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Economic and Environmental Impacts of Movement Toward a More Sustainable Agriculture on the Southeastern United States: Draft Final Report

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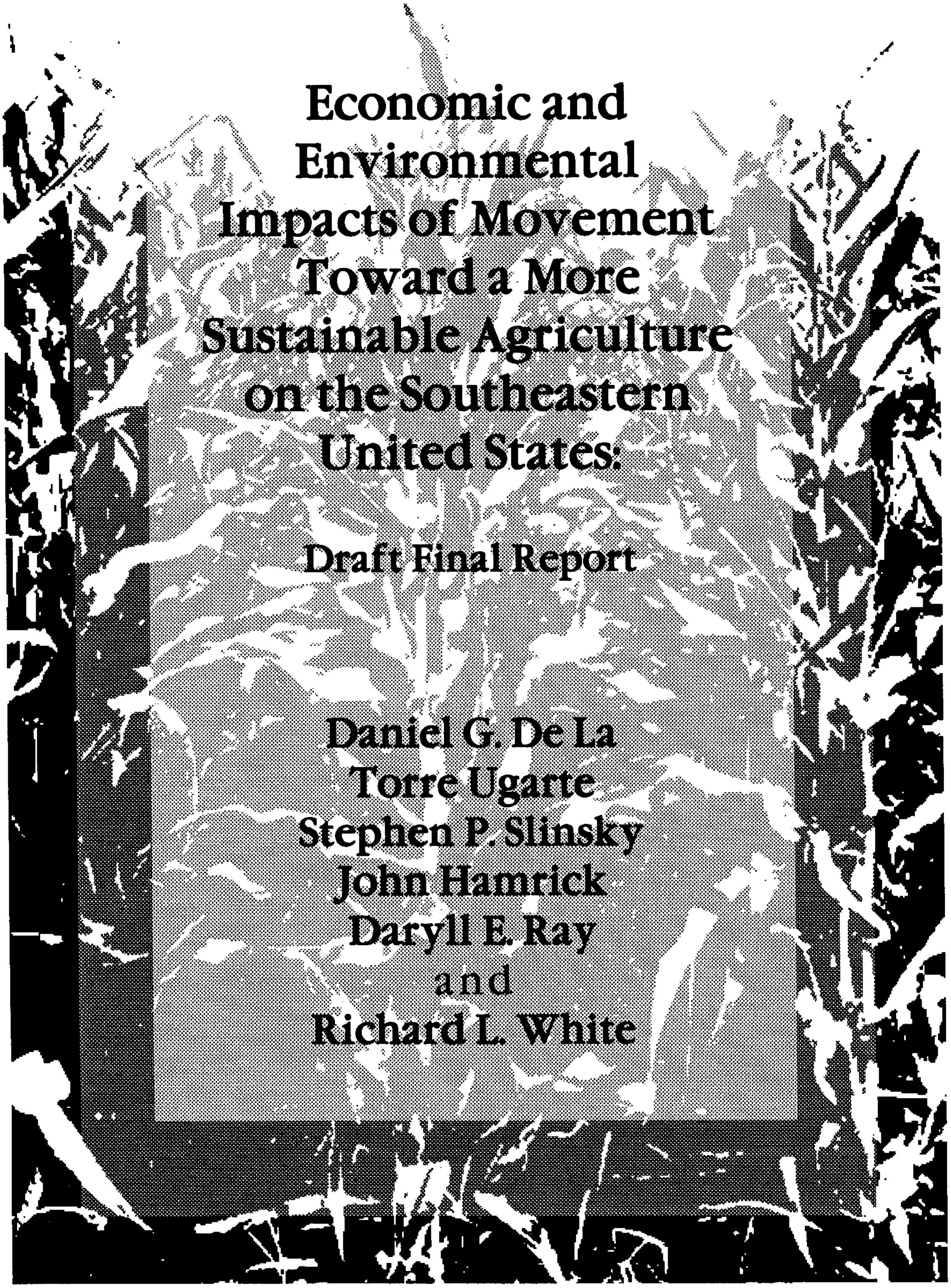

Economic and Environmental Impacts of Movement Toward a More Sustainable Agriculture on the Southeastern United States:

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Executive Summary

This study examines the potential impacts on the Southeastern United States of widespread adoption of more sustainable agricultural practices. For analytical purposes the study region was defined as the states of Alabama, Florida, Georgia, North Carolina, Mississippi, South Carolina and Tennessee. the smallest level of analysis is 48 substate or POLYSYS regions - each of which corresponds to the Agricultural Statistic District designations drawn by the U. S. Department of Agriculture (USDA). The agricultural land in each substate region is classified with as many as four dominant soils, and relevant regions also are distinguished between irrigated and dry-land areas. The study covers the seven major crops: barley, corn, cotton, grain sorghum, oats, soybeans and wheat; therefore all the results in this study are referred to the land allocated to those seven crops, with an exception only made in order to include cover crops in alternative rotations.

The study includes the analysis of three scenarios, the first of which is *Baseline* defined from the economic data presented in the December 1994 USDA agricultural baseline. Based on those data, a rotational baseline is estimated which includes existing and more sustainable rotations, given that it is assumed that some use of more sustainable practices already exists. The second scenario, *Acreage Shift*, involves the assumption of a greater flexibility in the shifting of acreage which can occur from one crop to another; this can be understood as an increase in the own and cross elaticities of supply. The third scenario is the *Maximize* scenario, in which the use of acreage under more sustainable rotations is maximized by artificially driving to zero the returns of the existing rotations.

The core of this study's methodology is a redefined version of POLYSYS, an economic modeling system which integrates substate production regions with the national demand for the major crops. POLYSYS's regional land allocation is driven by the relative returns of the crop rotations in that region. The economic and rotational information was developed using the APAC Budgeting System (ABS), which was developed specifically to keep budgeting activities consistent across rotations and regions. ABS not only produces economic budgeting information, but also the schedule of operations and input applications - data which are transferred to the Environmental Production Integrated Climate (EPIC) model in order to generate the environmental indicators relevant for the study.

The study's results rest primarily in the relevance of the existing and alternative rotations identified for each POLYSYS region in the Southeast. Also, the results are dependent on the validity of the agronomic and economic information developed for the rotations included in the study. Both tasks - as well as the dominant soil selection, economic modeling, and the overall framework which ties this vast amount of information together - represent an integrated effort to address the above issues with a consistent and transparent methodology. However, the lack of databases with specialized focuses and broad geographic coverage make the rotational data at the POLYSYS region level almost impossible to validate. Further, the price effects resulting from changes in production patterns are estimated, but the two scenarios only affect rotation solutions in the Southeast. Price effects could be significantly more pronounced and, possibly, reverse direction if the entire nation were simulated under the two scenarios.

The main conclusions of the study can be summarized as follows:

- While regional growth in the use of more sustainable rotations grows from 9.5 percent 14 percent under *Baseline* conditions, several ASDs grow much faster. This subregional growth suggests that important environmental gains can be achieved in some areas through increased education and extension efforts to show the economic and environmental benefits of such practices.
- The results of the *Acreage Shift* scenario indicate that although planting flexibility is an important component for sustainability, it may not be the primary component. While the overall level of acreage in more sustainable practices did not show a significant improvement at the regional or generally at the state level, the greater ability to shift production in the *Acreage Shift* scenario has a significant impact on net returns. Thus, it can be said that farmers were able to make more profitable decisions, though not necessarily more environmentally sound decisions, with increased flexibility.
- The *Maximize* scenario showed that currently available alternative practices such as no-till, chemical banding, double-cropping, the use of cover crops, and terraces could be adopted widely and have a positive environmental impact. However, given the assumptions of the model, such a shift could mean a loss of 39 percent in net returns from *Baseline* levels in the Southeast. Nationwide adoption and targeting agricultural policy to foster the use of the more sustainable practices could diminish these losses in net returns.
- The practices and scenarios simulated indicate the potential for significant ASD-specific changes in labor demand. In North Carolina, the overall increase in labor expenditures under *Maximize* was 19 percent and 34 percent in Tennessee, which could indicate that as the use of more sustainable practices becomes more prevalent, potential regional bottlenecks could occur in the farm labor markets.

This study showcases the advantages of the POLYSYS analytical framework and its use through the integration of economic and environmental analysis in substate geographic levels. Along the study, it has be shown many times that the interpretation of the results becomes more precise and relevant as the geographic area becomes smaller. A POLYSYS region defined in terms of Agricultural Statistic District has proven to be useful in identifying and analyzing economic and environmental impacts.

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Chapter 1. Introduction

During the post-World War II era, U.S. agricultural production changed dramatically, becoming highly mechanized and reliant on the use of nitrogen fertilizers and synthetic pesticides. Total nitrogen use has more than quadrupled - increasing from 2.7 million tons in 1960 to 11.5 million tons in 1985 (USDA, 1987). Total active ingredients of pesticides applied also has increased dramatically, from 335 million pounds in 1965 to 861 million pounds in 1987 (Daberkow and Reichelderfer, 1988).

Modern agricultural production techniques and their possible environmental consequences are topics of great concern for the general public, policymakers, and agricultural researchers. This concern stems from evidence that current production methods, which tend to rely on these synthetic production inputs, create environmental externalities which may extend to public health risks from agricultural nonpoint source pollution.

The soil degradation associated with monocultural production and conventional tillage also is a topic of concern. Production practices which return little plant residue to the soil diminish both the qualities of soil which farmers find desirable as well as overall soil productivity with respect to agricultural production. Erosion is the most severe threat to soil quality because of the loss of topsoil laden with organic matter in various stages of decay. When topsoil erodes faster than it is created, agriculture's future productive capacity is threatened.

Soil erosion is the major pathway by which sediment, nutrients, and pesticide residues reach surface water (National Research Council, 1993). In fact, studies conducted by the Environmental Protection Agency (EPA) have identified agriculture as the largest U.S. nonpoint source of surface water pollution (National Research Council, 1993).

These are among the concerns which have led to pressure for government action to protect environmental quality and agriculture's future productive capacity. The National Research Council's Committee on Long-Range Soil and Water Conservation (1993) identifies four policy guidelines for improving agriculture's environmental performance while maintaining profitability. According to the committee, government policies should be formulated to conserve and enhance soil quality as a first step toward environmental improvement; increase nutrient, pesticide, and irrigation efficiency; reduce erosion and runoff; and increase the use of field and landscape buffer zones. Policies designed to achieve these goals will encourage agricultural producers to adopt technologies and practices which are less harmful to the environment and potentially will enhance agriculture's long-term sustainability.

Many technologies and production methods which are potentially more sustainable already exist. Reduced tillage, for example, tends to decrease erosion rates and increase organic matter in soil. Recent research also has shown that herbicides applied at rates lower than label specifications may control weeds effectively (Rhodes, 1993-95). Other potentially more sustainable practices, such as crop rotations, were considered standard procedures during the first half of this century.

Land Grant universities and other research centers also are developing completely new, cutting-edge technologies which have the potential to greatly enhance agricultural sustainability. For example, field-level, soil-fertility mapping combined with computer-controlled fertilizer application equipment could ensure that each portion of a field receives the "proper" amount of fertilizer. Biotechnology can play a most important role in achieving a more sustainable agriculture. Recombinant genetics already has been used to develop a cultivar of cotton which uses a gene from Bacillus thuringiensis (Bt) which effectively controls tobacco budworm and bollworm in field trials (Lentz, 1994).

This project provides estimates of the economic and environmental impacts of conversion to more sustainable agricultural practices in the Southeastern United States. While an earlier report focused on farm-level impacts, this report presents the project's regional-level results. The second chapter of this report presents the regional project's objectives. Because the regional project is a component of the ACE Macro study, a subsequent chapter describes the overall data and methodology for the regional and macro studies.

Chapter Two: Objectives

The overriding objective of the regional portion of this project is to estimate the economic and environmental impacts associated with the adoption of more sustainable agricultural production practices in the Southeastern United States. The specific objectives in estimating regional-level impacts are to:

1. Develop a modeling framework through which the regional-level impacts of moving toward a more sustainable agriculture may be estimated. A key component of fulfilling this objective is the development of farm-system budgets which reflect the cost-and-return effects of adoption of more sustainable production practices.
2. Evaluate agricultural practices which may result in improved environmental parameters for the region. To fulfill this objective, current practices in the Southeast were identified as well as appropriate, potentially more sustainable practices and sustainable production systems available to the region.
3. Simulate and evaluate the effects of adopting alternative agricultural practices in terms of their economic and environment effects on the region. This evaluation may indicate which areas more economically suited for the sustainable practices which were modeled as well as their overall impact on the region's agricultural economy.

As with the farm-level portion of this project, the regional project's objectives are achieved by comparing the impacts of possible alternative scenarios against a baseline in terms of: a) environmental degradation associated with production systems; b) output mix; c) input requirements; d) risk; and e) agricultural returns.

Chapter 3. Methodology

For this study, the Southeastern United States is defined as an area encompassing North Carolina, South Carolina, Tennessee, Florida, Alabama, and Mississippi. This area is comprised of 48 ASDs which serve as the primary level of aggregation (figure 1). This study focuses on land in the seven major crops and does not consider alternative crops or crop-livestock operations; as will be discussed later, however, the analytical does consider livestock variables at a higher level of aggregation than is addressed in this study. The

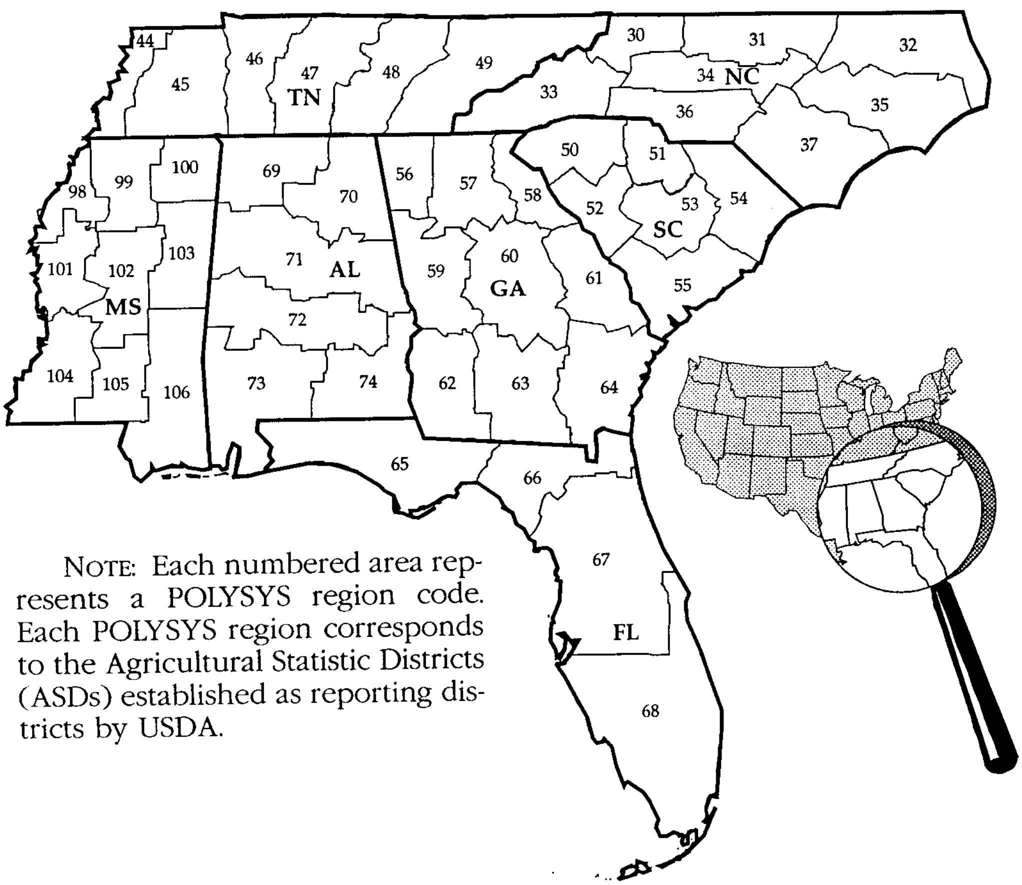

Figure 2
Southeastern United States' Study Area by Region, State, and ASD

remainder of this chapter addresses the methodologies employed to meet the study objectives.

Objective: The Modeling Framework

The analytical framework developed for the regional analysis is designed to estimate environmental and economic impacts of various resource, production, and policy scenarios. As with the farm-level analysis, the modeling system is driven primarily by data from existing USDA databases. The farm-level and regional modeling systems both rely on the demand module of the Policy Analysis System (POLYSYS) for macroeconomic projections. Unlike the farm-level analysis, regional variations in crop prices are estimated by POLYSYS' supply module based on the USDA baseline employed in the analysis.

Combined, the models which comprise POLYSYS form an interdependent framework in which data outputted from one model are fed to the next. This cumulative, stepwise process in which input data are derived from output generated by previous models is illustrated in figure 2.

The Policy Analysis System (POLYSYS)

POLYSYS is a decision-support system which uses parameters generated by large and complex process models, linear programming (LP) models, and econometric models. POLYSYS estimates agricultural production response, resource use, and changes in environmental indicators in relatively homogenous production areas. The system also estimates national commodity utilization, prices, and aggregate cost-and-return measures. Information generated by POLYSYS may be reported by Agricultural Statistic Districts (ASD), other multicounty areas, states, and regions.

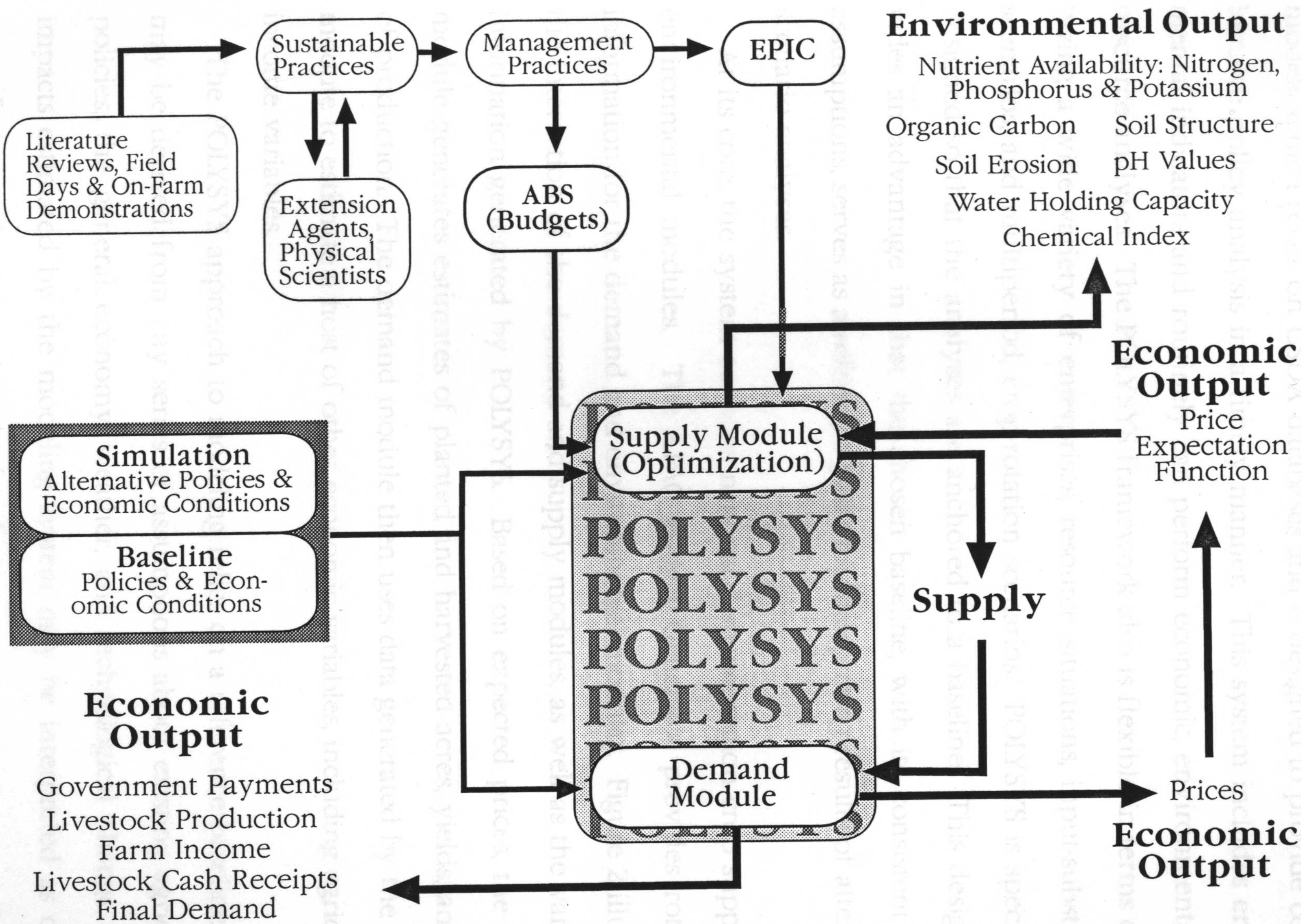

Figure 2
Analytical Framework Used for the ACE Regional-Level Analysis

As has been mentioned, POLYSYS is a unique combination of existing models which relies on USDA databases and is designed to provide comprehensive policy analysis in a timely manner. This system includes environmental indicators and routinely can perform economic, environmental, and resource analyses. The POLYSYS framework also is flexible in terms of analyzing a wide variety of enterprises, resource situations, input-substitution scenarios, and multiperiod, crop-rotation scenarios. POLYSYS is specifically designed so that the analyses are anchored to a baseline. This design provides an advantage in that the chosen baseline, with its consistent set of assumptions, serves as a reference point for interpreting results of alternative scenario analyses.

At its core, the system contains national demand, region crop supply, and environmental modules. The APAC Budget Generator provides rotational information for the demand and environmental modules. Figure 2 illustrates the interaction of the demand and supply modules, as well as the variety of information generated by POLYSYS. Based on expected prices, the supply module generates estimates of planted and harvested acres, yields, and costs of production. The demand module then uses data generated by the supply module to estimate a host of other economic variables, including agricultural income variables.

The POLYSYS approach to modeling relies on a reference baseline which may be derived from any series of assumptions about existing agricultural policies, the general economy, weather, and technological change. Thus, impacts estimated by the modeling system may be interpreted as changes away from a reference point (the baseline).

Supply Module

The crop supply model is an interregional, linear programming (LP) model which estimates the expected distribution of crop-production activities across 267 production areas generally corresponding to ASDs. For each region, the supply module summarizes the cost, yield, price, acreage, resource allocation, and environmental data for a specific crop in each of the 267 production areas in the contiguous United States. As such, its national supply estimates are based on the combined results of 267 LP models which correspond to these regions.

The crop-rotation information included in the activities of the LP models includes data for economic returns, yields, input use, and EPIC-generated environmental coefficients. The use of the Environment Productivity Integrated Climate (EPIC) model in this methodology will be described shortly.

The coefficients used to estimate the environmental indicators are generated from EPIC - taking into account four dominant soils by region - and are introduced in each of the 267 LP models as constraints or accounting rows. The environmental indicators contained refer to soil erosion, nutrient availability, organic carbon, soil structure, pH values, water-holding capacity, and pesticide indicators. The model has the capability to include any variable generated by EPIC to estimate regional environmental indicators.

Demand Module

The crop demand module is based on the National Policy Simulator (POLYSIM), an econometric model which estimates the annual demand for major U.S. crop and livestock categories, as well as net farm income and government outlays (Ray, 1993). The demand module contains the critical components for an econometric demand systems model, yet it is constructed in a manner which simplifies the simulation procedure. This national demand module estimates demand and income variables for the seven major crops (corn, wheat, soybeans, cotton, grain sorghum, oats, and barley) as well as production, market price, and cash receipts for seven livestock categories (cattle and calves, hogs, sheep, broilers, turkeys eggs, and milk).

Erosion Production Integrated Climate (EPIC)

EPIC provides environmental and yield estimates based on mathematical relationships between soil erosion and productivity. EPIC uses available inputs and a wide range of physical characteristics to simulate soil erosion processes and their impacts on productivity (Williams et al., 1990). The model originally was developed to evaluate the relationship between soil erosion and crop productivity but has the capability of examining broader environmental impacts of agricultural practices (Jones et al., 1991). Much of the published research conducted using EPIC, however, has focused on evaluating the model's simulation of crop growth and yields (Martin et al., 1993; Steiner et al., 1987; and Cabelguenne et al., 1990) and water percolation and nitrogen leaching (Benson et al., 1992). Some research has examined the economic viability of changing farm practices (Hughes et al., 1994).

For this project, EPIC uses information derived from the ABS-generated budgets - together with its own soil and weather data - to provide estimates of yield, erosion, chemical uptake and leaching, and other environmental variables. EPIC requires the following information provided by ABS: dates of operations, equipment, crop, and the levels and dates of fertilizer and other chemical applications.

The pesticide variables generated by EPIC are converted into a Chemical Environmental Index (CINDEX) format for analytical and discussion purposes. This index of environmental risk incorporates information regarding pesticides characteristics - such as toxicity to fish and humans - as well as the chemical amounts lost from the farm through runoff and percolation (Teague et al., 1995; Teague et al., forthcoming).

The index is calculated using the following equation:

$$CINDEX = (PERC_{ij} * HA_i * 0.5) + (RUNOFF_{ij} * LC_i * 0.5) \quad (1)$$

where $PERC_{ij}$ is the pesticide quantity which is lost in percolation, HA_i is the the toxicity weight for percolation, $RUNOFF_{ij}$ is the the amount of pesticide lost in runoff, and LC_i is the toxicity weight for runoff. The 0.5 weights may be adjusted to account for differences in the proportion of surface and groundwater affected by the pesticide externality.

The APAC Budgeting System (ABS)

Although listed last, the development of budgetary and field operations data using the APAC Budgeting System actually is the first step in the modeling effort. ABS provides field operations schedules and associated per-acre production costs for all production systems considered in this analysis. Crop production data are entered into ABS to produce budgets for a set of enterprises and rotations which have been determined to be feasible in the particular region being analyzed. These budgets contain production costs and returns, monthly and quarterly labor requirements, detailed operations schedules, levels of crop residue, and nutrient contributions from leguminous crops and manure application.

Much of the data required for budget development are contained in databases which are built into ABS. A machinery database contains price and technical data assembled from existing databases (Benson, 1993; Kletke and Sestak, 1991). Labor costs are based on data obtained from *Farm Labor* (USDA, 1992b). Chemical prices are based on information published in *AGCHEMPRICE* (DPRA, 1992). Application rates and rotation restrictions for herbicides and insecticides are from Meister Publishing Company's *Weed Control Manual 1994*, *Insect Control Guide 1995*, and *First Edition Plant Health Guide*. Fertilizer and seed prices are from *Agricultural Prices-1992 Summary* (USDA, 1993).

ABS output - which serves as input for EPIC and POLYSYS - consists of operations schedules formatted specifically for input into EPIC and production cost and returns for input into POLYSYS. For each POLYSYS region, as many as 20 ABS-generated rotations are available for estimating the production of eight major crops (corn, wheat, soybeans, cotton, grain sorghum, oats, barley, and rice) on each soil included in the analysis. An additional 20 rotations are available to those regions with irrigated land. Four soil types - each with its own profile of environmental parameters by cropping practice and yield by crop - also are identified for each region. Each soil type represents a dominant soil defined by specific slope and hydrological characteristics.

Dominant Soils

Dominant soils identified in each POLYSYS region are presented in tables 1 through 7. These soils were identified through GRASS and STATSGO using selection criteria provided by the Natural Resources Conservation Service (NRCS). All soils in the STATSGO database for a given ASD were examined and classed by interpretive groups established by NRCS. Then, one soil for each interpretive group was selected; the interpretive group in question must have comprised at least 5 percent of a region's crop land, and a maximum of

Table 1
North Carolina Dominant Soils Selected for the ACE Regional Analysis

POLYSYS Region	ASD	Soil Name*	Percent of Total Soils in ASD	Slope (Percent)	Slope Length (Feet)
30	10	MADISON	60.8	16.08	162.29
30	10	CECIL	29.4	13.89	156.60
30	10	CHEWACLA	6.1	13.18	156.05
30	10		2.0	2.84	133.83
33	20	MADISON	65.6	18.55	132.58
33	20	CECIL	23.6	15.05	143.77
33	20	CHEWACLA	7.2	14.53	143.76
33	20		1.4	3.06	175.62
31	40	CECIL	49.7	6.09	162.19
31	40	APPLING	40.3	8.67	158.99
31	40	CHEWACLA	5.2	5.99	162.06
31	40		3.5	3.68	164.70
34	50	CECIL	42.6	9.34	174.90
34	50	CECIL	40.9	6.29	188.87
34	50	CECIL	7.4	3.30	199.90
34	50	CHEWACLA	5.9	6.02	188.63
36	60	APPLING	36.9	8.77	151.27
36	60	CECIL	29.8	5.99	150.66
36	60	FUQUAY	16.1	3.31	151.04
36	60	BLANTON	9.7	5.83	151.15
32	70	DOTHAN	26.1	0.44	159.43
32	70	BLANTON	16.5	1.17	175.41
32	70		13.1	1.17	175.41
32	70	LYNCHBURG	12.4	1.17	175.41
35	80	DOTHAN	30.8	0.51	193.20
35	80	KENANSVILLE	15.5	1.15	195.10
35	80	CECIL	11.5	7.76	143.78
35	80	LYNCHBURG	10.0	1.15	195.10
37	90	DOTHAN	36.3	0.69	190.16
37	90	KENANSVILLE	23.9	1.53	194.69
37	90	LEON	13.7	1.29	194.60
37	90	CECIL	9.9	7.09	196.60

* A blank indicates that this soil was not available in the EPIC soil database

four soils could be selected. Through this selection process, the number of soils on which crop practices would be simulated was reduced to a manageable yet representative number of soils in the study areas. It is important to

Table 2
Tennessee Dominant Soils Selected for the ACE Regional Analysis

POLYSYS Region	ASD	Soil Name*	Percent of Total Soils in ASD	Slope (Percent)	Slope Length (Feet)
44	10	MEMPHIS	28.3	6.14	77.43
44	10	ROUTON	27.2	3.69	74.07
44	10	LORING	25.9	11.36	73.28
44	10	COLLINS	9.8	0.89	70.23
45	20	LORING	27.5	5.42	89.88
45	20	LAWRENCE	23.9	4.22	88.24
45	20	COLLINS	22.1	0.87	83.67
45	20	LORING	18.6	9.59	85.37
46	30	ETOWAH	56.5	8.13	97.40
46	30	BAXTER	21.9	12.52	100.96
46	30	NOLIN	19.2	0.91	116.60
46	30		1.0	7.39	99.37
47	40	BAXTER	41.0	8.30	106.60
47	40	BAXTER	32.6	13.25	102.47
47	40	NOLIN	21.0	0.99	133.99
47	40		3.3	7.46	109.75
48	50	ETOWAH	39.3	8.38	110.88
48	50	NOLIN	31.2	0.96	125.05
48	50	FULLERTON	23.6	13.26	105.01
48	50		2.9	2.88	118.50
49	60	SEQUATCHIE	37.8	11.91	120.12
49	60	ETOWAH	32.7	15.12	124.39
49	60	SEQUATCHIE	17.4	0.97	125.58
49	60	GRENADA	5.5	2.87	111.85

* A blank indicates that this soil was not available in the EPIC soil database

Table 3
South Carolina Dominant Soils Selected for the ACE Regional Analysis

POLYSYS Region	ASD	Soil Name*	Percent of Total Soils in ASD	Slope (Percent)	Slope Length (Feet)
50	10	CECIL	40.6	6.61	138.59
50	10	CECIL	33.9	8.79	136.39
50	10	BLANTON	13.1	6.47	138.90
50	10	FUQUAY	6.2	3.72	141.87
51	20	APPLING	29.0	5.90	130.07
51	20	BLANTON	24.5	5.38	134.74
51	20	MADISON	22.8	9.18	128.63
51	20	FUQUAY	18.3	3.01	138.57
54	30	DOTHAN	31.3	0.58	166.81
54	30	FUQUAY	19.5	1.32	183.11
54	30	LUCY	18.5	1.58	182.08
54	30	DOTHAN	12.7	7.37	159.28
52	40	CECIL	36.3	4.76	187.96
52	40	FUQUAY	26.4	3.15	198.00
52	40	CECIL	17.4	9.02	174.64
52	40	BLANTON	9.5	4.29	193.47
53	50	DOTHAN	29.9	0.67	160.90
53	50	FUQUAY	20.3	1.58	181.01
53	50	LUCY	20.3	1.93	179.37
53	50	DOTHAN	16.9	3.47	201.91
55	80	LEON	35.4	1.26	164.10
55	80	YAUHANNAH	32.7	0.63	151.13
55	80	BLANTON	15.6	1.43	164.02
55	80	DOTHAN	5.7	3.47	197.07

* A blank indicates that this soil was not available in the EPIC soil database

Table 4
Florida Dominant Soils Selected for the ACE Regional Analysis

POLYSYS Region	ASD	Soil Name*	Percent of Total Soils in ASD	Slope (Percent)	Slope Length (Feet)
65	10	BLANTON	37.1	2.91	140.63
65	10	FUQUAY	22.7	2.47	146.32
65	10	DOTHAN	16.4	0.69	163.58
65	10	ORANGEBURG	16.1	3.53	134.18
66	30	BLANTON	48.2	2.10	124.45
66	30	DOTHAN	18.9	0.72	76.86
66	30	FUQUAY	18.3	1.94	122.39
66	30	TIFTON	9.0	2.96	154.28
67	50	MYAKKA	71.8	1.35	78.20
67	50	CANDLER	22.7	2.01	78.50
67	50		2.0	12.82	83.45
67	50		1.3	2.01	78.50
68	80	TERRA CEIA	73.8	0.46	53.15
68	80	CANDLER	15.4	0.52	53.16
68	80		3.5	0.35	52.14
68	80		2.9	3.28	70.62

* A blank indicates that this soil was not available in the EPIC soil database

Table 5
Georgia Dominant Soils Selected for the ACE Regional Analysis

POLYSYS Region	ASD	Soil Name*	Percent of Total Soils in ASD	Slope (Percent)	Slope Length (Feet)
56	10	ETOWAH	51.1	6.34	122.79
56	10	ETOWAH	19.3	0.96	124.73
56	10	CHEWACLA	14.1	5.33	123.16
56	10	ETOWAH	13.0	10.24	110.41
57	20	FUQUAY	63.9	3.00	142.85
57	20	ORANGEBURG	18.6	8.15	135.00
57	20	MADISON	11.9	10.26	129.30
57	20		5.0	7.59	134.28
58	30	FUQUAY	64.5	3.37	160.63
58	30	APPLING	17.4	7.26	148.69
58	30	CECIL	16.4	9.03	142.40
58	30		1.5	7.04	148.83
59	40	FUQUAY	34.0	3.34	135.81
59	40	DOTHAN	25.6	5.63	122.15
59	40	TIFTON	24.9	0.86	136.97
59	40	CECIL	6.7	8.54	103.17
60	50	TIFTON	40.0	0.86	179.53
60	50	TIFTON	26.9	4.10	182.79
60	50	FUQUAY	20.4	3.02	188.89
60	50	LUCY	6.2	3.83	182.51
61	60	TIFTON	36.5	0.99	222.95
61	60	TIFTON	28.1	3.58	175.16
61	60	FUQUAY	20.4	2.83	184.11
61	60	LUCY	7.3	3.23	181.70
62	70	TIFTON	38.9	0.97	182.08
62	70	TIFTON	32.0	3.14	203.32
62	70	FUQUAY	19.3	2.30	200.25
62	70	LUCY	5.5	2.59	197.91
63	80	TIFTON	32.5	0.93	224.51
63	80	FUQUAY	25.5	2.43	205.79
63	80	TIFTON	20.6	3.10	198.03
63	80	LUCY	9.2	2.61	204.02
64	90	LUCY	30.5	2.05	255.60
64	90	FUQUAY	29.4	1.76	258.89
64	90	TIFTON	14.4	0.79	292.23
64	90	TIFTON	12.3	3.45	215.30

* A blank indicates that this soil was not available in the EPIC soil database

Table 6
Alabama Dominant Soils Selected for the ACE Regional Analysis

POLYSYS Region	ASD	Soil Name*	Percent of Total Soils in ASD	Slope (Percent)	Slope Length (Feet)
69	10	ETOWAH	43.8	0.79	45.71
69	10	SPADRA	24.6	5.15	60.47
69	10	ETOWAH	22.7	9.43	64.64
69	10	MALBIS	5.7	2.61	55.35
70	20	ETOWAH	39.5	5.77	77.25
70	20	SPADRA	31.6	0.95	59.09
70	20	HARTSELLS	22.1	9.53	76.36
70	20		3.2	5.30	75.48
71	30	ETOWAH	43.8	7.09	79.04
71	30	MADISON	24.4	10.43	76.89
71	30	SPADRA	23.8	1.00	79.29
71	30		3.6	6.45	79.06
72	40	DOTHAN	31.1	0.90	78.57
72	40	KIPLING	29.7	4.07	86.96
72	40	LUCY	12.5	3.20	84.66
72	40	APPLING	12.3	8.20	90.02
73	50	MALBIS	44.4	0.94	128.52
73	50	ORANGEBURG	39.1	3.96	106.62
73	50	FUQUAY	6.9	8.44	78.23
73	50	BLANTON	5.0	2.93	114.09
74	60	DOTHAN	37.7	0.95	80.55
74	60	ORANGEBURG	22.6	4.57	79.88
74	60	FUQUAY	17.9	3.13	82.78
74	60	LUCY	14.0	4.21	79.95

* A blank indicates that this soil was not available in the EPIC soil database

Table 7
Mississippi Dominant Soils Selected for the ACE Regional Analysis

POLYSYS	ASD	Soil Name*	Percent of Total Soils in ASD	Slope (Percent)	Slope Length (Feet)
98	10	FORESTDALE	62.5	0.86	234.25
98	10	BONN	18.7	0.86	234.25
98	10	COLLINS	9.0	0.86	234.25
98	10		4.1	12.57	91.77
99	20	COLLINS	49.2	4.45	114.18
99	20	LORING	18.0	11.11	83.58
99	20	LORING	12.4	7.34	87.27
99	20	COLLINS	10.6	4.45	114.18
100	30	KIPLING	30.4	6.28	123.53
100	30	LEEPER	29.8	3.62	146.14
100	30	KIPLING	18.7	0.71	170.85
100	30	SUMTER	16.1	9.21	105.41
101	40	FORESTDALE	77.1	0.98	253.00
101	40	BONN	14.5	0.98	253.00
101	40	COLLINS	5.0	0.98	253.00
101	40		1.8	0.62	267.85
102	50	LEEPER	42.9	4.23	168.60
102	50	KIPLING	21.8	0.92	175.00
102	50	LORING	12.0	9.05	147.62
102	50	LORING	11.9	5.99	165.22
103	60	LEEPER	33.9	2.91	206.07
103	60	SUSQUEHANNA	20.0	9.06	127.16
103	60	KIPLING	19.0	5.12	154.23
103	60	POARCH	15.3	0.83	254.74
104	70	FORESTDALE	30.8	4.88	145.96
104	70	CALLOWAY	26.7	0.91	180.94
104	70	LORING	19.3	10.06	121.44
104	70	LORING	14.5	6.74	129.61
105	80	LEEPER	35.3	5.02	127.26
105	80	KIPLING	30.6	0.97	123.16
105	80	KIPLING	14.8	5.69	127.94
105	80	RUSTON	13.4	9.87	103.05
106	90	POARCH	24.8	5.28	160.19
106	90	MALBIS	22.4	0.99	159.43
106	90	LEEPER	20.5	4.44	160.04
106	90	SUSQUEHANNA	16.7	8.99	130.65

* A blank indicates that this soil was not available in the EPIC soil database

note that for POLSYSY regions or ASDs in which there is a significant variation in topgraphy, especially in moutainous regions, the selection of slope percentages likely will be skewed upward. This bias occurs because the information included in STATSGO and GRASS lacks the fine detail necessary to identify the land area used for the crops included in this study. The cropland data included in these databases include land in uses which all for steeper slopes than those included in this study.

Objective: Evaluate Production Alternatives

The use of more sustainable practices varies dramatically by region of the country and crop activity, and there are no hard data which provide POLYSYS region- or ASD-level information on the relative importance of these practices. The data provided by the NRI on land allocated by rotations is not necessarily statistically reliable at the level of POLYSYS regions. Moreover, while this research looks at the total land planted to the seven major crops, the NRI acreage includes other crops besides pasture and hay; thus, in many cases the land allocated to a rotation obtained from the NRI can be grossly underestimated

Despite these data limitations, it has been documented that more sustainable practices are being implemented on a significant and growing number of acres (USDA, 1994). These practices include no-till, chemical banding, and various forms of nutrient management. Fueled initially, perhaps, by the Conservation Compliance program's requirements, the resulting improvements in agronomic and economic performance of these more sustainable practices are likely to retain farmers' interest - even beyond the strictures of Conservation Compliance. Recent technological developments, such as Bt cotton (in which *Bacillus thuringiensis* has been transgenically introduced to resist pests) could provide both economic and environmental benefits.

The Baseline: Existing Production Systems

As was discussed earlier, POLYSYS analyses are anchored to an economic baseline - in this case, the USDA agriculture sector baseline released in December 1994 and updated in February 1995. To employ the baseline approach in this research, however, also requires alignment to a baseline set of values for rotational land allocation and environmental indicators. Given the scarcity of comprehensive, consistent, and reliable data sources regarding land allocation by rotations, production practices, and tillage systems, the task of developing a rotational baseline becomes the result of the artistic ability of the researchers rather than a strictly objective, analytical process.

The analytical procedure for this study begins with the identification of the dominant rotations in each POLYSYS region; this was accomplished using the National Resources Inventory (NRI). For each POLYSYS region, rotations employed on more than 5 percent on the region's acreage - excluding hay and pasture - were selected and labeled as current or existing rotations/practices.

The set of existing practices and the set of alternative or more sustainable practices, were included in the rotational linear programming model to estimate their initial acreage allocation, and later on provided enough acreage flexibility, estimate the values for each of the baseline years. To produce a credible set of *Baseline* values, the changes in rotational acreage by type and year were constrained. These constraints were set based on the following considerations:

The rotational *Baseline* for each POLYSYS region was estimated assuming that each of the more sustainable practices identified could have a maximum of 1 percent of the total crop land planted to the seven major crops in the first year of the baseline. Regarding the existing practices, it was assumed that the *allowable* shift of land could range as much as 20 percent in a given year. This rather wide variation was established to include the NRI reported acreage as well as ensure the feasibility of each regional LP's solution.

Once the *Baseline* was estimated, the corresponding acreage and EPIC-generated environmental coefficients associated would interact in the environmental module to generate baseline values for the environmental indicators.

Alternative Production Systems

As was the case with the farm-level component of this overall study, alternative and potentially more sustainable production systems were developed through a qualitative process involving interaction with researchers and Extension Service specialists. This process begins with a review of sustainable agriculture research and attendance at field days to gather information about possible alternative practices.

Quickly it became apparent that some crops (e.g., rapeseed) which have environmental benefits but do not have a) a base of research for their use in the Southeast, or b) markets in the Southeast would not be accepted by farmers seeking to maximize profit. Thus, the development of alternative practices naturally grew to focus on the development of rotations and changes to the practices for existing crops. Further, the set of more sustainable practices identified in this study require little, if any, additional capital investment by producers. Most, however, require an increase in management.

Once these potential alternatives were developed, Extension Service specialists and researchers were consulted to determine whether enough quantifiable information was available to create an enterprise budget for the practice and whether the practice could be useful, given local conditions and culture. Once this information was assembled, the environmental problems evident within each POLYSYS region was reviewed using U.S. Department of Agriculture (1994). Only alternative practices designed to address those conditions were modeled to streamline the simulation process and reduce computational costs.

Objective: Evaluate Effects of Sustainable Agriculture

Once an economic and environmental *Baseline* using current practices is developed using the analytical system described in figure 2, alternative scenarios can be developed and simulated to capture changes away from this baseline. As mentioned above, the *Baseline* includes USDA price projections for the ten-year period, 1994-2003, and assumes a continuation of federal agricultural programs as detailed in the Food, Agricultural, Conservation, and Trade Act of 1990.

Scenario One: Acreage Shift

Federal commodity programs often have been criticized for locking farmers into producing a fixed mix of commodities and restricting their ability to take advantages of the agronomic and, at times, economic advantages of crop diversification. This rigidity in crop mixes also is modeled in POLYSYS; within each POLYSYS region, each crop can gain or lose only as much as 10 percent of its acreage every year. When returns above cash costs for a particular crop are negative, a given crop can lose as much as 20 percent of its acreage. If both returns above cash *and* variable costs are negative, all acreage planted to a crop can shift to other uses.

An important underlying assumption in POLYSYS is that diversification can occur - though only within the context of the seven major crops. This assumption is not as restrictive as it appears, however, given the fact that there are relatively few alternative crops to which farmers can shift a large portion of their acreage. Hay and pasture are likely alternatives for a major movement of acreage. If livestock conditions are right, hay and pasture may be a good alternative for some regions of the country, though not as much in the Southeast. Hence, within the time span of the baseline, POLYSYS' designated diversification possibilities are at least adequate.

For the *Increased Flexibility* scenario, it is assumed that steps have been taken to loosen the regulations which keep farmers from diversifying their crop mixes. For modeling purposes, this implies that as much as 30 percent of a crop's acreage can shift from or to another crop in a given year. This change was simulated only within the Southeast region. A much better scenario would be nationwide changes, but this could only be possible when the national model is ready. If returns above cash costs are negative, then 50 percent can shift; and, as before, if returns over cash and variable costs are negative, then all of the acreage can shift to another crop.

Scenario Two: Maximize

Both of the previously described simulations - *Baseline* and *Acreage Shift* - can be categorized as economic or policy-driven scenarios. The former allows the relative profitability of current versus more sustainable practices determine the rotational baseline through the year 2003. *Acreage Shift* lifts policy restrictions to allow a freer movement of acreage between crops. This third scenario focuses on the environmental dimension of sustainability - the base assumption being that as the acreage being worked with more sustainable practices grows, so should the positive impacts on environmental indicators.

This scenario's objective is to allow as much acreage in more sustainable practices as it is feasible, taking into account the need to fulfill the constraints of crop demand and acreage shifts. To implement this scenario in POLYSYS, the net returns to the existing practices were artificially set to a very small number to allow alternative practices with positive returns to gain as much acreage as allowed by the model, within the boundaries of the rate of shifting described earlier.

In practice, this scenario substitutes for the *No Current* scenario employed in the Farm-Level component of this study. In that scenario, all acreage is converted to more sustainable practices. Given the use of the rotational linear programming in POLYSYS, the *No Current* scenario likely would result in infeasibilities for several regions of the Southeast; hence, it was replaced by this less-drastic scenario which shall be designated *Maximize* for reference purposes.

By comparing the *Maximize* scenario with *Acreage Shift*, one can evaluate how well increased crop flexibility fosters the usage of all profitable alternative rotations. Also, the change in net returns would be an indicator of the effort needed to achieve a supposedly higher level of environmental performance - as given by the indicators of soil erosion, chemical risk, expenditures in chemicals, etc.

Some Final Notes on the Scenarios

These scenarios are not phased in but are fully implemented in the simulation's first year. Also, among the assumptions imbedded in each scenario is the idea that the farm-management capability to implement new practices exists on each farm. Thus, each alternative practice is efficiently implemented in the simulation; in actual practice, the level of management expertise on a particular farm will vary, as will environmental effects and economic returns.

Finally, baseline prices are assumed to continue in each scenario. As this is a regional-level study, prices were held constant to examine the impacts of changing each farm's production mix. When the ACE macro study is complete, this work can be revisited to examine what would occur when price impacts are included in the simulation. The national-level prices included in the baseline are shown in table 8.

Table 8
Crop Prices in the USDA Baseline Used in This Analysis

Crop (Unit)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Corn ($/bu)	2.15	2.30	2.30	2.35	2.45	2.45	2.50	2.55	2.60	2.65
Sorghum ($/bu)	2.00	2.15	2.15	2.20	2.30	2.30	2.35	2.40	2.45	2.50
Oats ($/bu)	1.25	1.35	1.35	1.35	1.40	1.40	1.45	1.45	1.50	1.55
Barley ($/bu)	2.05	2.20	2.20	2.20	2.25	2.25	2.30	2.30	2.35	2.35
Wheat ($/bu)	3.45	3.20	3.10	3.10	3.20	3.30	3.40	3.50	3.60	3.70
Soybeans ($/bu)	5.30	5.65	5.70	6.00	6.25	6.35	6.45	6.55	6.65	6.80
Cotton ($/#)	0.68	0.63	0.59	0.60	0.61	0.62	0.64	0.65	0.66	0.67
Tobacco ($/#)	1.70	1.73	1.76	1.79	1.82	1.85	1.88	1.91	1.94	1.96
Peanut ($/#)	0.34	0.35	0.35	0.36	0.37	0.38	0.38	0.39	0.40	0.41

Chapter 4: Analytical Results

In reviewing these results, it should be remembered that this study's *Baseline* is not a no-sustainable practice *Baseline*. Sustainable practices are allowed into the *Baseline* solution; such a move makes sense if for no other reason than the great bulk of the alternative rotations use proven, existing agricultural technologies. Also, it can be expected that the more sustainable rotations will not across-the-board improve the study's environmental indicators. For example, a no-till practice may be expected to reduce soil erosion and fertilizer expenses, but it also may increase pesticide costs.

As noted earlier, the policies and economic conditions assumed in the February 1995 USDA baseline are used throughout the analysis and are tabled in the appendix. The baseline assumptions include continuation of the 1990 farm bill and moderate growth in grain exports. Also, recall that price effects resulting from changes in production patterns are estimated, but the two scenarios only affect rotation solutions in the Southeast. The price effects could be significantly more pronounced and, possibly, reverse direction if the entire nation were simulated under the two scenarios.

The data at the Southeast level are presented graphically and in tables, while the state-level data are tabled and presented at the end of each state subsection. The results at the ASD level are tabled and presented in the appendix, as is an index for the current and alternative production alternatives by state.

Impacts on the Southeastern United States

Production Effects

Planted Acreage. The amount of acreage planted to the seven major crops generally grows from 1996 levels in all scenarios, but *Maximize* acreage is significantly lower than *Baseline* levels (table 9). In the *Baseline*, major crop acreage grows 3.6 percent over the simulation period to its 2003 level of 18.6 million acres. Over this time, most of the gain is allocated to corn and cotton. *Acreage Shift* acreage registers nearly identical growth with the *Baseline*; although as in the *Baseline*, the additional land goes primarily to corn and cotton, soybeans acreage declines an average 841.8 thousand acres below *Baseline* levels.

The *Maximize* scenario results in acreage which averages 642,600 acres (3.5 percent) below *Baseline* levels. At the same time, however, *Maximize* acreage planted to the seven major crops grows 6.0 percent from its 1996 level of 17.1 million acres to reach 18.1 million acres by 2003. Despite the gains and

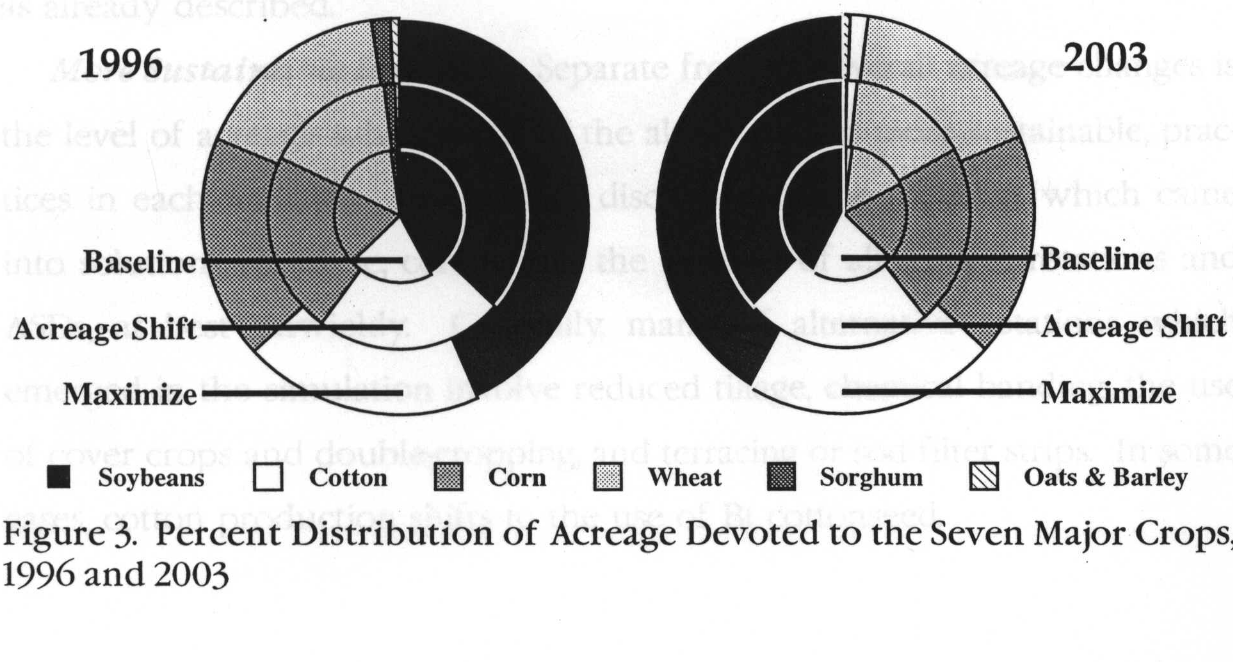

Figure 3. Percent Distribution of Acreage Devoted to the Seven Major Crops, 1996 and 2003

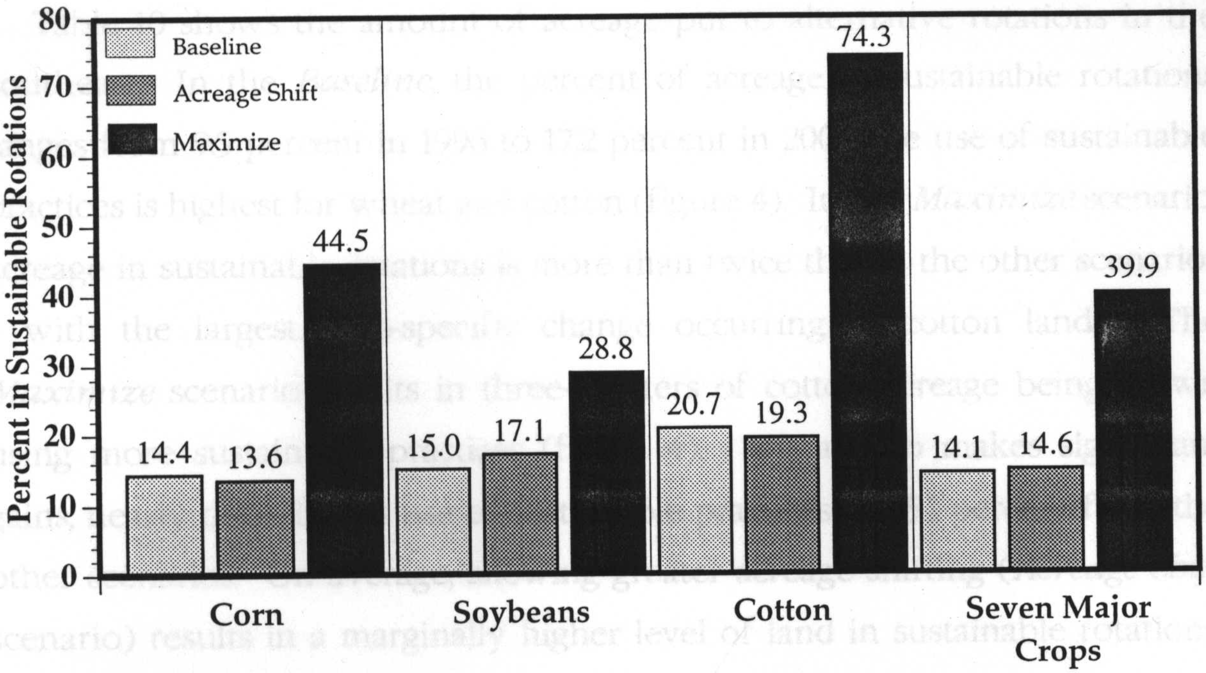

Figure 4. Average Percent of Acreage Planted to Sustainable Rotations, 1996-2003

losses for particular crops, the relative distribution of acreage between the seven major crops changes little between 1996 and 2003 over the scenarios (figure 3). The biggest change comes for soybeans (a 4.7-point loss to 37 percent) under the *Acreage Shift* scenario in 2003. Corn and cotton make gains as already described.

More Sustainable Rotations. Separate from the overall acreage changes is the level of acreage which shifts to the alternative, or more sustainable, practices in each scenario. An in-depth discussion of the rotations which came into solution would be, considering the number of alternative rotations and ASDs, at best unwieldy. Generally, many of alternative rotations which emerged in the simulation involve reduced tillage, chemical banding, the use of cover crops and double-cropping, and terracing or sod filter strips. In some cases, cotton production shifts to the use of Bt cottonseed.

Table 10 shows the amount of acreage put to alternative rotations in the Southeast. In the *Baseline*, the percent of acreage in sustainable rotations ranges from 9.5 percent in 1996 to 17.2 percent in 2003; the use of sustainable practices is highest for wheat and cotton (figure 4). In the *Maximize* scenario, acreage in sustainable rotations is more than twice that in the other scenarios - with the largest crop-specific change occurring in cotton lands. The *Maximize* scenario results in three-quarters of cotton acreage being grown using more sustainable practices (figure 4). Wheat also makes significant gains, nearly doubling its use of sustainable practices to 65.1 percent from the other scenarios. On average, allowing greater acreage shifting (*Acreage Shift* scenario) results in a marginally higher level of land in sustainable rotations, with soybeans coming in slightly higher than *Baseline* levels and cotton and

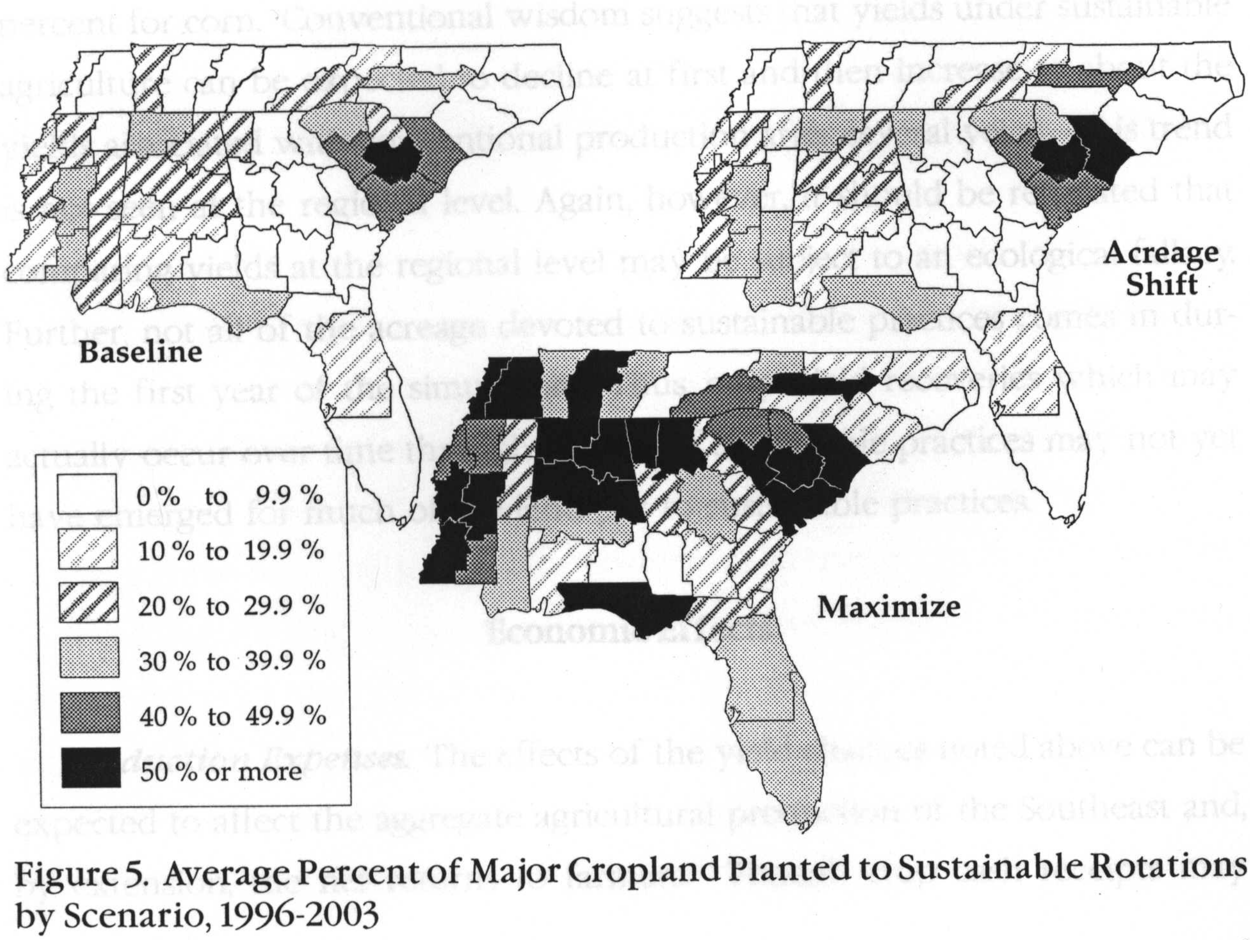

Figure 5. Average Percent of Major Cropland Planted to Sustainable Rotations by Scenario, 1996-2003

corn slightly lower. Figure 5 shows the aggregate shifts in cropland to the more sustainable practices at the ASD level.

Crop Yield. Use of the alternative practices has a varying impact on crop yields. It should be noted, however, that at the regional level of aggregation, yield comparisons should be regarded with caution, as they may mask a great deal of variation across different CRDs, practices, and soils and other geographic characteristics. Having said that, at the regional level, *Acreage Shift* crop yields remain generally at their *Baseline* levels, with slight increases occurring for wheat, cotton, sorghum, and barley. The exception is soybeans, whose average yields decline .2 percent (table 11).

Under *Maximize*, crop yields are below *Baseline* in all cases. The worst decline is in wheat, which experiences a 7.8 percent average decline in yield. Declines for other major crops range from .4 percent for grain sorghum to 3.4 percent for corn. Conventional wisdom suggests that yields under sustainable agriculture can be expected to decline at first and then increase to about the yields associated with conventional production after several years. This trend is not seen at the regional level. Again, however, it should be reiterated that comparing yields at the regional level may be subject to an ecological fallacy. Further, not all of the acreage devoted to sustainable practices comes in during the first year of the simulation. Thus, crop yield recoveries which may actually occur over time through the use of sustainable practices may not yet have emerged for much of the land put to sustainable practices.

Economic Effects

Production Expenses. The effects of the yield changes noted above can be expected to affect the aggregate agricultural production of the Southeast and, by extension, the net returns to farmers. Though crop cash receipts may change, the introduction of the production alternatives changes production expenses, especially for pesticides and farm labor. Although fuel and lubrication expenses also may change with the use of reduced tillage, pesticides and farm labor are the major categories of production costs this study will examine due to the changes expected by shifting to the alternative rotations.

As the level of sustainable acreage increases sharply, three of the four categories decline. In the *Maximize* scenario, fertilizer expenses average 8.4 percent lower, herbicide costs average .2 percent lower, and insecticide 7.9 percent lower than *Baseline* levels. Labor, on the other hand, averages 6.2 percent higher. Summing these changes, annual average expenses for these cost categories average $21.8 million below *Baseline* (table 12).

In the *Acreage Shift* scenario, fertilizer, insecticide, and labor expenses average 4.3 percent, 9.4 percent, and 4.2 percent above than *Baseline* while herbicide costs average 3.4 percent lower (table 12). Summing these changes results in annual average production costs for these four categories of $61.3 million above *Baseline* levels. It should be remembered, however, that planted acreage is greater in this scenario than under *Maximize*.

Net Returns to the Seven Major Crops. By the very nature of the scenarios, our a priori expectations are that net returns would be higher under *Acreage Shift*, where farms are allowed greater acreage shifting between years, and lower under *Maximize*, which forces in sustainable rotations on much of the cropland. The results follow these expectations (figure 6, table 12).

Despite the seemingly slight aggregate acreage changes in the *Acreage Shift* scenario, the shifting between crops and practices results in an average $68.9 million (23.9 percent) gain from *Baseline* levels in net returns over the simulation period.. The most dramatic average relative increases at the state-level under this scenario occur in Florida (26.1 percent) and Mississippi (76.3 percent), the latter of which is responsible for half of the gains from *Baseline*.

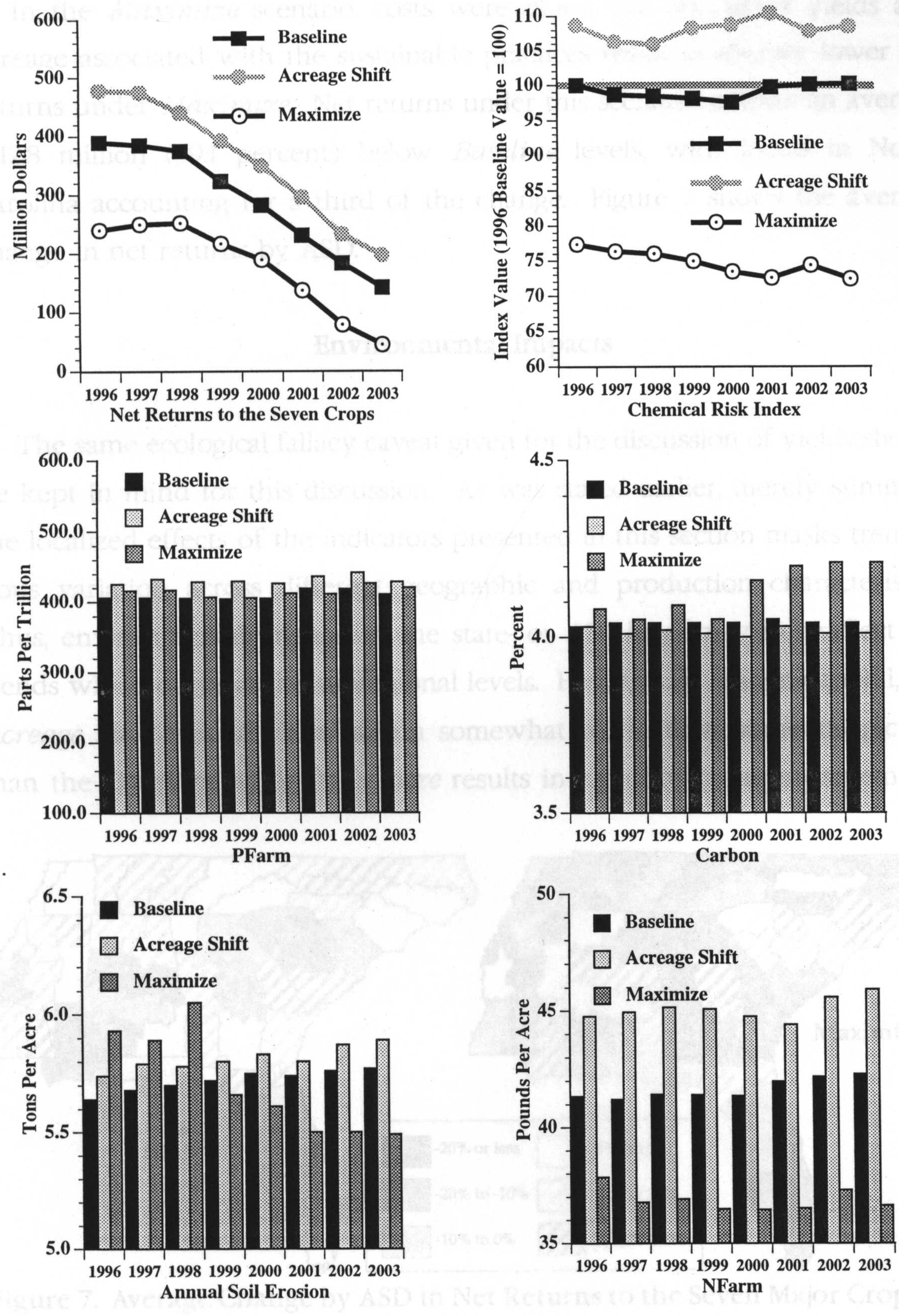

Figure 6. Economic and Environmental Indicators for the Southeast

In the *Maximize* scenario, costs were down, but the lower yields and acreage associated with the sustainable practices result in sharply lower net returns under *Maximize*. Net returns under this scenario decline an average $112.8 million (39.1 percent) below *Baseline* levels, with losses in North Carolina accounting for a third of the change. Figure 7 shows the average change in net returns by ASD.

Environmental Impacts

The same ecological fallacy caveat given for the discussion of yields should be kept in mind for this discussion. As was stated earlier, merely summing the localized effects of the indicators presented in this section masks tremendous variation across different geographic and production characteristics. Thus, environmental impacts at the state- or ASD-level may not reflect the trends which occur at the subregional levels. Having said that, in general, the *Acreage Shift* scenario results in a somewhat worse environmental picture than the *Baseline*, while *Maximize* results in environmental improvements

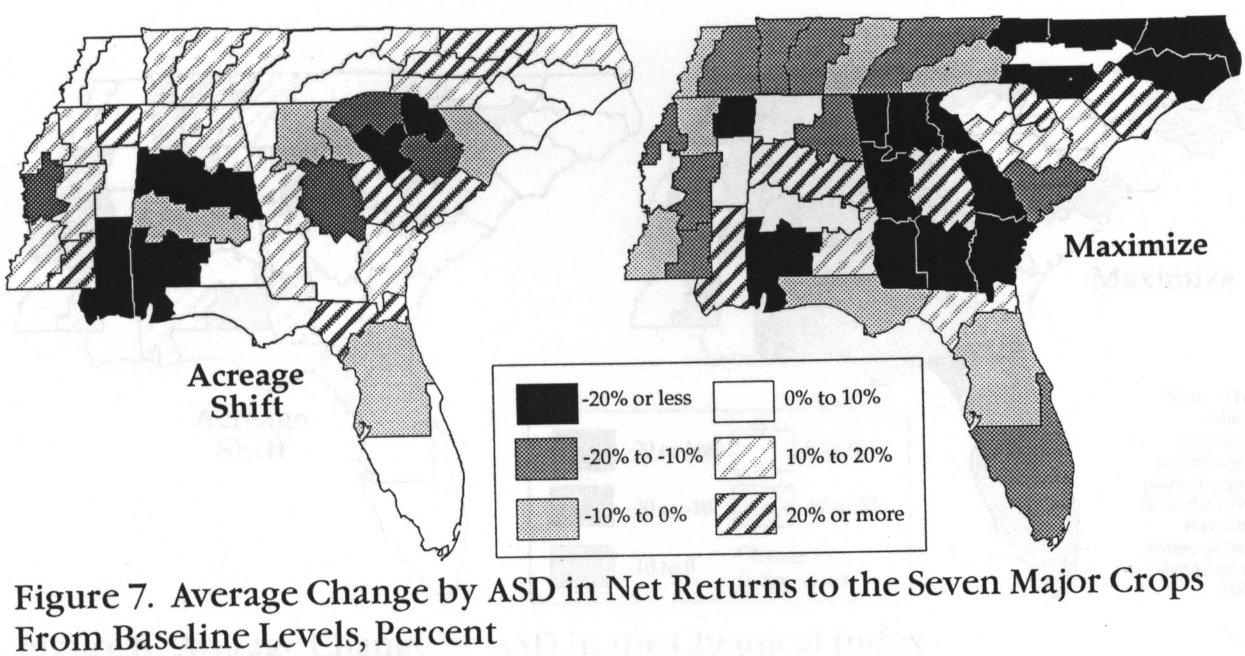

Figure 7. Average Change by ASD in Net Returns to the Seven Major Crops From Baseline Levels, Percent

for all indicators except the amount of phosphorus which leaves the farm (PFarm). These results are presented in table 13.

Under *Acreage Shift*, the average chemical risk index (Chemical Index) value increases 9.1 percent. As was stated earlier, the actual value of the index has no meaning, and it is the change in the index value which is important. Under this scenario, the Chemical Index varies little over time. Further, the amount of carbon in the soil (Carbon) declines slightly, while Soil Erosion (as measured by the Universal Soil Loss Equation) increases slightly. The amount of nitrogen leaving the farm rises 8.2 percent above *Baseline* on average to reach 45.9 pound per acre by 2003. PFarm also increases 5.3 percent to reach 428.0 parts per billion by 2003. There is little change in Soil Erosion and Carbon. Figures 8 through 10 show average changes in the Chemical Index, Soil Erosion, and NFarm and the ASD level.

The most dramatic change evident under the *Maximize* scenario results from the reductions in chemical use noted earlier. The Chemical Index falls 24.7 percent from *Baseline* while NFarm falls an average of 4.8 pounds per acre (11.5 percent). Another way to look at NFarm is that under this scenario,

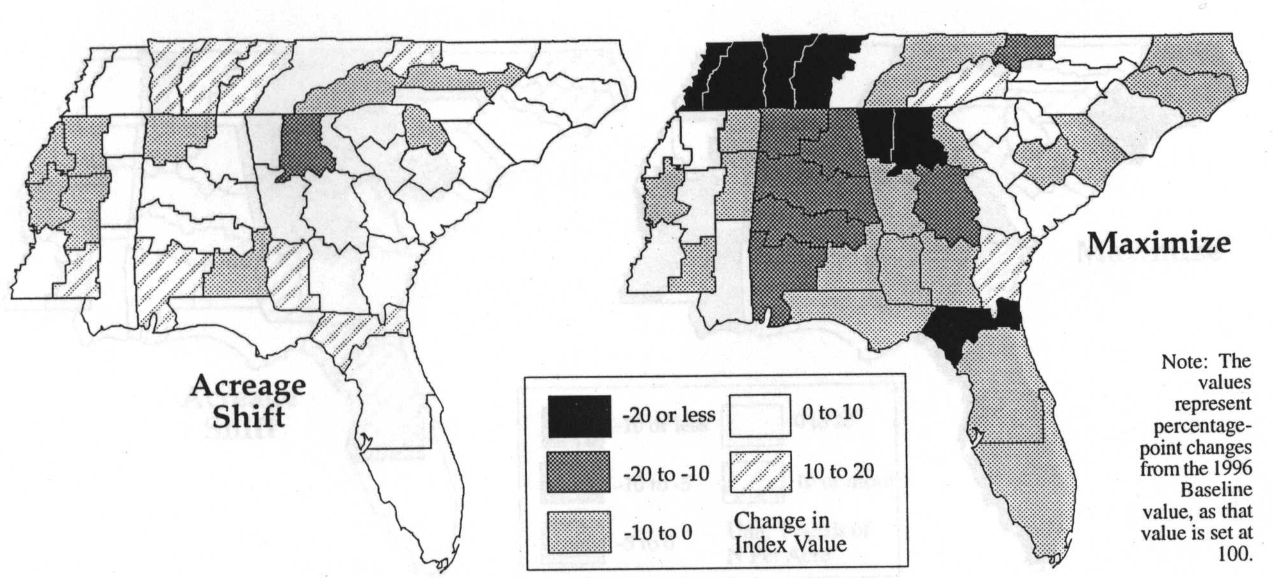

Figure 8. Average Change by ASD in the Chemical Index

an annual average of 84,639.8 pounds less nitrogen leaves crop lands in the Southeast than occurs under the *Baseline*. PFarm on the other hand, increases slightly (1.2 percent), while Carbon averages slightly higher and Soil Erosion slightly lower than *Baseline* levels.

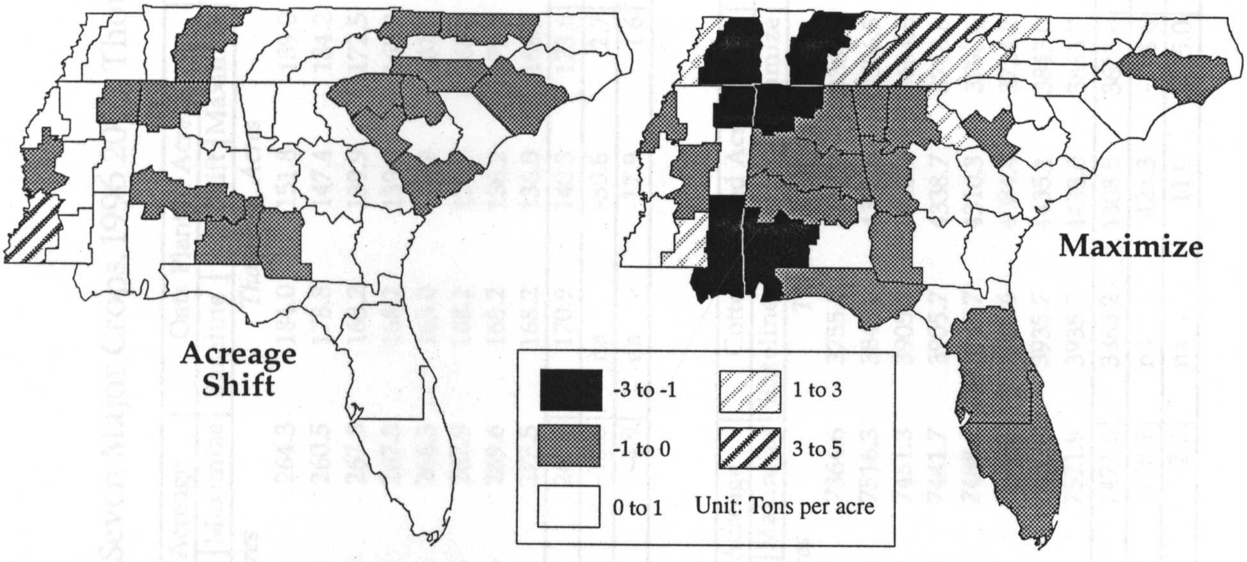

Figure 9. Average Change by ASD in Erosion

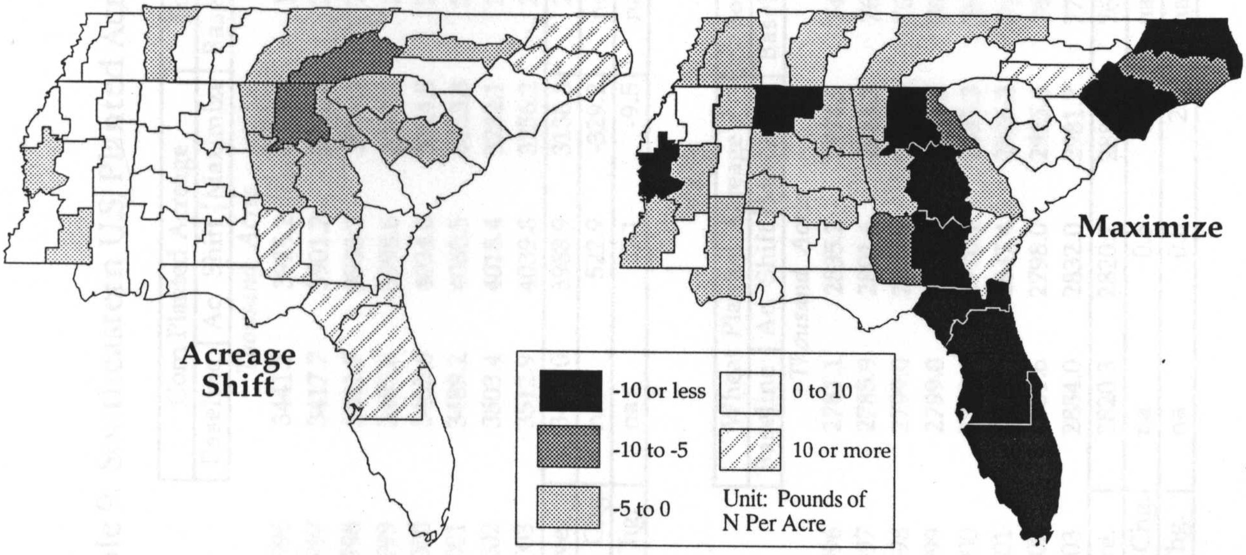

Figure 8. Average Change by ASD in Nitrogen Leaving the Farm (NFarm)

Table 9. Southeastern U.S. Planted Acreage to the Seven Major Crops, 1996 2003, Thousand Acres

	Corn Planted Acreage			Sorghum Planted Acreage			Oats Planted Acreage			Barley Planted Acreage		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Acres			*Thousand Acres*			*Thousand Acres*			*Thousand Acres*		
1996	3441.7	3925.2	3085.3	272.0	239.1	264.3	184.0	151.8	189.0	48.3	41.2	47.2
1997	3417.7	3901.2	3063.6	275.0	238.1	260.5	178.8	147.4	184.2	49.7	46.0	47.4
1998	3441.7	3933.3	3089.2	278.0	242.5	267.8	168.2	139.9	172.5	51.0	43.5	49.9
1999	3455.8	3998.6	3099.5	281.0	245.5	267.3	168.2	139.5	169.2	52.4	44.3	51.3
2000	3465.6	4034.0	3114.5	281.0	239.6	266.3	163.0	134.9	161.9	52.7	43.7	51.9
2001	3489.2	4060.5	3153.8	284.0	234.5	267.9	168.2	136.5	168.1	52.7	43.7	51.9
2002	3503.4	4018.4	3232.1	287.0	235.6	269.6	168.2	136.2	175.8	53.4	44.2	52.6
2003	3512.9	4039.8	3256.2	290.0	238.9	273.5	168.2	136.0	168.1	54.1	43.4	53.9
Ave.	3466.0	3988.9	3136.8	281.0	239.2	267.2	170.9	140.3	173.6	51.8	43.7	50.8
Ave. Chg.	na	522.9	-329.2	na	-41.8	-13.8	na	-30.6	2.7	na	-8.1	-1.0
% Chg.	na	15.1	-9.5	na	-14.9	-4.9	na	-17.9	1.6	na	-15.6	-2.0

	Wheat Planted Acreage			Soybeans Planted Acreage			Cotton Planted Acreage			Seven Crops Planted Acreage		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Acres			*Thousand Acres*			*Thousand Acres*			*Thousand Acres*		
1996	2781.1	2835.2	2774.5	7476.0	6554.0	7364.6	3755.5	4191.7	3367.2	17958.6	17938.2	17092.1
1997	2785.9	2801.6	2783.3	7617.3	6671.1	7516.3	3845.6	4355.6	3506.5	18169.9	18160.9	17361.8
1998	2799.0	2857.0	2853.0	7604.4	6775.0	7451.3	3905.7	4318.9	3664.6	18248.0	18310.1	17548.2
1999	2799.0	2824.7	2878.1	7630.1	6743.2	7441.7	3905.7	4338.7	3748.8	18292.2	18334.5	17655.8
2000	2812.4	2770.1	2891.3	7668.6	6903.2	7488.0	3935.7	4310.3	3790.6	18379.1	18435.5	17764.5
2001	2839.3	2847.4	2936.2	7668.6	6986.7	7502.5	3845.6	4084.4	3724.2	18347.6	18393.5	17804.7
2002	2861.6	2798.0	2955.3	7694.3	6863.7	7486.7	3935.7	4435.1	3843.0	18503.7	18531.1	18015.1
2003	2884.0	2832.0	2981.7	7758.5	6886.7	7521.9	3935.7	4433.0	3863.7	18603.4	18609.8	18119.1
Ave.	2820.3	2820.7	2881.7	7639.7	6797.9	7471.6	3883.2	4308.5	3688.6	18312.8	18339.2	17670.1
Ave. Chg.	na	0.5	61.4	na	-841.8	-168.1	na	425.3	-194.6	na	26.4	-642.6
% Chg.	na	0.0	2.2	na	-11.0	-2.2	na	11.0	-5.0	na	0.1	-3.5

Table 10. Southeastern U.S. Acreage in Sustainable Practices, 1996 2003, Percent

	Corn in Sustainable Practices			Sorghum in Sustainable Practices			Oats in Sustainable Practices			Barley in Sustainable Practices		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
		Percent			*Percent*			*Percent*			*Percent*	
1996	9.72	8.87	29.34	3.92	5.13	4.73	0.00	0.00	0.00	0.00	0.00	0.00
1997	12.24	11.09	35.43	4.00	5.45	4.64	0.00	0.00	0.00	0.00	0.00	0.00
1998	13.60	12.87	40.57	4.09	5.50	4.56	0.00	0.00	0.00	0.00	0.00	0.00
1999	14.63	13.76	45.08	4.17	5.71	4.62	0.00	0.00	0.00	0.00	0.00	0.00
2000	15.26	14.40	48.76	4.26	5.59	4.63	0.00	0.00	0.00	0.00	0.00	0.00
2001	15.83	14.86	51.52	4.34	5.66	4.65	0.00	0.00	0.00	0.00	0.00	0.00
2002	16.48	16.07	52.10	4.43	5.69	4.67	0.00	0.00	0.00	0.00	0.00	0.00
2003	17.12	16.63	53.49	4.48	5.64	4.65	0.00	0.00	0.00	0.00	0.00	0.00
Ave.	14.36	13.57	44.54	4.21	5.55	4.64	0.00	0.00	0.00	0.00	0.00	0.00
Ave. Chg.	na	-0.79	30.18	na	1.34	0.43	na	0.00	0.00	na	0.00	0.00
% Chg.	na	-5.51	210.14	na	31.70	10.27	na	na	na	na	na	na

	Wheat in Sustainable Practices			Soybeans in Sustainable Practices			Cotton in Sustainable Practices			7 Crops in Sustainable Practices		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
		Percent			*Percent*			*Percent*			*Percent*	
1996	24.04	24.34	44.28	10.98	12.93	20.20	12.75	11.55	60.35	9.50	9.79	28.85
1997	29.26	29.48	51.37	13.23	15.32	23.25	15.65	13.81	68.65	11.73	11.91	33.70
1998	32.21	32.73	55.96	14.73	17.36	26.51	17.63	16.32	73.08	13.16	13.79	37.47
1999	33.28	34.76	59.34	15.40	18.59	28.65	19.61	18.62	76.11	14.12	15.09	40.39
2000	33.88	33.96	61.07	15.82	17.66	30.17	21.84	20.86	77.55	14.96	15.47	42.34
2001	34.38	33.37	62.59	16.38	17.70	32.12	24.40	23.87	78.90	15.85	16.17	44.02
2002	34.42	34.40	63.69	16.70	18.36	33.95	25.99	23.79	79.27	16.51	16.88	45.41
2003	34.04	34.15	65.11	16.97	18.69	35.75	28.00	25.78	80.09	17.18	17.61	46.85
Ave.	31.94	32.15	57.93	15.03	17.08	28.83	20.73	19.33	74.25	14.13	14.59	39.88
Ave. Chg.	na	0.21	25.99	na	2.05	13.80	na	-1.41	53.52	na	0.46	25.75
% Chg.	na	0.66	81.37	na	13.64	91.83	na	-6.79	258.11	na	3.27	182.30

Table 11. Southeastern U.S. Average Crop Yields, 1996 2003, Bushels Per Acre (Pounds Per Acre for Cotton)

	Average Corn Yields			Average Sorghum Yields			Average Oat Yields			Average Barley Yields		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Bushels Per Acre			*Bushels Per Acre*			*Bushels Per Acre*			*Bushels Per Acre*		
1996	92.8	92.8	88.9	63.3	63.8	64.2	56.4	56.5	55.0	53.5	55.7	52.4
1997	93.9	93.9	90.3	64.1	64.8	64.7	56.6	56.9	55.2	53.9	54.1	52.3
1998	95.0	95.0	91.5	64.5	64.8	65.0	55.7	55.9	54.2	54.3	54.6	53.2
1999	96.1	96.2	93.2	64.8	65.2	63.8	57.2	57.4	55.9	55.2	55.6	54.1
2000	97.2	97.3	94.2	65.3	65.9	64.1	57.5	57.6	56.1	55.7	56.0	54.5
2001	98.3	98.4	95.1	65.6	66.4	64.5	57.2	57.0	55.8	55.7	56.1	54.6
2002	99.4	99.2	96.3	66.4	67.1	65.2	57.2	56.8	56.3	56.1	56.5	55.0
2003	100.5	100.4	97.3	66.6	67.4	65.5	57.2	56.8	55.8	56.6	56.5	55.6
Ave.	96.6	96.6	93.3	65.1	65.7	64.6	56.8	56.9	55.5	55.1	55.6	54.0
Ave. Chg.	na	0.0	-3.3	na	0.6	-0.4	na	0.0	-1.3	na	0.5	-1.1
% Chg.	na	0.0	-3.4	na	0.9	-0.7	na	0.0	-2.3	na	1.0	-2.1

	Average Wheat Yields			Average Soybean Yields			Average Cotton Yields		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Bushels Per Acre			*Bushels Per Acre*			*Pounds Per Acre*		
1996	37.4	37.7	34.0	26.0	25.9	25.8	520.2	521.0	504.6
1997	37.7	38.0	34.4	26.3	26.2	26.1	528.1	527.8	515.4
1998	37.9	38.1	35.0	26.6	26.6	26.3	536.9	536.2	526.2
1999	38.2	38.4	35.0	26.8	26.8	26.5	542.6	542.7	533.2
2000	38.5	38.9	35.7	27.0	27.0	26.8	552.5	553.2	543.0
2001	38.8	39.3	36.1	27.3	27.3	27.0	559.7	562.5	550.6
2002	39.1	39.5	36.4	27.7	27.6	27.4	566.5	566.4	556.1
2003	39.4	39.8	36.6	27.9	27.9	27.6	574.9	574.0	562.4
Ave.	38.4	38.7	35.4	26.9	26.9	26.7	547.7	548.0	536.4
Ave. Chg.	na	0.3	-3.0	na	0.0	-0.3	na	0.3	-11.2
% Chg.	na	0.8	-7.8	na	-0.2	-1.0	na	0.1	-2.1

Table 12. Southeastern U.S. Economic Indicators, 1996 2003

	Fertilizer Expenses			Herbicide Expenses			Insecticde Expenses			Labor Expenses		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Dollars			*Thousand Dollars*			*Thousand Dollars*			*Thousand Dollars*		
1996	608,699	634,706	547,415	454,972	434,913	453,292	206,663	226,919	185,031	749,649	784,899	769,901
1997	612,990	641,819	551,787	458,952	439,349	464,165	211,021	232,845	189,796	761,675	802,476	792,918
1998	615,561	641,006	558,142	458,237	440,956	465,571	213,827	233,196	195,962	769,371	801,346	816,818
1999	615,277	644,424	562,921	458,001	440,153	461,277	213,610	234,600	198,520	771,179	803,478	832,235
2000	616,770	643,559	567,148	459,242	447,487	456,350	214,799	234,314	199,371	776,487	803,177	833,063
2001	615,335	635,385	569,312	456,184	444,394	448,742	210,571	226,492	195,548	768,238	783,515	822,762
2002	621,919	649,810	580,576	459,240	446,398	452,626	214,880	236,112	200,382	779,956	819,427	834,943
2003	624,288	651,834	581,056	460,347	445,860	454,435	214,914	235,708	201,570	782,227	821,072	836,915
Ave.	616,355	642,818	564,795	458,147	442,439	457,057	212,536	232,523	195,772	769,848	802,424	817,444
Ave. Chg.	na	26,463	-51,560	na	-15,708	-1,090	na	19,988	-16,763	na	32,576	47,596
% Chg.	na	4	-8	na	-3	0	na	9	-8	na	4	6

	Returns to the Seven Major Crops		
	Baseline	Flex	Maximize
	Million Dollars		
1996	389	478	240
1997	385	475	250
1998	374	440	252
1999	323	392	217
2000	282	350	189
2001	231	296	137
2002	183	233	78
2003	142	197	45
Ave.	289	358	176
Ave. Chg.	na	69	-113
% Chg.	na	24	-39

Table 13. Southeastern U.S. Environmental Indicators, 1996 2003

	Chemical Index			Carbon			Soil Erosion			NFarm		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	*Index Value**			*Percent*			*Tons Per Acre*			*Pounds Per Acre*		
1996	100.00	108.73	77.35	4.03	4.03	4.08	5.64	5.74	5.93	41.34	44.76	37.84
1997	98.65	106.33	76.33	4.04	4.01	4.05	5.68	5.79	5.89	41.20	44.95	36.77
1998	98.44	105.94	76.00	4.04	4.02	4.09	5.70	5.78	6.05	41.43	45.15	36.91
1999	98.14	108.34	74.92	4.04	4.01	4.05	5.72	5.80	5.66	41.41	45.08	36.49
2000	97.57	108.85	73.42	4.04	4.00	4.16	5.75	5.83	5.61	41.36	44.75	36.46
2001	99.73	110.53	72.55	4.05	4.03	4.20	5.74	5.80	5.50	41.98	44.41	36.52
2002	100.12	107.95	74.35	4.04	4.01	4.21	5.76	5.87	5.50	42.19	45.59	37.29
2003	100.24	108.67	72.40	4.04	4.01	4.21	5.77	5.89	5.49	42.30	45.92	36.63
Ave.	99.11	108.17	74.66	4.04	4.02	4.13	5.72	5.81	5.70	41.65	45.08	36.86
Ave. Chg.	na	9.06	-24.45	na	-0.03	0.09	na	0.09	-0.02	na	3.43	-4.79
% Chg.	na	9.14	-24.67	na	-0.62	2.26	na	1.62	-0.28	na	8.22	-11.49

	PFarm		
	Baseline	Ac. Shift	Maximize
	Parts Per Billion		
1996	406.29	425.18	416.01
1997	405.90	432.56	416.57
1998	405.38	428.54	406.69
1999	404.07	429.30	405.67
2000	404.84	426.13	412.09
2001	418.73	436.01	411.00
2002	418.31	441.35	426.02
2003	410.30	427.98	419.87
Ave.	409.23	430.88	414.24
Ave. Chg.	na	21.65	5.01
% Chg.	na	5.29	1.22

* Chemical Index values have been indexed such that the 1996 baseline value equals 100.

North Carolina State-Level Results

North Carolina has the most diverse land characteristics of any of the Southeastern states. Geographically, this state ranges from mountains to coastal plains, and more than three-quarters of the state's production of major crops is centered in the three coastal ASDs - POLYSYS regions 32, 35, and 37. Thus, state-level changes in production, economic, and environmental indicators may be skewed toward the changes occurring in these ASDs.

Production Effects. Acreage planted to the seven major crops rises slightly under the *Acreage Shift* scenario, but substantial shifts occur between crops (table 14). Soybean acreage declines 18.2 percent from *Baseline* on average, while corn and wheat register average gains of 196,600 acres (16.1 percent) and 99,000 acres (15.9 percent), respectively. Of the *Acreage Shift* cropland, the relative amount of land in sustainable practices is nearly identical to the *Baseline* level of 2.2 percent (table 15). Slightly less corn and wheat acreage and slightly more soybeans acres are put to alternative practices than under *Baseline*.

Under the *Maximize* scenario, planted acreage declines significantly, averaging 201,500 acres (5.3 percent) below *Baseline* levels (table 14). More than half of this loss in acreage occurs on corn acreage, and wheat and cotton also are significantly below *Baseline* levels. The bulk of the *Maximize* acreage declines is centered on the three coastal ASDs. As occurs at the regional level, acreage grows steadily in each scenario from its initial (1996) level. The average percent of cropland dedicated to sustainable practices in North Carolina is 16.1 percent -substantially higher than the *Baseline* (table 15). The major use of the alternative practices is for corn (which has the second-highest acreage), which has 30.7 percent of its land in alternative practices, and wheat, one-quarter of which is put to more sustainable practices.

Most of the *Baseline's* acreage in more sustainable practices are in western two-thirds of the state and include practices such as no-till and the use of a wheat cover crops and wheat-soybeans double-crops. In the coastal areas, the alternative practices identified do not present an economic advantage given *Baseline* prices; therefore, no significant acreage moves to sustainable practices in these areas. The *Maximize* scenario continues the tendency shown in the *Baseline* situation, although in this scenario, the coastal areas show a significant shift of acreage to no-till and nonleguminous cover crops.

On average crop yields generally are near *Baseline* levels in both scenarios (table 16). An important exception is wheat under *Maximize*, whose yield declines 5.2 bushels per acre (12.2 percent) on average.

Economic Effects. The increased use of more sustainable practices results in somewhat higher fertilizer, insecticide, and labor expenses under *Acreage Shift* (table 17). Lower herbicide costs associated with chemical banding, however, offsets many of these increased costs - resulting in an average annual increase from *Baseline* of $978,900 for North Carolina. Under the *Maximize* scenario, the greater use of alternative practices results in average annual costs which are $3.6 million above *Baseline* levels. The largest increase comes under labor expenses; though herbicide and fertilizer costs are lower under the *Maximize* scenario, they are not offsetting.

Net returns to the seven major crops (table 17) increases an average of $6.7 million (11.9 percent) under *Acreage Shift*, with the coastal regions 32 and 35 accounting for 84.7 percent of the gains. With the increased costs of the production regimes imposed on North Carolina under *Maximize*, net returns fall an average of $35.2 million (62.8 percent) below *Baseline* levels. Changes in region 32 account for nearly half of the statewide decline.

Environmental Effects. Generally, the environmental indicators for North Carolina present a mixed picture in both scenarios, although the *Maximize* scenario fares somewhat better (table 18). Compared with the *Baseline*, the Chemical Index rises 17.1 percent, Carbon falls slightly, and NFarm and PFarm rise (the former more sharply) under *Acreage Shift*. NFarm rises an average of 9.3 pounds per acre (14.4 percent), while PFarm increases 5.7 percent.

The *Maximize* scenario results in significant gains in chemical risk and nitrogen leaving the farm but also deterioration in erosion and PFarm. On average, the Chemical Index under *Maximize* declines 15.5 percent, NFarm falls 9.8 pounds per acre (15.2 percent), and Carbon rises slightly. On the other hand, Soil Erosion increases slightly and PFarm rises 6.4 percent.

Table 14. North Carolina Planted Acreage to the Seven Major Crops, 1996-2003

	Corn Planted Acreage			Sorghum Planted Acreage			Oats Planted Acreage			Barley Planted Acreage		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Acres			*Thousand Acres*			*Thousand Acres*			*Thousand Acres*		
1996	1210.9	1401.8	1058.5	44.2	44.0	40.8	56.6	46.0	56.6	37.0	31.4	36.1
1997	1202.3	1396.2	1052.1	44.7	43.3	40.6	55.0	44.0	55.0	38.0	35.9	36.0
1998	1210.9	1405.2	1057.5	45.2	45.0	41.7	51.8	43.3	51.8	39.0	33.1	38.1
1999	1215.9	1410.6	1061.5	45.7	45.4	42.1	51.8	43.3	51.8	40.1	34.0	39.1
2000	1219.5	1418.4	1064.6	45.7	42.2	42.1	50.1	41.9	50.1	40.3	33.5	39.6
2001	1227.8	1427.0	1076.2	46.2	34.1	42.5	51.8	42.9	51.8	40.3	33.5	39.6
2002	1232.8	1432.4	1134.7	46.7	33.9	43.0	51.8	42.6	59.4	40.8	34.0	40.1
2003	1236.1	1437.8	1133.2	47.2	34.9	44.3	51.8	42.4	51.8	41.3	33.1	41.3
Ave.	1219.5	1416.2	1079.8	45.7	40.3	42.1	52.6	43.3	53.5	39.6	33.6	38.8
Ave. Chg.	na	196.6	-139.7	na	-5.4	-3.6	na	-9.3	1.0	na	-6.0	-0.8
% Chg.	na	16.1	-11.5	na	-11.7	-7.8	na	-17.6	1.8	na	-15.2	-2.1

	Wheat Planted Acreage			Soybeans Planted Acreage			Cotton Planted Acreage			Seven Crops Planted Acreage		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Acres			*Thousand Acres*			*Thousand Acres*			*Thousand Acres*		
1996	615.6	757.2	578.7	1579.1	1286.8	1585.0	178.2	156.3	146.4	3721.6	3723.4	3502.0
1997	616.9	704.9	578.2	1608.9	1309.7	1618.0	182.4	216.9	149.9	3748.3	3750.8	3529.8
1998	619.6	706.0	578.5	1606.2	1309.8	1615.6	185.3	220.3	152.2	3758.0	3762.6	3535.4
1999	619.6	706.0	578.5	1611.7	1313.8	1625.0	185.3	220.3	152.2	3769.9	3773.3	3550.2
2000	622.5	709.5	581.3	1619.8	1320.1	1637.4	186.7	222.0	153.4	3784.7	3787.5	3568.5
2001	628.5	772.0	586.7	1619.8	1327.4	1639.5	182.4	161.3	149.9	3796.8	3798.3	3586.3
2002	633.4	702.9	591.5	1625.2	1350.9	1645.5	186.7	221.9	159.2	3817.4	3818.6	3673.5
2003	638.4	727.9	595.9	1638.8	1343.3	1659.6	186.7	221.9	153.4	3840.2	3841.3	3679.4
Ave.	624.3	723.3	583.7	1613.7	1320.2	1628.2	184.2	205.1	152.1	3779.6	3782.0	3578.1
Ave. Chg.	na	99.0	-40.6	na	-293.5	14.5	na	20.9	-32.2	na	2.4	-201.5
% Chg.	na	15.9	-6.5	na	-18.2	0.9	na	11.3	-17.5	na	0.1	-5.3

Table 15. North Carolina Crop Acreage in Sustainable Practices, 1996-2003

	Corn in Sustainable Practices			Sorghum in Sustainable Practices			Oats in Sustainable Practices			Barley in Sustainable Practices		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Percent			*Percent*			*Percent*			*Percent*		
1996	1.64	1.42	17.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1997	2.08	1.79	22.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	2.39	2.06	26.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1999	2.57	2.21	31.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000	2.73	2.35	34.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2001	2.90	2.49	36.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2002	3.06	2.64	37.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2003	3.24	2.79	38.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ave.	2.58	2.22	30.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ave. Chg.	na	-0.36	28.07	na	0.00	0.00	na	0.00	0.00	na	0.00	0.00
% Chg.	na	-13.88	1089.57	na	na	na	na	na	na	na	na	na

	Wheat in Sustainable Practices			Soybeans in Sustainable Practices			Cotton in Sustainable Practices			7 Crops in Sustainable Practices		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Percent			*Percent*			*Percent*			*Percent*		
1996	2.15	1.75	15.66	1.86	2.28	6.72	0.00	0.00	6.95	1.34	1.34	9.36
1997	2.70	2.37	19.65	2.29	2.82	8.25	0.00	0.00	6.95	1.67	1.68	11.55
1998	3.23	2.80	23.58	2.76	3.36	9.91	0.00	0.00	6.95	1.97	1.97	13.75
1999	3.79	3.27	27.56	3.19	3.88	11.52	0.00	0.00	6.95	2.22	2.22	15.93
2000	4.08	3.53	28.01	3.43	4.18	12.94	0.00	0.00	6.95	2.38	2.38	17.47
2001	4.15	3.47	28.30	3.54	4.45	14.42	0.00	0.00	6.95	2.48	2.53	18.98
2002	4.25	4.28	28.84	3.66	4.89	16.07	0.00	0.00	6.70	2.58	2.76	20.14
2003	4.38	4.58	29.37	3.78	5.43	17.43	0.00	0.00	6.95	2.69	2.98	21.40
Ave.	3.59	3.26	25.12	3.06	3.91	12.16	0.00	0.00	6.92	2.17	2.23	16.07
Ave. Chg.	na	-0.34	21.53	na	0.85	9.09	na	0.00	6.92	na	0.07	13.91
% Chg.	na	-9.33	599.51	na	27.66	296.82	na	na	na	na	3.06	641.95

Table 16. North Carolina Average Crop Yields, 1996-2003

	Average Corn Yields			Average Sorghum Yields			Average Oat Yields			Average Barley Yields		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Bushels Per Acre			*Bushels Per Acre*			*Bushels Per Acre*			*Bushels Per Acre*		
1996	92.2	92.4	87.0	58.0	58.1	57.2	53.4	53.2	54.2	53.8	56.7	53.0
1997	93.3	93.6	88.0	58.7	58.9	56.9	53.6	53.6	54.2	54.2	54.4	52.8
1998	94.4	94.6	89.1	59.0	59.2	57.2	52.7	52.9	53.2	54.6	54.9	53.7
1999	95.5	95.8	91.6	59.3	59.5	58.6	54.1	54.4	54.9	55.6	55.9	54.7
2000	96.6	96.8	91.4	59.8	60.1	57.9	54.4	54.6	55.0	56.0	56.4	55.1
2001	97.6	98.0	92.7	60.0	59.9	58.1	54.1	54.2	54.7	56.0	56.4	55.2
2002	98.7	99.1	94.6	60.7	60.6	58.4	54.1	54.1	56.2	56.5	56.9	55.6
2003	99.8	100.2	95.7	61.0	60.8	59.0	54.1	54.0	54.6	56.9	56.8	56.3
Ave.	96.0	96.3	91.3	59.6	59.6	57.9	53.8	53.9	54.6	55.5	56.0	54.5
Ave. Chg.	na	0.3	-4.7	na	0.1	-1.7	na	0.0	0.8	na	0.6	-0.9
% Chg.	na	0.3	-4.9	na	0.1	-2.8	na	0.1	1.4	na	1.0	-1.7

	Average Wheat Yields			Average Soybean Yields			Average Cotton Yields		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Bushels Per Acre			*Bushels Per Acre*			*Pounds Per Acre*		
1996	41.4	40.8	35.9	29.4	29.3	28.5	435.6	431.4	430.4
1997	41.7	40.9	36.6	29.7	29.7	28.9	442.2	443.7	438.1
1998	42.0	41.2	37.2	30.0	30.0	29.2	449.6	451.5	446.0
1999	42.3	41.6	35.5	30.3	30.3	29.5	454.4	456.2	450.6
2000	42.7	41.9	38.1	30.6	30.6	29.9	462.6	464.5	458.9
2001	43.0	42.4	38.2	30.9	30.7	30.0	468.7	464.3	464.9
2002	43.3	42.6	38.4	31.3	31.2	30.3	474.4	476.3	465.7
2003	43.6	43.0	38.5	31.6	31.5	30.6	481.4	483.4	477.5
Ave.	42.5	41.8	37.3	30.5	30.4	29.6	458.6	458.9	454.0
Ave. Chg.	na	-0.7	-5.2	na	-0.1	-0.9	na	0.3	-4.6
% Chg.	na	-1.7	-12.2	na	-0.2	-2.9	na	0.1	-1.0

Table 17. North Carolina Economic Indicators, 1996-2003

	Fertilizer Expenses			Herbicide Expenses			Insecticde Expenses			Labor Expenses		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Dollars			*Thousand Dollars*			*Thousand Dollars*			*Thousand Dollars*		
1996	132,284	137,663	119,366	84,048	75,224	78,731	5,161	5,304	5,844	112,805	111,280	127,012
1997	132,801	140,396	119,779	85,090	77,400	79,468	5,236	6,118	6,245	113,767	115,879	133,509
1998	133,511	141,086	120,148	85,093	77,550	79,020	5,293	6,178	6,628	114,227	116,451	139,307
1999	134,074	141,641	120,567	85,268	77,680	78,928	5,293	6,178	6,971	114,571	116,771	145,212
2000	134,628	142,335	121,373	85,599	77,951	78,954	5,327	6,219	6,697	115,055	117,282	141,582
2001	137,229	141,369	122,481	85,593	76,806	78,609	5,278	5,448	6,362	115,082	113,609	137,761
2002	138,649	146,028	128,461	85,962	79,098	79,359	5,367	6,201	6,210	115,851	118,203	136,394
2003	139,329	146,432	127,215	86,497	78,852	79,148	5,385	6,291	5,807	116,433	118,692	131,777
Ave.	135,313	142,119	122,424	85,393	77,570	79,027	5,292	5,992	6,345	114,724	116,021	136,569
Ave. Chg.	na	6,806	-12,889	na	-7,823	-6,367	na	700	1,053	na	1,297	21,845
% Chg.	na	5.03	-9.53	na	-9.16	-7.46	na	13.22	19.90	na	1.13	19.04

	Returns to the Major Crops		
	Baseline	Ac. Shift	Maximize
	Million Dollars		
1996	69.88	83.87	31.37
1997	71.07	82.45	32.85
1998	72.05	76.62	35.57
1999	62.88	67.63	29.00
2000	54.71	60.44	24.39
2001	46.47	51.96	13.74
2002	39.12	42.61	2.08
2003	32.51	36.52	-2.23
Ave.	56.09	62.76	20.85
Ave. Chg.	na	6.68	-35.24
% Chg.	na	11.90	-62.83

Table 18. North Carolina Environmental Indicators, 1996-2003

	Chemical Index			Carbon			Soil Erosion			NFarm		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	*Index Value**			*Percent*			*Tons Per Acre*			*Pounds Per Acre*		
1996	100.00	125.05	87.22	5.68	5.72	5.99	2.55	2.50	2.80	62.96	71.16	54.74
1997	98.99	117.42	86.97	5.68	5.61	5.90	2.58	2.52	2.83	62.31	72.52	53.92
1998	99.24	117.93	87.78	5.67	5.60	6.02	2.58	2.54	2.81	62.59	72.75	53.95
1999	99.29	117.98	88.84	5.67	5.60	5.75	2.59	2.54	2.77	62.60	72.77	53.52
2000	99.19	118.64	88.08	5.67	5.61	6.22	2.60	2.55	2.77	62.56	72.89	53.59
2001	114.04	128.84	89.65	5.72	5.74	6.30	2.59	2.53	2.75	66.28	72.37	53.88
2002	118.28	132.73	99.44	5.73	5.66	6.33	2.59	2.56	2.70	67.42	76.91	57.46
2003	117.98	132.83	87.83	5.73	5.65	6.41	2.59	2.56	2.68	67.21	76.64	54.65
Ave.	105.88	123.93	89.48	5.69	5.65	6.12	2.58	2.54	2.76	64.24	73.50	54.46
Ave. Chg.	na	18.05	-16.40	na	-0.05	0.42	na	-0.05	0.18	na	9.26	-9.78
% Chg.	na	17.05	-15.49	na	-0.79	7.40	na	-1.79	6.97	na	14.41	-15.22

	PFarm		
	Baseline	Ac. Shift	Maximize
	Parts Per Billion		
1996	295.17	313.83	328.15
1997	291.83	309.88	322.31
1998	292.48	310.44	323.93
1999	292.80	310.94	323.46
2000	292.30	310.15	322.81
2001	338.78	346.76	326.23
2002	350.77	373.28	381.87
2003	350.03	372.72	334.64
Ave.	313.02	331.00	332.93
Ave. Chg.	na	17.98	19.91
% Chg.	na	5.74	6.36

* Chemical Index values have been indexed such that the 1996 baseline value equals 100.

Tennessee State-Level Results

An important point in examining Tennessee is that two ASDs comprise approximately four-fifths of the land planted to the seven major crops. As a result, production, economic, and environmental changes which occur in ASDs 44 and 45 generally drive the state-level results.

Production Effects. Acreage for the seven major crops (table 19) generally increases slightly under *Acreage Shift* and declines slightly under *Maximize*, compared with the *Baseline*. Under *Acreage Shift*, soybean acreage averages 9.3 percent under *Baseline*, and wheat acreage averages 12.6 percent below. This acreage shifts neatly to corn and cotton, with 91,900 acres shifting to the former and 98,000 to the latter. Under *Maximize*, corn acreage averages 10.9 percent below and soybeans slightly below *Baseline*; in this scenario, the acreage shifts somewhat to cotton and more strongly to wheat, whose acreage rises 12.8 percent.

The use of sustainable practices covers generally the same aggregate percentage in the *Baseline* and *Acreage Shift* scenario (table 20). Under *Maximize*, overall use of the alternative practices rises to cover an average of 56.2 percent of the land in the seven major crops. Nearly all of the cotton *Acreage Shifts* to alternative practices, as does 87.6 percent of the wheat acreage. On the others, the use of alternative practices for soybeans, which comprises the most land of the major crops, averages 29.7 percent. Nearly 65 percent of the corn acreage, on average, employs the more sustainable practices under *Maximize*.

Much the sustainable rotations employed under the *Baseline* situation focus on the introduction of cover crops and the use of terraces to reduce erosion. The *Maximize* scenario for the West Tennessee ASDs results in a large shift to in double-crops, terraces, and no-till. Further, a significant portion of cotton acreage shifts to Bt cotton.

For soybeans and cotton, both scenarios show reductions in crop yields (table 21). The declines are slight for soybeans under the two scenarios and for cotton under *Acreage Shift*. The use of more sustainable practices on nearly all Tennessee cotton lands, however, reduces cotton yields by an average of 28.3 pounds (5.1 percent) per acre. Wheat is nearly unchanged in each scenario, and corn and sorghum yields rise slightly under both scenarios.

Economic Effects. *Acreage Shift* experiences higher fertilizer, insecticide, and labor costs than *Baseline* levels (table 22). *Maximize* insecticide and fertilizer costs are below *Baseline* levels, but not enough to offset herbicide and labor costs, which respectively are 28.2 percent and 34.4 percent above *Baseline* levels.

Average net returns rise 6.0 percent ($12.8 million) above *Baseline* levels under the *Acreage Shift* scenario but fall $19.5 million (9.2 percent) below in the *Maximize* scenario. Together, POLYSYS regions 44 and 45 account for nearly 70 percent of the *Acreage Shift* change and 75.3 percent of the *Maximize* changes in net returns (table 22).

Environmental Effects. Generally, the *Acreage Shift* scenario somewhat worsens all environmental indicators except PFarm, while *Maximize* improves all indicators except Carbon (table 23). Under *Acreage Shift*, the Chemical Index rises 9.06 percent and NFarm and Soil Erosion rise slightly, while Carbon falls slightly and PFarm declines 3.7 percent.

Under *Maximize*, soil erosion declines slightly at the state-level. ASD 44, which has the state's highest erosion (averaging 18.5 tons per acre in the *Baseline*) actually has increased erosion (to 21.1 tons per acre) under *Maximize*. Thus, this more localized impact depresses the state-level impact of the alternative practices on Soil Erosion. Also at the state-level on average, PFarm declines 54.4 percent, NFarm falls 15.3 percent, and the Chemical Index falls 46.9 percent below *Baseline*. Carbon, however, declines slightly.

Table 19. Tennessee Planted Acreage to the Seven Major Crops, 1996-2003

	Corn Planted Acreage			Sorghum Planted Acreage			Oats Planted Acreage			Barley Planted Acreage		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Acres			*Thousand Acres*			*Thousand Acres*			*Thousand Acres*		
1996	632.4	691.5	561.2	56.5	55.0	54.3	0.0	0.0	0.0	0.0	0.0	0.0
1997	628.0	691.1	558.8	57.2	55.2	54.9	0.0	0.0	0.0	0.0	0.0	0.0
1998	632.4	697.4	563.8	57.8	56.1	55.4	0.0	0.0	0.0	0.0	0.0	0.0
1999	635.0	748.2	557.2	58.4	56.7	53.7	0.0	0.0	0.0	0.0	0.0	0.0
2000	636.7	770.7	569.3	58.4	56.7	53.7	0.0	0.0	0.0	0.0	0.0	0.0
2001	641.1	775.0	570.9	59.0	57.3	54.3	0.0	0.0	0.0	0.0	0.0	0.0
2002	643.7	722.1	578.3	59.6	57.9	54.9	0.0	0.0	0.0	0.0	0.0	0.0
2003	645.4	733.8	581.8	60.3	58.5	55.5	0.0	0.0	0.0	0.0	0.0	0.0
Ave.	636.8	728.7	567.7	58.4	56.7	54.6	0.0	0.0	0.0	0.0	0.0	0.0
Ave. Chg.	na	91.9	-69.2	na	-1.7	-3.8	na	na	na	na	na	na
% Chg.	na	14.4	-10.9	na	-2.9	-6.5	na	na	na	na	na	na

	Wheat Planted Acreage			Soybeans Planted Acreage			Cotton Planted Acreage			Seven Crops Planted Acreage		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Acres			*Thousand Acres*			*Thousand Acres*			*Thousand Acres*		
1996	467.3	405.4	477.3	1330.3	1178.7	1312.1	785.1	941.9	694.3	3271.6	3272.5	3099.2
1997	468.0	413.9	483.8	1355.5	1188.4	1330.8	803.9	964.5	767.9	3312.6	3313.1	3196.2
1998	470.3	414.9	514.6	1353.2	1285.1	1314.3	816.5	877.2	853.2	3330.1	3330.6	3301.3
1999	470.3	413.2	547.1	1357.8	1222.5	1310.0	816.5	897.9	895.7	3337.9	3338.4	3363.8
2000	472.5	414.1	552.9	1364.6	1262.4	1327.0	822.8	851.6	902.6	3355.0	3355.5	3405.5
2001	477.0	417.2	560.2	1364.6	1332.6	1326.1	803.9	770.6	881.9	3345.7	3352.7	3393.4
2002	480.8	421.0	566.1	1369.2	1189.8	1337.0	822.8	987.1	886.8	3376.1	3377.9	3423.0
2003	484.6	414.3	572.5	1380.6	1200.4	1347.3	822.8	987.1	879.9	3393.6	3394.1	3436.9
Ave.	473.8	414.2	534.3	1359.5	1232.5	1325.5	811.8	909.7	845.3	3340.3	3341.8	3327.4
Ave. Chg.	na	-59.6	60.5	na	-127.0	-33.9	na	98.0	33.5	na	1.5	-12.9
% Chg.	na	-12.6	12.8	na	-9.3	-2.5	na	12.1	4.1	na	0.0	-0.4

Table 20. Tennessee Crop Acreage in Sustainable Practices, 1996-2003

	Corn in Alt. Practices			Sorghum in Alt. Practices			Oats in Alt. Practices			Barley in Alt. Practices		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Percent			*Percent*			*Percent*			*Percent*		
1996	1.36	1.25	38.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1997	1.68	1.52	48.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	1.33	1.64	55.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1999	1.21	1.53	63.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000	1.38	1.62	73.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2001	1.55	1.76	78.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2002	1.67	2.02	78.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2003	1.50	1.97	78.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ave.	1.46	1.66	64.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ave. Chg.	na	0.20	62.94	na	0.00	0.00	na	0.00	0.00	na	0.00	0.00
% Chg.	na	13.96	4310.62	na	na	na	na	na	na	na	na	na

	Wheat in Alt. Practices			Soybeans in Alt. Practices			Cotton in Alt. Practices			7 Crops in Alt. Practices		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Percent			*Percent*			*Percent*			*Percent*		
1996	8.82	10.17	74.94	2.45	2.77	23.63	13.14	10.96	94.33	4.47	4.47	44.98
1997	10.93	12.36	85.36	3.00	3.42	26.51	16.28	13.57	98.56	5.58	5.58	50.98
1998	11.27	12.78	89.76	3.30	3.24	29.62	19.34	18.00	98.68	6.44	6.44	54.63
1999	11.67	13.28	90.39	3.48	3.55	31.33	22.62	20.57	98.75	7.30	7.29	57.81
2000	12.02	13.72	90.42	3.52	3.51	30.36	25.79	24.92	98.75	8.16	8.15	59.17
2001	12.32	14.09	90.10	3.58	3.39	30.34	29.55	30.83	98.75	9.02	9.00	59.94
2002	12.64	14.43	89.86	3.65	3.88	31.91	30.49	25.41	98.72	9.40	9.39	60.65
2003	12.97	15.17	89.86	3.85	4.03	33.64	32.30	27.57	98.71	9.87	10.06	61.33
Ave.	11.58	13.25	87.59	3.35	3.47	29.67	23.69	21.48	98.16	7.53	7.55	56.19
Ave. Chg.	na	1.67	76.01	na	0.12	26.31	na	-2.21	74.47	na	0.02	48.66
% Chg.	na	14.42	656.36	na	3.58	784.61	na	-9.33	314.36	na	0.23	646.17

Table 21. Tennessee Average Crop Yields, 1996-2003

	Average Corn Yields			Average Sorghum Yields			Average Wheat Yields			Average Soybean Yields		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Bushels Per Acre			*Bushels Per Acre*			*Bushels Per Acre*			*Bushels Per Acre*		
1996	103.5	103.9	101.5	81.4	82.9	89.4	38.2	37.8	38.9	29.4	29.1	28.8
1997	104.7	105.2	104.2	82.4	84.2	88.7	38.5	38.3	38.9	29.8	29.5	29.6
1998	105.9	106.3	107.0	82.8	84.4	89.2	38.8	38.6	39.2	30.1	29.7	29.4
1999	107.2	107.4	109.2	83.2	84.8	82.3	39.1	38.9	39.5	30.4	30.1	29.7
2000	108.4	108.6	112.1	83.9	85.5	82.9	39.4	39.2	39.8	30.6	30.3	29.8
2001	109.6	109.7	113.8	84.3	85.9	83.3	39.7	39.5	40.1	31.0	30.6	30.1
2002	110.8	110.8	115.2	85.3	86.9	84.3	40.0	39.8	40.4	31.3	31.1	30.5
2003	112.0	111.8	116.3	85.6	87.3	84.6	40.3	40.1	40.8	31.6	31.4	30.8
Ave.	107.7	107.9	109.9	83.6	85.2	85.6	39.2	39.0	39.7	30.5	30.2	29.8
Ave. Chg.	na	0.2	2.2	na	1.6	2.0	na	-0.2	0.5	na	-0.3	-0.7
% Chg.	na	0.2	2.0	na	1.9	2.4	na	-0.5	1.2	na	-1.0	-2.2

	Average Cotton Yields		
	Baseline	Ac. Shift	Maximize
	Pounds Per Acre		
1996	528.5	523.0	506.8
1997	536.5	530.9	513.2
1998	545.5	544.1	523.1
1999	551.2	548.8	527.1
2000	561.2	561.5	532.7
2001	568.6	572.7	536.8
2002	575.5	569.1	540.1
2003	584.0	577.4	544.4
Ave.	556.4	553.4	528.0
Ave. Chg.	na	-3.0	-28.3
% Chg.	na	-0.5	-5.1

Table 22. Tennessee Economic Indicators, 1996-2003

	Fertilizer Expenses			Herbicide Expenses			Insecticde Expenses			Labor Expenses		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Dollars			*Thousand Dollars*			*Thousand Dollars*			*Thousand Dollars*		
1996	134,294	144,260	108,559	80,930	80,385	100,944	33,956	39,558	31,078	105,566	119,578	131,807
1997	135,218	145,511	111,504	82,050	81,186	109,567	34,448	40,223	33,309	108,379	122,872	138,937
1998	135,335	141,546	115,006	82,329	82,736	114,605	34,895	37,742	35,420	110,485	114,663	148,207
1999	134,706	144,523	117,087	82,550	82,297	111,849	34,942	39,186	36,395	111,151	117,246	153,313
2000	134,566	143,241	119,035	83,021	83,208	107,448	35,156	38,181	36,170	112,347	113,126	154,865
2001	132,878	138,982	119,157	82,778	83,879	99,978	34,673	35,852	34,661	111,056	105,684	153,415
2002	134,108	145,766	119,669	83,490	82,579	101,266	35,278	41,417	35,086	113,388	127,881	154,808
2003	134,114	146,071	118,536	83,983	83,190	102,242	35,311	41,611	35,233	113,932	128,160	155,759
Ave.	134,402	143,737	116,069	82,641	82,433	105,987	34,832	39,221	34,669	110,788	118,651	148,889
Ave. Chg.	na	9,335	-18,333	na	-209	23,346	na	4,389	-163	na	7,863	38,101
% Chg.	na	6.9	-13.6	na	-0.3	28.2	na	12.6	-0.5	na	7.1	34.4

	Returns to the Major Crops		
	Baseline	Ac. Shift	Maximize
	Million Dollars		
1996	203.62	217.35	174.28
1997	213.93	231.83	190.78
1998	221.60	234.70	202.06
1999	217.19	233.07	200.88
2000	215.74	229.16	201.23
2001	208.08	220.51	193.11
2002	206.83	214.97	187.91
2003	205.39	212.81	186.12
Ave.	211.55	224.30	192.05
Ave. Chg.	na	12.75	-19.50
% Chg.	na	6.03	-9.22

Table 23. Tennessee Environmental Indicators, 1996-2003

	Chemical Index			Carbon		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	*Index Value**			*Percent*		
1996	100.00	105.21	55.53	3.08	3.06	2.70
1997	98.40	104.03	56.23	3.08	3.07	2.68
1998	98.30	103.45	55.88	3.07	3.07	2.70
1999	98.13	109.50	53.35	3.07	3.04	2.82
2000	97.48	111.21	49.59	3.06	3.04	2.85
2001	97.72	111.14	46.87	3.05	3.03	2.90
2002	97.04	104.90	49.69	3.05	3.03	2.89
2003	96.74	105.42	48.72	3.05	3.02	2.86
Ave.	97.98	106.86	51.98	3.06	3.05	2.80
Ave. Chg.	na	8.88	-45.99	na	-0.02	-0.26
% Chg.	na	9.06	-46.94	na	-0.61	-8.61

	Soil Erosion			NFarm		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Tons Per Acre			*Pounds Per Acre*		
1996	13.52	13.81	15.02	17.11	18.22	17.80
1997	13.65	13.92	14.51	17.07	18.21	15.82
1998	13.74	13.91	15.49	16.96	17.52	15.81
1999	13.83	14.01	13.38	16.81	17.48	14.07
2000	13.92	14.04	13.14	16.67	17.03	13.31
2001	13.99	14.05	12.93	16.44	16.43	12.92
2002	14.01	14.28	12.96	16.44	17.54	12.03
2003	14.03	14.37	13.04	16.34	17.38	11.60
Ave.	13.84	14.05	13.81	16.73	17.48	14.17
Ave. Chg.	na	0.21	-0.03	na	0.75	-2.56
% Chg.	na	1.54	-0.20	na	4.46	-15.30

	PFarm		
	Baseline	Ac. Shift	Maximize
	Parts Per Billion		
1996	107.10	102.18	98.63
1997	104.69	102.60	94.10
1998	104.24	101.77	45.75
1999	103.54	100.38	24.65
2000	102.91	99.35	44.51
2001	103.57	99.52	23.52
2002	102.89	99.13	23.86
2003	102.61	95.76	23.99
Ave.	103.94	100.09	47.38
Ave. Chg.	na	-3.86	-56.57
% Chg.	na	-3.71	-54.42

* Chemical Index values have been indexed such that the 1996 baseline value equals 100.

South Carolina State-Level Results

As with Tennessee, two South Carolina ASDs encompass 72 percent of the land planted to the seven major crops. POLYSYS regions 53 and 54 drive many of the changes presented here at the state level.

Production Effects. Planted acreage averages nearly the same under *Acreage Shift* while dropping 2.2 percent on average from *Baseline* levels (table 24). Significant *Acreage Shift*ing between crops occurs in the scenarios, however. Under *Acreage Shift*, soybeans acreage averages 167,600 acres (18.7 percent) below *Baseline*. The bulk of this *Acreage Shift*s to corn and wheat, and cotton acreage also gains 19.6 percent on average. Under *Maximize*, wheat acreage is 11.5 percent below and cotton 12.5 percent below *Baseline*; this *Acreage Shift*s primarily to soybeans.

More than any other state in the Southeast, South Carolina adopts the sustainable practices at greater levels under the *Baseline* and *Acreage Shift*, as indicated in table 25. Overall, the *Baseline* averages 45 percent of South Carolina major crop acreage in alternative rotations, with chemical banding, and no-till with chemical banding being the primary rotational strategies.

Acreage Shift averages 48.9 percent and *Maximize* 59.3 percent of South Carolina cropland in more sustainable practices. Of the major crops, corn devotes the highest share of its land (from 76.7 percent in the *Baseline* to 91.1 percent under *Maximize*) to the production alternatives. By 2003 under *Maximize*, 95.6 percent of wheat, 95.4 percent of corn, and 79.5 percent of soybean acreage is in more sustainable rotations, which generally follow the trend noted in the *Baseline*.

Crop yields on the whole decline slightly or increase by fractions of a percent under the scenarios (table 26). The most dramatic change occurs with corn under *Maximize*, which averages 5 bushels per acre below *Baseline*; however, as suggested earlier, this yield effect is driven by Region 53, which has one-third of the state's acreage and whose yield declines an average of 10.9 bushels per acre from the *Baseline* average of 73.7 bushels per acre (the lowest in the state).

Economic Effects. Under the *Acreage Shift*, the balance of fertilizer, pesticide, and labor costs is an average net increase on average of $1.6 million annually for South Carolina (table 27). Herbicide costs are 10.9 percent below *Baseline* levels, while fertilizer, insecticide, and labor costs all are above *Baseline* levels. The *Maximize* scenario shifts this balance to a net $5.7 million average annual savings for the categories, with each category trending below *Baseline*.

Net returns to the seven crops average a $6.6 million (11.3 percent) higher in the *Acreage Shift* scenario but sharp increase in expenses push returns $8.2 million (14.0 percent) lower than *Baseline* levels under *Maximize* (table 27). Nearly half of the *Acreage Shift* increase is accounted for by changes in a single coastal ASD, region 55. The *Maximize* loss is centered in region 54 (the other coastal ASD), whose returns decline 12.2 percent on average.

Environmental Effects. The *Acreage Shift* scenario results in marginally worse levels of environmental indicators, except for erosion, which is unaffected by the scenario (table 28). The biggest changes occur with the Chemical Index, which averages 12.9 percent above *Baseline*, and in PFarm, which averages 4.5 percent higher.

The *Maximize* scenario results in an average 1.4-pound-per-acre (8.3 percent) decline in NFarm and slight improvements in the Chemical Index, Carbon, and PFarm (table 28). Soil erosion - which is not considered a problem in the state - rises .2 tons per acre above *Baseline*.

Table 24. South Carolina Planted Acreage to the Seven Major Crops, 1996-2003

	Corn Planted Acreage			Sorghum Planted Acreage			Oats Planted Acreage			Barley Planted Acreage		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Acres			*Thousand Acres*			*Thousand Acres*			*Thousand Acres*		
1996	1210.9	1401.8	1058.5	44.2	44.0	40.8	56.6	46.0	56.6	37.0	31.4	36.1
1997	1202.3	1396.2	1052.1	44.7	43.3	40.6	55.0	44.0	55.0	38.0	35.9	36.0
1998	1210.9	1405.2	1057.5	45.2	45.0	41.7	51.8	43.3	51.8	39.0	33.1	38.1
1999	1215.9	1410.6	1061.5	45.7	45.4	42.1	51.8	43.3	51.8	40.1	34.0	39.1
2000	1219.5	1418.4	1064.6	45.7	42.2	42.1	50.1	41.9	50.1	40.3	33.5	39.6
2001	1227.8	1427.0	1076.2	46.2	34.1	42.5	51.8	42.9	51.8	40.3	33.5	39.6
2002	1232.8	1432.4	1134.7	46.7	33.9	43.0	51.8	42.6	59.4	40.8	34.0	40.1
2003	1236.1	1437.8	1133.2	47.2	34.9	44.3	51.8	42.4	51.8	41.3	33.1	41.3
Ave.	1219.5	1416.2	1079.8	45.7	40.3	42.1	52.6	43.3	53.5	39.6	33.6	38.8
Ave. Chg.	na	196.6	-139.7	na	-5.4	-3.6	na	-9.3	1.0	na	-6.0	-0.8
% Chg.	na	16.1	-11.5	na	-11.7	-7.8	na	-17.6	1.8	na	-15.2	-2.1

	Wheat Planted Acreage			Soybeans Planted Acreage			Cotton Planted Acreage			Seven Crops Planted Acreage		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Acres			*Thousand Acres*			*Thousand Acres*			*Thousand Acres*		
1996	615.6	757.2	578.7	1579.1	1286.8	1585.0	178.2	156.3	146.4	3721.6	3723.4	3502.0
1997	616.9	704.9	578.2	1608.9	1309.7	1618.0	182.4	216.9	149.9	3748.3	3750.8	3529.8
1998	619.6	706.0	578.5	1606.2	1309.8	1615.6	185.3	220.3	152.2	3758.0	3762.6	3535.4
1999	619.6	706.0	578.5	1611.7	1313.8	1625.0	185.3	220.3	152.2	3769.9	3773.3	3550.2
2000	622.5	709.5	581.3	1619.8	1320.1	1637.4	186.7	222.0	153.4	3784.7	3787.5	3568.5
2001	628.5	772.0	586.7	1619.8	1327.4	1639.5	182.4	161.3	149.9	3796.8	3798.3	3586.3
2002	633.4	702.9	591.5	1625.2	1350.9	1645.5	186.7	221.9	159.2	3817.4	3818.6	3673.5
2003	638.4	727.9	595.9	1638.8	1343.3	1659.6	186.7	221.9	153.4	3840.2	3841.3	3679.4
Ave.	624.3	723.3	583.7	1613.7	1320.2	1628.2	184.2	205.1	152.1	3779.6	3782.0	3578.1
Ave. Chg.	na	99.0	-40.6	na	-293.5	14.5	na	20.9	-32.2	na	2.4	-201.5
% Chg.	na	15.9	-6.5	na	-18.2	0.9	na	11.3	-17.5	na	0.1	-5.3

Table 25. South Carolina Crop Acreage in Sustainable Practices, 1996-2003

	Corn in Alt. Practices			Sorghum in Alt. Practices			Oats in Alt. Practices			Barley in Alt. Practices		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Percent			*Percent*			*Percent*			*Percent*		
1996	1.64	1.42	17.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1997	2.08	1.79	22.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	2.39	2.06	26.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1999	2.57	2.21	31.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000	2.73	2.35	34.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2001	2.90	2.49	36.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2002	3.06	2.64	37.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2003	3.24	2.79	38.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ave.	2.58	2.22	30.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ave. Chg.	na	-0.36	28.07	na	0.00	0.00	na	0.00	0.00	na	0.00	0.00
% Chg.	na	-13.88	1089.57	na	na	na	na	na	na	na	na	na

	Wheat in Alt. Practices			Soybeans in Alt. Practices			Cotton in Alt. Practices			Seven Crops in Alt. Practices		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Percent			*Percent*			*Percent*			*Percent*		
1996	2.15	1.75	15.66	1.86	2.28	6.72	0.00	0.00	6.95	1.34	1.34	9.36
1997	2.70	2.37	19.65	2.29	2.82	8.25	0.00	0.00	6.95	1.67	1.68	11.55
1998	3.23	2.80	23.58	2.76	3.36	9.91	0.00	0.00	6.95	1.97	1.97	13.75
1999	3.79	3.27	27.56	3.19	3.88	11.52	0.00	0.00	6.95	2.22	2.22	15.93
2000	4.08	3.53	28.01	3.43	4.18	12.94	0.00	0.00	6.95	2.38	2.38	17.47
2001	4.15	3.47	28.30	3.54	4.45	14.42	0.00	0.00	6.95	2.48	2.53	18.98
2002	4.25	4.28	28.84	3.66	4.89	16.07	0.00	0.00	6.70	2.58	2.76	20.14
2003	4.38	4.58	29.37	3.78	5.43	17.43	0.00	0.00	6.95	2.69	2.98	21.40
Ave.	3.59	3.26	25.12	3.06	3.91	12.16	0.00	0.00	6.92	2.17	2.23	16.07
Ave. Chg.	na	-0.34	21.53	na	0.85	9.09	na	0.00	6.92	na	0.07	13.91
% Chg.	na	-9.33	599.51	na	27.66	296.82	na	na	na	na	3.06	641.95

Table 26. South Carolina Average Crop Yields, 1996-2003

	Average Corn Yields			Average Sorghum Yields			Average Oat Yields			Average Barley Yields		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Bushels Per Acre			*Bushels Per Acre*			*Bushels Per Acre*			*Bushels Per Acre*		
1996	92.2	92.4	87.0	58.0	58.1	57.2	53.4	53.2	54.2	53.8	56.7	53.0
1997	93.3	93.6	88.0	58.7	58.9	56.9	53.6	53.6	54.2	54.2	54.4	52.8
1998	94.4	94.6	89.1	59.0	59.2	57.2	52.7	52.9	53.2	54.6	54.9	53.7
1999	95.5	95.8	91.6	59.3	59.5	58.6	54.1	54.4	54.9	55.6	55.9	54.7
2000	96.6	96.8	91.4	59.8	60.1	57.9	54.4	54.6	55.0	56.0	56.4	55.1
2001	97.6	98.0	92.7	60.0	59.9	58.1	54.1	54.2	54.7	56.0	56.4	55.2
2002	98.7	99.1	94.6	60.7	60.6	58.4	54.1	54.1	56.2	56.5	56.9	55.6
2003	99.8	100.2	95.7	61.0	60.8	59.0	54.1	54.0	54.6	56.9	56.8	56.3
Ave.	96.0	96.3	91.3	59.6	59.6	57.9	53.8	53.9	54.6	55.5	56.0	54.5
Ave. Chg.	na	0.3	-4.7	na	0.1	-1.7	na	0.0	0.8	na	0.6	-0.9
% Chg.	na	0.3	-4.9	na	0.1	-2.8	na	0.1	1.4	na	1.0	-1.7

	Average Wheat Yields			Average Soybean Yields			Average Cotton Yields		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Bushels Per Acre			*Bushels Per Acre*			*Pounds Per Acre*		
1996	41.4	40.8	35.9	29.4	29.3	28.5	435.6	431.4	430.4
1997	41.7	40.9	36.6	29.7	29.7	28.9	442.2	443.7	438.1
1998	42.0	41.2	37.2	30.0	30.0	29.2	449.6	451.5	446.0
1999	42.3	41.6	35.5	30.3	30.3	29.5	454.4	456.2	450.6
2000	42.7	41.9	38.1	30.6	30.6	29.9	462.6	464.5	458.9
2001	43.0	42.4	38.2	30.9	30.7	30.0	468.7	464.3	464.9
2002	43.3	42.6	38.4	31.3	31.2	30.3	474.4	476.3	465.7
2003	43.6	43.0	38.5	31.6	31.5	30.6	481.4	483.4	477.5
Ave.	42.5	41.8	37.3	30.5	30.4	29.6	458.6	458.9	454.0
Ave. Chg.	na	-0.7	-5.2	na	-0.1	-0.9	na	0.3	-4.6
% Chg.	na	-1.7	-12.2	na	-0.2	-2.9	na	0.1	-1.0

Table 27. South Carolina Economic Indicators, 1996-2003

	Fertilizer Expenses			Herbicide Expenses			Insecticde Expenses			Labor Expenses		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Dollars			*Thousand Dollars*			*Thousand Dollars*			*Thousand Dollars*		
1996	59,895	62,527	59,347	42,059	37,704	42,772	6,356	7,370	5,867	63,066	66,191	60,327
1997	60,307	62,406	58,991	41,667	37,300	41,964	6,880	7,872	6,238	62,564	65,800	59,605
1998	60,318	62,940	59,275	41,262	36,711	40,658	7,056	8,173	6,730	62,675	65,527	59,510
1999	60,313	62,938	59,416	41,098	36,022	39,623	7,040	8,426	7,010	62,915	64,876	58,953
2000	60,543	63,168	59,146	40,924	36,172	38,728	7,095	8,435	7,289	63,408	65,376	58,178
2001	60,781	63,468	61,119	40,761	36,343	38,992	7,262	8,387	7,721	63,005	65,198	58,499
2002	61,429	63,699	61,767	41,018	36,708	38,774	7,600	8,386	7,943	63,485	66,236	59,156
2003	61,821	63,911	62,278	40,501	36,387	37,874	7,855	8,355	8,150	63,377	66,327	59,025
Ave.	60,676	63,132	60,167	41,161	36,668	39,923	7,143	8,176	7,118	63,062	65,691	59,157
Ave. Chg.	na	2,456	-508	na	-4,493	-1,238	na	1,033	-25	na	2,630	-3,905
% Chg.	na	4.0	-0.8	na	-10.9	-3.0	na	14.5	-0.3	na	4.2	-6.2

	Returns to the Major Crops		
	Baseline	Ac. Shift	Maximize
	Million Dollars		
1996	-39.15	-27.57	-53.33
1997	-43.11	-32.97	-53.54
1998	-47.47	-41.27	-55.72
1999	-54.15	-49.14	-59.59
2000	-60.69	-54.99	-64.65
2001	-66.36	-60.60	-73.81
2002	-73.73	-69.84	-81.90
2003	-80.30	-76.16	-87.67
Ave.	-58.12	-51.57	-66.28
Ave. Chg.	na	6.55	-8.16
% Chg.	na	-11.27	14.03

Table 28. South Carolina Environmental Indicators, 1996-2003

	Chemical Index			Carbon			Soil Erosion			NFarm		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	*Index Value**			*Percent*			*Tons Per Acre*			*Pounds Per Acre*		
1996	100.00	125.05	87.22	5.68	5.72	5.99	2.55	2.50	2.80	62.96	71.16	54.74
1997	98.99	117.42	86.97	5.68	5.61	5.90	2.58	2.52	2.83	62.31	72.52	53.92
1998	99.24	117.93	87.78	5.67	5.60	6.02	2.58	2.54	2.81	62.59	72.75	53.95
1999	99.29	117.98	88.84	5.67	5.60	5.75	2.59	2.54	2.77	62.60	72.77	53.52
2000	99.19	118.64	88.08	5.67	5.61	6.22	2.60	2.55	2.77	62.56	72.89	53.59
2001	114.04	128.84	89.65	5.72	5.74	6.30	2.59	2.53	2.75	66.28	72.37	53.88
2002	118.28	132.73	99.44	5.73	5.66	6.33	2.59	2.56	2.70	67.42	76.91	57.46
2003	117.98	132.83	87.83	5.73	5.65	6.41	2.59	2.56	2.68	67.21	76.64	54.65
Ave.	105.88	123.93	89.48	5.69	5.65	6.12	2.58	2.54	2.76	64.24	73.50	54.46
Ave. Chg.	na	18.05	-16.40	na	-0.05	0.42	na	-0.05	0.18	na	9.26	-9.78
% Chg.	na	17.05	-15.49	na	-0.79	7.40	na	-1.79	6.97	na	14.41	-15.22

	PFarm		
	Baseline	Ac. Shift	Maximize
	Parts Per Billion		
1996	295.17	313.83	328.15
1997	291.83	309.88	322.31
1998	292.48	310.44	323.93
1999	292.80	310.94	323.46
2000	292.30	310.15	322.81
2001	338.78	346.76	326.23
2002	350.77	373.28	381.87
2003	350.03	372.72	334.64
Ave.	313.02	331.00	332.93
Ave. Chg.	na	17.98	19.91
% Chg.	na	5.74	6.36

* Chemical Index values have been indexed such that the 1996 baseline value equals 100.

Georgia State-Level Results

Production Effects. As occurs with several states, planted acreage changes little from the *Baseline* under *Acreage Shift*, although there is significant shifting between crops (table 29). Nearly one-fifth of Georgia's wheat acreage and 6 percent of its soybean acreage on average under the *Baseline* shifts corn and cotton under *Acreage Shift*. Under the *Maximize* scenario, acreage in the seven major crops averages 152,200 (5.4 percent) below *Baseline*. The bulk of these *Maximize* losses occur in corn and cotton, whose average acreage is 12.1 percent and 12.5 percent below *Baseline* levels.

Relatively little Georgia cropland is put to the more sustainable rotations under the *Baseline* and *Acreage Shift* scenarios, which respectively put 4.7 percent and 4.8 percent of major crop land to such practices on average (table 30). Under the *Maximize* scenario, the average percent of land in alternative rotations rises to 20.2 percent, with sharp increases coming in for most crops except sorghum (which averages 4.7 percent) and oats (which has no such acreage in any scenario).

The alternative practices more commonly used in Georgia under the *Baseline* are chemical banding and no-till, also with chemical banding. Regions 57, 60 and 64, however, show little use of more sustainable practices under *Baseline* conditions. Under *Maximize*, more acreage shifts to the already mentioned rotations. Another significant share shifts to the use of Bt cotton - particularly in in regions 60, 61 and 64.

Crop yields decline slightly (with the exception of wheat, which gains 1.7 bushels per acre on average) under the *Acreage Shift* scenario (table 31). Under *Maximize*, yields generally trend down with the greatest increase coming for wheat, whose yield declines 21.4 percent from *Baseline* levels.

Maximize corn yields are 3.4 bushels per acre (2.4 percent) below *Baseline*, and cotton is 13.5 pounds per acre (2.4 percent) below.

Economic Effects. The *Acreage Shift* scenario increases fertilizer, insecticide, and labor costs while reducing herbicide costs only slightly, resulting in a balance of these costs which averages $13.3 million higher annually than *Baseline* levels (table 32). These costs are lower across the board for the *Maximize* scenario, resulting in a net balance of $18.1 million lower on average than such costs in the *Baseline*.

Interestingly, net returns diverge from the production expense trends just noted (table 32). *Acreage Shift* returns average $7.9 million (3 percent) below *Baseline* levels, while *Maximize* returns (which show lower expenses) average $27.5 million (66.3 percent) below *Baseline*.

Environmental Effects. The *Acreage Shift* scenario generally returns poorer levels of environmental indicators, with the exceptions of Carbon (which marginally improves) and Soil Erosion, which is not a problem in Georgia (table 33). *Acreage Shift* Chemical Index values average 9.8 percent higher, PFarm averages 12.4 percent higher, NFarm gains 5.2 pounds per acre (8.2 percent) from *Baseline* levels.

The *Maximize* scenario, on the other hand, provides significant environmental improvements (table 33). The Chemical Index falls 10 percent from *Baseline*, Carbon is marginally higher, and NFarm averages 5.8 pounds per acre (9.1 percent) lower than *Baseline*. PFarm, however, averages 6.9 percent above *Baseline* levels.

Table 29. Georgia Planted Acreage to the Seven Major Crops, 1996-2003

	Corn Planted Acreage			Sorghum Planted Acreage			Oats Planted Acreage			Barley Planted Acreage		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Acres			*Thousand Acres*			*Thousand Acres*			*Thousand Acres*		
1996	1210.9	1401.8	1058.5	44.2	44.0	40.8	56.6	46.0	56.6	37.0	31.4	36.1
1997	1202.3	1396.2	1052.1	44.7	43.3	40.6	55.0	44.0	55.0	38.0	35.9	36.0
1998	1210.9	1405.2	1057.5	45.2	45.0	41.7	51.8	43.3	51.8	39.0	33.1	38.1
1999	1215.9	1410.6	1061.5	45.7	45.4	42.1	51.8	43.3	51.8	40.1	34.0	39.1
2000	1219.5	1418.4	1064.6	45.7	42.2	42.1	50.1	41.9	50.1	40.3	33.5	39.6
2001	1227.8	1427.0	1076.2	46.2	34.1	42.5	51.8	42.9	51.8	40.3	33.5	39.6
2002	1232.8	1432.4	1134.7	46.7	33.9	43.0	51.8	42.6	59.4	40.8	34.0	40.1
2003	1236.1	1437.8	1133.2	47.2	34.9	44.3	51.8	42.4	51.8	41.3	33.1	41.3
Ave.	1219.5	1416.2	1079.8	45.7	40.3	42.1	52.6	43.3	53.5	39.6	33.6	38.8
Ave. Chg.	na	196.6	-139.7	na	-5.4	-3.6	na	-9.3	1.0	na	-6.0	-0.8
% Chg.	na	16.1	-11.5	na	-11.7	-7.8	na	-17.6	1.8	na	-15.2	-2.1

	Wheat Planted Acreage			Soybeans Planted Acreage			Cotton Planted Acreage			Seven Crops Planted Acreage		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Acres			*Thousand Acres*			*Thousand Acres*			*Thousand Acres*		
1996	615.6	757.2	578.7	1579.1	1286.8	1585.0	178.2	156.3	146.4	3721.6	3723.4	3502.0
1997	616.9	704.9	578.2	1608.9	1309.7	1618.0	182.4	216.9	149.9	3748.3	3750.8	3529.8
1998	619.6	706.0	578.5	1606.2	1309.8	1615.6	185.3	220.3	152.2	3758.0	3762.6	3535.4
1999	619.6	706.0	578.5	1611.7	1313.8	1625.0	185.3	220.3	152.2	3769.9	3773.3	3550.2
2000	622.5	709.5	581.3	1619.8	1320.1	1637.4	186.7	222.0	153.4	3784.7	3787.5	3568.5
2001	628.5	772.0	586.7	1619.8	1327.4	1639.5	182.4	161.3	149.9	3796.8	3798.3	3586.3
2002	633.4	702.9	591.5	1625.2	1350.9	1645.5	186.7	221.9	159.2	3817.4	3818.6	3673.5
2003	638.4	727.9	595.9	1638.8	1343.3	1659.6	186.7	221.9	153.4	3840.2	3841.3	3679.4
Ave.	624.3	723.3	583.7	1613.7	1320.2	1628.2	184.2	205.1	152.1	3779.6	3782.0	3578.1
Ave. Chg.	na	99.0	-40.6	na	-293.5	14.5	na	20.9	-32.2	na	2.4	-201.5
% Chg.	na	15.9	-6.5	na	-18.2	0.9	na	11.3	-17.5	na	0.1	-5.3

Table 30. Georgia Crop Acreage in Sustainable Practices, 1996-2003

	Corn in Alt. Practices			Sorghum in Alt. Practices			Oats in Alt. Practices			Barley in Alt. Practices		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Percent			*Percent*			*Percent*			*Percent*		
1996	3.58	3.09	16.26	1.97	2.43	4.62	0.00	0.00	0.00	0.00	0.00	0.00
1997	4.53	3.90	20.42	2.45	3.02	4.64	0.00	0.00	0.00	0.00	0.00	0.00
1998	5.32	4.66	23.94	2.91	3.56	4.65	0.00	0.00	0.00	0.00	0.00	0.00
1999	6.04	5.28	27.11	3.37	4.11	4.65	0.00	0.00	0.00	0.00	0.00	0.00
2000	6.79	5.93	30.20	3.86	4.35	4.65	0.00	0.00	0.00	0.00	0.00	0.00
2001	7.42	6.45	32.83	4.32	4.35	4.65	0.00	0.00	0.00	0.00	0.00	0.00
2002	8.20	7.14	35.37	4.79	4.35	4.65	0.00	0.00	0.00	0.00	0.00	0.00
2003	8.96	7.78	36.87	5.11	4.19	4.65	0.00	0.00	0.00	0.00	0.00	0.00
Ave.	6.36	5.53	27.88	3.60	3.80	4.65	0.00	0.00	0.00	0.00	0.00	0.00
Ave. Chg.	na	-0.83	21.52	na	0.20	1.05	na	0.00	0.00	na	0.00	0.00
% Chg.	na	-13.00	338.63	na	5.49	29.12	na	na	na	na	na	na

	Wheat in Alt. Practices			Soybeans in Alt. Practices			Cotton in Alt. Practices			7 Crops in Alt. Practices		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Percent			*Percent*			*Percent*			*Percent*		
1996	1.46	1.81	8.89	3.18	3.40	16.06	2.27	1.89	18.17	2.34	2.34	12.44
1997	3.83	2.37	11.18	5.34	4.11	19.20	2.79	2.33	20.13	3.40	2.92	14.98
1998	4.53	5.65	12.91	6.41	7.48	23.10	3.30	3.68	21.91	4.05	4.45	17.39
1999	4.97	5.88	14.76	7.23	8.10	25.70	3.86	4.06	23.99	4.61	4.92	19.51
2000	5.37	6.29	16.56	8.05	8.95	28.54	4.40	4.53	25.49	5.17	5.47	21.61
2001	5.74	6.77	18.30	8.88	9.71	31.29	5.08	4.87	27.16	5.73	5.93	23.50
2002	6.12	7.82	20.38	9.74	10.51	34.65	5.55	4.51	27.01	6.29	6.30	25.33
2003	2.16	2.43	21.77	7.45	7.78	36.87	6.13	4.95	27.68	5.77	5.67	26.73
Ave.	4.27	4.88	15.59	7.04	7.51	26.93	4.17	3.85	23.94	4.67	4.75	20.19
Ave. Chg.	na	0.61	11.32	na	0.47	19.89	na	-0.32	19.77	na	0.08	15.52
% Chg.	na	14.16	264.98	na	6.68	282.75	na	-7.67	473.82	na	1.71	332.25

Table 31. Georgia Average Crop Yields, 1996-2003

	Average Corn Yields			Average Sorghum Yields			Average Oat Yields			Average Wheat Yields		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Bushels Per Acre			*Bushels Per Acre*			*Bushels Per Acre*			*Bushels Per Acre*		
1996	99.4	99.3	95.9	46.8	46.9	45.3	58.4	58.3	57.6	36.2	37.9	28.1
1997	100.6	100.4	97.1	47.4	47.2	46.3	58.7	58.7	58.0	36.5	38.8	28.5
1998	101.7	101.9	98.5	47.6	47.4	46.5	57.7	57.6	56.9	36.7	38.3	28.9
1999	102.9	103.1	99.8	47.8	47.7	46.7	59.3	59.1	58.6	37.0	38.6	29.1
2000	104.1	104.3	100.9	48.2	48.1	47.0	59.6	59.3	58.9	37.3	38.9	29.4
2001	105.2	105.4	101.9	48.4	48.3	47.2	59.3	59.0	58.6	37.6	39.1	29.7
2002	106.5	106.3	102.9	49.0	48.8	47.8	59.3	59.0	58.6	37.9	39.4	30.1
2003	107.6	107.6	104.0	49.2	49.0	47.9	59.3	59.0	58.6	38.2	39.9	29.8
Ave.	103.5	103.5	100.1	48.0	47.9	46.8	58.9	58.7	58.2	37.2	38.9	29.2
Ave. Δ	na	0.0	-3.4	na	-0.1	-1.2	na	-0.2	-0.7	na	1.7	-8.0
% Δ	na	0.0	-3.3	na	-0.3	-2.5	na	-0.3	-1.2	na	4.5	-21.4

	Average Soybean Yields			Average Cotton Yields		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Bushels Per Acre			*Pounds Per Acre*		
1996	24.9	24.8	25.0	527.9	526.1	517.2
1997	25.2	25.1	25.3	535.9	534.2	523.4
1998	25.5	25.4	25.6	544.9	542.5	531.5
1999	25.7	25.6	25.8	550.6	548.3	538.1
2000	25.9	25.8	26.0	560.6	558.4	547.1
2001	26.2	26.1	26.3	568.0	566.0	553.3
2002	26.5	26.5	26.7	574.9	573.6	559.7
2003	26.8	26.6	27.0	583.4	582.3	568.3
Ave.	25.8	25.7	26.0	555.8	553.9	542.3
Ave. Δ	na	-0.1	0.1	na	-1.9	-13.5
% Δ	na	-0.5	0.5	na	-0.3	-2.4

Table 32. Georgia Economic Indicators, 1996-2003

	Fertilizer Expenses			Herbicide Expenses		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Dollars			*Thousand Dollars*		
1996	59,895	62,527	59,347	42,059	37,704	42,772
1997	60,307	62,406	58,991	41,667	37,300	41,964
1998	60,318	62,940	59,275	41,262	36,711	40,658
1999	60,313	62,938	59,416	41,098	36,022	39,623
2000	60,543	63,168	59,146	40,924	36,172	38,728
2001	60,781	63,468	61,119	40,761	36,343	38,992
2002	61,429	63,699	61,767	41,018	36,708	38,774
2003	61,821	63,911	62,278	40,501	36,387	37,874
Ave.	60,676	63,132	60,167	41,161	36,668	39,923
Ave. Chg.	na	2,456	-508	na	-4,493	-1,238
% Chg.	na	4.0	-0.8	na	-10.9	-3.0

	Insecticde Expenses			Labor Expenses		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Dollars			*Thousand Dollars*		
1996	6,356	7,370	5,867	63,066	66,191	60,327
1997	6,880	7,872	6,238	62,564	65,800	59,605
1998	7,056	8,173	6,730	62,675	65,527	59,510
1999	7,040	8,426	7,010	62,915	64,876	58,953
2000	7,095	8,435	7,289	63,408	65,376	58,178
2001	7,262	8,387	7,721	63,005	65,198	58,499
2002	7,600	8,386	7,943	63,485	66,236	59,156
2003	7,855	8,355	8,150	63,377	66,327	59,025
Ave.	7,143	8,176	7,118	63,062	65,691	59,157
Ave. Chg.	na	1,033	-25	na	2,630	-3,905
% Chg.	na	14.5	-0.3	na	4.2	-6.2

	Returns to the Major Crops		
	Baseline	Ac. Shift	Maximize
	Million Dollars		
1996	-39.15	-27.57	-53.33
1997	-43.11	-32.97	-53.54
1998	-47.47	-41.27	-55.72
1999	-54.15	-49.14	-59.59
2000	-60.69	-54.99	-64.65
2001	-66.36	-60.60	-73.81
2002	-73.73	-69.84	-81.90
2003	-80.30	-76.16	-87.67
Ave.	-58.12	-51.57	-66.28
Ave. Chg.	na	6.55	-8.16
% Chg.	na	-11.27	14.03

Table 33. Georgia Environmental Indicators, 1996-2003

	Chemical Index			Carbon			Soil Erosion			NFarm		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	*Index Value**			*Percent*			*Tons Per Acre*			*Pounds Per Acre*		
1996	100.00	110.17	95.49	3.39	3.42	3.50	1.34	1.38	1.37	65.07	71.13	60.64
1997	98.81	107.64	92.45	3.41	3.44	3.51	1.33	1.37	1.37	64.00	68.83	59.00
1998	98.33	107.37	90.01	3.41	3.45	3.52	1.33	1.37	1.37	63.93	69.01	58.81
1999	97.76	107.39	88.86	3.41	3.45	3.53	1.35	1.37	1.37	63.63	68.88	58.26
2000	97.23	107.20	87.06	3.41	3.45	3.53	1.35	1.37	1.37	63.36	68.65	57.66
2001	97.05	107.75	85.65	3.41	3.46	3.54	1.35	1.37	1.36	63.34	68.91	57.25
2002	97.82	106.51	83.56	3.42	3.45	3.54	1.33	1.38	1.37	63.61	68.27	56.75
2003	98.99	109.13	84.00	3.41	3.44	3.55	1.32	1.37	1.36	64.84	70.02	57.01
Ave.	98.25	107.90	88.39	3.41	3.45	3.53	1.34	1.37	1.37	63.97	69.21	58.17
Ave. Chg.	na	9.65	-9.86	na	0.04	0.12	na	0.04	0.03	na	5.24	-5.80
% Chg.	na	9.82	-10.04	na	1.06	3.48	na	2.62	2.24	na	8.19	-9.07

	PFarm		
	Baseline	Ac. Shift	Maximize
	Parts Per Billion		
1996	1129.26	1249.18	1140.70
1997	1135.52	1295.93	1159.70
1998	1150.89	1295.59	1184.62
1999	1158.08	1300.72	1207.30
2000	1165.59	1306.38	1233.34
2001	1179.16	1318.02	1260.96
2002	1158.97	1320.20	1293.48
2003	1101.72	1235.27	1329.70
Ave.	1147.40	1290.16	1226.22
Ave. Chg.	na	142.76	78.83
% Chg.	na	12.44	6.87

* Chemical Index values have been indexed such that the 1996 baseline value equals 100.

Florida State-Level Results

Florida has the least amount of land planted to the seven major crops of any of the Southeastern states. Also, 67.9 percent of Florida's acreage in these crops is located in Region 65, the state's northwestern ASD. Therefore, the changes which occur in this ASD will drive the analytical results

Production Effects. Overall acreage planted to the major crops is identical in the *Baseline* and *Acreage Shift* scenario, averaging 253,900 acres (table 34). Within the *Acreage Shift* scenario, 20 percent of the *Baseline* soybeans acreage on average shifts to corn and cotton. Under the *Maximize* situation, acreage declines 7.6 percent on average from *Baseline* levels, with most of the decline occurring in corn acreage.

As with South Carolina, Florida under the *Baseline* and *Acreage Shift* has relatively high levels of acreage in sustainable rotations, averaging 23.9 percent and 23.7 percent, respectively (table 35). In these situations, the greatest share of acreage in the alternative rotations occurs for cotton, which averages 54.4 percent and 45.3 percent, respectively. *Baseline* and *Acreage Shift* cotton more than doubles the land put to more sustainable rotations by the end of the simulation period. Under the *Maximize* situation, the overall average percent of land in alternative rotations is 51.5 percent, while corn, soybeans, and cotton lands have 49.7 percent, 51.5 percent, and 60.4 percent of their lands in alternative rotations. By 2003, more than 70 percent of Florida's corn, soybeans, and cotton acreage is in more sustainable rotations.

The primary alternative practices which enter the *Baseline* solution include, in order of importance, chemical banding, no-till with banding, and double-cropping with banding. In the *Maximize* scenario, some additional cotton production shifts to Bt cotton.

Corn yields suffer, while wheat and soybean yields make slight gains from *Baseline* levels under *Acreage Shift* and *Maximize* (Table 36). Corn yields fall an average of 1.5 bushels per acre under *Acreage Shift* and 3.2 bushels per acre under *Maximize*. For cotton, the *Acreage Shift* scenario sees an 8-pound-per-acre yield decline, while under *Maximize*, average yields rise 11.5 pounds per acre.

Economic Effects. *Acreage Shift* fertilizer, insecticide, and labor expenses are above *Baseline* levels and result in a net average annual increase, when lower herbicide costs are factored in, of $1.1 million above *Baseline* for these costs (table 37). Under *Maximize*, only labor costs register above *Baseline* levels, and the overall average change for these costs categories is an annual savings of $807,000 from *Baseline* levels.

Coupled with the changes in yields, the expenses associated with *Acreage Shift* result in net returns for this scenario which average $180,000 (26.1 percent) below *Baseline* (table 37). The cost savings noted above somewhat offset the yield impacts under the *Maximize* scenario, and returns to the seven major crops decline $100,000 (14.3 percent) on average from the *Baseline*.

Environmental Effects. The *Acreage Shift* scenario generally depress the environmental indicators while the *Maximize* scenario improves all but Carbon (table 38). Under *Acreage Shift*, Chemical Index, Carbon, and Soil Erosion all deteriorate slightly; further, NFarm increases an average of 10.2 percent (11.5 pounds per acre) above *Baseline*. The only *Acreage Shift* improvement occurs in PFarm, which falls an average of 5.5 percent below *Baseline*.

Under *Maximize*, the Chemical Index shows the greatest relative improvement (17.9 percent), while NFarm declines an average 11.4 pounds per acre (10.1 percent) and PFarm is 9.5 percent below *Baseline* (table 38). Carbon deteriorates slightly, and Soil Erosion falls slightly on average from *Baseline* levels.

Table 34. Florida Planted Acreage to the Seven Major Crops, 1996-2003

	Corn Planted Acreage			Sorghum Planted Acreage			Oats Planted Acreage			Barley Planted Acreage		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Acres			*Thousand Acres*			*Thousand Acres*			*Thousand Acres*		
1996	96.3	108.6	83.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997	95.7	108.9	80.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1998	96.3	106.8	81.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1999	96.7	107.2	81.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000	97.0	107.5	82.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2001	97.7	108.4	82.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2002	98.1	108.7	83.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2003	98.3	110.9	82.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ave.	97.0	108.4	82.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ave. Chg.	na	11.4	-14.8	na	na	na	na	na	na	na	na	na
% Chg.	na	11.7	-15.3	na	na	na	na	na	na	na	na	na

	Wheat Planted Acreage			Soybeans Planted Acreage			Cotton Planted Acreage			Seven Crops Planted Acreage		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Acres			*Thousand Acres*			*Thousand Acres*			*Thousand Acres*		
1996	14.1	11.2	14.9	93.0	74.4	93.0	46.0	55.2	41.4	249.4	249.4	232.5
1997	14.1	10.4	14.1	94.8	75.8	94.8	47.1	56.5	42.4	251.6	251.6	232.1
1998	14.2	13.1	14.2	94.6	75.7	94.6	47.8	57.4	43.0	252.9	252.9	233.3
1999	14.2	13.1	14.2	95.0	76.0	95.0	47.8	57.4	43.0	253.7	253.7	234.0
2000	14.2	13.2	14.2	95.4	76.4	95.4	48.2	57.8	43.4	254.8	254.8	235.1
2001	14.4	13.3	14.4	95.4	76.4	95.4	47.1	56.5	42.4	254.5	254.5	234.7
2002	14.5	13.4	14.5	95.8	76.6	95.8	48.2	57.8	43.4	256.5	256.5	236.6
2003	14.6	11.7	15.5	96.6	77.3	96.6	48.2	57.8	43.4	257.6	257.6	238.1
Ave.	14.3	12.4	14.5	95.1	76.1	95.1	47.5	57.0	42.8	253.9	253.9	234.5
Ave. Chg.	na	-1.8	0.2	na	-19.0	0.0	na	9.5	-4.8	na	0.0	-19.4
% Chg.	na	-12.9	1.6	na	-20.0	0.0	na	20.0	-10.0	na	0.0	-7.6

Table 35. Florida Crop Acreage in Sustainable Practices, 1996-2003

	Corn in Alt. Practices			Sorghum in Alt. Practices			Oats in Alt. Practices			Barley in Alt. Practices		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Percent			*Percent*			*Percent*			*Percent*		
1996	14.56	12.92	27.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1997	18.54	16.28	35.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	22.22	19.94	41.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1999	25.88	22.88	47.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000	29.65	26.16	53.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2001	32.67	28.95	58.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2002	36.13	32.35	64.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2003	39.49	34.98	70.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ave.	27.39	24.31	49.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ave. Chg.	na	-3.09	22.31	na	0.00	0.00	na	0.00	0.00	na	0.00	0.00
% Chg.	na	-11.26	81.44	na	na	na	na	na	na	na	na	na

	Wheat in Alt. Practices			Soybeans in Alt. Practices			Cotton in Alt. Practices			7 Crops in Alt. Practices		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Percent			*Percent*			*Percent*			*Percent*		
1996	42.29	45.01	49.86	5.29	5.43	30.62	29.40	24.50	32.67	13.70	13.29	29.44
1997	45.03	44.04	50.04	5.34	4.34	35.50	36.33	30.27	40.36	16.70	15.87	35.99
1998	47.74	57.47	51.34	5.51	7.90	41.91	43.17	35.97	47.97	19.70	20.02	42.31
1999	50.52	57.47	51.34	5.63	7.53	48.02	50.49	42.08	56.10	22.68	22.66	48.34
2000	53.23	59.51	53.23	5.76	7.54	54.44	57.56	47.96	63.95	25.69	25.57	54.69
2001	53.56	59.86	53.56	5.60	7.50	60.51	66.00	55.00	73.33	28.36	28.30	60.80
2002	53.56	59.86	53.56	5.36	7.53	66.98	72.31	60.26	80.34	31.04	31.11	66.88
2003	53.56	53.56	56.31	5.10	5.16	73.70	79.88	66.57	88.76	33.68	32.93	73.45
Ave.	49.94	54.60	52.41	5.45	6.62	51.46	54.39	45.33	60.44	23.94	23.72	51.49
Ave. Chg.	na	4.66	2.47	na	1.17	46.01	na	-9.07	6.04	na	-0.23	27.54
% Chg.	na	9.33	4.94	na	21.43	844.44	na	-16.67	11.11	na	-0.94	115.04

Table 36. Florida Average Crop Yields, 1996-2003

	Average Corn Yields			Average Wheat Yields			Average Soybean Yields			Average Cotton Yields		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Bushels Per Acre			*Bushels Per Acre*			*Bushels Per Acre*			*Bushels Per Acre*		
1996	78.7	77.1	74.4	25.3	25.3	25.8	24.1	24.1	25.9	522.3	515.3	506.1
1997	79.6	78.1	75.7	25.5	24.7	25.5	24.4	24.3	26.1	530.2	523.6	523.8
1998	80.5	80.5	77.0	25.7	26.9	25.7	24.7	24.8	25.9	539.1	517.7	542.7
1999	81.5	79.5	76.9	25.9	27.1	25.9	24.9	25.1	25.6	544.8	540.5	571.2
2000	82.4	81.0	79.4	26.1	27.3	26.1	25.1	25.3	25.3	554.7	544.2	579.4
2001	83.3	81.3	80.8	26.3	27.6	26.3	25.4	25.6	25.6	561.9	556.7	585.1
2002	84.3	82.2	82.2	26.5	27.8	26.5	25.7	25.9	25.9	568.8	564.0	588.8
2003	85.2	83.3	83.5	26.7	26.7	27.2	25.9	25.9	26.2	577.2	572.9	594.1
Ave.	81.9	80.4	78.7	26.0	26.7	26.1	25.0	25.1	25.8	549.9	541.9	561.4
Ave. Chg.	na	-1.5	-3.2	na	0.7	0.1	na	0.1	0.8	na	-8.0	11.5
% Chg.	na	-1.9	-3.9	na	2.7	0.5	na	0.4	3.2	na	-1.5	2.1

Table 37. Florida Economic Indicators, 1996-2003

	Fertilizer Expenses			Herbicide Expenses			Insecticde Expenses			Labor Expenses		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Dollars			*Thousand Dollars*			*Thousand Dollars*			*Thousand Dollars*		
1996	10,135	10,282	9,125	6,245	5,848	5,764	3,575	4,078	3,362	6,595	7,462	7,153
1997	10,179	10,350	9,004	6,295	5,911	5,741	3,619	4,135	3,425	6,679	7,549	7,399
1998	10,207	10,312	8,982	6,293	5,842	5,703	3,626	4,152	3,452	6,749	7,676	7,697
1999	10,213	10,328	8,940	6,299	5,849	5,673	3,586	4,113	3,437	6,747	7,663	7,893
2000	10,232	10,350	8,905	6,311	5,859	5,646	3,572	4,103	3,445	6,778	7,697	8,133
2001	10,215	10,334	8,830	6,302	5,853	5,599	3,457	3,973	3,362	6,674	7,582	8,242
2002	10,270	10,382	8,827	6,319	5,864	5,576	3,490	4,020	3,413	6,763	7,694	8,548
2003	10,299	10,454	8,796	6,342	5,929	5,548	3,452	3,981	3,400	6,751	7,656	8,791
Ave.	10,219	10,349	8,926	6,301	5,869	5,656	3,547	4,069	3,412	6,717	7,622	7,982
Ave. Chg.	na	130	-1,293	na	-431	-644	na	522	-135	na	905	1,265
% Chg.	na	1.3	-12.6	na	-6.8	-10.2	na	14.7	-3.8	na	13.5	18.8

	Returns to the Major Crops		
	Baseline	Ac. Shift	Maximize
	Million Dollars		
1996	1.89	2.44	0.90
1997	1.15	1.37	0.65
1998	0.62	0.41	0.37
1999	-0.18	-0.52	-0.16
2000	-0.92	-1.28	-0.87
2001	-1.75	-2.05	-1.58
2002	-2.69	-3.14	-2.48
2003	-3.49	-4.00	-2.97
Ave.	-0.67	-0.85	-0.77
Ave. Chg.	na	-0.18	-0.10
% Chg.	na	26.07	14.34

Table 38. Florida Environmental Indicators, 1996-2003

	Chemical Index			Carbon			Soil Erosion			NFarm		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	*Index Value**			*Percent*			*Tons Per Acre*			*Pounds Per Acre*		
1996	100.00	104.29	87.00	2.89	2.83	2.84	2.27	2.33	2.22	118.42	130.24	109.25
1997	99.49	104.38	84.76	2.89	2.82	2.86	2.28	2.33	2.30	115.45	127.69	103.64
1998	99.73	104.22	83.87	2.88	2.82	2.85	2.29	2.38	2.29	114.12	124.76	102.78
1999	101.32	104.00	82.92	2.88	2.82	2.86	2.31	2.37	2.28	112.40	123.65	101.66
2000	100.23	103.53	81.60	2.88	2.82	2.86	2.30	2.36	2.27	110.96	122.12	99.64
2001	101.00	103.96	81.19	2.88	2.82	2.86	2.29	2.35	2.27	110.26	121.71	98.41
2002	100.97	103.70	80.11	2.88	2.82	2.85	2.28	2.35	2.28	108.53	119.70	96.54
2003	101.20	105.18	78.80	2.89	2.82	2.85	2.27	2.33	2.30	106.87	118.85	94.26
Ave.	100.49	104.16	82.53	2.88	2.82	2.85	2.29	2.35	2.28	112.13	123.59	100.77
Ave. Chg.	na	3.67	-17.96	na	-0.06	-0.03	na	0.06	-0.01	na	11.46	-11.35
% Chg.	na	3.65	-17.87	na	-2.17	-1.04	na	2.79	-0.44	na	10.22	-10.13

	PFarm		
	Baseline	Ac. Shift	Maximize
	Parts Per Billion		
1996	333.32	315.53	368.77
1997	324.38	307.05	329.01
1998	316.40	283.09	295.36
1999	299.97	288.85	282.63
2000	301.86	288.63	263.31
2001	302.96	293.09	250.36
2002	301.50	286.09	235.71
2003	301.79	283.11	221.47
Ave.	310.27	293.18	280.83
Ave. Chg.	na	-17.09	-29.45
% Chg.	na	-5.51	-9.49

* Chemical Index values have been indexed such that the 1996 baseline value equals 100.

Alabama State-Level Results

Acreage for the major crops is relatively evenly dispersed across Alabama, though slightly more than one-quarter is centered in the northwesternmost ASD, POLYSYS region 69.

Production Effects. Compared with the *Baseline*, acreage planted to the seven major crops increases marginally under *Acreage Shift* but falls 52,800 acres (3.4 percent) under the *Maximize* scenario (table 39). As in other states, 15.8 percent of Alabama *Baseline* soybean *Acreage Shifts* to other crops under *Acreage Shift* - in this case, primarily to wheat and cotton. Under *Maximize*, the aggregate decline is the result of changes in cotton, whose acreage declines 6.8 percent, and corn, whose acreage falls 6.7 percent from *Baseline* levels.

Under the *Baseline* 21.6 percent of the acreage in major crops employs the alternative production practices (table 40). Under this initial condition, an average of 87.4 percent of the state's wheat acreage, 26.1 percent of the soybeans acreage, and 21.2 percent of the cotton acreage employs more sustainable rotations. Under *Acreage Shift*, the overall percent rises slightly from the *Baseline*; the use of these practices increases several points for soybeans but declines slightly for corn and cotton. Under *Maximize*, the use of more sustainable rotations roughly doubles from the levels noted in the other scenarios. On average, 46 percent of Alabama croplands are in these rotations in *Maximize*. Cotton increases the use such practices to an average of 77.3 percent of its acreage, wheat an average of 89.9 percent, and corn, 34.8 percent.

Practices like no-till, cover crops, and terraces are the predominant alternative rotations which occur under the *Baseline*. Regions 70 and 71 show a significant use of no-till, while regions 72 and 73 are characterized by a strong use of terraces. Under the *Maximize* scenario, the most important change in the use of more sustainable practices is the adoption of double-cropping and the use of Bt cotton in the northern half of Alabama.

Crop yields generally decline slightly in both scenarios, with the following exceptions (table 41). Under *Maximize*, wheat yields are slightly higher and soybeans are unchanged from *Baseline* levels. *Maximize* corn yields, however, average 4.2 bushels per acre below *Baseline*. Under *Acreage Shift*, cotton and soybean yields make slight gains.

Economic Effects. Under *Acreage Shift*, the balance of the four cost categories adds an average annual increase of $5.3 million to overall production costs (table 42). As has been the case in many of the Southeastern states, the use of banding decreases herbicide costs; these lower costs, however, are offset by higher fertilizer, insecticide, and labor expenses. Under *Maximize*, all cost categories are below *Baseline* levels, subtracting an annual average of $11.6 million from overall production costs.

Despite these costs, the changes in crop yield result in *Acreage Shift* turning in better net returns to the seven major crops than *Maximize* (table 42). *Acreage Shift* returns fall $240,000 (3.0 percent) on average, while *Maximize* returns plunge an average of $5.1 million (63.1 percent) below *Baseline* levels.

Environmental Effects. Both scenarios result in generally positive environmental gains; where deterioration occurs, it occurs in different indicators (table 43). While the *Acreage Shift* scenario results in a 7.2 percent rise in the Chemical Index, PFarm drops 7.4 percent. NFarm also rises 1.0 pounds per acre (4.2 percent)on average, but Carbon and Soil Erosion both improve slightly.

Under *Maximize*, sharp average improvements occur in the Chemical Index (33.1 percent), Soil Erosion (0.5 tons per acre), and NFarm (3.2 pounds per acre or 13.3 percent). While a slight improvement occurs in Carbon, the PFarm value deteriorates 10.2 percent from *Baseline*.

Table 39. Alabama Planted Acreage to the Seven Major Crops, 1996-2003

	Corn Planted Acreage			Sorghum Planted Acreage			Oats Planted Acreage			Barley Planted Acreage		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Acres			*Thousand Acres*			*Thousand Acres*			*Thousand Acres*		
1996	255.9	267.3	239.7	24.1	25.1	24.0	28.1	22.5	28.1	0.0	0.0	0.0
1997	254.1	263.5	236.8	24.4	25.4	23.9	27.3	21.9	27.3	0.0	0.0	0.0
1998	255.9	270.5	238.6	24.6	25.7	24.1	25.7	20.6	25.7	0.0	0.0	0.0
1999	257.0	274.0	242.4	24.9	27.2	25.3	25.7	20.6	25.7	0.0	0.0	0.0
2000	257.7	274.2	241.7	24.9	25.5	24.4	24.9	19.9	24.9	0.0	0.0	0.0
2001	259.4	275.6	242.1	25.1	25.5	24.6	25.7	20.6	25.7	0.0	0.0	0.0
2002	260.5	276.3	243.4	25.4	25.8	24.9	25.7	20.6	25.7	0.0	0.0	0.0
2003	261.2	268.8	238.0	25.7	26.1	25.2	25.7	20.6	25.7	0.0	0.0	0.0
Ave.	257.7	271.3	240.3	24.9	25.8	24.5	26.1	20.9	26.1	0.0	0.0	0.0
Ave. Chg.	na	13.6	-17.4	na	0.9	-0.4	na	-5.2	0.0	na	0.0	0.0
% Chg.	na	5.3	-6.7	na	3.6	-1.4	na	-20.0	0.0	na	na	na

	Wheat Planted Acreage			Soybeans Planted Acreage			Cotton Planted Acreage			Seven Crops Planted Acreage		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Acres			*Thousand Acres*			*Thousand Acres*			*Thousand Acres*		
1996	191.5	222.3	180.4	510.3	423.0	495.3	505.4	557.7	436.2	1515.3	1517.9	1403.6
1997	191.8	227.1	187.3	519.9	427.6	519.6	517.5	567.9	433.6	1535.1	1533.4	1428.5
1998	192.7	225.3	195.1	519.0	435.1	526.9	525.6	565.0	456.9	1543.6	1542.2	1467.3
1999	192.7	221.5	202.2	520.8	446.1	522.6	525.6	564.1	499.4	1546.7	1553.5	1517.6
2000	193.7	225.3	202.5	523.4	451.5	524.2	529.7	568.0	505.8	1554.2	1564.4	1523.5
2001	195.5	225.1	203.3	523.4	446.2	523.7	517.5	555.4	491.7	1546.7	1548.3	1511.1
2002	197.1	223.9	203.0	525.2	439.2	515.4	529.7	577.6	523.7	1563.5	1563.5	1536.1
2003	198.6	233.6	210.6	529.6	442.7	516.0	529.7	581.8	550.3	1570.4	1573.6	1565.7
Ave.	194.2	225.5	198.0	521.4	438.9	518.0	522.6	567.2	487.2	1546.9	1549.6	1494.1
Ave. Chg.	na	31.3	3.8	na	-82.5	-3.5	na	44.6	-35.4	na	2.7	-52.8
% Chg.	na	16.1	2.0	na	-15.8	-0.7	na	8.5	-6.8	na	0.2	-3.4

Table 40. Alabama Crop Acreage in Sustainable Practices, 1996-2003

	Corn in Alt. Practices			Sorghum in Alt. Practices			Oats in Alt. Practices			Barley in Alt. Practices		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
		Percent			*Percent*			*Percent*			*Percent*	
1996	9.25	8.86	18.72	40.22	45.02	41.99	0.00	0.00	0.00	0.00	0.00	0.00
1997	11.83	11.41	24.06	40.22	46.28	41.07	0.00	0.00	0.00	0.00	0.00	0.00
1998	14.19	13.42	28.85	40.22	46.28	41.07	0.00	0.00	0.00	0.00	0.00	0.00
1999	15.81	14.64	33.03	40.22	45.36	39.62	0.00	0.00	0.00	0.00	0.00	0.00
2000	16.80	15.43	33.92	40.22	45.35	41.07	0.00	0.00	0.00	0.00	0.00	0.00
2001	17.66	16.01	34.43	40.22	44.82	41.07	0.00	0.00	0.00	0.00	0.00	0.00
2002	18.71	17.07	33.98	40.22	44.82	41.07	0.00	0.00	0.00	0.00	0.00	0.00
2003	19.72	18.52	34.83	40.22	44.82	41.07	0.00	0.00	0.00	0.00	0.00	0.00
Ave.	15.50	14.42	30.23	40.22	45.34	41.00	0.00	0.00	0.00	0.00	0.00	0.00
Ave. Chg.	na	-1.08	14.73	na	5.12	0.78	na	0.00	0.00	na	0.00	0.00
% Chg.	na	-6.95	95.06	na	na	na	na	na	na	na	na	na

	Wheat in Alt. Practices			Soybeans in Alt. Practices			Cotton in Alt. Practices			Seven Crops in Alt. Practices		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
		Percent			*Percent*			*Percent*			*Percent*	
1996	66.22	57.56	70.53	20.22	24.57	20.92	13.25	13.39	53.93	14.66	15.37	30.85
1997	78.65	67.31	83.43	23.35	28.78	24.39	15.98	14.87	68.33	17.62	18.06	38.50
1998	88.21	77.41	90.98	26.55	32.49	27.31	18.11	17.25	77.69	20.32	20.98	44.78
1999	90.97	83.21	93.03	27.03	33.31	29.11	20.35	19.38	82.67	21.76	22.67	49.27
2000	92.11	87.75	94.09	27.01	35.50	29.02	22.50	21.39	83.65	22.81	24.56	50.06
2001	93.17	87.93	95.08	27.66	36.27	29.50	24.78	23.25	84.65	24.11	25.66	50.40
2002	94.32	88.99	96.15	28.22	37.08	30.21	26.27	24.25	84.35	25.14	26.51	51.48
2003	95.42	87.48	95.68	28.61	37.63	31.17	28.19	26.01	83.37	26.26	27.71	52.25
Ave.	87.38	79.71	89.87	26.08	33.20	27.70	21.18	19.97	77.33	21.59	22.69	45.95
Ave. Chg.	na	-7.68	2.49	na	7.12	1.62	na	-1.21	56.15	na	1.11	24.36
% Chg.	na	-8.79	2.85	na	27.31	6.22	na	na	na	na	5.12	112.87

Table 41. Alabama Average Crop Yields, 1996-2003

	Average Corn Yields			Average Sorghum Yields			Average Oat Yields			Average Wheat Yields		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Bushels Per Acre			*Bushels Per Acre*			*Bushels Per Acre*			*Bushels Per Acre*		
1996	79.8	80.4	78.0	56.7	58.3	56.8	51.2	51.7	42.5	33.5	34.4	34.0
1997	80.8	81.3	78.7	57.5	59.1	56.4	51.4	51.9	42.7	33.5	34.4	34.0
1998	81.7	82.5	79.2	57.8	59.4	56.7	50.5	51.0	42.0	33.5	34.4	34.0
1999	82.7	83.7	79.8	58.1	59.7	57.0	51.9	52.4	43.1	33.5	34.4	34.0
2000	83.6	84.7	81.3	58.5	60.1	57.4	52.1	52.7	43.3	33.5	34.4	34.0
2001	84.5	85.6	82.5	58.8	60.3	57.6	51.9	52.4	43.1	33.5	34.4	34.0
2002	85.5	86.4	82.9	59.5	61.0	58.3	51.9	52.4	43.1	33.5	34.4	34.0
2003	86.4	87.5	83.5	59.7	61.3	58.6	51.9	52.4	43.0	33.5	34.4	34.0
Ave.	83.1	84.0	80.7	58.3	59.9	57.4	51.6	52.1	42.8	33.5	34.4	34.0
Ave. Chg.	na	0.9	-2.4	na	1.6	-1.0	na	0.5	-8.7	na	0.9	0.5
% Chg.	na	1.1	-2.9	na	2.7	-1.6	na	1.0	-16.9	na	2.7	1.6

	Average Soybean Yields			Average Cotton Yields		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Bushels Per Acre			*Pounds Per Acre*		
1996	22.1	22.2	23.0	455.2	451.7	438.6
1997	22.4	22.4	23.3	462.1	457.9	453.2
1998	22.6	22.7	23.4	469.8	467.1	464.3
1999	22.9	23.0	23.2	474.8	472.2	468.1
2000	23.0	23.2	23.3	483.4	480.8	476.6
2001	23.3	23.5	23.5	489.7	487.0	482.7
2002	23.6	23.7	23.6	495.7	491.8	485.6
2003	23.8	23.9	23.7	503.1	498.5	489.1
Ave.	23.0	23.1	23.4	479.2	475.9	469.8
Ave. Chg.	na	0.1	0.4	na	-3.4	-9.5
% Chg.	na	0.6	1.8	na	-0.7	-2.0

Table 42. Alabama Economic Indicators, 1996-2003

	Fertilizer Expenses			Herbicide Expenses			Insecticde Expenses			Labor Expenses		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Dollars			*Thousand Dollars*			*Thousand Dollars*			*Thousand Dollars*		
1996	48,066	49,900	43,302	45,426	43,239	41,124	25,856	28,261	22,332	86,472	90,874	78,509
1997	48,428	50,178	42,939	45,879	43,281	41,408	26,303	28,598	22,051	87,737	91,944	78,917
1998	48,681	50,279	43,826	45,862	43,411	42,047	26,667	28,536	22,992	88,396	91,554	82,091
1999	48,447	50,264	45,583	45,886	44,049	43,007	26,674	28,528	24,828	88,349	91,467	87,445
2000	48,328	50,328	45,480	46,135	44,316	43,495	26,837	28,674	25,060	88,754	91,805	87,627
2001	47,670	49,507	44,840	45,730	43,720	43,323	26,318	28,158	24,442	87,410	90,175	85,457
2002	48,012	50,073	45,874	46,188	44,060	43,649	26,857	29,134	25,769	88,788	92,442	89,379
2003	47,855	49,942	46,665	46,373	44,120	43,971	26,860	29,194	26,771	88,860	93,053	92,960
Ave.	48,186	50,059	44,814	45,935	43,775	42,753	26,547	28,635	24,281	88,096	91,664	85,298
Ave. Chg.	na	1,873	-3,372	na	-2,160	-3,182	na	2,089	-2,266	na	3,569	-2,797
% Chg.	na	3.9	-7.0	na	-4.7	-6.9	na	7.9	-8.5	na	4.1	-3.2

	Returns to the Major Crops		
	Baseline	Ac. Shift	Maximize
	Million Dollars		
1996	9.54	14.28	2.29
1997	5.79	8.25	0.07
1998	0.88	0.60	-2.82
1999	-5.39	-7.07	-10.03
2000	-10.07	-12.96	-14.63
2001	-15.23	-16.33	-19.49
2002	-21.91	-24.36	-26.63
2003	-27.97	-28.70	-33.74
Ave.	-8.05	-8.29	-13.12
Ave. Chg.	na	-0.24	-5.08
% Chg.	na	3.00	63.11

Table 43. Alabama Environmental Indicators, 1996-2003

	Chemical Index			Carbon			Soil Erosion			NFarm		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	*Index Value**			*Percent*			*Tons Per Acre*			*Pounds Per Acre*		
1996	100.00	105.31	70.96	4.41	4.41	4.55	5.12	5.06	4.79	24.74	25.87	22.39
1997	97.67	102.51	67.20	4.41	4.42	4.61	5.08	5.01	4.46	24.69	25.96	21.18
1998	97.06	103.91	64.17	4.42	4.43	4.68	4.99	4.88	4.25	24.65	25.63	20.87
1999	95.89	103.35	61.98	4.43	4.44	4.66	4.97	4.87	4.28	24.38	25.14	20.94
2000	94.81	102.59	61.98	4.43	4.44	4.64	4.99	4.88	4.32	24.17	24.98	20.73
2001	94.90	103.47	62.77	4.43	4.44	4.62	4.95	4.86	4.31	23.76	24.61	20.41
2002	93.91	102.19	62.97	4.42	4.43	4.55	5.00	4.97	4.58	23.67	24.75	20.68
2003	93.09	99.27	61.25	4.42	4.42	4.48	4.99	5.03	4.77	23.38	24.64	20.58
Ave.	95.91	102.82	64.16	4.42	4.43	4.60	5.01	4.95	4.47	24.18	25.20	20.97
Ave. Chg.	na	6.91	-31.75	na	0.01	0.18	na	-0.07	-0.54	na	1.02	-3.21
% Chg.	na	7.20	-33.11	na	0.17	4.01	na	-1.32	-10.80	na	4.21	-13.27

	PFarm		
	Baseline	Ac. Shift	Maximize
	Parts Per Billion		
1996	308.88	299.65	344.80
1997	283.25	273.68	322.54
1998	259.82	250.36	292.10
1999	254.34	238.72	275.38
2000	252.26	226.31	273.77
2001	251.57	225.45	274.97
2002	245.99	218.50	270.34
2003	244.84	213.78	261.01
Ave.	262.62	243.31	289.36
Ave. Chg.	na	-19.31	26.74
% Chg.	na	-7.35	10.18

* Chemical Index values have been indexed such that the 1996 baseline value equals 100.

Mississippi State-Level Results

Mississippi has the most acreage devoted to the seven major crops of any of the Southeastern states. More than half of this acreage is centered in the two northernmost ASDs bordering on the Mississippi River (regions 98 and 101).

Production Effects. The *Acreage Shift* scenario results in a slight average increase in acreage planted to the major crops, while acreage under the *Maximize* scenario declines 3.5 percent (160,500 acres) below *Baseline* (table 44). Cotton makes the biggest acreage gain - somewhat at the expense of a small portion of soybean acreage - under *Acreage Shift*, averaging 7.1 percent above *Baseline*.

Under *Maximize*, soybeans loses the most acreage, averaging 149,200 acres (6.7 percent) below *Baseline*. Cotton acreage also averages 4.3 percent (69,800 acres) below *Baseline*, but wheat gains an average 76,100 acres (16.6 percent) above *Baseline* levels.

Approximately one-fifth of Mississippi cropland are put to the alternative rotations under the *Baseline* and *Acreage Shift* - the largest relative level occurring with wheat which averages about 95 percent in more sustainable rotations (table 45). For soybeans and cotton, the relative shares of land in alternative practices for the two scenarios is about 19 percent and 22 percent, respectively. In the most-heavily cropped regions of Mississippi (98 and 101), double-cropping and extended-period rotations are the most prevalent alternative practices. Also region 101 is the only region in the Southeast in which Bt cotton covers significant acreage in the *Baseline*.

Under *Maximize*, the use of sustainable practices rise to cover 50.2 percent of the cropland (table 45). The largest crop-specific increase in the use of more sustainable practices occurs in cotton, which averages 84.6 percent and reaches 93.8 percent by 2003. The most important change in the use of more sustainable practices is the wider use of Bt cotton in the regions bordering the Mississippi river and Tennessee. Also, the southeast portion of the state makes use of filter strips, sod strips, and terraces.

Acreage Shift crop yields improve for the state's most important crops, soybeans and cotton (table 46). Cotton yields, in particular, gain an average 7.1 pounds per acre (1.2 percent) above *Baseline*. Other *Acreage Shift* yields are slightly below *Baseline*. Under *Maximize*, corn suffers the greatest relative loss of yield, averaging 4.8 bushels per acre (5.6 percent) below *Baseline*. In regions 98 and 101, corn yields from 18.3 bushels per acre and 17.7 bushels per acre below *Baseline*, while other ASDs experience much lower declines in yield. Cotton suffers a loss similar to the gain noted in *Acreage Shift*, with the greatest decline (24.2 pounds per acre) occurring in region 98. However, wheat yields improve marginally, and soybean yields are unchanged from *Baseline*.

Economic Effects. Though important crop yields improve under *Acreage Shift*, the improvements come at the cost of higher expenses for fertilizer, herbicide, insecticide, and labor (table 47). Combined, these costs add an average $19.6 million annually to overall production costs above *Baseline* levels. Under *Maximize*, these costs trend below *Baseline*, subtracting an average of $32.2 million annually from production costs, compared with the *Baseline*.

Despite the changes in costs from *Baseline* levels, it is the changes in yields which determine the direction of net returns to the seven major crops (table 47). Under *Acreage Shift*, net returns enjoy a sharp increase, averaging $35.5 million (76.3 percent) above *Baseline*. On the other hand, the *Maximize* scenario results in a 37.0 percent ($17.2 million) average annual decline in net returns compared with the *Baseline*. Slightly more than 40 percent of these declines are centered in region 98.

Environmental Effects. The *Acreage Shift* scenario presents a mixed environmental picture for Mississippi (table 48). The Chemical Index, Carbon, Soil Erosion, and NFarm all deteriorate slightly from *Baseline* levels, while PFarm improves by 4.3 percent.

The *Maximize* scenario increases chemical risk slightly more than the *Acreage Shift* scenario but improves PFarm at about the same level as the latter. NFarm declines by 4.1 pounds per acre (10.8 percent), and Carbon improves slightly, while erosion grows slightly.

Table 44. Mississippi Planted Acreage to the Seven Major Crops, 1996-2003

	Corn Planted Acreage			Sorghum Planted Acreage			Oats Planted Acreage			Barley Planted Acreage		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Acres			*Thousand Acres*			*Thousand Acres*			*Thousand Acres*		
1996	196.5	228.7	185.0	86.8	63.9	81.9	0.0	0.0	0.0	0.0	0.0	0.0
1997	195.2	230.1	182.0	87.8	63.7	81.3	0.0	0.0	0.0	0.0	0.0	0.0
1998	196.5	227.4	186.2	88.8	64.1	86.7	0.0	0.0	0.0	0.0	0.0	0.0
1999	197.4	228.4	187.4	89.7	64.8	85.1	0.0	0.0	0.0	0.0	0.0	0.0
2000	197.9	229.0	188.1	89.7	64.8	85.1	0.0	0.0	0.0	0.0	0.0	0.0
2001	199.2	230.8	187.2	90.7	66.6	84.7	0.0	0.0	0.0	0.0	0.0	0.0
2002	200.1	231.4	184.5	91.6	66.1	84.5	0.0	0.0	0.0	0.0	0.0	0.0
2003	200.6	232.2	184.2	92.6	67.1	85.6	0.0	0.0	0.0	0.0	0.0	0.0
Ave.	197.9	229.7	185.6	89.7	65.1	84.4	0.0	0.0	0.0	0.0	0.0	0.0
Ave. Chg.	na	31.8	-12.3	na	-24.6	-5.4	na	na	na	na	na	na
% Chg.	na	16.1	-6.2	na	-27.4	-6.0	na	na	na	na	na	na

	Wheat Planted Acreage			Soybeans Planted Acreage			Cotton Planted Acreage			Seven Crops Planted Acreage		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Acres			*Thousand Acres*			*Thousand Acres*			*Thousand Acres*		
1996	452.4	457.3	533.2	2187.0	2037.8	2059.1	1572.9	1679.9	1477.0	4495.8	4467.5	4336.3
1997	453.2	475.9	549.5	2228.3	2062.8	2109.1	1610.7	1729.9	1515.8	4575.2	4562.5	4437.6
1998	455.4	506.9	543.3	2224.6	2093.1	2094.8	1635.9	1766.3	1549.5	4601.1	4657.7	4460.5
1999	455.4	481.4	528.7	2232.1	2100.7	2080.2	1635.9	1766.4	1556.5	4610.4	4641.7	4438.0
2000	457.5	414.5	535.8	2243.4	2199.0	2092.8	1648.4	1771.8	1575.7	4636.9	4678.9	4477.4
2001	461.9	416.2	538.7	2243.4	2207.1	2092.3	1610.7	1720.7	1557.1	4605.9	4641.3	4459.9
2002	465.5	419.8	527.2	2250.9	2199.8	2074.5	1648.4	1751.5	1607.4	4656.5	4668.7	4478.1
2003	469.2	429.1	523.2	2269.7	2206.9	2083.0	1648.4	1745.2	1614.3	4680.4	4680.4	4490.3
Ave.	458.8	450.1	534.9	2234.9	2138.4	2085.7	1626.4	1741.5	1556.7	4607.8	4624.8	4447.3
Ave. Chg.	na	-8.7	76.1	na	-96.5	-149.2	na	115.0	-69.8	na	17.1	-160.5
% Chg.	na	-1.9	16.6	na	-4.3	-6.7	na	7.1	-4.3	na	0.4	-3.5

Table 45. Mississippi Crop Acreage in Sustainable Practices, 1996-2003

	Corn in Alt. Practices			Sorghum in Alt. Practices			Oats in Alt. Practices			Barley in Alt. Practices		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Percent			*Percent*			*Percent*			*Percent*		
1996	21.75	17.54	31.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1997	25.26	20.24	33.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	28.07	25.57	37.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1999	30.26	26.57	40.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000	31.22	27.01	41.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2001	32.01	29.95	41.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2002	32.95	31.94	40.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2003	33.39	32.37	42.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ave.	29.36	26.40	38.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ave. Chg.	na	-2.97	9.18	na	0.00	0.00	na	0.00	0.00	na	0.00	0.00
% Chg.	na	-10.10	31.25	na	na	na	na	na	na	na	na	na
	Wheat in Alt. Practices			**Soybeans in Alt. Practices**			**Cotton in Alt. Practices**			**7 Crops in Alt. Practices**		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Percent			*Percent*			*Percent*			*Percent*		
1996	77.97	80.43	84.09	15.31	17.17	22.59	14.10	13.04	66.40	14.35	14.64	39.35
1997	89.74	90.39	91.36	17.25	19.78	24.94	17.33	15.96	76.64	16.92	17.38	44.91
1998	96.78	93.32	96.52	18.84	21.58	26.79	19.33	18.09	82.16	18.73	19.50	48.50
1999	100.00	99.08	100.00	19.43	21.67	27.83	21.30	20.76	85.96	19.94	20.82	50.86
2000	100.00	99.67	100.00	19.35	17.71	28.87	23.97	23.18	88.56	21.00	19.83	52.50
2001	100.00	100.00	100.00	19.48	17.65	29.99	27.00	26.18	90.81	22.26	21.14	53.82
2002	100.00	100.00	100.00	19.50	17.77	30.64	29.49	28.60	92.19	23.34	22.36	55.30
2003	100.00	100.00	100.00	19.42	18.06	31.22	32.35	31.50	93.77	24.42	23.70	56.32
Ave.	95.56	95.36	96.50	18.57	18.92	27.86	23.11	22.16	84.56	20.12	19.92	50.20
Ave. Chg.	na	-0.20	0.94	na	0.35	9.29	na	-0.95	61.45	na	-0.20	30.08
% Chg.	na	-0.21	0.98	na	1.89	50.00	na	-4.09	265.93	na	-0.99	149.48

Table 46. Mississippi Average Crop Yields, 1996-2003

	Average Corn Yields			Average Sorghum Yields			Average Wheat Yields			Average Soybean Yields		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Bushels Per Acre			*Bushels Per Acre*			*Bushels Per Acre*			*Bushels Per Acre*		
1996	83.0	82.7	78.2	67.9	67.4	67.8	31.8	31.4	31.7	24.3	24.5	24.3
1997	84.0	83.4	79.1	68.8	68.5	68.7	32.0	31.7	32.2	24.6	24.7	24.5
1998	85.0	84.9	80.5	69.1	68.0	68.6	32.3	32.5	32.5	24.8	25.2	24.9
1999	86.0	85.7	80.9	69.5	68.4	69.0	32.5	32.3	32.7	25.1	25.3	25.0
2000	87.0	86.6	82.1	70.0	68.9	69.6	32.8	32.7	32.8	25.3	25.4	25.2
2001	87.9	87.7	83.1	70.3	69.4	70.4	33.0	32.9	33.1	25.6	25.6	25.5
2002	88.9	88.9	83.9	71.1	70.0	71.3	33.3	33.1	33.5	25.9	25.9	25.9
2003	89.9	89.9	85.4	71.4	70.4	71.7	33.5	33.4	33.7	26.1	26.3	26.2
Ave.	86.5	86.2	81.7	69.8	68.9	69.6	32.6	32.5	32.8	25.2	25.4	25.2
Ave. Chg.	na	-0.3	-4.8	na	-0.9	-0.1	na	-0.2	0.1	na	0.2	0.0
% Chg.	na	-0.3	-5.6	na	-1.3	-0.2	na	-0.5	0.4	na	0.7	0.0

	Average Cotton Yields		
	Baseline	Ac. Shift	Maximize
	Pounds Per Acre		
1996	561.3	569.3	545.9
1997	569.9	577.0	556.9
1998	579.4	583.2	567.9
1999	585.5	591.4	578.7
2000	596.1	603.0	591.9
2001	603.9	612.3	602.1
2002	611.3	620.4	610.6
2003	620.4	628.3	618.3
Ave.	591.0	598.1	584.1
Ave. Chg.	na	7.1	-6.9
% Chg.	na	1.2	-1.2

Table 42. Alabama Economic Indicators, 1996-2003

	Fertilizer Expenses			Herbicide Expenses			Insecticde Expenses			Labor Expenses		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	Thousand Dollars			*Thousand Dollars*			*Thousand Dollars*			*Thousand Dollars*		
1996	48,066	49,900	43,302	45,426	43,239	41,124	25,856	28,261	22,332	86,472	90,874	78,509
1997	48,428	50,178	42,939	45,879	43,281	41,408	26,303	28,598	22,051	87,737	91,944	78,917
1998	48,681	50,279	43,826	45,862	43,411	42,047	26,667	28,536	22,992	88,396	91,554	82,091
1999	48,447	50,264	45,583	45,886	44,049	43,007	26,674	28,528	24,828	88,349	91,467	87,445
2000	48,328	50,328	45,480	46,135	44,316	43,495	26,837	28,674	25,060	88,754	91,805	87,627
2001	47,670	49,507	44,840	45,730	43,720	43,323	26,318	28,158	24,442	87,410	90,175	85,457
2002	48,012	50,073	45,874	46,188	44,060	43,649	26,857	29,134	25,769	88,788	92,442	89,379
2003	47,855	49,942	46,665	46,373	44,120	43,971	26,860	29,194	26,771	88,860	93,053	92,960
Ave.	48,186	50,059	44,814	45,935	43,775	42,753	26,547	28,635	24,281	88,096	91,664	85,298
Ave. Chg.	na	1,873	-3,372	na	-2,160	-3,182	na	2,089	-2,266	na	3,569	-2,797
% Chg.	na	3.9	-7.0	na	-4.7	-6.9	na	7.9	-8.5	na	4.1	-3.2

	Returns to the Major Crops		
	Baseline	Ac. Shift	Maximize
	Million Dollars		
1996	9.54	14.28	2.29
1997	5.79	8.25	0.07
1998	0.88	0.60	-2.82
1999	-5.39	-7.07	-10.03
2000	-10.07	-12.96	-14.63
2001	-15.23	-16.33	-19.49
2002	-21.91	-24.36	-26.63
2003	-27.97	-28.70	-33.74
Ave.	-8.05	-8.29	-13.12
Ave. Chg.	na	-0.24	-5.08
% Chg.	na	3.00	63.11

Table 48. Mississippi Environmental Indicators, 1996-2003

	Chemical Index			Carbon			Soil Erosion			NFarm		
	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize	Baseline	Ac. Shift	Maximize
	*Index Value**			*Percent*			*Tons Per Acre*			*Pounds Per Acre*		
1996	100.00	102.60	100.68	3.78	3.77	3.77	7.26	7.50	7.40	38.27	39.38	34.32
1997	98.64	101.41	99.77	3.78	3.78	3.74	7.27	7.57	7.65	38.55	39.92	33.39
1998	98.30	99.21	104.75	3.78	3.78	3.79	7.27	7.48	7.65	38.96	40.90	33.82
1999	98.30	99.55	104.13	3.78	3.76	3.78	7.24	7.46	7.55	38.96	40.10	33.94
2000	98.08	100.62	105.49	3.77	3.73	3.79	7.25	7.50	7.38	38.80	39.02	34.47
2001	98.30	99.55	105.89	3.76	3.72	3.82	7.24	7.44	7.18	38.30	38.38	34.78
2002	98.02	98.36	106.68	3.75	3.71	3.82	7.27	7.49	7.11	38.39	38.51	35.22
2003	97.96	98.36	105.89	3.73	3.71	3.83	7.29	7.48	6.97	37.95	38.31	35.09
Ave.	98.45	99.96	104.16	3.77	3.75	3.79	7.26	7.49	7.36	38.52	39.32	34.38
Ave. Chg.	na	1.51	5.71	na	-0.02	0.03	na	0.23	0.10	na	0.79	-4.14
% Chg.	na	1.53	5.80	na	-0.56	0.70	na	3.15	1.38	na	2.06	-10.76

	PFarm		
	Baseline	Ac. Shift	Maximize
	Parts Per Billion		
1996	367.25	352.54	352.25
1997	364.87	352.46	353.95
1998	358.07	344.57	344.33
1999	353.14	342.56	348.49
2000	353.76	336.02	345.07
2001	353.89	335.77	334.51
2002	354.75	336.12	329.42
2003	355.95	337.33	324.64
Ave.	357.71	342.17	341.58
Ave. Chg.	na	-15.54	-16.13
% Chg.	na	-4.34	-4.51

* Chemical Index values have been indexed such that the 1996 baseline value equals 100.

Chapter 5. Summary and Conclusions

In this study the Southeast region includes the states of Alabama, Florida, Georgia, North Carolina, Mississippi, South Carolina and Tennessee. It also includes 48 substate or POLYSYS regions - each of which is defined as an Agricultural Statistic District. The agricultural land in each POLYSYS region has been divided into as many as four dominant soils, and relevant regions also are distinguished between irrigated and dry-land areas. The study covers the seven major crops: barley, corn, cotton, grain sorghum, oats, soybeans and wheat; therefore all the results in this study are referred to the land allocated to those seven crops, with an exception only made in order to include cover crops in alternative rotations.

The core of this study's methodology is a redefined version of POLYSYS, an economic modeling system which integrates substate production regions with the national demand for the major crops. POLYSYS's regional land allocation is driven by the relative returns of the crop rotations in that region. The economic and rotational information was developed using the APAC Budgeting System (ABS), which was developed specifically to keep budgeting activities consistent across rotations and regions. ABS not only produces economic budgeting information, but also the schedule of operations and input applications - data which are transferred to the Environmental Production Integrated Climate (EPIC) model in order to generate the environmental indicators relevant for the study.

The study includes the analysis of three scenarios, the first of which is *Baseline* defined from the economic data presented in the December 1994

USDA agricultural baseline. Based on those data, a rotational baseline is estimated which includes existing and more sustainable rotations, given that it is assumed that some use of more sustainable practices already exists. The second scenario, *Acreage Shift*, involves the assumption of a greater flexibility in the shifting of acreage which can occur from one crop to another; this can be understood as an increase in the own and cross elaticities of supply. The third scenario is the *Maximize* scenario, in which the use of acreage under more sustainable rotations is maximized by artificially driving to zero the returns of the existing rotations.

The study's results rest primarily in the relevance of the existing and alternative rotations identified for each POLYSYS region in the Southeast. Also, the results are dependent on the validity of the agronomic and economic information developed for the rotations included in the study. Both tasks - as well as the dominant soil selection, economic modeling, and the overall framework which ties this vast amount of information together - represent an integrated effort to address the above issues with a consistent and transparent methodology. However, the lack of databases with specialized focuses and broad geographic coverage make the rotational data at the POLYSYS region level almost impossible to validate. Further, the price effects resulting from changes in production patterns are estimated, but the two scenarios only affect rotation solutions in the Southeast. Price effects could be significantly more pronounced and, possibly, reverse direction if the entire nation were simulated under the two scenarios.

The main conclusions of the study can be summarized as follows:

- In the *Baseline* scenario for the Southeast as a whole, the land in more sustainable practices grows from 9.5 percent to 14 percent. However, in many

POLYSYS regions - specfically, Alabama, Mississippi, and South Carolina - this level grows beyond 30 percent, indicating that important environmental gains can be achieved in these areas through increasing education and extension efforts with regard to the economic and environmental benefits of such practices.

- The results under the *Acreage Shift* scenario indicate that although planting flexibility is an important component for sustainability, it may not be the primary component. The overall level of acreage in more sustainable practices did not show a significant improvement at the regional or generally at the state level; increased flexibility impacted only a few POLYSYS regions and then only marginally. However, the greater ability to shift production in the *Acreage Shift* scenario has a significant impact on net returns. Thus, it can be said that farmers were able to make more profitable decisions, though not necessarily more environmentally sound decisions.

- The *Maximize* scenario showed that currently available alternative practices such as no-till, chemical banding, double-cropping, the use of cover crops, and terraces could be adopted widely and have a positive environmental impact. This scenario showed an improvement in the key environmental indicators, as well as a reduction in fertilizer, herbicide, and insecticide expenditures. However, given the assumptions of the model, such a shift could mean a loss of 39 percent in net returns from *Baseline* levels in the Southeast.

Nationwide adoption and targeting agricultural policy to foster the use of the more sustainable practices could reduce these losses in net returns significantly. Current programs such as conservation compliance and cost sharing could be redirected or reinforced achieve a higher level of use of more sustainable practices and to reduce economic losses to producers.

- The practices and scenarios simulated indicate the potential for significant changes in labor demand. Labor demand grew for the Southeast by 4 percent and 6 percent, respectively, in *Acreage Shift* and *Maximize*. In North Carolina, the overall increase in labor expenditures under *Maximize* was 19 percent and 34 percent in Tennessee, which could indicate that as the use of more sustainable practices becomes more prevalent, potential regional bottlenecks could occur in the farm labor markets.

This study showcases the advantages of the POLYSYS analytical framework and its use through the integration of economic and environmental analysis in substate geographic levels. Along the study, it has be shown many times that the interpretation of the results becomes more precise and relevant as the geographic area becomes smaller. A POLYSYS region defined in terms of Agricultural Statistic District has proven to be useful in identifying and analyzing economic and environmental impacts.

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