



The University of Georgia

Center for Agribusiness and Economic Development

College of Agricultural and Environmental Sciences

Productivity Analysis of Georgia Agriculture

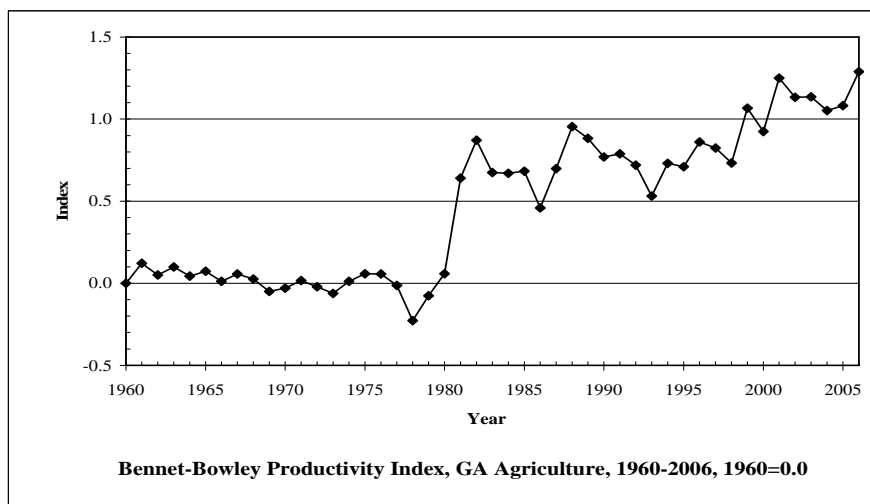
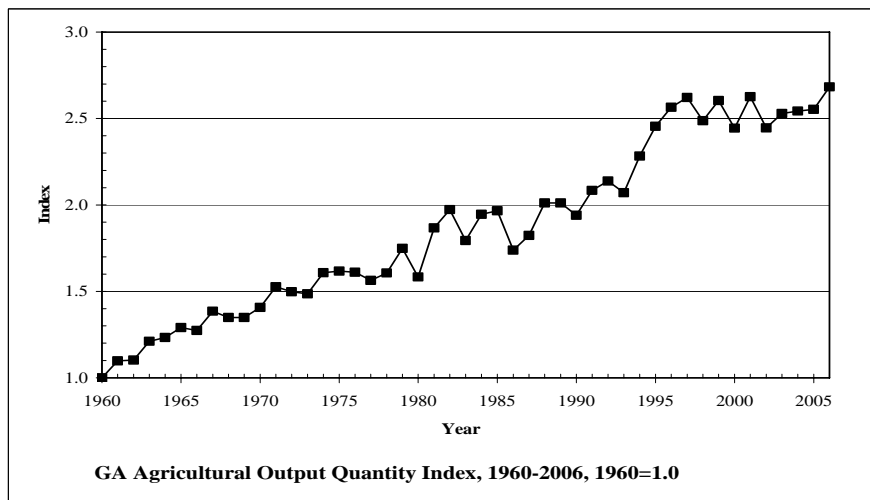
Prepared by:
Archie Flanders, Fred White, and John McKissick
Center Report: CR-07-18
November 2007



Productivity Analysis of Georgia Agriculture

Executive Summary

Georgia agricultural output has followed an increasing trend since 1950, and the 2006 quantity index of aggregate output reached a historical high. In 2006, Georgia farm gate value of agricultural products was \$10.4 billion. Total output impact of agricultural production and directly related processing was \$55.2 billion, representing 8.1% of state output value. Expansion of agricultural production leads to economic growth in other sectors of the state economy. Agricultural production impacts agribusinesses in the Georgia economy through backward linkages related to inputs, as well as forward linkages related to food and fiber processing. Increases in output have been accompanied by relatively lower levels of input increases. The Bennet-Bowley measure of productivity indicates an average annual productivity increase of 2.8% during 1960-2006. Productivity increases explain how the Georgia agricultural economy is expanding during a period when farm acreage and the number of farms are declining. Technological innovations have increased output and have been applied by Georgia agricultural producers to increase farm profits.



Productivity Analysis of Georgia Agriculture

Output of agricultural products impacts the overall state economy through linkages in other economic sectors that supply production inputs and process Georgia commodities for consumer purchase. In 2006, Georgia farm gate value of agricultural products was \$10.4 billion. (Boatright and McKissick). Total output impact of agricultural production and directly related processing was \$55.2 billion, representing 8.1% of state output value. Expansion of agricultural production leads to economic growth in other sectors of the state economy. Agricultural production impacts agribusinesses in the Georgia economy through backward linkages related to inputs, as well as forward linkages related to food and fiber processing. Productivity analysis assesses the relationship between output and inputs utilized in the production process. The objective of this research is to develop a method for evaluating productivity in the Georgia agricultural economy.

Data

Data for productivity analysis include farm revenue and expenses for Georgia during 1960-2006 (USDA, ERS 2007). Output values are reported by commodity categories of crops, livestock, as well as services. Output quantities are determined by an indirect approach that applies weighted prices for each output value category as $Quantity = Value/Price$. Individual commodity prices are applied to determine weighted prices for each output value category (USDA, NASS 2007). Quantities for output categories are normalized to a value of 1960 = 1.0 so that annual output indexes represent change from the base year.

Agricultural Production

Agricultural production in Georgia consists of diverse crop and livestock commodities. Application of an index measure representing total output indicates annual aggregate quantity changes in the agricultural economy. The Tornqvist index is a weighted average of output quantity expressed as:

$$(1) \quad Q_{0t} = \prod_{i=1}^N \left[\frac{q_{it}}{q_{i0}} \right]^{\frac{w_{i0} + w_{it}}{2}},$$

where t is the current year, 0 represents the base year, i represents each commodity in the index, and w is a weight determined by the percentage of total revenue derived from commodity i in each time period (Coelli et al). Equation (1) can be rearranged into logarithmic form as:

$$(2) \quad \ln Q_{0t} = \sum_{i=1}^N \left(\frac{w_{i0} + w_{it}}{2} \right) (\ln q_{it} - \ln q_{i0}).$$

Output for Georgia agriculture in Chart 1 indicates that production follows a steady upward trend over the previous 47 years. Output increases average 3.7% per year. Table 1 shows commodities with increased or decreased output quantities in 2006 when compared to the base year of 1960. For 2006, there are 16 commodities with greater output and 6 commodities with less output than

in 1960. Previous research by White (1998) shows that Georgia agricultural production increased by 33% from 1951-1960. That reported increase and results from this report indicate that Georgia agricultural production continues on an increasing trend and reached a historical high in 2006.

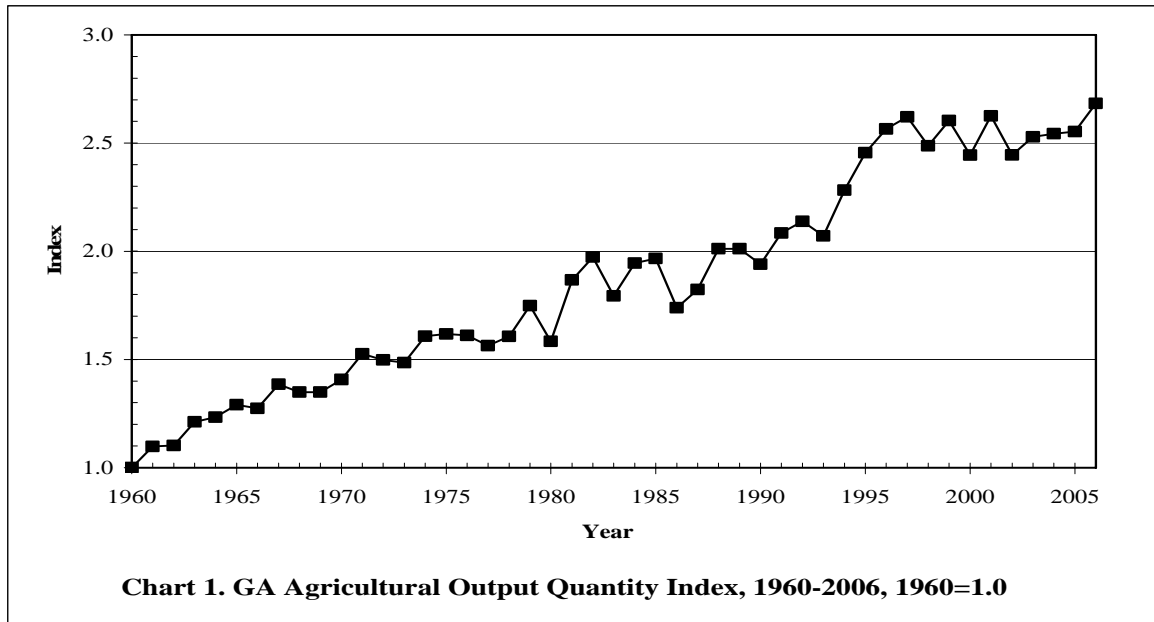


Table 1. Commodities with Increases and Decreases in Output Quantity, 2006 Compared to 1960

Increase	Decrease
Grain Sorghum, Hay, Wheat, Rye, Pecans, Blueberries, Grapes, Beef, Soybeans, Peanuts, Broilers, Eggs, Cotton, Milk, Vegetables, Other (Includes Nursery and Greenhouse)	Corn, Oats, Peaches, Apples, Tobacco, Hogs

Data sources for expenses and prices for inputs are similar to output sources. Input prices for electricity are from USDC, BEA 2007. Input quantities are derived in a similar manner as output quantities with application of Equation (1) or Equation (2). Chart 2 indicates an average input increase with cyclical characteristics during 1960-2006. Table 2 shows that the average input increase is 0.52% during the entire period with an average increase of 0.02% since 1974. Thus, most of the overall input increase occurred during 1960-1973 and since that period, inputs have not followed an increasing trend. Comparing annual output indexes to input indexes indicates that the quantity measure of increasing productivity averages 2.53% per year.

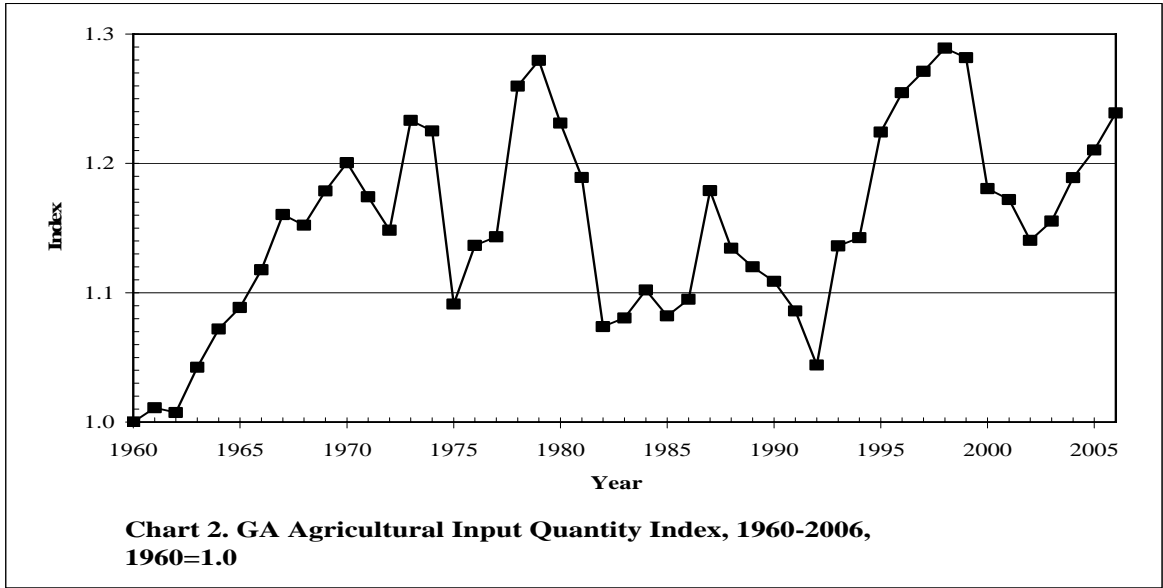


Table 2. Average Input Change, 1960-2006

Period	Percent
1960-2006	0.52
1960-1973	1.79
1974-2006	0.02
1960-1970	2.00
1971-1979	0.88
1980-1992	-1.81
1993-1998	4.08
1999-2002	-3.71
2003-2006	2.47

Agricultural Prices

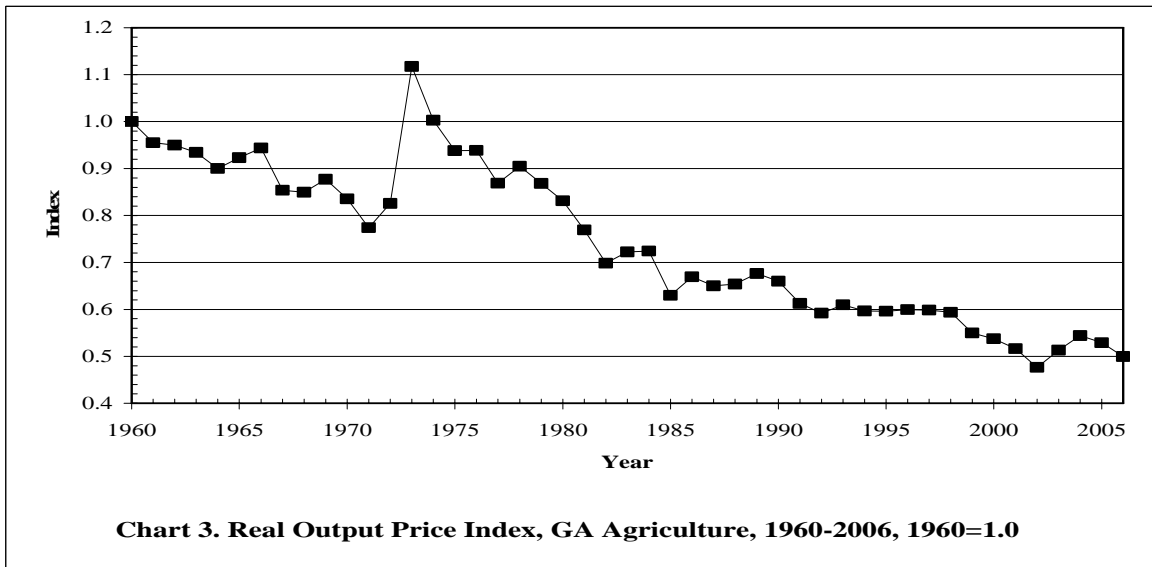
Agricultural productivity includes producer responses to changing relationships between output and input prices, as well as technological relationships depicted in Chart 1 and Chart 2. A Tornqvist price index is developed with a formulation identical to the Tornqvist output index. The Tornqvist price index is expressed as:

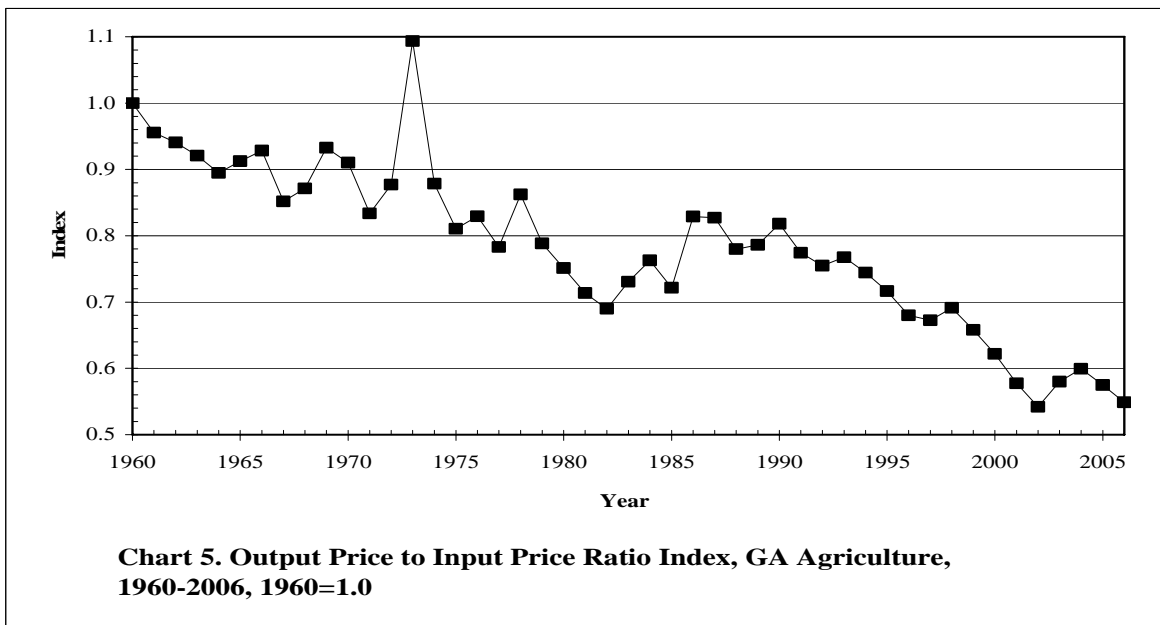
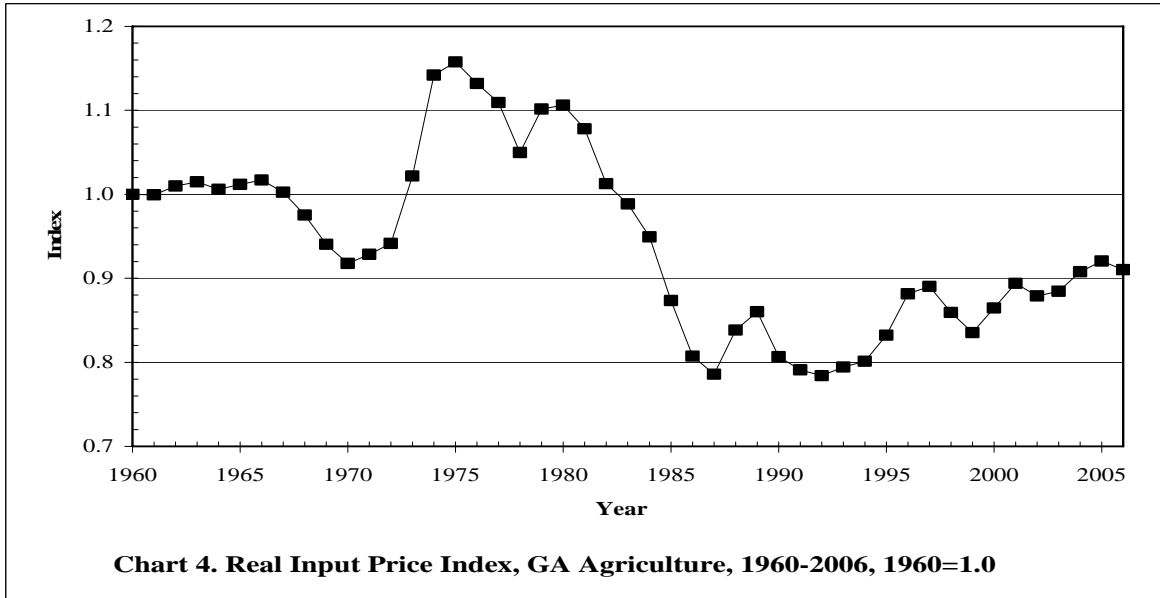
$$(3) \quad P_{0t} = \prod_{i=1}^N \left[\frac{p_{it}}{p_{i0}} \right]^{\frac{w_{i0} + w_{it}}{2}},$$

where P represents price and all other variables are identical to Equation (1). A logarithmic form of the Tornqvist price index is:

$$(4) \quad \ln P_{0t} = \sum_{i=1}^N \left(\frac{w_{i0} + w_{it}}{2} \right) (\ln p_{it} - \ln p_{i0}) .$$

An aggregate output price index for commodities produced in Georgia is presented in Chart 3. Price indexes represent real dollars discounted by the GDP implicit price deflator (USDC, BEA 2007). A 2006 output price index of 0.5 indicates that real prices received have decreased by 50% since 1960. Input prices in Chart 4 have decreased 9% during 1960-2006. The current input price level is a result of declining input prices from 1975 through 1992, followed by an increasing trend beginning in 1993. Chart 5 shows a steadily declining trend in the ratio of output prices to input prices. The declining trend averages -0.98% per year and results in a 2006 ratio that is 55% of the 1960 ratio.





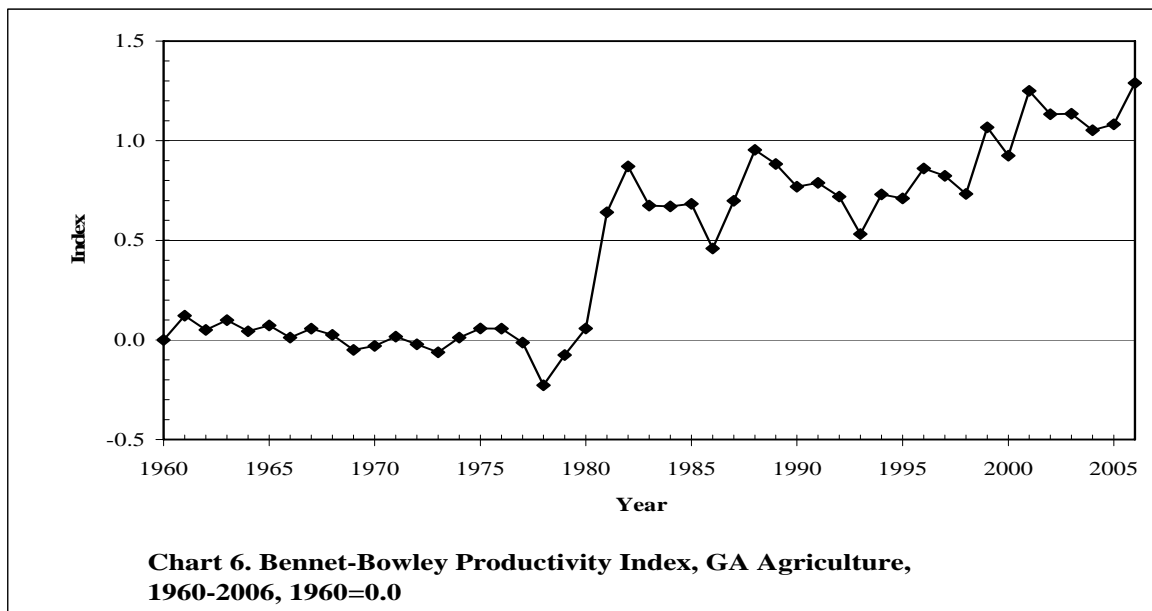
Bennet-Bowley Productivity Measure

Productivity analysis attempts to determine whether output growth is increasing relative to input utilization. Measuring productivity of a state economy involves determining the ratio of Y/X over time, where Y is aggregate output and X is aggregate input. The Bennet-Bowley productivity measure equals the difference in profit between the base period 0 and the current period t . Under assumptions that all producers face the same prices in each period, the aggregate Bennet-Bowley index is the average of Bennet-Bowley farm level productivity measures (Chambers and Pope 1996). A formulation for this index from Flanders and White (1997) is:

$$(5) \quad 2P_t = \sum_{m=1}^M (p_{mt}^* + p_{m0}^*) (y_{mt} - y_{m0}) - \sum_{n=1}^N (w_{nt}^* + w_{n0}^*) (x_{nt} - x_{n0}),$$

where $p_{mt}^* = p_{mt} / (\sum_{m=1}^M p_{mt} + \sum_{n=1}^N w_{nt})$ and, $w_{nt}^* = w_{nt} / (\sum_{m=1}^M p_{mt} + \sum_{n=1}^N w_{nt})$.

Profits are evaluated at normalized prices, with p representing output price and w representing input price. Bennet-Bowley index measures are presented in Chart 6 for the years 1960-2006. Index measures are changes from the base period, and the initial index for the base year of 1960 is 0. The index change averages 2.80% per year from 1960 through 2006 to achieve 1.29 as the ending measure for the period. There is virtually no change in the index from 1960 through 1980, but thereafter an increasing trend averages 4.7% per year.



Increasing output relative to input indicates technological innovations in Georgia agriculture. A measure for output quantity relative to input quantity results in a productivity increase that averages 2.53% per year. The Bennet-Bowley productivity measure averages 2.80% per year and includes price changes, as well as technology. A Bennet-Bowley productivity index with increases that are greater than the productivity index with only technology indicates that producer decisions have included adaptations to decreasing output prices. Technological innovations have increased output and have been applied by Georgia agricultural producers to increase farm profits.

The input index presented in Chart 2 includes a decreasing trend in farm acreage with total 2006 acreage 49% of 1960 acreage. During this time, the number of farms decreased from 112,000 in 1960 to 49,000 in 2006 (USDA, NASS 2007). Number of farms in 2006 is 44% of the 1960

level. Thus, output increases in Chart 1 have been accompanied by decreasing trends in acreage and farms. Productivity increases in Chart 6 explain how the Georgia agricultural economy is expanding during a period when farm acreage and the number of farms are declining.

Summary

Expansion of agricultural production leads to economic growth in other sectors of the state economy. Agricultural production impacts agribusinesses in the Georgia economy through backward linkages related to inputs, as well as forward linkages related to food and fiber processing. Georgia agricultural output has followed an increasing trend since 1950, and the 2006 quantity index of aggregate output reached a historical high. Productivity analysis assesses the relationship between output and inputs utilized in the production process. Increases in output have been accompanied by relatively lower levels of input increases. The Bennet-Bowley measure of productivity indicates an average annual productivity increase of 2.80% during 1960-2006. Productivity increases explain how the Georgia agricultural economy is expanding during a period when farm acreage and the number of farms are declining. Producers have adapted to decreasing output prices while utilizing production technology. Technological innovations have increased output and have been applied by Georgia agricultural producers to increase farm profits.

References

- Boatright, S. and J. McKissick (2007). *2006 Farm Gate Value Report*, Center for Agribusiness and Economic Development, AR-07-01, Athens, GA.
- Chambers, R. and R. Pope (1996). "Aggregate Productivity Measures," *American Journal of Agricultural Economics*, Vol. 78, No. 5, pp.1360-1365.
- Coelli, T., D. Prasada Rao, C. O'Donnell, and G. Battese (2005). *An Introduction to Efficiency and Productivity Analysis, Second Edition*, Springer Science + Business Media, New York, NY.
- Flanders, A. and F. White (1997). "A Comparison of Productivity Measures for Georgia Agriculture," Paper presented at the Southern Agricultural Economics Association meetings, Birmingham, AL.
- U.S. Dept. of Commerce, BEA. (2007). "National Income and Product Accounts Tables," Available at: <http://www.bea.gov/national/nipaweb/Index.asp>.
- U.S. Dept. of Agriculture, ERS. (2007). "Farm Income: Data Files," Available at: <http://www.ers.usda.gov/data/FarmIncome/finfidmu.htm>.
- U.S. Dept. of Agriculture, NASS. (2007). "Browse NASS by Subject," Available at: <http://www.nass.usda.gov/QuickStats/index2.jsp>.

White, F. (1998). "An Analysis of Productivity Growth in Georgia Agriculture," College of Agricultural and Environmental Sciences, The University of Georgia, Research Bulletin Number 433, Athens, GA.

The Center for Agribusiness & Economic Development



The Center for Agribusiness and Economic Development is a unit of the College of Agricultural and Environmental Sciences of the University of Georgia, combining the missions of research and extension. The Center has among its objectives:

To provide feasibility and other short term studies for current or potential Georgia agribusiness firms and/or emerging food and fiber industries.

To provide agricultural, natural resource, and demographic data for private and public decision makers.

To find out more, visit our Web site at: <http://www.caed.uga.edu>

Or contact:

John McKissick, Director
Center for Agribusiness and Economic Development
Lumpkin House
The University of Georgia
Athens, Georgia 30602-7509
Phone (706)542-0760
caed@agecon.uga.edu

The University of Georgia and Fort Valley State University, and the U.S. Department of Agriculture and counties of the state cooperating. The Cooperative Extension Service offers educational programs, assistance and materials to all people without regard to race, color, national origin, age, sex or disability.

An equal opportunity/affirmative action organization committed to a diverse work force.

Report Number: CR-07-18

November 2007

Issued in furtherance of Cooperation Extension Acts of May 8 and June 30, 1914, the University of Georgia College of Agricultural and Environmental Sciences, and the U.S. Department of Agriculture cooperating.

J. Scott Angle, Dean and Director