presents livestock and crop production data for the Coastal Rivers Basin. Corn, small grains, soybeans, and vegetables are the major sources of farm income in this basin.

Table 4.22. Livestock and Crop Production in the Chesapeake Bay Coastal Basin.

Livestock Production		
Livestock	**% of Farmers Raising**	**# per 100 Acres of Surveyed Land**
Aquaculture (lbs. of fish)	2	<1
Beef cattle	25	2
Dairy cattle	0	0
Horses	5	<1
Poultry	12	4238
Sheep	3	<1
Swine	7	7
Crop Production		
Crops	**% of Farmers Growing**	**% of Total Acreage**
Alfalfa	3	<1
Other hay	18	1
Corn	55	24
Cotton	3	<1
Fruits, orchards & vineyards	4	<1
Peanuts	<1	<1
Small grains	60	29
Soybeans	83	56
Tobacco	<1	<1
Vegetables	33	11

A variety of different BMPs are implemented on the farms in the Coastal Rivers Basin. Results of the study showed that 36 percent of the farmers implemented cost-share BMPs on their farms, 85 percent of the farmers implemented non-cost-share BMPs, and 93 percent implemented any type of BMP. The average farmer adopts 1 cost-share BMP and 4 non-cost-share BMPs. Filter or buffer strips (15 percent of the farmers), cover crops (14 percent of the farmers), and permanent vegetative cover (12 percent of the farmers) were the most commonly implemented cost-share BMPs. Conservation tillage (8 percent), surface soil sampling (9 percent), animal waste storage facilities (6 percent), and grassed waterways (5 percent) were other frequently implemented cost-share BMPs. The most often implemented non-cost-share BMPs were conservation tillage (59 percent of the farmers on 37 percent of the farmed land) and field scouting (50 percent of the farmers on 45 percent of the farmed land). Other non-cost-share BMPs commonly implemented were cover crops (46 percent of the farmers on 9 percent of the farmland), split fertilizer applications (45 percent of the farmers on 29 percent of the farmed land), surface soil sampling (42 percent of the farmers), and sprayer calibration checks (41 percent of the farmers). A complete list of cost-share and non-cost-share BMP implementation is provided in Table 4.23. The most commonly indicated sources of information on BMPs for farmers in the Coastal Rivers Basin were extension agents, extension bulletins, farm magazines, DSWC Districts, ASCS, and NRCS. The major reasons given for not implementing BMPs were operation is too small, lack of a problem, too much paperwork or red tape, and not wanting government subsidies.

Table 4.23. BMP Implementation in the Chesapeake Bay Coastal Basin.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Biological pest controls -		
(a) Cost-Share	0 (0%)[1]	0 (0%)[2]
(b) Non-Cost-Share	5 (13%)	586 (3%)
(c) Ratio (b)/(a)	-----	-----
Contour strip cropping -		
(a) Cost-Share	0 (0%)	4 (<1%)
(b) Non-Cost-Share	1 (3%)	32 (<1%)
(c) Ratio (b)/(a)	-----	8
Conservation tillage -		
(a) Cost-Share	3 (8%)	1,881 (9%)
(b) Non-Cost-Share	22 (55%)	7,998 (37%)
(c) Ratio (b)/(a)	7	4
Cover crops -		
(a) Cost-Share	5 (13%)	404 (2%)
(b) Non-Cost-Share	17 (43%)	1,958 (9%)
(c) Ratio (b)/(a)	3	5
Field scouting -		
(a) Cost-Share	0 (0%)	925 (4%)
(b) Non-Cost-Share	18 (45%)	9,566 (45%)
(c) Ratio (b)/(a)	-----	10
Grass or legume in rotation -		
(a) Cost-Share	0 (0%)	0 (0%)
(b) Non-Cost-Share	6 (15%)	1,270 (6%)
(c) Ratio (b)/(a)	-----	-----
Hayland or pasture management-		
(a) Cost-Share	1 (3%)	33 (<1%)
(b) Non-Cost-Share	10 (25%)	261 (1%)
(c) Ratio (b)/(a)	10	8
Irrigation improvement -		
(a) Cost-Share	0 (0%)	0 (0%)
(b) Non-Cost-Share	6 (15%)	1937 (9%)
(c) Ratio (b)/(a)	-----	-----

Table 4.23. Continued.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Permanent vegetation cover -		
(a) Cost-share	4 (10%)	140 (1%)
(b) Non-Cost-Share	5 (13%)	51 (<1%)
(c) Ratio (b)/(a)	1	0.36
Rotational grazing -		
(a) Cost-share	1 (3%)	15 (<1%)
(b) Non-Cost-Share	3 (8%)	65 (<1%)
(c) Ratio (b)/(a)	3	4
Split fertilizer applications -		
(a) Cost-Share	1 (3%)	1,049 (5%)
(b) Non-Cost-Share	16 (40%)	6,258 (30%)
(c) Ratio (b)/(a)	16	6
Tissue analysis -		
(a) Cost-Share	0 (0%)	125 (1%)
(b) Non-Cost-Share	6 (15%)	2,671 (12%)
(c) Ratio (b)/(a)	-----	21

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Animal waste storage facilities -		
(a) Cost-Share	2 (5%)	3 facilities
(b) Non-Cost-Share	0 (<1%)	0 facilities
(c) Ratio (b)/(a)	0	0
Animal waste sampling/analysis -		
(a) Cost-Share	0 (0%)	0 analyses/year
(b) Non-Cost-Share	2 (5%)	10 analyses/year
(c) Ratio (b)/(a)	-----	-----
Deep soil sampling/analysis-		
(a) Cost-Share	0 (0%)	0 samples/acre/farmer
(b) Non-Cost-Share	3 (8%)	1 sample/acre/farmer
(c) Ratio (b)/(a)	-----	-----

Table 4.23. Continued.

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Surface soil sampling/analysis-		
(a) Cost-Share	3 (8%)	1 samples/acre/farmer
(b) Non-Cost-Share	15 (38%)	1 samples/acre/farmer
(c) Ratio (b)/(a)	5	1
Diversions (acres affected) -		
(a) Cost-Share	0 (0%)	0 acres (0%)
(b) Non-Cost-Share	2 (5%)	775 acres (4%)
(c) Ratio (b)/(a)	-----	-----
Filter/buffer strips (acres affected) -		
(a) Cost-Share	6 (15%)	994 acres (5%)
(b) Non-Cost-Share	13 (33%)	1,693 acres (8%)
(c) Ratio (b)/(a)	2	2
Grass waterways (acres affected) -		
(a) Cost-Share	2 (5%)	36 acres (<1%)
(b) Non-Cost-Share	8 (20%)	443 acres (2%)
(c) Ratio (b)/(a)	4	12
Terraces (acres affected) -		
(a) Cost-Share	0 (0%)	0 acres (0%)
(b) Non-Cost-Share	0 (0%)	0 acres (0%)
(c) Ratio (b)/(a)	-----	-----
Sediment traps/basin (acres affected) -		
(a) Cost-Share	1 (3%)	37 acres (< 1%)
(b) Non-Cost-Share	6 (15%)	635 acres (3%)
(c) Ratio (b)/(a)	6	17
Stream protection or fencing -		
(a) Cost-Share	1 (3%)	3,353 ft
(b) Non-Cost-Share	3 (8%)	3,502 ft
(c) Ratio (b)/(a)	3	1
Sprayer calibration checks-		
(a) Cost-Share	1 (3%)	15 checks/year
(b) Non-Cost-Share	15 (38%)	232 checks/year
(c) Ratio (b)/(a)	15	15

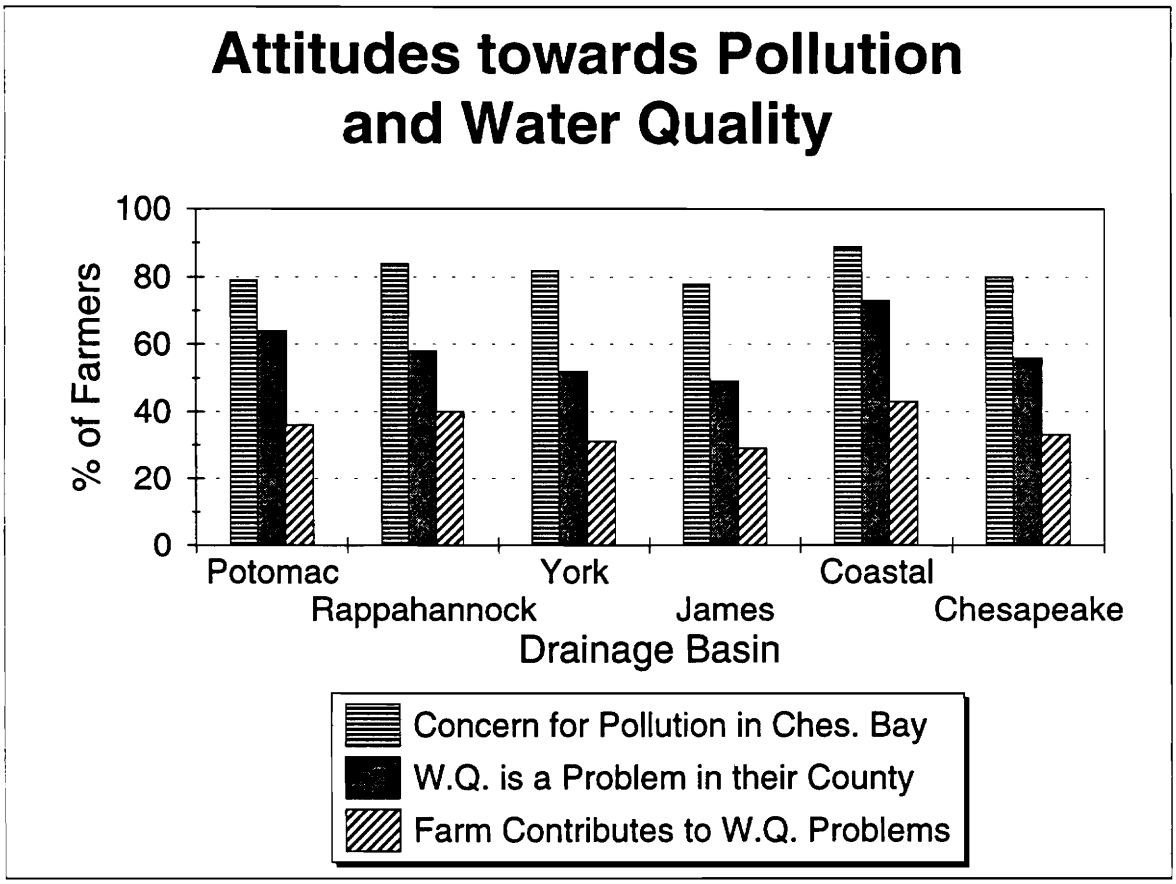
[1] - Values in parenthesis are the percentage of respondents using the BMPs.

[2] - Values in parenthesis are the percentage of acres farmed.

Summary

The major rivers basins discussed were the Potomac River, Rappahannock River, York River, James River, and the Coastal Rivers Basins. The Coastal Rivers Basin was a major exception in many areas because it does not extend outside of the Tidewater area into the Piedmont and mountainous areas of Virginia. Therefore, corn, small grains, and soybeans can be grown throughout the entire basin, unlike the other river basins that extend beyond the Tidewater area. There was very little variation in the average age of the farming operators, ranging from 57 years in the Coastal Rivers Basin to 59 years in the James River Basin, and years of farming experience, ranged from 29 years in the Potomac River Basin to 32 years in the Coastal Rivers Basin. The survey data revealed that farmers in the Potomac, Rappahannock, York, and James River Basins generate more than half of their family income from off-farm sources, whereas farmers in the Coastal Rivers Basin earn a majority of their income from the farming operation.

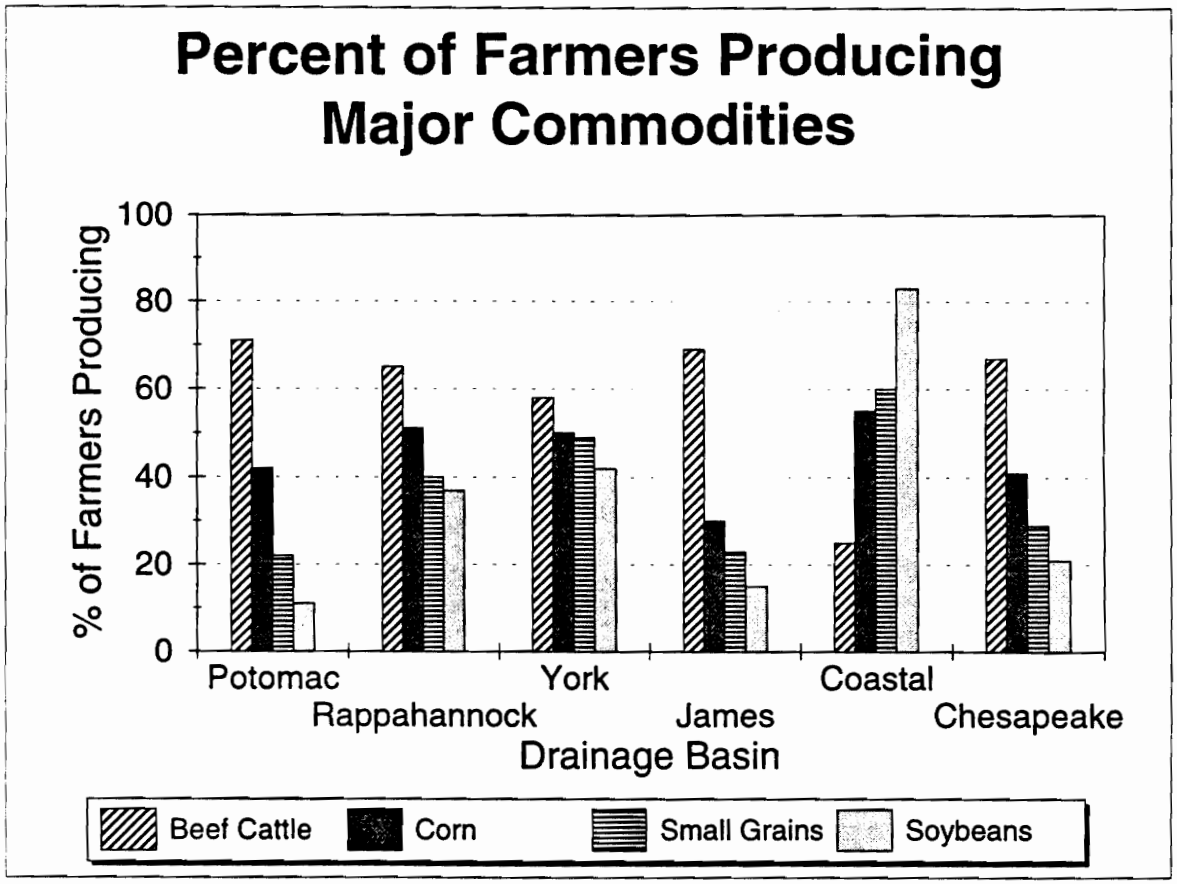
The "proximity effect" was evident in all of the river basins as most farmers generally had a concern about pollution in the Chesapeake Bay, a slightly lower percentage believed water pollution is a problem in their county, but only approximately one-half of those having concerns about pollution in the Chesapeake Bay thought that their farm contributes to water quality problems. Figure 4.7 illustrates the information regarding the farmers' attitudes towards pollution and water quality in the major drainage basins. The major perceived sources of pollution by the farmers in each river basin were runoff from



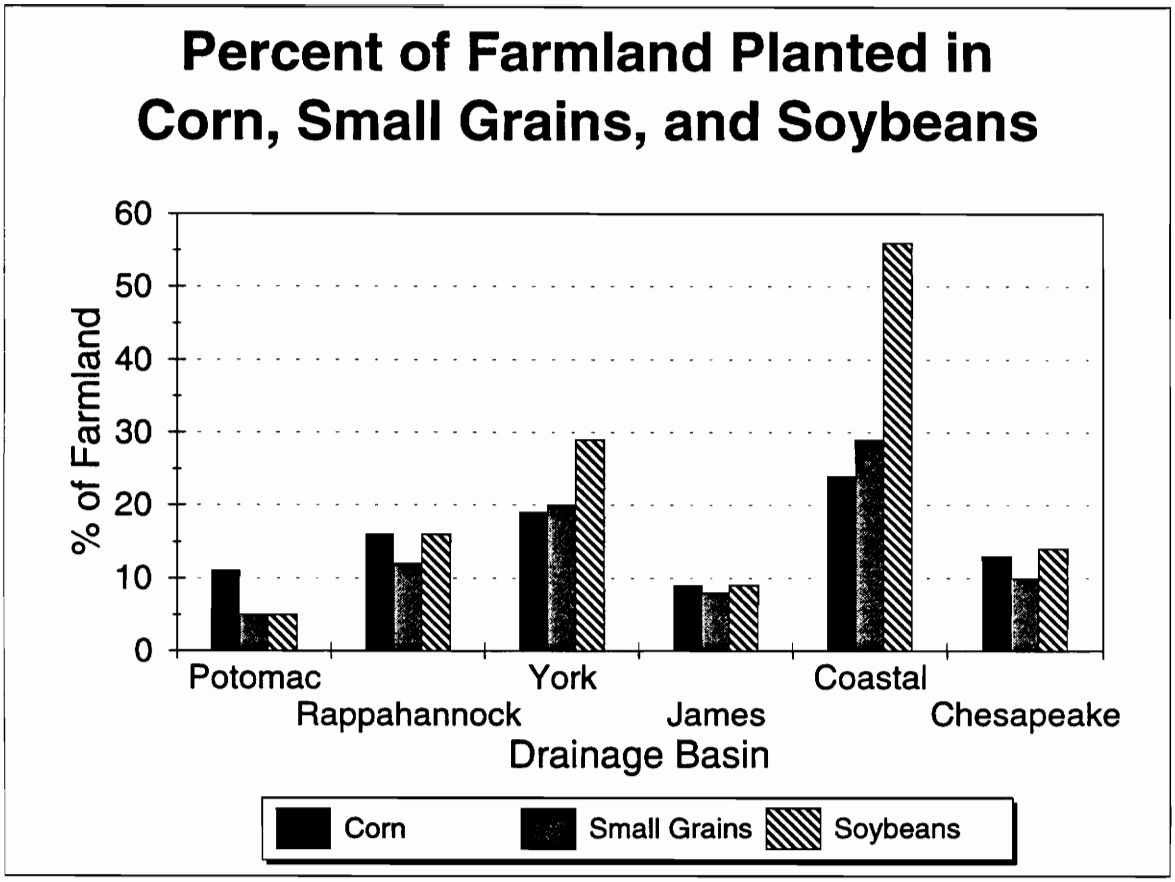
Graph 4.7. Attitudes towards Pollution and Water Quality.

urban areas, industrial waste or factory discharge, city or town sewer systems, and litter or garbage. These pollution sources were generally perceived as more serious causes of pollution than those originating from agricultural areas, such as pesticides, fertilizers, animal waste, and runoff from cropland. The most important considerations for the farming operation were decreasing production costs, increasing yield, reducing fertilizer use, access to markets, and complying with government regulations.

A majority of the farmland in each of these basins is devoted to crop production, except for the Potomac River Basin. Beef cattle and hay are produced by most farmers in each basin, with the exception of the Coastal Rivers Basin. Corn, small grains, and soybeans were also predominant throughout the major river basins. The Potomac River Basin did not have nearly as many farmers, on a percentage basis, producing soybeans as did the other river basins. Comparisons of the percent of farmers in each drainage basin producing beef cattle, corn, small grains, and soybeans can be found in Figure 4.8, and Figure 4.9 compares the percentage of farmland on which corn, small grains, and soybeans are produced. In each of the major river basins, the average farmer adopts 1 cost-share practice. The predominant cost-share BMPs implemented were grassed waterways, filter or buffer strips, permanent vegetative cover, hayland or pasture management, and cover crops. Surprisingly, the implementation of animal waste facilities with cost-share funds in the Coastal Rivers Basin was indicated by 6 percent of the farmers. This may be due to 12 percent of farmers producing poultry, a higher

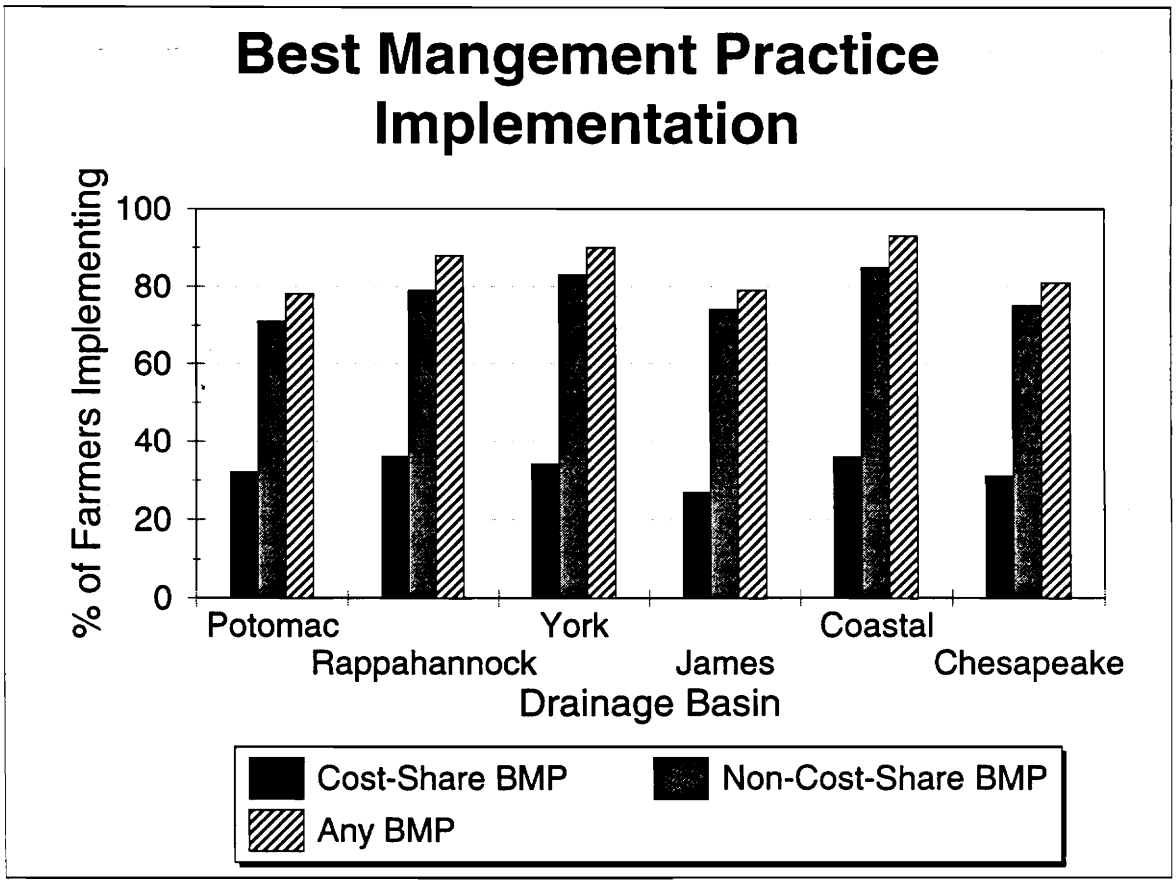


Graph 4.8. Percent of Farmers Producing the Major Commodities.



Graph 4.9. Percent of Farmland in Corn, Small Grains, and Soybeans.

percentage than any other basin, rather than the extremely low percentage of farmers raising beef cattle (only 25 percent compared to 58 to 71 percent raising beef cattle in the other river basins). The average farmer in each of the major river basins implements 4 to 5 non-cost-share BMPs. Hayland or pasture management and conservation tillage are predominant non-cost-share BMPs implemented in each basin. Other non-cost-share commonly implemented in the river basins were surface soil sampling, cover crops, grasses or legumes in rotation, permanent vegetative cover, split fertilizer applications, field scouting, and rotational grazing. Figure 4.10 compares the percentage of farmers implementing BMPs with cost-share assistance, without cost-share assistance, and regardless of funding in each of the major drainage basins. In all of the river basins the major sources of information on BMPs were extension agents, extension bulletins, farm magazines, DSWC, ASCS, and NRCS. Lack of a problem, too small of an operation, and too much paperwork or red tape were the major reasons given for not implementing BMPs.



Graph 4.10. Percent of Farmers Implementing BMPs.

DSWC Field Office Regions

The Division of Soil and Water Conservation Field Office regions included in the survey were the Central Tidewater, Central Virginia, Northern Piedmont, Shenandoah Valley, Southeast Virginia, and Southside Virginia. The Southeast Virginia and Southside Virginia regions were the only ones not fully represented by the survey. Table 4.24 lists the Soil and Water Conservation Districts that constitute each Field Office region. Table 3.3 lists the counties included in the survey that comprise each of the regions. According to the VirGIS land use and VDACS databases, the total agricultural land in the Central Tidewater region is 521,334 acres and is farmed by 2,932 farmers. The total farmland in the Central Virginia region is 688,259 acres and is farmed by 4,771 farmers. The 4,252 farmers in the Northern Piedmont region in the region farm 863,470 acres. The total farmland in the Shenandoah Valley region is 1,360,733 acres and is farmed by 7,822 farmers. The portion of the Southeast Virginia region covered by the survey has 1,576 farmers and 423,907 acres of farmland. The portion of the Southside Virginia region covered by the survey has 2,590 farmers and 325,792 acres of farmland. Figure 4.11 summarizes the percentage of farmland in the DSWC regions, and Figure 4.12 compares the number of farmers in the regions.

Table 4.24. DSWC Field Offices and the Soil and Water Conservation Districts within each Field Office.

DSWC Field Office	Soil and Water Conservation Districts
Central Tidewater	Colonial, Hanover-Caroline, Northern Neck, Three Rivers, Tidewater, Tri-County/City
Central Virginia	Henricopolis, James River, Monacan, Peter Francisco, Robert E. Lee, Thomas Jefferson
Northern Piedmont	Culpeper, John Marshall, Loudoun, Northern Virginia
Shenandoah Valley	Headwaters, Lord Fairfax, Mountain, Mountain Castles, Natural Bridge, Shenandoah Valley
Southeast Virginia*	Appomattox River, Eastern Shore, Peanut, Virginia Dare
Southside Virginia*	Peaks of Otter, Piedmont

* These DSWC Field Offices have other counties and Districts under their jurisdiction that were not covered by the survey.

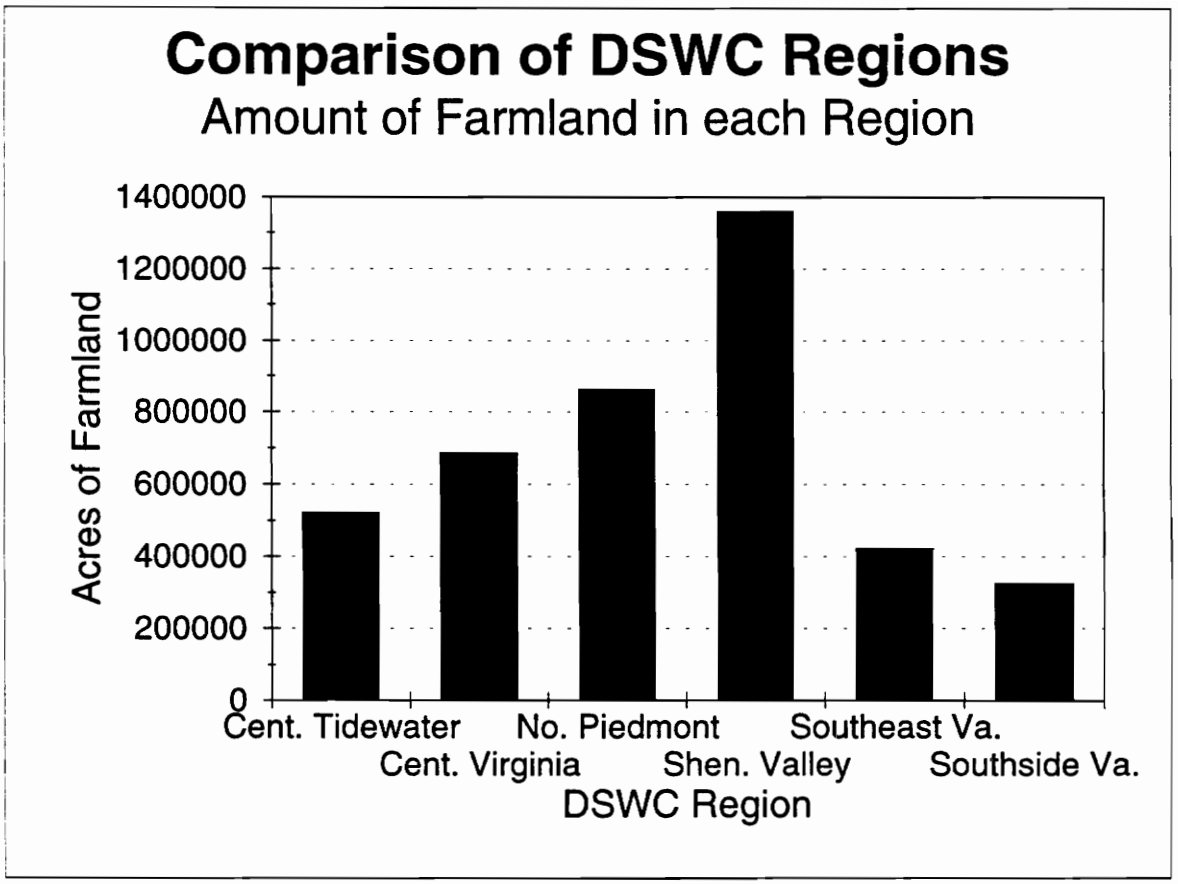


Figure 4.11. Amount of Farmland in each DSWC Region.

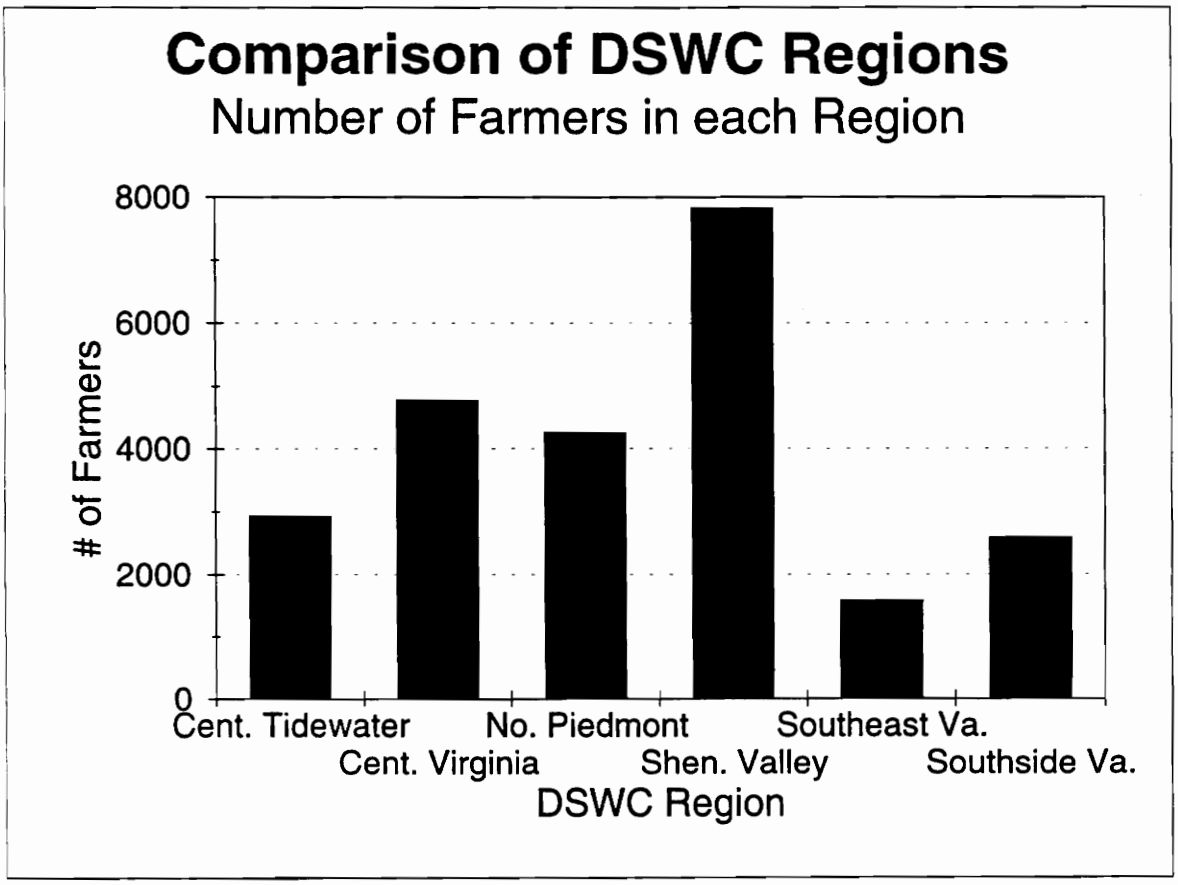


Figure 4.12. Number of Farmers in each DSWC Region.

Central Tidewater Region

The information presented in this section is based on 209 responses (7 percent of the total number of farmers in the region) and covers 113,005 acres of farmland (22 percent of total farmland in the region). Data show that crop production is the major agricultural land use. Approximately 38 percent of farmland is owned by farmers and the remaining 62 percent of the farmland in rented. About 75 percent of the farmers have conservation plans for their farms.

The survey results indicate that the farm operators are of highly varied characteristics. On average, respondents were 58 years of age with 32 years of farming experience and earn 46 percent of their family income from farming operations. The average farm size is approximately 630 acres, and an average of one full-time and two part-time employees are hired at peak season. About 86 percent of the respondents have completed high school, 13 percent have received an associate's or bachelor's degree, and 9 percent have an advanced or graduate degree. About 52 percent of the respondents were members of a farm or environmental organization.

The considerations for the farming operation, most commonly indicated as either very or somewhat important, were decreasing production costs (98 percent of the farmers), increasing yield (93 percent), and access to markets (90 percent). The "proximity effect" was evident in the Central Tidewater region, as 91 percent of the farmers indicated they

were somewhat or very concerned with pollution in the Chesapeake Bay, 61 percent think water pollution in their county is a problem, but only 37 percent believe that their farm contributes to water quality problems.

Runoff from urban areas (61 percent of the farmers), Industrial waste or factory discharge (53 percent) and city or town sewer systems (49 percent) were most commonly indicated as perceived serious or moderate sources of pollution. Fertilizers, pesticides, animal waste, and runoff from cropland were perceived to be either a serious or moderate cause of pollution by only 24 percent, 18 percent, 13 percent, and 26 percent of the respondents, respectively.

Beef cattle is the primary livestock raised by farmers. About 47 percent of the surveyed farmers raise beef cattle, while 8 percent raise horses and 4 percent raise dairy cattle. The average number of beef cattle raised by each farmer is 67 head. A total of 16 percent of the farmers raise dairy cattle, poultry, sheep, or swine. Soybeans (66 percent of the farmers), corn (63 percent), and small grains (61 percent) were the major crops produced. These were produced on 40, 27 and 27 percent of the farmland, respectively. Also, 48 percent of the farmers produced hay on 6 percent of the farmland. Table 4.25 presents livestock and crop production in the Central Tidewater region. Soybeans, corn, and small grains are the major sources of farm income.

Table 4.25. Livestock and Crop Production in the Central Tidewater DSWC Region.

Livestock Production		
Livestock	**% of Farmers Raising**	**# per 100 Acres of Surveyed Land**
Aquaculture (lbs. of fish)	2	<1
Beef cattle	47	6
Dairy cattle	4	<1
Horses	8	<1
Poultry	6	91
Sheep	4	<1
Swine	6	4
Crop Production		
Crops	**% of Farmers Growing**	**% of Farmland**
Alfalfa	16	1
Other hay	48	6
Corn	63	27
Cotton	1	<1
Fruits, orchards & vineyards	6	<1
Peanuts	1	<1
Small grains	61	27
Soybeans	66	40
Tobacco	4	1
Vegetables	12	<1

The survey data indicate that most of the farmers implemented a combination of different BMPs on their farms. An average of 1 cost-share BMP and 5 non-cost share BMPs are implemented by farmers in the Central Tidewater region. About 34 percent of the farmers implemented cost-share BMPs on their farms, 78 percent of the farmers implemented non-cost-share BMPs, and 87 percent implemented any type of BMP. Hayland or pasture management (11 percent of the farmers), grassed waterways (11 percent), and cover crops (10 percent) were the most commonly implemented cost-share BMPs. The most often implemented non-cost-share BMPs were conservation tillage (60 percent of the farmers on 26 percent of the farmland), field scouting (49 percent of the farmers on 34 percent of the farmland), and split fertilizer applications (48 percent of the farmers on 27 percent of the farmland). A complete list of cost-share and non-cost-share BMP implementation is provided in Table 4.26. The sources of information on BMPs most often indicated in the Central Tidewater region were extension agents, farm magazines, and ASCS. The major reasons given for not implementing BMPs included: lack of a problem, operation is too small, and too much paperwork or red tape.

Central Virginia

The information presented in this section is based on 259 responses (5 percent of the total number of farmers in the region) and covers 70,611 acres of farmland (10 percent of total farmland in the region). Data show that 45 percent of the farmland is used for crop production. Approximately 68 percent of farmland is owned by farmers and the

Table 4.26. BMP Implementation in the Central Tidewater DSWC Region.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Biological pest controls -		
(a) Cost-Share	1 (1%)[1]	2 (<1%)[2]
(b) Non-Cost-Share	16 (8%)	1,173 (1%)
(c) Ratio (b)/(a)	16	587
Contour strip cropping -		
(a) Cost-Share	6 (3%)	341 (<1%)
(b) Non-Cost-Share	21 (11%)	568 (1%)
(c) Ratio (b)/(a)	4	2
Conservation tillage -		
(a) Cost-Share	10 (5%)	5,441 (5%)
(b) Non-Cost-Share	118 (60%)	29,239 (26%)
(c) Ratio (b)/(a)	12	5
Cover crops -		
(a) Cost-Share	19 (10%)	1,323 (1%)
(b) Non-Cost-Share	78 (39%)	3,799 (3%)
(c) Ratio (b)/(a)	4	3
Field scouting -		
(a) Cost-Share	7 (4%)	5,803 (5%)
(b) Non-Cost-Share	97 (49%)	38,164 (34%)
(c) Ratio (b)/(a)	14	7
Grass or legume in rotation -		
(a) Cost-Share	7 (4%)	119 (<1%)
(b) Non-Cost-Share	55 (28%)	4,218 (4%)
(c) Ratio (b)/(a)	8	35
Hayland or pasture management -		
(a) Cost-Share	21 (11%)	598 (1%)
(b) Non-Cost-Share	74 (37%)	4,968 (4%)
(c) Ratio (b)/(a)	4	8
Irrigation improvement -		
(a) Cost-Share	1 (1%)	175 (<1%)
(b) Non-Cost-Share	23 (12%)	1,387 (1%)
(c) Ratio (b)/(a)	23	8

Table 4.26. Continued.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Permanent vegetation cover -		
(a) Cost-share	18 (9%)	479 (<1%)
(b) Non-Cost-Share	57 (29%)	3,031 (3%)
(c) Ratio (b)/(a)	3	6
Rotational grazing -		
(a) Cost-share	4 (2%)	137 (<1%)
(b) Non-Cost-Share	37 (19%)	1,884 (2%)
(c) Ratio (b)/(a)	9	14
Split fertilizer applications -		
(a) Cost-Share	9 (5%)	3,183 (3%)
(b) Non-Cost-Share	95 (48%)	30,456 (27%)
(c) Ratio (b)/(a)	11	10
Tissue analysis -		
(a) Cost-Share	6 (3%)	604 (1%)
(b) Non-Cost-Share	46 (23%)	6,320 (6%)
(c) Ratio (b)/(a)	8	10

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Animal waste storage facilities -		
(a) Cost-Share	3 (2%)	4 facilities
(b) Non-Cost-Share	5 (3%)	8 facilities
(c) Ratio (b)/(a)	2	2
Animal waste sampling/analysis -		
(a) Cost-Share	0 (0%)	0 analyses/year
(b) Non-Cost-Share	8 (4%)	34 analyses/year
(c) Ratio (b)/(a)	-----	-----
Deep soil sampling/analysis -		
(a) Cost-Share	1 (1%)	<1 samples/acre/farmer
(b) Non-Cost-Share	7 (4%)	1 sample/acre/farmer
(c) Ratio (b)/(a)	7	8

Table 4.26. Continued.

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Surface soil sampling/analysis -		
(a) Cost-Share	11 (6%)	6 samples/acre/farmer
(b) Non-Cost-Share	84 (42%)	87 samples/acre/farmer
(c) Ratio (b)/(a)	8	15
Diversions (acres affected) -		
(a) Cost-Share	1 (1%)	10 acres (<1%)
(b) Non-Cost-Share	5 (3%)	685 acres (<1%)
(c) Ratio (b)/(a)	5	69
Filter/buffer strips (acres affected) -		
(a) Cost-Share	18 (9%)	1,227 acres (1%)
(b) Non-Cost-Share	60 (30%)	4,102 acres (4%)
(c) Ratio (b)/(a)	3	3
Grass waterways (acres affected) -		
(a) Cost-Share	22 (11%)	755 acres (1%)
(b) Non-Cost-Share	64 (32%)	4,706 acres (4%)
(c) Ratio (b)/(a)	3	6
Terraces (acres affected) -		
(a) Cost-Share	0 (0%)	0 acres (0%)
(b) Non-Cost-Share	4 (2%)	43 acres (<1%)
(c) Ratio (b)/(a)	-----	-----
Sediment traps/basin (acres affected) -		
(a) Cost-Share	2 (1%)	100 acres (< 1%)
(b) Non-Cost-Share	15 (8%)	273 acres (<1%)
(c) Ratio (b)/(a)	8	3
Stream protection or fencing -		
(a) Cost-Share	5 (3%)	20,208 ft
(b) Non-Cost-Share	14 (7%)	69,981 ft
(c) Ratio (b)/(a)	3	3
Sprayer calibration checks -		
(a) Cost-Share	3 (2%)	6 checks/year
(b) Non-Cost-Share	59 (30%)	359 checks/year
(c) Ratio (b)/(a)	20	60

[1] - Values in parenthesis are the percentage of respondents using the BMPs.
[2] - Values in parenthesis are the percentage of acres farmed.

remaining 32 percent of the farmland in rented. About 53 percent of the farmers have conservation plans for their farms.

The survey results indicate that the farm operators are of highly varied characteristics. On average, respondents were 60 years of age with 28 years of farming experience and earn 26 percent of their family income from farming operations. The average farm size is approximately 335 acres, and an average of one full-time and two part-time employees are hired at peak season. About 85 percent of the respondents have completed their high school education, 21 percent have received an associate's or bachelor's degree, and 12 percent have an advanced or graduate degree. About 44 percent of the respondents were members of a farm or environmental organization.

The considerations for the farming operation, most commonly indicated as either very or somewhat important, were decreasing production costs (84 percent of the farmers), increasing yield (83 percent), and access to markets (80 percent). The "proximity effect" was evident in the Central Virginia region, as 85 percent of the farmers indicated they were somewhat or very concerned with pollution in the Chesapeake Bay; 72 percent think water pollution in their county is a problem; but only 26 percent believe that their farm contributes to water quality problems. Industrial waste or factory discharge (49 percent), runoff from urban areas (45 percent of the farmers), and litter/garbage (45 percent) were most commonly indicated as perceived serious or moderate sources of pollution.

Fertilizers, pesticides, animal waste, and runoff from cropland were perceived to be either a serious or moderate cause of pollution by 26 percent, 30 percent, 17 percent, and 24 percent of the respondents, respectively.

Beef cattle is the primary livestock raised by farmers. About 72 percent of the surveyed farmers raise beef cattle and 12 percent raise horses. The average number of beef cattle raised by each farmer is 80 head. A total of 16 percent of the farmers indicate raising dairy cattle, poultry, sheep, or swine. Hay production is significant in the Central Virginia region, as 77 percent of the farmers produce hay on approximately 22 percent of the total farmland. Corn (28 percent of the farmers), small grains (21 percent), soybeans (12 percent) were the major crops produced. These were produced on 21, 6 and 7 percent of the farmland, respectively. Table 4.27 presents livestock and crop production in the Central Virginia region. Beef cattle and hay are the major sources of farm income.

The survey data indicate that most of the farmers implemented a combination of different BMPs on their farms. An average of 1 cost-share BMP and 3 non-cost share BMPs are implemented by farmers in the Central Virginia region. About 22 percent of the farmers implemented cost-share BMPs on their farms, 61 percent of the farmers implemented non-cost-share BMPs, and 68 percent implemented any type of BMP. Hayland or pasture management (9 percent of the farmers), grassed waterways (6 percent), and cover crops (5 percent) were the most commonly implemented cost-share BMPs. The most often

Table 4.27. Livestock and Crop Production in the Central Virginia DSWC Region.

Livestock Production		
Livestock	**% of Farmers Raising**	**# per 100 Acres of Surveyed Land**
Aquaculture (lbs. of fish)	1	<1
Beef cattle	72	18
Dairy cattle	4	1
Horses	12	<1
Poultry	6	408
Sheep	1	<1
Swine	5	4
Crop Production		
Crops	**% of Farmers Growing**	**% of Farmland**
Alfalfa	19	2
Other hay	77	21
Corn	28	7
Cotton	<1	<1
Fruits, orchards & vineyards	6	<1
Peanuts	1	<1
Small grains	21	6
Soybeans	12	7
Tobacco	5	<1
Vegetables	8	<1

implemented non-cost-share BMPs were hayland or pasture management (45 percent of the farmers on 14 percent of the farmland), conservation tillage (36 percent of the farmers on 14 percent of the farmland), and permanent vegetative cover (36 percent of the farmers on 9 percent of the farmland). A complete list of cost-share and non-cost-share BMP implementation is provided in Table 4.28. The most commonly indicated sources of information on BMPs for farmers in the Central Virginia region were extension agents, farm magazines, and NRCS. The major reasons given for not implementing BMPs were lack of a problem, operation is too small, and too much paperwork or red tape.

Northern Piedmont

There were a total of 206 responses (5 percent of the total number of farmers in the region) from the Northern Piedmont region and covered 111,079 acres of farmland (13 percent of total farmland of the region). Data show that 37 percent of the farmland is used for crop production. Approximately 67 percent of farmland is owned by farmers and the remaining 33 percent of the farmland in rented. About 63 percent of the farmers have conservation plans for their farms.

The survey results indicate that the farm operators are of highly varied characteristics. On average, respondents were 58 years of age with 28 years of farming experience and earn 34 percent of their family income from farming operations. The average farm size is

Table 4.28. BMP Implementation in the Central Virginia DSWC Region.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Biological pest controls -		
(a) Cost-Share	0 (0%)[1]	0 (0%)[2]
(b) Non-Cost-Share	13 (6%)	1,070 (2%)
(c) Ratio (b)/(a)	-----	-----
Contour strip cropping -		
(a) Cost-Share	5 (2%)	1,529 (2%)
(b) Non-Cost-Share	32 (14%)	735 (1%)
(c) Ratio (b)/(a)	7	0.5
Conservation tillage -		
(a) Cost-Share	9 (4%)	863 (1%)
(b) Non-Cost-Share	81 (36%)	9,603 (14%)
(c) Ratio (b)/(a)	9	11
Cover crops -		
(a) Cost-Share	10 (5%)	661 (1%)
(b) Non-Cost-Share	68 (31%)	4,483 (6%)
(c) Ratio (b)/(a)	7	7
Field scouting -		
(a) Cost-Share	1 (<1%)	400 (1%)
(b) Non-Cost-Share	42 (19%)	6,956 (10%)
(c) Ratio (b)/(a)	42	17
Grass or legume in rotation -		
(a) Cost-Share	2 (1%)	340 (<1%)
(b) Non-Cost-Share	56 (25%)	4,645 (7%)
(c) Ratio (b)/(a)	28	14
Hayland or pasture management-		
(a) Cost-Share	21 (9%)	1,392 (2%)
(b) Non-Cost-Share	99 (45%)	9,833 (14%)
(c) Ratio (b)/(a)	5	7
Irrigation improvement -		
(a) Cost-Share	0 (0%)	0 (0%)
(b) Non-Cost-Share	11 (5%)	214 (<1%)
(c) Ratio (b)/(a)	-----	-----

Table 4.28. Continued.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Permanent vegetation cover -		
(a) Cost-share	7 (3%)	308 (<1%)
(b) Non-Cost-Share	79 (36%)	6,236 (9%)
(c) Ratio (b)/(a)	11	20
Rotational grazing -		
(a) Cost-share	5 (2%)	63 (<1%)
(b) Non-Cost-Share	69 (31%)	6,380 (9%)
(c) Ratio (b)/(a)	14	101
Split fertilizer applications -		
(a) Cost-Share	5 (2%)	333 (<1%)
(b) Non-Cost-Share	67 (30%)	8,010 (11%)
(c) Ratio (b)/(a)	13	24
Tissue analysis -		
(a) Cost-Share	1 (<1%)	1 (<1%)
(b) Non-Cost-Share	17 (8%)	1,525 (2%)
(c) Ratio (b)/(a)	17	1525

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Animal waste storage facilities -		
(a) Cost-Share	2 (1%)	2 facilities
(b) Non-Cost-Share	8 (4%)	12 facilities
(c) Ratio (b)/(a)	4	6
Animal waste sampling/analysis -		
(a) Cost-Share	1 (<1%)	1 analysis/year
(b) Non-Cost-Share	9 (4%)	19 analyses/year
(c) Ratio (b)/(a)	9	19
Deep soil sampling/analysis -		
(a) Cost-Share	1 (<1%)	<1 samples/acre/farmer
(b) Non-Cost-Share	7 (4%)	1 sample/acre/farmer
(c) Ratio (b)/(a)	7	1

Table 4.28. Continued.

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Surface soil sampling/analysis -		
(a) Cost-Share	9 (4%)	3 samples/acre/farmer
(b) Non-Cost-Share	65 (29%)	18 samples/acre/farmer
(c) Ratio (b)/(a)	7	6
Diversions (acres affected) -		
(a) Cost-Share	0 (0%)	0 acres (0%)
(b) Non-Cost-Share	6 (3%)	134 acres (<1%)
(c) Ratio (b)/(a)	-----	-----
Filter/buffer strips (acres affected) -		
(a) Cost-Share	6 (3%)	384 acres (1%)
(b) Non-Cost-Share	35 (16%)	1,675 acres (2%)
(c) Ratio (b)/(a)	6	4
Grass waterways (acres affected) -		
(a) Cost-Share	13 (6%)	588 acres (1%)
(b) Non-Cost-Share	44 (20%)	2,339 acres (3%)
(c) Ratio (b)/(a)	3	4
Terraces (acres affected) -		
(a) Cost-Share	0 (0%)	0 acres (0%)
(b) Non-Cost-Share	7 (3%)	292 acres (<1%)
(c) Ratio (b)/(a)	-----	-----
Sediment traps/basin (acres affected) -		
(a) Cost-Share	4 (2%)	45 acres (< 1%)
(b) Non-Cost-Share	8 (4%)	90 acres (<1%)
(c) Ratio (b)/(a)	2	2
Stream protection or fencing -		
(a) Cost-Share	9 (4%)	6,516 ft
(b) Non-Cost-Share	24 (11%)	44,010 ft
(c) Ratio (b)/(a)	3	7
Sprayer calibration checks -		
(a) Cost-Share	1 (<1%)	2 checks/year
(b) Non-Cost-Share	27 (12%)	90 checks/year
(c) Ratio (b)/(a)	27	45

[1] - Values in parenthesis are the percentage of respondents using the BMPs.
[2] - Values in parenthesis are the percentage of acres farmed.

approximately 522 acres, and an average of two full-time and two part-time employees are hired at peak season. About 85 percent of the respondents have completed high school, 21 percent have received an associate's or bachelor's degree, and 18 percent have an advanced or graduate degree. About 40 percent of the respondents were members of a farm or environmental organization.

The considerations for the farming operation, most commonly indicated as either very or somewhat important, were decreasing production costs (89 percent of the farmers), increasing yield (84 percent), and complying with government regulations (83 percent). The "proximity effect" was evident in the Northern Piedmont region, as 89 percent of the farmers indicated they were somewhat or very concerned with pollution in the Chesapeake Bay; 62 percent think water pollution in their county is a problem; but only 44 percent believe that their farm contributes to water quality problems. Runoff from urban areas (57 percent of the farmers), litter/garbage (45 percent), and pesticides (41 percent) were most commonly indicated as perceived serious or moderate sources of pollution. Fertilizers, animal waste, and runoff from cropland were perceived to be either a serious or moderate cause of pollution by 38 percent, 33 percent, and 36 percent of the respondents, respectively.

Beef cattle, horses, and dairy cattle are the primary livestock raised by farmers. About 68 percent of the surveyed farmers raise beef cattle, 23 percent raise horses, and 12 percent

raise dairy cattle. The average number of beef cattle raised by each farmer is 181 head. A total of 10 percent of the farmers raise poultry, sheep, or swine. Hay production is significant in the Northern Piedmont region as 79 percent of the farmers produce hay on approximately 18 percent of the total farmland. Corn (34 percent of the farmers), small grains (21 percent), soybeans (12 percent) were the major crops produced. These were produced on 9, 3 and 3 percent of the farmland, respectively. Table 4.29 presents information on livestock and crop production in the Northern Piedmont region. Beef cattle and hay are the major sources of farm income.

The survey data indicate that most of the farmers implemented a combination of different BMPs on their farms. An average of 1 cost-share BMP and 4 non-cost share BMPs are implemented by farmers in the Northern Piedmont region. About 30 percent of the farmers implemented cost-share BMPs on their farms, 73 percent of the farmers implemented non-cost-share BMPs, and 78 percent implemented any type of BMP. Grassed waterways (8 percent), permanent vegetative cover (7 percent) and conservation tillage (7 percent) were the most commonly implemented cost-share BMPs. The most commonly implemented non-cost-share BMPs were hayland or pasture management (53 percent of the farmers on 14 percent of the farmland), conservation tillage (38 percent of the farmers on 8 percent of the farmland), and permanent vegetative cover (38 percent of the farmers on 11 percent of the farmland). A complete list of cost-share and non-cost-share BMP implementation is provided in Table 4.30. The most commonly indicated

Table 4.29. Livestock and Crop Production in the Northern Piedmont DSWC Region.

Livestock Production		
Livestock	**% of Farmers Raising**	**# per 100 Acres of Surveyed Land**
Aquaculture (lbs. of fish)	2	9
Beef cattle	68	22
Dairy cattle	12	2
Horses	23	<1
Poultry	2	54
Sheep	5	1
Swine	4	2
Crop Production		
Crops	**% of Farmers Growing**	**% of Farmland**
Alfalfa	29	3
Other hay	79	18
Corn	34	9
Cotton	0	0
Fruits, orchards & vineyards	4	1
Peanuts	1	<1
Small grains	21	3
Soybeans	12	73
Tobacco	0	0
Vegetables	3	<1

Table 4.30. BMP Implementation in the Northern Piedmont DSWC Region.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Biological pest controls -		
(a) Cost-Share	3 (2%)[1]	91 (<1%)[2]
(b) Non-Cost-Share	16 (8%)	948 (1%)
(c) Ratio (b)/(a)	5	10
Contour strip cropping -		
(a) Cost-Share	8 (4%)	512 (<1%)
(b) Non-Cost-Share	29 (15%)	2,153 (2%)
(c) Ratio (b)/(a)	4	4
Conservation tillage -		
(a) Cost-Share	13 (7%)	1,150 (1%)
(b) Non-Cost-Share	74 (38%)	9,153 (8%)
(c) Ratio (b)/(a)	6	8
Cover crops -		
(a) Cost-Share	9 (5%)	379 (<1%)
(b) Non-Cost-Share	66 (34%)	4,712 (4%)
(c) Ratio (b)/(a)	7	12
Field scouting -		
(a) Cost-Share	6 (3%)	236 (<1%)
(b) Non-Cost-Share	55 (28%)	9,121 (8%)
(c) Ratio (b)/(a)	9	39
Grass or legume in rotation -		
(a) Cost-Share	8 (4%)	547 (<1%)
(b) Non-Cost-Share	69 (35%)	6,298 (6%)
(c) Ratio (b)/(a)	9	12
Hayland or pasture management-		
(a) Cost-Share	13 (7%)	1,047 (1%)
(b) Non-Cost-Share	104 (53%)	15,983 (14%)
(c) Ratio (b)/(a)	8	15
Irrigation improvement -		
(a) Cost-Share	1 (1%)	100 (<1%)
(b) Non-Cost-Share	6 (3%)	377 (<1%)
(c) Ratio (b)/(a)	6	4

Table 4.30. Continued.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Permanent vegetation cover -		
(a) Cost-share	14 (7%)	667 (1%)
(b) Non-Cost-Share	74 (38%)	11,717 (11%)
(c) Ratio (b)/(a)	5	18
Rotational grazing -		
(a) Cost-share	8 (4%)	246 (<1%)
(b) Non-Cost-Share	73 (37%)	15,452 (14%)
(c) Ratio (b)/(a)	9	63
Split fertilizer applications -		
(a) Cost-Share	3 (2%)	526 (<1%)
(b) Non-Cost-Share	49 (25%)	4,007 (4%)
(c) Ratio (b)/(a)	16	8
Tissue analysis -		
(a) Cost-Share	1 (1%)	2 (<1%)
(b) Non-Cost-Share	17 (8%)	1,022 (<1%)
(c) Ratio (b)/(a)	17	511

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Animal waste storage facilities -		
(a) Cost-Share	10 (5%)	14 facilities
(b) Non-Cost-Share	12 (6%)	16 facilities
(c) Ratio (b)/(a)	1	1
Animal waste sampling/analysis -		
(a) Cost-Share	2 (1%)	3 analysis/year
(b) Non-Cost-Share	15 (8%)	58 analyses/year
(c) Ratio (b)/(a)	8	19
Deep soil sampling/analysis -		
(a) Cost-Share	1 (1%)	<1 sample/acre/farmer
(b) Non-Cost-Share	5 (3%)	<1 sample/acre/farmer
(c) Ratio (b)/(a)	5	23

Table 4.30. Continued.

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Surface soil sampling/analysis -		
(a) Cost-Share	12 (6%)	4 samples/acre/farmer
(b) Non-Cost-Share	70 (36%)	69 samples/acre/farmer
(c) Ratio (b)/(a)	6	17
Diversions (acres affected) -		
(a) Cost-Share	2 (1%)	16 acres (<1%)
(b) Non-Cost-Share	6 (3%)	433 acres (<1%)
(c) Ratio (b)/(a)	3	27
Filter/buffer strips (acres affected) -		
(a) Cost-Share	12 (6%)	954 acres (1%)
(b) Non-Cost-Share	42 (22%)	3,198 acres (3%)
(c) Ratio (b)/(a)	4	3
Grass waterways (acres affected) -		
(a) Cost-Share	15 (8%)	1,924 acres (2%)
(b) Non-Cost-Share	51 (26%)	3,198 acres (3%)
(c) Ratio (b)/(a)	3	2
Terraces (acres affected) -		
(a) Cost-Share	0 (0%)	0 acres (0%)
(b) Non-Cost-Share	3 (2%)	137 acres (<1%)
(c) Ratio (b)/(a)	-----	-----
Sediment traps/basin (acres affected) -		
(a) Cost-Share	3 (2%)	128 acres (<1%)
(b) Non-Cost-Share	14 (7%)	873 acres (1%)
(c) Ratio (b)/(a)	5	7
Stream protection or fencing -		
(a) Cost-Share	11 (6%)	13,707 ft
(b) Non-Cost-Share	33 (17%)	110,652 ft
(c) Ratio (b)/(a)	3	8
Sprayer calibration checks -		
(a) Cost-Share	5 (3%)	20 checks/year
(b) Non-Cost-Share	26 (13%)	61 checks/year
(c) Ratio (b)/(a)	5	3

[1] - Values in parenthesis are the percentage of respondents using the BMPs.
[2] - Values in parenthesis are the percentage of acres farmed.

sources of information on BMPs for farmers in the Northern Piedmont region were extension agents, farm magazines, and ASCS. The major reasons given for not implementing BMPs were lack of a problem, operation is too small, and too much paperwork or red tape.

Shenandoah Valley

The information presented in this section is based on 471 responses (6 percent of the total number of farmers in the region) and covers 154,674 acres of farmland (11 percent of total farmland of the region). Results indicate that 37 percent of the farmland is used for crop production. Approximately 61 percent of farmland is owned by farmers and the remaining 39 percent of the farmland in rented. About 45 percent of the farmers have conservation plans for their farms.

The survey results indicate that the farm operators are of highly varied characteristics. On average, respondents were 59 years of age with 31 years of farming experience and earn 42 percent of their family income from farming operations. The average farm size is approximately 373 acres, and an average of three full-time and four part-time employees are hired at peak season. About 80 percent of the respondents have completed high school, 15 percent have received an associate's or bachelor's degree, and 11 percent have an advanced or graduate degree. About 36 percent of the respondents were members of a farm or environmental organization.

The considerations for the farming operation, most commonly indicated as either very or somewhat important, were decreasing production costs (85 percent of the farmers), increasing yield (86 percent), and complying with government regulations (83 percent). About 81 percent of the farmers indicated they were somewhat or very concerned with pollution in the Chesapeake Bay, 79 percent think water pollution in their county is a problem, but only 43 percent believe that their farm contributes to water quality problems. Industrial waste/factory discharge (63 percent of the farmers), runoff from urban areas (59 percent), and litter/garbage (48 percent) were most commonly indicated as perceived serious or moderate sources of pollution. Fertilizers, pesticides, animal waste, and runoff from cropland were perceived to be either a serious or moderate cause of pollution by 35 percent, 34 percent, 33 percent, and 31 percent of the respondents, respectively.

Livestock production is predominant in the Shenandoah Valley region. Beef cattle is raised by 77 percent of the farmers, 14 percent raise dairy cattle, 13 percent raise poultry, 12 percent raise horses, and sheep are raised by 11 percent. The average number of beef cattle raised by each farmer is 116 head. Only 37 of the farmland is used for crop production. Hay production is significant in the Shenandoah Valley region, as 79 percent of the farmers produce hay on approximately 16 percent of the total farmland. Corn (39 percent of the farmers on 9 percent of the farmland), small grains (19 percent of the farmers on 3 percent of the farmland) are the major crops produced. Table 4.31 presents

Table 4.31. Livestock and Crop Production in the Shenandoah Valley DSWC Region.

Livestock Production		
Livestock	**% of Farmers Raising**	**# per 100 Acres of Surveyed Land**
Aquaculture (lbs. of fish)	1	76
Beef cattle	77	25
Dairy cattle	14	4
Horses	13	<1
Poultry	13	5417
Sheep	11	3
Swine	5	2
Crop Production		
Crops	**% of Farmers Growing**	**% of Farmland**
Alfalfa	36	3
Other hay	79	16
Corn	39	9
Cotton	<1	<1
Fruits, orchards & vineyards	3	3
Peanuts	1	<1
Small grains	19	3
Soybeans	6	1
Tobacco	0	0
Vegetables	4	<1

information on livestock and crop production in the Shenandoah Valley region. Beef cattle and hay are the major sources of farm income.

The survey data indicate that most of the farmers implemented a combination of different BMPs on their farms. An average of 1 cost-share BMP and 4 non-cost share BMPs are implemented by farmers in the Shenandoah Valley region. About 28 percent of the farmers implemented cost-share BMPs on their farms, 63 percent implemented non-cost-share BMPs, and 69 percent implemented any type of BMP. Hayland or pasture management (9 percent), animal waste storage facilities (7 percent) and permanent vegetative cover (5 percent) were the most widely implemented cost-share BMPs. The most often implemented non-cost-share BMPs were hayland or pasture management (40 percent of the farmers on 8 percent of the farmland), conservation tillage (38 percent of the farmers on 10 percent of the farmland), and cover crops (33 percent of the farmers on 5 percent of the farmland). A complete list of cost-share and non-cost-share BMP implementation is provided in Table 4.32. The most commonly indicated sources of information on BMPs for farmers in the Shenandoah Valley region were extension agents, farm magazines, and ASCS. The major reasons given for not adopting BMPs were lack of a problem, operation is too small, and too much paperwork or red tape.

Southeast Virginia

The information presented in this section is based on 80 responses (5 percent of the total

Table 4.32. BMP Implementation in the Shenandoah Valley DSWC Region.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Biological pest controls -		
(a) Cost-Share	7 (2%)[1]	367 (<1%)[2]
(b) Non-Cost-Share	23 (5%)	2,991 (2%)
(c) Ratio (b)/(a)	3	8
Contour strip cropping -		
(a) Cost-Share	14 (3%)	695 (<1%)
(b) Non-Cost-Share	71 (16%)	5,416 (4%)
(c) Ratio (b)/(a)	5	8
Conservation tillage -		
(a) Cost-Share	11 (3%)	503 (<1%)
(b) Non-Cost-Share	165 (38%)	15,803 (10%)
(c) Ratio (b)/(a)	15	31
Cover crops -		
(a) Cost-Share	14 (3%)	376 (<1%)
(b) Non-Cost-Share	142 (33%)	8,128 (5%)
(c) Ratio (b)/(a)	10	22
Field scouting -		
(a) Cost-Share	6 (1%)	174 (<1%)
(b) Non-Cost-Share	89 (21%)	15,346 (10%)
(c) Ratio (b)/(a)	15	88
Grass or legume in rotation -		
(a) Cost-Share	11 (3%)	551 (<1%)
(b) Non-Cost-Share	134 (31%)	7,866 (5%)
(c) Ratio (b)/(a)	12	14
Hayland or pasture management -		
(a) Cost-Share	41 (9%)	3,947 (3%)
(b) Non-Cost-Share	174 (40%)	12,552 (8%)
(c) Ratio (b)/(a)	4	3
Irrigation improvement -		
(a) Cost-Share	1 (<1%)	100 (<1%)
(b) Non-Cost-Share	29 (7%)	1,817 (1%)
(c) Ratio (b)/(a)	29	18

Table 4.32. Continued.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Permanent vegetation cover -		
(a) Cost-share	23 (5%)	2,989 (2%)
(b) Non-Cost-Share	138 (32%)	13,374 (9%)
(c) Ratio (b)/(a)	6	4
Rotational grazing -		
(a) Cost-share	21 (5%)	3,522 (2%)
(b) Non-Cost-Share	123 (28%)	13,275 (9%)
(c) Ratio (b)/(a)	6	4
Split fertilizer applications -		
(a) Cost-Share	17 (4%)	2,421 (2%)
(b) Non-Cost-Share	113 (26%)	7,826 (5%)
(c) Ratio (b)/(a)	7	3
Tissue analysis -		
(a) Cost-Share	0 (0%)	0 (0%)
(b) Non-Cost-Share	37 (9%)	3,272 (2%)
(c) Ratio (b)/(a)	-----	-----

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Animal waste storage facilities -		
(a) Cost-Share	30 (7%)	49 facilities
(b) Non-Cost-Share	41 (9%)	250 facilities
(c) Ratio (b)/(a)	1	5
Animal waste sampling/analysis -		
(a) Cost-Share	14 (3%)	63 analysis/year
(b) Non-Cost-Share	42 (10%)	240 analyses/year
(c) Ratio (b)/(a)	3	4
Deep soil sampling/analysis -		
(a) Cost-Share	3 (1%)	<1 sample/acre/farmer
(b) Non-Cost-Share	19 (4%)	<1 sample/acre/farmer
(c) Ratio (b)/(a)	6	5

Table 4.32. Continued.

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Surface soil sampling/analysis -		
(a) Cost-Share	15 (3%)	1 sample/acre/farmer
(b) Non-Cost-Share	136 (31%)	22 samples/acre/farmer
(c) Ratio (b)/(a)	9	22
Diversions (acres affected) -		
(a) Cost-Share	0 (0%)	0 acres (0%)
(b) Non-Cost-Share	6 (1%)	129 acres (<1%)
(c) Ratio (b)/(a)	-----	-----
Filter/buffer strips (acres affected) -		
(a) Cost-Share	6 (1%)	176 acres (<1%)
(b) Non-Cost-Share	46 (11%)	3,615 acres (2%)
(c) Ratio (b)/(a)	8	21
Grass waterways (acres affected) -		
(a) Cost-Share	15 (3%)	648 acres (<1%)
(b) Non-Cost-Share	83 (19%)	6,896 acres (4%)
(c) Ratio (b)/(a)	6	11
Terraces (acres affected) -		
(a) Cost-Share	0 (0%)	0 acres (0%)
(b) Non-Cost-Share	8 (2%)	270 acres (<1%)
(c) Ratio (b)/(a)	-----	-----
Sediment traps/basin (acres affected) -		
(a) Cost-Share	2 (<1%)	30 acres (<1%)
(b) Non-Cost-Share	11 (3%)	437 acres (<1%)
(c) Ratio (b)/(a)	6	15
Stream protection or fencing -		
(a) Cost-Share	14 (3%)	15,752 ft
(b) Non-Cost-Share	43 (10%)	98,848 ft
(c) Ratio (b)/(a)	3	6
Sprayer calibration checks -		
(a) Cost-Share	3 (1%)	13 checks/year
(b) Non-Cost-Share	53 (12%)	130 checks/year
(c) Ratio (b)/(a)	18	10

[1] - Values in parenthesis are the percentage of respondents using the BMPs.
[2] - Values in parenthesis are the percentage of acres farmed.

number of farmers) that cover 53,795 acres of farmland (13 percent of total farmland). Data show that the majority of the farmland is used for crop production. Approximately 29 percent of farmland is owned by farmers and the remaining 71 percent of the farmland in rented. About 51 percent of the farmers have conservation plans for their farms.

The survey results indicate that the farm operators are of highly varied characteristics. On average, respondents were 52 years of age with 29 years of farming experience and earn 71 percent of their family income from farming operations. The average farm size is approximately 708 acres, and an average of five full-time and six part-time employees are hired at peak season. About 92 percent of the respondents have completed their high school education, 24 percent have received an associate's or bachelor's degree, and 4 percent have an advanced or graduate degree. About 49 percent of the respondents were members of a farm or environmental organization.

The considerations for the farming operation most commonly indicated as very important were decreasing production costs (95 percent of the farmers) and increasing yield (86 percent). Complying with government regulations, access to markets, reducing fertilizer use and reducing pesticide use were also indicated as primary considerations. About 91 percent of the farmers indicated they were somewhat or very concerned with pollution in the Chesapeake Bay, 66 percent think water pollution in their county is a problem, but only 42 percent believe that their farm contributes to water quality problems. Industrial

waste/factory discharge (54 percent of the farmers), runoff from urban areas (53 percent), and litter/garbage (43 percent) were most commonly indicated as perceived serious or moderate sources of pollution. Fertilizers, pesticides, animal waste, and runoff from cropland were perceived to be either a serious or moderate cause of pollution by 23 percent, 24 percent, 21 percent, and 23 percent of the respondents, respectively.

Crop production is predominant in the Southeast Virginia region. Beef cattle is raised by only 18 percent of the farmers, however 19 percent of the farmers raise swine and 12 percent raise poultry. A total of 8 percent of the farmers raise dairy cattle or horses. Only 11 percent of the farmers grow hay on approximately 2 percent of the farmland. A variety of crops are produced by a significant number of farmers in this region. Soybeans (84 percent of the farmers on 46 percent of the farmland), small grains (75 percent of the farmers on 28 percent of the farmland), and corn (66 percent of the farmers on 22 percent of the farmland) are the major crops produced. Peanuts (45 percent of the farmers on 11 percent of the farmland), vegetables (30 percent of the farmers on 7 percent of the farmland), and cotton (14 percent of the farmers on 4 percent of the farmland) are all widely produced. Table 4.33 presents information on livestock and crop production in the Southeast Virginia region. Soybeans, small grains, peanuts, and corn are the major sources of farm income.

The survey data indicate that most of the farmers implemented a combination of different

Table 4.33. Livestock and Crop Production in the Southeast Virginia DSWC Region.

Livestock Production		
Livestock	**% of Farmers Raising**	**# per 100 Acres of Surveyed Land**
Aquaculture (lbs. of fish)	3	<1
Beef cattle	18	4
Dairy cattle	4	<1
Horses	4	<1
Poultry	12	2993
Sheep	0	0
Swine	19	31
Crop Production		
Crops	**% of Farmers Growing**	**% of Farmland**
Alfalfa	4	<1
Other hay	10	1
Corn	66	18
Cotton	14	3
Fruits, orchards & vineyards	4	<1
Peanuts	45	9
Small grains	75	23
Soybeans	84	38
Tobacco	3	<1
Vegetables	30	6

BMPs on their farms. An average of 1 cost-share BMP and 5 non-cost share BMPs are implemented by farmers in the Southeast Virginia region. About 35 percent of the farmers implemented cost-share BMPs on their farms; 85 percent of the farmers implemented non-cost-share BMPs; and 88 percent implemented any type of BMP. Filter or buffer strips (13 percent of the farmers), cover crops (13 percent), and surface soil sampling and analysis (10 percent) were the most commonly implemented cost-share BMPs. The most widely implemented non-cost-share BMPs were conservation tillage (62 percent of the farmers on 25 percent of the farmland), and cover crops (58 percent of the farmers on 14 percent of the farmland), field scouting (53 percent of the farmers on 31 percent of the farmland), and sprayer calibration checks (51 percent of the farmers). A complete list of cost-share and non-cost-share BMP implementation is provided in Table 4.34. The most commonly indicated sources of information on BMPs for farmers in the Southeast Virginia region were extension agents, farm magazines, and ASCS. The major reasons given for not implementing BMPs were lack of a problem, operation is too small, and too much paperwork or red tape.

Southside Virginia

The information presented in this section is based on 148 responses (6 percent of the total number of farmers in the region) and covers 37,736 acres of farmland (12 percent of total farmland in the region). The majority of the counties in this region are located outside of the Chesapeake Bay drainage basin and were not included in the survey. Data show that

Table 4.34. BMP Implementation in the Southeast Virginia DSWC Region.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Biological pest controls -		
(a) Cost-Share	0 (0%)[1]	0 (0%)[2]
(b) Non-Cost-Share	8 (10%)	1,002 (2%)
(c) Ratio (b)/(a)	-----	-----
Contour strip cropping -		
(a) Cost-Share	1 (1%)	30 (<1%)
(b) Non-Cost-Share	1 (1%)	1 (<1%)
(c) Ratio (b)/(a)	1	<1
Conservation tillage -		
(a) Cost-Share	6 (8%)	1,901 (4%)
(b) Non-Cost-Share	48 (62%)	13,526 (25%)
(c) Ratio (b)/(a)	8	7
Cover crops -		
(a) Cost-Share	10 (13%)	2,604 (5%)
(b) Non-Cost-Share	45 (58%)	7,644 (14%)
(c) Ratio (b)/(a)	5	3
Field scouting -		
(a) Cost-Share	5 (6%)	1,437 (3%)
(b) Non-Cost-Share	41 (53%)	16,918 (31%)
(c) Ratio (b)/(a)	8	12
Grass or legume in rotation -		
(a) Cost-Share	0 (0%)	0 (0%)
(b) Non-Cost-Share	18 (23%)	2,806 (5%)
(c) Ratio (b)/(a)	-----	-----
Hayland or pasture management -		
(a) Cost-Share	2 (3%)	101 (<1%)
(b) Non-Cost-Share	17 (22%)	621 (1%)
(c) Ratio (b)/(a)	9	6
Irrigation improvement -		
(a) Cost-Share	0 (0%)	0 (0%)
(b) Non-Cost-Share	11 (14%)	3,859 (7%)
(c) Ratio (b)/(a)	-----	-----

Table 4.34. Continued.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Permanent vegetation cover -		
(a) Cost-share	4 (5%)	57 (<1%)
(b) Non-Cost-Share	8 (10%)	28 (<1%)
(c) Ratio (b)/(a)	2	0.5
Rotational grazing -		
(a) Cost-share	0 (0%)	0 (0%)
(b) Non-Cost-Share	9 (12%)	1,568 (3%)
(c) Ratio (b)/(a)	-----	-----
Split fertilizer applications -		
(a) Cost-Share	4 (5%)	1,285 (2%)
(b) Non-Cost-Share	41 (53%)	10,214 (19%)
(c) Ratio (b)/(a)	10	8
Tissue analysis -		
(a) Cost-Share	0 (0%)	0 (0%)
(b) Non-Cost-Share	13 (17%)	4,553 (8%)
(c) Ratio (b)/(a)	-----	-----

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Animal waste storage facilities -		
(a) Cost-Share	7 (9%)	10 facilities
(b) Non-Cost-Share	6 (8%)	109 facilities
(c) Ratio (b)/(a)	0.9	10
Animal waste sampling/analysis -		
(a) Cost-Share	3 (4%)	127 analysis/year
(b) Non-Cost-Share	7 (9%)	17 analyses/year
(c) Ratio (b)/(a)	2	0.1
Deep soil sampling/analysis -		
(a) Cost-Share	0 (0%)	0 samples/acre/farmer
(b) Non-Cost-Share	5 (6%)	33 samples/acre/farmer
(c) Ratio (b)/(a)	-----	-----

Table 4.34. Continued.

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Surface soil sampling/analysis -		
(a) Cost-Share	8 (10%)	43 samples/acre/farmer
(b) Non-Cost-Share	37 (48%)	107 samp./acre/farmer
(c) Ratio (b)/(a)	5	2
Diversions (acres affected) -		
(a) Cost-Share	2 (3%)	204 acres (<1%)
(b) Non-Cost-Share	7 (9%)	1,885 acres (4%)
(c) Ratio (b)/(a)	4	9
Filter/buffer strips (acres affected) -		
(a) Cost-Share	10 (13%)	2,218 acres (4%)
(b) Non-Cost-Share	18 (23%)	4,792 acres (9%)
(c) Ratio (b)/(a)	2	2
Grass waterways (acres affected) -		
(a) Cost-Share	7 (9%)	301 acres (1%)
(b) Non-Cost-Share	16 (21%)	2,004 acres (4%)
(c) Ratio (b)/(a)	2	7
Terraces (acres affected) -		
(a) Cost-Share	0 (0%)	0 acres (0%)
(b) Non-Cost-Share	0 (0%)	0 acres (0%)
(c) Ratio (b)/(a)	-----	-----
Sediment traps/basin (acres affected) -		
(a) Cost-Share	5 (6%)	405 acres (1%)
(b) Non-Cost-Share	13 (17%)	1,875 acres (3%)
(c) Ratio (b)/(a)	3	5
Stream protection or fencing -		
(a) Cost-Share	0 (0%)	0 ft
(b) Non-Cost-Share	7 (9%)	10,600 ft
(c) Ratio (b)/(a)	-----	-----
Sprayer calibration checks -		
(a) Cost-Share	6 (8%)	132 checks/year
(b) Non-Cost-Share	39 (51%)	1,394 checks/year
(c) Ratio (b)/(a)	7	11

[1] - Values in parenthesis are the percentage of respondents using the BMPs.
[2] - Values in parenthesis are the percentage of acres farmed.

47 percent of the farmland is used for crop production. Approximately 63 percent of farmland is owned by farmers and the remaining 37 percent of the farmland in rented. About 52 percent of the farmers have conservation plans for their farms.

The survey results indicate that the farm operators are of highly varied characteristics. On average, respondents were 60 years of age with 32 years of farming experience and earn 35 percent of their family income from farming operations. The average farm size is approximately 339 acres, and an average of one full-time and four part-time employees are hired at peak season. About 80 percent of the respondents have completed high school, 10 percent have received an associate's or bachelor's degree, and 7 percent have an advanced or graduate degree. About 37 percent of the respondents were members of a farm or environmental organization.

The considerations for the farming operation most commonly indicated as either very or somewhat important were decreasing production costs (87 percent of the farmers), increasing yield (86 percent), reducing fertilizer use (80 percent), and access to markets (77 percent). About 79 percent of the farmers indicated they were somewhat or very concerned with pollution in the Chesapeake Bay; 44 percent think water pollution in their county is a problem; but only 24 percent believe that their farm contributes to water quality problems. Litter/garbage (50 percent of the farmers), industrial waste/factory discharge (46 percent of the farmers), and runoff from urban areas (40 percent) were most

commonly indicated as perceived serious or moderate sources of pollution. Fertilizers, pesticides, animal waste, and runoff from cropland were perceived to be either a serious or moderate cause of pollution by 15 percent, 29 percent, 14 percent, and 16 percent of the respondents, respectively.

Beef cattle is the primary livestock produced in the Southside Virginia region. About 69 percent of the farmers raise beef cattle, 7 percent raise dairy cattle, and 6 percent raise horses. The average number of beef cattle raised by each farmer is 76 head. Approximately 5 percent of the farmers raise poultry, sheep, and swine. Hay production is significant in the Southside Virginia region, as 79 percent of the farmers produce hay on approximately 20 percent of the total farmland. Small grains (23 percent of the farmers on 7 percent of the farmland), corn (22 percent of the farmers on 7 percent of the farmland), soybeans (13 percent of the farmers on 9 percent of the farmland), and tobacco (16 percent of the farmers on 2 percent of the farmland) are the major crops produced. Table 4.35 presents information on livestock and crop production in the Southside Virginia region. Beef cattle, tobacco, and hay are the major sources of farm income.

The survey data indicate that most of the farmers implemented a combination of different BMPs on their farms. An average of 1 cost-share BMP and 4 non-cost share BMPs are implemented by farmers in the Southside Virginia region. About 24 percent of the farmers implemented cost-share BMPs on their farms, 68 percent of the farmers

Table 4.35. Livestock and Crop Production in the Southside Virginia DSWC Region.

Livestock Production		
Livestock	**% of Farmers Raising**	**# per 100 Acres of Surveyed Land**
Aquaculture (lbs. of fish)	1	2
Beef cattle	69	19
Dairy cattle	7	3
Horses	6	<1
Poultry	1	265
Sheep	1	<1
Swine	3	12
Crop Production		
Crops	**% of Farmers Growing**	**% of Farmland**
Alfalfa	17	1
Other hay	79	20
Corn	22	7
Cotton	1	<1
Fruits, orchards & vineyards	2	<1
Peanuts	4	1
Small grains	23	6
Soybeans	13	9
Tobacco	16	33
Vegetables	7	<1

implemented non-cost-share BMPs, and 75 percent implemented any type of BMP. Permanent vegetative cover (11 percent of the farmers), hayland or pasture management (10 percent), and grassed waterways (7 percent) were the most commonly implemented cost-share BMPs. The most widely implemented non-cost-share BMPs were hayland or pasture management (47 percent of the farmers on 10 percent of the farmland), permanent vegetative cover (40 percent of the farmers on 11 percent of the farmland), and conservation tillage (37 percent of the farmers on 12 percent of the farmland. A complete list of cost-share and non-cost-share BMP implementation is provided in Table 4.36. The most commonly indicated sources of information on BMPs for farmers in the Southside Virginia region were extension agents, farm magazines, and ASCS. The major reasons given for not implementing BMPs were lack of a problem, operation is too small, and too much paperwork or red tape.

Summary

The major DSWC regions discussed were the Central Tidewater, Central Virginia, Northern Piedmont, Shenandoah Valley, Southeast Virginia, and Southside Virginia. The Shenandoah Valley is by far the largest region, having both the most farmland acreage and number of farmers. The Central Virginia region has the next highest number of farmers and the Northern Piedmont region has the second highest acres of farmland (Figures 4.11 and 4.12). Except for the Southeast Virginia region, in which the average age of the farmers is 52 years old, there was very little variation in the average age of the

Table 4.36. BMP Implementation in the Southside Virginia DSWC Region.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Biological pest controls -		
(a) Cost-Share	0 (0%)[1]	0 (0%)[2]
(b) Non-Cost-Share	5 (4%)	232 (1%)
(c) Ratio (b)/(a)	-----	-----
Contour strip cropping -		
(a) Cost-Share	3 (2%)	102 (<1%)
(b) Non-Cost-Share	26 (19%)	1,562 (4%)
(c) Ratio (b)/(a)	9	15
Conservation tillage -		
(a) Cost-Share	5 (4%)	256 (1%)
(b) Non-Cost-Share	50 (37%)	4,448 (12%)
(c) Ratio (b)/(a)	10	17
Cover crops -		
(a) Cost-Share	4 (3%)	82 (<1%)
(b) Non-Cost-Share	50 (37%)	3,218 (9%)
(c) Ratio (b)/(a)	13	39
Field scouting -		
(a) Cost-Share	1 (1%)	320 (1%)
(b) Non-Cost-Share	27 (20%)	4,693 (12%)
(c) Ratio (b)/(a)	27	15
Grass or legume in rotation -		
(a) Cost-Share	1 (1%)	1 (<1%)
(b) Non-Cost-Share	44 (33%)	2,027 (5%)
(c) Ratio (b)/(a)	44	2,027
Hayland or pasture management -		
(a) Cost-Share	13 (10%)	791 (2%)
(b) Non-Cost-Share	64 (47%)	3,624 (10%)
(c) Ratio (b)/(a)	5	5
Irrigation improvement -		
(a) Cost-Share	2 (1%)	16 (<1%)
(b) Non-Cost-Share	13 (10%)	207 (1%)
(c) Ratio (b)/(a)	7	13

Table 4.36. Continued.

BMPs	Number of Farmers Implementing BMP	Acreage under BMP
Permanent vegetation cover -		
(a) Cost-share	15 (11%)	1,107 (3%)
(b) Non-Cost-Share	54 (40%)	4,127 (11%)
(c) Ratio (b)/(a)	4	4
Rotational grazing -		
(a) Cost-share	4 (3%)	392 (1%)
(b) Non-Cost-Share	41 (30%)	1,881 (5%)
(c) Ratio (b)/(a)	10	5
Split fertilizer applications -		
(a) Cost-Share	4 (3%)	329 (1%)
(b) Non-Cost-Share	41 (30%)	2,214 (6%)
(c) Ratio (b)/(a)	10	7
Tissue analysis -		
(a) Cost-Share	1 (1%)	300 (1%)
(b) Non-Cost-Share	9 (7%)	184 (<1%)
(c) Ratio (b)/(a)	9	0.6

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Animal waste storage facilities -		
(a) Cost-Share	0 (0%)	0 facilities
(b) Non-Cost-Share	10 (7%)	21 facilities
(c) Ratio (b)/(a)	-----	-----
Animal waste sampling/analysis -		
(a) Cost-Share	1 (1%)	1 analysis/year
(b) Non-Cost-Share	4 (3%)	8 analyses/year
(c) Ratio (b)/(a)	4	8
Deep soil sampling/analysis -		
(a) Cost-Share	0 (0%)	0 samples/acre/farmer
(b) Non-Cost-Share	1 (1%)	<1 samples/acre/farmer
(c) Ratio (b)/(a)	-----	-----

Table 4.36. Continued.

BMPs	Number of Farmers Implementing BMP	BMP Implementation
Surface soil sampling/analysis -		
(a) Cost-Share	3 (2%)	1 sample/acre/farmer
(b) Non-Cost-Share	52 (39%)	38 samples/acre/farmer
(c) Ratio (b)/(a)	17	38
Diversions (acres affected) -		
(a) Cost-Share	0 (0%)	0 acres (0%)
(b) Non-Cost-Share	6 (4%)	468 acres (1%)
(c) Ratio (b)/(a)	-----	-----
Filter/buffer strips (acres affected) -		
(a) Cost-Share	2 (1%)	11 acres (<1%)
(b) Non-Cost-Share	18 (13%)	1,733 acres (5%)
(c) Ratio (b)/(a)	9	158
Grass waterways (acres affected) -		
(a) Cost-Share	9 (7%)	239 acres (1%)
(b) Non-Cost-Share	30 (22%)	2,447 acres (6%)
(c) Ratio (b)/(a)	3	14
Terraces (acres affected) -		
(a) Cost-Share	0 (0%)	0 acres (0%)
(b) Non-Cost-Share	13 (10%)	736 acres (2%)
(c) Ratio (b)/(a)	-----	-----
Sediment traps/basin (acres affected) -		
(a) Cost-Share	1 (1%)	44 acres (<1%)
(b) Non-Cost-Share	7 (5%)	303 acres (1%)
(c) Ratio (b)/(a)	7	7
Stream protection or fencing -		
(a) Cost-Share	1 (1%)	3,000 ft
(b) Non-Cost-Share	11 (8%)	23,409 ft
(c) Ratio (b)/(a)	11	8
Sprayer calibration checks -		
(a) Cost-Share	0 (0%)	0 checks/year
(b) Non-Cost-Share	18 (13%)	117 checks/year
(c) Ratio (b)/(a)	-----	-----

[1] - Values in parenthesis are the percentage of respondents using the BMPs.
[2] - Values in parenthesis are the percentage of acres farmed.

farming operators in other regions (58 to 60 years old). The survey data revealed that farmers in the Central Tidewater, Central Virginia, Northern Piedmont, Shenandoah Valley and Southside Virginia regions generate more than half of their family income from off-farm sources, whereas farmers in the Southeast Virginia region earn the majority of their income from the farming operation.

The "proximity effect" was evident in all of the regions as most farmers generally had a concern about pollution in the Chesapeake Bay. A large percentage of the respondents also believed that water pollution is a problem in their county, but only approximately one-half of those having concerns about pollution in the Chesapeake Bay thought that their farm contributes to water quality problems. Figure 4.13 illustrates the responses for these three questions for the various DSWC regions. The major perceived sources of pollution by the farmers in each region were runoff from urban areas, industrial waste or factory discharge, city or town sewer systems, and litter or garbage. These pollution sources were generally perceived as more serious causes of pollution than those stemming from agricultural areas, such as pesticides, fertilizers, animal waste, and runoff from cropland. An exception was in the Northern Piedmont region where pesticides were indicated as a prominent cause of pollution. The most important considerations for the farming operation were decreasing production costs, increasing yield, access to markets, and complying with government regulations.

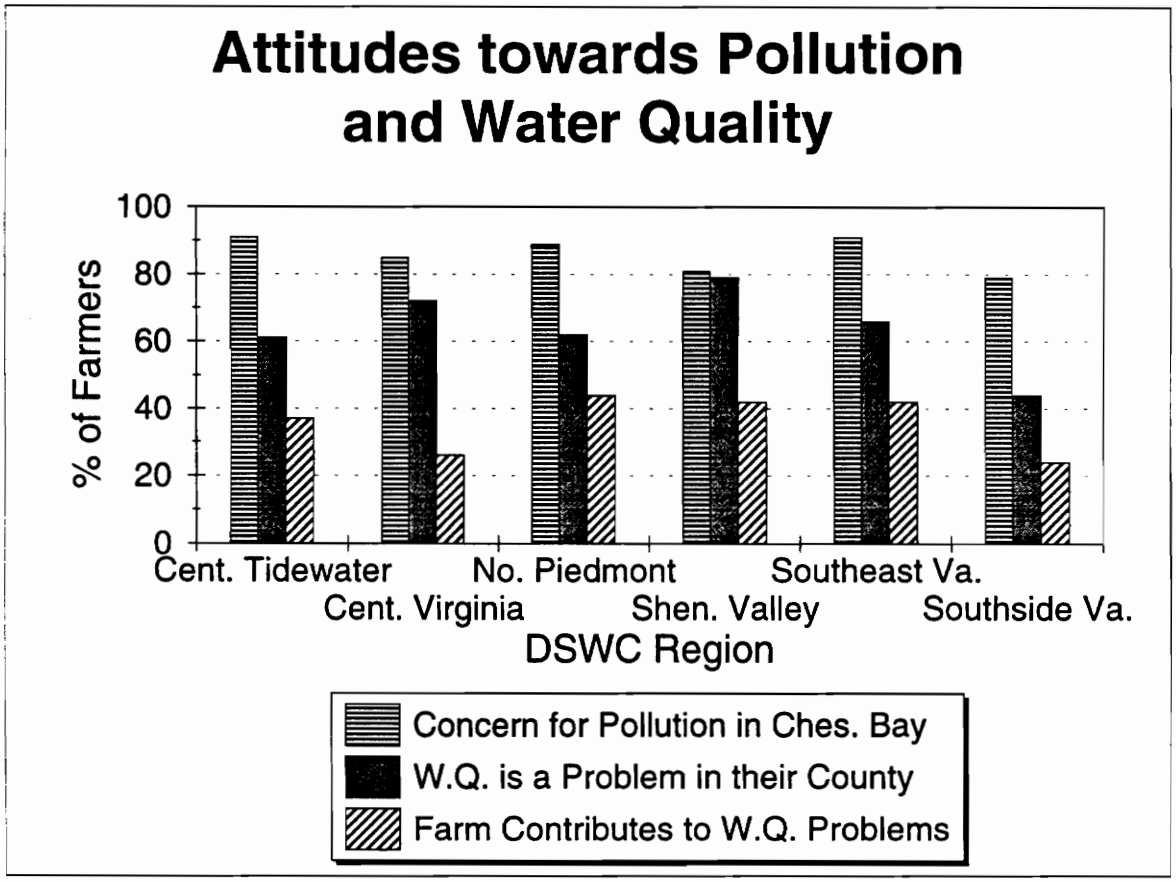


Figure 4.13. Attitudes towards Pollution and Water Quality.

Cropland is the major agricultural land use in the Central Tidewater and the Southeast Virginia regions. The other regions produce livestock, especially beef cattle, and hay as prominent commodities. The Shenandoah Valley region is primarily a livestock producing region, as higher percentages of farmers produce dairy cattle, horses, poultry, and sheep than in other regions. The Southeast Virginia region has higher percentages of farmers producing poultry and swine than other regions. Corn, small grains, and soybeans were the major crops produced in the DSWC regions. Peanuts, vegetables, and cotton are also significant in the Southeast Virginia region and tobacco is a major commodity in the Southside Virginia region. Accordingly, farmers in the Central Virginia, Northern Piedmont, Shenandoah Valley, and Southside Virginia regions indicated beef cattle and hay as primary sources of their farm income. Farmers in the Central Tidewater and Southeast Virginia regions indicate corn, small grains, and soybeans as primary sources of farm income. Peanuts were also listed as a primary source of farm income in the Southeast Virginia region and tobacco was listed as a primary source of farm income in the Southside Virginia region. Comparisons of the percent of farmers in each regions producing beef cattle, corn, small grains, and soybeans can be found in Figure 4.14, and Figure 4.15 compares the percentage of farmland on which corn, small grains, and soybeans are produced.

In each of the DSWC regions, the average farmer adopts 1 cost-share practice. The predominant cost-share BMPs implemented were grassed waterways, filter or buffer

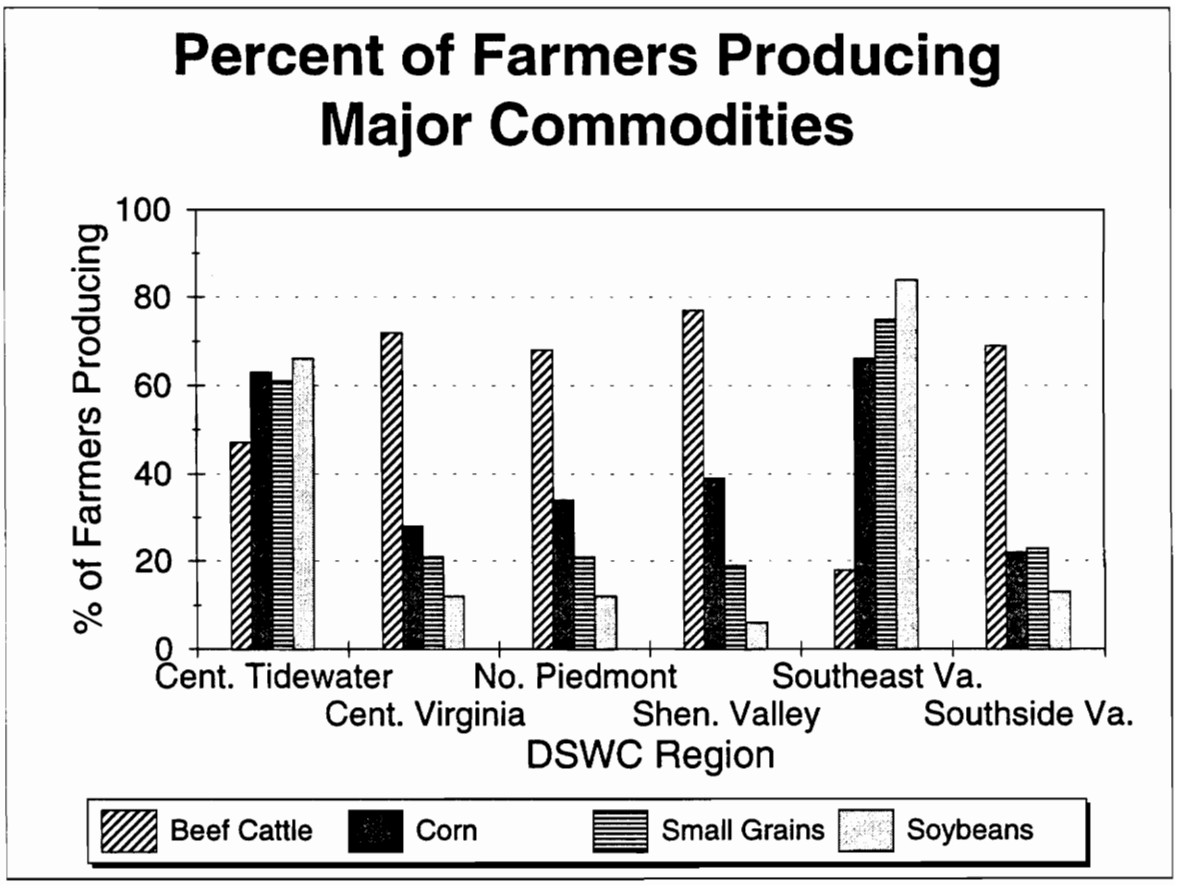


Figure 4.14. Percent of Farmers Producing the Major Commodities.

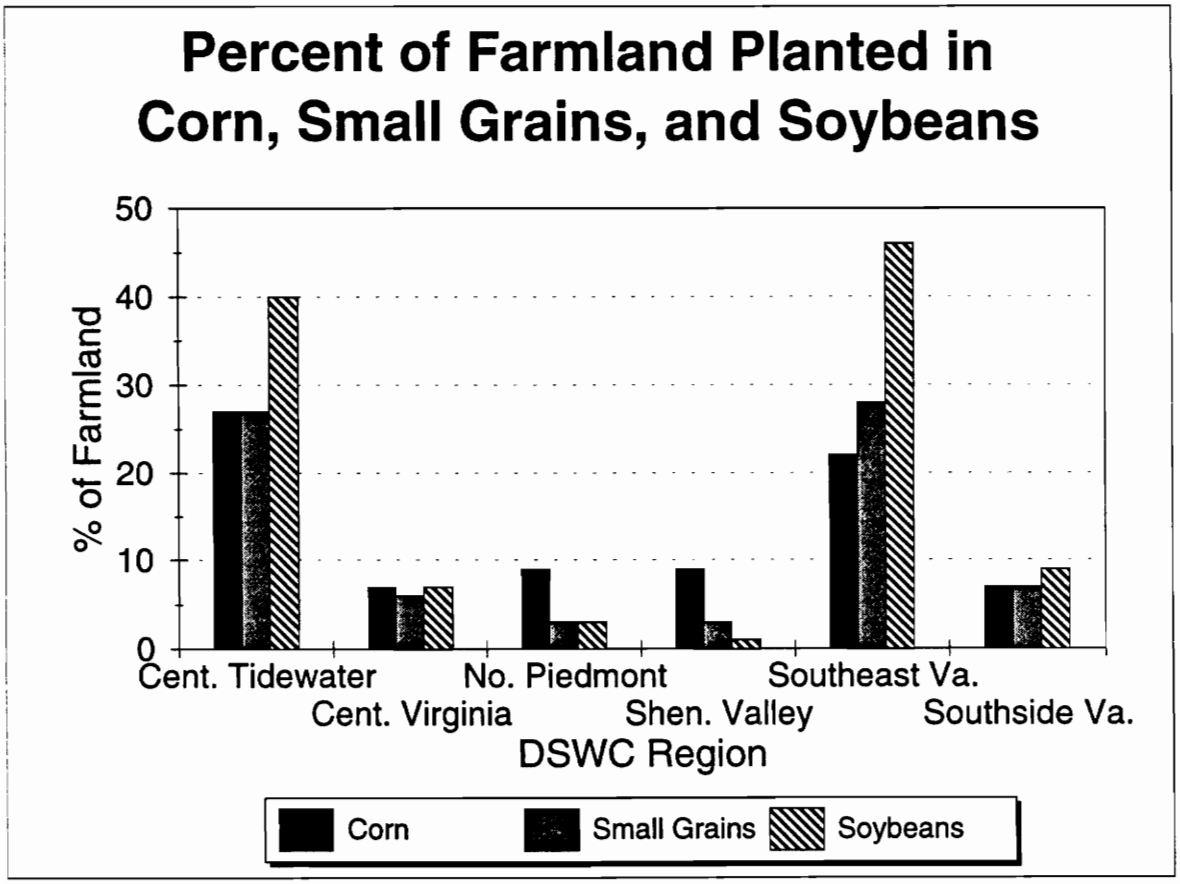


Figure 4.15. Percent of Farmland in Corn, Small Grains, and Soybeans.

strips, permanent vegetative cover, hayland or pasture management, and cover crops. Animal waste facilities were implemented with cost-share funds by 7 percent of the farmers in the Shenandoah Valley region. This should be expected due to the great amount of livestock production in this area. The average farmer in each of the DSWC regions implements 3 to 5 non-cost-share BMPs. Hayland or pasture management and conservation tillage are the predominant non-cost-share BMPs implemented in each region. Other non-cost-share BMPs commonly implemented in the DSWC regions were sprayer calibration checks, cover crops, permanent vegetative cover, split fertilizer applications, and field scouting. Figure 4.16 compares the percentage of farmers In all of the regions, the major sources of information on BMPs were extension agents, farm magazines, ASCS, and NRCS. Lack of a problem, too small of an operation, and too much paperwork or red tape were the major reasons given for not implementing BMPs.

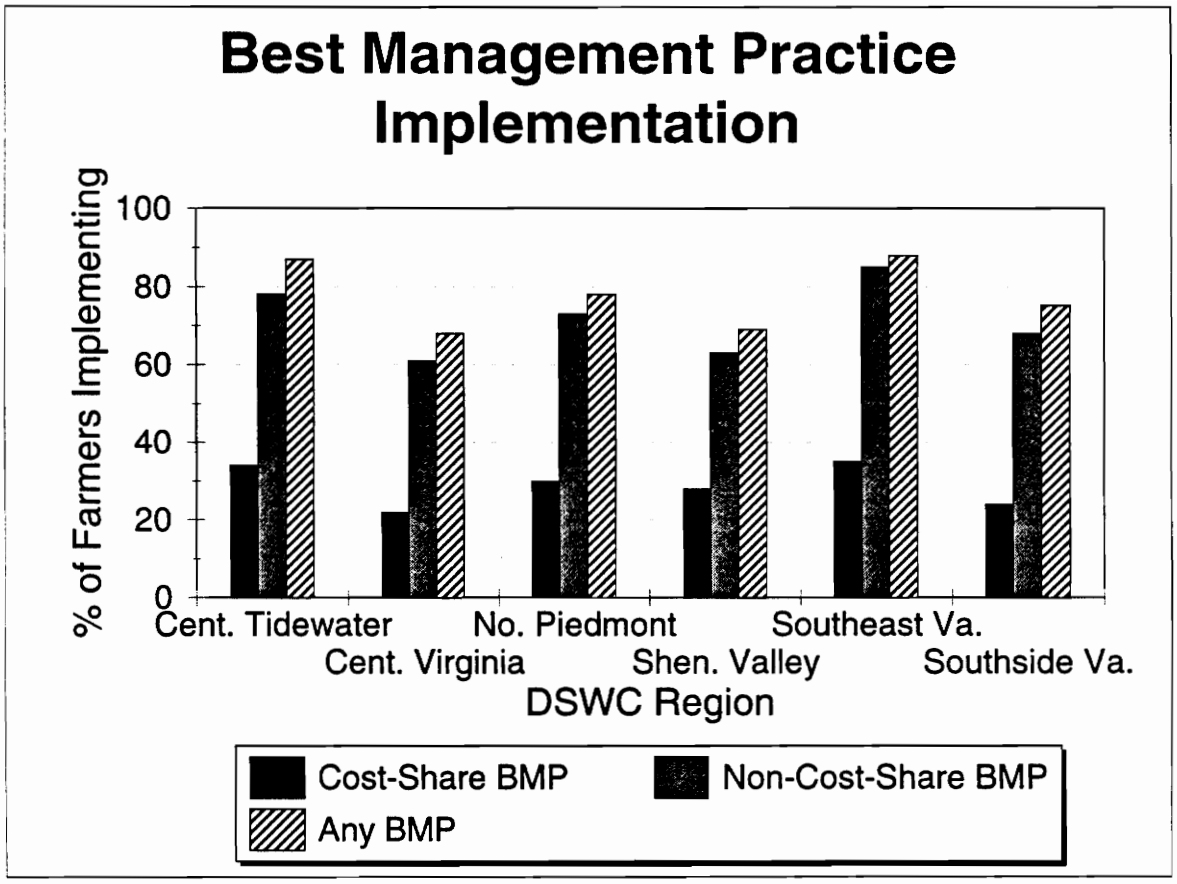


Figure 4.16. Percent of Farmers Implementing BMPs.

5 Verification of the Survey Results

The purpose of this chapter is to assess the reliability of the survey results and appropriateness of extrapolating the results to the entire Chesapeake Bay basin. Many different databases were compiled to compare commodity production and BMP implementation data from other sources to the information collected by the survey. The DSWC Field Office areas were used to describe BMP implementation in specific regions of the Chesapeake Bay basin. Table 3.3 lists the DSWC Field Offices and the counties surveyed that comprise each field office. If the difference between the survey results and those reported by the independent data sources were less than the error values for the various regions (Table 3.4), then one could conclude that the results obtained through the survey are representative of the population.

Commodity Production

The crop production data obtained by the survey was compared to the Virginia Agricultural Statistics Summary (VDACS, 1992) to determine how well the survey represented commodity production in the Chesapeake Bay basin (Figures 4.2 & 4.3). Total cropland, as a percentage of total agricultural land in the Chesapeake Bay basin, was estimated to be 55% and 58%, by the survey and VDACS data, respectively. Correspondingly, 45% and 42% of the total agricultural land were used as pasture according to the survey and the VDACs data (Figure 5.1). The survey results indicate that

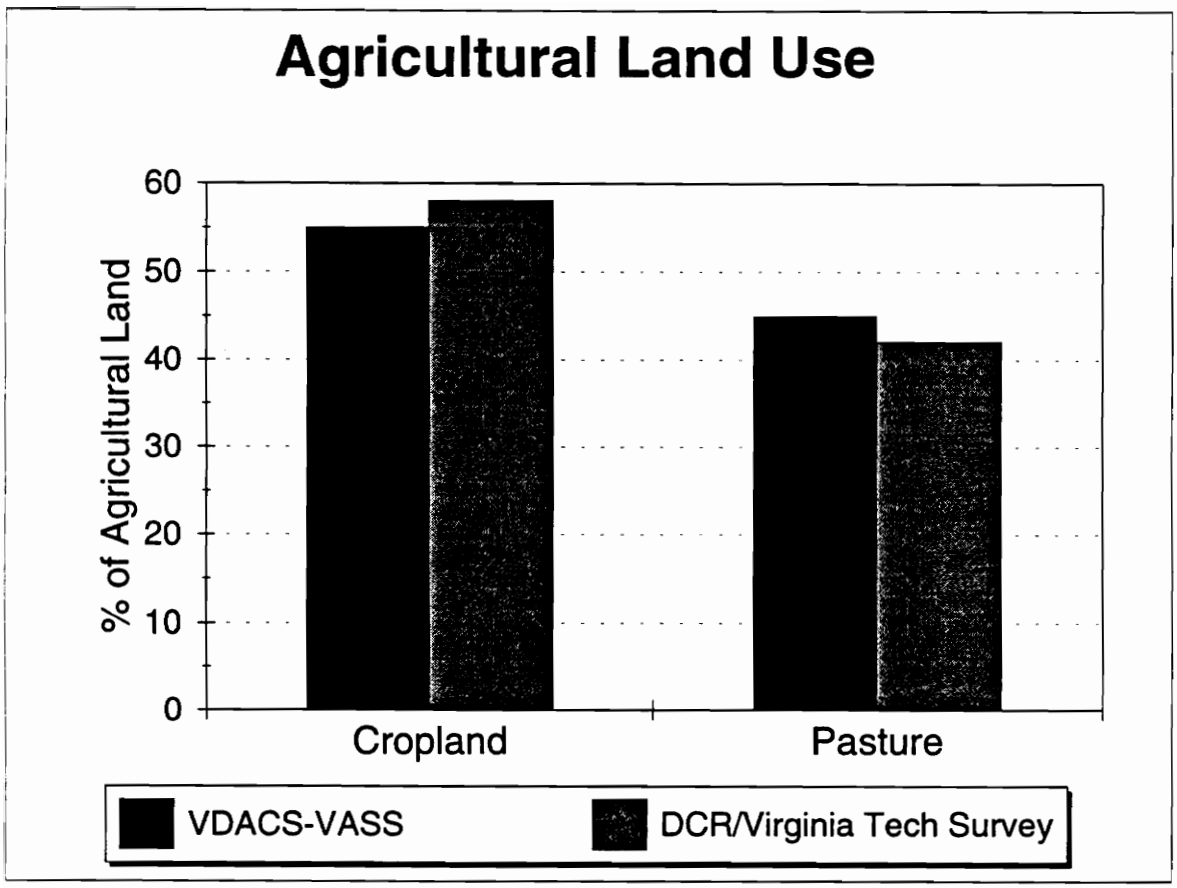


Figure 5.1. Comparison of Agricultural Land Use Data.

about 12% of the total farmland from the survey was under corn production compared to the 13% reported by the VDACS data. Similar to corn production, according to the survey results, 12% of the total agricultural land was under soybean production, compared to 14% reported by the VDACS data. Small grains production was estimated to be 9% of the total farmland by the survey and 10% by the VDACS data, respectively. Alfalfa accounted for 2% of the total agricultural acreage, according to both the survey and VDACS agricultural acreage, while production of other hay accounted for 17% of the farmland based on the survey results and 14% based on the VDACS data. Cotton, peanut, and tobacco production data obtained by the survey were all consistent with the VDACS data, however, their contribution to the total agricultural acreage was not significant (Figure 5.2). All errors were within the estimated errors listed in Table 3.4.

Best Management Practice Implementation

The BMP implementation data in the various databases are not compatible. There are many discrepancies in the level of BMP implementation represented by the different sources. For example, there is about a 30% difference in the percentage of agricultural land under conservation tillage in the Chesapeake Bay basin, as reported by the Natural Resource Inventory, NRI, and Conservation Tillage Information Center, CTIC databases (Figure 5.3). These significant differences indicate the incompatibility of the databases and made the verification of the survey results difficult.

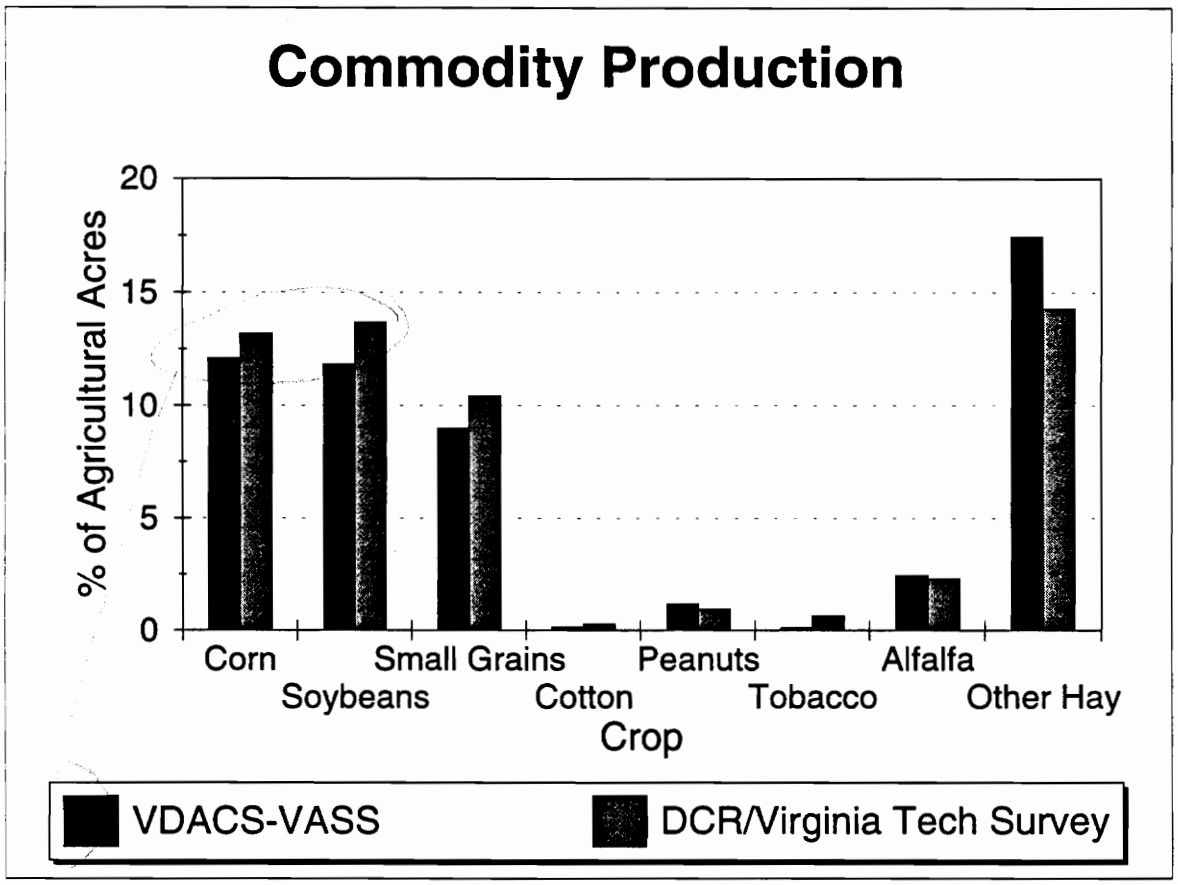


Figure 5.2. Comparison of Commodity Production Data.

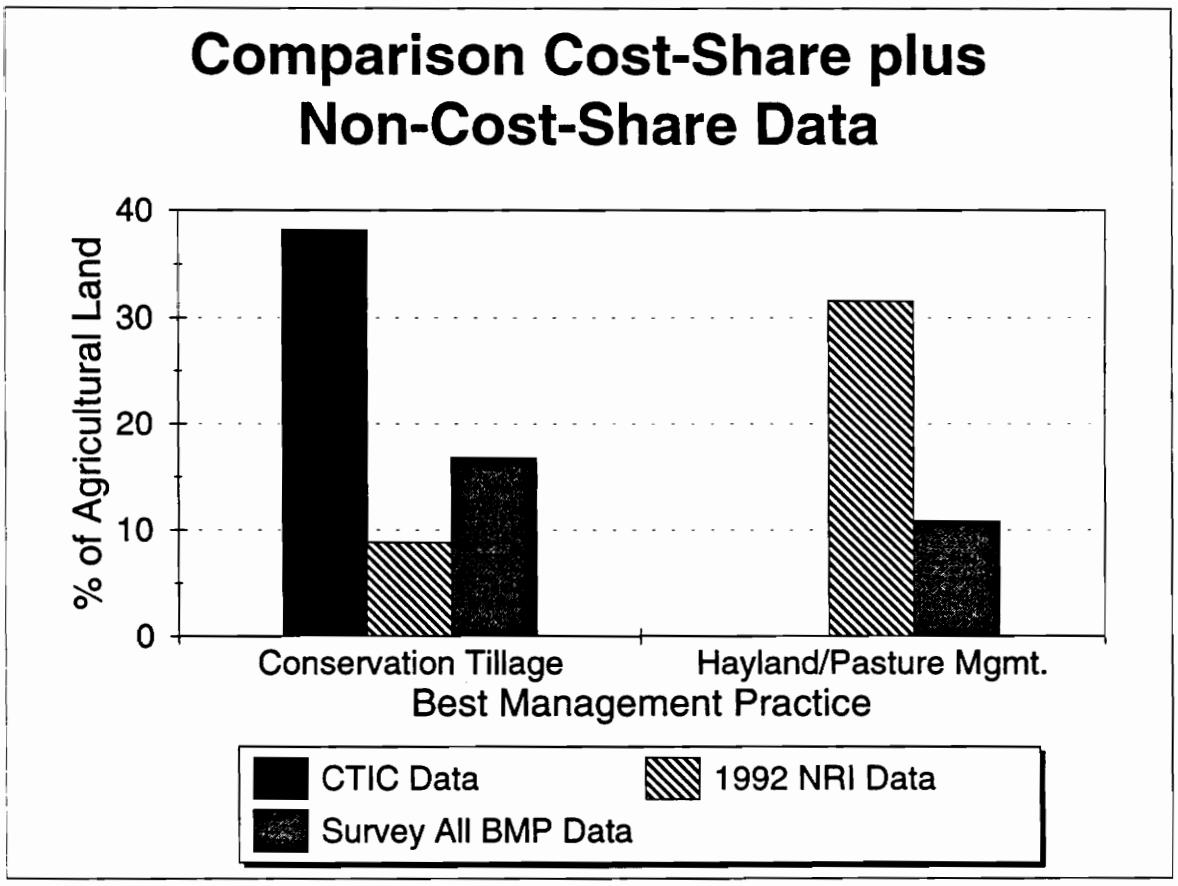


Figure 5.3. Comparison of Cost-Share plus Non-Cost-Share Data.

Figure 5.4 shows that the percent difference between the survey cost-share data and DSWC-NRCS data for cover crop, strip-cropping, conservation tillage, and hayland and pasture management in the Chesapeake Bay basin were all less than the 4 percent potential error associated with the survey results. The comparisons of BMP implementation between the survey results and other databases, at the DSWC Field Office level indicate that the differences are within the error values established for the survey results at the 95 percent confidence level (Table 5.1). Figures 5.5a, 5.6a, and 5.7a illustrate the percentage of farmland in each region under which cover crops, hayland/pasture management, and conservation tillage are implemented using cost-share funds. These figures correspond to the error values listed in Table 5.1. As shown in Figures 5.5a and 5.5b, the survey results regarding the implementation of cover crops with cost-share funds, compared favorably with the DSWC-NRCS data for all the DSWC Field Office areas, except for the number of acres of cover crops implemented per farmer using cost-share funds in the Southeast Virginia region (Figure 5.5b). As indicated in Table 3.4, due to the small number of respondents, the potential error associated with the survey results for the Southeast Virginia region was higher than the other regions. Figures 5.6a and 5.6b indicate that the Northern Piedmont area is underestimated by the survey with regard to the amount of cost-share implementation of hayland and pasture management. The results presented in Figures 5.7a and 5.7b demonstrate that the survey data, on the amount of conservation tillage implemented with cost-share funds in various DSWC Field Office regions, compared favorably with the NRCS data, except for the

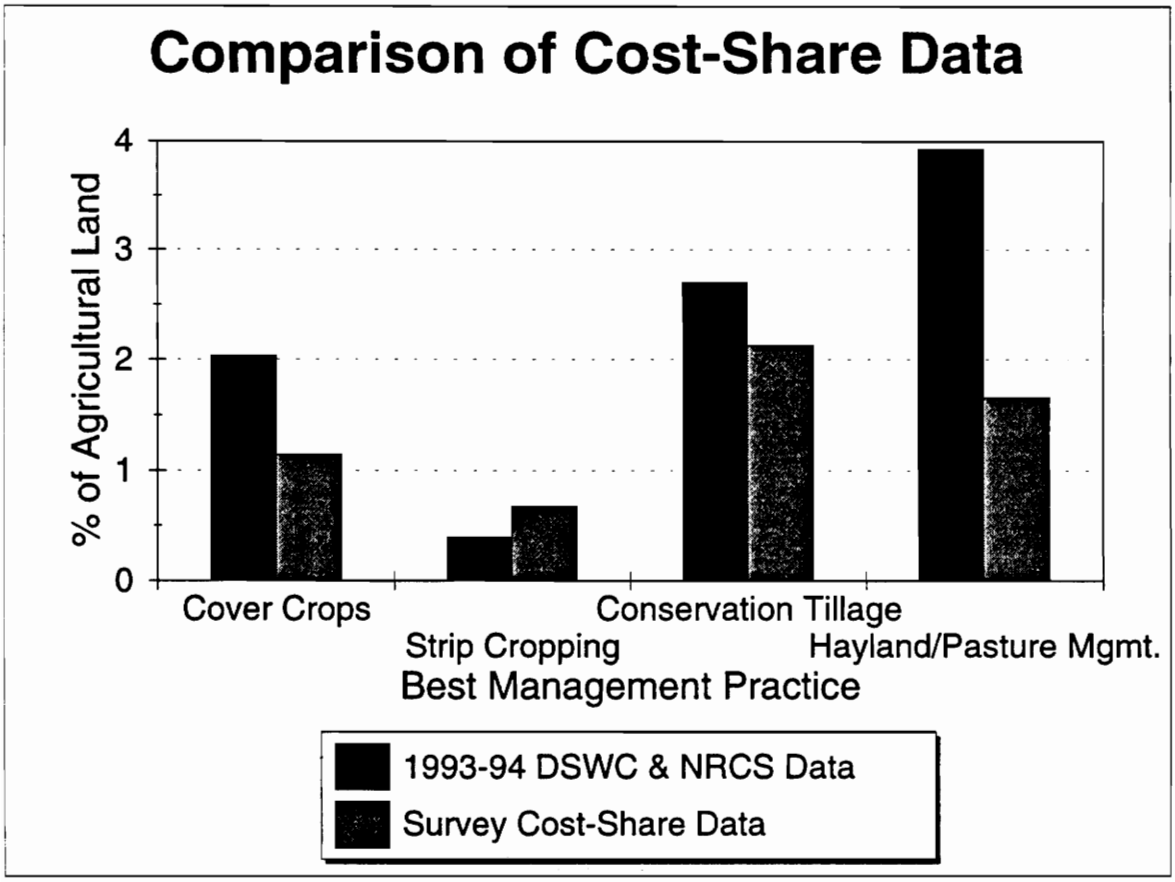


Figure 5.4. Comparison of Cost-Share Data.

Table 5.1. Error associated with the DSWC Field Office areas and the Chesapeake Bay Drainage Basin between the survey cost-share data and DSWC & NRCS data.

		% difference between the Survey Results and DSWC & NRCS Data		
	Error with 95% C.L.*	Cover Crops	Hayland/Pasture Management	Conservation Tillage
Central Tidewater	8 %	1.39 %	1.90 %	0.60 %
Central Virginia	8 %	0.07 %	0.16 %	0.92 %
Northern Piedmont	8 %	0.18 %	6.77 %	2.30 %
Shenandoah Valley	6 %	1.97 %	0.27 %	0.93 %
Southeast Virginia	13 %	1.69 %	0.06 %	2.76 %
Southside Virginia	10 %	1.51 %	2.99 %	1.16 %
Chesapeake Bay Basin	4 %	0.89 %	2.27 %	0.57 %

* Estimated error in the survey results for the various regions.

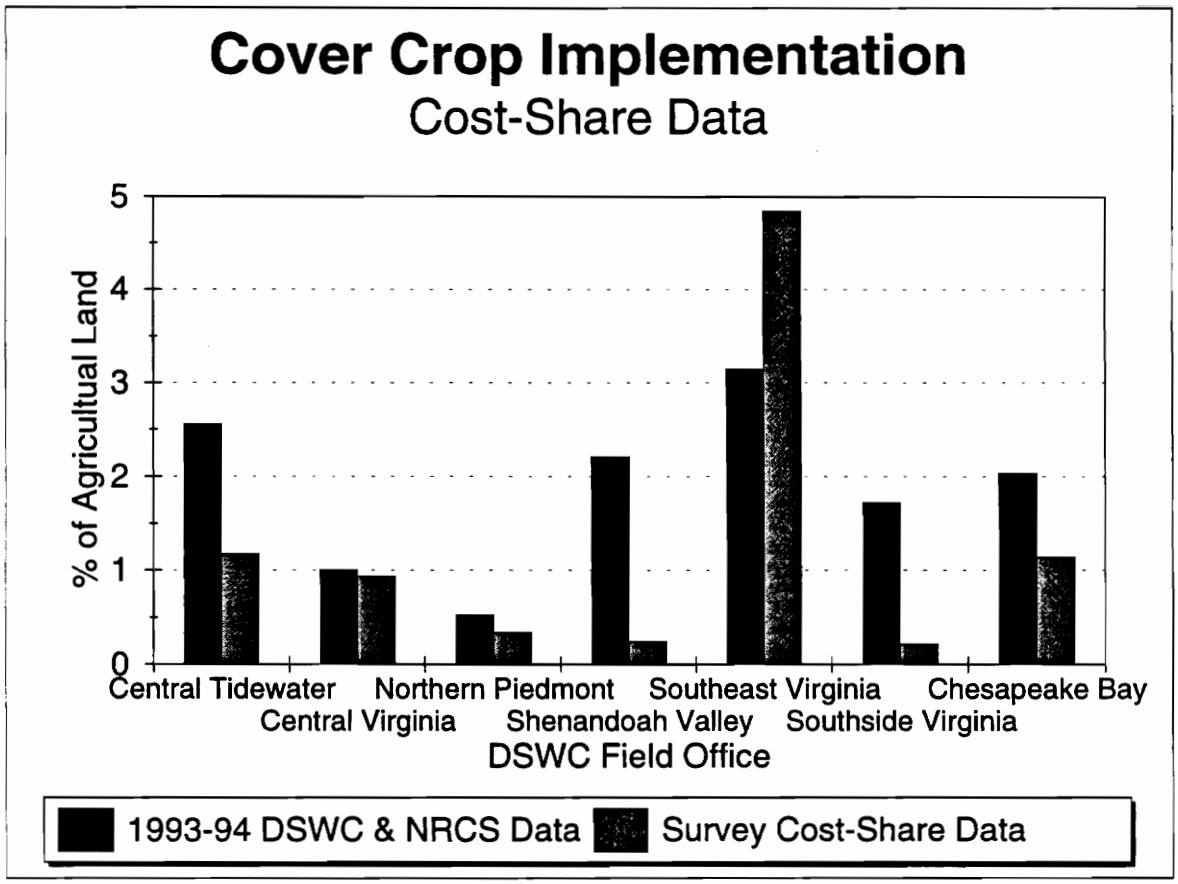


Figure 5.5a. Comparison of Cost-Share Cover Crop Data.

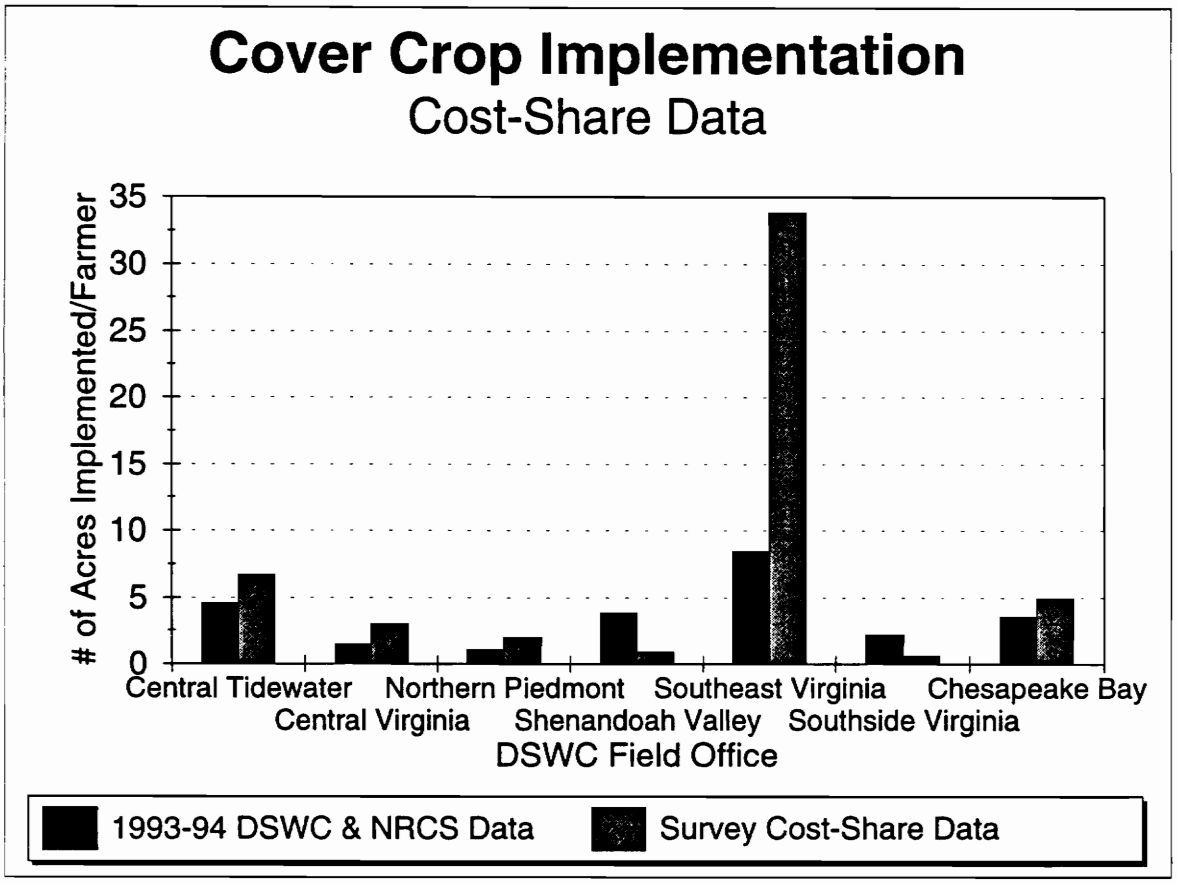


Figure 5.5b. Comparison of Cost-Share Cover Crop Data.

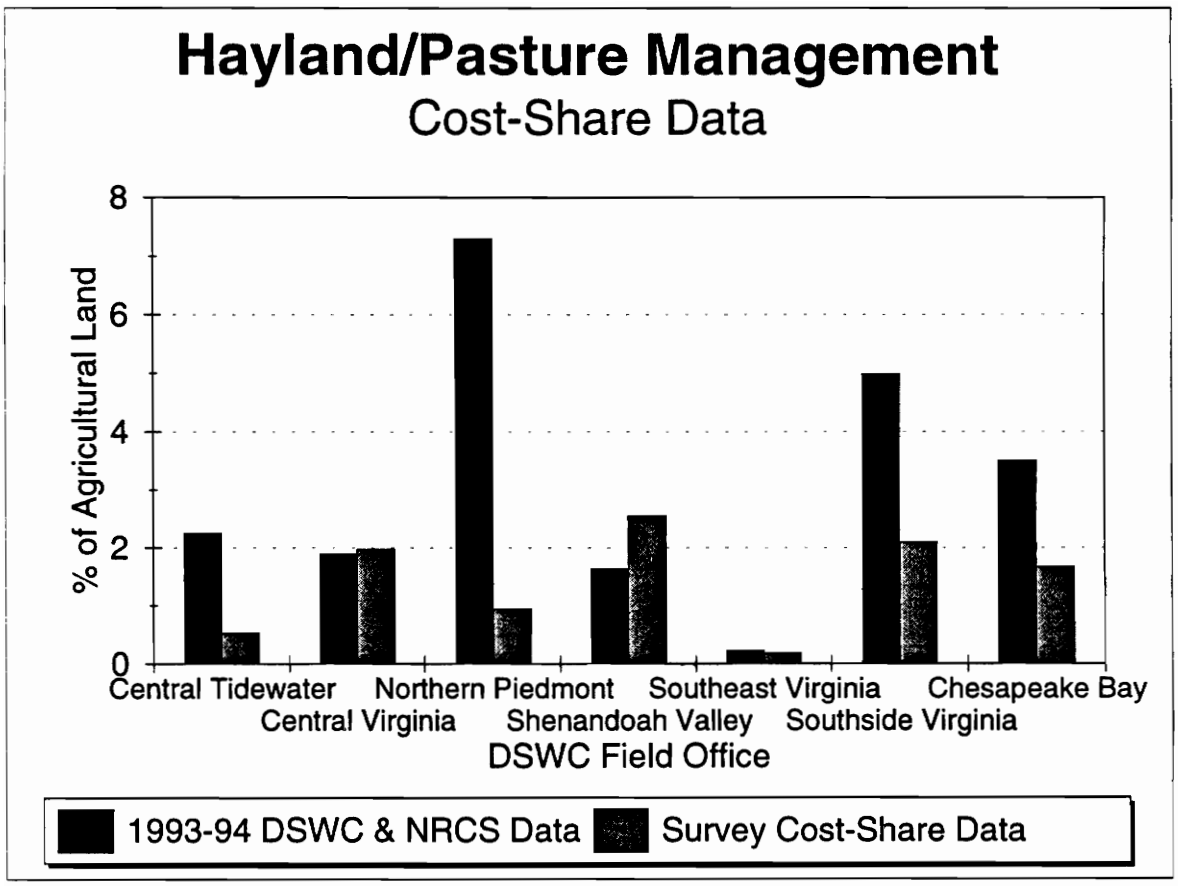


Figure 5.6a. Comparison of Cost-Share Hayland/Pasture Management.

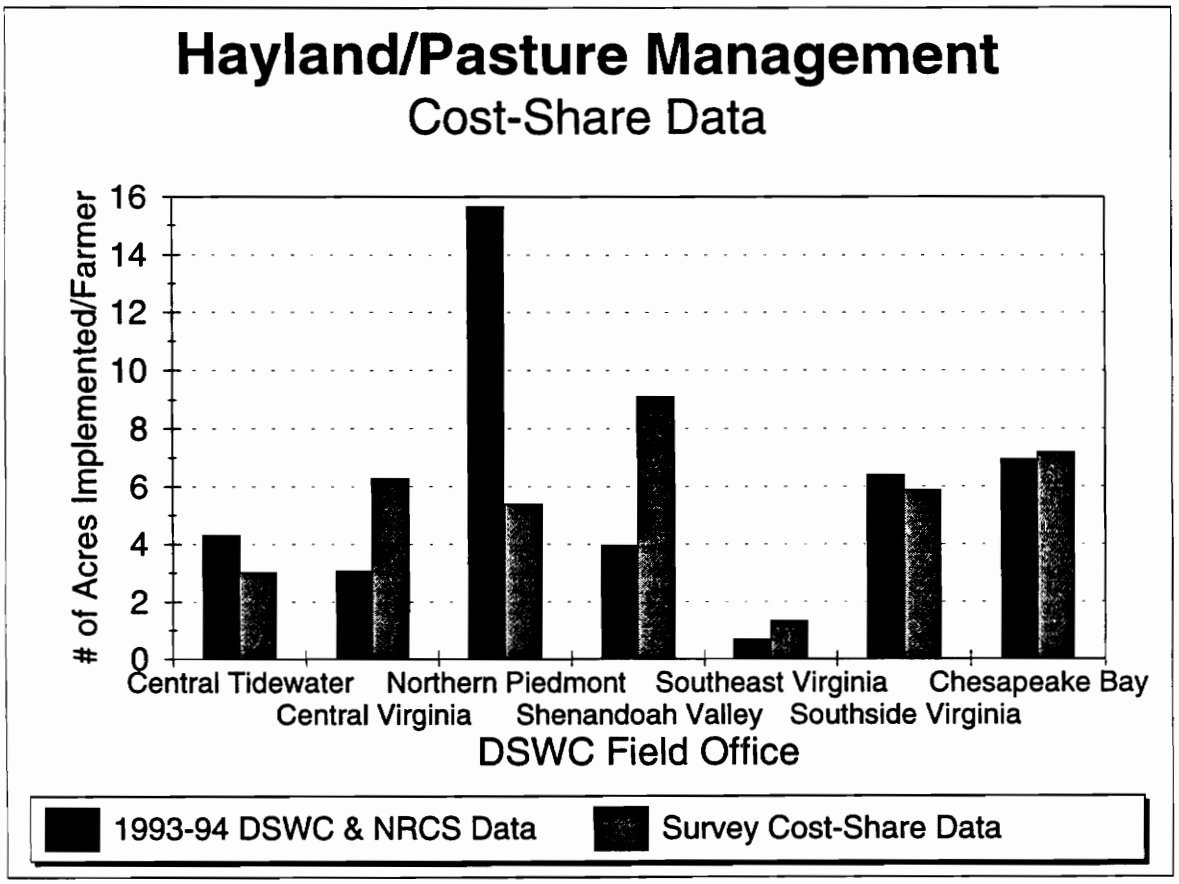


Figure 5.6b. Comparison of Cost-Share Hayland/Pasture Management.

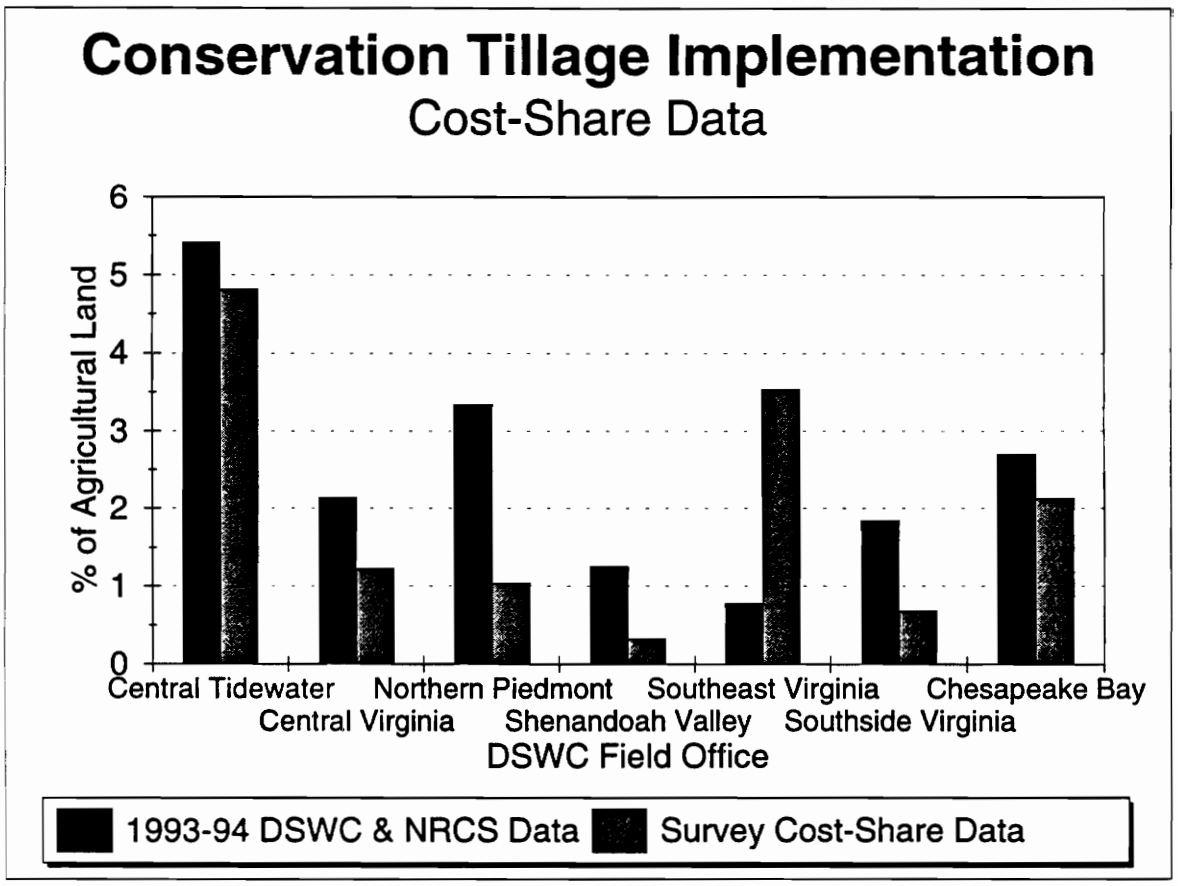


Figure 5.7a. Cost-Share Conservation Tillage Implementation.

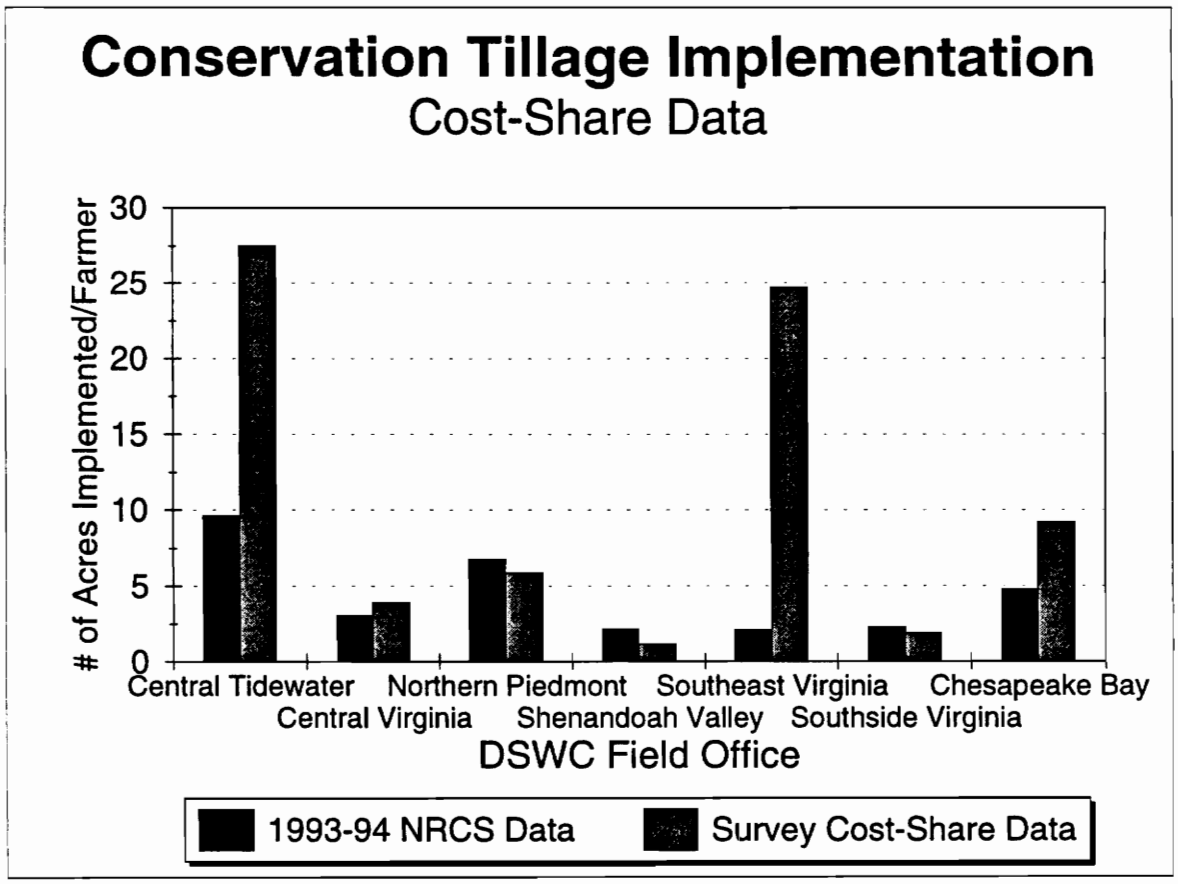


Figure 5.7b. Cost-Share Conservation Tillage Implementation.

Central Tidewater and the Southeast Virginia Regions. The number of acres of conservation tillage implemented per farmer with cost-share funds, also differed considerably between the NRCS data and the survey data. These differences, however, were all within the error values estimated for the survey results for the various regions (Table 5.1). The DSWC and NRCS total implementation of conservation tillage (both cost-share and non-cost-share) also compared well with the number of acres implemented per farmer in all of the DSWC Field Office areas and the Chesapeake Bay drainage basin (Figure 5.8).

The actual data for animal waste storage facilities in Augusta, Page, and Rockingham counties indicate that there are approximately 557 total facilities handling poultry, swine, and beef and dairy cattle waste in these counties. The extension agents records show that 338 of these facilities were cost-shared through DCR-DSWC. As shown in Figure 5.9, the survey depicted the number of cost-share animal waste storage facilities implemented in the Chesapeake Bay basin fairly well but overpredicted the number of facilities implemented in the counties of Augusta, Page, and Rockingham. It should be noted that the DSWC cost-share data used in the comparison of the animal waste storage facilities were for the period between 1984-1994. The survey was conducted in 1995 and may represent a different time frame with regard to some BMP implementation. Figure 5.10 also shows that the survey overestimated the total number of animal waste storage facilities in Augusta, Page, and Rockingham counties, compared to the data reported by

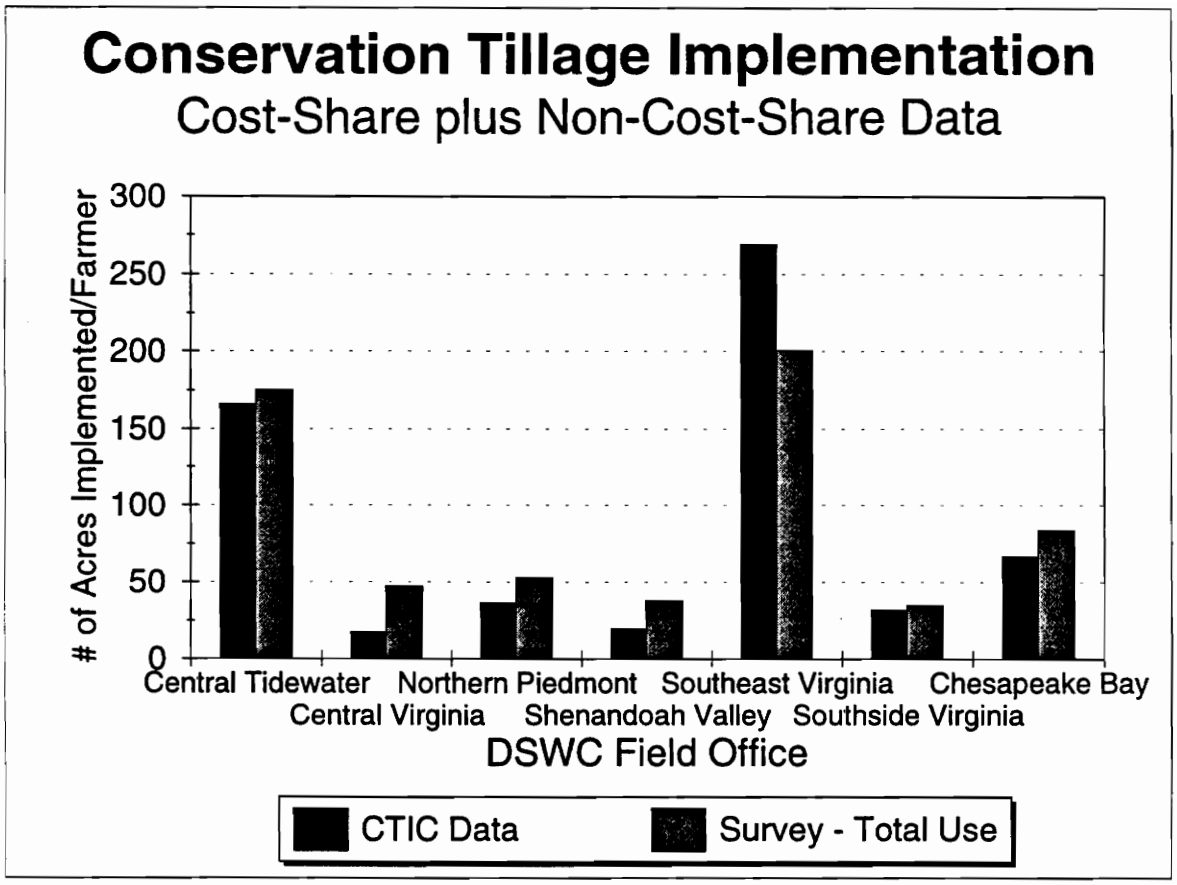


Figure 5.8. Comparison of Conservation Tillage Implementation Data..

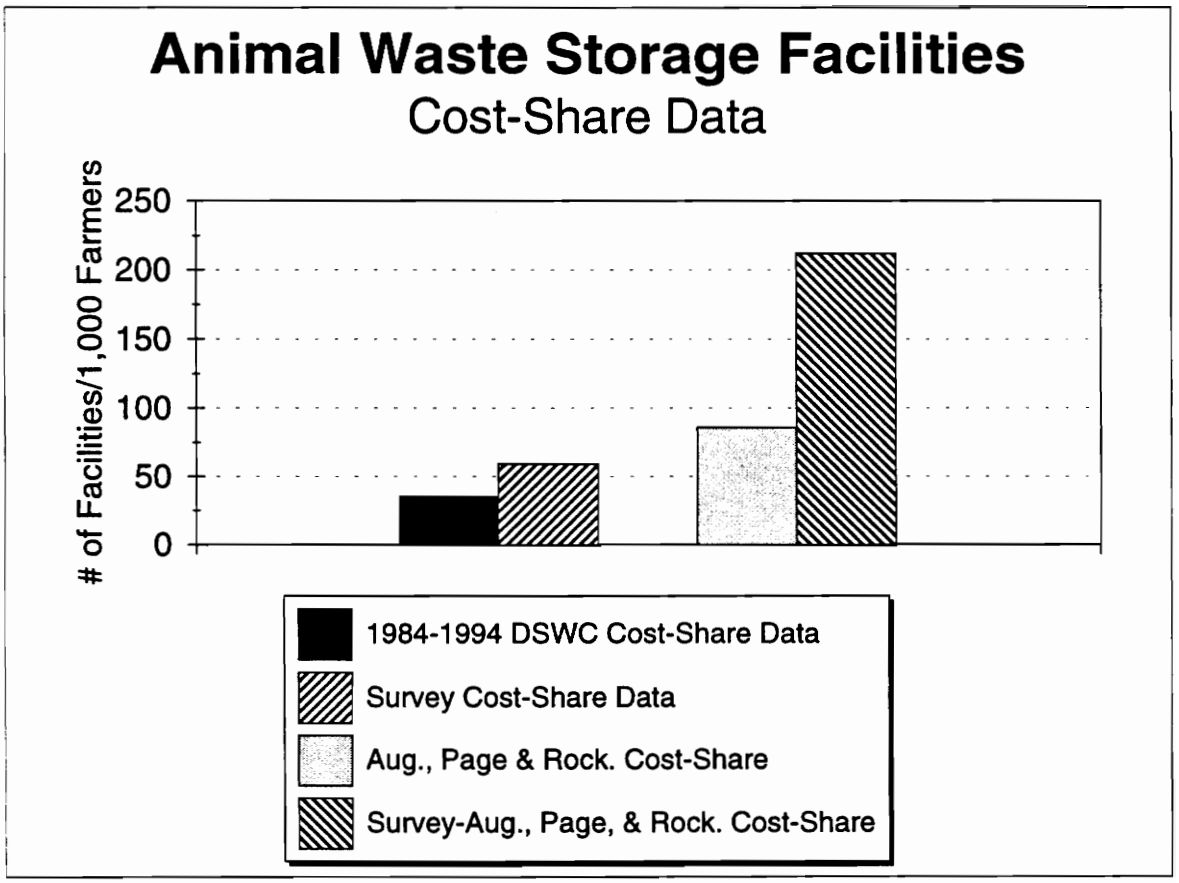


Figure 5.9. Cost-Share Animal Waste Storage Facilities Implementation.

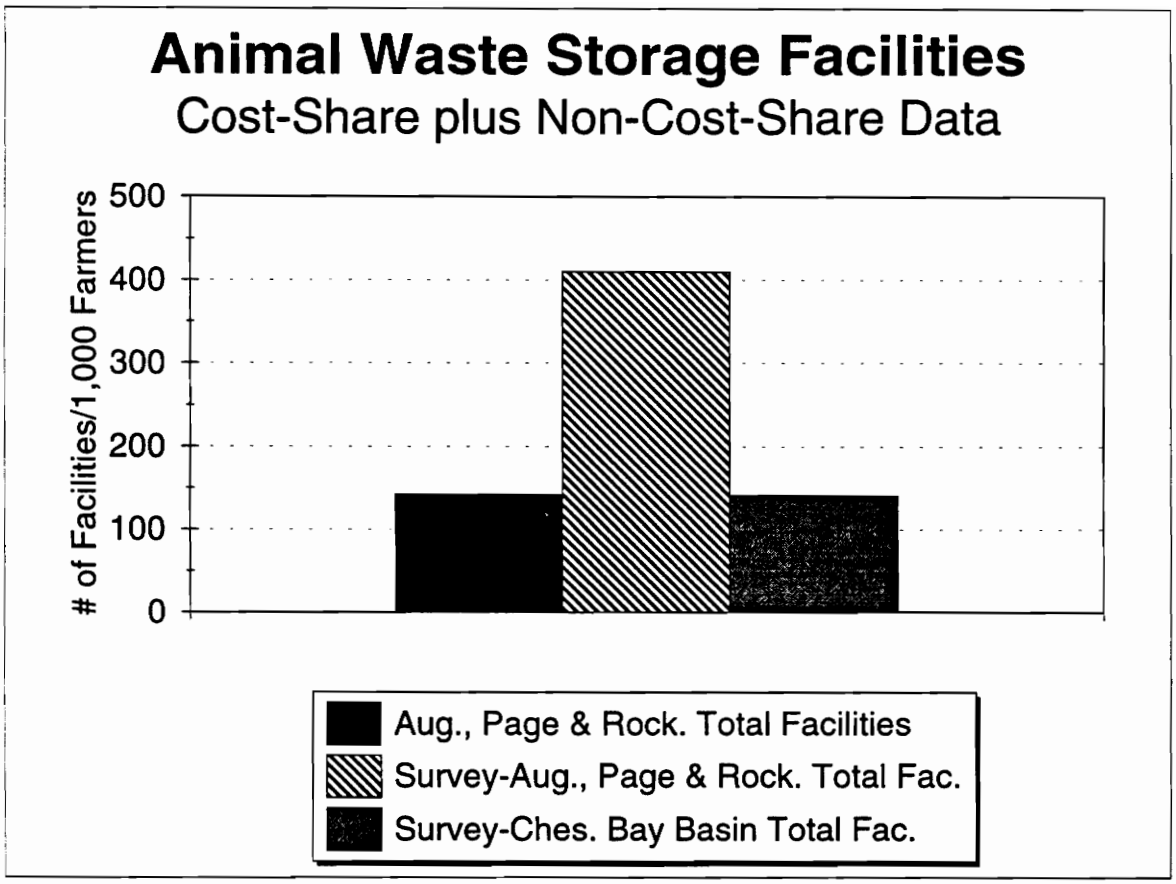


Figure 5.10. Comparison of Animal Waste Storage Facilities Data.

the extension agent in those counties. The comparisons of the animal waste storage facilities does not include any NRCS data but does include DSWC cost-share data since 1984. The data was used because the design life of an animal waste facility is 10 years.

Summary

Comparisons of the survey results of crop production with those from the VDACS database indicated that the sample population used in the survey accurately represented the farming population in the Chesapeake Bay basin. In addition, the survey results compared favorably with the VDACS-VASS data on the amount of cropland and pasture land in the Chesapeake Bay basin. In many cases the results of the survey on cost-share BMP levels in various DSWC Field Office areas and the Chesapeake Bay basin were within the potential error values estimated for the survey results. However, in regions with a smaller number of returned surveys, such as Southeast Virginia and Southside Virginia, the survey results deviated from those reported by various databases regarding the implementation of certain BMPs. The discrepancies between the different data sources and inconsistency in the representation of the BMP implementation data precluded a complete verification of the survey results. For example, some of the data was summarized at the DSWC District level and others were combined into river basin totals. Therefore, a direct comparison of the results of the survey and other data sources was not possible for various regions. Furthermore, the information on animal waste storage facilities, as reported by DSWC covered a period of 10 years, whereas the survey

results reported a different time frame for BMP implementation.

Based on the results presented in this report, it could be concluded that the statistical sample surveyed in this study favorably represented the entire farming population in the Chesapeake Bay basin. The survey results compared favorably with those reported by the various databases for several BMPs, although discrepancies were observed for few BMPs. These discrepancies could be partially explained by a lack of compatibility data between the type of information reported in the survey and those available in the databases.

Summary and Conclusions

A survey of farmers was conducted to determine the extent of cost-share and non-cost-share BMP implementation and to evaluate the impact of socio-economic variables on the adoption of BMPs by farmers in the Virginia's Chesapeake Bay drainage basin and to verify the results with other data sources. The survey covered 67 counties in Virginia, all having at least 90 percent of their total land in the Chesapeake Bay basin. 1,377 responses were returned, of which approximately 1,198 (6 percent of the total farming population) were estimated to be from the Chesapeake Bay drainage basin. The respondents covered approximately 474,772 acres of farmland (13 percent of the total farmland in the Chesapeake Bay basin in Virginia).

On average, respondents were 58 years of age and had 31 years of farming experience. The average farm size is approximately 436 acres, and 60 percent of the farmers own the majority of the land they farm. About 84 percent of the respondents live on their farm and approximately 40 percent of the family income is derived from the farming operation. Approximately 78 percent of the respondents have completed high school. Increasing yield, decreasing production costs, access to markets, complying with government regulations, and reducing fertilizer use were the most important considerations in their farming operation. Most respondents agreed with statements "water pollution can best be controlled through educational programs that encourage farm operators to use BMPs" and

"farm operators do not have the right to farm in ways that damage water quality". The "proximity effect" was evident as 80 percent of farmers had concerns about water pollution in the Chesapeake Bay, 56 percent believed that there were water quality problems in their county, yet only 33 percent believed their farm contributed to water quality problems. The most often indicated perceived causes of pollution in the farmer's county were runoff from urban or paved areas, industrial waste or factory discharge, sewer systems, and litter or garbage. Runoff from cropland, fertilizers, and pesticides were perceived as causes of pollution by a slightly fewer farmers.

Crop production is practiced on 63% of farmland covered by the survey. Approximately 57 percent of farmland is owned by farmers and 55 percent of the farmers have conservation plans for their lands. Approximately 67 percent of the farmers in the Chesapeake Bay basin raise beef cattle. Accordingly 70 percent of the respondents grow some type of hay. Corn, small grains and soybeans are the other predominant crops grown in the Chesapeake Bay basin. Other commodities such as peanuts, tobacco, poultry, and swine are commonly produced in certain portions of the basin, but are not significant in the basin as a whole. Not surprisingly, the most common commodities indicated as a major source of income were beef cattle, hay, corn, small grains, and soybeans.

Overall, 81 percent of the farmers implemented a BMP; 31 percent implemented a BMP

with cost-share funds; and 75 percent adopted a BMP without cost-share assistance. The major BMPs implemented on a cost-share basis were hayland or pasture management, permanent vegetative cover, grassed waterways, cover crops, and surface soil sampling/analysis. The predominant BMPs implemented without the use of cost-share funds were hayland or pasture management, conservation or reduced tillage, cover crops, surface soil sampling/analysis, permanent vegetative cover, and field scouting. The major information sources used by farmers in learning about BMPs are farm magazines, extension agents/specialists, ASCS, and NRCS offices. An average of 5 information sources were indicated by farmers who obtained information on BMPs.

Several regression models were developed to determine the influence of farming characteristics, personal characteristics, including water quality concerns, farming considerations, and information sources on a farmer's decision to implement BMPs. Factors that were prominent in a farmer's decision to implement new BMPs, as well as several opinion statements regarding water quality problems and pollution control were also included in these models. The number of cost-share BMPs implemented, the number of non-cost-share BMPs implemented, and the number of BMPs implemented regardless of the funding source were used as dependent variables. The factors proved significant for all three dependent variables were farm size, having a farm conservation plan, membership in farm organizations, perceived pollution from cropland, and their farm's contribution to water quality problems. The DSWC Districts and NRCS were the only

sources of information significant for each dependent variable. Availability of technical assistance, decreasing production costs, and trying new crops were significant farming considerations in predicting the number of BMPs implemented. Therefore, those farmers more aware and concerned with pollution that received adequate information on BMPs were more likely to implement a BMP, regardless of the funding source. The farmers who were willing to try new crops were also more likely to experiment with conservation techniques and thus, implement BMPs. Economic considerations also factor played important roles in the farmer's decision to implement BMPs.

The major factors from each of these models were combined into a single model for the cost-share index, the non-cost-share index, and the any BMP (cost-share plus non-cost-share) index to determine which factors interactively influence a farmers decision to implement BMPs. A seven parameter model was developed for the cost-share BMPs implemented. The availability of cost-share funds, having a farm conservation plan, and farm size were the three most important factors when predicting cost-share BMP implementation. An eight parameter model was constructed for the non-cost-share BMPs. The major factors in this model were production of corn, soybeans, or small grains and farm size. A ten parameter model was developed to predict the implementation of a BMP, regardless of the funding source. This model was similar to the non-cost-share model, as farm size and production of corn, soybeans, or small grains, production, and conservation ethic were the most important factors. The models

developed for the non-cost-share and any BMPs have a large enough coefficients of determination to be considered good models for predicting BMP implementation.

The adoption of a conservation plan was one of the major factors influencing the use of BMPs. Of the 55 percent of the farmers that had a conservation plan, 42 percent implemented a BMP with cost-share funds, 84 percent implemented a BMP on a non-cost-share basis, and 91 percent implemented a BMP, regardless of the funding source. Whereas, of the 45 percent of the farmers that did not have a conservation plan, only 15 percent implemented a BMP on a cost-share basis, 60 percent implemented a non-cost-share BMP on a non-cost-share basis, and 64 percent implemented any BMP. Regression models similar to those developed for the entire sample population were used to determine the significant factors influencing farmers to implement the three types of BMPs discussed, however the farmers who had a farm conservation plan were separated from those farmers that did not have a conservation plan. For the farmers with a conservation plan, farm size, production of beef cattle, horses, or sheep, the farm's contribution to water quality problems, NRCS, and the statement "the government should help by paying more for water pollution control on farms" were significant for each of the dependent variables. Those variables that were significant for the three dependent variables of farmers without a conservation plan were membership in farm organizations, trying new crops, and availability of technical assistance. In general, the factors significant for the implementation of any BMP were also significant in the non-cost-share

BMP index models, regardless of the adoption of a conservation plan.

Comparisons of the survey results of crop production with those from the VDACS database indicated that the sample population used in the survey accurately represented the farming population in the Chesapeake Bay basin. In addition, the survey results compared favorably with the VDACS-VASS data on the amount of cropland and pasture land in the Chesapeake Bay basin. In many cases the results of the survey on cost-share BMP levels in various DSWC Field Office areas and the Chesapeake Bay basin were accurate when compared to the DSWC and NRCS databases. There were discrepancies between the different data sources and some inconsistency in the representation of the BMP implementation data. This precluded a complete verification of the survey results, and a direct comparison of some of the survey results and other data sources was not possible. Based on the results presented, it could be concluded that the statistical sample surveyed, favorably represented the entire farming population in the Chesapeake Bay basin. The survey results also compared favorably with those reported by the various databases for several BMPs, although discrepancies were observed for some other BMPs.

Based on the survey results and the results of the verification, one may conclude that the survey accurately represents the farming population of the Chesapeake Bay basin. The survey results also give adequate proof that non-cost-share BMPs are being implemented in the Chesapeake Bay basin. Seventy-five percent of the farmers implemented a BMP

without cost-share assistance, whereas only 31 percent implemented a BMP with cost-share assistance. On the average, a farmer implemented 4 non-cost-share BMPs for every cost-shared BMP in the Chesapeake Bay basin. The farmers most likely to implement BMPs without cost-share assistance are those that produce corn, small grains, or soybeans; have a large farm; are younger; feel that conservation ethic is an important consideration in adopting a BMP; indicate farm magazines and pesticide and fertilizer dealers as sources of information on BMPs; disagree with the statement "the best way to control pollution is through the enforcement of strict regulations"; and feel that decreasing production costs is an important consideration for their farm operation. The adoption of a conservation plan is also an important factor in the implementation of non-cost-share BMPs. Farm operators in the Chesapeake Bay basin, in general, are concerned with pollution in the Chesapeake Bay, but do not perceive agricultural practices as a major cause of water pollution.

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Appendix A:

Copy of the Survey

DCR
Department of Conservation & Recreation
CONSERVING VIRGINIA'S NATURAL AND RECREATIONAL RESOURCES

FARM BUREAU VIRGINIA

Dear Farm Operator:

The Virginia Department of Conservation and Recreation's soil and water conservation division has contracted with the Virginia Tech Department of Agricultural Engineering and Radford University to conduct a survey regarding the agricultural community's efforts to install and maintain best management practices (BMPs). State and federal agencies promote these practices through cost-share funds, while conducting educational and technical assistance programs. Participation in these kinds of programs is easily documented. However, we believe that the voluntary conservation efforts of farmers are not as well documented. You, and some 6,000 farmers, were **chosen at random** to represent Virginia's agricultural community through participation in this survey.

Virginia Farm Bureau believes that farmers have done much more for water quality than they are given credit for. Your help in promptly completing and returning this survey is greatly needed to credit the farm community's conservation efforts.

The results of this study will help us project the extent of voluntary BMP efforts and help improve the effectiveness of Virginia's educational and technical assistance programs. The survey has been designed to be used at a county level; therefore, please answer the following questions regarding your farming operations in the county specified on page 1 of the survey.

The questions we have will take about 20-30 minutes to answer. **All the information you give will be treated confidentially**. Upon completing the survey, please return it in the enclosed postage-paid envelope. Your contribution to the success of this survey is greatly appreciated and will help us ensure the conservation efforts of Virginia farmers are fully recognized.

Thank you very much for your help with this survey. If you have any questions regarding this survey, please contact Mr. Phillip McClellan of Virginia Tech at (703) 231-7602.

Sincerely,

Jack E. Frye

Jack E. Frye, Director
DCR soil and water conservation division

C. Wayne Ashworth

C. Wayne Ashworth, President
Virginia Farm Bureau

enclosures

PLEASE ANSWER THE FOLLOWING QUESTIONS REGARDING YOUR FARMING OPERATIONS IN:
(Even if you have farming operations in other counties as well.)

1. How serious a problem do you think water pollution is in this County?

   Not a problem _____
   Somewhat of a problem _____
   Serious problem _____
   Do not know _____

2. What do you think are the major causes of water pollution in this County?

	(Please circle one for each item) Serious Cause	Moderate Cause	Minor Cause	Not a Cause
a. City or town sewer systems	SER	MOD	MIN	NOT
b. Fertilizers (nutrients)	SER	MOD	MIN	NOT
c. Home and garden chemicals	SER	MOD	MIN	NOT
d. Household septic systems	SER	MOD	MIN	NOT
e. Industrial waste/factory discharge	SER	MOD	MIN	NOT
f. Litter or garbage	SER	MOD	MIN	NOT
g. Livestock/animal waste (manure)	SER	MOD	MIN	NOT
h. Logging or timber harvest	SER	MOD	MIN	NOT
i. Mining	SER	MOD	MIN	NOT
j. Pesticides--insecticides/herbicides	SER	MOD	MIN	NOT
k. Runoff from cropland	SER	MOD	MIN	NOT
l. Runoff from urban or paved areas	SER	MOD	MIN	NOT
m. Other, Please specify:_____	SER	MOD	MIN	NOT

3. Do you believe your farm contributes to water quality problems?

   Does **not** contribute _____
   Contributes a small amount _____
   Contributes significantly _____
   Do not know _____

4. How concerned are **you** about pollution in the Chesapeake Bay?

   Very concerned _____
   Somewhat concerned _____
   Not concerned _____
   Do not know _____

5. Please tell us how important the following considerations are for your farm operation.

	(please circle one for each item) Very Important	Somewhat Important	Not Important
a. Increasing yield	VI	SI	NI
b. Decreasing production costs	VI	SI	NI
c. Trying new crops	VI	SI	NI
d. Reducing fertilizer use	VI	SI	NI
e. Reducing pesticide use	VI	SI	NI
e. Access to markets	VI	SI	NI
f. Credit	VI	SI	NI
g. Complying with government regulations	VI	SI	NI
h. Avoiding regulatory programs	VI	SI	NI
j. Other, Please specify: _____	VI	SI	NI

VT/002/0994/6M/951136

6. In 1993, how many acres did you farm? _____ Total
Of that, how many acres do you own? _____ Owned
and how many were rented? _____ Rented

7. Do you have a farm conservation plan? (Circle one) Yes No

If yes, what agency prepared the plan? _____

8. What commodities do you produce on your farm(s)? How much of each commodity do you raise? Please check which are your **primary** sources of income in 1993.

	Livestock (numbers)	Primary Sources of income (check no more than 4 from the entire column)
a. Aquaculture (pounds of fish produced)	_____	_____
b. Beef Cattle	_____	_____
c.. Dairy Cattle (Total milked herd)	_____	_____
d. Horses	_____	_____
e. Poultry (Birds annually)	_____	_____
f. Sheep	_____	_____
g. Swine	_____	_____
h. Other livestock, Specify:_____	_____	_____
	Crops (acres)	
i. Alfalfa	_____	_____
j. Other Hay	_____	_____
k. Corn	_____	_____
l. Cotton	_____	_____
m. Fruits, orchards and vineyards	_____	_____
n. Peanuts	_____	_____
o. Small grains	_____	_____
p. Soybeans	_____	_____
q. Tobacco	_____	_____
r. Vegetables	_____	_____
s. Other crops, Specify:_____	_____	_____

9. If you indicated any of the crops in question #8, approximately how much of your cropland has a slope greater than five percent (5%)?

_____ acres

+ 10a. Indicate whether or not you are currently using any of the practices listed below? If so, would you indicate whether these practices are being implemented on a cost-share basis or on a non-cost-share (voluntary) basis and the number of acres on which they are practiced.

(please mark any aplicable columns for each practice)

	On a Cost-Share Basis (acres)	On a Non-Cost-Share Basis (acres)	Practice Never Used or Not Applicable
a. Biological pest controls	_____	_____	_____
b. Contour strip-cropping	_____	_____	_____
c. Conservation or reduced tillage	_____	_____	_____
d. Cover crops	_____	_____	_____
e. Field scouting -- insects, disease, weeds	_____	_____	_____
f. Grasses or legumes in rotation	_____	_____	_____
g. Hayland or pasture planting and management	_____	_____	_____
h. Irrigation improvement	_____	_____	_____
i. Permanent vegetation cover	_____	_____	_____
j. Rotational grazing	_____	_____	_____
k. Split fertilizer applications	_____	_____	_____
l. Tissue analysis	_____	_____	_____

10b. For each of the following indicate whether you are participating in these practices on a cost-share or non-cost-share (voluntary) basis. Where applicable and if possible, please give any information corresponding to the units following each item.

	On a Cost-Share Basis (number or size of field affected)	On a Non-Cost-Share Basis (number or size of field affected)	Never Used or Not Applicable
m. Animal waste sampling/analysis	_____ # times/year	_____ # times/year	_____
n. Number of animal waste storage facilities (minimum 90 days storage)	_____ # of facilities	_____ # of facilities	_____
o. Deep soil sampling/analysis (greater than one foot depth)	_____ samples/acre	_____ samples/acre	_____
p Diversions	_____ acres affected*	_____ acres affected*	_____
q. Filter or buffer strips	_____ acres affected*	_____ acres affected*	_____
r. Grass waterways	_____ acres affected*	_____ acres affected*	_____
s. Sediment traps or basins	_____ acres affected*	_____ acres affected*	_____
t. Number of sprayer calibration checks	_____ checks/year	_____ checks/year	_____
u. Stream protection or fencing	_____ feet of fencing	_____ feet of fencing	_____
v. Surface soil sampling/analysis	_____ samples/acre	_____ samples/acre	_____
w. Terraces	_____ acres affected*	_____ acres affected*	_____

* Acres affected means the total land area impacted by a BMP -- not the size of the management practice.

11. How satisfied have you been with these practices? Do you plan to continue using these practices?

	(Please circle one for each practice) Very Satis-fied	Somewhat Satis-fied	Not Satis-fied	Never Used	(Please circle either yes or no where applicable) Do you Plan to Continue?	
a. Biological pest controls	VS	SS	NS	NU	YES	NO
b. Contour strip-cropping	VS	SS	NS	NU	YES	NO
c. Conservation or reduced tillage	VS	SS	NS	NU	YES	NO
d. Cover crops	VS	SS	NS	NU	YES	NO
e. Field scouting -- disease, insects, weeds	VS	SS	NS	NU	YES	NO
f. Grasses or legumes in rotation	VS	SS	NS	NU	YES	NO
g. Hayland or pasture planting and management	VS	SS	NS	NU	YES	NO
h. Irrigation improvement	VS	SS	NS	NU	YES	NO
i. Permanent vegetated cover	VS	SS	NS	NU	YES	NO
j. Rotational grazing	VS	SS	NS	NU	YES	NO
k. Split fertilizer applications	VS	SS	NS	NU	YES	NO
l. Tissue analysis	VS	SS	NS	NU	YES	NO
m. Animal waste sampling/analysis	VS	SS	NS	NU	YES	NO
n. Animal waste storage facility -- minimum 90 days storage	VS	SS	NS	NU	YES	NO
o. Deep soil sampling/analysis	VS	SS	NS	NU	YES	NO
p. Diversions	VS	SS	NS	NU	YES	NO
q. Filter or buffer strips	VS	SS	NS	NU	YES	NO
r. Grassed waterways	VS	SS	NS	NU	YES	NO
s. Sediment traps or basins	VS	SS	NS	NU	YES	NO
t. Sprayer calibration checks	VS	SS	NS	NU	YES	NO
u. Stream protection or fencing	VS	SS	NS	NU	YES	NO
v. Surface soil sampling/analysis	VS	SS	NS	NU	YES	NO
w. Terraces	VS	SS	NS	NU	YES	NO

FOR THE NEXT SEVERAL QUESTIONS,
PLEASE REFER TO THE PRACTICES LISTED IN QUESTION #11

12. How important were the following considerations in your decision to use any of the practices listed in question #11?

(Please circle one for each item)

	Very Important	Somewhat Important	Not Important
a. Assistance and encouragement from farm organizations	VI	SI	NI
b. Assistance and encouragement from government	VI	SI	NI
c. Assistance and encouragement from other farm operators	VI	SI	NI
d. Availability of cost-share funds	VI	SI	NI
e. Concern for effects on water pollution	VI	SI	NI
f. Concern for future pollution regulations	VI	SI	NI
g. Conservation ethic/right thing to do	VI	SI	NI
h. Demonstrations or meetings sponsored by Virginia BMP program	VI	SI	NI
i. Increased farm production	VI	SI	NI
j. Regulatory compliance	VI	SI	NI
k. Other? Please specify: _____	VI	SI	NI

13a. Where did you learn about the practices listed in question #11?
(PLEASE CIRCLE ALL LETTERS THAT APPLY)

a. Conferences
b. Extension agents/specialists
c. Extension bulletins
d. Field trips
e. Exhibitions or Fairs
f. Farm magazines
g. Meetings or workshops
h. Newspapers
i. Nutrient Management Specialists
j. Other farm operators
k. Pesticide or fertilizer dealers
l. Private Consultants
m. Radio
n. Television
o. Tours or demonstrations
p. Virginia Farm Bureau
q. Virginia Soil & Water Conservation District
r. U. S. Agricultural Stabilization & Conservation Service (ASCS)
s. U. S. Soil Conservation Service (SCS)
t. Other sources; Please specify: _____

13b. Please list which, if any, of the above have given you technical assistance implementing these practices.

_____

_____

14. Approximately, what percentage of your annual operating costs go to financing the practices listed in question #11?

_____ percent

15. Could you estimate the overall effect of using the practices listed in question #11 on your **crop yield or animal production**?

(Please check one for each column)

	Effect on Crop Yield	Effect on Animal Production
Increase	_____	_____
No change	_____	_____
Decrease	_____	_____

16. As a result of using the practices listed in question #11, has your **net farm income**:

Increased
If so, by approximately what percentage? _____ %
Remained about the same _____
Decreased
If so, by approximately what percentage? _____ %
Don't know _____

17. In using the practices listed in question #11 has the number of people you hire:

	At peak Season (check one)	On Average (check one)
Increased substantially	_____	_____
Increased moderately	_____	_____
Increased slightly	_____	_____
Decreased	_____	_____
Remains about the same	_____	_____
Don't use any of these practices	_____	_____

18. In your opinion, what effect have the practices you have implemented (listed in question #11) had on:

(Please circle one for each)

	Positive Effect	No Effect	Negative Effect
a. Surface water quality in your area	PE	NE	NEG
b. Ground water quality in your area	PE	NE	NEG
c. Your knowledge about water quality	PE	NE	NEG

19. How important would each of the following factors be in helping you decide whether to use a new practice to help protect water quality?

(Please circle one column for each)

	Very Important	Somewhat Important	Not Important
a. Availability of government cost-sharing	VI	SI	NI
b. Availability of technical assistance	VI	SI	NI
c. Cost of the practice	VI	SI	NI
d. Difficulty of implementation	VI	SI	NI
e. Effects of the practice on profits	VI	SI	NI
f. Experience of other farm operators	VI	SI	NI
g. Information from farm agribusinesses	VI	SI	NI
h. Information from government agencies	VI	SI	NI
i. Labor or time required	VI	SI	NI
j. Potential to improve water quality	VI	SI	NI
k. Tax credits	VI	SI	NI
l. Other? Please specify: _____	VI	SI	NI

20. Please read the statements below and indicate whether you agree or disagree with them.

	(Please circle one for each statement)				
	Strongly Agree	**Somewhat Agree**	**Somewhat Disagree**	**Strongly Disagree**	**Don't Know**
a. Farm practices that protect water quality usually require more labor.	STA	SMA	SMD	STD	DK
b. The best way to control pollution is through the enforcement of strict regulations.	STA	SMA	SMD	STD	DK
c. The government should help by paying more for water pollution control on farms.	STA	SMA	SMD	STD	DK
d. Farm operators do not have the right to farm in ways that damage water quality.	STA	SMA	SMD	STD	DK
e. Farm practices that protect water quality mean lower profits.	STA	SMA	SMD	STD	DK
f. Water pollution can best be controlled through educational programs that encourage farm operators to use **B**est **M**anagment **P**ractices (BMPs).	STA	SMA	SMD	STD	DK

21a. If you **have participated** in implementing BMPS on a **cost share basis**, would you continue to install these practices without cost assistance? **GO TO QUESTION #21b IF YOU <u>HAVE NOT</u> IMPLEMENTED ANY OF THESE BMPs**.

Yes _____; If yes, please check the **four** most important reasons.

a) If required by law _____
b) To reduce production costs _____
c) To increase productivity _____
d) To improve soil and water quality _____
e) To correct an agricultural pollution problem _____
f) It is the environmentally correct thing to do _____
g) Other, please specify:_____

No _____; If no, please check the **four** most important reasons.

a) Don't have the financial resources _____
b) The government should pay for pollution control _____
c) No contractor to implement BMPs _____
d) Farm has short term lease _____
e) Don't need BMPs on farm _____
f) Others, please specify:_____ _____

21b. If you **have not participated** in implementing BMPs, please check up to 5 reasons as to why you have not. **SKIP THIS QUESTION IF YOU ANSWERED QUESTION #21a.**

a) BMPs are too costly, even with cost-share _____
b) Cost-share payments are too low _____
c) Cost-share regulations are too strict _____
d) Don't have a problem _____
e) Don't want to receive government subsidies _____
f) Farm has a short-term lease _____
g) My operation is too small _____
h) Payback time is too long _____
i) Practice designs are too rigid _____
j) Too much paperwork or red tape _____
k) Others, please specify: _____

22. What is the likelihood that you will adopt additional or begin to implement new BMPs?

	(Please circle one column for each)		
	Very Likely	**Somewhat Likely**	**Not Likely**
a) With current cost-share level	VL	SL	NL
b) With higher cost-share level	VL	SL	NL
c) With lower cost-share level	VL	SL	NL
d) With relaxed cost-share regulations	VL	SL	NL
e) With shorter period for cost-share payment	VL	SL	NL
f) If regulations require them	VL	SL	NL

23. What ideas or suggestions do you have about ways in which the Virginia Agricultural BMP cost-share program can be improved?

_____

_____

_____

Now we have a few questions about you and your farm operation. Most of these questions are the same as those used on the Farm Census. All of the information you give will be treated confidentially.

24. How many years have you farmed? _____ Years

25. In what year were you born? _____

26. Do you live on your farm? (Circle one) YES NO

27. How likely is it that any of your children or grandchildren will operate your farm in the future?

Very likely _____
Somewhat likely _____
Somewhat unlikely _____
Very unlikely _____
No children _____

28. In 1993, did you and your spouse have an **off-farm** job?

	You (Check one)	**Your spouse** (Check one)
Yes, part-time	_____	_____
Yes, full-time	_____	_____
No	_____	_____
Not married		_____

29. In 1993, approximately what percent of your net family income was from farm and what percentage, if any, was from other sources? **(TOTAL MUST BE 100%)**

Farm _____
Other _____
Total = 100%

30. What is the number of full-time or part-time employees you hired at the peak season of 1993?

Full-time _____
Part-time _____
Total _____

31. Is labor supply or management a problem for you?

Not a problem ____
Somewhat a problem ____
A serious problem ____

32. Do you or your family members belong to any farm or environmental organizations? List all the farm and environmental groups and organizations in which either you or someone in your immediate family are members.

1. _____
2. _____
3. _____
4. _____
5. _____

33. What is the highest level of educaion you have completed? (Check one)

One to sixth grade ____
Seventh to eleventh grade ____
High school graduate (diploma/GED) ____
Associate degree ____
Some college, no degree ____
Bachelor's (BA, BS, AB) ____
Some graduate school, no advanced degree ____
Advanced degree ____

34. Are you:

White ____
African American (Black) ____
Asian ____
Spanish origin ____
Other? Please Specify: _____

35. What is your gender? (Circle one) Male Female

Thank you for your help and cooperation with our survey. Please return the survey in the enclosed postage-paid return envelope to:

Virginia Tech
Assessment of Virginia's Agricultural Practices
Room 307 Seitz Hall
P.O. Box 850
Blacksburg, VA 24063-9959