# Cleaner Water in the Chesapeake Bay: Can CRP Help?

## *A Case Study of the Conservation Reserve Program in Richmond County, Virginia 1985-1989*

by

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# CLEANER WATER IN THE CHESAPEAKE BAY: CAN THE CRP HELP?

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**(ABSTRACT)**

The paper examines the 1985 Farm Bill-version of the Conservation Reserve Program (CRP) as a potential water-quality improvement tool in the Chesapeake Bay region of Virginia. Participation levels, bidding behavior, land use options and other conditions in Richmond county, a predominantly agricultural county in Virginia's Northern Neck region, were analyzed. The following conclusions were drawn:

1) Increases in the maximum acceptable rental rates (MARRs), and possibly increased awareness of the program's costs and benefits, appear to have gradually increased participation and acres enrolled. However, overall enrollment was still low.

2) Because crop production is profitable and other land-use options are limited, many farmers in the county may have preferred to continue farming most of their acres rather than placing them in CRP. The net present value of returns to crop production for average-yielding and marginal acres were higher than those from CRP enrollment.

3) Farmers in Richmond county could have received additional income from their CRP land by planting trees because of suitable growing conditions and markets and(or) by leasing hunting rights for their CRP acres because of high demand for hunting land. However, few participants took advantage of these options.

4) The low number of acres in Richmond county that were planted in trees will limit the length of time water-quality benefits will be accrued. To obtain maximum benefits

from acres enrolled in Richmond county, acres should have been targeted for enrollment on the basis of their contributions to water-quality degradation.

5) Accepted bids in Richmond county nearly matched the county's maximum acceptable rental rate (MARR), indicating that at least some farmers were aware or became aware of the MARR. This bidding behavior may imply that the $50, $61, and $70 per acre per year rents were sufficient to encourage at least some of the county's farmers to enroll a portion of their cropland acres. However, the low overall enrollment in the county may indicate that most farmers were not aware of the MARR and did not have enough information to make a decision, or, for those who were aware of the MARR, that the rental rates offered did not adequately cover the opportunity costs.

6) More water quality benefits could have been derived if more farmers had enrolled filter strips. Low enrollment in this option and the fact that no farmers in Richmond county enrolled in it when additional financial incentives were offered may indicate that the opportunity costs of enrolling this land are high.

8) The federal and state cost-share programs may improve farmers' treatment of their non-CRP acres and prevent them from intensifying production on those acres. On the other hand, these programs may have given farmers another route for meeting conservation compliance standards.

9) There is little incentive for Richmond county farmers to maintain their CRP acres in grass cover after their contracts expire. Few farmers in the county have livestock and opportunities to sell hay appear to be limited.

10) Participation and water-quality benefits could have been increased if a marketing program had been targeted at eligible landowners, especially those with acreage eligible for the filter-strip program or those with an interest in producing timber.

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This paper is dedicated to the memory of my grandfathers, Marcus Craig and Henry Ligon. Their love for the land and respect for the life it provided their families inspired two generations of agriculturalists. Even today, their legacy is a source of pride and inspiration for us all.

"The selfsame moment I could pray;
And from my neck so free
The Albatross fell off, and sank
Like lead into the sea."

from *The Rime of the Ancient Mariner*
by Samuel Taylor Coleridge

"That would have been the easy way,
but it wouldn't have been the cowboy way."

"Too Slim" of Riders in the Sky

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## WATER QUALITY BENEFITS: THE PROMISE OF THE CONSERVATION RESERVE

Nonpoint-source pollution is a continuing problem in the Chesapeake Bay. In an average year, pollutants from nonpoint sources in the Bay Basin contribute 67 percent of the total nitrogen loading and 39 percent of the total phosphorous loading to the Bay (USEPA, 1983). Nonpoint-source pollutants can affect the balance of aquatic life and interfere with navigation and recreational uses (Lovejoy, Lee, and Beasley, 1985; Young and Osborn, 1990).

Virginia is one of 24 states where nonpoint-source pollution has been ranked as a "major problem" (USEPA, 1985). The state is part of the Bay watershed, which drains a 64,000 square-mile area that also covers New York, Pennsylvania, Maryland, West Virginia, Delaware, and Washington, DC. Five major tributaries in the watershed-- the James, Potomac, Susquehanna, Rappahannock, and York rivers -- supply 90 percent of the bay's fresh water (Chesapeake Executive Council, 1987).

Agriculture is not the only industry that generates nonpoint source pollutants; forestry, mining, and construction can also contribute to the problem, as do golf courses, residences and other sources in urban areas (Hansen, Babcock, and Clark, 1988). However, there are indications that nonpoint-source pollutants from cropland are major contributors to ecological degradation in the Chesapeake Bay. In an average year, pollutants from cropland make up approximately 40 percent of the total nitrogen loading and 10 percent of the total phosphorus loading in the Bay (USEPA, 1983). An

estimated 37 percent of the land in the Bay watershed is devoted to agriculture (Chesapeake Executive Council, 1987).

Pollutants from farmland reach water supplies in one of two ways. As sediment washes from farmland into waterways, it often carries with it materials such as nutrients, salts, organic matter, pesticides, and pathogens. These materials can also leach through the soil into groundwater supplies (Hansen, Babcock, and Clark, 1988).

Whatever the source, nonpoint-source pollution is a costly problem. Estimates from the U.S. Department of Agriculture's (USDA) Economic Research Service indicate that, nationwide, the yearly cost of damage from all sources to surface water quality is between $5 billion and $18 billion (USGAO, 1989). A study by the Conservation Foundation estimated the direct and indirect damages to surface water quality from cropland erosion may be $3.1 billion each year (Clark, Havercamp and Chapman, 1985).

As a result of growing concern for water quality and the costs associated with cleaning up the nation's waterways, new programs have been developed at the state and regional level to address the water quality problems in the bay. At the national level, water quality goals have been incorporated into agricultural legislation to control nonpoint-source pollution from agricultural sources.

## THE CONSERVATION RESERVE IS A POTENTIAL WATER-QUALITY TOOL

The 1985 Farm Bill established a set of conservation programs aimed at an array of farm and environmental problems including the effects of agricultural nonpoint-source pollutants on the quality of the nation's waterways such as the Chesapeake Bay. This initiative included the Conservation Reserve Program (CRP), a voluntary program that offers farmers an annual rental per-acre payment to remove highly erodible

cropland from production for at least 10 years.[1] The national goal was to enroll 40 to 45 million acres into the program by 1990 (Osborn, Llacuna, and Linsenbigler, 1990).

CRP has the potential to enhance the water-quality programs being carried out in the Chesapeake Bay. This potential comes from several features of the program's design and implementation.

Landowners who enroll in CRP enter into a contract with USDA and agree to refrain from growing crops on the land they place in the program for 10 years. The land must be planted in vegetative cover, such as introduced species of grasses and legumes, trees, permanent wildlife habitat, field windbreaks, and shallow-water areas for wildlife. Filter strips next to waterways may also be enrolled.

These program criteria and characteristics have potential benefits for water quality in three ways:

- By planting erodible land in cover crops that anchor the soil, erosion is reduced.
- Use of fertilizers and agricultural chemicals is decreased or eliminated since the land is not being cropped.
- CRP land that borders waterways can trap sediment and prevent the chemicals and fertilizers from being carried into the waterways (Gianessi, Peskin, Crosson, and Puffer, 1986).

It has been predicted that, if all eligible acres were enrolled, CRP could reduce soil erosion in the United States by approximately 574 million tons annually and would reduce the amount of fertilizers and chemicals that run into waterways by about 5 percent (USGAO, 1989). If the 45 million-acre target for CRP is reached, the surface-water quality benefits are predicted to total $3.6 billion over the 10-year contract period (USGAO, 1989).

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[1] CRP was re-designed under the 1990 Farm Bill. Bidding procedures and enrollment criteria were modified to stimulate enrollment in environmentally sensitive watersheds. The implications of these changes will be discussed in Chapter 4. The discussion in chapters 1 through 3 focuses on the 1985-version of the program.

Land-diversion programs like CRP may be particularly beneficial in the Bay watershed. In a study of groundwater protection strategies in Richmond county, Virginia, Diebel (1990) concluded that land retirement policies were the only policies that significantly reduced chemical, nitrogen, and soil contributions to water.

## CONFLICTING CRP GOALS MAY REDUCE WATER-QUALITY BENEFITS

One factor that may affect CRP's ability to address water quality problems is the conflicting goals that influenced the program's design. As is typical of many farm programs, CRP legislation was formed by compromises made to meet the goals of different interest groups. Taff (1989) noted that, at the time CRP was formed, two perceptions about agriculture were dominant: 1) surplus commodity stocks needed to be reduced to raise prices and 2) pollutants from agricultural production were having a negative impact on the environment.

The push for CRP's inclusion in the 1985 Farm Bill came from organizations not directly tied to agriculture, including the National Audubon Society and the Sierra Club, and from agricultural conservation groups, including the American Farmland Trust, the National Association of Conservation Districts, and the Soil Conservation Society (Esseks and Kraft, 1987). The interests of these groups, as well as traditional farm organizations involved in the policy-making process, were all addressed in the design and implementation of the 1985-version of CRP.

As a result of multiple goal-setting and tradeoffs, CRP became an instrument for pursuing several goals that were not necessarily consistent. The program was intended to:

- Reduce acreage and thus reduce supplies of certain commodities.
- Reduce base acreage and thus reduce commodity program payments.

- Contribute to improved groundwater and surface-water quality.
- Provide supplementary income for farm families.
- Protect long-term soil productivity by reducing soil erosion.
- Create new wildlife habitats (USDA, 1989; Reichelderfer and Boggess, 1988).

This multiple goal-setting and comprise approach to policy formation also occurred in the 1990 Farm Bill legislation. Representative Kika de la Garza commented that the 1990 Farm Bill ". . . would not have been possible without cooperation and support of leading agricultural groups and environmental organizations that helped us reach a compromise on key elements of the title" (Committee on Agriculture, 1990).

Performance of programs like CRP greatly depends on how they are implemented. USDA was given "broad discretionary powers" to implement CRP (Dicks and Grano, 1987). Charged with directing a program with so many conflicting goals, USDA officials had to create their own agenda. Evidently, water quality benefits were de-emphasized in USDA's struggle to meet enrollment and soil productivity goals. CRP was closely scrutinized by the U.S. Government Accounting Office (USGAO) because of the high cost of implementing it in a time of increasing efforts to reduce the federal budget deficit. In GAO's review of CRP, USDA was chastised for not specifically addressing water quality issues by targeting the appropriate lands for enrollment. GAO accused USDA of treating water quality as a "secondary benefit" or a by-product that resulted from the acres enrolled (USGAO, 1989; p. 22). According to their review, two problems limited CRP's impacts on water quality:

- The incentives to enroll land were greater in areas with wind-caused erosion (rather than water-caused erosion) because maximum

acceptable rental rates[2] (MARRs) in those areas were set higher than local cash rents. With the 45-million-acre cap set on CRP enrollment nationwide, farmers in those areas would probably enroll a larger quantity of their land, thus leaving less available to be enrolled from areas with water-caused erosion.

- Through the 5th CRP sign-up period, eligibility was based on erodibility and not the magnitude of off-site damages. A partial incentive to enroll lands with potentially high off-site damages was introduced in the 6th sign-up period when USDA relaxed the highly erodible land criteria for cropland along streams and waterways.

Problems at the federal level may have influenced CRP's implementation at the state level and further reduced potential water quality benefits for environmentally sensitive watersheds. For states in these watersheds, CRP was an opportunity to use federal dollars to help meet goals of decreasing nonpoint-source pollution by targeting lands with high off-site damages for CRP enrollment (Ogg, 1986). But, at the time CRP was initiated, there were concerns that budget cuts could leave CRP only partially implemented. And, even if CRP were fully funded, the 45-million-acre cap on enrollment would have eventually limited the amount of land that could be enrolled. These concerns may have pushed states into a "let's-hurry-up-and-get-acres-enrolled-before-all-the-federal-money-is-gone" mentality. In a rush to get acres enrolled, states in watersheds like the Chesapeake Bay may not have taken full advantage of CRP's potential water quality benefits by failing to target those acres with the highest off-site damages.

In the Chesapeake Bay region, where concerns over water quality are high, this approach to CRP was apparent, especially during the initial sign-ups when enrollment

[2] Maximum Acceptable Rental Rates (MARRs) were set by USDA for each bidding pool in the United States. Land was tentatively accepted into CRP if a landowner's bid was below or equal to the MARR for the respective pool.

was low. In an article in the Summer 1987 issue of *Chesapeake Citizens Report*, Gardner wrote:

> About 1.5 million acres of highly erodible land lie within the Bay watershed and these lands account for about three quarters of the region's average erosion. Sadly, the federal conservation systems' potential to clean up soil erosion in the Bay is passing us by. The participation rate for Chesapeake Bay farmers is 2.6 percent vs. 23 percent nationwide and as a result more than $375 million in conservation payments may go elsewhere.

## PURPOSE OF THIS STUDY: WHAT BENEFITS CAN BE EXPECTED?

Given the confused goals for CRP at both the state and federal level, what water quality benefits *can* be expected from the lands in the Chesapeake Bay watershed that were enrolled in the 1985-version of the program? According to USDA (1989), the program's ability to improve water quality is a function of six factors:

- Evidence of water-quality problems that can be attributed to agricultural sources.
- The quantity and location of cropland enrolled in CRP.
- Reductions in fertilizer and pesticide use that result from enrollment.
- The sediment-delivery ratio of enrolled acres.
- The type of cover crop planted on enrolled acres.
- The degree of coordination between programs at the state and federal levels to control both point and nonpoint sources.

Using these factors as a guideline, this paper will examine the potential water quality benefits from CRP as it was originally designed and implemented under the 1985 Farm Bill. It will focus on enrollment activity and conditions that existed during the nine program sign-up periods between March 1986 and July/August 1989.

The area of study is Richmond county, Virginia, a predominantly agricultural county located in Virginia's Northern Neck between the Rappahannock and Potomac

rivers, both major tributaries to the Chesapeake Bay (see figure 1.1). Three aspects of the program will be considered: incentives for CRP enrollment, effectiveness of that enrollment, and coordination of CRP with other water-quality programs.

**CRP Enrollment.** If CRP is to be an effective tool for improving water quality in the Chesapeake Bay, it must first provide enough incentives for landowners in the watershed to enroll a significant amount of cropland. Prior to the 1990 Farm Bill, landowners had nine opportunities to enroll land in CRP. Initially, participation in the Chesapeake Bay Basin was low. Over 1.5 million acres of highly erodible land in the watershed would have qualified for CRP. But, by the summer of 1987, only .73 percent of the eligible acres in Maryland, 2.9 percent of those in Virginia, and 3.6 percent of those in Pennsylvania had been enrolled (Gardner, 1987). As of the fifth sign-up period (July 1987), only 17,279 of the 447,402 eligible acres (3.86 percent) in the Chesapeake Bay Basin had been enrolled (Ligon et al., 1988).

Enrollment in Richmond county, Virginia, was typical of this trend: only 447.3 (5.7 percent) of the county's 7,825 eligible acres[3] were enrolled during the first five sign-up periods. Participation levels in Richmond increased during sign-up periods 6 through 9. During those periods, an additional 1,098.1 acres were enrolled. In total, 19.7 percent (1,545.4 acres) of the county's cropland acres were enrolled during the nine sign-up periods. The Agricultural Conservation and Stabilization Service (ASCS) made 80 contracts with 69 farm units[4] (USDA-ASCS, 1990). But, under the 25 percent cap,

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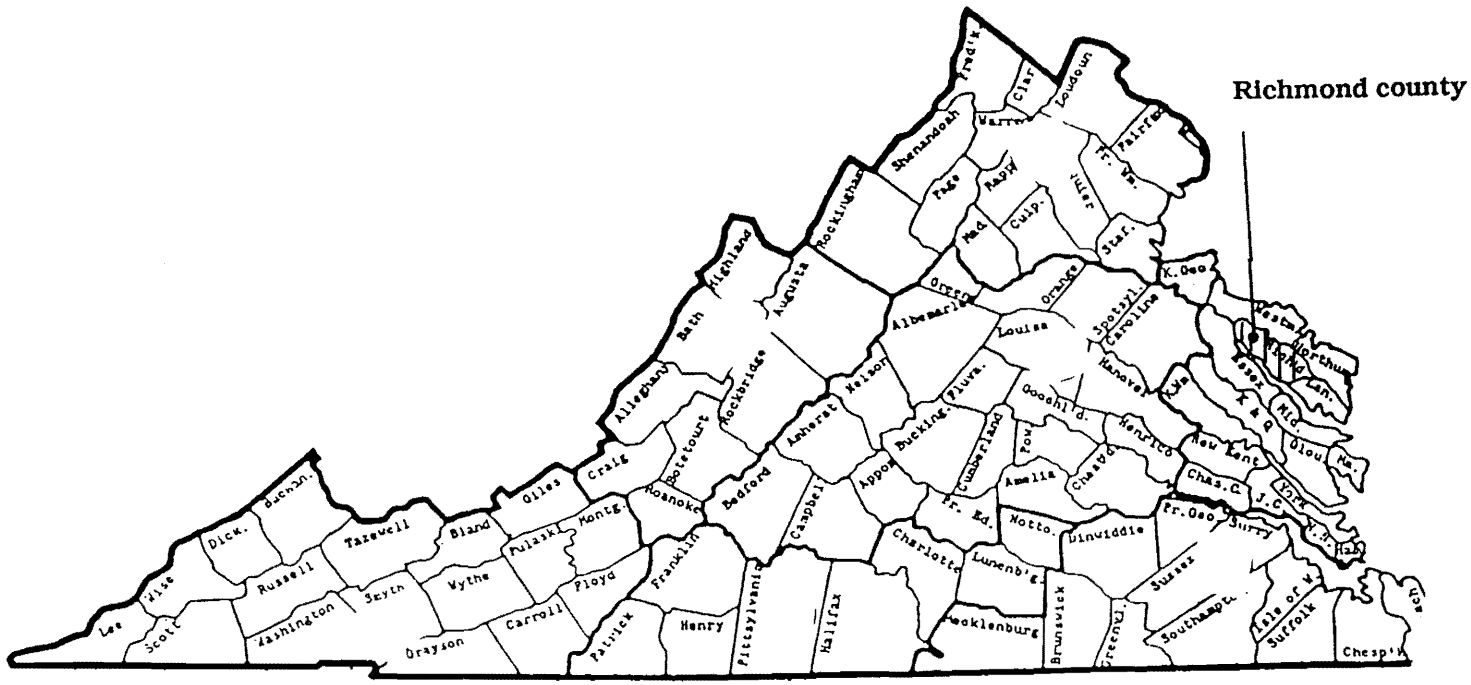
[3] Under CRP rules, no more than 25 percent of a county's total cropland base can be enrolled in CRP. Richmond has 31,000 acres of cropland, which means a maximum of 7,825 acres can be enrolled. Eligible acres refers the amount of land that can be enrolled under the 25% rule and does not indicate the amount of land that would meet erodibility criteria.

[4] CRP contracts were identified by ASCS farm unit numbers. Farms may contain more than one farm unit.




Richmond county is located in northeast Virginia between the Rappahannock and Potomac rivers which drain into the Chesapeake Bay. The Washington, DC, metropolitan area is to the north of the county.

**Figure 1.1 Location of Richmond county, Virginia.**

Richmond still had additional acreage that could have been enrolled in the 1985 Farm Bill- version of CRP, provided the land met erodibility criteria.

To be successful, voluntary programs such as CRP must provide incentives that are congruent with the goals of farmers and landowners and sufficient to compete with other land-use alternatives. From previous studies of CRP, it is evident that opportunity costs have an affect on farmers' decisions to participate. For example, a national survey of CRP participants and non-participants by the American Farmland Trust found that non-participants thought rental rates offered were too low and that high land values, better income from farming, and a desire to keep open their cropping options were these farmers' reasons for not submitting a bid (Esseks and Kraft, 1987).

From their study of a hypothetical filter-strip program, Purvis, Hoehn, and Sorenson (1989) concluded that "opportunity costs, future expectations, and individual preferences are statistically important in explaining participants responses" (p.19). Farmers surveyed in a study of CRP enrollment in five Virginia counties, including Richmond, indicated that their main reason for not submitting a bid was that the rental rates offered were too low. Many farmers also said that they wanted to protect their grain base and other farm program benefits. Most indicated they did not want to tie up future uses of their land (Ligon et al., 1988).

As with other farm programs, CRP design was based on an "typical" image of the nation's farmers. Because of recent changes in southern agriculture, however, the incentives offered under the 1985 Farm Bill-version of CRP may not have meshed with the goals of landowners and farmers in the Chesapeake Bay region.

The structure of U.S. agriculture, particularly in the south, has changed in the last decade. This transition has been fueled by declining commodity prices and land values,

high farm debt loads, new food consumption patterns, and changes in the macroeconomic environment (Molnar, 1986; Madden, 1987; and Babb and Long, 1987).

In Virginia, the traditional view is of medium-sized, independently managed, family-owned farms (Norris and Shabman, 1987). Most of these farms' income is assumed to be from producing cash crops and livestock. These operations are thought to be capital-intensive, and to be high-level users of chemicals and commercial fertilizers. According to Norris and Shabman (1987), this type of operation will continue to be a part of the agricultural sector. However, southern agriculture is moving toward a more bi-modal structure characterized by large, vertically integrated production units and by small "hobby" farms that provide supplemental income for their owners. In addition they note that the production of high-value specialty crops, such as fruits, vegetables, nursery stock and organically grown crops, will grow as an industry to provide for nearby urban markets (Norris and Shabman, 1987; Shabman and Batie, 1987).

As agriculture moves toward this alternative structure, new opportunities develop for farmers, bringing changes in farmers' goals. For example, profit-maximization may not be a goal for hobby farmers who farm only part-time or have substantial off-farm income. Rather, less-intensive farm production as a means of relaxation and increased emphasis on maintaining the amenities of the farm become their goals. Shabman and Batie (1987) note that "[T]hese land owners will be more willing to voluntarily consider moving agricultural production away from waterways draining to the Bay and will be especially interested in incentive payments for buy out of land now in row crops with its' dedication to wooded buffers along waterways." In addition, if maintaining base acreage is no longer a goal for this new generation of farm owners and operators, the base reduction associated with CRP enrollment may not be an important factor in participation. In contrast, the goals of the "franchise farms" may be

dictated by a higher management structure and be highly profit motivated. Such enterprises may not be able to give up land for CRP (Shabman and Batie, 1987).

These changes may also present traditional farmers with new opportunities; for example, to sell off parcels of land for small farmettes, or to franchise and thus remove some of the decision-making functions from their responsibility. Traditional farmers may also be faced with new production options. Urban markets may demand alternative crops, such as vegetables. All of these opportunities may influence farmer's views of CRP as a production option.

**Effectiveness of CRP enrollment.** Even if a large quantity of land in the Chesapeake Bay region is enrolled in CRP, the question is whether the "right" lands -- those contributing to water quality problems -- are being enrolled and treated appropriately. As previously discussed, though, lands contributing to off-site water-quality problems were not specifically targeted for enrollment under the 1985 Farm Bill-version of CRP. However, some of this land could have been enrolled by "accident" and thus water-quality benefits would be derived from their enrollment.

Aside from targeting, some of the factors that determine the effectiveness of CRP enrollment are the potential changes in pesticide and fertilizer use on CRP and non-CRP land, the sediment-delivery ratios[5] of the lands that were enrolled, and the type of cover planted on enrolled lands (USDA, 1989).

By removing land from production, CRP reduces or eliminates fertilizer and chemical use. Thus, the types and amounts of these materials used on CRP land prior to their enrollment may indicate the potential decreases in loadings of these pollutants to

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[5] According to USDA (1989), these ratios indicate the amount of eroding soil and the amount that reaches waterways. The ratio is a function of at least 5 factors: distance to water bodies, watershed channel density, watershed size, soil characteristics, and rainfall intensity.

water bodies. The intensity with which land owners manage their remaining, non-CRP acres may also affect these loadings.

Planting permanent cover on lands with high sediment-delivery ratios and adjacent to waterways is an effective way to reduce loadings of sediment and other pollutants (USDA, 1989). During the 6th CRP sign-up period, USDA allowed filter-strips -- bands of land adjacent to waterways -- to be enrolled in CRP regardless of the land's erosion rate. High levels of participation in the CRP filter strip program would thus enhance the program's water quality potential. Planting trees on CRP land may also increase the program's water quality benefits. With respect to types of cover planted, Smolen et al. (1988) noted that water quality benefits may be maintained for a longer time if trees are the predominant cover.

**Coordination of CRP with other programs.** The degree to which state, regional and federal programs have been coordinated with CRP can influence the quantity and location of acres enrolled and farmers' treatment of their non-CRP acres (Hamilton, 1987-88; Ogg, 1986). The 1985 Farm Bill contained a highly erodible land provision, which established two companion conservation programs for CRP -- conservation compliance and sodbuster. These provisions penalize farmers for producing crops on highly erodible land without a conservation plan and bringing new highly erodible land into production. (See appendix A for a description of these programs.)

Through the 1983 Chesapeake Bay Agreement, a partnership was formed between the Environmental Protection Agency, the Chesapeake Bay Commission, the District of Columbia, Virginia, Maryland, and Pennsylvania to develop comprehensive plans to restore the bay. As part of this agreement, Virginia has established programs to encourage farmers to adopt best management practices (BMPs), which are designed to reduce and control surface runoff of soil, nutrients, and chemicals (Chesapeake

Executive Council, 1987). In addition, the 1972 Clean Water Act was amended in 1987 to require states to initiate programs to control nonpoint-source pollution from all sources (Hansen, Babcock, and Clark, 1988). In Virginia, the State Water Control Board develops and implements plans for controlling all nonpoint sources of pollutants and the Division of Soil and Water Conservation handles the development and implementation of plans for agricultural BMPs (Norris, 1988).

Richmond is one of 23 counties designated for intensive control of sediment runoff from cropland under the Virginia Agricultural BMP Cost-share Program. Cost-sharing is available through this program for establishing filter strips (a practice used to stop pollutants from entering waterways) and other BMPs (Ben Headley, Richmond County SCS, personal communication, July 9, 1990) and for planting trees (Stanley, Haney, Grimm, and Deaton, 1987).

Depending on when these programs were implemented, they could have complemented or restricted CRP enrollment. These programs may also magnify the water quality benefits of CRP by encouraging better management practices on non-CRP acres.

## STUDY OBJECTIVES AND STRUCTURE

The objectives of this paper are:

- To identify and discuss factors influencing Richmond county farmers' decisions to enroll in CRP -- particularly the opportunity costs associated with forgoing other land-use alternatives and farm program benefits, and the characteristics of farmers and their farms that may influence their perception of these costs. (Chapter 2 )
- To assess the potential water quality benefits of the acres enrolled under the 1985 Farm Bill-version of CRP. (Chapter 3)
- To draw conclusions from these two chapters and assess the potential of the 1990 Farm Bill-version of CRP to meet water quality objectives (Chapter 4).

Chapters 2 and 3 will also consider the role of existing federal, regional and state programs that could enhance or interfere with the location and quantity of land enrolled in CRP and influence the magnitude of attained water-quality benefits.

**THE STUDY AREA**

Richmond is one of five counties in the Northern Neck peninsula of Virginia and is bordered on the south by the Rappahannock River (see figure 1.1). Richmond county was selected for study because of its location in the Bay watershed and its large proportion of agricultural land and potentially eligible CRP land. It has also been included in several studies related to groundwater, CRP participation, and low-input agriculture and other conservation issues (including Diebel, 1990; Ligon et al., 1988; Norris, 1988; Hwang, 1990; and others). Thus, descriptive information about the county is available.

Richmond is also representative of the other four counties in the Northern Neck -- King George, Lancaster, Northumberland, and Westmoreland. Analyzing CRP in Richmond should reveal points to consider in other areas of the region.

All five of these counties are fairly similar in terms of land use and the characteristics of their farmers and farms. In these counties, farmland makes up between 22 percent and 48 percent of the total land area (see table 1.1) . Most farms are family owned, average between 223 and 388 acres in size, and produce cash grains. The average ages of farmers in these counties are between 53 and 56. In all counties except King George, farmers that farm as their principle occupation make up over half

**Table 1.1 Land use and farm and farmer characteristics in Virginia's Northern Neck, 1987.**

| Category | King George | Lancaster | Northumberland | Richmond | Westmoreland |
|---|---|---|---|---|---|
| Approximate land area (acres) | 115,244 | 85,043 | 118,105 | 123,334 | 145,049 |
| Percentage of land in farms | 33.1 | 22.0 | 40.8 | 31.7 | 48.4 |
| Number of farms | 141 | 84 | 159 | 148 | 181 |
| Average farm size (acres) | 270 | 223 | 303 | 264 | 388 |
| Average age of farm operators | 54.2 | 53.7 | 56.4 | 54.7 | 54.9 |
| Operators by principle occupation (%): | | | | | |
| -- Farming | 41.13 | 53.57 | 59.75 | 53.38 | 60.22 |
| -- Other | 58.87 | 46.43 | 40.25 | 46.62 | 39.78 |
| Ownership structure of farms(%): | | | | | |
| -- Full owners | 64.54 | 29.67 | 40.25 | 47.30 | 45.30 |
| -- Part owners | 32.62 | 60.71 | 53.46 | 39.86 | 45.86 |
| -- Tenants | 2.84 | 9.52 | 6.29 | 12.84 | 8.84 |
| Years on present farm | 18.8 | 21.0 | 26.3 | 22.8 | 22.1 |
| Type of farm organization (%): | | | | | |
| -Individual or family | 90.1 | 86.9 | 85.53 | 81.76 | 79.56 |
| -- Partnership | 6.38 | 3.57 | 9.43 | 12.16 | 12.15 |

Source: USDC (1989)

Notes: Some statistics were calculated from Census data. The Census data assumes that the number of farm operators is the same as the number of farms.
Organizational types not listed include corporations, trusts, and institutional farms.

of all farmers in each county. Most have been on their farms between 18 and 22 years (USDC, 1989) (see table 1.1).

The traditional structure of agriculture still predominates in Richmond county. The total number of farms reporting declined between 1982 and 1987, falling from 193 to 148 (USDC, 1989). However, in 1987, most farms were still medium-sized (264 acres), increasing from an average size of 225 acres in 1982 (see table 1.2). In 1987, most farmers still resided on the land they operated (74.3 percent), were still farmers by principle occupation (53.4 percent), and produced cash grains (see table 1.1).

Pressure on this traditional structure may be increasing. Compared to other areas in Virginia, counties in the Northern Neck may be subject to urban development because of their close proximity to Washington, DC, and other growing areas such as Fredericksburg, Richmond City, and Norfolk (Richmond County RIS; Gray, Dann, and Vinis, 1988). Of all five counties in the Northern Neck, however, Richmond ranks fourth in terms of developed land (Kelly Liddington, Richmond Extension Service, personal communication, 1989). But, a study by Gray, Dann, and Vinis (1988) predicted that urban and commuter growth in Richmond would grow over the next century as a result of state plans that will develop major highways to Fredericksburg, reducing travel time to Washington, DC. These new highway connections to urban centers may increase the number of people buying homes or weekend cottages in Richmond and other counties in the Northern Neck.The roads could also increase farmers' access to urban markets.

Figures from the 1987 U.S. Census of Agriculture (USDC, 1989) show some signs that agriculture in Richmond is also moving toward an alternative structure. While the number of farms in Richmond that were less than 100 acres in size declined between 1982 and 1987 (from 85 in 1982 to 55 in 1987), the number of farms between 50 and 69

**Table 1.2** **Changes in farmer and farm characteristics, ownership structure, and land use and other selected statistics in Richmond county, Virginia, between 1982 and 1987.**

| Category | 1982 | 1987 |
|---|---|---|
| **Farms, land in farms, and land use** | | |
| Farms (#) | 193 | 148 |
| Land in farms (acres) | 43,355 | 39,091 |
| Average farm size | 225 | 264 |
| Total cropland (acres) | 31,300 (188) | 35,041 (146) |
| Harvested cropland | 30,786 (187) | 22,027 (187) |
| Cropland used only for pasture or grazing | 378 (30) | 962 (28) |
| Other cropland | 136 (21) | 3,406 (69) |
| **Total acres by farm size category** | | |
| 1 to 9 | 26 (10) | 10 (3) |
| 10 to 49 | 1,050 (39) | 680 (25) |
| 50 to 69 | 930 (16) | 1,114 (19) |
| 70 to 99 | 1,669 (20) | 652 (8) |
| 100 to 139 | 2,128 (18) | 1,684 (15) |
| 140 to 179 | 2,095 (13) | 1,936 (13) |
| 180 to 219 | 2,600 (13) | 1,805 (9) |
| 220 to 259 | 726 (3) | 924 (4) |
| 260 to 499 | 14,126 (40) | 13,538 (35) |
| 500 to 999 | 9,209 (14) | 8,004 (12) |
| 1,000 to 1,999 | 8,797 (7) | NA (4) |
| 2,000 acres or more | 0 (0) | NA (1) |
| **Operator Characteristics (total acres)** | | |
| Full owners | 11,711 (85) | 12,778 (70) |
| Harvested cropland | 5,833 (79) | 4,963 (63) |
| Part owners | 29,152 (83) | 22,769 (59) |
| Owned land in farms | 14,655 | 9,681 |
| Rented land in farms | 14,497 | 13,088 |
| Harvested cropland | 22,494 | 14,195 |
| Tenants | 2,492 (25) | 3,544 (19) |
| Harvested cropland | 2,459 | 2,869 |

Source: USDC (1989)

Notes: Per farm averages were calculated from census data when per farm data was not available. Numbers in parentheses represent the number of farms reporting for a specific category.NA= Data not available.

(Continued on next page.)

**Table 1.2 (con.)** **Changes in selected statistics in Richmond county, Virginia, between 1982 and 1987.**

| Category | 1982 | 1987 |
|---|---|---|
| Operator Characteristics (# of farms) | | |
| Operators by Place of Residence: | | |
| On farm operated | 121 | 110 |
| Not on farm operated | 41 | 30 |
| Not reported | 31 | 8 |
| Operators by principle occupation: | | |
| Farming | 97 | 79 |
| Other | 96 | 69 |
| Operators days worked off farm: | | |
| None | 74 | 62 |
| Any | 97 | 82 |
| 1 to 49 days | 10 | 14 |
| 50 to 99 days | 3 | 10 |
| 100 to 149 days | 4 | 3 |
| 150 to 199 days | 10 | 4 |
| 200 days or more | 70 | 51 |
| Operators by years on present farm: | | |
| 2 years or less | 10 | 5 |
| 3 or 4 years | 13 | 15 |
| 5 to 9 years | 20 | 21 |
| 10 years or more | 94 | 80 |
| Average years on present farm | 21.9 | 22.8 |

Source: USDC (1989)

Notes: Per farm averages were calculated from census data when per farm data was not available. Numbers in parentheses represent the number of farms reporting for a specific category. NA= Data not available.

acres in size increased (see table 1.2). Sixteen farms were in the 50-to-69 acre category in 1982; these farms harvested an total of 930 acres. In 1987, 19 farms in that category reported harvesting 1,114 acres. These farms may signal a movement toward smaller farms for weekend farmers. In addition, one "mega-farm" with more than 2,000 acres appeared in the Census between 1982 and 1987 (see table 1.2 ).

The 1987 Census also showed an increase in the acres of specialty crops grown. While the number of farms producing vegetables and melons declines from 21 in 1982 to 12 in 1987, the total acres used to produce these crops increased: 156 acres in 1982 and 348 acres in 1987. In addition, Richmond had 4 farms producing nursery crops in 1987, which included a new farm that was added between 1982 and 1987 (USDC, 1989; see table 1.3).

If agriculture in Richmond is moving toward this new structure, and farmers were aware of the new opportunities this structure would offer, then these opportunities could have competed with CRP enrollment.

**DATA AND INFORMATION SOURCES**

Data on CRP participation in Richmond county (the number of farms and acres enrolled per farm, bid levels, and practices implemented) was obtained from the Richmond county's Agricultural Stabilization and Conservation Service (ASCS) office. Information on farmer and farm characteristics, prices and markets, and land use in Richmond county was obtained from the 1987 U.S. Census of Agriculture and 1989 Virginia Agricultural Statistics. Interviews with appropriate personnel from ASCS, Soil Conservation Service (SCS), extension service, Virginia's Department of Forestry, and the Virginia Division of Soil and Water Conservation provided insight into administrative procedures, CRP implementation, and CRP participation in the county. In addition, information from a survey of CRP participation in Virginia's portion of the

**Table 1.3 Changes in crops grown, value of crops grown and average production expenses in Richmond county, Virginia, between 1982 and 1987.**

| Category | 1982 | 1987 |
|---|---|---|
| Market value of agricultural products sold | | |
| Total sales ($1,000) | 6,881 (193) | 6,051 (148) |
| Average per farm | 35,653 | 40,886 |
| Farms selling certain commodities (# of farms) | | |
| Grains | 178 | 132 |
| Corn for grain | 127 | 101 |
| Wheat | 106 | 89 |
| Soybeans | 164 | 125 |
| Hay, silage, and field seeds | 10 | 7 |
| Vegetables, sweet corn, and melons | 21 | 12 |
| Nursery and greenhouse crops | 3 | 4 |
| Fruits, nuts, and berries | | |
| Dairy products | 3 | 1 |
| Cattle and calves | 30 | 37 |
| Average production expenses per farm ($) | | |
| Commercial fertilizer | 7,427 (180) | 6,307 (127) |
| Agricultural chemicals | 2,605 (129) | 3,507 (132) |
| Hired farm labor | 3,684 (57) | 10,000 (54) |
| Custom work, machine hire, and rental of machinery/equipment | 1,011 (90) | NA (43) |
| Livestock (#) | | |
| Cattle and calves | 1,485 (40) | 1,217 (37) |
| Milk cows | 298 (14) | NA (5) |
| Hogs and pigs | 1,557 (29) | 1,017 (27) |
| Sheep and lambs | 34 (3) | NA (1) |
| Selected crops (acres) | | |
| Corn for grain or seed | 10,687 (138) | 6,303(107) |
| Wheat for grain | 7,173 (106) | 5,021 (89) |
| Soybeans for beans | 14,338 (164) | 11,593(125) |
| Hay | NA (28) | 965 (30) |
| Vegetables, sweet corn, and melons harvested for sale | 156 (21) | 348 (12) |
| Nursery and greenhouse crops | NA (3) | NA (4) |

Source: USDC (1989)

Notes: Per farm averages were calculated from census data when per farm data was not available. Numbers in parentheses represent the number of farms reporting for a specific category.
NA= Data not available.

Chesapeake Bay Basin (Ligon et al., 1987) was used explain enrollment patterns and participation rates.

Because of the diverse nature of the data sources used, few implicit results and direct correlations, such as those between farmer characteristics and enrollment and between enrolled acres and reductions in chemical and fertilizer use, can be drawn. Thus the main goal of this paper is to explore the overall potential of the 1985-version of CRP as a water-quality protection tool and identify areas of future study that could result in enhanced program design.

## *Chapter 2*
## OPPORTUNITY COSTS: HOW DID THEY INFLUENCE CRP PARTICIPATION?

If CRP is to meet any of its goals, including those for improved water quality, it must provide sufficient incentives for farmers to enroll a significant number of cropland acres. The question posed in this chapter is whether 1985-Farm Bill version of CRP was designed and implemented in a way that encouraged or discouraged participation in the Chesapeake Bay watershed. Factors that can determine whether a program like CRP reaches it's goals include the rate and pattern of participation, the identity of the participants and nonparticipants, and the motives of participants (Potter and Gasson, 1988).

Bidding behavior and enrollment in Richmond county will be analyzed in the context of prevailing land-use and production opportunities. Opportunity costs will be studied as a key factor in determining participation. The characteristics of farmers, their farms, and their production environment will be used to explain farmer's choices with respect to CRP enrollment and other opportunities and, more specifically, to explain why participation has not been higher in the county.

**ELIGIBLE ACRES**

Up to 7,825 acres of Richmond county's 31,300 acres of cropland could have been enrolled in CRP. This figure is based on the 25 percent cap on county enrollment mandated by the U.S. Department of Agriculture (USDA).[6] At the end of the nine CRP sign-up periods, only 1,545.4 acres (less than 5 percent of the county's cropland) had been enrolled.

To put CRP enrollment in Richmond county in perspective, it is necessary to know the number of acres and landowners that would have been eligible for the program. The 1985-version of CRP had three eligibility criteria (USGAO, 1989):

- The person who enrolled the land must have owned or operated it since 1985 or three years prior to the date of enrollment.
- The land must have been planted to an agricultural commodity for 2 of the 5 years between 1981 and 1985.
- The land must have been highly erodible, as defined by USDA.

Available information about the county indicates that most farmers and farmland in Richmond county would have met the ownership requirements for CRP enrollment:

- The 1987 U.S. Census of Agriculture reported that farmers in Richmond county had been on their present farms for an average of 22.8 years (USDC, 1989). Only five farm operators reported that they have been on their present farm for two years or less. Thus, most farmers would have met the length-of-ownership requirements.
- In 1982, crops were harvested or hay was cut on over 98 percent of the county's total cropland base. In 1987, nearly 63 percent of the county's total cropland was used for these purposes. These figures indicate that most of the county's cropland would probably have met the cropping requirement for CRP enrollment.

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[6] 31,300 acres of cropland were reported in Richmond county in the 1982 U.S. Census of Agriculture and 35,041 acres were reported in the 1987 census (USDC, 1989). ASCS used the 1982 census figures to determine the enrollment cap (USDA-ASCS, 1990).

Since most farm operators probably would have met the cropping and ownership criteria, the erodibility criteria would determine the total number of acres in the county that were eligible. Although USDA revised and redefined their definition of highly erodible land between 1985 and 1990, fields were generally eligible for CRP if at least two-thirds of the land:

- Was in Land Capability Classes VI - VIII.
- Was in Land Capability Classes II-V with annual erosion greater than or equal to 3T.
- Was in Land Capability Classes II-V with annual erosion greater than or equal to 2T and exhibited serious gully erosion problems.
- Had an Erodibility Index (EI) greater than or equal to 8 for wind or water erosion and an erosion rate greater than that recommended by the SCS Field Office Technical Guide between 1981 and 1985 (Dicks, Llacuna, and Linsenbigler, 1988; Osborn, Llacuna, and Linsenbigler, 1990; USDA, 1989; and USGAO, 1989).[7]

As of the sixth sign-up period, USDA also accepted fields in which at least one-third of the land was in Land Capability Classes II - V and had an annual erosion rate greater than 2T, if the owner agreed to plant trees; 66 to 99-foot wide filter strips bordering water ways, regardless of the land's erosion rate; any land subject to erosion from periodic flooding; and any wetlands previously converted to cropland.

Richmond Agricultural Conservation and Stabilization Service (ASCS) had no information available on the number of acres that would have met erodibility requirements (Roger Brown, Richmond ASCS, personal communication, March 8, 1990). However, it appears that a large percentage of land in Richmond would probably have qualified as highly erodible land. Table 2.1 shows that at least 8,253 acres of cropland, total of all cropland with EI greater than 10, would have met the requirement

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[7] For a general explanation of Land Capability Classes, Erodibility Indices and T-values, and other classifications see appendices B.1and B.2; for a summary of erodibility criteria used for each CRP sign-up period see appendix B.3.

**Table 2.1 Acres of erodible land in Richmond county, Virginia: All land, cropland, and pasture.**

| Category | Non-highly erodible land (EI<5) | Potentially erodible land (5≤EI<10) | Highly erodible land (10≤EI<15) | Very highly erodible land (EI≥15) |
|---|---|---|---|---|
| **All land** | 47,371 | 13,917 | 19,600 | 41,876 |
| **Cropland** | 18,991 | 5,086 | 4,370 | 3,883 |
| **Pastureland** | 876 | 271 | 260 | 487 |

Source: Adapted from Ligon et al., 1987
Note: EI=Erodibility index=RKLS of the Universal Soil Loss Equation/Soil-loss tolerance (T-value)

of EI≥8. For her study of low-input practices in Richmond county, Diebel (1990) used 8,253 acres to represent the number of acres that would be eligible for CRP. This finding means that at the end of the ninth CRP sign-up period in Richmond, less than 19 percent of the county's eligible land had been enrolled (1,545.4 acres enrolled out of 8,253 acres). Some portion of the potentially highly erodible land (that with an EI greater than or equal to 8) may also have qualified for CRP which would lower the percentage of eligible acres actually enrolled.

In addition, a 1982 Soil Survey of Richmond county (Robinette and Hoppe, 1982) indicated that, of the 122,777 acres in the county,[8] over 37 percent (48,101 acres) were in LCCs VI, VII, and VIII. Most of this land was in trees, although some were in farms. Over 48 percent were in LCCs II, III, and IV. No soils were in LCC V. Most of the land in LCC II was being cultivated; lands in LCCs III and IV were mostly in trees although some was being used for crops, pasture or hay (see table 2.2). The predominance of land in capability classes III -IV, and the number of highly erodible acres, indicates that much of the county's cropland would have met erodibility requirement, at least more than the

[8]This figure does not include acres of water or acres of sand pits and gravel.

**Table 2.2 Land Capability Classes and subclasses of soils in Richmond county, Virginia: total acreage and percent of total acreage.**

| Land Capability Class | Total acreage | Percent of total acreage |
|---|---|---|
| I | 12,366 | 9.5 |
| II | 47,683 | 36.6 |
| IIe | 36,518 | 28 |
| IIw | 7,899 | 6.1 |
| IIs | 3,266 | 2.5 |
| III | 2,580 | 2.1 |
| IIIs | 719 | .6 |
| IIIw | 1,861 | 1.5 |
| IV | 12,047 | 9.3 |
| IVe | 7,624 | 5.9 |
| IVw | 4,423 | 3.4 |
| V | 0 | 0 |
| VIw | 1,571 | 1.2 |
| VII | 41,819 | 32.2 |
| VIIw | 5,457 | 4.2 |
| VIIe | 36,362 | 28.0 |
| VIII | 4,711 | 3.6 |

Source: Robinette and Hoppe, 1982.
Notes: For subclasses, "e" indicates erosion, "w" indicates excess water, and "s" indicates soil limitations within the root zone.

1,545 acres that were enrolled. For a summary of soil types in Richmond county, see Appendix C.

**CRP IMPLEMENTATION IN RICHMOND COUNTY**

Between 1986 and 1989, landowners in Richmond county and other areas of the country had nine opportunities to enroll in CRP. Nationwide sign-up periods, which were designated by USDA, were held in March, May and August of 1986; February and July of 1987; February and July/August 1988; and February and July/August 1989 (Osborn, Llacuna, and Linsenbigler, 1990).[9]

To inform Richmond county farmers, the Richmond county ASCS, Soil Conservation Service (SCS), and Extension Service offices conducted an informational program from the beginning of CRP. They used newsletters, letters, radio, and newspaper stories to promote the program and worked with various county organizations. ASCS discussed the program with their "walk-in" traffic -- farmers who came in the office for other reasons (Roger Brown, Richmond ASCS, personal communication, March 8, 1989). Most of these efforts were not directly targeted to eligible farmers.

To enroll in CRP, landowners were required to submit a sealed bid to the county ASCS office during one of the sign-up periods. The bid specified the desired rental payment per acre, the number of acres that would be enrolled, and when the land would be retired (Taff, 1989).

Land was tentatively accepted into CRP if the landowner's bid was below or equal to the maximum acceptable rental rate (MARR) that USDA established for the bidding pool where the land is located. MARRs were determined by ASCS based on land values

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[9]Sign-ups have continued under the 1990 Farm Bill. However, only the first nine sign-up periods will be considered in this discussion.

and rental rates within each bidding pool. However, a local committee could still reject the bid if they determined that it was higher than local cash rents for comparable land (Osborn, Llacuna, and Linsenbigler, 1990).

During sign-up periods one through five, the MARR was $50 per acre per year for the entire state of Virginia. However, as of the sixth sign-up period in February 1988, the state was divided into three bidding pools, each with a different MARR, to encourage enrollment and enhance the state's water-quality initiatives. The MARRs were $70 per acre for counties in the Rappahannock and York River basins, which includes Richmond county, and $60 per acre for the James and Shenandoah river basins. MARRs remained at $50 per acre for the other counties in the state. The Rappahannock, York, James, and Shenandoah river basins include all of the land in Virginia that is part of the Chesapeake Bay watershed (Ligon et al., 1988).

In Richmond county, bids went through a two-round acceptance process. The county's ASCS office set bid levels based on the costs of establishing cover, soil loss, local rental rates, and the cost of clipping (maintaining cover). A county committee determined the county-level MARRs independently of the state bidding pools and were not informed of the bid pool MARRs. However, it appears that the county-level MARRs closely matched those of the state bidding pool. County-level MARRs in Richmond were $50 per acre for sign-up periods 1 through 5, $61 per acre for sign-up period 6, and $70 per acre for sign-up periods 7 through 9 (Roger Brown, Richmond ASCS, personal communication, March 8, 1990).

Bids accepted at the county level (those under the county's MARR) were then sent to the state for final approval within the bid pool's MARR (Brown, personal communication, March 8, 1990). If the bid was accepted, the landowner entered into a contract with ASCS. The contract was then turned over to the local SCS office, which

assured that the land met the erodibility and cropping requirements. In Richmond county, these criteria were checked by using county soil maps and visiting the site to determine if the land met eligibility requirements for slope length and erodibility (Ben Headley, Richmond County SCS, personal communication, July 9, 1990).

Once the eligibility criteria were checked, SCS helped the landowner select and establish the appropriate cover crop. Landowners could plant grass cover, trees or wildlife food plots on their CRP acres. If trees were to be planted, the Forest Service provided additional technical assistance (USGAO, 1990). In addition to an annual rental payment for each acre enrolled, landowners received a cost-share payment for up to 50 percent of the cost of establishing cover, unless an appropriate cover crop was already established.

Farmers who enrolled in CRP were required to reduce their aggregate cropland base[10] by the ratio of CRP land to total cropland acreage (Hoag, 1988; Taff and Halbach, 1988). The base was to be reduced by this ratio for each year during the 10-year contract period. For example, if a farmer with a 100-acre farm and 50 acres of combined bases and allotments for corn, small grains, and wheat enrolled 50 acres, he or she reduced base acreage by 50 percent (25 acres). At the end of the contract period, however, the farmer would receive credit for the base taken out by CRP (Wilson Leggett, Virginia ASCS, personal communication, July 15, 1991).

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[10] "Base" is derived from a 5-year moving average of acres planted and those considered planted (idled acres or those not planted because of disaster) (USDA-ERS, 1990). Crop acreage bases are not specific geographic designations, but are accounting entities used to determine government payments (Taff and Halbach, 1988).

## FARMER DECISION-MAKING BEHAVIOR AND THE CRP CHOICE

Why did some farmers in Richmond county chose to participate in CRP while others did not? For those who chose to participate, what determined the quantity and location of the land they enrolled?

Studies of CRP nationwide have shown that opportunity costs had an influence on farmers' decisions with regard to CRP and similar programs (AFT, 1987; Purvis, Hoehn and Sorenson, 1989; Ligon et al., 1988). A review of economic theory related to farmers' goals and decision-making behavior provides some insights into why opportunity costs are important and how they may have influenced the decisions of Richmond county farmers.

### CRP as a Production Option: The Theoretical Framework

Farmers make three general types of production decisions (Beattie and Taylor, 1985; Haines, 1982):

- enterprise selection (what to produce);
- resource allocation (how to manage available resources); and
- marketing (how to market what is produced).

All of these decisions are related. For example, the labor and management time available for crop production may influence the choice of what to produce and the practices used to produce it.

Resource allocation involves finding the optimal combination of land, labor, and capital that will enable farmers to reach their goals. According to neoclassical economic theory, farmers allocate these resources to achieve maximum profits (Beattie and Taylor, 1985).

In general, farm management decisions about the use of available resources are made within opportunity sets. These opportunity sets contain all possible options

available to that farmer -- each option requiring a distinct allocation of land, labor and capital. For each option there is an opportunity cost or price attached (Randall, 1987). When a farmer adopts one production practice or strategy, the opportunity cost is equal to the foregone income or non-monetary benefits from the remaining options within the set.

Each farmer's opportunity set is bounded by or framed within a set of constraints (Randall, 1987). These constraints can be technological, agronomic, or economic factors; personal factors, such as lack of understanding of agronomic processes; and institutional factors, such as a lack technical assistance (Van Kooten, 1986). Time and capital constraints may also inhibit farmers' decisions.

Batie and Taylor (1989) noted that choices within agricultural production sets can be "conditioned" or influenced by farm programs, environmental constraints, credit and tax policies, and integrated contracts and leases. These factors may influence which opportunities a farmer or landowner perceives as feasible. Choices within one time period may also influence the contents of future opportunity sets by affecting a farmer's ability to respond to new opportunities (Randall, 1987).

Recent research has recognized that farmers may have goals other than profit maximization such as social and personal welfare maximization that guide their farm management decisions (Coughenour and Tweeten, 1986). In a review of studies related to farmer's adoption of soil conservation practices, Duff et al. (1990) pointed out that "there are farmers who have voluntarily adopted conservation strategies even when the economics of doing so are unclear and uncertain" (p. 5). These alternative goals may affect how farmers view the opportunity costs associated with CRP enrollment (Taff and Halbach, 1988).

The innovation-decision model developed by Rogers (1983) is often used to explain the process a farmer goes through when deciding to adopt a production innovation or strategy. In this model, the decision to adopt or reject is composed of five stages: knowledge, persuasion, decision, implementation, and confirmation. The factors that carry farmers through this decision-making process and determine the outcome are the characteristics of the farmers and their farms; the relative advantage, compatibility, and other characteristics of the innovation or strategy being considered; and the communication channels that deliver information and opinions about the innovation or strategy (Duff et al., 1990).

Ervin and Ervin (1982) offer a simplified format for this decision-making model for soil conservation decisions. This model includes three steps: (1) the perception of erosion problems; (2) the decision to use soil conservation practices; and (3) soil conservation effort, that is, the type and extent of practices used on the farm. In this model, perception of erosion problems is influenced by personal factors such as education and conservation attitudes, physical factors (slope length, slope degree, and soil erodibility) and institutional factors such as education and technical assistance. In addition to these factors, the decision to use soil conservation practices and the level of effort employed are influenced by the amount of cost-sharing, and by economic factors including net farm income, debt level, off-farm income, discount rate/ planning period, risk aversion, and farm type.

Although both of these models apply to the adoption of new technologies, they lend some insight into the stages that occur when farmers decide to shift their allocation of resources. In the case of CRP, these models provide a framework for analyzing the decision to participate.

**Awareness, Information, and the CRP Choice**

A main prerequisite to adoption (or in the case of CRP, participation) is that the decision-maker perceives a need, problem or opportunity and recognizes the technology, strategy or action as an appropriate solution. Without enough awareness of an opportunity or information about it, a decision-maker cannot adequately or confidently weigh all available options.

Studies conducted during the first five CRP sign-up periods indicate that awareness of the program and access to information about it may have influenced farmers' participation decisions. Landowners were confused about the eligibility requirements and how the program applied to them, as well as the program requirements and the procedures for bidding. In a nationwide study of CRP participation, Esseks and Kraft (1987) determined that there was a great deal of misunderstanding and misinformation about the cropping requirements. They also determined that farmers who received technical assistance from the SCS were more likely to enter a bid because they were aware of their eligibility for CRP and were more comfortable about signing the contract. In their 1987 study of CRP participation in Virginia, Ligon et al. (1988) concluded that enrollment in CRP could be increased if farmers were better informed about the program.

Perception of erosion problems also appears to have been a factor in CRP participation, at least in the early stages of the program. A study by the American Farmland Trust (Esseks and Kraft,1987), conducted just after the first two CRP sign-up periods, found that over 40 percent of farmers they surveyed who had not submitted bids, and did not intend to bid in the third sign-up period, claimed their land was ineligible because of inadequate erosion rates. The authors concluded that most of these farmers had inaccurate perceptions of their lands' erosion rates since the sample was

selected from counties with a relatively high proportion of land that met CRP erodibility requirements.

But, the longer the program was in affect, awareness and information may have become less of a factor in participation. Boggess (1987) hypothesized that the limited number of bids submitted in the earlier sign-up periods was related to farmer uncertainty about the program. Subsequently, bidding would increase as farmers became aware of CRP, and the eligibility requirements and procedures for signing up. Many farmers may have waited to enter bids until they saw how the program worked and became aware of the rental rates that would be offered. Nowak and Schnepf (1989) found that the number of Agricultural Conservation and Stabilization Service (ASCS), SCS, and Extension Service personnel who said farmers were not participating due to misunderstandings about erodibility requirements declined between their studies in 1987 and 1988.

**Attributes of the CRP Choice**

CRP can be viewed as a new option within a farmer's opportunity set. Participating in CRP entails a decision by the landowner to voluntarily remove land from production for a given period of time (10 years) in exchange for an annual rental payment. By deciding to participate, the farmer also decides to forgo other land-use options, such as renting the land, for the extent of the contract period.

The rental payment distinguishes the decision to participate in CRP from the decision to adopt a soil conservation practice, even though idling land under protective cover is regarded as a soil-conserving practice. Purvis, Hoehn, and Sorenson (1989; p.1) noted this distinction in their study of farmers' willingness to place land in a 10-year filter strip program in exchange for a rental payment:

> A long-term commitment to set aside filter strips is a fundamentally different kind of choice than a decision to adopt a conservation practice . . . adopting conservation practices involves changing a farm management strategy in order to control soil erosion. The use of conservation is expected to pay off in either sustained or improved net production revenues over time. On the other hand, entering a ten year contract to set aside filter strips means exchanging revenues from crop production for a yearly payment.

In other words, programs such as CRP offer economic returns for conservation behavior now, instead of an undefined and uncertain payoff at some point in the future. From that perspective, opportunity costs should play an important role in farmers' decisions concerning CRP participation.

From a profit maximization viewpoint, farmers will enroll land in CRP when the rental payment and associated cost-share payments are equal to or greater than the "foregone net return to land and management" from other potential land uses (Huang et al., 1988). Non-monetary benefits and costs of the program may also have a role in determining whether farmers choose to participate and the extent of their participation (Taff and Halbach, 1988; Konyar and Osborn, 1990).

Assuming farmers eventually became aware of CRP and informed about the program's enrollment criteria and how it applied to them, they would have been in a position to weigh both the costs and benefits associated with participating or not participating in CRP. Konyar and Osborn (1990) refer to these costs and benefits as attributes of the choice. The attributes are determined by the components of the program's design, such as the length of the contract, the rental payment offered, and the eligibility requirements, as well as the other options available to the farmer (Konyar and Osborn, 1990). Attributes can be monetary, such as the CRP rental payment compared to returns from other land uses, or non-monetary, such as the security associated with a guaranteed payment.

The length of the CRP can influence the opportunity costs associated with enrolling. Because the CRP contract is 10 years in length, a farmer's decision to enroll in CRP today, will constrain his or her production options for that land during the 10-year contract life. In addition, the real value of the rental payment declines over time since it is a fixed payment for the 10-year enrollment period.

Studies of CRP participation behavior and other types of land diversion programs have focused on two main areas: (1) the attributes of the program, their impact on farmers' opportunity costs, and the influence of those costs on participation and (2) the socioeconomic factors that characterize both participants and nonparticipants. These two areas may be studied separately; but, studied together, they may provide insight into why farmers enroll and the extent of their enrollment (that is, the number of acres they choose to enroll).

Characteristics of farmers and their farms have a role in explaining how farmers weigh the opportunity costs associated with enrollment (Konyar and Osborn, 1990). Perception of the costs and benefits of the CRP choice may be weighed or perceived differently among farmers because of differences in farm characteristics and in farmers' production goals and socioeconomic backgrounds. Characteristics of farmers' operating environments can determine the availability and feasibility of competing land uses.

National and regional studies of CRP participation have indicated several farmer and farm characteristics that influence participation. These include age, education, the type of operation, farm size, and previous participation in farm programs (AFT, 1987; Esseks and Kraft, 1987; Konyar and Osborn, 1990; Ligon et al., 1988; Swanson, Stephenson, and Skees, 1990; Taff and Halbach, 1988).

**ANALYSIS OF CRP ENROLLMENT IN RICHMOND COUNTY**

Although the enrollment information available from Richmond county (USDA-ASCS, 1990) does not include information about potential participants or those whose bids were rejected, it does indicate the number of successful bidders and the extent of their participation ( that is, the number of acres enrolled per contract). At the end of the ninth sign-up period, 1,545.4 acres in Richmond county were enrolled in CRP and ASCS had 80 contracts from 69 farm units (see table 2.3).

The enrollment data also indicates that, as the sign-ups continued, more decisions were made to enroll in CRP. Only one or two contracts were made during the first three sign-up periods and 15 were made in the fourth sign-up period. Enrollment peaked at 24 contracts in the seventh sign-up period. This increase may have been partially fueled by Richmond county farmers' growing awareness of CRP and a better understanding of how it applied to them.

Lack of information may have prevented some potential participants from bidding in the earlier sign-up periods. A survey of Richmond county farmers conducted by Virginia Tech prior to the fifth sign-up periods indicated that, while farmers were generally aware of CRP, many farmers lacked enough information to decide whether to bid (VPI&SU, 1987). Of the 24 who gave reasons for not submitting a bid, 53.3 percent indicated they did not have enough information to decide, 46.7 percent indicated they didn't understand the eligibility requirements and 46.6 percent said they did not know how to figure a bid. (See appendix D for a summary of these responses.)

Farmers who submitted a bid in the earlier sign-ups may also have been rejected because their bids were too high. Analysis of the bids from Richmond county landowners, however, indicates that some farmers eventually became aware of the program "rules" and MARRs, and became successful bidders.

**Table 2.3 Bidding and enrollment during CRP sign-up periods 1 through 9 in Richmond county, Virginia.**

| Sign-up period | Total contracts | Total acres accepted | County maximum acceptable rental rate ($/acre) | Average acres enrolled per contract |
|---|---|---|---|---|
| 1 | 2 | 32.9 | 50 | 16.45 |
| 2 | 1 | 8.5 | 50 | 8.50 |
| 3 | 2 | 71.5 | 50 | 35.75 |
| 4 | 15 | 176.0 | 50 | 11.73 |
| 5 | 7 | 158.4 | 50 | 22.63 |
| 6 | 11 | 147.2 | 61 | 13.38 |
| 7 | 24 | 525.0 | 70 | 21.88 |
| 8 | 9 | 184.9 | 70 | 20.55 |
| 9 | 9 | 241.0 | 70 | 26.70 |

Source: USDA-ASCS (1990)

The rents paid under CRP were intended to be based on a bid system. In reality, though, the program became an offer system (Huang et al. ,1988). Although the MARRs were never officially announced, farmers eventually learned became aware of them and began bidding to that level (Boggess, 1987). Taff (1989) referred to this phenomenon as "bid convergence."

Analysis of the accepted bids in Richmond county across the nine sign-up periods shows that these bids converged toward the MARR within one or two bidding periods (see table 2.4), which indicates that at least some of the farmers entering bids were aware of the MARRs. Average bid ratios (bid/MARR) show that, initially, farmers were unsure of the MARR; the average bid ratio was .89 during the first bidding period. By the second sign-up, accepted bids were equal to or within a few cents of the MARR.

**Table 2.4** **Total contracts, average bids, and average bid ratios for each CRP sign-up periods one through nine in Richmond county, Virginia.**

| Sign-up period | County maximum acceptable rental rate ($/acre) | Average rental rate per contract ($/acre) | Average bid ratio |
|---|---|---|---|
| 1 | 50 | 44.50 | .890 |
| 2 | 50 | 50.00 | 1.000 |
| 3 | 50 | 50.00 | 1.000 |
| 4 | 50 | 49.99 | .999 |
| 5 | 50 | 50.00 | 1.000 |
| 6 | 61 | 52.27 | .857 |
| 7 | 70 | 69.83 | .997 |
| 8 | 70 | 70.00 | 1.000 |
| 9 | 70 | 70.00 | 1.000 |

Source: USDA-ASCS (1990)

When the county MARR was raised to $61 in the sixth sign-up, most farmers were still bidding according to the MARR from the previous round. The average bid ratio for the sixth sign-up period was .857. When the MARRs were raised to $70 in the seventh sign-up period the bid ratio increased to .998. All bids accepted during the last two sign-ups were equal to the MARR. Thus, farmers who were successfully bidding were learning to "play the bidding game."

In addition to increasing awareness of the program, several other factors seem to have had an impact on CRP enrollment in Richmond county. Bidders appear to have responded to the changes in the MARRs and to special incentives for enrolling corn land. Analysis of the MARRs and incentives and corresponding participation rates

indicates that they may have had an impact on enrollment by making CRP more competitive with other options.

**Adjustments in the MARRs.** The changes in the MARRs appear to have had a positive affect on enrollment. During the first five sign-up periods (when MARRs were $50), 447.3 acres were enrolled at an average of 16.56 acres per contract. ASCS reports that 27 contracts were made during these sign-up periods, with three farm units holding more than one contract. When county MARRs were raised to $61 in the sixth sign-up period, 11 contracts were made to enroll 147.2 acres (12.38 acres per contract). Two of those contracts were made with farm units that had bid in the first five contract periods. In the sign-ups after the MARR was raised to $70 per acre in sign-up periods 7 through 9, an additional 42 contracts were made to enroll a total of 950.9 acres. Six farm units had more than one bid accepted during sign-up periods 7 through 9. One contract was made with a farm unit that had enrolled land during the first five sign-up periods .

Overall, 71.06 percent of the 1,545.4 CRP acres in Richmond were enrolled and 66.25 percent of the 80 contracts were made after the MARR was raised. The differences in enrollment may indicate that the $61 and $70 MARRs were sufficient to cover the opportunity costs of enrolling and thus induce more farmers to participate, and enroll a greater number of acres. The number of repeat bids from some farm units indicates that some landowners were encouraged to enroll additional acreage.

Increases in the MARRs may also have encouraged farmers to enroll more acres per contract. When the MARRs were $50, farmers enrolled an average of 16.6 acres per contract: 6.9 percent of the cropland acres of an average 240-acre farm. When the MARRs were $60, farmers enrolled an average of 13.4 acres: 5.58 percent of the cropland

acres of an average farm. When the MARRs were $70, farmers enrolled an average of 22.6 acres: 9.4 percent of the cropland acres of an average farm.

**Bonus payments for corn acres.** During the fourth sign-up period in February 1987, a one-time bonus of $2 per bushel per acre was offered for corn acreage enrolled in CRP. The bonus was offered to any farmer who participated in price and income support programs (USGAO, 1989) and was based on estimated yields set by the county committee (Brown, personal communication, July 19, 1991).

Because corn is a major crop in Richmond county, many of the county's farmers could have benefited from the special incentive. According to the 1987 U.S. Census of Agriculture (USDC, 1989), 127 farms were growing corn for grain in 1982 and 101 were in 1987. The Virginia Agricultural Statistics Service (1990) reports that 10,200 acres of corn were planted in 1986 (32.6 percent of the county's cropland); 6,500 acres were planted in 1987 (20.8 percent of the county's cropland); 6,700 were planted in 1988 (21.4 percent of the county's cropland); and 7,000 in 1989 (22.4 percent of the county's cropland) .

ASCS enrollment summaries indicates that 176 acres were accepted into CRP during the fourth sign-up period from 15 contracts (see table 2.3). In the previous sign-up period, only two contracts for a total of 71.5 acres had been enrolled. In the fifth sign-up period, seven contracts were made for 158.4 acres. The number of contracts made in the fourth sign-up period was the second highest of all nine sign-up periods, which may indicate that the corn bonus program had a positive affect on enrollment. However, the average number of acres per contract in the fourth sign-up period (11.73 acres per contract) was the next to lowest of all nine sign-ups. Farmers may have been encouraged by the incentive to enroll corn land; but because of the productive value of the land did not enroll much of it.

**Table 2.5** **Summary of commodity base reductions from all final bids in Richmond county, Virginia, sign-up periods one through nine.**

| Sign-up period | Total contracts | Total acres enrolled | Total base reduction (acres) | Wheat (base/yield) | Corn (base/yield) | Barley (base/yield) |
|---|---|---|---|---|---|---|
| 1 | 2 | 32.9 | 31.0 | 0/0 | 15/87 | 15/52 |
| 2 | 1 | 8.5 | 2.0 | 2/43 | 0/0 | 0/0 |
| 3 | 2 | 71.5 | 17.0 | 1/37 | 3/80 | 12/46 |
| 4 | 15 | 176.0 | 153.0 | 29/30 | 92/86 | 31/55 |
| 5 | 7 | 158.4 | 124.0 | 43/37 | 25/90 | 56/48 |
| 6 | 11 | 147.2 | -- | -- | -- | -- |
| 7 | 24 | 525.0 | -- | -- | -- | -- |
| 8 | 9 | 184.9 | -- | -- | -- | -- |
| 9 | 9 | 241.0 | 199.7 | 65/- | 56.2/- | 78.5/- |

Source: USDA-ASCS (1990)
Notes: Data for sign-up periods 6, 7, and 8 was unavailable.
Yields are given in bushels per acre.

Richmond county ASCS reports that few farmers decided to enroll corn land simply because of the bonus; most simply "took it because it was available" at the time they decided to enroll (Roger Brown, Richmond ASCS, personal communication, March 8, 1990). However, compared to other sign-up periods, reductions of corn base acres in sign-up period 4 was higher than other sign-up periods, which may indicate that more corn acreage was enrolled in CRP (see table 2.5).

**Filter-strip incentive.** One special incentive appears to have had no affect on enrollment. An incentive was offered in the sixth sign-up period which allowed landowners to enroll strips of land adjacent to water bodies. These "filter strips" were to be between 66 and 99 feet wide and could be enrolled regardless of their erodibility

(USGAO, 1990). During the ninth sign-up period farmers in Richmond county were offered an additional incentive to enroll filter strips. The Virginia Division of Soil and Water offered one-time incentive payments to farmers in the Bay-watershed counties including Richmond county who enrolled land in the CRP filter-strip program. For filter strips planted in grass cover, the payment was $50 per acre; for those planted in trees, the payment was $100 per acre. However, no CRP acres were enrolled in the filter-strip program during the ninth sign-up period.

Richmond county has 31 miles of waterfront on the Rappahannock River and a total of 180 miles of shoreline. Two major waterways in Richmond -- Totuskey Creek and Cat Point Creek -- feed into the Rappahannock (Gray, Dann, and Vinis, 1988). Altogether, the county has 4,556 acres of marshland and 22,074.2 acres of stream networks (VIRGIS). No figures were available to indicate how much cropland borders these waterways. Nor does ASCS have an estimate of the number of acres that would have qualified for the filter-strip program (Roger Brown, Richmond ASCS, personal communication, March 8, 1990).

In the CRP sign-ups after the filter strip program was started, only two farms enrolled a total of 32.3 acres in the program (USDA-ASCS, 1990). Both of these farm enrolled filter strip acres at the same time they enrolled other CRP acres.

**THE ATTRIBUTES OF CRP ENROLLMENT IN RICHMOND COUNTY**

Part of the gradual increase in CRP enrollment across the nine sign-up periods could be attributed to farmers' growing awareness of the program. However, the enrollment response to the changes in MARRs and the corn bonus seem to indicate that, once farmers knew about the program, economic opportunity costs became an important consideration. To understand the CRP choice in Richmond, this section

considers the attributes of CRP as they may have appeared to Richmond county farmers, and their potential affects on participation. The costs, benefits and feasibility of CRP discussed in this section are summarized in table 2.6.

**Direct Benefits and Costs**

The most obvious benefit of enrolling in CRP is the direct monetary payments a landowner receives for participating. Taff and Halbach (1988) define the total direct monetary benefits of CRP participation as the annual rental payment plus the cost-share payment minus establishment and maintenance costs not covered by the cost-share payment.

As previously mentioned, the annual per-acre rental rate that farmers could have received by enrolling in CRP varied during the nine sign-up periods. In Richmond county's bidding pool, these rates were $50 per acre for acreages enrolled in periods one through five, $61 per acre for those enrolled in sign-up period six, and $70 per acre for those enrolled in sign-up periods seven through nine.

While all Richmond county CRP participants did not receive the maximum rental rate, most eventually bid to that level as shown by the converging bids in table 2.4. The amount of the bid farmers offer for CRP land should theoretically equal the value of the foregone opportunity costs and other costs associated with CRP enrollment. Boggess (1987) hypothesized that break-even bids would depend on market net returns, commodity program benefits, ground cover costs, additional income sources (trees and wildlife) and the potential costs of conservation compliance. But, because of the convergence of bids to the MARR, some accepted bids might instead reflect a reservation price -- the least amount farmers were willing to accept in exchange for enrolling in CRP. For other farmers, bidding at the level of the MARR may have been strategic behavior: they may have enrolled marginal land, knowing that the

**Table 2.6 Monetary benefits, indirect benefits, direct costs, indirect costs and feasibility[a] of CRP enrollment options in Richmond county, Virginia.**

| Attributes of the Choice | CRP Options | | | |
|---|---|---|---|---|
| | Grass cover | Trees | Wildlife food plots | Filter strips |
| Monetary benefits | *Annual payments for 10 years. | *Annual payment plus income from harvest after contract expires/ trees mature. *Rental during hunting season. | *Annual payment plus rental during hunting season. | *Annual payment plus incentive payments if enrolled in sign-up period nine.[b] |
| Indirect benefits | *May put farm "in-compliance." *Maintenance or improvement in soil productivity. *Release of labor and management. *Guaranteed income. | *Less management time than grass cover. *Forest products can be held for better markets. *Highly drought tolerant. *Same as grass cover. | *Same as grass cover. | *Protects water quality (not a direct benefit to the farmer). *Same as grass cover. |
| Direct costs | *50% of cover establishment costs. | *Same as grass cover. | *Same as grass cover. | *Same as grass cover. |
| Indirect/ opportunity costs | *Foregoing other land-use options. *Reduction in base acreage and farm program benefits. | *Foregoing other land-use options until harvest. *Difficult to convert back to crops. *Reduction in base acreage. | *Must grant access to hunters. *Same as grass cover. | *Same as grass cover. |
| Feasibility | *Feasible if land meets cropping, ownership, and erodibility criteria. | *Most soils have medium to high tree productivity potential. *Well-established timber industry. | *Demand for hunting land exists -- 24 to 30 hunt clubs. *Diverse game population. | *Feasible for farmers with cropland along waterways. |

[a] Feasibility indicates whether the option has the potential to generate the benefits listed or is an option for farmers in the county.

[b] $50/acre extra for filter strips planted in grass cover; $100/acre extra for those planted in trees.

**Table 2.7 Type of practices implemented on CRP land and estimated cost-share payments in Richmond county, Virginia, sign-up periods 1-9.**

| Type of cover | Average estimated cost-share ($/acre) | Number of contracts | Number of acres | Number of acres per contract |
|---|---|---|---|---|
| **Grass cover** | 69.29 | 54 | 1,272.4 | 23.6 |
| **Trees** | 28.83 | 13 | 126.0 | 9.7 |
| **Cover already established** | 0.00 | 10 | 77.9 | 7.8 |
| **Wildlife food plots** | -- | 1 | 4.0 | 4.0 |
| **Filter strips** | 90.55 | 2 | 32.3 | 16.2 |
| **Wetland -- trees established** | 30.00 | 1 | 32.8 | 32.8 |

Source: USDA-ASCS (1990)

opportunity costs of enrolling this land would be sustantially lower than the MARR. For farmers who were aware of the MARR, but chose not to submit a bid, the MARRs may not have been high enough to cover what they perceived as the cost of enrolling. The cost of establishing vegetative cover (minus the initial cost-share payment) and maintaining it was one of the few direct costs associated with participating in the CRP. The amount of the cost-shares offered to Richmond county farmers varied by the type of cover selected , as shown in table 2.7, and were estimated by ASCS as 50 percent of the cost of establishing cover. Actual cost-shares paid were slightly lower than the estimates, but this information was not available for all contracts made in Richmond county. No cost-share estimates were available for wildlife food plots; no cost-shares were paid if cover was already established. Since participating farmers were required to pay the remaining 50 percent of costs, the estimated cost-shares represent their first -year establishment costs.

Farmers who enrolled also were required to bear the cost of maintaining the vegetative cover on their CRP land. As part of the contract, farmers in Richmond agreed to carry out weed control on the enrolled acres to make sure cover was maintained for the life of the contract. Participants were allowed to use herbicides to control weeds, but could not get cost-share payment for it unless they included it in the plan and then only in the first year (Headley, personal communication, July 9, 1990).

**Indirect Benefits**

Richmond county farmers could also have obtained indirect monetary benefits and non-monetary benefits from CRP participation. These benefits include income from trees planted on CRP land and leasing CRP land for hunting, the opportunity to devote labor and management resources to other use, and the security of a guaranteed income.

**Income from Planting Trees.** Farmers who enrolled in CRP could have planted trees on the land, received payments to meet establishment costs, and sold them for cash at the end of the contract period. A farmer's ability to obtain monetary benefits would depend on the available market, the conditions available for growing trees, his or her experience with trees, and the amount of technical assistance available.

Richmond county also has an extensive timber industry. Sixty-two percent (76,818 acres) of the county's land is forested: 21 percent of those acres are owned by companies or individuals operating wood-using plants, 41 percent are owned by non-farming individuals, and 34 percent are owned by farmers (Brown and Craver, 1985). Thus many farmers in the county may have the technical ability and knowledge necessary to produce a profitable timber stand. Esseks and Kraft (1989) hypothesized that landowners with experience in commercial forestry were more likely to be aware of the CRP tree-planting option. Awareness of the tree-planting option does not appear to have been a problem in Richmond; as of the fifth sign-up 70.8 percent of the

respondents to the 1987 Virginia Tech survey said they were aware of the tree planting provision.

Farmers in Richmond could have increased their returns from CRP land by planting trees. Loblolly pine is the most common variety of tree grown in Virginia's coastal plain and in Richmond county (Stanley, Haney, Grimm and Deaton, 1987; Tom Brooks, Richmond County Forester, personal communication, July 15, 1991). Many of the county's soils have high to moderately high potential for producing this type of pine (Robinette and Hoppe, 1982). Most CRP lands designated for trees were planted in Loblolly Pine (Brooks, personal communication, July 15, 1991).

Table 2.8 shows the annual equivalent values of net returns to one acre of Loblolly pine in a 45-year rotation. These values account for the periodic income achieved by thinning the trees during the life of the rotation and the costs of establishment, property taxes and land management (Stanley, Haney, Grimm,and Deaton, 1987). Most sites in Richmond county would qualify as "Good" sites for growing Loblolly pine (Phil T. Grimm, Virginia Deparment of Forestry, personal communication, May 28, 1992). As shown in the table, returns to timber produced on land with a "Good" site index are generally positive even when timber prices vary between $55 and $130. For example, a one-acre stand of timber that is expected to reach a height of 60 feet in 25 years and 84 feet in 50 years (a "Good" site index) will probably yield 11 cords of wood per acre when thinned at 20 years and 16,000 board feet per acre at harvest. At discount rates between 8 and 12 percent, the annual equivalent value of net returns varies between $4 per acre per year and $81 per acre per year with sawtimber prices ranging between $55 and $130 per thousand board feet. Because of growing conditions in Richmond county, some stands can be thinned for pulpwood after only 14 years (Brooks, personal communication, July 15, 1991).

**Table 2.8 Annual equivalent values of net returns per acre of Loblolly pine in Virginia, 45-year rotation.**

| Site index | Wood Yield | | Saw timber stumpage prices | Annual equivalent value of financial returns ($/acre) are various discount rates | | |
|---|---|---|---|---|---|---|
| | Thinning | Harvest | | | | |
| (ft) | (cords/ acre) | (thousand board ft/acre) | ($/thou-sand board ft) | 8% | 10% | 12% |
| 50@25 yrs. | 8@25yrs. | 13 | 55 | 22 | 7 | -2 |
| 70@50 yrs. | 7@33yrs. | | 80 | 34 | 13 | 1 |
| (FAIR) | | | 105 | 45 | 20 | 5 |
| | | | 130 | 57 | 26 | 8 |
| 55@25 yrs. | 12@24 yrs. | 14 | 55 | 28 | 11 | 1 |
| 77@50 yrs. | 9@33 yrs. | | 80 | 42 | 18 | 5 |
| (GOOD) | | | 105 | 55 | 26 | 8 |
| | | | 130 | 68 | 33 | 12 |
| 60@25 yrs. | 11@20 yrs. | 16 | 55 | 36 | 16 | 4 |
| 84@50yrs. | | | 80 | 51 | 24 | 8 |
| (GOOD) | | | 105 | 66 | 32 | 12 |
| | | | 130 | 81 | 40 | 17 |
| 65@25 yrs. | 12@18 yrs. | 18 | 55 | 42 | 20 | 7 |
| 61@50 yrs. | | | 80 | 58 | 29 | 11 |
| (EXCELL- | | | 105 | 75 | 38 | 16 |
| ENT) | | | 130 | 91 | 46 | 21 |

Source: Reprinted from Stanley, Haney, Grimm, and Deaton (1987)
Notes: Site index is the expected height of the largest trees at 25 years or 50 years of age. Wood yields at thinning indicate the number of cords per acre that can be harvested at the thinning year given.

The market for trees in Virginia appears to have future profit potential. Stanley, Haney, Grimm and Deaton (1987) noted that predicted shortages of pine would increase prices. Trees also have several non-monetary benefits for farmers. They can be turned into several different products that can be held for better markets. Once a stand is established, trees are highly tolerant to drought. Compared to grass covers, the management time required to maintain the stand is low (Stanley, Haney, Grimm and Deaton, 1987).

Few Richmond CRP participants took the option of planting trees. Of the 80 CRP contracts made in Richmond county, only 13 included some acres designated for tree

planting. Overall, 8.2 percent (126 acres) of all 1,545.4 acres enrolled were to be planted in trees (USDA-ASCS, 1990). In addition, one farm enrolled 32.8 acres that were too wet to farm and, according to ASCS officials, that land is being planted in trees. Over 67 percent of the contracts made in Richmond county were designated for grass cover (see table 2.7).

Richmond county farmers may not have considered the tree-planting option an incentive for enrollment because it would limit their options after the 10-year contracts expire. In a study of a CRP-type program in the United Kingdom, Potter and Gasson (1988) found that woodland schemes were unpopular because farmers thought planting productive farmland in trees was "...too long-term and irreversible..." (p.369). Farmers in this study also indicated that planting trees would "reduce flexibility and their ability to respond to new opportunities" (p. 370). County forester Tom Brooks suggests that most CRP participants in Richmond planted grass cover, instead of trees, because it would make it easier to bring their CRP acreage back into production at the end of the contract period (Brooks, Richmond county Forester, personal communication, July 15, 1991). Richmond county farmers may also have perceived timber production as a different business than farming that required a different set of skills and, thus, were not interested in this option.

**Leasing land for hunting.** Farmers participating in CRP may also earn extra income by planting the land in trees or grass cover attractive to wildlife and leasing the land for hunting. Non-monetary benefits may include the farmer's utility from seeing wildlife attracted to the land ( Konyar and Osborn, 1990). Most studies have found that the opportunity to create wildlife habitats or plant trees have provided little incentive for CRP participation. The AFT study (Esseks and Kraft, 1987) found that only a small percentage of participants said they had submitted a bid to promote habitats for

wildlife and recreation. However, Miller and Bromley (1988) found that a high percentage (72 percent of 616 participants surveyed) of Virginia landowners who had already enrolled in CRP were interested in improving wildlife habitats on their CRP land. Their reasons included the satisfaction of seeing wildlife, personal opportunities for hunting, and the preservation of wildlife for future generations. It cannot be determined whether the wildlife benefits were an incentive for enrollment or an afterthought.

The market for hunting land in Richmond appears to be growing. According to County Forester Tom Brooks, more and more commercial timber land in the county is being leased out for hunting and private landowners are following suit (Brooks, personal communication, July 1991). Deer and turkey hunting are popular in the county, as well as some duck and goose hunting. Small game such as rabbits, squirrel and quail are also hunted. The county has 25 to 30 hunt clubs that lease land for hunting (Charles Johnson, Richmond County Game Warden, personal communication, July 18, 1991). In addition, a non-permanent structure such as a duck blind could be placed on CRP land to make it more attractive to hunters (Roger Brown, Richmond ASCS, personal communication, May 27, 1992).

Estimates of average leasing rates range from $1 per acre to $3 per acre, with some rates as high as $5 to $6 per acre (Johnson; Brooks; Steve Brock, Department of Game and Inland Fisheries, personal communication, July 18, 1991). It is not uncommon for groups from Fredericksburg and other metropolitan areas to pay $15,000 to $18,000 to contract 100 acres for seasonal hunting rights (Johnson).

The opportunity to develop hunting land does not appear to have attracted many CRP participants in Richmond county. In addition to the low enrollment in the tree-

planting option, only one contract designated 4 acres of CRP land to be planted in wildlife food plots.

**Release of labor and management/Guaranteed 10-year income.** An indirect monetary benefit of CRP enrollment results from the release of labor and management resources that occurs when the land was enrolled. These resources could be directed toward earning income from sources off the farm (Boggess,1987) or toward other farming enterprises (Taff and Halbach, 1988) and possibly result in additional income.

This benefit may have appealed to older farmers, who had "fewer risks" and chose to enroll as a means of retiring from farming or cutting back the number of acres they farmed while having a guaranteed annual income. Swanson, Stephenson, and Skees (1990) and Mortensen et al. (1989) found that older farmers were more likely to sign up. Other studies, however, have shown that older farmers were less likely to enroll (Konyar and Osborn, 1990; Esseks and Kraft, 1987). Some farmers may also have considered the decreased land-management demands to be a benefit that allowed them to spend more time with their family or have more vacation time (Konyar and Osborn, 1990).

Although enrolling in CRP could have reduced farmers' labor and management time and allowed them to seek off-farm employment, such opportunities are limited in Richmond county. In phone interviews with Richmond county ASCS, SCS, and Extension personnel (1987), one official reported that, while 60 to 65 percent of the farmers were full-time, some were switching to part-time. However, their options were limited because agriculture is the main economic activity in the county.

However, many farmers in the county already appear to be farming less than full-time. Of the 144 farms reporting in the 1987 U.S. Census of Agriculture (USDC, 1989), more than 43 percent (62 farm operators) did not work off the farm at anytime during

the year, while 56.9 percent did at some point. Of those who did work off the farm, 62.2 percent spent 200 days or more working at sites off the farm.

Many farmers in Richmond are approaching retirement age and participating in CRP could have allowed them to retire with a guaranteed income. The average age of farmers in Richmond is 54.7 years (USCD, 1989). It is also possible that some of these older farmers have children to pass their land to and would not have wanted to get tied into CRP. However, in a survey of 39 Richmond county farmers, Hwang (1990) found that over 64 percent of the farmers surveyed were 55 years or older and that only 16 percent of those farmers had children or relatives to whom they could transfer their land. Most of these farmers planned to farm their land for another 10 years.

The 10-year agreement could also be perceived as a cost by some farmers since it would limit their ability to respond to other profitable land uses as they arise. For Richmond county farmers that were aware of the potential for increased development in the Northern Neck region, the lack of flexibility may have have been perceived as a high cost. The importance of flexibility may also be influenced by farmers' perceptions of future opportunities; for example, what they believe will happen to crop prices.

**Getting "In Compliance".** Conservation compliance, another conservation program established in the 1985 Farm Bill, may also have been an incentive to CRP participation. This program required farmers to file a conservation plan for their highly erodible acres with ASCS by January 1990. The plan must be implemented by January 1995 or they will lose all farm program benefits. Although there were some definitional discrepancies between the land eligible for CRP and land subject to conservation compliance, the penalty for non-compliance was intended to encourage farmers to enroll in CRP by increasing the costs associated with not enrolling (Dicks, 1987). These costs include the cost of implementing the conservation plan, future loses

of program base, and future loses of all program benefits. The base reductions associated with CRP enrollment in Richmond county (see table 2.5) indicate that at least some of the CRP participants were maintaining farm program base acres.

Interviews with extension and SCS personnel indicated that conservation compliance penalties may have encouraged some farmers to enroll. Incentive to enroll would be strong in cases where conservation plans required farmers to take land out of production, were too restrictive to continue raising crops,or required crop rotations that could not be carried out or were unnecessary -- for example, a rotation that included 2 years of hay production that the farmer couldn't use (Headley, personal communication, July 9, 1990; Kelly Liddington, Richmond County Extension Service, personal communication, 1989).

However, the conservation plans required for compliance in Richmond county do not appear to have been very demanding. Roger Brown of Richmond county ASCS estimates that approximately 50 percent of the land in the county was subject to conservation compliance, based on farm program enrollment. By 1991 almost all of the operators of these farms had completed their compliance plan; many had only needed to file their plan since the practices were already in place (Brown, personal communication, July 7, 1991).

Compliance may not have been an incentive to enroll in CRP because of the other cost-share programs available to farmers in the county. The Agricultural Conservation Program (ACP) is a federal program that offers payments to farmers to cover up to 75 percent of the costs of implementing BMPs; total payments to individual farmers cannot exceed $3,500 per year (Atwood, Frohberg, Johnson, Robertson, and Thompson, 1989; Wilson Leggett, Virginia ASCS, personal communication, July 15, 1991). According to Atwood et al. (1989), ACP provides funds for conservation cropping

systems, water diversion, and forest-timber protection and maintenance. The goals of ACP are similar to those of CRP: reducing soil erosion and nonpoint-source pollution and improving soil productivity, water quality and wildlife habitats. Lands that met the criteria for ACP were also eligible for CRP (Dicks, Llacuna, and Lisenbigler, 1988). However, CRP participants could not receive ACP payments for their CRP acres.

The Virginia Agricultural BMP Cost-Share Program also offers cost-share payments for a variety of practices including no-till cropland and pastureland, strip-cropping systems, sod waterways and terraces. The amount of the cost-share paid depends on the type of practice that needs to be implemented.

These programs may have competed with CRP as a way of getting in compliance, since they provide funds to farmers to install conservation practices but do not require them to idle their land. For farmers who needed to get in-compliance to retain their farm program benefits, yet wanted to continue farming all of their cropland, participation in these programs may have been preferable to CRP.

**Indirect costs**

The reduction in base associated with CRP enrollment, popularly known as the "base bite," is the main indirect cost of enrolling in CRP. The base bite reduces the number of permitted acres,[11] which is the maximum number of acres that can be planted to a crop (Taff and Halbach, 1988). Since government payments are based on "program production" (permitted acres x program yields), deficiency payments are reduced in proportion to the amount of base acres reduced by the base bite. The decrease in permitted acres also decreases revenues from the sale of the crop (Taff and Halbach, 1988).

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[11] "Permitted acres" is the amount of base acres minus idled acres (USDA-ERS, 1990).

Taff and Halbach (1988) note that the amount of land that must be "set-aside" is reduced because of the base bite, which decreases set-aside maintenance costs and thus CRP entry costs. In addition, they predicted that farmers who participated in CRP would allocate their base bite over the program acres that were the "least lucrative" and thus reduce the amount of lost revenue. However, they concluded the net effect of CRP enrollment on farm program benefits is always negative.

Participation in farm programs may have two additional effects on CRP enrollment. Taff and Runge (1988) noted that marginal acres that were eligible for CRP may have been held out of the program so they can be counted toward ARP. Esseks and Kraft (1989) hypothesized that farmers enrolled in farm programs would be more aware of CRP because of their annual contact with the ASCS office, and subsequently would be more likely to enroll.

Because of the base bite, farm program participants who enrolled in CRP would have required a higher rental rate to compensate for the loss of farm program benefits (Boggess, 1987). In counties such as Richmond, the impact of farm program participation on CRP enrollment depends on the relative size and make-up of commodity acreage bases on farms (Taff and Halbach, 1988), and the relative importance of those benefits to individual farmers.

How important are farm program benefits to farmers in Richmond county? Virginia Tech's 1987 survey of farmers in Richmond county indicates some of the attitudes about the relationship of farm programs to CRP (VPI&SU, 1987). Fifty percent of the respondents who had not yet submitted a bid agreed or tended to agree that one reason they had not submitted a bid was to protect their grain base. However, only 18.8 percent indicated that one of their reasons for not entering a bid was a preference not to participate in government programs (see appendix D).

When asked about their participation in farm programs from 1981 through 1988, all the respondents said they had not participated in the feed grain programs (which include corn sorghum, oats and barley), 40 percent had not participated in the wheat program, 86.7 percent had not participated in FmHA loan programs, and 93.3 percent had not participated in federal crop insurance programs. The feed grain program results may be suspect because participation in feed grain programs in Richmond county and the other four counties surveyed averages over fifty percent. Respondents may not have known that what they call "corn programs" or "set-aside" programs are technically known as "feed grain programs" (Ligon et al., 1988).

There is additional evidence, however, that participating in farm programs or at least maintaining base is important to Richmond county farmers. The 1987 U.S. Census of Agriculture indicates that 82 farms in Richmond county received $749,000 in government payments in 1987, an average of $9,139 per farm (USDC, 1989).[12] In 1982, two farms in Richmond county reported acreage diverted under annual commodity adjustment programs. In 1987, 73 farms reported a total of 3,244 acres diverted under annual commodity acreage adjustment programs (USDC, 1989).[13]

In 1987, over 23,073 acres were registered with 63.6 percent (14,660 acres) enrolled in the Acreage Reduction Program (ARP), which means farmers received deficiency payments on those acres for that year. Based on cropland estimates reported in the 1987 U.S. Census of Agriculture (35,041 acres), base acreage compromised 65.8 percent of the county's cropland and 42 percent of the cropland was enrolled in ARP (USDC, 1989). In

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[12] According to the 1987 Census of Agriculture (USDC, 1989), "government payments" is limited to direct cash or generic commodity certificate payments (PIK) and includes all federal farm programs that made payments directly to farm operators.

[13] According to the U.S. Census of Agriculture (USDC, 1989), these figures include acres diverted or set aside under the provisions of the Federal Commodity Acreage Program by growers of wheat, cotton, rice, corn, sorghum, barley, and oats, and devoted to conservation uses.

1988, in 22,888 acres (65.32 percent of the county's cropland base) were registered with 70.79 percent enrolled in ARP (Jack Hubert, Virginia ASCS State Office, personal communication, July 19, 1991). These figures indicate that many acres in the county are tied into farm programs, at least for the purposes of maintaining base.

While base enrollment and farm program participation is fairly high in terms of acreage, it may be low in terms of the number of farm operators receiving these benefits (Brown, personal communication, July 19, 1991). For example, in 1990, 580 farm units in Richmond county enrolled a total of 19,231 acres of base, and only 100 farm units with 7,983 acres actually participated by enrolling in ARP (Jack Hubert, Virginia ASCS, personal communication, March 1991). The reductions in base acreage associated with CRP enrollment indicate that at least some farm program participants were enrolling in CRP (see table 2.5).

## OTHER LAND-USE OPTIONS IN RICHMOND COUNTY

In general farmers have several options for using their cropland other than placing it in CRP. They could use it for pasture, hay or cash crops; rent or sell it to another farmer; or sell the land for another purpose, such as residential development or hunting land. The feasibility and viability of these options indicates how strongly they may have competed with CRP enrollment.

**Producing pasture or hay.** CRP rules do not allow either grazing or hay cutting on CRP land, although both have been allowed in certain regions during periods of drought. For farmers with livestock or who have an opportunity to sell hay, this restriction represents an opportunity cost. If they enroll in CRP, they forego potential income from selling hay or have fewer acres for grazing or providing hay for their own livestock. Both Esseks and Kraft (1987) and Purvis, Hoehn, and Sorenson (1989)

**Table 2.9** **Comparison of hay production and livestock numbers in Virginia's Northern Neck, 1989 (except as noted).**

| | Total hay production | | Livestock numbers | | | |
|---|---|---|---|---|---|---|
| County | Harvested acres | Production (tons) | All cattle and calves | Milk cows | Sheep and lambs | Horses and ponies |
| King George | 3,500 | 8,300 | 3,000 | 0 | 0 | 198 |
| Lancaster | <500 | -- | 700 | 0 | 0 | 36 |
| Northumberland | 700 | 1,900 | 800 | 0 | 0 | 57 |
| Richmond | 1,200 | 2,900 | 1,500 | 0 | 0 | 14 |
| Westmoreland | 1,800 | 4,500 | 2,800 | 0 | 0 | 42 |

Source: Virginia Agricultural Statistics Service (1990); USDC (1989)
Notes: Horse and pony numbers are from 1987.

determined that permitting grazing and hay cutting on CRP land and on filter strips would be an attractive enrollment incentive.

The 1987 Census of Agriculture reports that only 2.7 percent of the cropland (962 acres) in Richmond county is used only for pasture or grazing. The livestock, horse, and dairy industries are fairly small in Richmond (see table 2.9); only 1,500 cattle and calves and 14 horses were reported in the 1987 Census of Agriculture (USDC, 1989). With such a limited amount of livestock, few farmers may have perceived the grazing and hay-cutting restrictions as a disincentive to enrolling. The grazing and hay-cutting restrictions were relaxed for two years in Richmond between 1986 and 1989. CRP participants were allowed to cut hay and take a 25 percent reduction in their payments or let their cattle graze with no reduction in payments. However, according to SCS, nobody took advantage of either option ( Roger Brown, Richmond ASCS, personal

communication, March 1991). This lack of activity may further indicate that those enrolled in CRP did not need the land to feed livestock, or it could simply indicate a lack of information.

Producing and selling hay, however, may have been competitive with enrolling in CRP. In 1989, hay production in the county totaled 2,900 tons from 1,200 acres, with average yields of 2.4 tons per acre (see table 2.9). Between 1985 and 1989, hay prices in Richmond were between $82.50 per ton and $94.00 per ton (Virginia Agricultural Statistics Service, 1990).

The limited amount of livestock production in the county may indicate a limited market for hay, at least within the county. Both King George and Westmoreland counties had roughly twice the number of cattle and calves Richmond county did in 1987 (USCD, 1989). These counties, as well as Lancaster and Northumberland, produce some hay (see table 2.9). It is hypothesized that these counties would not be strong markets for Richmond-grown hay or competitors in the hay market.

**Selling land for commercial or residential development.** Growth in metropolitan areas may increase opportunities to sell land for residential or commercial development (Gray, Dann, and Vinis, 1988). At the present time, however, opportunities to sell cropland for nonfarm purposes appear to be limited in Richmond county.

Compared to other counties in the Northern Neck, Richmond ranks fourth in terms of developed land (Kelly Liddington, Richmond Extension Service, personal communication, November 1989). Most farms in the county are located in rural areas with limited commercial or residential development. Of the 30 farmers who responded to the 1987 Virginia Tech survey (VPI&SU, 1987), 43 percent farmed in a very rural area and 53 percent farmed in areas with limited residential development. Only one

respondent indicated that he/she farmed in an area with mostly residential or commercial development.

In addition, the Commissioner of Revenue's office in Richmond county reported that the market for both marshland and waterfront property in 1990 was slow. Marshland that is being sold is going for approximately $75 per acre; waterfront lots, which is usually small cottages and a limited number of acres, is selling for $35,000 to $40,000 per lot (personal communication, July 9, 1990).

CRP land can be sold. In most cases the original landowner must pay back all rental payments and the new owner must continue or re-start the contract (Hoag, 1988). While this would preclude the land from being sold for development, it could be sold for hunting land or other purposes. Farmland values in Virginia averaged $1,221.25 per acre between 1986 and 1989 (Virginia Agricultural Statistics Service, 1990).

**Renting farmland.** Renting cropland offers some benefits to landowners: it allows them to maintain control of their land and provides a temporary release of labor and management time. The 1987 U.S. Census of Agriculture (USDC, 1989) reports that, in 1987, 70 farmers in Richmond were owned all the land they operated and accounted for 12,778 acres of cropland and 4,963 acres of harvested cropland. Fifty-nine farmed both owned and rented land. All together, these farmers rented 13, 088 acres and owned 9,681 acres. Nineteen farmers were tenants, accounting for some 3,544 acres.

Average cash rents per acre for farmland in Virginia remained steady between 1984 and 1989 (see table 2.10). Rents ranged from $36.20 to $37.70 for cropland, and from $20.40 to $24.60 for pastureland. A survey of landowners in the Northern Neck Peninsula in 1988 (VCES, 1988) indicated that rents were $53.75 for 120-bushel corn land, $42.50 for 100-bushel corn land, and $34.55 for 80-bushel corn land, and $32.50

**Table 2.10 Farms, cropland, and pasture rented for cash in Virginia -- gross cash rents ($/acre), 1980-1990.**

| Year | Farms | Cropland | Pasture |
|---|---|---|---|
| **1980** | 27.80 | 37.10 | 17.70 |
| **1984** | 33.33 | 36.75 | 24.26 |
| **1985** | 29.40 | 37.60 | 22.30 |
| **1986** | 30.20 | N/A | 20.00 |
| **1987** | 30.50 | 37.70 | 22.80 |
| **1988** | 28.70 | 36.20 | 20.40 |
| **1989** | 29.20 | 37.40 | 21.00 |
| **1990** | 30.10 | 37.70 | 22.40 |

Source: Virginia Agricultural Statistics Service (1990)
Note: N/A = data not available.

for hayland. Thus, at the farm level, cash rents may vary according to the land's production potential and use.

While many farmers in the county appear to be cutting back on their operations and attempting to place more of their land on the rental market, Richmond county extension agent Kelly Liddington reported that overall, cash rents tended to be low due to a shortage of renters. Some farmers were getting up to $80 per acre for their land, but those instances were the exception (Kelly Liddington, Richmond Extension Service, personal communication, November 1989). Richmond county farmers who responded to Virginia Tech's 1987 CRP survey indicated that, on average, they received $44.27 per acre per year for renting cropland and pastureland (VPI&SU, 1987). Their responses ranged from $10 to $85.

For some Richmond county farmers, renting their cropland to another farmer may have been an attractive option: they could still receive a rental payment for the land without being locked into a 10-year agreement. They may have been willing to accept

the slightly lower rental rate offered on the open market and forgo higher CRP rental rates in exchange for a little flexibility. However, based on the rental values given above, and the fact that the rental market in Richmond is somewhat weak, it is not likely that the option of renting farmland was competitive with CRP enrollment for most farmers.

**Continuing crop production.** In general, rental prices for farmland are dependent on the market for land, which in turn depends on prices and production costs, excluding the cost of the land, as well as the productive capacity and location of the land itself (Bressler and King, 1978). From that perspective it appears that the value of cash rents can be used to measure both the potential income from renting land to another farmer and the net revenues from production forfeited when land is enrolled in CRP. However, since many farmers in Richmond may be choosing to place their land on the rental market for personal reasons rather than financial and because there is a shortage of renters, farmers may be willing to accept lower cash rents for their land. Thus, cash rents may not reflect the productive value of the land. In this case, then, the potential returns from growing crops must be considered separately when analyzing CRP enrollment opportunity costs.

Crop prices may have had an affect on CRP enrollment. Purvis, Hoehn, and Sorenson (1989) found that as average yields increased, farmers were less likely to participate in filter-strip programs. They also found that future expectations about prices significantly affected enrollment. They concluded that, while the length of the contract was a deterrent to some farmers, those farmers who believe that farm prices would rise slower than inflation were more willing to participate.

According the 1987 U.S. Census of Agriculture (USDC, 1989), cash crops were harvested on nearly 63 percent of the county's 35,041 acres of cropland. Corn, wheat,

**Table 2.11** **Acreage and total production of barley, corn, soybeans and wheat in Richmond county, Virginia, 1987.**

| Crop | Amount planted (acres) | Amount harvested (acres) | Total production (bushels) |
|---|---|---|---|
| **Barley** | 2,500 | 2,500 | 162,500 |
| **Corn** | 6,500 | 6,300 | 510,300 |
| **Soybeans** | 11,800 | 11,700 | 222,300 |
| **Wheat** | 5,800 | 5,500 | 264,000 |

Source: Virginia Agricultural Statistics Service (1990)

barley and soybeans are the main crops grown in Richmond county (see table 2.11). In the Northern Neck, these crops are often grown in a 2-year rotation. This rotation includes minimum tillage corn in one year followed by conventional-tilled small grains, usually wheat and barley, followed by no-till soybeans in the second year (Norris, 1988). Results of a survey of 38 Richmond county farmers reported by Dietz and Ross (1990) showed that 75 percent of those surveyed were practicing crop rotations.

Average net returns for these crops in Virginia's Northern Neck were projected for 1987 using a 10-year average of real prices and yields (see table 2.12). Net returns per acre for all crops and a corn/wheat-barley/soybeans rotation were positive.

Because of the positive returns, crop production in Richmond county has the potential to be highly competitive with CRP enrollment. Other factors may also have encouraged Richmond county farmers to continue raising crops: Nassauer (1989) suggests that some farmers may receive additional benefit from being able to continue carrying out farm operations and maintaining a productive look to their farm by keeping it in crops.

**Table 2.12 Expected net revenues from selected crops in Richmond county, Virginia, in 1987 dollars ($/acre).**

| Crop | Expected gross revenue | Variable costs | Expected net revenue |
|---|---|---|---|
| **Corn** | 373.49 | 177.34 | 196.15 |
| **Wheat** | 181.94 | 111.63 | 70.31 |
| **Barley** | 151.69 | 116.25 | 35.44 |
| **Soybeans** | 243.21 | 116.43 | 126.78 |
| **Rotation** | 391.77 | 203.31 | 188.46 |

Note: See appendix E for a summary of these calculations.

**CRP VERSUS CROP PRODUCTION**

Growing cash crops and placing land in CRP appear to have been the most feasible land-use options for Richmond county farmers. Producing hay to sell, renting cropland to other producers and selling land all have the potential to be financially competitive with CRP. However, these options appear to have been limited in Richmond county due to restricted markets, at least during the CRP sign-ups between 1986 and 1989. (See table 2.13 for a summary of benefits, costs and feasibility of land-use options.)

As a result, it is likely that most farmers in Richmond county weighed CRP participation against the foregone returns to crop production, once they were aware of CRP and their eligibility for it. Since the decision to enroll in CRP represents a 10-year commitment, the decision to continue crop production must be compared on a 10-year basis.

Net present values for CRP enrollment were calculated for rental payments of $50,$61, and $70 per acre per year for a 10-year period at 8-, 10-, and 12 -percent discount rates. The maximum acceptable rental rates were used as the standard rental

**Table 2.13 Monetary benefits, indirect benefits, direct costs, indirect costs, and feasibility[a] of land-use options in Richmond county, Virginia.**

| Attributes of the Choice | Land-Use Options: Sell land | Continue producing crops | Produce pasture or hay | Rent farmland | Enroll in CRP |
|---|---|---|---|---|---|
| Monetary benefits | *Income from sale of land. | *Annual income from sale of crops. | *Income from sale of hay. | *Rental payments. | *Annual payments for 10 years.[b] |
| Indirect benefits | *Release of labor and management. | *Aesthetic/personal benefits from continuing to farm. | *Ability to provide hay or pasture for livestock. | *Maintain control of land<br>*Temporary release of labor and management. | *May put farm "in compliance."<br>*Maintenance or improvement of soil productivity.<br>*Release of labor/management.<br>*Guaranteed income.<br>*Additional income from tree-harvest or leasing for hunting. |
| Direct costs | *Transaction costs. | *Production costs. | *Production costs. | *Transaction costs. | *50% of cover establishment costs. |
| Indirect/ opportunity costs | *Forgo all future opportunities to farm. | *Future losses of soil productivity due to soil erosion.<br>*Failure to be "in-compliance/loss of all program benefits. | *Forgo other land uses. | *Forgo other land uses.<br>*Lose direct control of land. | *Foregoing other land-use options for 10 years. years. More if trees are planted.<br>*Reductions in base acreage and farm program benefits. |
| Feasibility | *Limited market; may improve in the future. | *Agriculture is the main industry; marketing/ transportation structure is in place. | *Limited livestock & and horse production.<br>*Limited hay markets. | *Rental market is soft; little room for new lands to enter rental market. | *Feasible if land meets cropping, ownership and erodibility requirements. |

[a] Feasibility indicates whether the option has the potential to generate the benefits listed or is an option for farmers in the county.

[b] In addition to the rental payment, one-time incentive payments were offered for corn land enrolled in sign-up period four and filter strips enrolled in sign-up period nine.

rates since most CRP participants eventually began bidding at that level (see table 2.4). Most CRP participants in Richmond designated their contracts to begin in the spring of the year following their decision to enroll and began receiving payments more than a year after their actual decision to enroll. Thus, a 10-year stream of returns was used to calculate the net present value of their decision to enroll. Discount rates were selected to reflect some variation in individual landowner's future expectations.

The impact of the "base bite" was not considered in this analysis since the degree of impact would vary between participants because of differences in enrolled acreage and registered base acreage. However, even though base is restored to pre-enrollment levels after the contract expires, reductions in farm program payments resulting from the base bite would still be a cost during the 10-year contract period. Thus, the actual returns to CRP participation may be lower than those shown in this analysis because the impact of the base bite is not included.

Net present values for CRP contracts that were designated for wildlife food plots or for trees to be planted on wetlands were not considered in this analysis since few participants chose these options. Although ASCS data did not distinguish between filter strips planted in trees and those planted in grass, it was assumed that these strips were planted in grass since most CRP acreage overall was planted in grass cover. Net present values for filter-strips payments were not calculated at the $50 per acre rental payment because the option was not available during the sign-up periods when the MARR was $50 per acre.

For grass cover and filter strips, establishment costs were assumed to be paid out in Year 1 of enrollment and were subtracted from that year's rental payment. These costs were derived from averages of the costs-share payments estimated by ASCS since farmers were to receive 50 percent of the establishment costs through a cost-sharing

program. Although actual cost-share payments made by ASCS would be a better indicator of farmers' establishment costs, complete data on these payments was unavailable. It should be noted, though, that actual payments that were reported by Richmond ASCS tended to be lower than the estimates. Establishment costs, which are reported in table 2.7, varied by the type of cover selected for CRP acreage.

Since cost-sharing was not available for maintaining CRP acreage, but maintenance was required by the contract, it was assumed that CRP acreage in grass cover and grass filter strips would be maintained by mowing. Custom rates for bush-hogging in the Northern Neck region average $20.94 per hour (VCES, 1988). Assuming that the equipment can work 5.73 acres per hour (VCES, 1988) and the acreage is to be mowed twice a year, the maintenance costs would be $7.30 per acre beginning in Year 2 of enrollment. For acreage with grass cover already established (no cost-share paid), this maintenance cost would began in Year 1.

Net present values were also calculated for returns to production of corn, wheat, barley and soybeans and a typical rotation of those crops. Projected net revenues for 1987 were derived from 10-year averages of yields and real prices in the Northern Neck region and production budgets for the region. These budgets accounted for labor and management time, input costs and production interest. For the purpose of this analysis, 1987 was assumed to represent expected net returns for each year in the 10-year contract period. Since many farmers may have enrolled marginally productive acreage in CRP, net present values were also calculated for crops assuming a 15 percent reduction in yields. See appendix E for a summary of these calculations.

The net present values of returns to CRP enrollment and crop production on average-yielding acres are compared in table 2.14. In almost all cases, net returns to crop production were higher than those from CRP acres planted in grass cover, with

**Table 2.14 Net present value of returns from a 10-year stream of CRP payments compared to a 10-year stream of net returns to crop production on average-yielding acres in Richmond county, Virginia ($/acre).**

| Rental rates | Discount rate | Grass cover | Pre-estalished cover | Filter strips | Corn | Wheat | Barley | Soybeans | Rotation |
|---|---|---|---|---|---|---|---|---|---|
| **$50** | 8% | 229.07 | 286.52 | ---------- | 1,316.17 | 471.78 | 237.80 | 850.69 | 1,264.57 |
| | 10% | 206.99 | 262.39 | ---------- | 1,205.34 | 432.05 | 217.78 | 779.06 | 1,158.09 |
| | 12% | 185.94 | 241.26 | ---------- | 1,108.25 | 397.25 | 200.24 | 716.31 | 1,064.80 |
| **$61** | 8% | 302.87 | 360.33 | 283.19 | 1,316.17 | 471.78 | 237.80 | 850.69 | 1,264.57 |
| | 10% | 273.58 | 329.99 | 254.26 | 1,205.34 | 432.05 | 217.78 | 779.06 | 1,158.09 |
| | 12% | 248.10 | 303.41 | 229.11 | 1,108.25 | 397.25 | 200.24 | 716.31 | 1,064.80 |
| **$70** | 8% | 363.25 | 420.72 | 343.56 | 1,316.17 | 471.78 | 237.80 | 850.69 | 1,264.57 |
| | 10% | 328.88 | 385.29 | 309.55 | 1,205.34 | 432.05 | 217.78 | 779.06 | 1,158.09 |
| | 12% | 298.95 | 354.26 | 279.97 | 1,108.25 | 397.25 | 200.24 | 716.31 | 1,064.80 |

Note: The filter-strip option was not available when Maximum Acceptable Rental Rates were $50.

grass cover already established, or filter strips. Barley was the exception. The net present value of returns to barley production were only higher than CRP acres in grass cover or pre-established cover at 8 percent discount rates when CRP rents were $50 per acre per year. Based this analysis, a profit-maximizing farmer would continue to grow crops rather than placing land in CRP since crop production has a higher profit potential.

CRP appears to have been more competitive with marginally productive crop acreage (see tables 2.15). The net present value of returns to corn, soybeans and the rotation on acreage that yielded 15 percent less than average were all higher than those from CRP lands in grass cover and filter strips at all discount rates and rent levels. However, at all rent levels and discount rates, the net present value of returns to barley production were lower than those from CRP. At $50 per acre rental rates, the net present value of returns to wheat production on marginal land were always higher than those from CRP. However, returns to wheat production were only a few dollars higher than those from CRP lands with cover already established. At $61 per acre rental rates, the net present value of returns to CRP were higher than wheat production with the exception of CRP land in filter strips. At $70 rental rates, the net present value of returns to CRP was higher than returns to wheat production in all cases.

From this analysis it appears that farmers growing wheat and barley would probably enrolled in CRP rather than continuing to raise those crop. However, they also could switch to one of crops with higher overall returns such as corn. Although crop production on marginal land was more profitable than CRP filter strips in the case of wheat and barley, it should be noted that filter strips as "bottomland" may not be marginally productive acreage (Frohberg et al., 1989).

**Table 2.15 Net present value of returns from a 10-year stream of CRP payments compared to a 10-year stream of returns to crop production in Richmond county, Virginia, assuming a 15-percent reduction in yields ($/acre).**

| Rental rates | Discount rate | Grass cover | Pre-established cover | Filter strips | Corn | Wheat | Barley | Soybeans | Rotation |
|---|---|---|---|---|---|---|---|---|---|
| **$50** | 8% | 229.07 | 286.52 | ---------- | 940.21 | 288.73 | 85.08 | 606.18 | 870.35 |
| | 10% | 206.99 | 262.39 | ---------- | 861.04 | 264.42 | 77.92 | 555.15 | 797.07 |
| | 12% | 185.94 | 241.26 | ---------- | 791.68 | 243.12 | 71.64 | 510.42 | 732.86 |
| **$61** | 8% | 302.87 | 360.33 | 283.19 | 940.21 | 288.73 | 85.08 | 606.18 | 870.35 |
| | 10% | 273.58 | 329.99 | 254.26 | 861.04 | 264.42 | 77.92 | 555.15 | 797.07 |
| | 12% | 248.10 | 303.41 | 229.11 | 791.68 | 243.12 | 71.64 | 510.42 | 732.86 |
| **$70** | 8% | 363.25 | 420.72 | 343.56 | 940.21 | 288.73 | 85.08 | 606.18 | 870.35 |
| | 10% | 328.88 | 385.29 | 309.55 | 861.04 | 264.42 | 77.92 | 555.15 | 797.07 |
| | 12% | 298.95 | 354.26 | 279.97 | 791.68 | 243.12 | 71.64 | 510.42 | 732.86 |

Note: The filter-strip option was not available when Maximum Acceptable Rental Rates were $50.

One positive aspect of CRP enrollment compared to crop production is the release of labor and management time derived from retiring land. However, the actual time released for farmers who enrolled in Richmond county may have been fairly low. The average contract made in Richmond county was for 19.73 acres. Based on the number of field hours required for producing corn, wheat, barley or soybeans, an average contract would only have released about 6 days of "extra" time each year. For crops grown in rotation, it would have only freed up a little over 7 day each year. (See appendix F for a summary of these calculations.)

The net present value of returns to CRP acreage planted in Loblolly pine were derived from annual equivalent returns to timber production at prices of $55, $80, $105 and $130 per thousand board feet compiled by Stanley, Haney, Grimm, and Deaton (1987; see table 2.8). These annualized values accounted for the periodic income from timber production at thinning and harvest over a 45-year rotation period and for establishment costs, land management fees and property taxes.

To convert these annual values to net present values, they were divided by the appropriate capitol recovery factor [$i(1+i)^n / (1+i)^n - 1$ where n=45 years] at 8-percent, 10-percent, and 12-percent discount rates (Harry Haney, professor and extension specialist in management and economics, Dept. of Forestry, Virginia Tech; personal communication, August 25, 1992). The net present values of $50, $61, and $70 rental rates were then added to these values for timber to obtain a total net present value of returns from CRP land planted in trees. This total value was then compared to the expected net present value of returns from crop production over a 45-year period on both average-yielding and marginal-yielding acres.

The net present value of returns from average-yielding cropland were compared to the net present value of timber returns from an "Excellent" site (expected height of 65

feet in 25 years; see table 2.8). According to Haney (personal communication, January 28. 1993), productive land suitable for row-crop production is roughly equivalent to an "Excellent" site. The net present value of returns from marginal-yielding crops were compared to the net present value of timber returns from a "Good" site (expected height of 60 feet in 25 years; see table 2.8).

It should be noted that a 45-year rotation may not reflect the true rotation length for stands of Loblolly pine on average or better-than-average sites in Richmond county. Haney (personal communication, January 28, 1993) points out that the maximum financial rotation lengths for these sites may vary between 25 and 35 years. However, because the annual equivalent values calculated by Stanley, Haney, Grimm, and Deaton (1987) were based on a 45-year rotation, that time period was used as a basis for this analysis.

It also should be noted that ASCS cost-share for establishing trees on CRP land was not included in this analysis. Estimated cost-shares for establishing trees on CRP land in Richmond county averaged $28.83 per acre (see table 2.7). Thus, the actual returns to CRP land planted in Loblolly pine may be slightly higher than resulting from this analysis.

On both average-yielding and marginal-yielding acres (see table 2.16 and table 2.17), the net present value of returns from corn and the rotation of corn, wheat, barley, and soybeans were always higher than the net present value of returns from CRP acreage planted in timber. With a few exceptions, the net present value of returns to soybeans produced on average-yielding acres was higher than those for CRP acreage in timber. In all of these cases, profit-maximizing farmers would probably choose to produce crops instead of enrolling in CRP and planting that acreage in Loblolly pine.

**Table 2.16 Net present value of returns to CRP acreage planted in Loblolly pine (45-year rotation; "Excellent" site) at a range of timber prices compared to the net present value of returns to crop production on average-yielding acres for a 45-year period in Richmond county, Virginia ($/acre).**

| Rental rate | Disount rate | Timber prices per thousand board ft. $55 | $80 | $105 | $130 | Corn | Wheat | Barley | Soybeans | Rotation |
|---|---|---|---|---|---|---|---|---|---|---|
| **$50** | 8% | 844.05 | 1,037.79 | 1,243.63 | 1,437.37 | 2,374.98 | 851.31 | 429.10 | 1,535.05 | 2,281.87 |
| | 10% | 504.51 | 593.27 | 682.04 | 760.94 | 1,934.63 | 693.47 | 349.55 | 1,250.43 | 1,858.78 |
| | 12% | 340.48 | 373.61 | 415.02 | 456.43 | 1,624.71 | 582.38 | 293.55 | 1,050.12 | 1,561.01 |
| **$61** | 8% | 917.86 | 1,111.60 | 1,317.44 | 1,511.18 | 2,374.98 | 851.31 | 429.10 | 1,535.05 | 2,281.87 |
| | 10% | 572.10 | 660.87 | 749.63 | 828.53 | 1,934.63 | 693.47 | 349.55 | 1,250.43 | 1,858.78 |
| | 12% | 402.63 | 435.76 | 477.17 | 518.58 | 1,624.71 | 582.38 | 293.55 | 1,050.12 | 1,561.01 |
| **$70** | 8% | 978.25 | 1,171.99 | 1,377.83 | 1,571.57 | 2,374.98 | 851.31 | 429.10 | 1,535.05 | 2,281.87 |
| | 10% | 627.41 | 716.17 | 804.94 | 883.84 | 1,934.63 | 693.47 | 349.55 | 1,250.43 | 1,858.78 |
| | 12% | 453.48 | 486.61 | 528.02 | 569.43 | 1,624.71 | 582.38 | 293.55 | 1,050.12 | 1,561.01 |

**Table 2.17 Net present value of returns to CRP acreage planted in Loblolly pine (45-year rotation; "Good" site) at a range of timber prices compared to the net present value of returns to crop production for a 45-year period in Richmond county, Virginia, assuming a 15 percent reduction in yields ($/acre).**

| Rental rate | Disount rate | Timber prices per thousand board ft. $55 | $80 | $105 | $130 | Corn | Wheat | Barley | Soybeans | Rotation |
|---|---|---|---|---|---|---|---|---|---|---|
| $50 | 8% | 771.40 | 953.08 | 1,134.66 | 1,316.28 | 1,696.57 | 521.01 | 153.53 | 1,093.84 | 1,570.53 |
| | 10% | 465.05 | 543.96 | 622.86 | 701.76 | 1,382.00 | 424.40 | 125.06 | 891.02 | 1,279.33 |
| | 12% | 315.63 | 348.76 | 381.89 | 432.30 | 1,106.61 | 356.42 | 105.03 | 748.29 | 1,074.39 |
| $61 | 8% | 845.21 | 1,026.89 | 1,208.47 | 1,390.09 | 1,696.57 | 521.01 | 153.53 | 1,093.84 | 1,570.53 |
| | 10% | 532.11 | 611.02 | 689.92 | 768.82 | 1,382.00 | 424.40 | 125.06 | 891.02 | 1,279.33 |
| | 12% | 377.78 | 410.91 | 444.04 | 485.45 | 1,106.61 | 356.42 | 105.03 | 748.29 | 1,074.39 |
| $70 | 8% | 905.60 | 1,087.28 | 1,268.86 | 1,450.48 | 1,696.57 | 521.01 | 153.53 | 1,093.84 | 1,570.53 |
| | 10% | 587.95 | 666.86 | 745.76 | 824.66 | 1,382.00 | 424.40 | 125.06 | 891.02 | 1,279.33 |
| | 12% | 428.63 | 461.76 | 494.89 | 536.30 | 1,106.61 | 356.42 | 105.03 | 748.29 | 1,074.39 |

On both average-yielding and marginal-yielding acres, the net present value of returns to barley production were always less than those from timber production on CRP land. The net present value of returns to wheat production were usually lower, except at 12-percent discount rates. However, in Richmond county, wheat and barley are usually grown as part of a rotation with corn, wheat and soybeans. Thus, it is unlikely that returns from barley or wheat alone would be compared with returns from CRP acres planted in timber.

In addition to the competitive value of crop production, another reason may have further discouraged farmers from enrolling in CRP and planting trees, or if they did enroll, choose to plant grass cover instead. A decision to plant Loblolly pine entails a 45-year commitment, as opposed to a 10-year commitment for CRP land planted in grass cover and the year-to-year decision to produce crops. Even though periodic income can be attained before harvest from CRP payments in the first 10 years and by thinning the stand, the largest portion of returns to this enterprise would not be realized until the timber was harvested. Some landowners near retirement or who have children who plan to farm may have shied away from the time commitment required to profit from timber. However, these landowners could have still enrolled a portion of their land in CRP and plant timber and sell it as timberland at the end of the 10-year contract period.

**CONCLUSIONS: WHAT INFLUENCED FARMERS' ENROLLMENT DECISIONS?**

The net present value analysis, combined with the characteristics of farmers and the existing economic environment in the county, reveals four areas may have determined the number of CRP participants in Richmond county and the number of acres enrolled: 1) the restrictions CRP enrollment would have placed on their crop production activities and their profits; 2) the restrictions CRP would have placed on

their future opportunities; 3) the effect of CRP enrollment on farm program benefits; 4) the options available for farmers to meet conservation compliance requirements.

Farmers in Richmond county who chose not to enroll in CRP may have done so for a variety of reasons. The most obvious is the positive present value of returns to corn production, a rotation of crops, and, in some cases, soybeans. Even when the added profits from planting Loblolly pine on CRP acreage were included in the analysis, the net present value of returns to producing corn and a rotation of crops were always higher.

Although farmers who did not enroll their highly erodible acreage in CRP would still be responsible for implementing a conservation compliance plan, it may not have encouraged them to enroll in CRP. The minimal effort that was apparently needed to comply and the existence of other cost-share programs may have lessened the threat of losing base acreage to compliance. Those Richmond county farmers who did enroll land in CRP may have enrolled just enough of their highly erodible acreage to avoid losing their farm program benefits. The number of base reductions corresponding to each sign-up period seem to indicate that many of the acres enrolled were from farms that were enrolled infarm programs. Further study of participation in CRP, ACP and the state's Best Management Practice program by farm program participants who were required to implement conservation plans would help explain the role of these programs and their impact on CRP enrollment.

The release of labor and management time provided by enrolling in CRP may not have attracted many farmers. For one reason, a farmer would probably have to enroll more than the county's average of 19.73 acres per contract if they expected to garner a substantial decrease in labor and management time. If Richmond county farmers had enrolled a substantial percentage of their acres in CRP to allow them to work off the

farm, they may not have been able to find work. Agriculture is the predominant industry in the county and employment opportunities off the farm appear to be limited Thus, prevailing economic conditions in Richmond county may have compounded the benefits of keeping acreage in crop production.

Limited off-farm opportunities and the fact that many farmers are 10 years from retirement age (the average age of farmers in the county is 54.7) may have affected both the number of farmers who chose to participate in CRP, as well as the quantity of land they chose to enroll. Farmers in Richmond county who planned to farm for another 10 years, such as those farmers surveyed and reported by Hwang, 1990, may have chosen not to enroll in CRP so they could continue to farm until retirement, or only enrolled a small number of acres in proportion to their total cropland so as not to interfere with their normal management practices or their profits. Future problems of soil erosion may not have encouraged these farmers to enroll since they are facing a fairly short planning horizon. On the other hand, some of these farmers near retirement may have enrolled just enough acreage to receive some of the guaranteed income to put away for retirement, while continuing to farm most of their acreage for another 10 years.

Many farmers may not have been willing to enroll in CRP since it would decrease their ability to respond to future opportunities. Richmond county's location with respect to Washington, D.C., and other metropolitan areas may increase opportunities to sell land to larger corporate farms or to suburbanites who wish to farm on the weekends, or to diversify their farming operations to meet new market opportunities. Those farmers who hoped to take advantage of these opportunities could have continued growing crops until the options became reality.

Farmers with a smaller number of total acres or those practicing crop rotations may not have been willing or able to sacrifice any of their cropland by placing it in CRP,

even if the land met the erodibility criteria. In addition, farmers already working part-time may have been farming an acreage appropriate to their available time for labor and management. These farmers may not have been able to increase their off-farm employment hours to match a decrease in farmable acreage created by CRP enrollment.

Most farmers in Richmond who enrolled in CRP appear to have enrolled only a small proportion of their acreage. For these farmers, the increase in the MARRs may have made it lucrative for them to enroll some acres, while still maintaining a "farmable" and profitable percentage of their total crop acres. The percentage of acres enrolled by the county's farmers may represent a break-even level of enrollment: farmers may have only enrolled acres that were visibly erodible, difficult to farm, least productive and(or) the minimum number of these acres they could enroll without interfering with normal cropping activities or their profits.

Further study of the relationship between farm size, crop production patterns, extent of off-farm employment and CRP participation could provide insights into Richmond county farmers' choices with respect to CRP. Factors such as whether these farmers intend to transfer their land to their children and their plans for retirement should also be studied further to determine farmers' planning horizons and their correlation with the existence and extent of CRP enrollment.

Of the farmers in Richmond county who have participated in farm programs, maintaining base acreage appears to be more important than actually enrolling, although actual participation (as shown by the acreage in the ARP programs) appears to be increasing from year to year. Although all farmers in Richmond county may not be involved in price-support and deficiency payment programs, there may have been enough of them for their choices to have made a significant impact on the number of participants and the number of acres enrolled.

Because maintaining base is important to these farmers, they may have chosen not to participate or limit the number of acres they enrolled because of the base bite. Because growing crops is one of the few profitable options for farmers in the county, farmers who chose to participate would have been particularly sensitive to the combined impact of ARP and CRP acreage reductions on their total cropland acres. Since some base acreage reductions corresponding to CRP enrollment were reported in the county, it can be assumed that some of the CRP participants were also maintaining farm-program base. This reason may explain why participation in CRP increased as the MARRs increased while the number of acres enrolled per contract increased only slightly: the higher rental rates may have encouraged these farmers to participate, but the base bite limited the number of acres they chose to enroll. A study of the relationship between the number of base acres enrolled by these farmers and the number of acres placed in CRP may help determine appropriate rental rates that would encourage participation among farm-program participants in Richmond county.

# *Chapter 3*
# CRP ENROLLMENT AND WATER QUALITY: POTENTIAL IMPACTS

Over the nine sign-up periods from 1986 to 1989, 1,545.4 acres in Richmond county were enrolled in CRP, approximately 4.9 percent of the county's cropland. Assuming county officials followed USDA eligibility criteria, enrollment of these acres was based on their erodibility and not their off-site impacts on water quality.

However, in the Chesapeake Bay, targeting land for CRP based solely on erodibility criteria may not have significantly improved water quality, regardless of the number of acres enrolled. Ribaudo (1989) found that per-acre water-quality benefits actually declined as more acreage was enrolled in CRP in the Appalachian, Mountain, Southeast, and Corn Belt regions. This result was attributed to the fact that acres that met the highly erodible criteria (high on-site damages) were enrolled first, not acres contributing to off-site damages. Thus, in Bay watershed counties like Richmond, enrolling acres in CRP without appropriate targeting could minimize CRP's overall potential to improve water quality in the region (Ribaudo, 1986) .

Given that CRP in Richmond county was not targeted to achieve maximum water quality benefits, what water quality benefits can be expected from the acres in

Richmond county that were enrolled in CRP? According to USDA (1989), the water-quality benefits attained from CRP will depend on three factors:

- the erosion levels, sediment-delivery ratios, and location of the lands that were actually enrolled;
- the type of cover planted on CRP land; and
- changes in fertilizer and pesticide use derived from taking land out of production.

The production practices used on non-CRP acres may also have an impact on water-quality benefits.

## INADVERTENT WATER QUALITY BENEFITS FROM CRP ENROLLMENT

Water-quality benefits from acres in the Chesapeake Bay Basin that were enrolled in CRP can be expected to be higher than acres in other regions for two reasons:

- water-induced erosion predominates; and
- the lands are located in a watershed where there are water-quality problems attributed to nonpoint-source pollution from cropland (USDA, 1989).

These two factors increase the likelihood that some acres contributing to water-quality were enrolled in CRP, even though they were not specifically targeted under the program.

In general, idling highly erodible acres can have some benefits for water quality. Ogg (1986) reports that these acres supply "most of the cropland sediment and biologically available phosphorus pollution that can be treated" ( p.372). In addition, phosphorous that leaves fields attached to sediment, as opposed to a dissolved state, can be prevented from entering waterways through standard conservation measures such as idling cropland through CRP (Ogg, 1986).

The amount of sediment and other potential pollutants from cropland that actually reach receiving water bodies is a function of several factors including the distance of

the land from water bodies, the density of streams in the watershed, soil characteristics, the amount of ground cover, the average slope of lands in the watershed, and rainfall intensity (Clark, Haverkamp, and Chapman, 1985; Ribaudo, 1986). Because of the extensive stream networks in Richmond county and it's location along the Rappahannock, it is possible that some of the highly erodible acres enrolled were also those contributing to water quality problems.

More than 2,964 acres of the county's 55,082 acres of prime farmland have a high water quality index (indices between 80 percent and 100 percent) (VIRGIS; Robinette and Hoppe, 1982). The Water Quality Index is one method of identifying lands that are potential sources of nonpoint-source pollution (Shanholtz et al., 1991). (See appendix B.2 for an explanation of this index.) Of all agricultural lands in the county, 6,923.4 acres have water quality indices than 80 percent. Another 7,767.7 acres have medium water quality indices (VIRGIS).

The contributions of highly erodible land to nonpoint-source pollution, predominance of stream networks in the county and existence of lands with medium to high water quality indices increases the probability that the acres in the county enrolled in CRP between 1986 and 1989 will yield some benefits for water quality. However, because only 4.9 percent of the county's total cropland was enrolled and water quality enhancement was not specifically a criteria for enrollment, the extent of these benefits are likely to be minimal.

**TYPES OF COVER PLANTED ON CRP LANDS**

Before CRP enrollees signed their contracts, conservation plans were developed for all acres to be enrolled. Farmers had a choice of what type of cover to plant on their CRP land. Their choices included grass cover, trees, and wildlife food plots, and, as of the

sixth sign-up period, filter strips. Two of these practices have been demonstrated to have positive water quality benefits: tree planting and filter strips. Enrollment in these two options could impact CRP's ability to meet water quality goals.

**Tree-Planting: Extended Water Quality Benefits**

CRP land planted to trees must be idled for a longer time than cover crops because of the size they must reach to be harvested for profit. This requirement keeps the highly erodible land out of agricultural production for a longer period of time and extends water-quality benefits (Smolen et al., 1988). Trees also have several conservation benefits. Forests can retain nitrogen and phosphorus runoff from adjacent farmland and soil erosion from established forests is often less than one-quarter ton per acre per year (Stanley, Haney, Grimm, and Deaton, 1987).

Loblolly pine is the most common variety grown in Virginia's coastal plain and in Richmond county; most Richmond county CRP acres designated for trees were planted in Loblolly pine (Stanley, Haney, Grimm and Deaton, 1987; Tom Brooks, Richmond County Forester, personal communication, July 15, 1991). An average rotation for this type of pine is 45 years (Stanley, Haney, Grimm, and Deaton, 1987). Thus, the benefits to having land planted in a cover crop are extended up to 35 years beyond the 10-year contract period. Planting Loblolly pines may have additional benefits for water quality; research has shown that this species of pine "meets most of the requirements of an ideal erosion control plant" (Monaghan, 1988; p. 97).

Of the 80 CRP contracts made in Richmond county, 14 included some acres designated for tree planting. Overall, 8.2 percent (126 acres) of the 1,545.4 enrolled acres were designated for tree planting. In addition, one farm unit enrolled 32.8 acres that were too wet to farm. According to the Agricultural Stabilization and Conservation Service (ASCS) office in Richmond county, this acreage was being

**Table 3.1 CRP acres planted in trees, sign-up periods 1 through 9.**

| Sign-up period | Total CRP acreage planted in trees | Number of contracts | Average number of acres per contract |
|---|---|---|---|
| 1 | 2.9 | 1 | 2.90 |
| 2 | 8.5 | 1 | 8.50 |
| 3 | 0.0 | 0 | 0.00 |
| 4 | 3.4 | 2 | 1.70 |
| 5 | 0.0 | 0 | 0.00 |
| 6 | 14.2 | 3 | 4.73 |
| 7 | 71.0 | 4 | 17.75 |
| 8 | 49.5 | 3 | 16.50 |
| 9 | 9.3 | 1 | 9.30 |
| **Totals** | 158.8 | 15 | 10.59 |

Source: USDA-ASCS (1990)

planted in trees (see table 3.1). Lack of awareness does not appear to have been a factor in the low percentage of CRP acres planted in trees. As of the 5th sign-up, 70.8 percent of the respondents to the 1987 Virginia Tech survey (VPI&SU, 1987) said they were aware of the tree-planting provision.

Before the end of the sixth sign-up period, USDA relaxed it's erodibility standards for farmers who wanted to plant trees on CRP acres. The new rules required that fields only be 1/3 highly erodible land, rather than 2/3, to be enrolled in CRP if trees were planted (Esseks and Kraft, 1989). A study by Esseks and Kraft (1989) conducted 7 months (two sign-up periods) after the new rule was announced found that 69 percent to 80 percent of the farmers they surveyed were still not aware of "the liberalized conditions

for tree planting" (p. 427). Nevertheless, in Richmond County, the change in the rules may have had a positive impact on enrollment in the tree-planting option. An analysis of CRP contracts designated for tree acres reveals that 90.7 percent (144 tree-acres from 11 contracts) were enrolled during sign-up periods six through nine, after the erodibility requirement was relaxed.

CRP may have received some competition from the Virginia Agricultural BMP Cost-share program, which offers cost-share funds for planting timber. The program offers a one-time incentive payment of $75 per acre, up to a total of $3,500 (Stanley, Haney, Grimm and Deaton, 1987). However, since this program does not offer an annual rental payment and focuses on reforestation, it probably did not compete very strongly with CRP. Cost-sharing was also available through the Agricultural Conservation Program, the Forestry Incentive Program and the Virginia Reforestation of Timberlands program. In most cases payments from all of these programs could not be combined with CRP payments.

Because few CRP participants took advantage of the tree-planting option, the likelihood that these farmers will convert their CRP acreage back to crop production at the end of the contract period is increased. Richmond county Forester Tom Brooks reports that more of the CRP acres in the county could have been planted in trees (Brooks, personal communication, July 15, 1991). Many chose to plant grass cover instead of trees, Brooks says, so they could easily begin producing crops on the land at the end of the 10-year contract period. This choice indicates that many CRP participants in Richmond county may be planning to resume crop production on their CRP acres after the contracts expire.

Other factors indicate that Richmond county farmers would be likely to convert their CRP acreage back to crop production at the end of the contract period. Based on

interviews with farmers in northwest Missouri and an analysis of CRP participation in the Midwest and Plains states, Heimlich and Kula (1990) concluded that small-farm operators, and mixed crop and livestock producers were more likely to maintain the grass cover on their CRP land. They also concluded that counties with over 10,000 acres enrolled in CRP, at least 20 head of cattle per farm, less than 20 percent of farms with gross sales over $100,000 and less than .28 acres of crop acreage base enrolled per CRP acre would be more likely to keep their CRP acres in permanent grass cover.

When this type of analysis is applied to Richmond county, it appears likely that many farmers will bring their CRP acres back into production at the end of the contract period. In 1987, the average total sales per farm in Richmond county was $40,886 (USDC, 1989). In addition, CRP enrollment in Richmond county is considerably less than 10,000 acres as total enrollment in sign-ups one through nine only equaled 1,545.4 acre. Base acreage enrollment per CRP acres is also greater than .28 acres. Livestock production in the county is limited. For sign-up periods one through six and sign-up nine, base acres reduced per CRP acre averaged .65. This analysis indicates that many Richmond county farmers may convert their CRP land back to cropland to receive credit for the base acres retired during the 10-year contract period.

Given that there is little incentive for farmers in the county to maintain their land in grass cover, higher participation in the CRP tree-planting option would have extended the soil productivity and water-quality benefits beyond the 10-year contract period. Participation could have been encouraged by making farmers more aware of the monetary benefits of planting trees, including the potential for leasing the land for deer hunting, which is popular in the county (Brooks, personal communication, July 15, 1991; Johnson, personal communication, July 18, 1991). In particular Richmond county officials could have built on the county's indigenous experience in timber production

and used this expertise to help overcome farmers' lack of experience with commercial forestry. Twenty-one percent of the county's forest acres are owned by forest industry[14] and 34 percent are owned by farmers. The remaining acres are owned by non-farming individuals (Brown and Craver, 1985). Esseks and Kraft (1989) hypothesized that landowners were more likely to be aware of the CRP tree-planting option if they had experience in commercial forestry.

**Filter-strips: A Targeting Mechanism**

The filter-strip option, which was added in the sixth sign-up period, increased CRP's potential to impact water quality. The option allowed farmers to enroll 66- to 99-foot strips of land along streams and waterways in CRP, regardless of the land's erosion level, and plant a cover crop of grass, trees or shrubs. USDA rules did require that the land pose a substantial threat to water quality (USGAO, 1989). Filter strips are designed to prevent sediment and the materials it carries from reaching waterways. This practice has been shown to be a highly effective for preventing pollutants from reaching waterways (Gianessi, Peskin, Crosson, and Puffer, 1986). According to Crutchfield (1989), the inclusion of filter strips in CRP is the only straightforward "pro-water quality" initiatives within CRP.

Since Richmond county contains an extensive network of streams and borders the Rappahannock river, many acres were probably eligible for this program, assuming they met the CRP ownership and cropping criteria. However, between the sixth and ninth sign-up periods, only two contracts specifying filter strips were made in the county. A total of 32.3 filter-strip acres were enrolled. It is possible that these figures do not take into account land enrolled prior to the sixth sign-up period that would have

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[14] "Forest Industry" includes land owned by companies or individuals operating wood-using plants (Brown and Craver, 1985).

been eligible for the filter-strip program (Frohberg et al., 1989). While nonpoint-source pollution will be decreased from the filter-strip acres that were enrolled, the overall impact on water quality will be low since few filter strips were enrolled.

Farmers in Richmond county did not respond to special program incentives offered. The state's incentive program attempted to increase water-quality benefits from CRP by encouraging enrollment in the filter-strip option. Ogg (1986) calls this type of program a "two-layered system of targeting" -- the state added incentives for farmers to enroll lands that will help meet state water quality goals. During the ninth sign-up period, The Virginia Division of Soil and Water offered one-time incentive payments to farmers in Bay-watershed counties including Richmond-county farmers who enrolled land in the CRP filter-strip program. For filter-strips planted in grass cover the payment was $50 per acre; for those planted in trees, the payment was $100 per acre. However, no CRP acres were enrolled in the filter-strip program during the this sign-up period.

Because the filter-strip option was not part of the original CRP, lack of awareness of the program may have been one reason why enrollment was low. A nationwide study by Esseks and Kraft (1989) carried out two months after the filter-strip provision was added found that 39 percent to 58 percent of those surveyed were still not aware of the program. Richmond ASCS did not have an estimate of the number of acres in the county that would qualify for the filter-strip program. Thus it can be assumed that promotional efforts were not targeted toward these landowners and that they may have been unaware of the program or their eligibility for it.

Using filter strips and similar practices does not appear to be a popular practice in Richmond county. In an analysis of Richmond county farmers' attitudes and farming practices, Dietz and Ross (1990) found that 92 percent of 38 farmers surveyed did not use

stream protection practices, 97 percent did not use water table control structures and 84 percent did not use water impoundment reservoirs, even though over half of these farmers had crop or pasturelands within 1,000 feet of rivers or creeks. Although the sample used in this study was randomly selected, it appears to have captured most of the county's commercial farmers. Twenty-two of the 30 respondents to Virginia Tech's CRP survey (VPI&SU, 1987) prior to the 5th sign-up period had land within 1,000 feet of water. Yet, at that time, only 5 of the 30 respondents had enrolled in CRP and the filter strip program was not yet available.

The concentration of ownership along the county's waterways may be affecting enrollment. According to Gray, Dann, and Vinis (1988), 28 families own 75 percent of the land that borders the Rappahannock River and the county's two creeks. Few of these families are developing their waterfront property, thus development probably did not compete with CRP filter-strip enrollment. Gray, Dann, and Vinis also noted that some of these landowners object to filter strips, because they would disrupt the scenic view of the river and creeks. Again, it is not known how many of these landowners are planting crops on their waterfront property.

The productivity of lands bordering rivers and streams may also have impacted enrollment in this option. Frohberg et al. (1989) noted that the productivity of lands eligible for CRP as filter strips tended to be higher-yielding acreage.

Targeting landowners for participation in the filter-strip program would have been particularly effective way of increasing the water quality benefits from CRP land. High enrollment in the filter-strip program would have created barriers that would prevent sediment and other materials form being washed into streams and waterways.

**CHANGES IN FERTILIZER AND PESTICIDE USE**

The use of fertilizer and chemicals is reduced or eliminated when land is enrolled in CRP because the land is no longer being cropped. However, studies have found that reductions in the use of agrichemicals will "yield less than proportional improvement in water quality" and that the improvements in water quality that do result, may take 3 to 5 year before they are apparent (USDA, 1989). It has been predicted that CRP enrollment will reduce U.S. fertilizer application by about three percent (USDA, 1989). CAST (1990) noted that herbicide use would be low on CRP land because it would not increase the income from that land since the land is not being used to produce a harvested crop.

As part of the CRP contract, farmers in Richmond agreed to carry out weed control on the enrolled acres to make sure cover was maintained for the life of the contract. Although maintenance could be carried out by mechanical means such as mowing, participants were allowed to use herbicides to control weeds. However they could not get cost-share payments for herbicide use unless it was included in the plan and carried out in the the first year (Ben Headley, Richmond county SCS office, personal communication, July 9, 1990). However, some herbicides might still be used to control weeds and maintain a "neat" appearance to the land (Nassauer, 1989).

While the amounts of fertilizer and chemicals applied in a given year are a function of pest infestations, cropping patterns, and weather, there are indications that the use of commercial fertilizer and agricultural chemicals is fairly well-accepted in Richmond county. In 1987, an average farm in Richmond spent approximately $6,307 on commercial fertilizer and $3,507 on agricultural chemicals (USDC, 1989). Between the 1982 Census of Agriculture and 1987 Census of Agriculture, the percentage of farms reporting production expenses for fertilizer declined slightly: 93.2 percent of the farms

reported production expenses for fertilizer in 1982; 85.8 percent so reported in 1987. Average expenditures for fertilizer per farm also decreased. The percentage of farms reporting production expenses for agricultural chemicals increased: 66.84 percent reported chemical expenses in 1982; 89.2 percent so reported in 1987. Average expenditures for chemicals per farm also increased. These figures may indicate trends in the use of fertilizers and agricultural chemicals (table 3.2).

In 1982 commercial fertilizer was applied to over 22,750 acres in the county (72.7 percent of the total cropland reported in 1982); fertilizer was applied to 18,055 acres in 1987, 51.53 percent of the total cropland reported 1987. Chemical treatments for insects were reported on 4,862 acres in 1982,15.5 percent of the total cropland acres reported in 1982; 8,883 treated acres were reported in 1987, 28.38 percent of the total cropland reported in 1987. Weeds, grasses and brush were controlled with chemicals on 12,520 acres in 1982, 40 percent of the total cropland reported for that year, and on 14,418 acres in 1987, 46.1 percent of the total cropland reported for that year (see table 3.3).

Fertilizer and chemical use will be reduced or eliminated on the acres enrolled in CRP in Richmond county. However, overall reductions in the county will be low since only a small percentage of the county's total cropland was enrolled.

**PRACTICES USED ON NON-CRP ACRES**

During the time CRP acres are idled, the way farmers manage their remaining acres will also affect water quality. It is possible that farmers will cultivate their remaining acres more intensively in order to maintain profits. While enrolling in CRP reduces the amount of fertilizer and chemicals being used on the idled acres, it may actually increase the use of agricultural chemicals on non-CRP land. According to report by the

**Table 3.2** **Farm production expenses for fertilizer and agricultural chemicals -- 1982 and 1987.**

| Category | 1982 | 1987 |
|---|---|---|
| **Total number of farms** | 193 | 148 |
| **Number of farms reporting commercial fertilizer expenses** | 180 | 127 |
| **--Percentage of farms reporting commercial fertilizer expenses** | 93.26% | 85.81% |
| **--Total expenses reported** | $1,337,000 | $801,000 |
| **--Average expenses per farm** | $7,427.78 | $6,307.09 |
| **Farms reporting agricultural chemical expenses** | 129 | 132 |
| **--Percentage of farms reporting** | 66.84% | 89.19% |
| **--Total expenses reported chemical expenses** | $336,000 | $463,000 |
| **--Average expenses per farm** | $2,604.65 | $3,507.57 |

Source: USDC (1989)

**Table 3.3** **Fertilizer and chemicals used on farmland in Richmond county, 1982 and 1987.**

| Chemicals and fertilizer used | 1982 Farms | 1982 Acres | 1982 Acres/ farm | 1987 Farms | 1987 Acres | 1987 Acres/ farm |
|---|---|---|---|---|---|---|
| **Commercial fertilizer** | 180 | 22,750 | 126.4 | 127 | 18,055 | 142.2 |
| **Percent of total cropland** | | (72.68%) | | | (51.53%) | |
| **-- Cropland fertilized** | 180 | 22,580 | 125.5 | 127 | 17,865 | 140.7 |
| **-- Pasture fertilized** | 17 | 170 | 10.0 | 11 | 190 | 17.3 |
| **Lime** | 73 | 3,735 | 51.2 | 51 | 2,863 | 56.1 |
| **Materials used to control:** | | | | | | |
| **Insects on hay and other crops** | 84 | 4,862 | 57.9 | 60 | 8,883 | 148.1 |
| **-- Percent of total cropland** | | (15.5%) | | | (28.38%) | |
| **Nematodes in crops** | 1 | N/A | N/A | 8 | 243 | 30.4 |
| **Diseases in crops and orchards** | 4 | 35 | 8.75 | 11 | 256 | 23.3 |
| **Weeds, grass, and brush in crops and pasture** | 83 | 12.520 | 150.8 | 110 | 14,418 | 131.1 |
| **-- Percent of total cropland** | | (40%) | | | (46.1%) | |

Source: 1987 U.S. Census of Agriculture (USDC, 1989)

Notes: Percentages of total cropland are based on the total acres of cropland reported in the county for that year by all farms participating in the survey (31,000 acres in 1982; 35,041 acres in 1987). NA = Not available

Council for Agricultural Science and Technology (CAST, 1990; p.1):

> ...some agriculturalists are concerned that the CRP and set-aside lands may become islands of infestation, increasing the exposure of surrounding cropland to weeds, insects, plant pathogens, and destructive wildlife.

However, the report also notes that vegetation on CRP acres can also serve as an alternative host for insects, drawing them away from cropland. It also notes that CRP combined with an integrated pest management program can mitigate the need for chemical controls. The use of integrated pest management programs and best management practices can enhance CRP's effectiveness, by decreasing fertilizer and chemical use and reducing off-site damages from non-CRP lands.

It appears that some Richmond county farmers may not be receptive to the idea of altering their pest management practices. In analyzing results of a survey of 38 farmers in Richmond county, Dietz and Ross (1990) found that sixty percent of these farmers believed reducing input use implied a return to antiquated farming techniques and 80 percent agreed or strongly agreed that reducing chemicals would decrease yields and increase management time. Again, while this study was not a random sample, it did include most of the commercial farmers in the county.

Some best management practices that have the potential to reduce the use of fertilizer and chemical inputs are being used by the county's farmers. Dietz and Ross reported that nearly 25 percent of these farmers used multiple cropping as a weed control method. Over half the farmers used Integrated Pest Management practices. Nearly 44.8 percent of these farmers used either university or commercial soil tests to determine fertilizer needs. If CRP participants are using these practices on their non-

CRP acres, they may be less likely to intensify production on these lands and over-apply fertilizer and chemicals.

**ADDITIONAL STATE AND FEDERAL PROGRAMS**

The 1985-version of the Conservation Reserve Program (CRP) was not created or implemented in isolation -- other federal, regional, and state programs existed during the nine CRP sign-up periods between 1985 and 1990. Depending on their design, objectives and implementation, these "other" programs could complement CRP enrollment, by encouraging farmers to put conservation structures in place, employ soil-conserving practices, and better-manage the inputs that are potential nonpoint-source pollutants on lands still in production. They could also prevent additional highly erodible or environmentally sensitive lands from being converted into cropland.

During the implementation of the 1985-version of CRP between 1985 and 1990, programs available to or affecting farmers in Richmond county, as well as other Bay watershed counties in Virginia, included other programs from the 1985 Food Security Act, the federal Agricultural Conservation Program (ACP), state and federal forestry cost-share programs, and state programs that provided cost-sharing for agricultural Best Management Practices (BMPs).

Conservation compliance and sodbuster, two other programs under the Highly Erodible Lands provision of the 1985 Farm Bill, may compliment CRP participation in Richmond county. Conservation Compliance denies farm program benefits to farmers who produce crops on highly erodible land without a conservation plan after 1990 (Dicks, 1987; Hoag, 1988). (See appendix A for further explanation of these programs.) For Richmond county farmers who maintain base or participate in farm programs,

conservation compliance may encourage them to install conservation practices and use BMPs on non-CRP acres. Roger Brown of the ASCS in Richmond County estimates that approximately 50 percent of the land in Richmond was subject to conservation compliance, based on farm program enrollment. However, these plans may not have been very demanding. By 1991 almost all of the operators of these farms had completed their compliance plans (Brown, personal communication, July 7, 1991).

Sodbuster was intended to prevent the agricultural production on highly erodible acres from expanding by denying specific program benefits to farmers who converted highly erodible land to cropland without first implementing an approved conservation plan (Dicks, 1987). According to Ogg (1986), sodbuster may help extend the benefits of CRP beyond the 10-year contract period, since CRP acres are subject to sodbuster after the contract expires.

In addition, the Agricultural Conservation Program and the Virginia Agricultural BMP Cost-sharing program have and will continue to provide farmers in the county with financial incentives to change their practices on their non-CRP acres. Reforestation cost-share programs such as the Forestry Incentive Program (FIP) and Virginia Reforestation Program and tree-planting incentives offered under the Virginia Agricultural BMP Cost-share program may also encourage planting of trees on non-CRP acres. The Virginia Division of Soil and Water also sponsors a Nutrient Management Program, which provides technical assistance to help farmers develop and implement nutrient management plans.

According to Brown (personal communication, July 19, 1991), participation in ACP is fairly widespread in Richmond county. However, in analyzing the results of Diebel's 1990 survey of 38 Richmond county farmers, Giuranna, Dietz, Ross, Taylor and Batie (1991) found that 86.8 percent of these farmers were not participating in ACP, and 89.5

percent were not participating in FIP. They also found that most of the farmers who were using management practices such as crop rotations, legume cover crops, and no-till, were doing so without any state or federal support funds.

State cost-share and technical assistance programs available in the county should help improve the farmers' practices on non-CRP acres. However, a concerted effort must be made to target farmers enrolled in CRP to take advantage of these programs on their remaining acres.

**CONCLUSIONS: WHAT IMPACTS CAN BE EXPECTED?**

Some water quality benefits will be derived from the highly erodible acres enrolled in CRP in Richmond county, the CRP acres planted in trees, and the acres enrolled in the filter-strip program. However, these benefits will fall short of expectations. For CRP to achieve it's full potential as a water-quality protection tool, the highly erodible lands with high off-site impacts on water quality should have been targeted for enrollment. Higher participation in the tree-planting and filter-strip options and in other state and federal programs by Richmond county farmers would also help maximize water quality benefits.

To achieve high participation in CRP and other programs, and to reach overall water quality goals, eligible lands and owners of those lands must be identified. Ribaudo (1989) notes that targeting CRP on the basis of water quality could decrease CRP's ability to meet it's other objectives. But because water-quality improvement is in demand in Richmond county, singling out landowners who farmed highly erodible acres that were eligible for CRP and were also contributing to off-site water quality problems would have improved the chances of achieving that goal.

Esseks and Kraft (1989) noted that local USDA offices should have used "more vigorous" marketing techniques to make potential CRP participants aware of their eligibility and the program's benefits (p. 430). Their suggestions included more interaction with walk-in Agricultural Stabilization and Conservation Service and Soil Conservation Service clientele and more on-farm visits per client. They also suggest that providing eligible landowners with information on Maximum Acceptable Rental Rates would have improved participation. In Richmond county, applying these intensified marketing techniques to landowners with land bordering waterways or land with high timber productivity potential could have increased enrollment in the filter-strip and tree-planting options.

During the years the 1985 CRP was being implemented, a potential mechanism for targeting eligible lands was being established through the development of the Virginia Geographic Information System (VIRGIS). VIRGIS is a database which was initiated in 1985 as a part of state and federal Bay-restoration programs. When fully implemented in all counties, it will provide maps of basic features such as soil types, elevations, agricultural land use, and derived features, such as soil erodibility and tolerance factors, sediment-delivery ratios, and water quality indices (Shanholtz et al., 1991).

A county-level version of VIRGIS, referred to as the Richmond Resource Information System (RIS), was developed in 1986 and 1987 for use in Richmond county. However, RIS was mainly used to assist planning and zoning efforts in the county and not for targeting CRP land (Richmond RIS; Bill Duncanson, Richmond RIS, personnel communication, July 18, 1991). Eligibility for CRP was decided on a case-by-case basis: the Soil Conservation Service (SCS) used county soil maps and visited the site to determine if the land met eligibility requirements for slope length and erodibility (Ben Headley, Richmond SCS, personal communication, July 9, 1990). With the highly

erodible land criteria mandated by USDA, this case-by-case method was a logical approach to determining eligibility. Water-quality benefits could have been greater if VIRGIS and RIS could have been used to target lands and landowners for CRP enrollment. With this kind of information, the Agricultural Conservation and Stabilization Service and SCS could have concentrated their efforts on owners of these acres to make sure they were aware of their eligibility for CRP and were aware of the program's benefits.

To further enhance CRP marketing efforts, coordination between all state and federal conservation programs should have also been considered. Korsching and Hoban (1988) noted that, in general, such coordination can help all organizations involved meet their goals and provide better service to clients. Better coordination could have eliminated some of the competition between CRP and state programs and some of the red tape that farmers may perceive as barriers to participation (Korsching and Hoban, 1988). Cost-share benefits from these programs could also have been piggybacked with CRP cost-share payments to further encourage enrollment of filter-strip acres and encourage tree planting on CRP land. Targeting state BMP programs to CRP participants could also have decreased the chances that these landowners would intensify production on their non-CRP acres.

Providing eligible landowners with pamphlets or other information detailing all state and federal conservation and water quality programs and the costs and benefits may have encouraged more participation in CRP and other federal programs, as well as the state programs. In addition, if both state and federal personnel had been trained in the details of all these programs and the costs and benefits they would have been in a better position to inform landowners and help them choose the programs that fit their farming goals.

## *Chapter 4*
## THE FUTURE OF CRP AND CRP WATER-QUALITY BENEFITS

In 1990, Congress passed a new Farm Bill that included an "extended/redirected" version of CRP (Osborn, 1991; p. 54) within its Agricultural Resource Conservation Program (ARCP). This new version was combined with the Wetlands Acreage Reserve to form the Environmental Conservation Acreage Reserve Program (ECARP). Other programs included under the ARCP were the Agricultural Water Quality Program and the Environmental Easement Program (Osborn, 1991; Sustainable Agriculture Working Group, 1991).

The new CRP maintains the basic elements of the original program: it offers landowners an annual rental payment in exchange for removing highly erodible land from production for 10 years. However, it was adjusted to alleviate some of the shortfalls of the 1985-Farm Bill version of the program, including the program's failure to yield maximum water-quality benefits in fragile watersheds such as the Chesapeake Bay.

The new CRP has arrived on the scene at the same time the 1989 Chesapeake Bay Preservation Act is being put into effect in Virginia. This law requires that all landowners in Virginia's portion of the bay watershed put resource management practices into place along riparian areas. CRP is viewed as a means of minimizing landowners' costs of complying with this law (Richmond Times Dispatch, 6/30/91).

The analysis undertaken in this paper has revealed several points of the 1985-version CRP's design which may have precluded the attainment of a high level of participation and maximum water quality benefits in Richmond county, Virginia, and, possibly other Virginia counties located in the Chesapeake Bay region. These conclusions may indicate if the new version of CRP, combined with the Bay Preservation Act, will garner more water quality benefits.

## THE 1985 VERSION OF CRP: WHAT HAVE WE LEARNED?

The following conclusions were drawn from this analysis of the 1985-version of CRP in Richmond county:

1) Farmers in Richmond county were sensitive to the opportunity costs of choosing CRP over crop production options. Increases in the maximum acceptable rental rates (MARRs), and possibly increased awareness of the program's costs and benefits, appear to have gradually increased participation and the number of acres enrolled. Overall, however, the number of acres enrolled compared to the total number of acres that could have been enrolled, based on the county enrollment cap and the number of highly erodible acres, was low.

2) Because off-farm employment opportunities and other land-use options are limited and because crop production is reasonably profitable, many farmers in the county may have preferred to continue farming most or all of their acres rather than placing them in CRP, or only enrolled those acres that were the least productive, the most difficult to farm, or visibly erodible. In general, the net present value of returns to crop production for average-yielding and marginal acres were higher than those netted from CRP enrollment.

3) Farmers in Richmond county could have received additional income from their CRP land by planting trees because growing conditions are suitable and the market outlook is good and(or) by leasing hunting rights for their CRP acres as demand for hunting land appears to be increasing. However, few participants took advantage of these options, which may indicate a lack of information with regard to the returns from these enterprises, a hesitancy on the part of landowners to switch to these atypical farming enterprises, or high transaction costs.

4) While some benefits will be derived from the acres that were enrolled in CRP, the low number of acres in Richmond county that were planted in trees will limit the length of time these benefits will be accrued.

5) To obtain maximum water quality benefits from acres enrolled in Richmond county, acres should have been targeted for enrollment on the basis of their contributions to water-quality degradation, as well as their erodibility.

6) Accepted bids in rental rates in Richmond county nearly matched the county's MARR, indicating that at least some farmers were aware or became aware of the MARR. The bidding behavior of the enrollees may imply that the $50, $61, and $70 per acre per year rents were sufficient to encourage at least some of the county's farmers to enroll a portion of their cropland acres. For some farmers, the rental rate may have equaled a "reservation price" -- the minimum payment they were willing to accept to enroll, considering other opportunities available to them. Bidding at the MARR may have been strategic behavior by other farmers: they may have enrolled acreage on which opportunity costs were significantly less than the MARR. However, the low overall enrollment in the county may indicate that most farmers were not aware of the MARR and thus did not have enough information to make a decision, or, for those who were

aware of the MARR, that the rental rates offered did not adequately cover the costs of forgoing other land-use opportunities.

7) More water quality benefits could have been derived if more farmers with cropland bordering waterways had taken advantage of the filter-strip option offered in sign-up periods six through nine. Low enrollment in the filter-strip option and the fact that no farmers in Richmond county enrolled in this option during the ninth CRP sign-up when additional financial incentives were offered may indicate that the opportunity costs of enrolling cropland bordering waterways is high, that there are non-monetary barriers to enrolling this land, that farmers are unaware of the filter-strip option, or that few farmers are producing crops on land bordering waterways.

8) The federal and state programs that provide technical and cost-sharing assistance to farmers in the county may improve farmers' treatment of their non-CRP acres and prevent them from intensifying production on those acres. On the other hand, for farmers who wished to continue crop production but were threatened by conservation compliance, these programs may have given them another route for meeting compliance standards, other than enrolling in CRP. Thus, the net impact of these alternatives on water quality may still be negative since a previous study in Richmond county showed that the only way to reduce the negative impacts of crop production on water quality was through land retirement (Diebel, 1990).

9) There appears to be little incentive for Richmond county farmers to maintain their CRP acres in grass cover after their contracts expire. Because few farmers in the county have livestock, they do not necessarily need acreage planted in grass cover for grazing or for hay production. In addition, opportunities to sell hay appear to be limited.

10) Participation and water-quality benefits could have been increased if a marketing program had been targeted at eligible landowners, especially those with acreage eligible for the filter-strip program or those with high timber productivity. Better coordination between CRP, other federal programs, and state programs would probably have increased CRP participation and overall participation other programs.

## PROVISIONS OF THE NEW CRP

The enrollment cap for the new version of CRP is set at 40-45 million acres minus the 33.9 million acres enrolled between 1986 and 1990 (Osborn, 1991). Adjustments made in this version include an expansion of the definition of eligible lands, designation of priority watersheds for enrollment, added incentives and options for meeting conservation compliance, changes in the procedures for evaluating bids, and elimination of contradictions between CRP and other programs.

### Expanded Eligibility: More Opportunities to Target

Land that contributes to water quality degradation or poses an "off-site environmental threat" is eligible for CRP (Osborn, 1991). This criteria widens the pool of eligible land beyond that defined as highly erodible to include lands that generate nonpoint-source pollutants either due to location, climatic conditions or treatment. In addition, enrollment of filter strips is still allowed (SAWG, 1991). In Bay counties such as Richmond, the new eligibility criteria would allow lands to be targeted for CRP based on water quality benefits, not just on erodibility.

### Priority on Enrollment in the Bay Watershed

The Chesapeake Bay has been designated as a conservation priority region under the new CRP. USDA has been mandated to achieve a "significant level" of enrollment in the region that maximize water quality benefits (Osborn, 1991). Setting a priority on

the Bay region may help decrease competition with other regions for enrollment created by the enrollment cap and allow county and state officials time to target those acres that would help meet water-quality goals, without worrying about the enrollment cap.

**Tree Planting: Another Change to Lengthen Benefits**

At least one-eighth of the land enrolled in the new CRP between 1991 and 1995 must be planted in trees or vegetation that provides a habitat for wildlife (Osborn, 1991). It is not known whether special incentives will be offered to help meet this enrollment goal. But, the increasing demand for hunting land in Richmond county, and the potential income from leasing hunting land, could attract more farmers to enroll and participate in this option.

Farmers in Richmond county who planted grass cover on their CRP acres enrolled under the 1985 program will have the opportunity to convert some of this acreage to trees and extend their contract by five years (SAWG, 1991). Farmers who initially planted trees on those acres also may extend their contracts for five years. New enrollees who plant trees on their CRP land will receive additional cost-share assistance for maintaining and establishing the stand for two to four years. Farmers can receive additional assistance if the stand fails (Osborn, 1991).

This "insurance policy" may encourage more landowners who are inexperienced in timber production to enroll in the CRP tree-planting options. The additional moneys to aid in establishing tree stands and the opportunity to extend their contracts may also encourage Richmond county CRP participants to convert their acreage to trees and encourage more participants to enroll in the tree-planting option during the new program sign-ups. An increase in tree plantings will extend the amount of time that water-quality benefits are accrued from CRP enrollment in Richmond county. An

effort should be made to provide technical assistance and inform farmers about the positive returns to timber production.

Since it appears that many farmers in Richmond county have a desire to continue crop production, one option under the new CRP may encourage tree-plantings on acres already enrolled in CRP and on acres enrolled in the new program. This option allows farmers to grow crops between rows of hardwood trees if they accept a 50 percent cut in their rental payments (SAWG, 1991). However, in the program's previous iteration, Loblolly pine -- a softwood --was planted on most CRP acres in Richmond county because of suitable growing conditions in the county. This factor, combined with the decrease in the rental payment, may decrease the attractiveness and feasibility of this option.

**An Improved Relationship with Other Programs**

The new CRP allows participants to receive cost-share assistance or tax benefits offered through other state and federal programs for the acres enrolled (Osborn, 1991). This provision opens the door for the state of Virginia to combine their the existing Agricultural BMP Cost-Share program and other state programs with CRP. Offering these programs to CRP participants may reduce the competition between state cost-share programs and CRP and increase the incentives for farmers to participate in CRP.

States will also have the opportunity to advise USDA on the implementation of CRP. State technical committees are to provide criteria identifying environmentally sensitive lands for enrollment and programs to control pests on CRP lands, as well as other information (Osborn, 1991).

**Compliance: An Incentive to Keep Grass Cover**

Highly erodible lands enrolled in CRP are subject to conservation compliance after the contracts expire (Osborn, 1991). For Richmond county farmers who are concerned

about maintaining their base acreage and wish to continue receiving farm program benefits that could be affected by conservation compliance, this requirement may prevent them from bringing CRP back into production at the end of the contract period; or, at least encourage them to put the proper practices in place before doing so.

**Ways to Farm While Protecting Water Quality**

Under the Agricultural Water Quality Protection Program (AWQPP), farmers enter into a three- to five-year agreement with the government to implement water-quality protection plans. They can continue to grow crops on the land enrolled, while receiving yearly payments and cost shares for each contract (Osborn, 1991). Payments are set to cover the costs of implementing the plan and foregone revenues (SAWG, 1991). AWQPP may allow Richmond county farmers to continue growing crops while reducing the impacts on water quality.

Another option within the new CRP allows farmers to enroll contour grass strips or grass waterways and continue crop production alongside these areas (Osborn, 1991, SAWG, 1991). These strips can be part of the conservation plans required for compliance (Osborn, 1991). A report by the Sustainable Agriculture Working Group (1991) predicts that "...[t]hrough these partial field entry options, many more farmers could participate in CRP than would with whole field entry" (p. 25). This prediction may hold true in Richmond county since crop production is the predominant enterprise. Because farms in Richmond tend to be medium-sized, more farmers may be willing to enroll "unfarmable" or less productive portions of their farm rather than a large proportion of the productive acres.

**New Bidding Procedures May Increase Farmer Uncertainty**

Instead of the county and state MARRs which were used to evaluate bids during the 1985-version of CRP, an environmental index is now used to evaluate bids submitted in

the new program. The index is divided by the per-acre, per-year bid submitted by the farmer (Richmond Times-Dispatch, June 30, 1991). Bids are placed into a national bidding pool, rather than a state or regional pool (Roger Brown, Richmond ASCS, personal communication, July 19, 1991).

Under this new system, accepted bids in Virginia have been lower than the $70 MARRs offered in in the Northern Neck regions during the last three sign-up periods of the 1985-version of CRP. For example, in the March sign-up in Virginia, rental rates averaged $52.30 per acre per year (Richmond Times-Dispatch, June 30, 1991).

Analysis of the bids accepted in Richmond county during the nine sign-up periods for the 1985-version of CRP indicates that farmers became aware of the MARRs quickly, usually within one or two bidding periods, and thus had a set value to use when comparing CRP to other options. Since acceptance into the new version of the program is based on the quality of the land submitted, as well as the level of the bid, it will be difficult for farmers to determine the exact rental payment they will receive or to learn from previous participants or their neighbors what level of bid will be accepted.

In addition, the percentage of bids accepted into CRP during the new program's sign-ups has been low: only 21 percent of the 6,958 acres bid in Virginia in the spring 1991 sign-up period were accepted (Richmond Times-Dispatch, June 30, 1991). One reason cited for the low acceptance rate is that farmers were bidding "too high." As the analysis of accepted bids in Richmond county indicates, farmers have a tendency to bid from the MARR in the previous round of bidding, even when the MARR changed. It could be that many farmers are still bidding at the $70 level offered during the last three sign-up periods of the 1985-version of CRP.

The use of the environmental index will help ensure that lands enrolled in Richmond county are those that are contributing to water-quality problems. As one

federal official said, it may help ensure that the state is "getting the most bang for the buck" (Jim McMullen, ASCS, quoted in the Richmond Times-Dispatch, June 30, 1991). However, the uncertainty created by the new bidding procedure may also discourage potential bidders in Richmond county, even those with lands contributing to off-site environmental problems, and cause those who do submit bids to be rejected.

**THE CHESAPEAKE BAY ACT AND THE CONSERVATION RESERVE**

In 1988 the Virginia legislature passed the Chesapeake Bay Preservation Act, which establishes Resource Protection Areas (RPAs) along shorelines to protect water quality in the Bay (SVPDC, 1990). Farmers will be required to plant 100-foot vegetative buffer strips in areas adjacent to the RPAs, which are called Resource Management Areas (SVPCD, 1990; Crafton, 1991). Farmers can reduce the size of the buffer-strip area to 50 feet by enrolling in a federal, state, or local best management practices program, or to 25 feet by implementing a soil and water-quality conservation plan (Crafton, 1991).

The Bay Act may complement the Conservation Reserve Program in two ways: by increasing participation in CRP and by shielding water supplies from other sources of nonpoint-source pollution such as construction.

Farmers can enroll in CRP to obtain cost-share and rental payments to off-set the costs of establishing the buffer strips, which may increase participation in CRP. Crafton (1991) calculated the costs of complying with the act including crop production losses from various rotations. In most cases, net annual income was lost for each acre placed in the buffer. But, scenarios where participation in CRP was included showed a positive return. However, these calculations were based on rental payments of $65 per acre. As previously mentioned, accepted bids during recent CRP sign-up averaged $52.30 per acre and the acceptance rate has been low. Thus, CRP may not be a profitable option

for complying with the state laws. However, they may be able to receive assistance through other federal programs such as AWQPP and the Environmental Easement Program or state programs such as Virginia's Agricultural BMP Cost-Share Program (Crafton, 1991).

**CONSIDERATIONS FOR THE FUTURE**

To design a Conservation Reserve Program that encourages farmers to enroll a significant amount of the lands that are contributing to water quality problems, the motives, goals and characteristics of both participants and non-participants in Richmond county and other Bay areas counties must be studied further. Future changes in the structure of agriculture, land ownership and land-use opportunities brought on by increased commercial and residential development should also be considered, in addition to markets for hay, crops, trees, and hunting land. These factors may not only affect the amount of land placed in the new version of CRP, but also the length of time that lands enrolled in the 1985-version of CRP remain in protective vegetative cover. This information can not only help in design of the product -- CRP -- but also in marketing the program to those farmers who have eligible lands that would help meet the region's water-quality goals and whose goals and needs can be satisfied by the program.

In addition, CRP should be better coordinated with state programs and other federal programs. Better coordination could eliminate conflicting rules between these programs and provide farmers with a clearer picture of the options offered by these programs.

While CRP still has the potential to help improve water quality, the limitations of such a land-diversion program should be recognized, especially in counties such as

Richmond where crop production is the predominant industry and other opportunities are limited. In fact, federal farm programs may not be the best answer to water quality problems. Doering (1991) notes that, in general, farm programs have been ineffective in "changing the way farmers farm" (p.1) and suggests that policies which target specific concerns and provide different incentives may be the answer to agriculture's impact on the environment.

Thus, ultimately, the solution to water quality problems may not lie solely in high CRP enrollment and in providing incentives to maintain CRP land in protective cover after the contracts expire. Instead, it may lie in providing all farmers with enough voluntary options to change their production practices or shift production practices away from environmentally sensitive lands, so they may pick the best combination of programs and options to suit their own needs and farming goals. Backing these programs with laws that force compliance on lands that require special treatment to meet water-quality goals, but have been placed out of reach by the costs required to make voluntary programs appealing to their owners, may also aid in the improvement of water quality in the Chesapeake Bay region.

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# Appendix A
# Other Conservation Programs

## Appendix A -- Other Conservation Programs in the 1990 Farm Bill

A summary of Highly Erodible Land (Conservation Compliance) and Wetlands Protection (Swampbuster) Provisions of the 1985 Food Security Act is shown below:

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**Conservation Compliance**

***Action:*** Producing an agricultural commodity on a highly erodible field after January 1, 1990 without a conservation plan. Producers must develop a conservation compliance plan based on ASCS and SCS technical guidelines for their soil region by January 1, 1990. The plan must be implemented by 1995.

***Penalty:*** Loss of all farm program benefits on all acres farmed for at least one year. Benefits can be regained if a conservation compliance plan is approved or the producer does not produce a crop on the land the next year.

**Sodbuster**

***Action:*** Converting a highly erodible field to cropland. Fields are subject to Sodbuster if they meet all the following criteria:

1) 1/3 or more of the field contains highly erodible land.

2) The field was not used to produce an agricultural commodity between 1981 and 1985.

3) The field does not have a conservation plan approved for Sodbuster.

***Penalty:*** Loss of all farm program benefits on all acres farmed for at least one year. Benefits can be regained if a sodbuster conservation plan is approved or the producer does not produce a crop on that land the next year.

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Sources: Hoag (1988); Atwood, Frohberg, Johnson, Robertson, and Thompson (1989)

Notes: According to Hoag (1988; pp. 9-10), "farm program benefits" include any price supports or payments made by the Commodity Credit Corporation, farm storage facility loans, disaster payments, federal crop insurance, Farmers Home Administration insured or guaranteed loans, Conservation Reserve payments, and any other commodity payments. An "agricultural commodity" is defined as any crop planted and produced by annual tilling of the soil. Alfalfa and legumes are not considered agricultural commodities.

# Appendix B
# Explanation of Erodbility Criteria

**Appendix B.1 Explanation of Land Capability Classes (LCCs) and their characteristics and limitations.**

| Land Capability Class | Characteristics and limitations |
|---|---|
| I | Few limitations on use. Can be intensely cultivated or used for grazing, rangeland or woodland. Characteristics: high fertility, responsive to fertilizer application, good drainage and water-holding capacity. |
| II | Some limitations on use and choice of crops.Conservation practices required to sustain intensive cropping. Characteristics: moderate to high fertility, gently slopes, shallow topsoil, and imperfect drainage. |
| III | Severe limitations on use. Cover is required to maintain fertility. Characteristics: steep slopes, shallow root zone layers, high erosion hazards, excessive moisture content, low fertility, unstable soil structure. Reduces choice of plants, requires careful management, or both. |
| IV | Very severe limitations on use and crop choice. Characteristics: very steep slopes, severe erosion hazards, or shallow, saline, alkali, stony or waterlogged soils. |
| *Lands classes unsuitable for cultivation* | |
| V | Unsuitable for cultivation because of frequent flooding, short growing seasons, or excessive stoniness, dampness or salinity. Little or no erosion hazard. Suited for pasture, rangeland, forestry or wildlife. |
| VI | Severe limits on use. Erosion hazards plus other limitations listed under LCC V. Suited for pasture, range, forestry, or wildlife and cover. |
| VII | Very severe limits on use. Suitable for range grazing woodland or wildlife only. Unsuitable for crops or pasture. |
| VIII | Unsuitable for all types of commercial crop production. Uses are limited to recreation, wildlife, or water supply. |

Source: Buckman and Brady, 1974; Schwab and Frevert, 1985; and Robinette and Hoppe, 1982

**Appendix B.2 -- Summary of methods for classifying lands and measuring erodibility and off-site impacts.**

**Land Capability Class (LCC)**

LCCs indicate the suitability of soils for most kinds of field crops (Robinette and Hoppe, 1982). Each unit (I,II, etc.) includes all lands that would require similar management and soil conservation measures. LCC is based on soil type, slope, degree of erosion, drainage, water-holding capacity, and the amount and distribution of rainfall (Schwab and Frevert, 1985). According to McCormack and Heimlich (1985), LCC was designed to help the Soil Conservation Service make general conservation recommendations to farmers. (See appendix X for an explanation of each LCC.)

**Prime Farmland**

Prime Farmland, which was developed by USDA, is used to designate land that is "best-suited for producing food, forage, fiber, and oilseed crops and is available for those uses (Heimlich, 1989; p. 3). Prime farmland is based on nine soil characteristics: soil acidity; water table in relation to root zone; conductivity, which is a measure of salinity; frequency of flooding, erodibility; permeability; and size of rock fragments present in the soil.

**Universal Soil Loss Equation (USLE)**

USLE is used to predict *actual* annual soil loss in tons/acre that results from water-caused sheet and rill erosion (Schwab and Frevert, 1985; Dicks, 1987). USLE is defined as:

A = RKLSCP

*where:*
A = Average annual soil loss in tons/acre
R= Rainfall and runoff erosivity index
K= Soil erodibility factor in tons/acre[a]
LS = Slope length/slope steepness factor (L=slope length; S=percent of slope)

[a] According to Schwab and Frevert (1985), "K" equals the average soil loss per unit for a soil in cultivated continuous fallow with a slope length of 72.6 feet and a slope of 9 percent.

C= Cropping management factor[b]
P= Conservation practices factor[c]

The RKLS portion of USLE can be predict *potential* soil loss.

**Soil Tolerance Value (T-Values)**

T-values are maximum rates of soil loss that have been established for different soil types throughout the United States. They are defined as the "maximum level of soil erosion that will permit a high level of crop production to be maintained economically and indefinitely" and indicate the soil's susceptibility to erosion damage (Hall, Logan and Young, 1985; Dicks, 1987).

According to Nowak, Timmons, Carlson and Miller (1985), T-values are based on five factors: topsoil thickness, physical properties of the soil, gully prevention, organic-matter reduction and plant nutrient losses.

T-values range from 1 to 5 tons per acre per year (USGAO, 1989; Dicks, 1987). T-T-values for are often expressed as 2T, 3T, etc. This indicates the actual erosion level relative to T. For example, if land has a T-value of 5 tons per acre per year and is actually eroding at a rate of 15 tons per acre per year, it is eroding at 3 times its T-value (3T) (USGAO, 1989).

**Erosion Index (EI)**

The erosion index for sheet and rill water-caused erosion is calculated by dividing the a soil's potential erosion (RKLS of the Universal Soil Loss Equation) by the T-value assigned to that soil. Thus, EI is defined as RKLS/T (USDA, 1989). The higher the value of EI the more erosion-prone the soil is.

**Sediment-Delivery Ratio**

According to USDA (1989), sediment-delivery ratios indicate the amount of eroding soil that actually reaches a body of water. The ratio is a function of distance from the

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[b] Ratio of soil loss for given conditions to soil loss under cultivated continuous fallow (Schwab and Frevert, 1985).
[c] Ration of soil loss for a given conservation practice to that of up-and-down-the-slope farming (Schwab and Frevert, 1985).

land to a body of water, watershed channel density, the amount of ground cover, the size of the watershed, soil characteristics, and rainfall intensity (USDA, 1989; Ribaudo, 1986).

**Water Quality Index**

The Water Quality Index indicates nonpoint-source pollution potential. In VIRGIS, Water Quality Indicies are derived "categorizing and ranking potential stream sediment loading as a surrogate to define NPS pollution potential" (Shanholtz, et al., 1991; p. 28). Higher values indicate greater potential to generate nonpoint-source pollution.

**Appendix B.3 – Erodibility criteria for CRP enrollment and the sign-up periods in which these criteria were in effect.**

| Criteria | Sign-up periods |
|---|---|
| (1) Fields in which at least 2/3 of the land is in Land Capability Classes (LCC) VI - VIII. | 1-9[a] |
| (2) Fields in which at least 2/3 of the land is in LCC II - V with actual erosion ≥ 3T. | 1-9[a] |
| (3) Fields in which at least 2/3 of the land is in LCC II - V with actual erosion ≥ 2T and exhibits serious gully erosion problems. | 3-9[a] |
| (4) Fields in which at least 2/3 of the land has an Erodibility Index (EI) ≥ 8 for wind or water erosion and an erosion rate greater than that recommended by the SCS Field Office Technical Guide between 1981 and 1985. | 4-9 |
| (5) Fields in which at least 1/3 of the land has an EI ≥ 2T, if the owner agrees to plant trees. | 6-9 |
| (6) Any land between 66 and 99 feet wide bordering waterways, regardless of erosion rate. | 6-9 |
| (7) Any land with subject to erosion from periodic flooding if owner agrees to plant trees (unless trees are unsuitable). | 8-9 |
| (8) Any wetlands previously converted to cropland. | 8-9 |

Sources: Dicks, Llacuna, and Linsenbigler, 1989; Osborn, Llacuna, and Linsenbigler, 1990; USDA, 1989; and USGAO, 1989

[a] This criteria was used to evaluate contracts during the sign-up periods indicated, except during sign-up period 4. During sign-up period 4, contracts that were scheduled to take affect in 1988 were accepted only if they met criteria (4). Evaluation of contracts made during sign-up period 4 that were scheduled to take affect in 1987 was based on criteria (1), (2), (3) or (4).

## Appendix C
## Soil Types in Richmond County, Virginia

**Appendix C -- Soil types in Richmond county, Virginia.**

Number of acres, percent of total land area, Land Capability Class, and use in Richmond county, Virginia (Robinette and Hoppe, 1982).

| Soil Type[a] | LCC[b] | Acres[c] | Use |
|---|---|---|---|
| Kempsville loam (PF) | I | 2,098 (1.6) | Most areas are in farmland; a few are wooded. |
| Pamunkey loam; wet substratum (PF) | I | 386 (.3) | Most areas are farmed; a few are wooded. |
| State fine sandy loam (0-2%) (PF) | I | 966 (.7) | Most used for cultivated crops and pasture and hay; a few areas are wooded. |
| Suffolk sandy loam (0-2%)(PF) | I | 8,916 (6.9) | Same as previous. |
| Atlee silt loam (PF) | IIw | 462 (.4) | Most is wooded; some is cultivated for used for pasture. |
| Dogue fine sandy loam (2 to 6%) (PF) | IIe | 873 (.7) | Over half is in cultivated crops and pasture and hay. The rest is wooded. |
| Emporia loam (PF) | IIe | 9,026 (6.9) | 2/3 in woodland; the rest is cultivated crops. A few acres are in pasture and hay. |
| Kempsville sandy loam (2-6%) | IIe | 3,067 (2.4) | Approximately 1/2 is wooded; the rest is cultivated crops and hay, and pasture. |
| Nansemond fine sandy loam (PF) | IIw | 2,206 (1.7) | Most areas are farmed. A few are wooded. |

[a] Numbers in parentheses are slope percentages. PF stands for Prime Farmland. AD indicates lands that classify as Prime Farmland only if they are artificially drained.
[b] "e" indicates erosion damage or susceptibility to erosion and "w"excess water
[c] Numbers in parentheses are the percent of total acres.

| Soil Type | LCC | Acres | Use |
|---|---|---|---|
| Rumford loamy sand (0-6%) (PF) | IIs | 3,266 (2.5) | Most areas are farmed; a few are wooded. |
| Savannah fine sandy loam (2 -6%) | IIw | 1,258 (1.0) | About 1/2 is wooded; the rest is in cultivated crops, hay and pasture. |
| Savannah fine sandy loam (2-6%) | IIe | 3,706 (2.9) | Same as previous. |
| State fine sandy loam (2-6%) (PF) | IIe | 690 (.5) | Most used for cultivated crops, pasture and hay; a few areas are wooded. |
| Suffolk sandy loam (2-6%) (PF) | IIe | 16,175 (12.3) | Half used for cultivated crops, hay and pasture; the rest is wooded. |
| Tetotum fine sandy loam (0-2%) (PF) | IIw | 5,231 (4.0) | Most is in crops, pasture and hay; a few acres are wooded. |
| Tetotum fine sandy loam (2-6%) (PF) | IIe | 1,723 (1.3) | Same as previous. |
| Catpoint sandy loam | IIIs | 719 (.6) | Half is wooded; half is in crops with some pasture and hay. |
| Wahee fine sandy loam (PF-AD) | IIIw | 753 (.6) | Most is wooded; a few areas are used for crops, pasture and hay. |
| Yemassee fine sandy loam (PF-AD) | IIIw | 1,108 (.9) | Same as previous. |
| Lumbee loam (PF-AD) | IVw | 666 (.5) | Same as previous. |
| Rumford and tetotum soils (6-15%) | IVe | 7,624 (5.9) | Same as previous. |

| Soil Type | LCC | Acres | Use |
|---|---|---|---|
| Tomotley fine sandy loam (PF-AD) | IVw | 3,757 (2.9) | Same as previous. |
| Leaf silt loam (PF - AD) | VIw | 1,571 (1.2) | Most areas are wooded; a few areas are farmed. |
| Bibb and levy | VII | 5,457 (4.2) | Most is wooded; some is cultivated or used for pasture. |
| Rumford soils (15-50%) | VIIe | 36,362 (28) | Most areas are wooded; a few are in farms. |
| Rappahannock muck | VIIIw | 4,711 (3.6) | Suited for wetlands only. |
| Pits sand and gravel | NA | 103 (.1) | NA |
| Water | NA | 7,040 (5.4) | NA |
| Total | | 129,920 | |

## Appendix D
## Landowners Reasons for not Submitting a Bid
## (Results of 1987 Virginia Tech Survey)

**Appendix D – Landowners's reasons for not submitting a bid in the Conservation Reserve : Results of a1987 Virginia Tech Survey .**

A study conducted by researchers at Virginia Polytechnic Institute and State University in the fall of 1987 (VPI&SU, 1987)asked respondents to rate their reasons for not submitting a bid in CRP. Responses from Richmond County respondents are shown below.

| Reason | Number of Respondents | Agree (%) | Tend to Agree (%) | Total (%) |
|---|---|---|---|---|
| Rental rates too low | 16 | 25 | 18.8 | 43.8 |
| Not enough information to decide | 15 | 33.3 | 20 | 53.3 |
| Prefer not to participate in government programs | 16 | 18.8 | - - | 18.8 |
| Not tie up future land use | 15 | 60 | 6.7 | 66.7 |
| Don't understand eligibility requirements | 15 | 26.7 | 20 | 46.7 |
| Not eligible because of crops grown | 14 | 14.3 | 7.1 | 21.4 |
| No land eroding at an eligible rate | 17 | 29.4 | 11.8 | 41.2 |
| Program too restrictive | 13 | 15.4 | 7.7 | 23.1 |
| Don't know how to figure a bid | 15 | 33.3 | 13.3 | 46.6 |
| Plan to sell land for commercial/residential development | 14 | - - | - - | - - |
| Need all land in cultivation | 15 | 20 | 20 | 40 |
| Cost of implementing practices is too high | 14 | 14.3 | 21.4 | 35.7 |
| Can make more money growing crops | 15 | 13.3 | 26.7 | 40 |
| Have owned land < 3 years | 13 | - - | - - | - - |
| Have not cultivated 2 of the last 5 years | 14 | 14.3 | - - | 14.3 |
| Do not want to forfeit grain base | 14 | 42.9 | 7.1 | 50 |
| Don't agree with restrictions on acreage use | 12 | 25 | 8.3 | 33.3 |
| Too little eligible land | 15 | 40 | 20 | 60 |
| Can't get landlord or tenant to agree | 13 | 15.4 | 7.7 | 23.1 |
| Too much red tape and effort required to get involved | 14 | 28.6 | 21.4 | 50 |
| Prefer not to change land use due to existing share lease agreement | 14 | 14.3 | - - | - - |

# Appendix E
# Calculation of Net Revenues from Crops

**Appendix E.1 -- Yield Data**

Average crop yields used in this analysis were based on 10-year averages, excluding drought years, for production in the Northern Neck.

| Year | Corn | Wheat | Barley | Soybeans |
|---|---|---|---|---|
| **1977** | 50* | 34 | 47.5 | 18* |
| **1978** | 86 | 37.5 | 52 | 28.5 |
| **1979** | 93 | 36.5 | 53 | 29.5 |
| **1980** | 50* | 39 | 53.5 | 14.5* |
| **1981** | 93 | 47 | 64 | 28.5 |
| **1982** | 118.5 | 43 | 62 | 30.5 |
| **1983** | 49* | 45 | 64 | 16* |
| **1984** | 116 | 46 | 62.5 | 28 |
| **1985** | 97.5 | 40 | 51.5 | 25.5 |
| **1986** | 49* | 45.5 | 56 | 23.5 |
| **10-year average** | 80.2 | 41.35 | 56.6 | 24.3 |
| **Avg. excluding drought years** | 100.67 | 41.35 | 56.6 | 27.7 |

*Indicates a drought year.
Source: Virginia Agricultural Statistics (various issues) as reported in Norris (1988)

**Appendix E.2 – Crop prices**

Crop prices used in this analysis were based on a 10-year average of prices for the Northern Neck (1977-1986) converted to 1987 dollars using the Consumer Price Index. The table is adapted from Ligon et al. (1988).

| | | Corn | | Wheat | | Barley | | Soybeans | |
|---|---|---|---|---|---|---|---|---|---|
| Year | CPI Factor | Nominal | Real | Nominal | Real | Nominal | Real | Nominal | Real |
| **1977** | 1.958 | 2.10 | 4.11 | 2.15 | 4.21 | 1.80 | 3.52 | 5.90 | 11.55 |
| **1978** | 1.833 | 2.35 | 4.31 | 3.05 | 5.59 | 1.85 | 3.39 | 6.85 | 12.56 |
| **1979** | 1.677 | 2.83 | 4.75 | 4.10 | 6.88 | 1.80 | 3.02 | 6.28 | 10.53 |
| **1980** | 1.472 | 3.48 | 5.12 | 3.87 | 5.70 | 2.26 | 3.33 | 7.89 | 11.61 |
| **1981** | 1.317 | 2.70 | 3.56 | 3.34 | 4.40 | 2.09 | 2.75 | 6.09 | 8.02 |
| **1982** | 1.215 | 2.55 | 3.10 | 3.06 | 3.72 | 1.90 | 2.31 | 5.70 | 6.93 |
| **1983** | 1.171 | 3.70 | 4.33 | 3.40 | 3.78 | 2.05 | 2.40 | 7.85 | 9.19 |
| **1984** | 1.125 | 2.95 | 3.32 | 3.35 | 3.77 | 2.35 | 2.64 | 6.00 | 6.75 |
| **1985** | 1.086 | 2.55 | 2.77 | 2.95 | 3.20 | 1.70 | 1.85 | 5.15 | 5.59 |
| **1986** | 1.045 | 1.65 | 1.72 | 2.55 | 2.67 | 1.50 | 1.57 | 4.85 | 5.07 |
| **1987** | 1.000 | 1.80 | 1.80 | 2.65 | 2.65 | 1.45 | 1.45 | 5.10 | 5.10 |
| **10-year avg. of real prices (1977-1986)** | | | 3.71 | | 4.40 | | 2.68 | | 8.78 |

Source: Ligon et al. (1987)

**Appendix E.3 – Production Budgets**

Production budgets were adapted from Norris (1988). Per-acre nitrogen costs are based on the assumption that 2 lbs. of nitrogen are required per bushel of target yield (Norris, personal communication, March 7, 1992). All operating capital was assumed to be borrowed at a rate of 10.5 percent to represent an average rate for short-term loans in the Northern Neck. Norris (1988) estimates these rates vary between 9 and 12 percent. A labor cost of $4 per hour was used to approximate returns to farmers' labor and(or) the costs of hired labor (Norris, 1988; VCES, 1989). Labor hours required for various field operations are calculated in appendix F.

**Production budget for corn, minimum tillage, 100 bushels per acre.**

| Item | Unit | Price/unit | Quantity | Total |
|---|---|---|---|---|
| **Seed** | (unit) | 71.00 | .30 | 21.30 |
| **P205** | (lb) | .28 | 50 | 14.00 |
| **K20** | (lb) | .16 | 70 | 11.20 |
| **Lime** | (ton) | 24.00 | .4 | 9.60 |
| **Fertilizer application** | (acre) | 4.50 | 1 | 4.50 |
| **Nitrogen** | (lb) | 200 | .27 | 54.00 |
| **Herbicide** | (acre) | 13.23 | 1 | 13.23 |
| **Pesticide application** | (acre) | 5.00 | 1 | 5.00 |
| **Production machinery (variable costs)** | | | | |
| **– chisel** | (acre) | 1.88 | 1X | 1.88 |
| **– disk** | (acre) | 2.05 | 2X | 4.10 |
| **– plant** | (acre) | 4.22 | 1X | 4.22 |
| **Harvest Machinery (variable costs)** | (acre) | 10.29 | 1X | 10.29 |
| **Labor** | (hours) | 4.00 | 1.7932 | 7.17 |
| **Subtotal** | | | | 160.49 |
| **Operating interest** | (dollars) | 0.105 | 160.49 | 16.85 |
| **Total variable costs** | | | | 177.34 |

**Production budget for wheat, conventional tillage, 40 bushels per acre.**

| Item | Unit | Price/unit | Quantity | Total |
|---|---|---|---|---|
| **Seed** | (bu) | 9.50 | 2 | 19.00 |
| **P205** | (lb) | .28 | 40 | 11.20 |
| **K20** | (lb) | .16 | 80 | 12.80 |
| **Lime** | (ton) | 24.00 | .2 | 4.80 |
| **Fertilizer application** | (acre) | 4.50 | 1 | 4.50 |
| **Nitrogen** | (lb) | 80.00 | .27 | 21.6 |
| **Herbicide** | (acre) | 1.60 | 1 | 1.60 |
| **Pesticide application** | (acre) | 5.00 | 1 | 5.00 |
| **Production machinery (variable costs)** | | | | |
| **– chisel** | (acre) | 1.88 | 1X | 1.88 |
| **– disk** | (acre) | 2.05 | 2X | 4.10 |
| **– plant** | (acre) | 4.13 | 1X | 4.13 |
| **Harvest machinery (variable costs)** | (acre) | 4.07 | 1X | 4.07 |
| **Labor** | (hours) | 4.00 | 1.5858 | 6.34 |
| **Subtotal** | | | | 101.02 |
| **Operating interest** | (dollars) | 0.105 | 101.02 | 10.61 |
| **Total variable costs** | | | | 111.63 |

**Production budget for barley, conventional tillage, 60 bushels per acre.**

| Item | Unit | Price/unit | Quantity | Total |
|---|---|---|---|---|
| **Seed** | (bu) | 4.95 | 2.5 | 12.38 |
| **P205** | (lb) | .28 | 40 | 11.20 |
| **K20** | (lb) | .16 | 80 | 12.80 |
| **Lime** | (ton) | 24.00 | .2 | 4.80 |
| **Fertilizer application** | (acre) | 4.50 | 1 | 4.50 |
| **Nitrogen** | (lb) | 120 | .27 | 32.4 |
| **Herbicide** | (acre) | 1.60 | 1 | 1.60 |
| **Pesticide application** | (acre) | 5.00 | 1 | 5.00 |
| **Production machinery (variable costs)** | | | | |
| **– chisel** | (acre) | 1.88 | 1X | 1.88 |
| **– disk** | (acre) | 2.05 | 2X | 4.10 |
| **– plant** | (acre) | 4.13 | 1X | 4.13 |
| **Harvest machinery (variable costs)** | (acre) | 4.07 | 1X | 4.07 |
| **Labor** | (hours) | 4.00 | 1.5858 | 6.34 |
| **Subtotal** | | | | 105.20 |
| **Operating interest** | (dollars) | 0.105 | 105.20 | 11.05 |
| **Total variable costs** | | | | 116.25 |

**Production budget for soybeans, double-cropped, no-till, 25-30 bushels per acre.**

| Item | Unit | Price/unit | Quantity | Total |
|---|---|---|---|---|
| **Seed** | (bu) | 10.50 | 1 | 10.50 |
| **P205** | (lb) | .28 | 40 | 11.20 |
| **K20** | (lb) | .16 | 50 | 8.00 |
| **Lime** | (ton) | 24.00 | .2 | 4.80 |
| **Insecticide** | (acre) | 6.70 | 1 | 6.70 |
| **Herbicide** | (acre) | 31.39 | 1 | 31.39 |
| **Pesticide application** | (acre) | 5.00 | 2 | 10.00 |
| **Production machinery (variable costs)** | | | | |
| **– plant** | (acre) | 7.14 | 1X | 7.14 |
| **Harvest machinery (variable costs)** | (acre) | 10.29 | 1X | 10.29 |
| **Labor** | (hours) | 4.00 | 1.0866 | 4.35 |
| **Subtotal** | | | | 104.37 |
| **Operating interest** | (dollars) | 0.105 | 104.37 | 10.96 |
| **Total variable costs** | | | | 115.33 |

**Production budget for full-season soybeans, minimum tillage, 25-30 bushels per acre.**

| Item | Unit | Price/unit | Quantity | Total |
|---|---|---|---|---|
| **Seed** | (bu) | 10.50 | .67 | 7.00 |
| **P205** | (lb) | .28 | 50 | 14.00 |
| **K20** | (lb) | .16 | 70 | 11.20 |
| **Lime** | (ton) | 24.00 | .25 | 6.00 |
| **Fertilizer application** | (acre) | 4.50 | 1 | 4.50 |
| **Insecticide** | (acre) | 6.70 | 1 | 6.70 |
| **Herbicide** | (acre) | 23.31 | 1 | 23.31 |
| **Pesticide application** | (acre) | 5.00 | 1 | 5.00 |
| **Production machinery (variable costs)** | | | | |
| **– chisel** | (acre) | 1.88 | 1X | 1.88 |
| **– disk** | (acre) | 2.05 | 2X | 4.10 |
| **– plant** | (acre) | 4.22 | 1X | 4.22 |
| **Harvest machinery (variable costs)** | (acre) | 10.29 | 1X | 10.29 |
| **Labor** | (hours) | 4.00 | 1.7932 | 7.17 |
| **Subtotal** | | | | 105.37 |
| **Operating interest** | (dollars) | 0.105 | 105.37 | 11.06 |
| **Total variable costs** | | | | 116.43 |

**Appendix E.4 – Expected net revenues from crop production on average-yielding acres.**

Average gross revenues for corn, wheat, barley and soybeans calculated from the crop yield data in Appendix E.1 and price data in Appendix E.2 are shown below.

| Crop | Average price ($/bu) | Average yield (bu/acre) | Expected Gross Revenue ($/acre) |
|---|---|---|---|
| **Corn** | 3.71 | 100.67 | 373.49 |
| **Wheat** | 4.40 | 41.35 | 181.94 |
| **Barley** | 2.68 | 56.60 | 151.69 |
| **Soybeans** | 8.78 | 27.70 | 243.21 |

Expected net revenues were calculated as shown below using variable costs derived in appendix E.3.

| Crop | Expected gross revenue | Variable costs | Expected net revenue |
|---|---|---|---|
| **Corn** | 373.49 | 177.34 | 196.15 |
| **Wheat** | 181.94 | 111.63 | 70.31 |
| **Barley** | 151.69 | 116.25 | 35.44 |
| **Soybeans** | 243.21 | 116.43 | 126.78 |

**E.5 -- Expected net revenues from a typical rotation of crops.**

To determine gross revenues for a corn/wheat-barley/soybean rotation, a composite total of gross revenues per acre (derived in appendix E.4) using .5 acres of corn, .5 acres of soybeans, .25 acres of wheat and .25 acres of barley was calculated as shown below:

| Crop | Average gross revenue ($/acre) | Proportion of acreage | Composite total |
|---|---|---|---|
| **Corn** | 373.49 | .5 | 186.75 |
| **Wheat** | 181.94 | .25 | 45.49 |
| **Barley** | 151.69 | .25 | 37.92 |
| **Soybeans** | 243.21 | .5 | 121.61 |
| **Composite gross revenue** | | | 391.77 |

Variable costs for a rotation were computed as shown below using variable cost information from appendix E.3:

| Crop | Average variable costs ($/acre) | Proportion of acreage | Composite total |
|---|---|---|---|
| **Corn** | 177.34 | .5 | 88.67 |
| **Wheat** | 111.63 | .25 | 27.91 |
| **Barley** | 116.25 | .25 | 29.06 |
| **Soybeans** | 115.33 | .5 | 57.67 |
| **Composite variable cost** | | | 203.31 |

Expected net returns to a rotation equal $188.46 per acre ($391.77 per acre -$203.31 per acre).

**Appendix E.6-- Expected net revenues from crop production on acres yielding 15 percent less than average.**

Net revenues from marginally producing acres were calculated by reducing average yields for corn, wheat, barley, and soybeans by 15 percent, multiplying them by average prices, and subtracting average production costs. Average yields forom appendix E.1 were reduced as shown below:

| Crop | Average yields | Average yield reduced by 15 percent |
|---|---|---|
| **Corn** | 100.67 | 85.57 |
| **Wheat** | 41.35 | 35.15 |
| **Barley** | 56.60 | 48.11 |
| **Soybeans** | 27.7 | 23.55 |

Average gross revenues from marginal acreage were calculated as follows using price data from appendix E.2.

| Crop | Average price ($/bu) | Average yield (bu/acre) | Average gross revenue ($/acre) |
|---|---|---|---|
| **Corn** | 3.71 | 85.57 | 317.46 |
| **Wheat** | 4.40 | 35.15 | 154.66 |
| **Barley** | 2.68 | 48.11 | 128.93 |
| **Soybeans** | 8.78 | 23.55 | 206.77 |

Expected net revenues for marginal acres were calculated as shown below using variable costs data from appendix E.3:

| Crop | Expected gross revenue ($/acre) | Variable costs ($/acre) | Expected net revenue ($/acre) |
|---|---|---|---|
| **Corn** | 317.46 | 117.34 | 140.12 |
| **Wheat** | 154.66 | 111.63 | 43.03 |
| **Barley** | 128.93 | 116.25 | 12.68 |
| **Soybeans** | 206.77 | 116.43 | 90.34 |

A composite gross revenue was calculated for crops grown in rotation on marginal land as shown below:

| Crop | Average gross revenue ($/acre) | Proportion of acreage | Composite total |
|---|---|---|---|
| **Corn** | 317.46 | .5 | 158.73 |
| **Wheat** | 154.66 | .25 | 38.67 |
| **Barley** | 128.93 | .25 | 32.23 |
| **Soybeans** | 206.77 | .5 | 103.39 |
| **Composite gross revenue** | | | 333.02 |

As calculated earlier, composite variable costs for the rotation equal $203.31 per acre. Net revenues for a rotation on marginal land equal $129.71 per acre ($333.02 per acre - $203.31 per acre).

# Appendix F
# Labor hours

**Appendix F – Calculation of labor hours required for various field operations and release of labor hours by enrolling in CRP.**

Labor hours for field operations, adapted from Norris ( 1988), are shown below. A 10 percent efficiency allowance was included to account for equipment down time.

| Crop | Chisel plow | Disk (2X) | Plant | Combine | Field hours | With 10% efficiency allowance |
|---|---|---|---|---|---|---|
| **Minimum-till corn/ Full-season soybeans** | .2717 | .5236 | .3058 | .5291 | 1.6302 | 1.7932 |
| **Conventional-till small grains** | .2717 | .5236 | .3817 | .2646 | 1.4416 | 1.5858 |
| **No-till, double-crop soybeans** | N/A | N/A | .4587 | .5291 | .9878 | 1.0866 |

Source: Norris 1988

Each CRP contract in Richmond county, Virginia, averaged 19.73 acres (USDA-ASCS, 1990). The days of labor released by placing an "average" contract in CRP are shown below.

| Crop | Labor total (hrs/acre) | Total hours released per contract | Total days released per contract |
|---|---|---|---|
| **Corn** | 7.17 | 141.46 | 5.89 |
| **Wheat** | 6.34 | 125.09 | 5.21 |
| **Barley** | 6.34 | 125.09 | 5.21 |
| **Soybeans** | 7.17 | 141.46 | 5.89 |
| **Rotation** | 8.95 | 176.58 | 7.35 |

## Vita

Polly C. Ligon was born in Lexington, Kentucky, on August 30, 1965. Soon after, her family moved to a farm in Pendleton, South Carolina, were she spent most of her growing-up years. Polly received her bachelor's degree in agricultural communication from the University of Georgia in 1987. After attending Virginia Tech for a year, she went to work for Winrock International Institute for Agricultural Development as a technical editor. Currently, she is a communication associate with Clear Window, Inc., in St. Louis, Missouri, where she serves as managing editor of *Dealer* PROGRESS magazine.