the Potential for Competitive Corn Production in Virginia's Coastal Plain

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This publication was printed on recycled paper.

TABLE of CONTENTS

ACKNOWLEDGEMENTS

The authors would like to thank Margaret Monnett and Vernon Shanholtz for their assistance using the VALUES and VirGIS programs respectively. The thoughtful comments of many reviewers are also greatly appreciated.

INTRODUCTION

During the 1980s the Virginia corn industry changed dramatically. One-third fewer acres were harvested for corn grain in 1989 than in 1980. Prior to 1980, corn grain had ranked second behind hay in harvested cropland acreage, but by 1989 corn grain had fallen to third in the state, with soybeans exceeding corn grain by 175,000 acres (Virginia Department of Agriculture and Consumer Services). Soybean and wheat acreage in Virginia also decreased during the 1980s, but the changes were not as great or as rapid as in corn (Figure 1). Figure 2 shows the change in harvested corn grain acres in individual counties between 1982 and 1987. The only area of the state that showed relatively minor changes was the Southwest where historically very little corn grain has been produced. By the early 1990s, however, the rapid decline in corn acreage had slowed, as the levelling off in Figure 1 shows. More details on the change in acreage and current use of former corn land can be found in the Rural Economic Analysis Program publication *Where Have All the Corn Acres Gone?* (Thornsbury and Kenyon[b]).

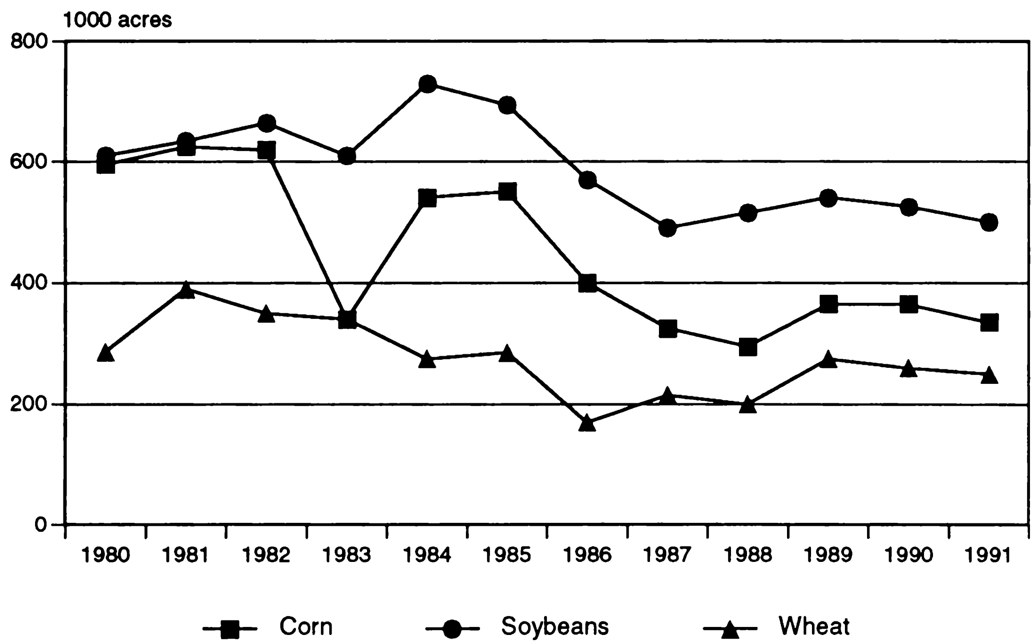

Figure 1. Corn, soybean, and wheat acreage harvested in Virginia, 1980-1991.
Source: Virginia Dept. Ag. and Cons. Services, *Virginia Agricultural Statistics*.

In the past, inconsistent yields and generally low prices caused many corn acres to become unprofitable and therefore to be taken out of production. The state average yield ranged from a high of 116 bushels per acre in 1992 to a low of 48 bushels per acre in 1983. Among individual counties, cities, and regions of the state, the variability was even greater. Since 1980, inconsistent yields have been due in part to frequent droughts. For example, a lack of adequate rainfall in 1980, 1983, 1986, and 1987 resulted in very low yields, sometimes below 40 bushels per acre in parts of the state. In five other years since 1980, however, the state average yield exceeded 100 bushels per acre—a yield never achieved in earlier decades.

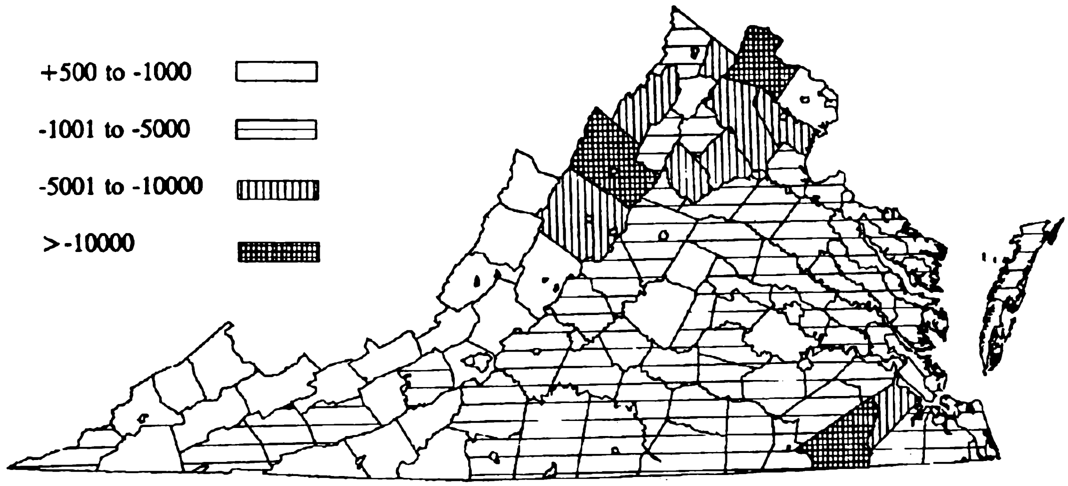

Figure 2. Change in Virginia corn acreage harvested from 1982 to 1987.
Source: U.S. Census Bureau, *Census of Agriculture*, 1982 and 1987.
(Data for Dickenson and York counties not available.)

Corn prices, too, have contributed to the loss of corn acreage. Although Virginia is a corn-deficit state (more corn is consumed than is produced), the market price available to Virginia corn producers is determined nationally. Buyers of corn grain will not pay more for locally produced corn than the price of corn in surplus areas plus the cost of transportation to Virginia. Virginia price is therefore affected by conditions in the Midwest, so Virginia corn producers cannot always expect their market price to increase sharply in years when local harvests are reduced but the U.S. crop is still adequate.

Thornsbury and Kenyon, using 1984-1989 market prices, determined that an average Virginia corn yield of approximately 90 bushels per acre is required for corn production costs to be competitive, relative to corn production costs in Ohio (Thornsbury and Kenyon[a]). Only two Virginia regions averaged better than 90 bushels per acre during the 1980s. With the exception of Southside, however, every region exceeded 90 bushels *in at least one year*, indicating the *potential* for competitive yields, given the right combination of management practices and adequate rainfall.

Each region of Virginia has some soils capable of producing yields consistently better than the state average and some soils that will not produce yields equal to the average. Knowing the extent and location of soils that can remain competitive in corn production relative to the Midwest is crucial for strategic planning by Virginia's feedgrain and livestock industries. Virginia livestock and poultry industries generated $1.3 billion in cash receipts during 1991, and corn remains a critical feed input to these industries. Corn also remains an important crop in many Virginia cropping rotations and an important product of many cash-grain farming operations. The future location of corn production will affect not only the Virginia feedgrain industry's infrastructure, but also the Virginia livestock and poultry industries' competitiveness in a national and international marketplace.

This study was designed to help meet the need for strategicplanning information on Virginia's soil resources and corn production. Specifically, we sought to do the following:

1) evaluate corn grain yield potentials by land use and soil type;

2) determine the location of cropland acreage within the Coastal Plain province that is capable of long-run competitive corn production relative to Midwest costs and yields; and

3) highlight some management practices for the Coastal Plain province that can help producers achieve corn yield potentials.

THE POTENTIAL for CORN PRODUCTION on VIRGINIA'S SOILS

Soil fertility and water availability are the two most critical yield-limiting factors. Fertility can be managed by adding nutrients as needed, but water depends on climate and the physical properties of the soil. While irrigation can supplement available water, and crop management can be used to conserve water, soil texture is the most critical factor that determines a given soil's capacity to supply water to plants.

Soil textures of very fine sandy loam, silt loam, or loam store and release the greatest amounts of water to growing plants. The next best textures are those with moderate amounts of clay, such as silty clay loam, clay loam, and sandy clay loam. Sands, loamy sands, and sandy loams are the textures providing the least water- storage capacity to plants. Where significant volumes of coarse fragments, greater than 2.0 millimeters (.079 inches) diameter, are present, water storage is decreased even further.

In growing seasons with ideal or wetter than normal rainfall, the well-drained, loamy soils, such as Suffolk, Sassafras, Kempsville, and Bojac will give the highest yields of corn (see Table A-1 in Appendix A). Because these soils are well-drained, they also have the greatest potential for leaching losses, especially of nitrogen, into ground waters.

In growing seasons with normal to lower rainfall conditions, soils with sandy clay, clay loam, or silty clay loam subsurfaces, usually accompanied by some restriction in drainage, will sustain the corn crop for longer periods of time. These soils produce higher yields than the better-drained soils in drought-stressed seasons. Soils such as Altavista, Acredale, Myatt, and Tomotley are in this category (Table A-1, Appendix A). Such soils even have an advantage for crop production in the extremely dry years; total crop failures are rare because water tables are near the surface.

Average sustainable yields are thus the highest on soils with slightly heavier subsoil textures accompanied by some restriction in internal soil drainage. Such soils are also less likely to leach nitrates, although volatilization of nitrogen (denitrification) may be high in wetter years.

Virginia's soils vary substantially across the four major physiographic provinces of the state, but soils with properties and characteristics that are compatible with row crop production, and specifically corn production, are found throughout Virginia. In the western provinces of the Ridge and Valley and the Blue Ridge, most soils are on steeply sloping landscapes and have a high content of coarse fragments and low natural fertility. The soils utilized for crop production are restricted to the relatively stone free uplands that have formed from carbonate rocks or carbonate- influenced shales, and to alluvial deposits forming stream terraces and bottom lands. Soils on slopes in the uplands that are used for cropland require special conservation tillage practices that limit continuous row crop production. The limited acreage and relatively small landscape units of the most productive soils, particularly the bottomland soils, limit the overall row crop production of these two physiographic provinces.

The next physiographic province to the east, the Piedmont, is two- thirds wooded, with the non-wooded lands on gently sloping to steeply sloping landscapes. Generally clayey soils in the subsurface horizons limit water-storage capacities, and most soils are naturally low in fertility. Profitable corn production is limited to those few soils—mainly in bottomlands—whose slopes and physical characteristics allow tillage without hazard of erosion, and which have high water-storage and water-supplying capacities.

Virginia's eastern-most province, the Coastal Plain, has a higher proportion of landscapes compatible with row crop production than do the other provinces. Most Coastal Plain soils have loamy to silty surface horizons with few coarse fragments to limit tillage operations. Throughout the region, the soils range from excessively drained (sandy soils) to poorly drained where subsurface horizons have higher clay contents or where water tables are near the soil surface.

Drainage capacity, however, does not limit corn production as much as does low water-supplying capacity. The greatest need for water by a corn crop is during mid-summer when, in normal years, rainfall is less than the water demand of the crop. On soils with medium to low water-storage capacity, yield is reduced because water supply is limiting during this critical time.

The loamy to silty texture of the surface horizons and the gently sloping to nearly level landscapes of many Coastal Plain soils are well suited to corn production. Where soil textures throughout the profile are such that water-supplying capacities are moderate to high, these soils represent the best potential for profitable corn production, even where soil drainage may be somewhat restricted. On the other hand, the location of many of these soils near the Chesapeake Bay, or near waters that drain into the Bay, means that best management practices are needed to reduce environmental impacts.

CORN YIELD in the COASTAL PLAIN

Potential Yield

The Coastal Plain province was selected for a more-detailed analysis of corn production potential because that province includes many of Virginia's traditional corn grain-producing areas and has the highest proportion of acres compatible with row crop production. The analysis covered 19 counties and cities that produced over 40 percent of the corn grain in Virginia in 1990 and 1991 (Figure 3), and was based on information from the Virginia Agronomic Land-Use Evaluation System (VALUES) and the Virginia Geographic Information System (VirGIS).[1]

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[1]Simpson, T. W., M. M. Monnett and S. T. Donohue, Virginia Agronomic Land-Use Evaluation System, Department of Crop, Soil, and Environmental Sciences, Virginia Tech, Blacksburg Va. 1992; and Shanholtz, Vernon, VirGIS, Information Support Systems Lab. Department of Agricultural Engineering, Virginia Tech, Blacksburg, Virginia.

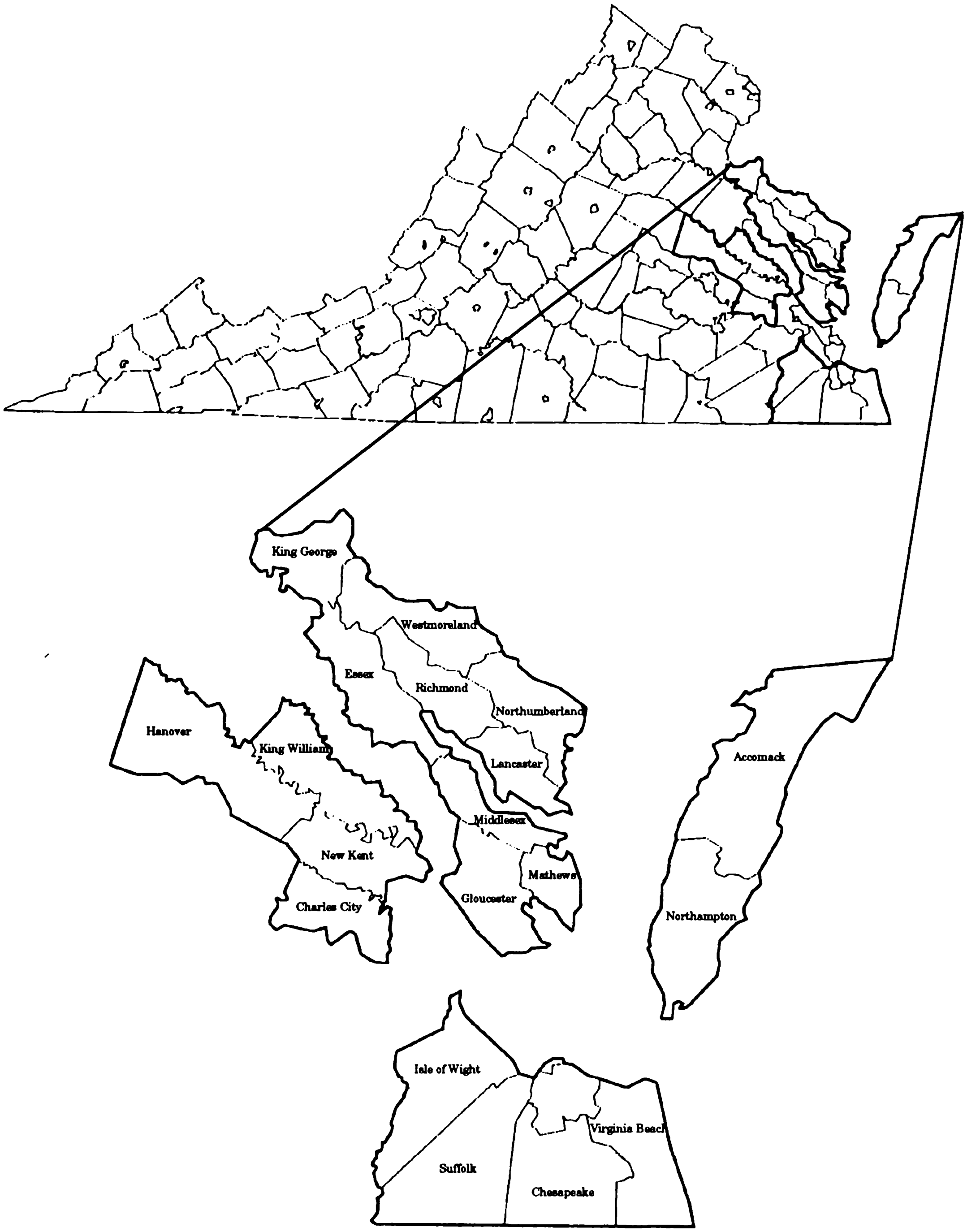

Figure 3. The study area.

VALUES identified the potential yield for six different crops on all individual Virginia soil types. The potential yield is the long-term median yield of a given soil assuming level slope and above average crop management. The yields were developed from recent crop management research results and yield information from 1969-1989 which could be related to soil type. Because the VALUES potential yields were developed from yield observations across several years, they implicitly include an assumption of "normal" moisture conditions. "Normal" is based on rainfall in the years between 1969 and 1989 when data was available. Rainfall in every year is not included, so "normal" rainfall does not equal average rainfall. In general, soils with higher potential yields are capable of holding and supplying more moisture in the years when rainfall is limiting.

VirGIS provided soil and land-use maps for individual counties for 1987-88. Acreage in specific soil types was broken down into non- agricultural, cropland, and pasture land uses. Information was also provided on the slope and erosion classification of specific soils. VirGIS data were used to adjust the potential yields for non-level slopes and topsoil erosion. Yield adjustment factors were provided by the VALUES project. (For more details on the use of VALUES and VirGIS, see Appendix A.)

Combining the soils information from the VirGIS program with the adjusted potential yield information from the VALUES program allowed the amount and distribution of corn production potential to be calculated on a county basis. The amount and location of soils with the potential to be competitive in corn production was calculated for five regions within the Coastal Plain province (Figure 4). The regions were defined based on historical land-use and production patterns. The availability of VirGIS data limited the initial planning yield calculations to 19 counties and cities, but in order to estimate the amount of corn land in the Coastal Plain province, additional counties were included in this part of the analysis.[2] The counties where VirGIS data were not available were assumed to have soil distributions similar to the other counties in the region.[3] Given total corn acreage harvested in 1990 and 1991, the acres of corn produced competitively if the crop was planted equally across all cropland soil types was calculated (Table 1). Based on current rotations, corn acreage would generally be equally spread across cropland in Charles City, Essex, King William, Lancaster, Middlesex, New Kent, Northumberland, Richmond, and Westmoreland counties. A more accurate distribution specifically for corn acreage by soil type would be needed to make adjustments in the other counties, but more detailed data are not currently available.

Table 1. Virginia Coastal Plain corn acreage by yield potential, 1990-91.

	Yield (bushels/acre)		
Region	**<91**	**91-115**	**>115**
		(acres)	
Coastal	4,072	529	15,449
Peanut	15,862	15,368	55,820
Eastern Shore	178	3,623	2,300
Middle Peninsula	7,929	7,593	21,828
Northern Neck	9,137	15,656	24,107
Total for Coastal Plain	**37,178**	**42,769**	**119,504**

In the Coastal Plain province, if corn were planted equally across soil types, there are 119,500 acres of corn land with soils capable of producing yields at least 20 percent higher than 90 bushels per acre with proper management. In other words, these acres have a 20-percent yield-potential buffer that can be used to remain competitive in years of stress due to low levels of rainfall. *Future improvements in production and / or reductions in costs must be achieved to maintain this competitiveness relative to any future improvements in Midwest production and costs.* There are 37,000 acres of corn land in the Coastal Plain province where the soils are *not* capable of producing a competitive yield. Alternative feed grains or

[2]Coastal Plain counties where VirGIS data were not available include King and Queen, Greensville, Prince George, Southampton, Surry, and Sussex.

[3]This assumption was based on information and recommendations from Virginia Tech soil scientists.

other crops should be considered to potentially improve the profit on these acres. Finally, there are almost 43,000 acres of corn land that can produce competitive yields *with careful management of soil fertility and available water*. Total costs must also be carefully controlled to assure these acres remain in a competitive position, because there is very little yield buffer on these soils. In very dry years, irrigation will be needed for these acres to produce corn at a competitive level.

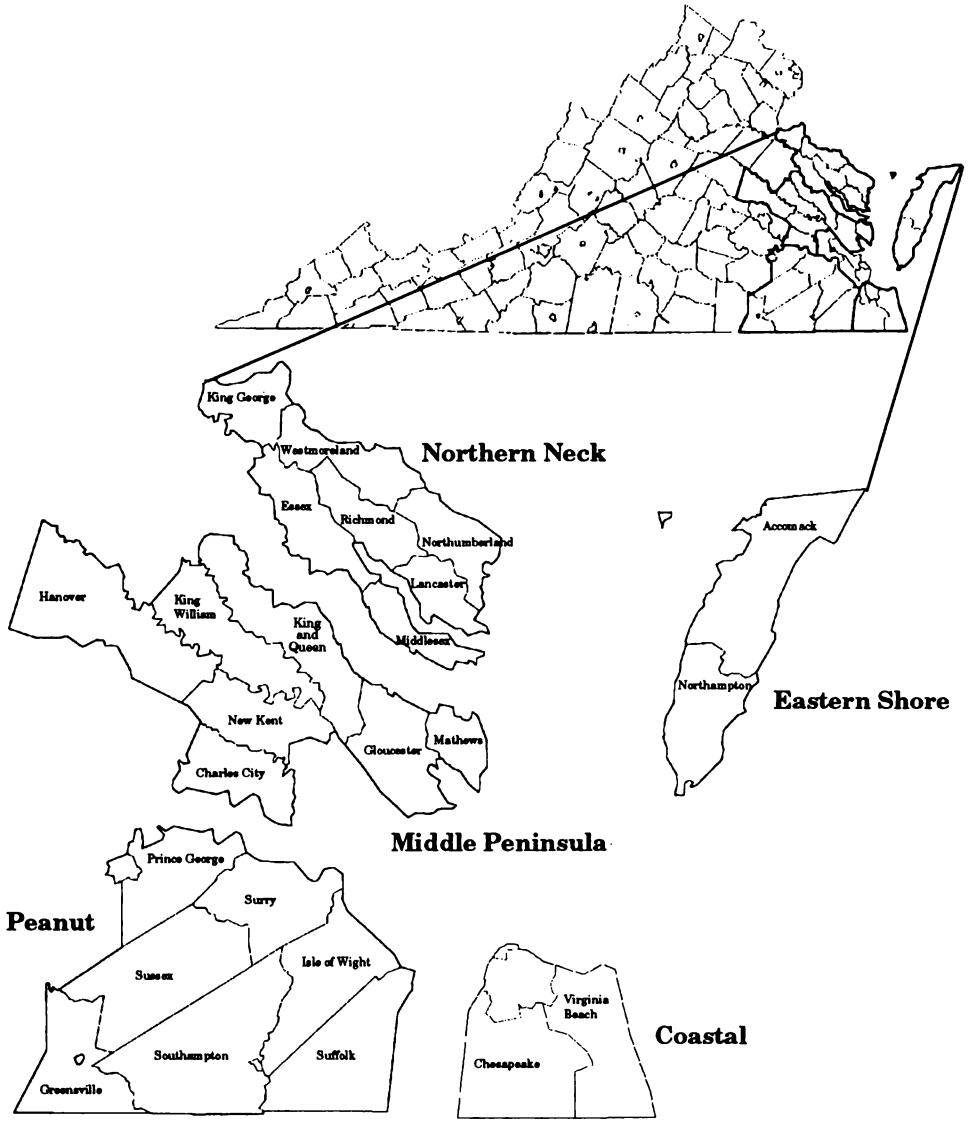

Figure 4. Regional divisions within the Virginia Coastal Plain.
Source: U.S. Census Bureau, Census of Agriculture.

The Peanut region (Figure 4) has the highest amount of total cropland available, as well as the most corn acres in the non- competitive (less than 91 bushels per acre) and highly competitive (more than 115 bushels per acre) yield categories. The Northern Neck region has an almost equal amount of corn acreage in the marginally competitive productivity range (91-115 bushels per acre). Within these two regions, there are 25,000 acres that are not competitive in corn production, 31,000 acres that can be competitive with careful management and cost control, and 80,000 acres that can produce a yield at least 20 percent higher than the competitive yield.

In the total Coastal Plain province, a total of 162,500 acres of corn land has the potential to be competitive in grain production. Soil characteristics do not limit the competitiveness of corn production on these acres. Improper management or failure to control production costs, however, can cause any, or all, of the acreage to become uncompetitive. Corn management strategies to achieve the maximum production potential are critical for producers with these soil types.

Appendix B shows a graphical distribution of potential yields for each county. The distributions indicate a high proportion of cropland with the potential for competitive corn yields (greater than 90 bushels/acre) in each county. Most of the acreage in the very low potential yield ranges (less than 65 bushels per acre) is a result of either steep or eroded cropland. Major soil types in each yield potential range for these nineteen counties are listed in Appendix C.

Potential versus Actual Yields

In order to compare the potential yields with actual yields, the potential yield for each soil type in the original 19 counties was weighted by the amount of acreage in that soil type and averaged for the county (Table 2). These average potential yields reflect the potential corn yield of *all* cropland within a particular county, not the potential yield of land *currently* in corn production. Table 2 compares the difference between actual county yields and the calculated average potential yields; that difference ranged from +5 to -51 bushels per acre, and the difference for any given county changed very little between the 1970s and the 1980s.

Rainfall

Although actual county yields approached the potential yields during some years in the last decade, there were several years with very low corn yields. Some of the discrepancy between potential and actual yields during the 1980s was due to lack of rainfall.

Virginia experienced four droughts between 1980 and 1989, with certain regions of the state suffering more than four drought years. Appendix D graphically depicts the relationship between total July rainfall and corn yields for each individual county. In each county, July rainfall was more highly correlated with corn yields than was rainfall in the other months of the growing season. The graphs in Appendix E indicate that rainfall had a large impact on average yields in certain years.

Compared to other crops, corn has a relatively high water requirement. Evapo-transpiration can be as high as 0.30 inches of moisture per day. In most areas of the United States, the amount of water needed by a corn crop exceeds the amount of rainfall during the mid-to-later portion of the growing season. Therefore, a successful crop depends on moisture that must be stored in the soil. Most Virginia soils have a lower water-holding capacity than Midwest soils, and therefore the timeliness of rainfall becomes much more critical in Virginia than in the Midwest. Short periods of wilting (1-2 days) during tasseling and pollination will result in large grain-yield reductions (Rhoades and Bennett). In some years, the total amount of rainfall has been adequate, but relatively short dry periods during critical growing stages have had an adverse affect on yield. Rhoades and Bennett estimate that, during the silking/early grainfill growth stage, a corn plant is using between .25 and .33 inches of water per day. This equates to a July water requirement greater than 7 inches.

During the 1980s July rainfall in Virginia was seldom above 7 inches. Therefore, extra moisture had to be stored in the soil to prevent severe yield losses. Because moisture-holding capacity is determined by soil type, a given amount of rainfall may be "adequate" for corn production on one soil but not on another.

Table 2. County weighted average corn yield potential compared to actual county 1970-1979 and 1980-1991 average yields.

County	Weighted Average Potential Yield[a]	Average Yield 70-79	Average Yield 80-91	Potential Yield Minus Actual Yield 70-79 Yield	Potential Yield Minus Actual Yield 80-91 Yield
		(bushels/acre)			
Accomack	122	90	94	-32	-28
Charles City	117	90	89	-27	-28
Chesapeake	94[b]	97	99	+3	+5
Essex	113	83	84	-30	-29
Gloucester	108	86	89	-22	-19
Hanover	102	63	82	-39	-20
Isle of Wight	123	90	78	-33	-45
King George	116	81	88	-35	-28
King William	123	81	87	-42	-36
Lancaster	103	83	83	-20	-20
Mathews	129	78	80	-51	-49
Middlesex	113	86	88	-27	-25
New Kent	118	89	90	-29	-28
Northampton	116	84	91[c]	-32	-25
Northumberland	107	86	88	-21	-19
Richmond	105	86	83	-19	-22
Suffolk	120	87	88	-33	-32
Virginia Beach	143	107	104	-36	-39
Westmoreland	108	90	83	-18	-25

[a]See text for explanation of how weighted averages were calculated.
[b]The weighted average potential yield was calculated assuming that corn acreage is evenly divided across cropland acreage. This assumption obviously does not hold true for the city of Chesapeake, because potential yield is less that actual yield.
[c]Data available for 1980-1982 only.

Management Considerations

Available moisture is probably part, but not all, of the reason that actual yields are not as high as potential yields. Proper management practices can be designed to take maximum advantage of the moisture that is available. A comparison of 1970s and 1980s corn yields (Table 2) indicates that there was not a large difference between the two time periods on average; in recent years, however, whenever July and August rainfall has been adequate, Virginia's corn yields have increased dramatically. For example, the state average yield never exceeded 100 bushels per acre before 1980, but it exceeded that level in five of the past twelve years (1982, 1984, 1989, 1990, and 1992). Corn yields set an state average yield record of 110 bushels per acre in 1989, and again in 1992 with a yield of 116 bushels per acre. These facts indicate improved management: taking better advantage of what moisture is available.

A further indication of improved management can be seen in the graphs in Appendix E, which indicate increasing productivity from the available moisture between 1987 and 1989. Lower amounts of rainfall in these years did not produce the dramatic yield decreases that low rainfall did earlier in the decade (for example, in 1983). Although the results vary between counties, all areas had higher yields with the same amount of rainfall in the later years. The corn yield increases in the 1980s, and again in 1987- 1989, reflect an increased level of management on the soils that are available for corn production in Virginia.

Because moisture is so important to corn grain yields, proper crop management becomes essential to get the most production out of the rainfall that is available. Producers cannot predict the weather prior to a growing season and manage for the "drought years." They must use management practices *every year*, to take advantage of increased yields in good years and provide the largest yield buffer possible in dry years.

Good corn management practices include selecting soils with at least moderate water-holding capacity and managing the crop to get maximum efficiency from the soil moisture that is available. On soils with a planning yield potential in the 70 to 120 bushel per acre range, research indicates that proper hybrid selection, plant population, and no-tillage could raise some individual farm yields by 10 to 20 bushels per acre.

Hybrid Selection and Plant Population

An important step toward reaching corn yield potential is selection of the best hybrid and plant population for a specific soil. The best hybrid for the soil should be determined annually based on all sources of information, including Virginia Cooperative Extension Publication 424-031 (Ball, Behl, and Brann). Similar hybrids are grown in Virginia and in the Midwest, but plant population must be adjusted to Virginia conditions. For example, Pioneer Brand 3140 should be planted at 22,000-24,000 plants per acre in the Midwest, on the best Virginia soils, or under irrigated conditions. On less productive soils, or under non-irrigated conditions, research results indicate higher yields when this hybrid is planted at populations of 15,000-18,000 plants per acre. With adequate moisture, lower plant populations of this hybrid will produce more than one good ear per stalk, so this variety is referred to as a prolific hybrid. Under drought conditions, however, lower plant populations of this hybrid will produce one good ear per stalk, while higher populations (i.e., 22,000-24,000 plants per acre) of the same hybrid will result in bare stalks. Thus, the lower plant population will result in higher yields when moisture is limited.

Plant population at harvest should be 18,000-20,000 plants per acre on soils with 80-120 bushel average yield potentials. On soils with average yield potentials of 120-140 bushels per acre, the plant population should be 20,000-22,000 plants per acre. On soils with an average yield potential above 140 bushels per acre, the final plant population for most hybrids should be 22,000-25,000 plants per acre.

Research results from Blacksburg, Holland, and Orange in 1988 and 1989 and evaluation of 75 corn hybrids at Blacksburg in 1990 showed that prolific hybrids have the greatest "stretch" potential. Stretch potential is the ability of a corn hybrid to produce high yields at relatively low plant populations when adequate moisture is available. A 1990 study at Blacksburg showed that the top 19 of 75 hybrids produced at least 1.2 ears per stalk and most hybrids in the top group produced at least 1.4 ears per stalk at 15,000 plants per acre. These prolific hybrids produced 145-174 bushels per acre at 15,000 plants per acre. Eight of the top yielding hybrids at 15,000 plants per acre were also the highest yielding hybrids at 30,000 plants per acre (McKenna *et al.*).

In a similar Blacksburg test, under the severe drought-stressed conditions of 1991, the average yield of 30 corn hybrids was 57 bushels per acre at 15,000, and 55 bushels per acre at 30,000 plants per acre. Planting 12 corn hybrids at final plant populations of 16,000-

18,000 plants per acre, compared to 23,000- 24,000 plants per acre, increased yields at the Poplar Hill Research Station (near Salisbury, Maryland) by 9 bushels per acre in 1990 and 16 bushels per acre in 1991, while reducing seed costs by approximately 25 percent. The consistent yield decrease with higher plant populations at the Salisbury location, but not at Blacksburg, may be related to the higher July temperatures at the Maryland location. The temperatures and soils at Salisbury are similar to the Coastal Plains regions of Virginia (Brann, Mulford, and Bandel [1992]).

Tillage Practices

A second practice that can help producers achieve the yield potential is planting no-tillage into a good moisture-conserving mulch; this practice will generally increase long-term yields by 10 bushels per acre. No-tillage corn production is not a new concept. Research conducted in the 1960s at Blacksburg showed dramatic yield increases when corn was planted no-till into a rye crop, compared to conventional tillage on a silt loam soil. Such research has been repeated in many other states with similar results.

Further studies in 1990 at the Poplar Hill Research Station showed that planting no-till into a small grain/double-crop soybean stubble increased the average yield of nine hybrids to 95 bushels per acre compared with 77 bushels per acre when planted using conventional tillage. The 1992 results of this research showed that the average yield from 12 hybrids was 122 bushels per acre for no-tillage compared to 111 bushels per acre for conventional tillage (Brann, Mulford, and Bandel [1991]).

SUMMARY and CONCLUSIONS

Demand is growing in Virginia for corn grain as livestock and poultry feed. To supply this need and remain competitive in a national market, Virginia feedgrain producers must be able to grow corn at a cost less than the Midwest cost of production plus transportation costs to Virginia. Given the total cost of production in the Midwest versus Virginia and 1984-1989 market prices, research has shown that Virginia producers need an average yield of approximately 90 bushels per acre to remain competitive.

An inventory of soil types in 19 Virginia Coastal Plain counties and cities indicates that over 80 percent of the cropland in these localities has the *potential* to produce corn yields greater than 90 bushels per acre. In fact, over 50 percent of the cropland has the potential to produce more than 115 bushels per acre, providing a significant "buffer" above the competitive yield level. *If* the 1990 and 1991 Coastal Plain corn grain acreage were evenly distributed across soil types, over 119,500 acres would have a competitive corn yield potential; almost 37,000 acres of soils would not be able to produce a corn crop competitively; and 43,000 acres would be able to produce a crop competitively *if* the crop received careful management of available water and soil fertility.

Clearly, then, a significant amount of cropland acreage in the Coastal Plain has the potential to be competitive in corn grain production. In the 1980s, erratic weather patterns often made it difficult for producers to achieve this potential. Many acres with relatively low yield potentials and little buffer against reduced yields became unprofitable and were taken out of production. Many remaining acres, however, are on highly productive soils that have the potential to grow corn competitively. One hopes that the decline in corn acreage reflects the wise decision of producers to take corn out of the rotation on the least productive soils.

Virginia producers can increase their competitive position in corn grain relative to Midwestern producers by either significantly decreasing total cost of production or increasing corn yields relative to those in the Midwest. A majority of the soils in the Coastal Plain province can produce competitive corn yields, but proper management is critical. Proper management practices for specific soils can help individual producers increase yields and reduce costs per bushel. Moreover, optimal management on productive soils will provide a significant yield buffer in years with favorable weather, and will minimize the yield loss and help producers remain competitive in years when the weather is unfavorable. *To maintain their competitiveness relative to any future improvements in Midwest production and costs, Virginia producers themselves must achieve future improvements in production, reductions in cost, or both.*

In the short term, regions where the average yield is dramatically lower than the potential yield can be aided by a research and educational program that identifies and implements technology to help achieve the potential yields. On over 70,000 acres in our study area, yields could be increased by an average of 20 bushels per acre with little change in production costs. In some counties, for example Isle of Wight, there is the potential to increase average yields by 30-40 bushels per acre.

Building on the Research

The results from this study could be applied in several ways. First, this information could be part of a useful management guide that provided specific production recommendations for each region in the Coastal Plain and each general group of soils. Such a guide could indicate what alternative crops could be grown on the soils that are not able to produce corn competitively. The guide could also include management practices designed to increase corn yields in the Peanut region on soils capable of producing 15 percent above the competitive yield level.

Second, a similar analysis could be undertaken for other crops and other regions of the state. Appendix E lists average corn yields and acreage harvested for five other regions of Virginia. Similar data for other crops could provide further information on the relative competitiveness among crops on the same soils. For example, are the soils that are highly competitive in corn production also highly competitive in soybean or wheat production? Which crop has the highest economic advantage for the producer?

Finally, land-use questions could also be addressed through a similar analysis. At some time in the future, some current producers will sell land and relocate, due to residential development, environmental pressures, or both. Where in Virginia should they look to buy the next farm? Where should communities plan to maintain farmland to provide both open space and sufficient economic opportunities for the farm family? Development and utilization of an agricultural suitability map, indicating soil productivity, environmental sensitivity, and development pressures, could help individuals and communities answer these questions, and in so doing help to shape Virginia's agricultural future.

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APPENDICES

APPENDIX A. CALCULATION of YIELD POTENTIALS from VIRGINIA AGRONOMIC LAND-USE EVALUATION SYSTEM (VALUES) and VIRGINIA GEOGRAPHIC INFORMATION SYSTEM (VIRGIS) DATA.

For this study, VALUES identified the potential yield for six different crops on all individual Virginia soil types, and VirGIS provided soil and land-use maps for individual counties for 1987-88. Combining the soils information from the VirGIS program with the adjusted potential yield information from the VALUES program allowed the amount and distribution of corn production potential to be calculated on a county basis.

For example, in Charles City County, VirGIS identified 7,062 acres of Caroline/Emporia complex soils (B slope), 9,018 acres of Craven/Uchee complex soils (C slope), 5,888 acres of Dogue soils (B slope), and 1,740 acres of Pamunkey soils (B slope). All of this acreage was not in cropland. Once the non-agricultural and pasture land acreage was subtracted, there were 1,287, 733, 1,944, and 1,245 acres of the four soils respectively that were in cropland uses.

The VALUES program was used to assign each soil type to a soil management group, and preliminary corn yields were assigned by soil management group. The Dogue soil has an expected corn yield of 130 bushels per acre. Pamunkey soil has an expected yield of 160 bushels per acre. A soil complex is made up of two soil types which may, or may not, be in the same management group. In these cases, weights were assigned to the soils with 60 percent to the first, or dominant, soil type and 40 percent to the second soil type.[1] Caroline and Emporia soils were in management groups "AA" (100 bushel yield) and "R" (120 bushel yield) respectively. A 60- 40 weighing gave an expected yield of 108 bushels per acre for the complex. A similar calculation gave an expected yield of 85 bushels per acre for the Craven/ Uchee complex.

Further yield adjustments were made for slope, erosion, and texture limitations. Of the four soils in this example, only the Craven/Uchee complex yield level was adjusted. Based on VALUES information, yields on C slope soils were decreased by nine percent, so the final yield for this complex was 77 bushels per acre. Similar procedures were followed for the other soils in Charles City County and for soils in the other counties.

[1]These weights are assigned based on information from the VALUES program.

Table A-1. Estimates of corn yield potentials under the Virginia Agronomic Land-Use Evaluation System (VALUES).

Soil Management Group	Soils	Corn Yield Potential
A	Bermudian, Buckton, Chagrin, Chagrin variant, Codorus, Codorus variant, Comus, Congaree, Elk, French, Greendale, Grigsby, Huntington, Lindside, Lobdell, Margo, Massanetta, Nolin, Pope, Ross, Rowland, Staser, Suches, Tioga, Tuckahoe, Weaver, Wheeling	160
B	Altavista, Delanco, McQueen, Pamunkey, Pamunkey variant, Sequatchie, State (Mainland), Wickham, Wickham variant	160
C (drained)	Acredale, Aden, Bayboro, Bethera, Bladen, Cape Fear, Chapanoke, Chatuge, Daleville, Deloss, Elkton, Hyde, Johns, Johns variant, Kinkora, Kinston, Leaf, Lumbee, Lumbee variant, Meggett, Myatt, Myatt variant, Orrville, Orrville variant, Othello, Pantego, Pasquotank, Pooler variant, Portsmouth, Rains, Tomotley, Toxaway, Wahee, Weeksville, Yemassee	150
D	Chester, Chester Loam, Farifax, Manassas, Myersville, Purcellville, Sudley	150
E	Alticrest, Barclay, Dragston, Fallsington, Lynchburg, Nimmo, Osier, Pocomoke, Torhunta, Weston	140
F	Iuka, Linden, Munden, Nansemond, Stough	140
G	Abell, Abell variant, Cotaco, Cotaco variant, Duffield, Emory, Meadowville, Meadowville variant, Murrill, Riverview, Seneca, Shouns, Slabtown, Starr, Timberville, Timberville variant, Tusquitee	140
H (drained)	Dunning, Lickdale, Melvin, Newark, Newark variant, Philo, Purdy, Roanoke	140
I	Bowmansville, Cartecay, Chenneby, Chewacla, Mantachie, Monacan	140
J	Bertie, Bleakhill, Bolling, Bolling variant, Goldsboro, Izagora, Mount Lucas, Woodstown, Wrightsboro	130
K	Ackwater, Dogue, Duplin, Keyport, Marumsco, Mattapex, Slagle, Tetotum, Tetotum variant, Yeopim, Zoar	130
L	Allegheny, Birdsboro, Clifton, Edneytown, Elsinboro, Evard, Hayter, Masada, Shelocta, Shelocta variant, Thurmont, Unison, Unison variant, Waynesboro	130
M	Athol, Bolton, Decatur, Edom, Elliber, Frederick, Frederick/Lodi, Groseclose, Guernsey, Hagerstown, Hublersburg, Lodi, Lowell, Maury, Pisgah, Poplimento, Swimley, Vertrees	130
N	Cullen, Davidson, Eubanks, Fauquier, Glenelg(BRH), Lloyd, Lloyd variant, Minnieville, Montalto, Rabun, Rapidan	130
O	Appomattox, Austinville, Braddock, Dyke, Hiwassee, Hiwassee variant, Nolichucky, Shenval, Starr-Dyke, Turbeville	130
P (drained)	Augusta, Augusta variant, Dunbar, Fork, Fork variant, McGary, Tygart	130
Q	Atlee, Dothan, Freemanville, Montross, Tifton, Varina, Vaucluse	120
R	Aycock, Bama, Cahaba, Emporia, Faceville, Granville, Marlboro, Matapeake, Mattaponi, Norfolk, Orangeburg, Quantico	120
S	Kalmia, Kempsville, Ruston	120

Soil Management Group	Soils	Corn Yield Potential
T	Aura, Bojac (ES, Va Beach, Ches.), Dumfries, Edneyville, Eunola, Gritney, Marr, Sassafras, State (ES), Suffolk	110
U	Arcola, Bookwood, Brecknock, Bucks, Clymer, Faywood, Fletcher, Frankstown, Gilpin, Gilpin variant, Glenelg (NV), Halewood, Jefferson, Jefferson variant, Leck Kill, Panorama, Rayne, Sequoia, Totier, Trappist, Webbtown, Westmoreland, Whiteford	110
V	Appling, Brockroad, Buckhall, Chesterfield, Gundy, Gunstock, Hanceville, Herndon, Legore, Mayodan, Mecklenburg, Mecklenburg variant, Nason, Spotsylvania, Watauga, Wedowee	100
W	Aldino, Ardilla, Clarksburg, Ernest, Glenville, Laidig, Landisburg, Malbis, Marbie, Meckesville, Monongahela, Raritan, Readington, Savannah, Trego	100
X	Catharpin, Cecil, Culpeper, Elioak, Georgeville, Grover, Gwinnett variant, Hayesville, Madison, Pacolet, Rion, Stoneville, Tatum, Wadesboro, Yadkin	100
Y	Bland, Caneyville, Carbo, Dulles, Endcav, Enon, Fluvanna, Oaklet, Pagebrook, Vance, Zion, Zion variant	100
Z (undrained)	Augusta, Augusta variant, Dunbar, Fork, Fork variant, McGary, Tygart	100
AA	Angie, Angie variant, Caroline, Christian, Christiana, Lunt	100
BB	Airmont, Beltsville, Belvoir, Bourne, Bourne variant, Buchanan, Burketown, Burrowsville, Calverton, Captina, Colfax, Colfax variant, Goldvein, Hoadley, Leadvale, Neabsco, Nicholson, Nixa, Rohrersville, York	85
CC	Craigsville, Durham, Edgehill, Edgehill variant, Hartsells, Hawksbill, Lewisburg, Matneflat, Rigley, Sherando	85
DD	Bojac (Mainland excluding Va Beach and Ches.), Bonneau, Conetoe, Kenansville, Kenansville variant, Lucy, McLaurin, Occoquan, Pocalla, Remlik, Rumford, Saffell, Uchee, Wagram	85
EE	Arapahoe, Bibb, Chavies, Chavies variant, Chipley, Corolla, Klej, Lakehurst, Pactolus, Plummer, Seabrook, Seagate, Woodington	85
FF	Alamance, Ashlar, Ayersville, Blairton, Brandywine, Brentsville, Burton, Cardiff, Dekalb, Drall, Gaila, Gainesboro, Hartleton, Lansdale, Laroque, Lew, Lily, Louisburg, Manor, Needmore, Oakhill, Oatlands, Penn, Poindexter, Poindexter variant, Porters, Rushtown, Sekil, Spivey, Stumptown, Sweetapple, Wateree	85
GG	Bailegap, Clarksville, Grimsley, Parker, Poynor, Summers, Weverton	85
HH	Atkins, Baile, Blago, Craven, Hatboro, Nevarc, Partlow, Peawick, Toddstav, Worsham, Worsham variant	85
II	Alaga, Biltmore, Buncombe, Catpoint, Evesboro, Galestown, Lakeland, Lakin, Leetonia, Leon, Lewisberry, Millrock, Molena, Ochlockonee, Ochlockonee variant, Schaffenaker, Tarboro, Toccoa, Wakulla, Westphalia	65
JJ	Albemarle, Ashe, Berks, Bremo, Buckingham, Calvin, Cataska, Catlett, Catoctin, Chilhowie, Clearbrook, Corydon, Dandridge, Goldston, Hazel, Hazleton, Klinesville, Lehew, Litz, Louisa, Louisa variant, Manteo, Misenheimer, Nestoria, Newbern, Opequon, Pinkston, Ramsey, Reaville, Spray, Spriggs, Steinsburg, Talladega, Tallapoosa, Tallapoosa variant, Wallen, Watt, Watt variant, Weikert, Wilkes, Wurno	65

Soil Management Group	Soils	Corn Yield Potential
KK	Albano, Creedmoor, Creedmoor variant, Haymarket, Helena, Iredell, Iredell variant, Jackland, Kelly, Leaksville, Library, Orange, Orange variant, Orenda, Sedgefield, Susquehanna, Sycoline, Trenholm, White Store, White Store variant	65
LL	Chastain, Chickahominy, Coxville, Croton, Elbert, Elbert variant, Evansham, Forestdale, Hollywood, Lenoir, Lignum, Newflat, Okeetee, Pouncey, Robertsville, Stanton, Waxpool	65
MM (undrained)	Muckalee, Wehadkee	65
NN (undrained)	Dunning, Lickdale, Melvin, Newark, Newark variant, Philo, Purdy, Roanoke	65
OO	Acredale, Aden, Bayboro, Bethera, Bladen, Cape Fear, Chapanoke, Chatuge, Daleville, Deloss, Elkton, Hyde, Johns, Johns variant, Kinkora, Kinston, Leaf, Lumbee, Lumbee variant, Meggett, Myatt, Myatt variant, Orrville, Orrville variant, Othello, Pantego, Pasquotank, Pooler variant, Portsmouth, Rains, Tomotley, Toxaway, Wahee, Weeksville, Yemassee	65
PP	Argent, Axis, Backbay, Belhaven, Bohicket, Camocca, Carteret, Chincoteague, Dawhoo, Dawhoo variant, Dorovan, Featherstone, Johnston, Lanexa, Levy, Magotha, Mattamuskeet, Mattan, Nawney, Pamlico, Pocaty, Pungo, Rappahanock	65
QQ	Assateague, Duckston, Fisherman, Fripp, Newhan	65

Source: Simpson *et al.*, "The Development and Implementation of the Virginia Agronomic Land Use Evaluation System (VALUES)."

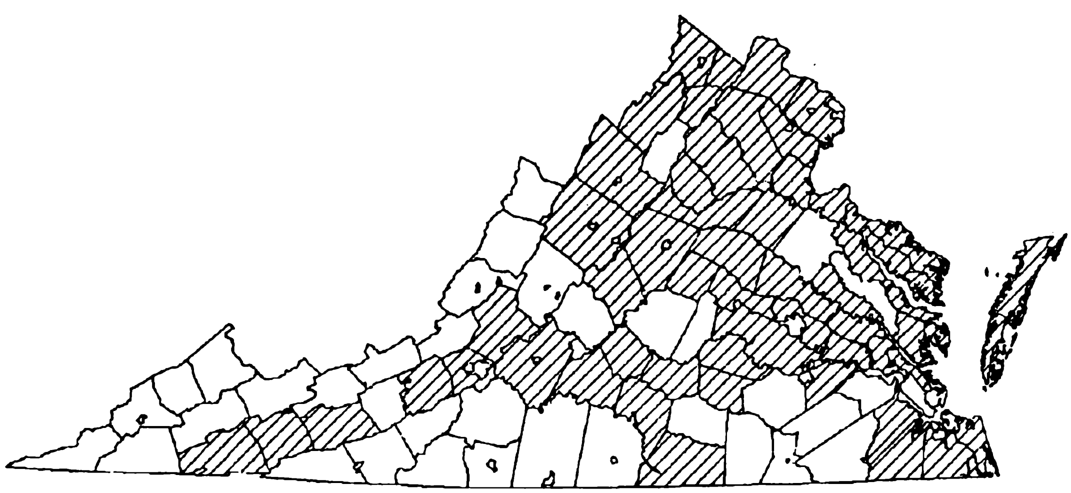
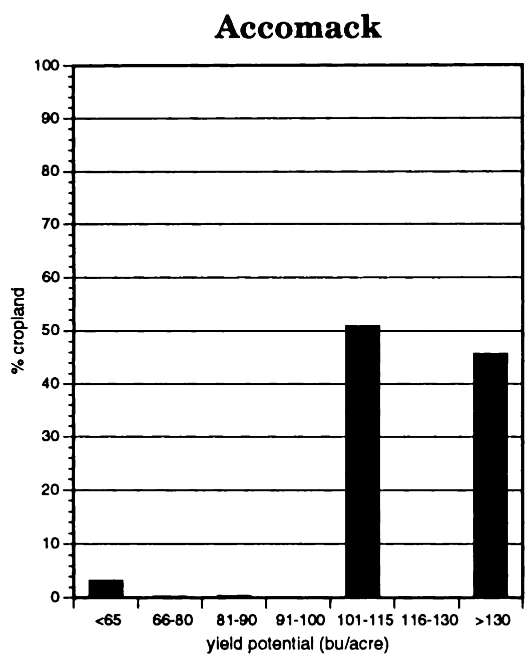
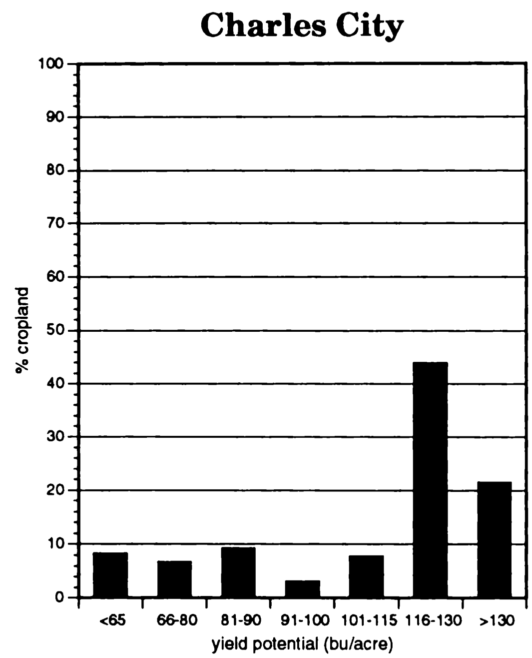
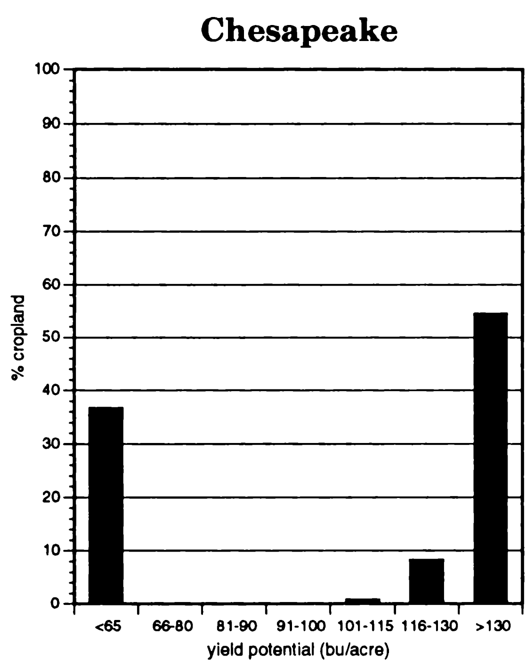


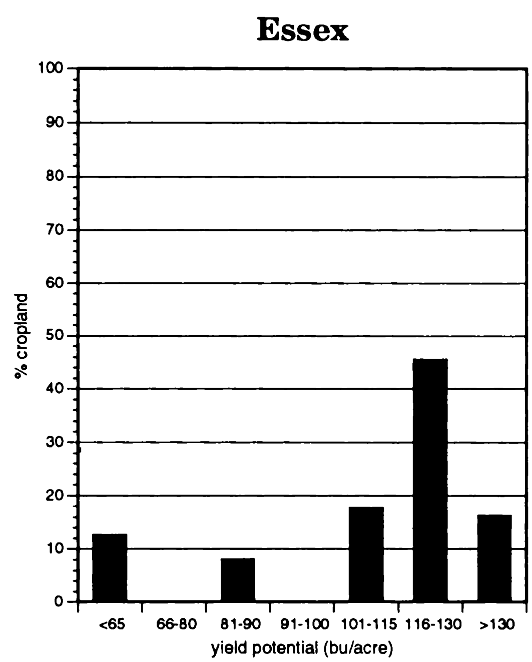
Figure A-1. VirGIS database availability, January 1992. (Shaded Areas indicate the counties where complete VirGIS data were available.)

APPENDIX B. DISTRIBUTION of COUNTY and CITY CORN YIELD POTENTIALS.









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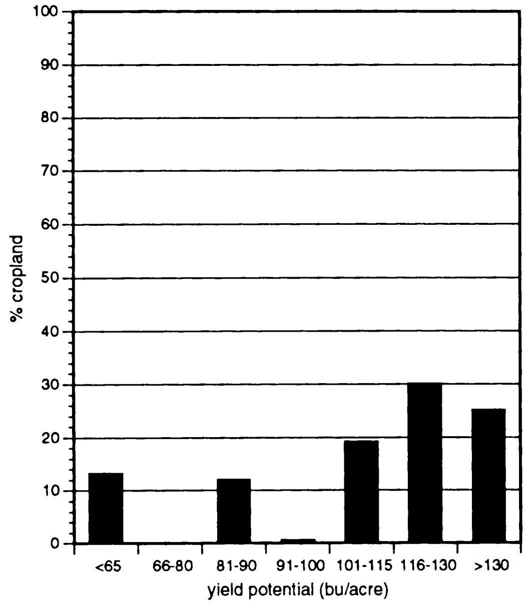

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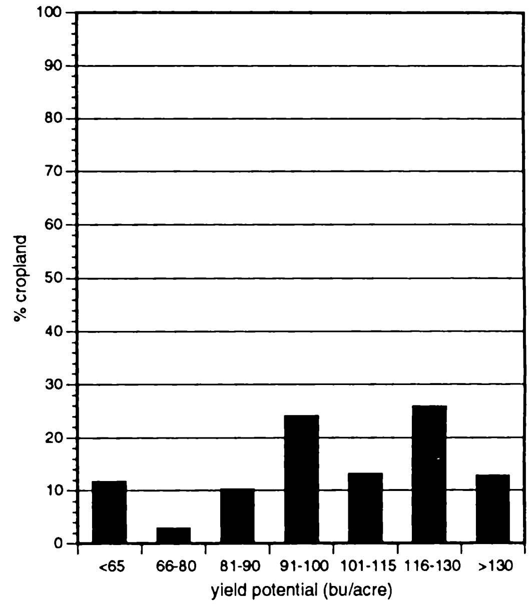

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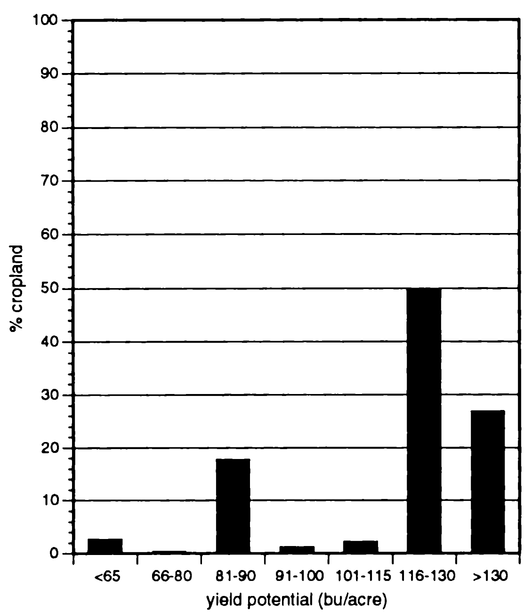

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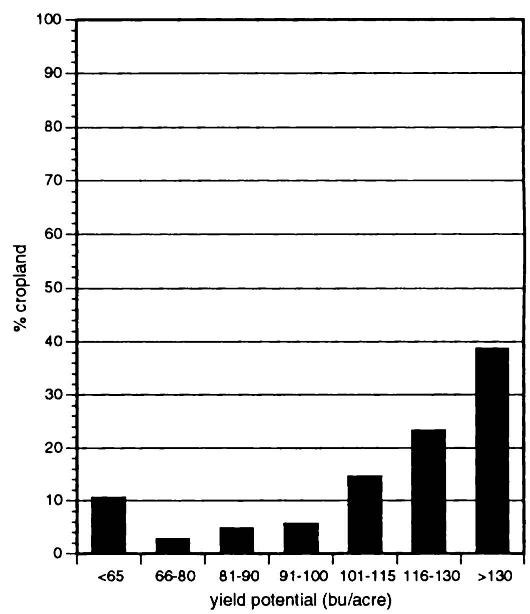

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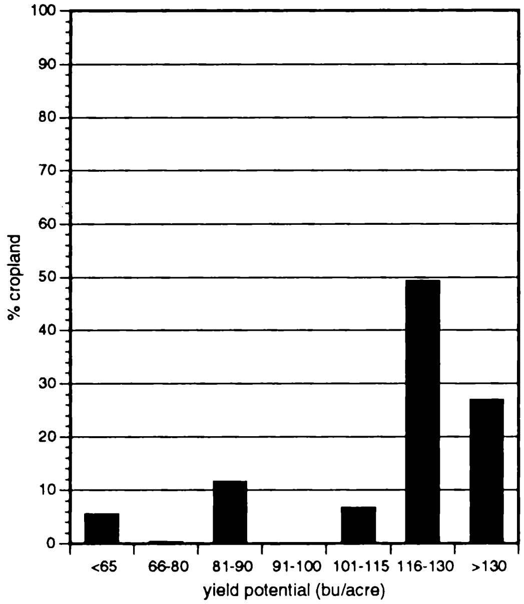
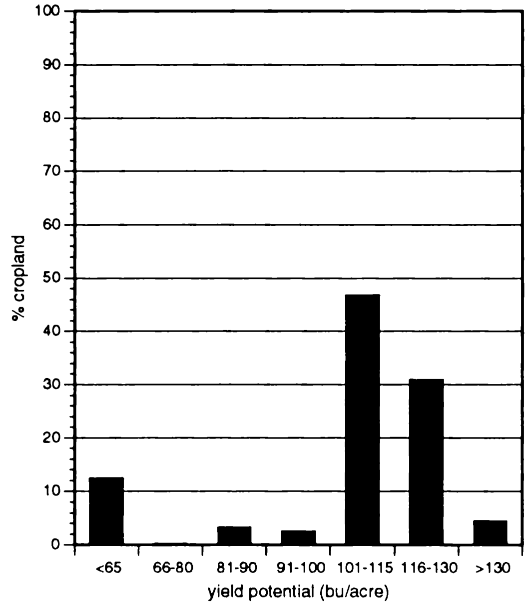
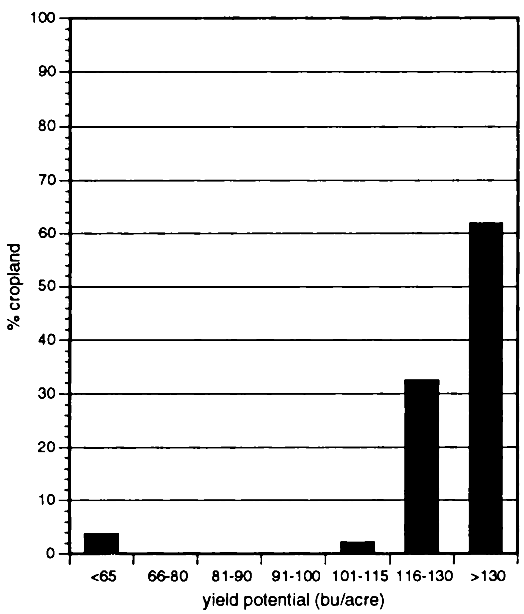


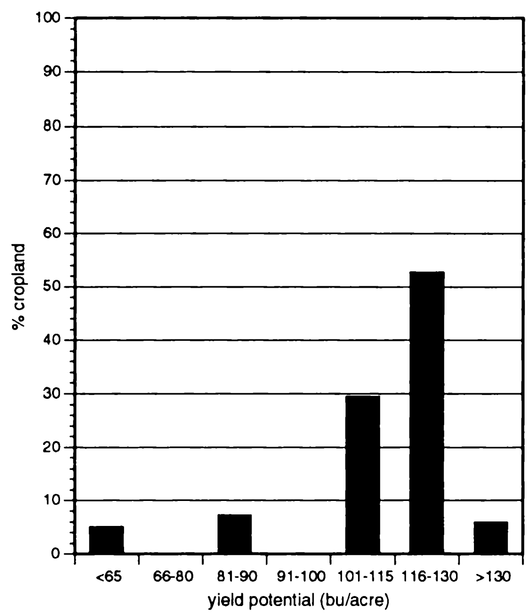
Lancaster



Mathews



Middlesex



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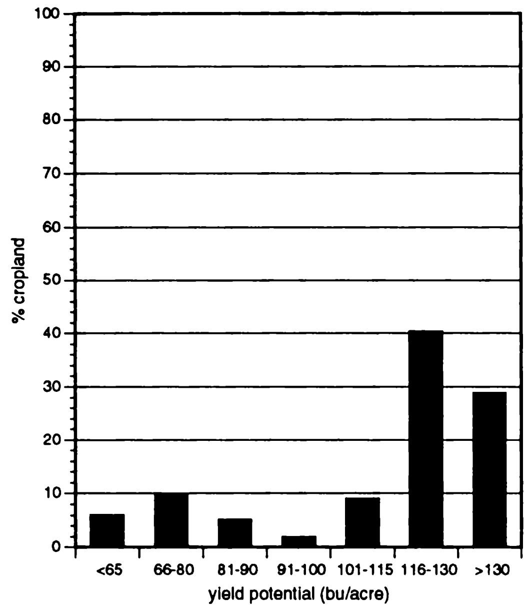
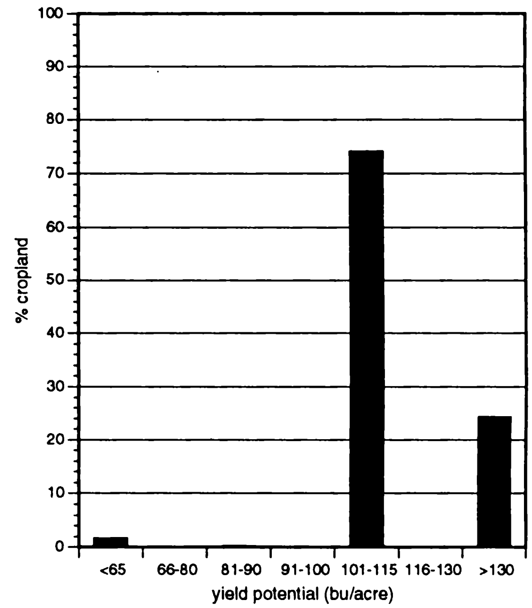
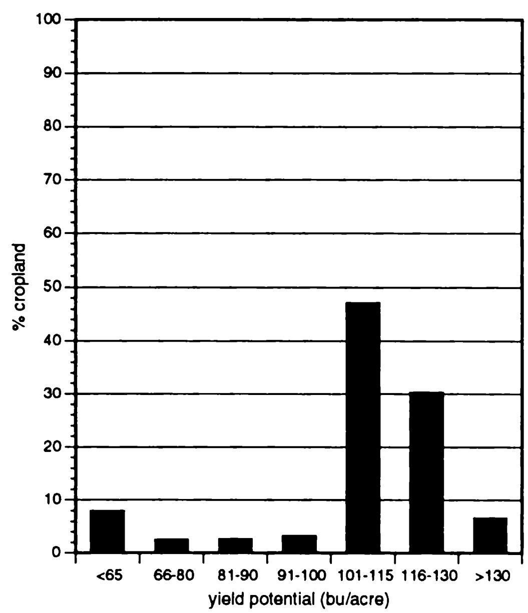


Northampton



Northumberland



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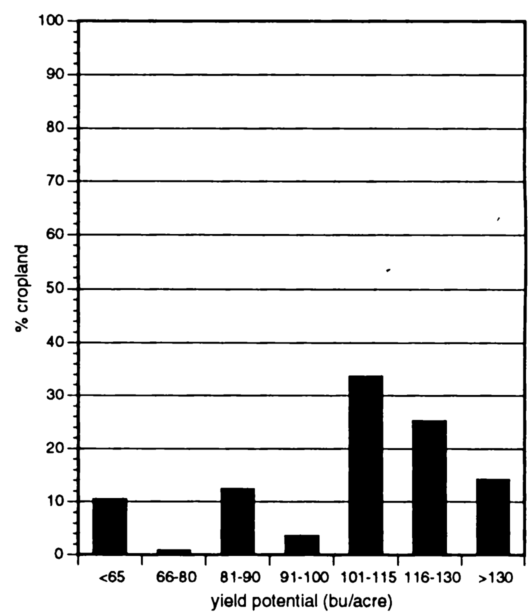

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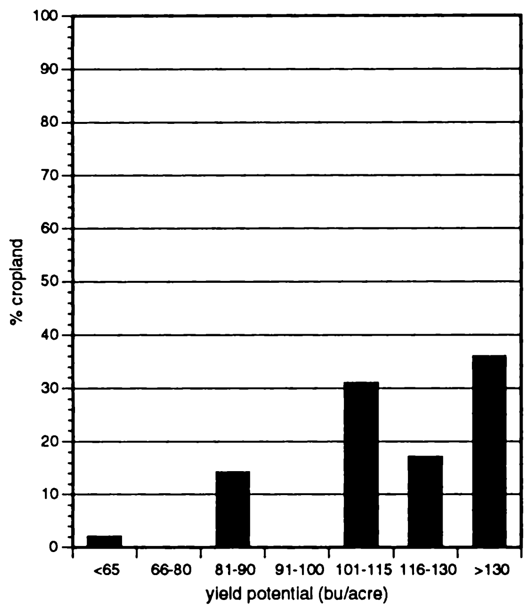
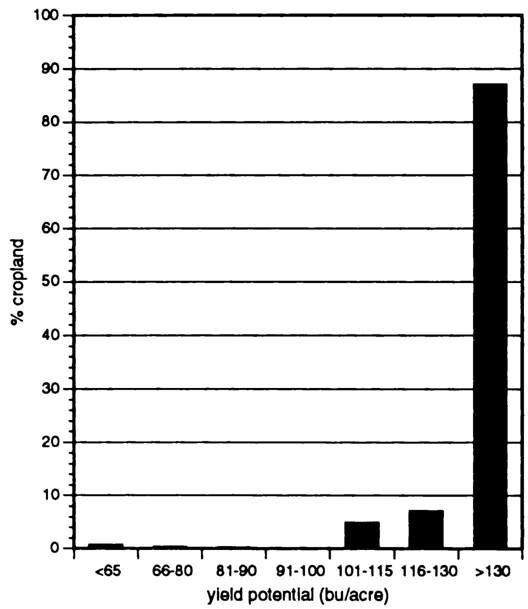
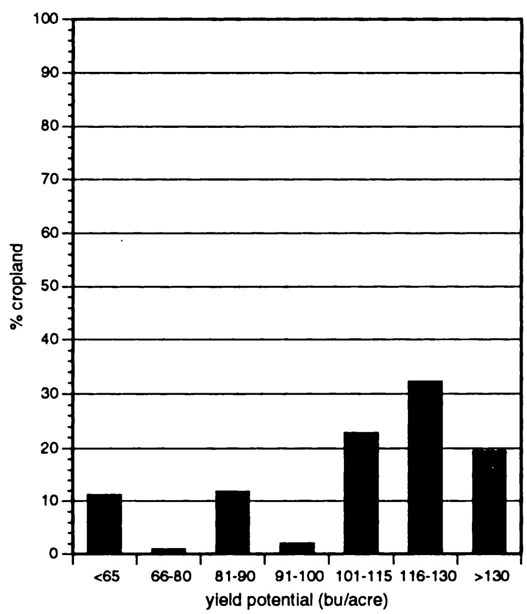


Virginia Beach



Westmoreland



APPENDIX C. MAJOR CROPLAND SOIL TYPES BASED ON CORN YIELD POTENTIALS.[a]

	Yield (bushels/acre)		
County	< 91	91-115	>115
Accomack	Molena	Bojac	Munden, Nimmo
Charles City	Newflat, Craven/Uchee complex	Caroline/Emporia complex	Dogue, Pamunkey
Chesapeake	Lenoir	Sassafras	Othello, Elkton
Essex	Rumford/Emporia complex, Rumford/Slagle complex, Molena	Suffolk	Tetotum, Kempsville, Emporia
Gloucester	Kenansville	Eunola	Meggett, Kempsville
Hanover	Cecil/Vance gravelly, Helena/Colfax complex	Suffolk, Pacolet, Wedowee	Orangeburg/Faceville complex, Norfolk
Isle of Wight	Uchee complex	Peawick/Slagle	Slagle, Yemassee
King George	Galestown/Sassafras complex[b]	Sassafras	Wickham
King William	Seabrook, Craven	Suffolk	Kempsville, Emporia, State
Lancaster	Rumford	Sassafras	Woodstown, Kempsville
Mathews	Rumford	Sassafras	Fallsington, Dragston
Middlesex	Emporia/Nevarc complex[c]	Suffolk	Emporia, Kempsville, State
New Kent	Nevarc/Remlik[c] complex	Caroline/Emporia complex	Kempsville/Emporia complex, Pamunkey

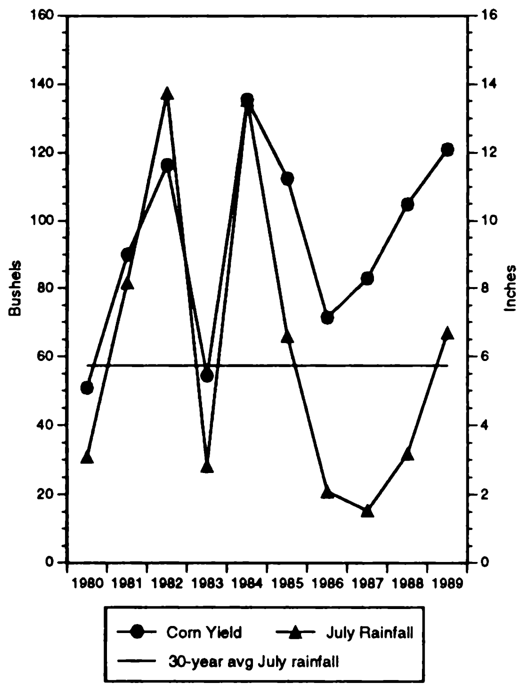
County	Yield (bushels/acre) < 91	91-115	>115
Northampton	Molena[c]	Bojac	Munden, Nimmo
Northumberland	Rumford	Sassafras	Matapeake, Mattapex
Richmond	Rumford[b], Rumford/Tetotum complex[c]	Suffolk	Tetotum, Emporia
Suffolk	Kenansville	Eunola	Lynchburg, Rains, Nansemond
Westmoreland	Rumford[b]	Suffolk	Kempsville, Tetotum
Virginia Beach	Pamlico/Lakehurst complex	Bojac	Acredale, Nimmo

[a] The three soil types that account for the largest number of acres are listed in each category. If less than three soils account for a significant portion of the acreage, less than three are listed.
[b] 15-25 percent slope.
[c] 10-15 percent slope.

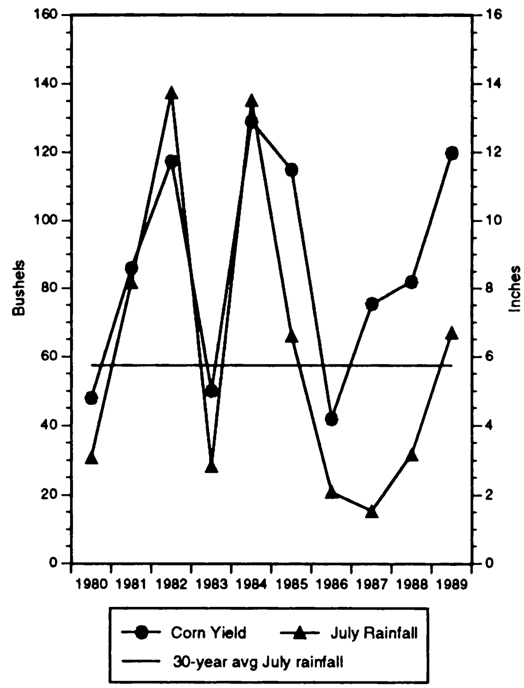
APPENDIX D.
JULY RAINFALL and COUNTY CORN GRAIN YIELDS, 1980-1989.

The sources of the rainfall data are Tom Johnson, Virginia Water Resources Research Center, Blacksburg; and *ClimateData*, published by EarthInfo, Boulder, Colorado.

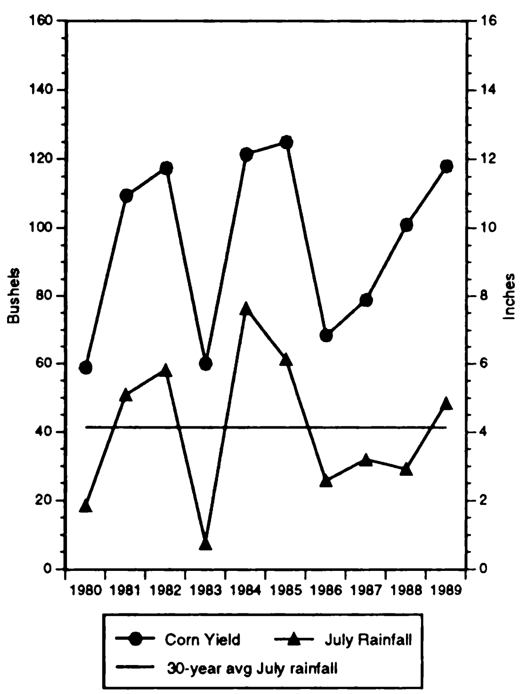
Accomack



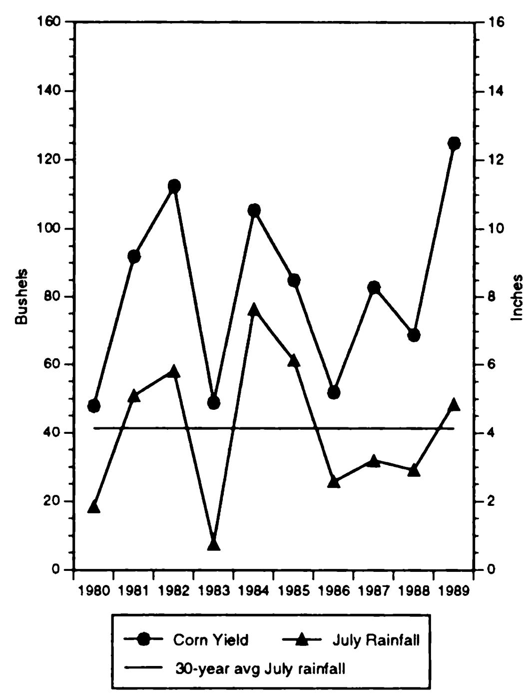
Charles City



Chesapeake



Essex



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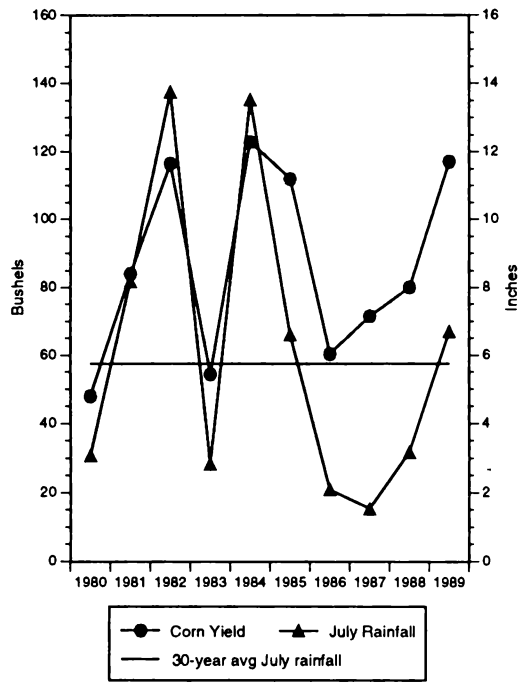
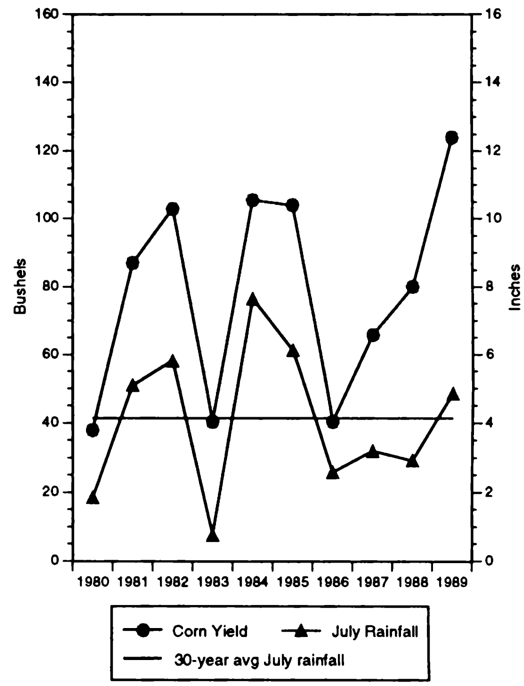
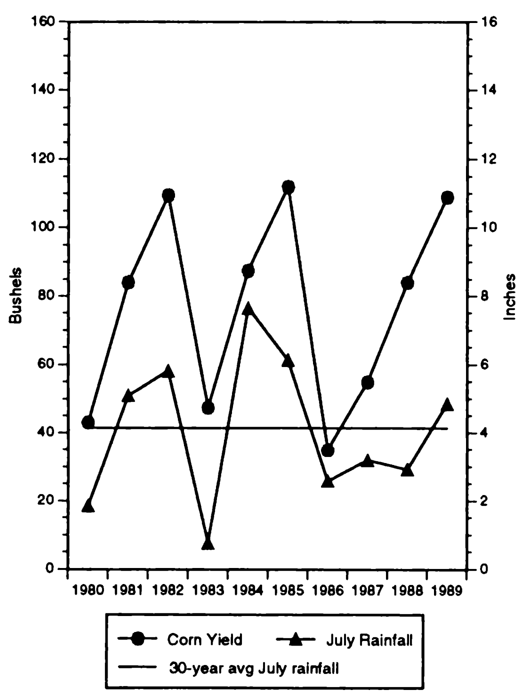


Hanover



Isle of Wight



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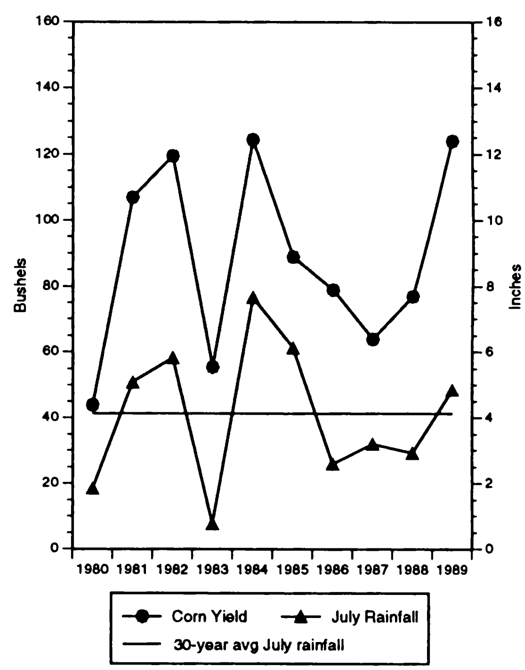

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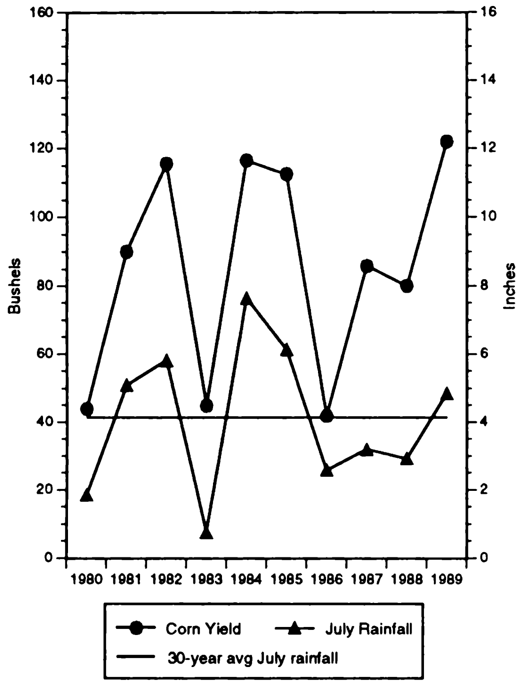

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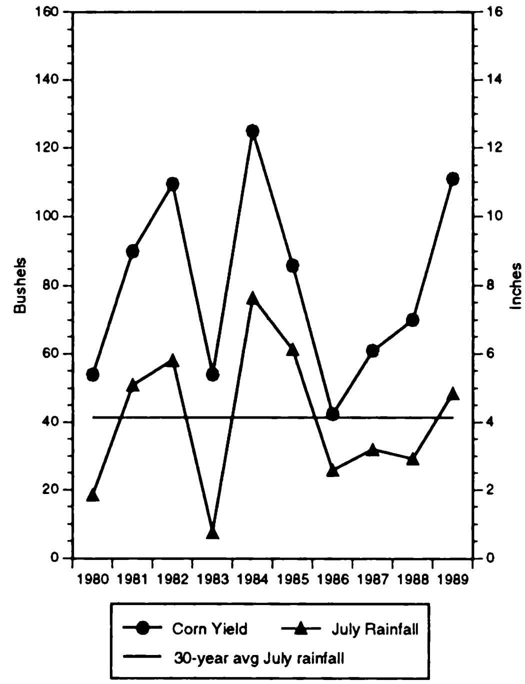
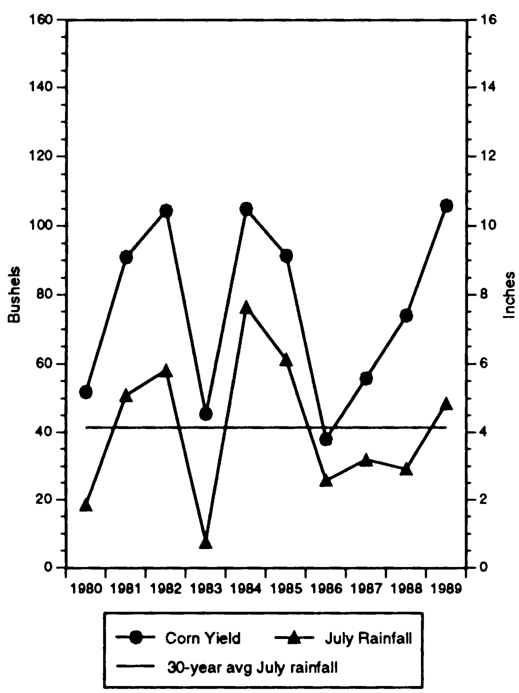
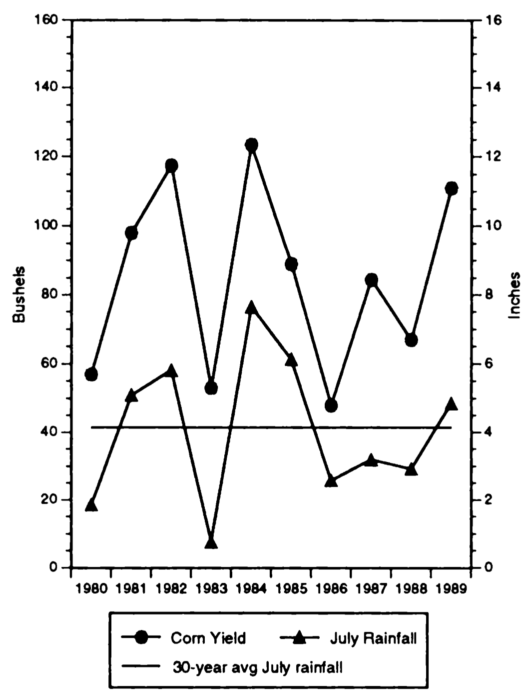


Mathews



Middlesex



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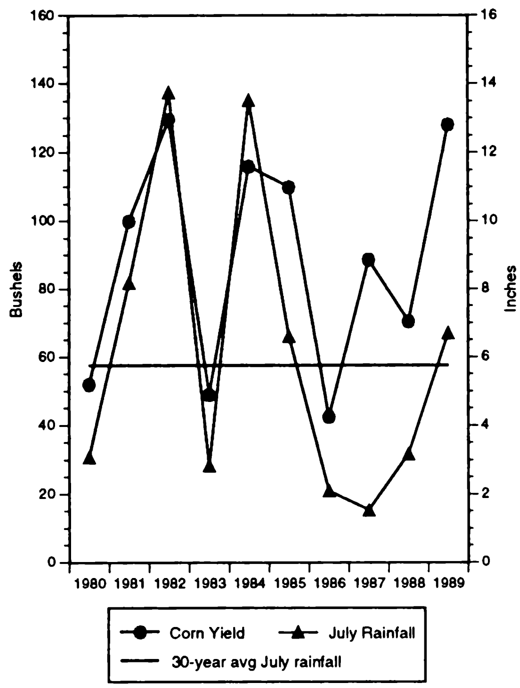

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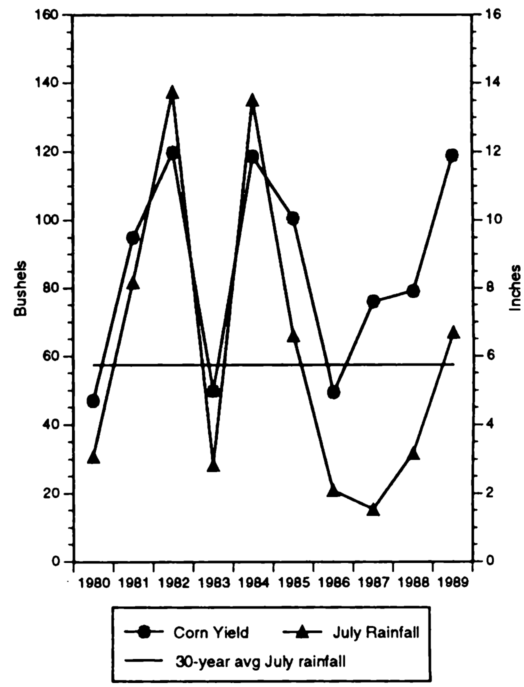

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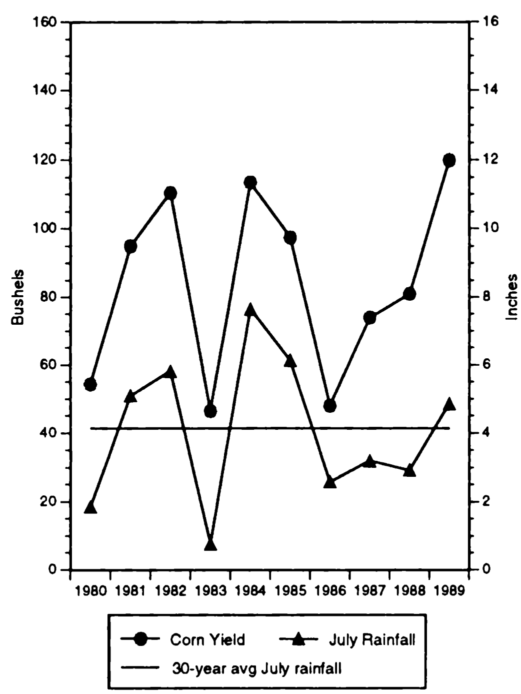
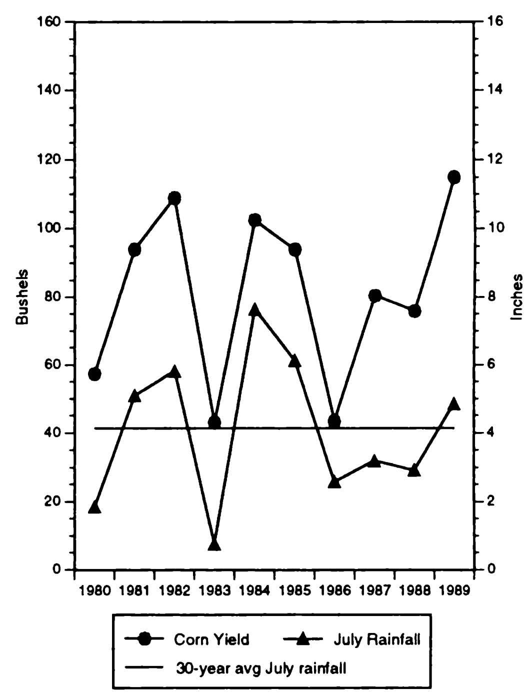


Richmond



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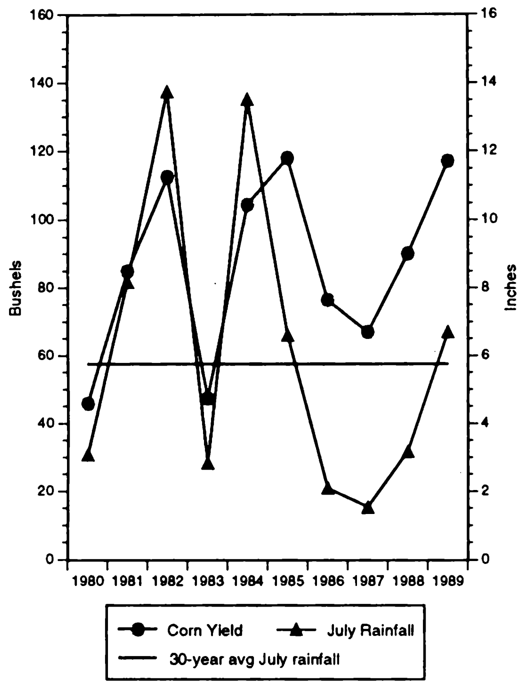
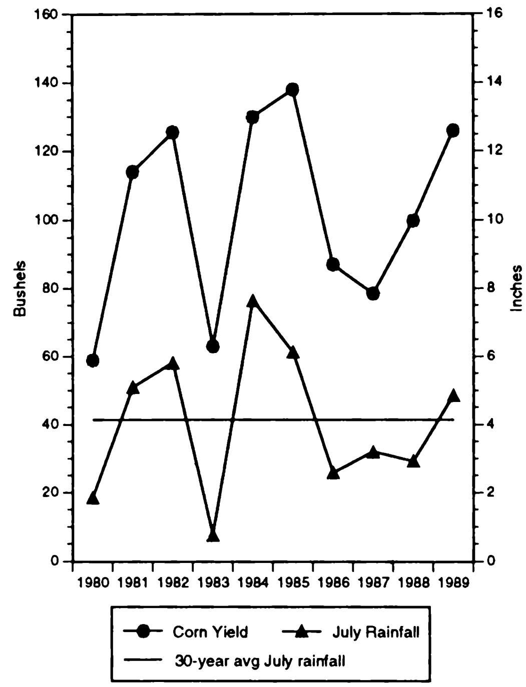
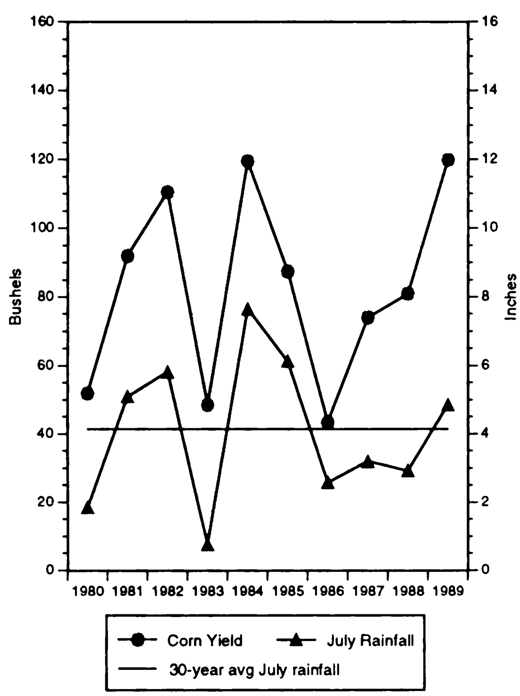


Virginia Beach



Westmoreland



APPENDIX E. CORN ACREAGE in the NON-COASTAL PLAIN REGIONS of VIRGINIA.

The Coastal Plains area accounted for almost 60 percent of the corn land harvested in Virginia during 1990 and 1991. The other 40 percent of corn land was spread throughout the state. Table 3 lists the five other areas of the state, the 1990-1991 corn acreage harvested, and the 1970-79 and 1980-91 average corn yields for these areas. The counties with the largest amount of acreage in each area are listed separately. Based on the actual yields in these areas, only the Southwest region produced an 1980-91 average corn yield that was competitive; however, the total acreage available in that region is relatively small. Some individual counties, for example Rockingham, also produced a competitive average yield (90 bushels per acre or greater). Compared to actual yields in the Coastal Plains, these regions have lower yields and will need greater yield improvements to become competitive. Additional analysis of the VirGIS and VALUES data is needed to determine the yield potentials in these areas and the distribution of available cropland.

Table E-1. Actual corn acreage harvested and average corn yield in the non-Coastal Plain regions of Virginia.

Region/ Selected Counties	Average Yield 1970-1979	(bushel/acre) 1980-1991	Corn Acres Harvested
Central	64	73	34,500
Caroline	71	83	5,500
Louisa	64	76	3,100
Orange	73	83	3,800
Northern	73	78	63,550
Culpeper	79	80	7,700
Fauquier	73	79	9,850
Loudoun	80	77	12,100
Madison	77	84	5,850
Page	71	78	3,050
Rockingham	82	91	11,900
Shenandoah	73	78	3,600
Southern	59	67	17,150
Franklin	67	75	3,100
Halifax	52	65	4,350
Pittsylvania	54	65	4,100
Southwestern	77	90	11,700
Wythe	79	87	2,700
Western	75	85	13,500
Augusta	76	86	8,450

Source: Virginia Dept. Ag. and Cons. Serv., *Virginia Agricultural Statistics*.

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1993 **Virginia Cooperative Extension** Publication 448-216 / REAP R018

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