AN ECONOMIC EVALUATION OF COTTON AND PEANUT RESEARCH IN SOUTHEASTERN UNITED STATES

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ABSTRACT

The purpose of this study was to utilize the economic surplus framework for evaluating the impact of investment in agricultural research. The economic impact measures used in this study were the total benefits and distribution of those benefits associated with investment in agricultural research. These results were used to calculate an internal rate of return on the investments. The focus of the research was on cotton and peanuts in the Southeast region of the United States. Two equations were estimated to determine the impacts of the money being spent on the research efforts of these two commodities.

The results revealed positive benefits to consumers and producers exceeded the investment amount in each year for both commodities in the period. The total social benefits averaged about 201 million (1982) dollars annually for cotton research. Peanut research averaged about 191 million (1982) dollars resulting form research investment. The internal rates of return were 23.87 percent for cotton and 53.58 percent for peanuts, suggesting that past research investments produced a high return to society. This result does not conflict the results of other similar studies as those mentioned in the literature review.

INTRODUCTION

Research is a fundamental component of economic development and growth. Agricultural research has been labeled the oldest form of research in the world. There is evidence suggesting methodic attempts to apply scientific knowledge to improving agricultural production as early as the eighteenth century. Around this time, the most pressing problem in developing economies was to produce adequate amounts of food to be self-sufficient. It makes sense that individuals began to improve agriculture in order to sustain them. Today, agricultural research is crucial in developing and maintaining the role of developed economies in world markets as well as keeping food prices low and stable.

Agricultural research requires scarce resources like skilled labor, capital, and other inputs to continue to address these concerns and rise to new levels. These inputs are intended to combine and produce some improved technology that makes agricultural production more efficient. Agricultural research improves efficiency through developing technologies that increase output using the same inputs or decrease the costs of production. Examples of innovations from research in agriculture are new crop varieties, better pesticides and fertilizers, and improved management and storage techniques that help to stabilize food prices and supply. Technological improvements in agriculture bring about shared benefits between the producer and consumer. Creating and increasing productivity, holding all other things constant, generates new revenues for the producer by widening the margin between production cost and quantity produced. An increase in productivity can then increase supply, and depress prices, affecting producers and consumers alike.

In the United States, agricultural research has been historically funded through a heavily legislated partnership between federal and state governments. As a result, either the United

States Department of Agriculture (USDA) or the State Agricultural Experiment Stations (SAES) are responsible for conducting most of the public research in the United States. When the USDA was established in 1862, the majority of the nation was involved in agriculture and taxpayer support of agricultural research was popular policy. Since then, the portion of the population involved in agriculture has decreased significantly, and the support for such policy has decreased and become more complicated as a result. Public tax dollars still support agricultural research not only because the knowledge it generates has characteristics of a public good[1], but also because the returns from public investment in agricultural research have been large. Studies have shown that the past public investment in research has resulted in at least a 35 percent annual rate of return (USDA/ERS). Despite these high returns, tax dollars for research have become progressively scarcer and state research stations have increased their reliance on contributions from the private sector (USDA/ERS). This increasing scarcity of funding presents a paradox: is the government cutting funding to a successful, cost-effective program or have the estimated rates of return been overstated?

For the states of Alabama, Florida, Georgia, and South Carolina, this paper addresses the returns from research in cotton and peanuts as well as the distribution of benefits among producers and consumers resulting from research dollars invested in cotton and peanuts over a thirty-three year period. Specifically, the objectives of this paper are:

i) To develop a theoretical framework for the analysis and evaluation of the social benefits of publicly funded cotton and peanut research in the Southeast as it is defined in the above paragraph.

[1] Benefits produced from certain types of research are not restricted to those producing the research. This is one of the reasons that "free riders" become a problem where some firms receive some of the benefits of research without incurring any of the costs (Alston, Norton, and Pardey 1995)

ii) To measure the social costs and returns form public research and development funding.

iii) To assess the distribution of these benefits between producers and consumers.

LITERATURE REVIEW

In 1953, Schultz calculated the cost savings resulting from new production and technology and compared this to costs of developing the new technology resulting in a 700 percent return on investment. Agricultural output was determined to be 32 percent higher in 1950 compared to what would have been if the research had not been conducted. Another early study evaluating the effectiveness of agricultural research investigated the rate of return on research devoted to developing hybrid corn was done by Zvi Griliches (1958). He suggested that his result of a 37 percent internal rate of return (IROR) on investment be taken as an indication that 'research is a good thing.'

Another hypothesis introduced in 1958 was called the "treadmill theory" which was introduced as a result of farmers constantly having to adopt new technologies in order to enhance productivity. The treadmill theory postulated that despite their constant adoption of new technologies, only the initial adopters made any of the resulting profits. As more farmers adopt the technology, any profits that may be made are eventually "worn away" as increased supply and/or competition pushes prices down. The downward pressure on prices resulting from an outward shift in supply makes any increase in profits impossible at such low prices. Since its introduction, there has been substantial evidence to support this theory's argument (Levins & Cochrane, 1996); however this theory was never empirically tested.

In 1995, Julian Alston, George Norton, and Philip Pardey wrote Science Under Scarcity, a book that "represents a culmination of a research agenda that extends all the way back to the late 1940's" (Ruttan foreword). The authors offer that the issues and questions surrounding resource evaluation and allocation are best answered when considered in their institutional setting, as well as scientific and policy context. These topics are a useful introduction when looking more closely at the factors affecting agricultural research benefits and measurement.

Between Griliches and Cochrane in 1958 and Science Under Scarcity in 1995, there has been a range of economic issues in agricultural research and many journal articles published debating these various issues. Many studies indicate that the land-grant system rates of return of research are very high. The estimated rates of return on agricultural research are commonly in the thirty to sixty percent range, as in the results of the studies outlined in Table 1.

Regardless of evaluation technique, time period, or database used, high rates of return to investment in agricultural research have been steadily realized. Studies that have indicated high rates of return to agricultural investments in research (Evenson, 1967; Cline 1975) were useful in the justification for allocation of public funds to agricultural research. However, there have been studies that indicate this rate declined over time (Peterson & Hayami, 1973; Davis 1979). This indicates that the stock of knowledge increases with investment over time, but will depreciate over time as well. According to them, this is why nearly half of all research conducted is necessary for maintenance of current stock of knowledge or productivity (Adusei 1988, Adusei & Norton, 1990). They recognize that different measures are appropriate for different types of research. The type of research evaluated determines the timing and magnitude of depreciation and obsolescence. The results of applied research are more susceptible to depreciation and obsolescence than basic research because applied research is inherently more sensitive to changes in controlling factors (Alston, Norton, and Pardey, 1995). Resistance in pesticides, for example, occurs as pests evolve to resist chemicals, making previous research obsolete.

Table1: Estimated Rates of Agricultural Research for the United States

Study	**Time Period**	**Annual Rate of Return**
Griliches, 1964	1949-1959	35-45+
Lattimer, 1964	1949-1959	Not significant
Evenson, 1968	1949-1959	47
Cline, 1975	1949-1958	39-47+
	1954-1968	32-39+
	1967-1972	28-35+
Peterson and Fitzharris, 1977	1957-1962	49+
	1967-1972	34+
Evenson, Waggoner, and Ruttan, 1979	1948-1971	45+
White, Havlicek, and Otto, 1979	1942-1957	48
	1958-1977	42
Lyu, White, and Liu, 1984	1949-1981	66
Braha and Tweeten, 1986	1959-1982	47
Huffman and Evenson, 1989	1960-1982	43
Norton and Ortiz, 1992	1987	30
+ returns to research and extension.		

Source: Norton, George W. “Benefits of US Agricultural Research”
www.warp.nal.usda.gov/pgdic/Probe/v2n2/bene.html

Research spillovers are the consequence of results from research in one region spilling over into another region. These may include spillovers of technologies themselves or the effects of research-induced price changes. When conducting studies on the evaluation of research investments based on state level observations, interstate spillovers become an additional problem. The importance of interregional spillovers was highlighted in a study conducted by White and Havlicek (1979) when the rate of return was reduced from 70 percent to 29 percent once outside research was considered. In Evenson's 1978 study, similar geo-climatic regions determine the impacts of interregional spillovers on a state's productivity. In addition, the structure of the agricultural experiment station system facilitates the interstate transfer and adaptation of research information in neighboring states. Once the information has been transferred, agricultural extension efforts, farmer education, and farmer income levels all affect the rate of adoption (Otto, 1981).

The earliest evaluation studies (Griliches, 1958; Schultz, 1953) utilized the economic surplus approach, also known as the consumer-producer surplus approach[2]. An economic surplus approach is used to evaluate the benefits from a shift in the supply curve due to a change in productivity. This productivity is theorized to be a result of technology generated form agricultural research. Investigating this relationship between research investments and improvements productivity using the economic surplus approach is shown as the most successful approach to evaluating agricultural research (Alston, Norton & Pardey, 1995). The model used in this approach is a comparative-static, partial equilibrium model of supply and demand in a commodity market. Using this model, the shift in the supply curve generated from research and technology is measured in relation to the "old" supply curve. Comparing the new and old

[2] An illustrative comparison of the models used in the early studies is presented in Figure 1(Source: Zentner R., 1982, page 202).

equilibrium point is then used to calculate the size and distribution of the resulting consumer and producer surplus.

The economic surplus approach is attractive for many reasons. It is flexible enough to be applied in different situations with limited data requirements. It is also an effective tool when the objectives include the measurement of welfare benefits from an induced shift in the supply curve. Then the distribution of these benefits to consumers and producers is determined without difficulty.

Duncan and Tisdell (1971) first emphasized the idea that the distribution of welfare benefits from agricultural research can vary drastically depending on the shape of the supply function. This suggests there are potential problems with using producer surplus to measure the benefits of some common types of technical change. These methods may seriously underestimate the change in profit from a new technology, depending on the characteristics, which constitute the technology that shapes the supply curve and the kind of technical change (Martin & Alston, 1994). Martin and Alston concluded that the producer surplus method is troublesome even in the case of a linear supply curve and a Cobb-Douglas (quadratic) production function. They find that the profit function is a more reliable resource, provides useful results, and suggest that it be used instead of producer surplus to measure welfare benefits resulting from a shift in the supply curve. They also discuss why the type of shift in the supply curve assumed is important but impossible to prove empirically. Due to the significant difference in total welfare benefits from a parallel shift in a linear supply curve versus a pivotal shift in the same.

curve, the authors maintain that the shift used in the analysis is crucially important. Specifically, they point out that producers will lose if the shift is pivotal

Based on the argument that there is no realistic and readily available estimate for the shape of a supply curve in a given study, the realistic approach is to assume the supply shift is parallel (Rose 1980 p. 837). Under this assumption, functional form of supply and demand is insignificant and it is appropriate to use local linear approximation.

As stated in the previous chapter, the dynamics of the shift in the supply curve and the resulting change in the stock of knowledge are important when measuring the consequences of research investments. Once research produces results, the response in the supply curve is not the static snapshot that the static model represents. Alston, Norton, and Pardey addressed lags in research and adoption by separating them into three categories. The idea is that the stock of knowledge yields a stream of benefits once it is increased and continues into the future until that knowledge or technology is obsolete. This happens in three stages. The first stage, the research lag, is a lag between the initial investment of the research and the results of the research. Then, the development lag is a lag between the results of the research and the development of the results into useful technology. And the third lag is called the adoption lag that is a lag in the generation of technology to its implementation in the real world. They postulate that applied research has shorter lags and basic research has longer lags.

EMPIRICAL RESULTS

The econometric model in this study consists of supply functions for cotton and peanuts that were estimated using data derived from pooled time-series cross-sectional data for the four states of Alabama, Florida, Georgia, and South Carolina. The data were mostly published with the exception of the research expenditure variable, which was collected and provided by Wallace Huffman from Iowa State University. The prices, quantities, harvested acres, and cost of production variables for both commodities are available from the National Agricultural Statistics Service (USDA), which maintains historical agricultural statistics for many commodities. The cost of production is an average per acre cost of producing cotton and peanuts in the Southeast. Chris McIntosh of University of Idaho provided the data for the amount of rainfall in the four-state region. The expected prices and average costs of production were deflated in 1982 dollars using the Consumer Price Index (CPI) published by the Bureau of Economic Analysis. The public agricultural research expenditures are in constant 1984 prices, or real terms. The nominal or current values were deflated by the Huffman and Evenson public agricultural research price index (Huffman & Evenson, 1993). Based on the theory that research spillovers occur within similar geo-climatic regions, all the data was averaged or aggregated to create a region-wide data set for each commodity over the 33 years from 1963 through 1995.

The first step in calculating returns to research in cotton and peanuts for this study is to directly estimate the supply function of each commodity. The exact functional form of supply equations for both crops is as follows:

$$\ln Q_t = \beta_0 + \beta_i(\ln P_t^*) + \beta_i(\ln W_t) + \beta_i(\ln \tau_t) + \beta_i(\ln U_t) + \beta_i(\ln A_t), \qquad (13)$$

In both of the above equations, the state of technology ($\tau_{t)}$) is defined as a Pascal lag of research expenditures. The research expenditure variable data is lagged seven years to account for the time it takes for an investment in research to produce results[3].

[3] The research lag assumption of seven years is reasonable based on the findings of previous empirical studies such as Evenson's 1968 study that found a mean research lag for all agricultural research in the United States was between 6 and 8 years.

The models were estimated using ordinary least squares. The parameter estimates for research expenditures and expected price are used in the calculation of the annual shift in the supply curve, which is then used in the calculations of the consumer and producer surplus measurements. The parameter estimates for all the exogenous variables resulting from the empirical estimation procedure are shown in Table 2. P-values are displayed so readers can evaluate statistical significance of the coefficients. In general, the estimated coefficients are highly significant statistically and have signs that conform to economic theory and magnitudes that pass a common sense test.

The estimated coefficient on acreage in the peanut regression had a negative sign, which could at first glance indicate that as acreage harvested increased, the quantity produced decreased. This result appears to conflict with prior theoretical expectations. However, a little thought suggests that the coefficient is the result of the federal quota program for peanuts and the aggregate time series nature of these data. Because the peanut quota is in pounds, not acres, as average yields rise over time the acreage (planted and) harvested will tend to decline unless farmers choose to grow a greater amount of additional peanuts outside the quota program. Thus, we are picking up this long-run correlation in our regression results, not any causative effect of acreage that reduces production.

Table 2: Estimated Parameters for the Cotton and Peanut Supply Functions

VARIABLES	**COTTON**		**PEANUTS**	
	Estimated Coefficients	p-value	Estimated Coefficients	p-value
Intercept	-50.72	.004249	.54	.271035
Lagged price	1.39	.000198	.81	.000000
Rainfall	3.69	.350197	.14	.001232
Acres Harvested	.85	.000004	-.28	.000000
Input Costs	-.68	.059431	-.43	.000000
Research Expenditures	.25	.000001	.00065	.000000
R-square	.7873		.9774	
Durbin-Watson	1.69		2.21	

Now that the supply curves have been empirically estimated for cotton and peanuts, the estimated coefficients and various exogenous variable combinations are used to calculate the annual shifts in the supply curves resulting from expenditures in research. The annual shifts in the supply curves are simulated using the estimated coefficients under two scenarios: with no research expenditures on that commodity and with the actual research expenditures. Comparing the two simulated models allows estimation of the increase in production resulting from the commodity-specific research expenditures.[4]

The calculations of producer and consumer surplus require not only annual shifts in the supply curve (h_t), but in the production curve (k_t) as well. The values for (k_t) are obtained using the price elasticity of supply for each commodity from the estimated models. These estimates are assumed to be the appropriate price elasticities of supply for each commodity in period covered in this study, so they can be used to get (k_t). In addition to the values for (h_t) and (k_t), calculation of the changes in consumer and producer surplus also requires price elasticities of demand. For cotton we use an estimated elasticity of demand from White and Wetzstein (1995) and for peanuts one from Zhang, Fletcher and Carley (1992).

The total and separate changes in producer and consumer surplus were calculated and are presented in tables 3 and 4 for cotton and peanuts, respectively. The surplus resulting from agricultural research expenditures was positive and substantial for every year in the period. The annual social benefits from investment in cotton research over the period 1963 through 1995 ranged from about 317 million dollars to 114 million dollars in 1982 terms. For peanuts, the annual social benefits ranged from $110 million to $336 million in 1982 dollars over the period.

[4] The no research expenditure simulation must be compared to a simulation of production with research expenditures, not to actual production so as to remove any bias due to the estimation of the coefficients and/or the specification of the models.

Table 3: Economic Surplus Measures for Cotton 1963-1995

Year	TOTAL BENEFITS	Δ PS	ΔCS
1963	$ 220,594,912.37	$51,981,599.50	$168,613,312.90
1964	$ 241,110,853.05	$56,815,716.40	$184,295,136.60
1965	$ 207,376,945.77	$48,865,477.60	$158,511,468.20
1966	$ 200,632,336.02	$47,271,380.10	$153,360,955.90
1967	$ 153,973,084.70	$36,275,908.20	$117,697,176.50
1968	$ 188,302,270.88	$44,365,524.60	$143,936,746.30
1969	$ 160,679,455.72	$37,857,468.80	$122,821,987.00
1970	$ 141,237,206.22	$33,276,838.30	$107,960,367.90
1971	$ 146,472,400.04	$34,511,404.50	$111,960,995.50
1972	$ 169,795,018.79	$40,006,412.40	$129,788,606.40
1973	$ 114,582,588.47	$26,997,226.50	$87,585,362.00
1974	$ 183,711,690.91	$43,289,386.90	$140,422,304.00
1975	$ 136,279,278.85	$32,108,517.60	$104,170,761.20
1976	$ 169,705,524.30	$39,985,378.00	$129,720,146.30
1977	$ 211,258,171.50	$49,773,208.30	$161,484,963.20
1978	$ 181,075,551.35	$42,661,644.40	$138,413,906.90
1979	$ 232,062,952.28	$54,674,149.10	$177,388,803.20
1980	$ 199,777,913.28	$47,067,242.20	$152,710,671.10
1981	$ 238,919,562.99	$56,291,999.80	$182,627,563.20
1982	$ 185,593,256.35	$43,728,079.60	$141,865,176.80
1983	$ 191,046,798.13	$45,009,624.60	$146,037,173.60
1984	$ 240,789,000.36	$56,732,756.20	$184,056,244.10
1985	$ 227,526,863.21	$53,609,493.20	$173,917,370.00
1986	$ 213,468,120.24	$50,293,567.00	$163,174,553.30
1987	$ 189,704,605.42	$44,696,618.50	$145,007,986.90
1988	$ 243,942,778.71	$57,476,936.50	$186,465,842.30
1989	$ 210,062,783.10	$49,494,314.40	$160,568,468.80
1990	$ 254,260,226.75	$59,908,482.10	$194,351,744.60
1991	$ 273,631,322.74	$64,480,946.40	$209,150,376.40
1992	$ 236,674,482.80	$55,771,804.10	$180,902,678.70
1993	$ 228,913,861.06	$53,940,902.50	$174,972,958.60
1994	$ 228,467,221.32	$53,848,012.50	$174,619,208.80
1995	$ 317,586,071.10	$74,850,018.00	$242,736,053.10

Table 4: Economic Surplus Measures for Peanuts 1963-1995

Year	TOTAL	∆ PS	∆CS
1963	$294,935,728.42	$50,471,278.98	$244,464,449.45
1964	$336,051,353.64	$57,501,264.59	$278,550,089.04
1965	$334,631,748.45	$57,252,243.48	$277,379,504.96
1966	$303,399,499.61	$51,913,487.82	$251,486,011.78
1967	$312,287,852.30	$53,422,388.01	$258,865,464.29
1968	$298,016,469.84	$50,982,313.81	$247,034,156.03
1969	$279,086,948.01	$47,738,878.86	$231,348,069.16
1970	$275,379,762.88	$47,089,521.89	$228,290,240.99
1971	$279,590,078.97	$47,789,997.06	$231,800,081.91
1972	$259,101,016.32	$44,276,163.55	$214,824,852.77
1973	$185,820,411.31	$31,744,890.93	$154,075,520.38
1974	$178,846,341.84	$30,524,575.54	$148,321,766.30
1975	$168,661,009.69	$28,761,538.26	$139,899,471.43
1976	$171,793,664.17	$29,304,911.21	$142,488,752.96
1977	$166,324,617.63	$28,369,148.58	$137,955,469.05
1978	$183,839,662.96	$31,359,496.45	$152,480,166.51
1979	$178,791,107.18	$30,508,417.67	$148,282,689.52
1980	$128,700,249.56	$21,997,284.35	$106,702,965.21
1981	$122,671,263.39	$20,907,583.26	$101,763,680.13
1982	$163,099,621.21	$27,810,125.98	$135,289,495.23
1983	$139,519,625.07	$23,789,505.41	$115,730,119.65
1984	$133,679,951.08	$22,742,543.61	$110,937,407.47
1985	$148,185,115.83	$25,216,540.80	$122,968,575.03
1986	$113,421,096.07	$19,319,178.54	$ 94,101,917.53
1987	$134,734,051.71	$22,950,395.35	$111,783,656.36
1988	$145,036,829.50	$24,696,888.75	$120,339,940.83
1989	$125,858,275.69	$21,414,508.37	$104,443,767.32
1990	$120,148,333.00	$20,491,422.42	$ 99,656,910.59
1991	$133,225,590.26	$22,620,202.60	$110,605,387.66
1992	$113,819,125.90	$19,349,226.44	$ 94,469,899.46
1993	$116,809,333.20	$19,904,089.20	$ 96,905,244.01
1994	$110,792,797.75	$18,833,581.28	$ 91,959,216.47
1995	$136,026,148.69	$23,174,765.46	$112,851,383.23

The producers captured 24% and consumers captured 76% of total benefits to society resulting from investment in cotton research. The proportion of benefits captured by producers resulting from investment in peanut research was 17%, leaving 83% to be captured by consumers. These figures for the distribution of benefits provide strong empirical evidence in favor of Cochrane's treadmill hypothesis.

Calculating Summary Economic Effects Using Internal Rate of Return (IRR)

The annual social benefits represent the benefits to society, but do not consider the social costs. Annual investment in research can be combined with the results in Tables 4 and 5 to calculate an internal rate of return to compare the costs and benefits of the investments. The research expenditure variable used to directly estimate the supply equations was lagged seven years using a Pascal lag and deflated in 1984 dollars. Two changes were made to the research variable in order to utilize it in equation (12) for the IRR calculations. The actual expenditures from 1956 through 1995 were used in the IRR calculations instead of the Pascal lagged version (1963-1995). The extra seven years from 1956 to 1962 were necessary to establish a stream of initial investment costs for the IRR to be calculated. This variable was also deflated to represent 1982 (rather than 1984) dollars to match the base year used in measuring the social benefits. This way expenditures and benefits were in real dollars in the IRR calculations and the internal rate of return is in real terms, meaning that it is separated from any effects of inflation.

The internal rates of return on cotton and peanuts are 53.58% and 23.87%, respectively. The results convey that society has benefited considerably from public investment in cotton and peanut research. The internal rate of return for investment in cotton research indicates that every dollar invested yielded, on average, $1.54 in annual social benefits for the period 1963-1995.

The internal rate of return on investment in peanut research indicates every dollar invested yielded an average $1.24 return in terms of annual social benefits.

Recall that the total benefits used in the IRR calculations utilized price elasticities of demand and supply based only on assumptions of what the true elasticities are. The price elasticities of demand were drawn from the literature and the price elasticities of supply were estimated in the regression analysis. Recognizing that these assumptions may be subject to error, four additional analyses were performed to evaluate the sensitivity of the results to changes in these assumptions. The price elasticity of supply for both commodities is increased and decreased by one standard error. The price elasticity of demand will also be varied up and down by the standard error from the study from which it was drawn. For Zhang, Fletcher and Carley (1992) that is .03. For cotton, that is by .10 based on White and Wetzstein (1995), which partly relied on the work of Shui, Shangnan, Beghin and Wohlgenant (1993). Results are displayed in Table 5.

By increasing the price elasticity of demand, a portion of the consumer surplus area is reduced and a portion of the producer surplus area is increased. The net reduction in the surplus area reduces the benefits associated with the same level of research investment, therefore decreasing the internal rate of return. This same mechanism increases the internal rate of return when the price elasticity of demand is decreased for both commodities. However, by increasing the price elasticity of supply the rate of shifts in the production function resulting from investment in research is decreased. The slower the rate of change of the production function shift, the smaller the producer surplus area and consumer surplus area. This reduction in the areas of consumer and producer surpluses reduces the internal rate of return on investment in research on each commodity.

Table 5: Sensitivity of IRR Results for Cotton and Peanuts

COTTON		
PRICE ELASTICITY OF SUPPLY	PRICE ELASTICITY OF DEMAND	IRR
1.391	.55	53.58%
1.711	.55	53.05%
1.071	.55	54.36%
1.391	.65	52.38%
1.391	.45	54.98%
PEANUTS		
PRICE ELASTICITY OF SUPPLY	PRICE ELASTICITY OF DEMAND	IRR
.81	.10	23.87%
.86	.10	23.94%
.76	.10	23.82%
.81	.13	23.04%
.81	.07	24.75%

The internal rates of return on cotton and peanut research were not very sensitive to the assumptions about price elasticities of supply or demand. For both commodities, an increase in the price elasticity of demand resulted in very small decreases in the return on research investment in that commodity. For both commodities, decreases in the price elasticity of demand resulted in increases in the internal rate of return on investment. For cotton, an increase in the price elasticity of supply caused a slight decrease in the return on research investment. A decrease in the price elasticity of supply of cotton increased the IRR nearly 1%. An increase in the price elasticity of supply for peanuts increased the return in peanut investment by only .07%. A decrease in this elasticity decreased the IRR on peanut research by only .05%. Changes in the price elasticity of supply for peanuts had a minor effect on the return to peanut research investment.

The internal rate of return above is an average rate of return that does not indicate how changes in research costs and benefits affected this rate over time. To investigate these changes in the internal rate of return over time, the period (1963-1995) was separated into three consecutive 10-year subperiods for each commodity. They will be for the years 1963-1973, 1974-1984, and 1985-1995. An internal rate of return was then calculated for each subperiod to compare how research investments were performing over time. An initial stream of investments was established using the seven previous years for each 10- year period. These results are presented in Table 6.

The estimates for the IRR for the subperiods are not to be taken as accurate since the period measured is too short to be meaningful. However, it should be noted that they are useful in showing the trend in the returns to research on these two commodities. The internal rate of return on cotton investment increased over the three subperiods. Investment in cotton research has decreased consistently over the thirty-three year period with a small increase from 1989-1995. During this time, total benefits for society have remained somewhat flat in comparison. Although investment in cotton research has declined steadily, the benefits have remained promising. Either the benefit of earlier research investments is being realized in later years (a longer lag between project initiation and realized results) or the money is being utilized more efficiently.

The internal rate of return for peanut research trended very differently from the returns on cotton investment. Over the thirty-three year period, the IRR steadily decreased. This results from the steady increase in expenditures for peanut research over the period. Total benefits to society over this period gradually decrease causing the internal rate of return to shrink over time. Given that investment decisions are made annually, shrinking annual benefits to society give no economic justification for continuing increases in peanut investment in research over the period. Research allocation decisions are vulnerable to political influence and the political interests of those in decision-making positions. This may be one explanation for continuing to increase the investment in peanut research despite the evidence of declining benefits to society.

Additionally, in a time when research initiatives in different commodities are competing for limited funds, the allocation of funds to peanut research could be forcing a decrease in allocations to cotton research. Although the estimated internal rate of return to research in cotton exceeds the estimate for peanuts, politics not economics may be the deciding factor in the respective trends in research funding.

Table 6: IRR Trends in Cotton and Peanut Research over Time

SUBPERIODS	COTTON	PEANUTS
1963-1973	54.37	124.03
1974-1984	58.67	83.23
1985-1995	73.80	63.65

SUMMARY AND CONCLUSIONS

Publicly funded agricultural research contributes to growth in agricultural productivity by reducing the real cost of food production through the advancement of output enhancing technology. Improvements in output enhancing technology include improvements in usage or quality of inputs that make production more efficient. The theory is that not only does investment in research contribute to improvements in production, but also that consumers and producers benefit as a result and there is a positive return on that investment. This study makes an effort to add empirical content to the economic theory that research in agriculture contributes to agricultural production by examining the specific case of cotton and peanuts in the southeastern region of the United States for the period from 1963-1995.

Assume broad societal goals of efficiency are aimed at the well being of the economy. For the research system of cotton and peanuts, the goals are to improve the total average of well being to producers and consumers taken in the aggregate. Public investment in agricultural research on cotton and peanuts in the region contributed to the production of those quantities commodities, respectively. These increases were due to the combination of inputs used in the production process and research expenditures in the area of production. The improved efficiency can be in the form of improvements in the quality of the inputs or in the way the inputs are combined. This growth in productivity reduces the real costs of production.

Public research scientists and administrators are being held more accountable for the resources allocated to conduct public agricultural research. This creates a need for current research systems to be continuously evaluated in order to monitor investment decisions. One way to monitor current research systems is to measure the effectiveness of monies allocated to research projects using an internal rate of return. Information on the nature, extent and distribution of social benefits and costs are useful for this type of evaluation.

The purpose of this study was to utilize the economic surplus framework for evaluating the impact of investment in agricultural research. The economic impact measures used in this study were the total benefits and distribution of those benefits associated with investment in agricultural research. These results were used to calculate an internal rate of return on the investments. The focus of the research was on cotton and peanuts in the Southeast region of the United States. Two equations were estimated to determine the impacts of the money being spent on the research efforts of these two commodities.

The model in this study consists of supply functions for cotton and peanuts that were estimated using data derived from pooled time-series cross-sectional data for the four states of Alabama, Florida, Georgia, and South Carolina. The prices, quantities, harvested acres, and cost of production were considered exogenous variables in the supply models for both commodities.

The cost of production is an average per acre cost of producing cotton and peanuts in the Southeast. Rainfall and research expenditures on each commodity on the area were also exogenous variables in the model. The expected prices and average costs of production were deflated in 1982 dollars. The public agricultural research expenditures are in constant 1984 prices, or real terms. Since research spillovers occur within similar geo-climatic regions, all the data was averaged or aggregated to create a region-wide data set for each commodity over the 33 years from 1963 through 1995.

The economic surplus framework used to evaluate the model described above measures the contribution of research investment to agricultural productivity by comparing two production scenarios. First, the supply equation is estimated with research expenditures as an exogenous variable. The second scenario measured in this framework is the fictional quantities that would have been produced with no investment in research. The theory is that new production technology generated from investment in the research shifts the production curve to the right and generates welfare benefits for society (the first scenario). The economic surplus framework measures producer and consumer surplus changes that result from comparing the two scenarios, as the production function shifts to the right. To evaluate the performance of the investment, these results are used in conjunction with the research investment costs to generate and internal rate of return on the investment

The results revealed positive benefits to consumers and producers exceeded the investment amount in each year for both commodities in the period. The total social benefits averaged about 201 million (1982) dollars annually for cotton research. Peanut research averaged about 191 million (1982) dollars resulting form research investment. The internal rates of return were 23.87 percent for cotton and 53.58 percent for peanuts, suggesting that past research investments produced a high return to society. This result does not conflict the results of other similar studies as those mentioned in the literature review.

The positive social benefits and internal rate of return indicate that investment in cotton and peanuts in the southeastern region of the United States has been a sound investment. These results indicate that society would benefit from increased investment in these commodities in the future. These results do not guarantee that similar investment in the future will yield the same results. They may indicate that research investment is a good thing, but do not indicate whether or not money invested in cotton and peanuts was efficiently allocated. The theoretical framework utilized in this study would be a useful tool for administrators in similar studies on public investment in other agricultural commodities to determine whether sufficient progress is made in the area. This may warrant this type of evaluation study one more regular basis.

Since the commodities in this study compete for the same funds, the result from the estimated supply functions is useful for comparing the allocation decisions between the two commodities. A suggestion for further research would be to evaluate allocative efficiency between these two commodities using a marginal rate of return. Allocative efficiency could also be useful in monitoring the role of private research in biotechnology and other agricultural research areas. In particular, this model could be used to compare the efficiency of private and public investment in specific commodities.

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