FUNCTIONS, RESOURCE ALLOCATION, AND THE PRODUCTIVITY OF THE STATE AGRICULTURAL EXPERIMENT STATION

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Introduction

The Hatch Act of 1887 created the federal-state research system to address the problem facing the agricultural sector of the economy and to build a core of scientific knowledge essential for the future development of the agricultural industry (Kerr, 1987). Since the signing of the Hatch Act, the state agricultural experiment station (SAES), in partnership with the United States Department of Agriculture (U.S.D.A), has been the principle source of new knowledge and information demanded by the agricultural industry and consumers of food products. The SAES has responded to local and national needs and adjusted to changing social, economic, and environmental issues facing the agricultural industry. Since the 1950's, the economic benefits of investment in agricultural research conducted by SAES and U.S.D.A. have been analyzed by many studies. However, the functions of SAES and resource allocation of each function have not been analyzed.

Agricultural research constitutes an investment aimed at improving society's well being by increasing returns to factors of production, by improving product quality or introducing new products, by reducing firm's vulnerability to forces beyond their control, by improving environmental quality, by improving quality of life, and by improving the efficiency of natural resources use. Recognizing the values of research, federal and state governments continue to make sizeable investments in agricultural research. Since the mid-1950's, economists have analyzed the economic impacts of investment in agricultural research. Aggregate evaluation of the impacts of investment in agricultural research has been conducted by several investigators. Measurements of research output at an aggregate level, however, have limitations in terms of meaningfulness to decision making at the individual SAES or agribusiness firm level. Evenson (1967) argues that a more useful approach is to measure research productivity for a particular commodity or a particular agricultural experiment station. Several studies have analyzed the impacts of investments in agricultural research for a wide range of commodities and countries.

Resource allocation and the productivity of the SAES have received little attention by economists evaluating the benefit of agricultural research. Norton et al. (1984) analyzed the benefit of investments in the Virginia agricultural experiment station and estimated an internal rate of return of 58 percent for total agricultural research. Araji (1990) evaluated investments in the Idaho agricultural experiment station. He estimated an internal rate of return of 57.6 percent to maintenance research, 26.5 percent to applied research, and 16.4 percent to basic research. However, the focus of the SAES research and resource allocation by research functions has not been adequately evaluated.

Objectives

The objectives of this study were to ascertain the functions of the SAES, determine the proportion of resources allocated to each function by geographic location and political districts, and evaluate the impacts of investment in each function by location and by districts.

Data

All of the 255 research projects that were funded by the Idaho Agricultural Experiment Station (IAES) in 1996 were analyzed. Personal interviews with all research and extension personnel in the IAES were conducted in 1996 and 1997. For each research project that was initiated prior to 1996, for which results are not yet available, and those that were initiated in 1996, the following information was obtained: Synatific man year (SMY) allocation; the objective(s); time required to achieve the objective(s); probability of research success; the time lag between the availability of research results and the initial adoption; probability and rate of adoption of research results; expected adoption time profile; scientific resources required to help firms implement the research results; scientific resources required to maintain the level of production achieved by implementing the research results; costs to firms to implement the new research results; the duration and the impacts of these research results on changes in productivity, cost, chemical use, health etc. A sample of potential adopters of research results was chosen for each case and interviewed to assess their judgment of the data provided by the researchers and extension specialists. In all cases, high, medium and low estimates were obtained for the probability of research success, the probability and rate of adoption of research results, and the impact of implementing research results. The low estimates were used in this study to minimize the potential upward bias in estimating the impact of investment in each function.

Research projects were classified by the type of research being conducted into one of the following: (a) maintenance research; (b) applied research; (c) basic research, and (d) information development research. Research projects were also classified by their impacts on one of the following areas: (a) farm production; (b) post harvest; (c) natural resources; (d) community and human resources; and (e) the environment. Resource allocation to each research project by commodity and resource group was determined by geographic locations and legislative districts.

Evaluation Methods

The contribution of research to productivity growth in agriculture is well documented for the U.S. and other countries. Returns to investment in agricultural research have been estimated for most major commodities. The estimated rate of return ranges from –47.5 percent of investment in wheat research in Bolivia, to 700 percent of investment in hybrid corn research in the U.S. (Arndt, Dalymple, and Ruttan, 1977; Araji, 1980; Norton and Davis, 1981; and

Echeverria, 1990). The two approaches used to evaluate the benefit of investment in agricultural research are: (1) *ex-post* and (2) *ex-ante*. Several different methods are used within each approach. No one method is superior or considered standard in all situations (Araji, 1980; Norton and Davis, 1981; Alston, Norton and Pardey, 1995).

The *ex-post* approach evaluates past research performance. The two principle methods used in *ex-post* research evaluation are: (1) production function, and (2) index-number. The production function method estimates the contribution of research in terms of its impact on improved production efficiency, and it estimates marginal rates of return. The production function method requires time series data, cross sectional data, or a combination of the two. Several mathematical models are used to estimate the production function, depending on the nature of the problem and the data. Sim and Araji (1981) used a Hybrid Production function to evaluate return to investments in wheat variatal development and management practice research in the U.S.. Araji (1989) used the Cobb-Douglas production function to evaluate the benefit of investments to wheat research in the western United States. Araji, White, and Guenthner (1995) used the supply response model to analyze the spillover effects of potato research in six U.S. potato-producing regions. Araji and White (1996) used Vector Autoregressions model, with time series and cross sectional data, to evaluate the impact of agricultural research on U.S. exports of agricultural products.

The index-number method estimates consumer and producer surpluses; it requires a supply shifter, price and quantity data before and after the supply shift, an elasticity of demand coefficient, and an elasticity of supply coefficient. This method estimates average rates of return. Araji and Gardner (1981) used the index-number method to estimate the benefit of investment in the Dairy Herd Improvement Extension Program to producers and consumers of milk and milk products. Araji and White (1990) used the index-number method to estimate the benefit of research to U.S. wheat producers and domestic and international consumers of U.S. wheat. Also, Araji and White (1991) used the index-number method to assess the multi-market effects of technological changes and benefit of research to consumers and producers of beef and pork in the U.S..

The *ex-ante* approach evaluates future research performance, and projects flow of future benefits and cost expected from the development and adoption of research results. The four principle methods used in the *ex-ante* approach are: (1) benefit-cost method, which estimates rate of return; (2) scoring method, ranks research activities; (3) simulation method; and (4) mathematical programming method, to select an optimal mix of research activities. The benefit-cost method is based on probability distribution of research success and research adoption. The three other methods are based on a preference function.

The benefit-cost is the most widely used *ex-ante* method. Fishel (1971), based on a survey of scientists at the Minnesota agricultural experiment station, estimated probability distributions of costs and values of proposed research projects and projected rate of return to investment in agricultural research. Easter and Norton (1977) used scientist's estimates of yield, expected adoption rates, and costs of various research projects to estimate rate of return to proposed research investments in soybeans and corn production. Araji, Sim, and Gardner (1978) developed probability distribution for research success and rate of adoption and estimated rates of return to research and extension investments in nine major commodities in the western United States. Araji (1981) used a similar *ex-ante* approach to estimate return to investment in integrated pest management for 20 major agricultural commodities in the U.S.. Araji (1988) developed probability distribution for research success and rate of adoption and estimated rates of return to investments in maintenance, applied, and basic research in the Idaho agricultural experiment station. Araji (1990) applied an *ex-ante* benefit-cost approach to analyze the focus, function, and the productivity of the state agricultural experiment station system.

The Model

Given the nature of the problem and flow of future benefit, *ex-ante* approach, with benefit-cost, is the appropriate evaluation procedure. An *ex-ante* model with probability distribution was developed to project annual gross benefits, present value of expected flow of benefits, present value of the flow of costs, and the benefit-cost ratio of investments in the development, extension, maintenance, and implementation of the results of each research project (technology). The model is outlined in a set of equations in this section and used to evaluate each research project.

The annual gross benefit is estimated using Equation 1.

$$\sum_{j=1}^{N} \beta_{jt} = \sum_{j=1}^{N} A_{jo} \left\{ \Delta P_{jt} V_{jt} + \left(V_{jt} - V_{jo} \right) \right\} \tag{1}$$

Where:

β_{jt} = the benefit accruing to the jth technology in year t

A_{jo} = the expected total production, animal acreage, storage, processing, chemical use, human and natural resources affected by the adoption of the jth technology in the base year

j = 1, 2,..., N

ΔP_{jt} = the expected percentage change in net productivity, quality, cost, chemical use, natural resources, human health and nutrition, due to the adoption of the jth technology in year t.

V_{jt} = the expected price received per unit of product.

$$V_{jt} = \left\{ V_{jo} + V_{jo}\left(f\Delta P_{jt} \right) \right\}$$

where f is the flexibility ratio and V_{jo} is the price per unit of potato in the base year. The flexibility ratio is the inverse of price elasticity and it gives the percentage change in price associated with 1 percent change in quantity. Haung (1991) calculated flexibility ratios for several products and used them in this study whenever applicable.

β_j is the benefit that accrues to producers, processors, communities, natural resources, and human resources as a result of adopting the jth technology. The outcome β_j is probabilistic because it depends on the probability of successful development and adoption of the jth technology, $P(A \cap S)$. The expected value of β_j is defined as:

$$\sum_{j=1}^{N} E(\beta_j) = \sum_{j=1}^{N} \sum_{t=0}^{T} \beta_{jt} P(A \cap S) \qquad (2)$$

The present value of the expected flow of benefits from the adoption of the jth technology is calculated by "discounting" the right-hand side of Equation 2 as shown in Equation 3 below.

$$\sum_{j=1}^{N} PE(\beta_j) = \sum_{j=1}^{N} \sum_{t=0}^{T} \frac{\beta_{jt}\left\{ P(A \cap S) \right\}}{(1+r)^t} \qquad (3)$$

Where:

$PE(\beta_j)$ = present value of the expected flow of benefit

r = the social discount rate

T = number of years for which the jth technology affects production, quality, and/or cost

A 6 percent social discount rate was used to discount the flow of future benefits; this is the risk free rate on government bonds recommended by several federal agencies. A 20-year productive life expectancy of the jth technology is estimated in consultation with the researchers, extension specialists, and the potential adopters of the new technology. It is assumed that a better technology will likely be available after 20 years.

The present value of the flow of costs is expressed as:

$$C = \sum_{t=0}^{T} \left\{ \left(R_t + T_t + I_t + M_t\right) / \left(1+r\right)^t \right\} = \sum_{t=0}^{T} \left\{ C_t \,/ \left(1+r\right)^t \right\} \tag{4}$$

Where:

C = the present value of total cost associated with the development, release, transfer, implementation, and maintenance of the jth technology

R_t = direct expenditures in the development of the new technology R_t is positive in t = 0 and zero in t = 1 to T

T_t = technology transfer cost to extend the jth technology

I_t = implementation cost by farmers to adopt the jth technology

M_t = the cost of maintenance research to sustain the effectiveness of the jth varieties

Prior to 1996, expenditures in the development, transfer, implementation, and maintenance of the jth technology were compounded at 6 percent to bring it to the 1996 level. The flow of expenditure after 1996 was discounted by 6 percent to bring it to the 1996 level. The flow of benefits and cost were measured at the 1998 purchasing power of the dollar.

Functions and Resource Allocation of the SAES

The results of this study show that the principle function of the SAES is to provide solutions to continuous problems confronting the agricultural industry in the following areas: (1) farm production; (2) post harvest; (3) natural resources, (4) community and human resources; and (5) the environment. New knowledge and evolving technologies of investments in several types of research conducted by the SAES provide solutions toward solving these problems. The results of this study show the following four types of research are conducted by the SAES: (1) information development research; (2) maintenance research; (3) applied research; and (4) basic research. The SAES investments in each area and type of research are analyzed by commodities, geographic locations, and legislative districts.

Research Areas

Resource allocation by the IAES to each research area is shown in Table 1. The largest portion of the experimental station synatific man year (SMY) of 38.74 percent is allocated to farm production. About 22.30 percent of the experiment station SMY is allocated to the environment, 14.68 percent to post harvest, 12.71 percent to community and human resources, and 11.56 percent to natural resources.

Types of Research

Resource allocation by the IAES to four major types of research is shown in Table 2. An estimated 50.47 percent of the experiment station SMY is allocated to applied research. Over 30 percent of the experiment station SMY is allocated to information development research, 15.63 percent to basic research, and 3.57 percent to maintenance research.

Applied research is the major type of research conducted by IAES. This type of research is directed toward the development of solutions facing the agricultural industry in the areas of farm production, the environment, post harvest, community and human resources, and natural resources. Applied research utilizes available knowledge to find solutions to current problems in all five major areas. This type of research, generally, ranges between 1 to 10 years in duration and it covers a variety of problems ranging from infant nutrition to variatal development.

Information development research is conducted to develop scientific information to compliment other scientists research programs, to satisfy demands by the private and the public sectors for scientific information to comply with state and federal regulations, and to enhance the ability of the public and the private sector to institute policy, laws, or regulations based on informed scientific knowledge. This type of research includes: (a) soil survey and soil mapping to provide information to such agencies as the Bureau of Land Management, Forest Service, Soil Conservation Service, Highway Department, and Municipalities in order to facilitate public services; (b) food quality research to help food processors comply with state and federal regulations concerning accurate labeling and to provide data to the Nutritional Data Bank maintained by the USDA for use by national and international health organizations; (c) develop and maintain various data bases and techniques for the application and/or interpretation of these data to help state and federal agencies institute appropriate policies and regulations on natural resource use, environmental quality, ecological balance, and food quality control; (d) pesticide impact assessment research to develop information needed to re-register old chemicals, register new chemicals, determine the chemical tolerance limit on agricultural products, (e) marketing, price, and management research to help agricultural firms in their economic decision process, and (f) ground water hydrology research to assess ground water movement and nutrient content to help legislative committees and state agencies make informed decisions on water allocation and water quality legislation, rules, and regulations.

Basic research is directed toward the development of new knowledge to solve problems that present available scientific knowledge is not adequate to solve. This type of research has relatively low probability of success and ranges between 5-20 years in duration. Basic research programs in the IAES include: (a) development of a gene marking system to link to disease resistance and quality; (b) gene design, embryo physiology, and growth regulators which intended to provide animal and plant breeders with basic information to select more efficient breeds of animals and breed and select plant varieties that are high yielding, more vigorous, require less energy, and are resistant to diseases and environmental stress; (c) bioengineering research to convert processing waste into useful protein supplements and reduce the presently incurred high disposal costs; (d) bio-mass conversion research to convert wheat, barley and corn straw, and potato processing waste into polyphenols and amino acids; (e) identification of hormones that regulate the feeding and egg laying behaviors of insects which lead to the development of effective biological control of various insects on plants and animals; (f) identification of gene that controls fungus growth and release of toxic materials during organ transplant; (g) Ecoli research; (h) DNA research; and (i) bioremediation and detoxification of hazardous and toxic materials from soil and water.

Most research output depreciates over time. However, because of the biological character of agriculture and the focus of agricultural research on improving production in biological production systems, depreciation of research results is more important in agriculture than in other industries. Previous research has provided some quantitative evidence of the importance of maintenance research. Heim and Blakeslee (1986) estimated that up to 70 percent of current research expenditures on wheat production in Washington State are needed to maintain current yields. Blakeslee argued that almost 90 percent of recent agricultural research and extension expenditures in the U.S. are needed to maintain the achieved production level (1987). These estimates are high compared to estimates by Adusei (1987), which conclude that maintenance research represents slightly over one-third of agricultural research. Araji et al. (1998) estimated the percentage of scientific time allocated to maintenance research for selected commodities in the Western Region of the U.S. to range between 10 and 35 percent. Araji (1990) estimated that 40 percent of the IAES resources are allocated to maintenance research. The distinction between applied research and maintenance research is often not clear. Thus, these estimates may vary according to how maintenance research is defined.

Commodity/Resource Group

The IAES resources allocated to commodity/resource group are shown in Table 3. About 21 percent of the experiment station SMY is allocated to row crops. This group includes potato with 15.67 percent, sugarbeets with 3.51 percent, onions with 1.43 percent, and corn with 0.34 percent. An estimated 18.83 of the experiment station SMY is allocated to animal research that benefits the beef, dairy, sheep, pigs, horses, and trout segments of the agricultural industry. Over 18 percent of the experiment station SMY is allocated to natural resource research that includes soils, water, forest, rangeland, and wild life.

Small grains, which include wheat and barley, receive 13.47 percent of the experiment station SMY. An estimated 11 percent of the experiment station SMY is allocated to people research, which benefits infants, children, adults, retirees, and families. An estimated 7.21 percent of the experiment station SMY is allocated to research on other crops that include alfalfa, hops, Kentucky blue grass, certified vegetable seeds, nursery, and pasture. An estimated 5.33 percent of the experiment station SMY is allocated to grain legumes research that includes dry beans, peas, lentils, and garbanzos.

Over 2.4 percent of the experiment station SMY is allocated to oil seed crops such as canola, rapeseed, and mustard seed. The remaining 0.50 SMY (0.68 percent) is allocated to waste management and others.

Economic Benefit

The economic benefits of investment in the IAES research are analyzed by areas of research, types of research, commodity/resource group, geographic locations, and legislative districts.

Research Area

The benefit of investments in the IAES research by area is shown in Table 4. Investment in post harvest research has the greatest payoff with a benefit-cost ratio of 57.08. Investment in farm production research has the second highest payoff with a benefit-cost ratio of 44.38. Investments in natural resource research and environmental research have the lowest payoff with benefit-cost ratio of 1.57 and 1.19, respectively.

Type of Research

The benefit of investment in the IAES research by type of research is shown in Table 5. Investments in applied research have the highest pay off with a benefit-cost ratio of 42.97. Investments in maintenance research have the second highest payoff with a benefit-cost ratio of 23.58. Investment in basic research has a benefit-cost ratio of 11.13 and investment in information development research has the lowest benefit-cost ratio of 2.67.

Geographic Districts

Investments in the IAES research by the four geographic districts are shown in Table 6. Investments in research that directly effect commodities and resources in the East district have the highest payoff with a benefit-cost ratio of 41.68. This is primarily due to the relatively large size of acreage in potato and small grain, location of potato processing plants, and the high number of beef animals. Investment in research that directly affects commodities and resources in the Southcentral district has the second highest payoff with a benefit-cost ratio of 28.04. This is primarily due to high beam production, sugarbeet production and processing, trout production and processing, and the rapidly expanding dairy production and processing. This district is also second to the Eastern district in the production and processing of potatoes.

Investment in research that directly affects commodities and resources in the Southwest district has a benefit-cost ratio of 19.41. This district produces all the onions, certified vegetables and alfalfa seeds, and fruit and wine in the state. It also produces some sugarbeets and potatoes. Investments in research that directly effect commodities and resources in the North district have a benefit-cost ratio of 11.78 and are significantly below the state average of 27.63. Primary commodities produced in this district are soft white wheat, legume crops, and some beef cattle.

Commodity/Resource Group

The benefit of investments in the IAES research by commodity/resource group is shown in Table 7. Investment in row crop research has the highest payoff with a benefit-cost ratio of 68.60. This is primarily due to the high returns to potato, sugarbeet, and onion production and processing. Investments in research that effect other crops and fruits have benefit-cost ratios of 30.30 and 31.17, respectively. Investments in research that effect animals, small grains, and grain legumes have benefit-cost ratios of 21.99, 25.64, and 26.52, respectively. Investments in research that effect people, natural resources, and oil seed crops have benefit-cost ratios of 4.11, 0.79, and 1.85, respectively. No benefit is determined for investment in waste management research.

Legislative Districts

The benefit of investments in the IAES research by legislative districts is shown in Table 8. The benefit-cost ratio of investments in research that directly effect commodities and resources in districts 26 through 35, that are located in East Idaho, are relatively high compared to other legislative districts located in other parts of the state. The benefit-cost ratios for investments in research that directly effect commodities and resources in these legislative districts range from a low 16.34 to a high of 52.69 with an average of 41.68. Investments in research that directly effect commodities and resources in legislative districts located in Southcentral Idaho have the second highest benefit-cost ratios. The benefit-cost ratios of investment in research that effect commodities and resources in districts 21 through 25 ranges from a low of 16.30 to a high of 38.57 with an average of 28.04.

The benefit-cost ratio of investments in research that effects commodities and resources in legislative districts 8 through 19, that are located in Southwest Idaho, ranges from a low 6.73 to a high of 28 with an average of 19.41. Return to investments in research that directly effect commodities and resources in legislative districts, 1 through 7, located in North Idaho, is low compared to other legislative districts in the state. The benefit-cost ratios range from a low of 6.52 to a high of 14.48 with an average of 11.78, which is significantly below the state average.

Summary and Implications

The task of the SAES in promoting economic growth in a healthy environment is to introduce technical change that facilitates efficient use of human and natural resources in the production, storage, processing, and distribution of food and fiber products. The significance of technological change is that it permits the substitution of knowledge for resources. Agricultural experiment station resources are allocated to five principle areas. They are: (1) farm production with 38.74 percent, (2) environment with 22.30 percent, (3) post harvest with 14.68 percent, (4) community and human resources with 12.71 percent, and natural resources with 11.56 percent.

Four types of research are conducted by the SAES to provide solutions to immediate, short-run, and long-run problems in the above five principle areas. They are: (1) applied resources with 50.74 percent of the SAES resources, (2) information development research with 30.07 percent of the SAES resources, and (4) maintenance research with 3.57 percent of the SAES resources. The largest proportion of the SAES resources was allocated to research on row crops such as potato and sugarbeets. Research resources allocated to research in animals, natural resources, and small grain, ranked second, third, and fourth, respectively.

Analysis of the return to investments in the five principle areas shows that investments in post harvest research have the highest payoff with a benefit-cost ratio of 57.08. Investment in farm production research has the second highest payoff with a benefit-cost ratio of 44.38. Investments in community and human resources, natural resources, and environmental research have benefit-cost ratios of 7.31,1.57, and 1.19, respectively. Analysis of the return to investments in four types of research show that investments in applied research have the highest payoff with a benefit-cost ratio of 42.97, followed by maintenance research with a benefit-cost ratio of 23.58, basic research with a benefit-cost ratio of 11.13, and information development research with a benefit-cost ratio of 2.67.

Analysis of return to the SAES investments in research that effect commodities and resource groups show that investments in research that effect row crops have the highest benefit-cost ratio of 68.60. Investments in research that effect fruits and wine, other crops, grain legumes, small grains, and animals have benefit-cost ratios of 31.17, 30.30, 26.52, 25.64, and

21.99, respectively. Returns to investments in the SAES research that effect commodities and resources by legislative districts is also analyzed in this study.

The results of this study point toward two policy issues with significant implications to the agricultural industry. The two issues that have been the subject of professional debate are the level of investment in the SAES research and the focus of the SAES research. Economists have debated the high return to public investment in agricultural research and its implications to the level of investment. Available evidence, including the results of this study, tends to support the hypothesis of under-investment in agricultural research.

The issue of how the SAES resources ought to be allocated cannot be answered by looking at one commodity, one resource, one area of research, one type of research, or one location. The results of this study provide a broad picture of the benefit of investments in all competing segments demanding research results from the SAES.

The focus of agricultural research is discussed and widely debated by economists and administrators of research. The state agricultural experiment stations in the United States, while they differ in the level of funding, areas of research, types of research, and type of commodity and resource group that dominates the core of their research programs, have a similar research focus. The results of this study show that farm production oriented research still dominates the SAES function. Compared with the early 1980's, increased emphasis in recent years has been directed toward research focusing on the environment, post harvest, community and human resources, and natural resources (Araji, 1990). This has been influenced by the rapidly changing social-political environment effecting the agricultural industry and consumers of food products.

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Table 1. Resource allocation to areas of research covered by IAES

Area of Research	Number of SMY	Percent of total SMY
Farm production	28.5	38.74
Environment	16.4	22.30
Post harvest	10.8	14.68
Community and human resources	9.35	12.71
Natural resources	8.50	11.56

Table 2. Resource allocation to types of research conducted by IAES

Type of Research	Number of SMY	Percent of total SMY
Applied research	37.3	50.74
Information development research	22.1	30.07
Basic research	11.13	15.63
Maintenance research	2.62	3.57

Table 3: Resource allocation to commodity/resource group by the IAES

Commodity/resource group	Total SMY	Percent of Total SMY
Row crops	15.41	20.95
Small grains	9.91	13.47
Grain legumes	3.92	5.33
Oil seeds	1.55	2.11
Other crops	5.33	7.21
Fruits	1.78	2.42
Animals	13.85	18.83
Natural resources	13.24	18.01
People	8.09	11.00
Miscellaneous	.15	0.20
Wastes	.35	.48

Table 4: The benefit of investments in the IAES research by area

Research area	Gross annual benefit ($)	Net annual benefit ($)	Present value ($)	Research and technology transfer cost ($)	B/C
Farm production	426,158,768	354,680,112	2,065,653,243	46,540,171	44.38
Environment	90,736,453	83,053,553	373,919,885	27,661,646	1.19
Post harvest	189,398,705	161,138	772,883,793	13,540,448	57.08
Community/human resources	22,201,590	21,510,283	86,824,400	11,871,773	7.31
Natural resources	7,586,143	6,279,343	32,872,414	11,871,773	1.57

Table 5: The benefit of investments in the IAES research by type of research

Type of research	Gross annual benefit ($)	Net annual benefit ($)	Present value ($)	Research and technology transfer cost ($)	B/C
Information development research	50,185,653	42,247,525	77,830,405	29,130,968	2.67
Maintenance research	20,473,017	18,279,330	97,133,020	4,119,253	23.58
Applied research	573,064,049	499,981,426	2,927,692,143	68,127,319	42.97
Basic research	95,491,951	68,722,911	229,498,169	20,616,946	11.13

Table 6: The benefit of investments in IAES research by geographic districts

Districts	Gross annual benefit ($)	Net annual benefit ($)	Present value ($)	Research and technology transfer cost ($)	B/C
North	62,216,523	56,531,907	254,654,706	12,732,735	11.78
Southwest	97,040,773	81,870,264	420,001,754	21,000,088	19.41
Southcentral	294,505,056	229,687,540	1,162,470,524	58,123,526	28.04
East	282,319,307	258,781,989	1,495,026,751	74,751,338	41.68
State	736,081,659	626,871,700	3,332,153,736	120,580,200	27.63

Table 7: The benefit of investment in the IAES research by commodity/resource group

Commodity/resource group	Gross annual benefit ($)	Net annual benefit ($)	Present value ($)	Research and technology transfer cost ($)	B/C
Row crops	378,415,452	342,291,234	2,113,251,561	30,805,978	68.60
Animals	170,600,839	110,222,971	390,730,978	17,768,960	21.99
Small grains	89,210,131	85,561,798	377,778,892	14,768,826	25.64
Other crops	39,267,509	33,903,769	176,040,941	5,809,976	30.30
Grain legumes	28,463,487	24,966,687	137,674,554	5,190,754	26.52
People	10,826,185	10,826,185	37,686,073	9,167,091	4.11
Fruits	10,607,403	10,408,403	68,687,355	2,203,736	31.17
Natural resource	7,714,286	7,714,286	24,885,799	31,589,403	0.79
Oil seeds	976,368	976,368	5,417,581	2,931,275	1.85
Miscellaneous	0	0	0	11,683	0
Wastes	0	0	0	365,519	0

Table 8: The benefit of investments in the IAES research by legislative districts

Legislative District	Gross annual benefit ($)	Net annual benefit ($)	Present value ($)	Research and technology transfer cost ($)	B/C
North	**62,216,523**	**56,531,907**	**254,654,706**	**21,624,201**	**11.78**
District 1	3,769,211	3,239,198	12,837,574	641,879	6.52
District 2	4,969,099	4,310,910	20,069,052	1,761,032	11.40
District 3	1,662,510	1,469,638	7,008,402	505,217	13.87
District 4	7,206,510	6,426,527	30,339,615	3,062,531	9.91
District 5	10,447,783	9,843,647	45,272,663	3,127,428	14.48
District 6	7,478,455	7,449,364	33,957,618	2,367,771	14.34
District 7	76,182,955	23,792,623	105,169,781	8,831,256	11.91
Southwest	**97,040,773**	**81,870,264**	**420,001,754**	**21,634,625**	**19.41**
District 8	8,516,842	7,484,725	36,655,230	2,254,746	16.26
District 9	23,100,216	19,999,812	109,360,027	3,797,858	28.00
District 10	16,532,582	13,925,437	74,676,580	2,774,354	26.92
District 11	11,413,567	9,193,694	59,595,716	2,682,474	22.22
District 12	15,879,580	12,850,430	71,682,591	2,689,364	26.65
District 13	2,260,853	1,801,345	7,136,688	1,036,994	6.88
District 14	2,820,890	1,872,340	7,581,678	1,125,984	6.73
District 15	2,980,700	1,921,520	7,894,700	1,130,595	6.98
District 16	2,352,905	1,850,700	7,205,580	1,032,800	6.97
District 17	2,250,600	1,720,692	7,050,962	1,034,905	6.81
District 18	2,300,500	1,124,500	7,092,524	1,038,600	6.82
District 19	2,600,281	1,201,306	7,102,609	1,039,905	6.83

Table 8: The benefit of investments in the IAES research by legislative districts, con't.

Legislative District	Gross annual benefit ($)	Net annual benefit ($)	Present value ($)	Research and technology transfer cost ($)	B/C
South central	**294,505,056**	**229,687,540**	**1,162,470,524**	**41,453,229**	**28.04**
District 20	28,913,178	24,852,811	126,852,811	7,780,311	16.30
District 21	57,207,101	42,385,491	199,087,817	8,919,126	22.32
District 22	30,679,499	22,717,863	108,761,121	4,038,934	26.93
District 23	24,891,805	19,209,391	95,849,013	3,617,831	26.49
District 24	88,066,023	66,541,114	339,500,583	9,515,029	35.68
District 25	64,747,449	53,992,840	292,419,178	7,581,268	38.57
East	**282,319,307**	**258,781,989**	**1,495,026,751**	**35,868,145**	**41.68**
District 26	41,062,338	38,054,610	220,988,552	5,497,699	40.20
District 27	50,680,656	47,969,733	290,078,307	5,505,235	52.69
District 28	36,389,368	34,525,470	204,583,570	4,310,486	47.46
District 29	6,211,408	5,903,348	35,033,517	824,548	42.49
District 30	11,732,659	11,150,769	66,174,420	1,557,480	42.49
District 31	33,225,482	30,141,665	174,181,191	4,013,064	43.40
District 32	24,956,971	20,001,182	91,861,303	4,439,590	20.69
District 33	2,490,928	2,306,130	11,565,656	708,009	16.34
District 34	691,924	640,592	3,212,682	196,669	16.34
District 35	74,877,573	68,288,490	397,347,553	8,815,365	45.07
State	**736,081,659**	**626,871,700**	**3,332,153,736**	**120,580,200**	**27.63**