An Assessment of the Economic Impact of Firms Assisted By the Oklahoma Food and Agricultural Products Center

Ann Ulmer, Rodney B. Holcomb, Michael D. Woods, Charles Willoughby, and Daniel S. Tilley

The evolution of value-added centers at land-grant universities, along with the recent development of numerous Ag Innovation Centers, has been viewed as a sign of a shifting emphasis to value-added agriculture research and technical assistance efforts. The entities that fund these centers, be they state or federal government, have a vested interest in the economic impacts of these centers. However, evaluating the efforts of a public good is not always an easy task. An economic-impact study of the Oklahoma Food and Agricultural Products Center (FAPC) was conducted to assess the total economic impacts of the firms assisted by the FAPC on Oklahoma's economy. A telephone survey was used to collect the necessary data and IMPLAN was used to estimate direct, indirect, and induced economic impacts.

Value-added centers have blossomed during the past decade. Their funding sources and organizational structures are varied: some are "centers in name" that make use of existing faculty/staff and funds at land-grant universities; some have facilities and positions that were created and funded through state legislative mandates; and others, such as Ag Innovation Centers, were designed and funded according to the guidelines of federal funding initiatives. The operational formats of these centers are also varied, with some focusing strictly on business/marketing assistance while others also provide highly technical assistance such as pilot-plant processing and laboratory services. These centers represent significant investments by taxpayers (and in several cases large capital investments) to aid the development of states' value-added industries.

Woods and Hoagland (2000) indicate that "there are several qualitative ways to show the effectiveness of spending tax dollars for state-led value-added programs." Yet while qualitative assessments abound, little has been done in terms of quantitative assessment of value-added programs and their impacts on state economies. Economic-impact assessments for such programs are difficult for a number of reasons: the cooperation needed to get detailed firm data from center clients, the difficulty in capturing job/income savings as opposed to job/income creation (i.e. the results of center efforts that help keep a business from diminishing, as opposed to efforts that help a business grow), and the difficulty in getting clientele to place a value on the technical and business support services they received from an entity that is viewed as a "public good." Furthermore, it is virtually impossible to isolate the impacts solely attributed to a value-added center's efforts from those associated with assistance/incentives provided by municipalities, county government, and other state agencies.

This study determined the total economic impacts (direct, indirect, and induced) of the companies assisted by the Oklahoma Food and Agricultural Products Research and Technology Center. The study was requested for three reasons: this data could potentially be used to demonstrate the impact the Center has on the state's food industry as well as on Oklahoma's economy as a whole, the data could be used as a metric to evaluate the execution of the Center's mission, and the information provided would be important to the Center's promotional efforts.

Previous qualitative studies found that the Center's variety of services were meeting the needs of its clients (Kelsey and Bond 2000) and that participants in the center's entrepreneurship workshops were receiving the skills needed to develop new value-added businesses (Mueseler 2000). However, the center had no set method to evaluate the economic impact of the services it provides. It is hoped that this study will help other value-added centers recognize methodology for and issues related to developing quantitative evaluations of their programs.

Ulmer is former research assistant, Holcomb is associate professor and Browning Endowed Professor, Woods is professor and extension economist, and Tilley is professor, Department of Agricultural Economics, Oklahoma State University, Stillwater, OK. Willoughby is business and marketing specialist, Oklahoma Food & Agricultural Products Center, Oklahoma State University.

The Food and Agricultural Products Center

The Oklahoma Food and Agricultural Products Research and Technology Center, better known as the Oklahoma Food and Agricultural Products Center (FAPC), was established in 1995 and staffed in 1997 to help local and regional entrepreneurs as well as established firms compete in the current marketplace. The purpose of the FAPC was to help Oklahoma's economy bridge the gap between agricultural production of raw commodities and finished products. The FAPC targets clients that are involved with existing or potential value-added agricultural-processing firms in the state of Oklahoma. The clearly defined customer base helps the FAPC allocate time and resources in a way to best serve the needs of clients.

The mission of the FAPC is to "generate and disseminate technical and business information that will stimulate and support the growth of value-added food and agricultural products processing in Oklahoma." Value-added is defined as adding time, place and/or form utility to a product in order to better meet the demands, tastes, and preferences of consumers. The amount of value-added is the after-tax return on invested capital used to accomplish the time, place, and/or form utility minus the overall costs of capital (FAPC 2005).

The facilities were constructed at a cost of more than $18 million, and have an annual operating budget of $2.8 million, funded with state dollars. The FAPC was a large capital investment put forth by Oklahoma's taxpayers, and state legislators have been keenly interested in the return on this particular investment. The legislature established an Industry Advisory Committee, comprised of several members of the food production, packaging, and distribution sectors, to oversee FAPC activities and make regular reports to the legislature. Thus there is a strong need for documenting how effectively the FAPC lives up to its mission.

The FAPC works to provide clients with a wide variety of services. Currently, the FAPC offers four main categories of services: Business and Marketing Assistance, Educational and Quality Programs, Technical Assistance, and Research.

The Business and Marketing Assistance Programs help address each firm's unique business needs. The FAPC can help the firm develop a business plan. Working with the firm to identify and evaluate possible markets, pricing and promotion of existing and future products, and potential financing options are valuable services that the FAPC has to offer. The FAPC can also help the firm comply with state and federal regulations or locate possible co-packers for the firm's products.

Educational and Quality Programs include a number of workshops designed by the FAPC to meet the needs of their clients. Most of the workshops are offered at a small fee to the client to help cover the costs of materials and meals that are provided. The FAPC currently offers seven workshops: an Entrepreneurial Workshop; Food Industry Roundtable Discussions; a Hazard Analysis and Critical Control Point (HACCP) Workshop, including a back-to-the-basics and an advanced session; a Master Canner's Workshop; a Better Process Control School; and a Deep Fat Frying Workshop.

Technical Assistance focuses on aiding customers with a variety of projects involving compliance with new regulations, process optimization, and product development and improvement. Approximately 20 faculty and staff in the FAPC encompass a wide variety of assistance areas, including food microbiology, food chemistry, food engineering, horticultural processing, meat science, cereal and oilseed processing, quality control, and economics.

The final service area is encompassed in the FAPC's research programs. The research usually takes place in the FAPC's pilot processing facilities and/or laboratories. The facilities are available to perform all levels of agricultural-product processing. Facilities can accommodate meat, cereal, dairy, fruit and vegetable products. The up-to-date equipment allows for thermal processing, drying, freezing, packaging, milling, and fermentation of various products. The flexibility of the processing plant allows the FAPC to meet the needs of the clients in terms of developing new products, evaluation of ingredients, testing new equipment, and creating new manufacturing techniques (FAPC 2005).

Data Collection

Data collection was accomplished via telephone survey in early 2002. Questions about services received by the firm and firm demographic information, including employment, payroll, and sales, were included in the telephone survey. The telephone survey focused on a population of 309 value-added businesses of all sizes and capabili-

ties, gathered from the FAPC's project database. The FAPC database includes the names and contact information of all firms with completed, active, and pending projects. The database contained information on a total of 405 project contacts, but 96 were disallowed from the survey because the contact information included wrong numbers, disconnected numbers, or the telephone numbers turned out to be fax or data lines.

The telephone survey of the 309 contacts resulted in an 80% response rate, although not every contact provided answers to every question. Of the 246 respondents, 67.5% were currently operating a value-added business in the state of Oklahoma. Eighty respondents (32.5%) were either entrepreneurs who decided against starting a business or were no longer operating a value-added firm. As part of the telephone survey, participants were asked if they would be willing to participate in a case-study analysis of the services received from the FAPC. Results of the case-study analysis are available upon request from the authors.

The data were analyzed using SPSS; frequency and percentages were calculated on each question. For the statistical questions on the survey, the mean, median, mode, minimum, maximum, and percentiles were also calculated to give a better idea of how the data points lie (Table 1).

Employment

The number of current employees working for the firms was collected as a part of the survey. Employees were divided into two categories: full-time and part-time. Full-time employees are persons who work at least 40 hours a week at the firm, and part-time employees are persons who work less than 40 hours a week at the firm. Three respondents to this question did not know the number of full-time employees and one refused to answer the question. The respondents to the survey indicated total full-time employment of 7883 workers; the mean number of full-time employees per firm was 56.54. The quartile percentages provide a better picture of the distribution of employees: 25% of the firms (35 firms) have one or fewer full-time employees, 50% have three or fewer full-time employees, and 75% have 12.75 or fewer full-time employees. This suggests that the majority of the firms that responded to the question were small firms.

Five firms did not know the number of part-time employees and one firm refused to answer the question. A total of 937 part-time employees worked for the firms in 2001. The mean number of part-time workers per firm was 6.79. The quartile percentages indicate that 25% of the firms do not employ part-time personnel, 50% employ one or

Table 1. Summary Statistics from Telephone Survey of Firms Assisted by the FAPC.

Statistic	Full-time employees (N=140)	Part-time employees (N=138)	Annual payroll to employees (N=84)	Total annual sales (N=92)
Total	7,883	937	$44,457,304.00	$544,915,000.00
Mean	57	7	$529,253.62	$5,922,989.00
Median	3	1	$22,500.00	$145,000.00
Mode	1	0	0	0
Minimum	0	0	0	0
Maximum	3,500	400	$20,000,000.00	$300,000,000.00
Quartiles:				
25%	1 or fewer	0	0	$14,250.00 or less
50%	3 or fewer	1 or fewer	$22,500.00 or less	$145,000.00 or less
75%	13 or fewer	4 or fewer	$106,000.00 or less	$1,000,000.00 or less

fewer part-time personnel and 75% employ four or fewer part-time personnel.

Annual Payroll

The total amount of annual payroll paid to employees in 2001 was gathered in the telephone survey. The data indicate a wide variation in the size of firms in the study. The total value paid to employees in 2001 by firms assisted by the FAPC was over $44 million. The minimum amount of payroll received by employees was zero and the maximum was $20 million. The quartile percentages show that 25% of the firms have no payroll, 50% have payroll of $22,500 or less, and 75% have payroll of $106,000 or less. A large portion of the respondents did not answer this question. Of the 144 possible responses, 51 indicated that they did not know the amount of annual payroll in 2001 and nine refused to answer, leaving 84 valid responses.

Annual Sales

Sales figures for 2001 were collected in the telephone survey. The figures were based on the total value of sales that each firm experienced for the year 2001. There were 92 valid responses. Total value in sale's for the firms that the FAPC has assisted accounted for over $544 million of the state's total sales. Thirty-seven contacts did not know sales, and 15 contacts refused to answer the question. Based on the valid responses the mean sales was almost $6 million. The quartile percentages showed that 25% of the firms had sales of $14,250 or less, 50% had sales of $145,000 or less, and 75% had sales of $1 million or less.

Five-Year Comparison

As part of the telephone survey, a question was asked to determine if the firms were in business five years ago (i.e., before the FAPC was established in 1997). Profile data for firms in business in 1997 (employment, payroll, sales) were collected for 1997 as well as for 2001 (Table 2). Of the 143 total responses to this question, 58% indicated that their firm was in business five years ago. Sixty of the firms (42%) had been established during or after 1997. For the comparison, only firms that replied to both 1997 and 2001 data for any given question were used. Full-time employment increased by 12% for the 72 firms that responded. Seventy firms responded to the part-time employment comparison; these firms indicated less than a 1% decrease in part-time employment. The comparison of payroll showed a 69% increase over the five-year period for 32 firms. There was a 144% increase in sales for the 43 firms that reported data for both 1997 and 2001.

Methodology

This study used input-output modeling to determine the level of firms' economic impacts. Input-output models are commonly used to estimate economic impacts on a region's current output, total amount of value-added through processing, number of jobs, employee compensation, and proprietors' income due to a change in the region's business activity (Stallmann et al. 2001). Doeksen and Schreiner (1974) identified the three basic components of input-output models as being a transaction or flow table, a set of direct coefficients, and direct and indirect coefficients that can be derived from the table. The flow table provides the foundation for the model, since the direct coefficients and the direct and indirect coefficients are derived from this table.

The flow table includes a processing section in the upper-left-hand portion. This includes sectors that produce goods and services from the other sectors. The final-demand portion of the flow chart is located on the right-hand side. Sectors that purchase goods and services from the processing sectors for final use are located in this part of the table. This portion of the table is usually made up of households, government, exports, inventory change, and capital formation. The primary-input section of the table consists of imports, households, governments, and depreciations. The row figures indicate the amount of goods and services that are purchased by the sectors in the processing and final-demand sectors on the table (Doeksen and Schreiner 1974).

Economic Impacts and Multipliers

The creation of a new firm or the expansion of an existing firm can have a large impact on a region's economy. The impacts can be broken down into three categories: direct, indirect, and induced effects. Direct impacts or direct effects are the changes in economic activity that result from the production and processing of a product. The new

Table 2. Comparisons of Center-Assisted Businesses that Were in Operation Before the Center's Inception.[a]

Business characteristics	1997	2001	Percentage change
	Full-time employment (N=72)		
Total	5,756	6,424	12
Mean	80	89	11
Median	4	7	75
Mode	1	1	----
Minimum	0	0	----
Maximum	3,500	3,500	----
	Part-time employment (N=70)		
Total	305	302	-1
Mean	4	4	----
Median	1	1	----
Mode	0	0	----
Minimum	0	0	----
Maximum	60	50	-17
	Annual payroll to employees (N=32)		
Total	$17,381,000.00	$29,126,000.00	69
Mean	$543,156.00	$939,548.39	73
Median	$27,500.00	$32,500.00	18
Mode	0	0	----
Minimum	0	0	----
Maximum	$12,000,000.00	$20,000,000.00	67
	Total annual sales (N=43)		
Total	$216,572,000.00	$528,612,000.00	144
Mean	$5,036,558.10	$12,293,302.00	144
Median	$500,000.00	$750,000.00	50
Mode	$300,000 and $600,000	$1,000,000.00 and $3,000,000.00	----
Minimum	0	0	----
Maximum	$100,000,000.00	$300,000,000.00	200

[a] Of the 143 respondents to this question, 83 (58%) had been in business before 1997 and 60 (42%) established a business during or after 1997.

firms or expanded firms are considered to be direct industries (Piewthongngam et al. 2002b; Stallmann et al. 2001).

Indirect effects occur when the new or expanded firms purchase goods and services from other sectors to produce more of the product. The indirect impact also includes the hiring of additional labor for production of the final product. These firms, called supporting industries, are the industries from which the direct industries purchase inputs. The indirect effects are a result of the increased business spending that occurs by the basic industry. The in-

crease in wages paid to employees in the direct and supporting industries is available for employees to purchase additional goods and services. The additional wages spent by employees create an induced effect on the region's economy (Piewthongngam et al. 2002b; Stallmann et al. 2001).

IMPLAN

The Impact Analysis for Planning (IMPLAN) software program was used for this input-output modeling effort. IMPLAN was first developed by the U.S. Forest Service. The program was used with the IMPLAN regional database to construct regional models. The IMPLAN database contains economic data for every county in the United States. Since 1990 the database has been updated annually (Holland, Geier, and Schuster 1997). IMPLAN is used to determine how local changes affect a region's or state's economy (Maki et al. 1989). The database includes 528 industrial sectors (Piewthongngam et al. 2002a). IMPLAN can divide industrial sectors by one- or two-digit SIC codes. Two-digit agricultural SIC codes range from 1 to 27 and manufacturing codes range from 58 to 432.

IMPLAN allows construction of localized, state-level, etc., input-output models. Wagner, Deller, and Alward (1992) discussed the application of input-output in detail. The mathematical representation of input-output models is included in the appendix of that article as well as in Doeksen and Schreiner (1974).

The input-output model was used to estimate direct, indirect, and induced effects of the changes created by the firms assisted by the FAPC. As the employment, payroll, and output increase in the value-added agribusiness sector, the firms will demand more goods from other sectors and thus will increase employment, payroll, and output in the other sectors. This was considered to be a direct impact, the primary impact of the FAPC's firms. The resulting increases in other sectors' employment, payroll, and output are the indirect effects. The induced effects involve the employees of the direct industries and supporting industries spending the additional income that is received due to the change in the value-added industry. The total effect is the summation of the three impacts. The state multiplier can then be calculated as the total effect divided by the direct effect.

Results from IMPLAN Models

Full-Time Employment

The first economic factor analyzed was employment. In the study, employment was broken down into two categories, full-time and part-time. The impact of full-time employment by the firms assisted by the FAPC is summarized in Table 3. An

Table 3. Full-Time Employment: Direct, Indirect, and Induced Effects on Oklahoma's Economy, 2001.

Industry sector	Direct employment[a]	Indirect and induced employment	Total related employment
Meat processing	6,167	12,518	18,685
Fruits and vegetables	24	1	26
Bakery and confectionary goods	166	127	293
Grain processing for food	20	5	25
Prepared and specialties food	1,647	247	1,894
Grain and other processing for feed	14	4	18
Fats and oils processing	60	423	483
Other	288	248	536
Total	8,385	13,573	21,960

[a]Direct employment includes full-time and part-time employment (two part-time employees equal one full-time employee).

employment multiplier represents the change in employment in the state from a one-unit change in the number of employees in a given sector. In the case of the fruits and vegetables industry, every additional individual employed by the fruits and vegetables industry creates 1.06 jobs throughout the state. The direct employment, the actual number of employees of the firms assisted by the FAPC, of the fruits and vegetables industry was 24; based on the 1.06 multiplier, the sector accounted for 26 jobs in the state. There were 8384 total full-time employees of the FAPC-assisted firms that directly and indirectly account for almost 22,000 full-time positions in the sate of Oklahoma. In comparison with the year 2000 statewide estimate of 39,609 value-added industry direct employment jobs (Piewthongngam et al. 2002b), the direct employment numbers for those firms assisted by the FAPC were 8385. This translates to roughly 21% of all direct employment in Oklahoma's food and fiber processing sectors.

Total Sales

The sales values for 2001 were used to determine the economic impact that the firms' sales had on the state. An income or sales multiplier measures the total change in the state's economy from a one-dollar change in income or sales by a given sector. In the case of Bakery and Confectionary Goods the sales multiplier is 1.53. For every $1 increase in sales by this sector, the state experienced $1.53 in sales from direct, indirect, and induced effects. The firms assisted by the FAPC account for nearly $545,000,000 in direct sales in the state, and approximately $2 billion in direct, indirect, and induced sales (see Table 4). Piewthongngam et al. (2002b) estimated total sales of food processing firms in the state of Oklahoma to be $1,720,814,000. Comparing this number with the direct sales of the firms assisted by the FAPC indicates that the firms assisted by the FAPC account for more than 31% of the state's direct food-processing sales.

Estimation of All Firms Assisted by the FAPC

The survey data was used to create an estimate of the impact of all of the firms assisted by the FAPC. To calculate the total estimate, averages were calculated for full-time employment, payroll, and sales. A scatter plot of responses was examined to determine extreme outlying observations. Based on the scatter plot, extreme observations were excluded when averages were calculated in order to account for those firms that did not respond. There were 140 valid responses for full-time employment. The calculated average was used to calculate the full-time employment for the entire 405 firms in the population. The survey results showed that 67.5% of the population was currently operating a value-added business. Therefore, full-time employment was calculated for 273 firms—67.5% of the 405 total firms. An average of 21 employees was used to determine full-time employees for the additional 69 firms that did not respond to the survey. The same

Table 4. Total Sales: Direct, Indirect, and Induced Effects on Oklahoma's Economy in 2001.

Industry sector	Total direct sales	Indirect and induced sales	Total related sales
Meat processing	$411,143,500	$1,424,827,093	$1,835,970,593
Fruits and vegetables	0	0	0
Bakery and confectionary goods	$1,869,000	$997,633	$2,866,633
Grain processing for food	$1,833,000	$380,547	$2,213,547
Prepared and specialties food	$81,739,500	$10,060,920	$91,800,420
Grain and other processing for feed	0	0	0
Fats and oils processing	$30,000,000	$132,702,813	$162,702,813
Other	$18,330,000	$15,770,861	$34,100,861
Total	$544,915,000	$1,584,739,871	$2,129,654,871

methodology was used to calculate the averages for payroll and sales. An average of $99,466 in payroll was used in the estimation of the additional 125 firms that did not respond to the payroll question. An average of $1,572,079 in sales was used to estimate the impact of the additional 117 firms that failed to respond. The estimates for all of the firms assisted by the FAPC are reported in Table 5.

Conclusions and Implications

The data gathered in the telephone survey indicate that the firms assisted by the FAPC account for over 21% of the states direct food-processing jobs, and 31% of the states direct food-processing sales are by firms that the FAPC has assisted. The IMPLAN results show the total impact of the firms on the state including direct, indirect, and induced effects. An estimation of all of the firms assisted by the FAPC indicates that the firms provide 28% of the direct food-processing jobs and 48% of the direct food-processing sales in the state. The five-year comparison of economic data shows an increase in full-time employment, payroll, and sales. The case-study analysis provided a closer look at the services provided by the FAPC and the impact they had on individual firms. All of the firms indicated that the services had a positive impact of their firm. The firms also indicated that they would seek assistance from the FAPC in the future if the need were to arise.

It is hoped that this study will help other value-added centers realize the importance of assessing their economic impacts on a state or region and justify their existence to stakeholders and funding agencies.

The information gathered from this study has been used when addressing legislative committees, the FAPC Industry Advisory Committee and other Oklahoma stakeholders. It has been published in the FAPC Annual Report and one issue of the *FAPC Flash*, a short newsletter distributed to industry members, chambers of commerce, state agencies, and more than 200 news media agencies. The information has also been useful when recruiting new Industry Advisory Committee members and when recruiting new staff, faculty, and administrative members to Oklahoma State University's Division of Agricultural Sciences and Natural Resources.

Oklahoma Department of Commerce officials and municipal and area Community Development Professionals have cited FAPC's successes when on industry recruitment missions. Universities interested in developing centers like FAPC have been provided with this study. Additionally, Small Business Development Centers interested in implementing a food-manufacturing component to their Business Incubator Programs have shown interest in this study. Finally, clients of the FAPC have used this information when preparing applications for SBA Loans, state Agricultural Diversification Grants/Loans, and USDA Value-Added Grants.

References

Doeksen, G. A. and D. F. Schreiner. 1974. "Interindustry Models for Rural Development Research." Agricultural Experiment Station, Oklahoma State University.

Holland, W. D., H. T. Geier, and E. G. Schuster.

Table 5. Comparison of Telephone Survey Results, Estimate for All Firms Assisted by the Center, and 2000 Report Totals.

	Direct impacts	Estimate for all firms assisted (Direct impact)	2000 report totals[a] (Direct impact)
Full-time employment	8,385	9,141[b]	39,609
Payroll	$44,457,304	$56,890,554[c]	Not reported
Sales	$544,915,000	$726,098,202[d]	$1,720,814,000

[a] Source: Piewthongngam et al. (2002a).
[b] Average used for calculation excluded the top three firms.
[c] Average used for calculation excluded the top four firms.
[d] Average used for calculation excluded the top three firms.

1997. "Using IMPLAN to Identify Rural Development Opportunities." United States Department of Agriculture, General Technical Report INT-GTR-350, May.

Kelsey, K. D. and J. Bond. 2000. "Evaluation of Customer Services Provided by the Oklahoma Food and Agricultural Products Research and Technology Center." Final Report, Department of Agricultural Education, Oklahoma State University, August.

Maki, W., D. Olson, S. Lindall, D. Senf, and C. Schallau. 1989. "IMPLAN Model Applications in State and Regional Development." Staff Paper P89-15, Department of Agricultural and Applied Economics, University of Minnesota, April.

Mueseler, M. 2000. "An Evaluation of Entrepreneurial Training by the Oklahoma State Food and Agricultural Products Research and Technology Center." Masters Thesis, Department of Agricultural Education, Oklahoma State University, May.

Oklahoma Food and Agricultural Products Center (FAPC). 2005. http://www.fapc.biz. [Accessed May 26, 2005.]

Piewthongngam, G., M. Woods, R. Holcomb, and S. Ralstin. 2002a. "The Economic Impact of Value Added Cooperative on the Economy of Woods County, Oklahoma." AE-02147, Food and Agricultural Products Research and Technology Center, Oklahoma State University, August.

Piewthongngam, G. M. D. Woods, R. Holcomb, and C. Willoughby. 2002b. "Impact of Agriculture on Oklahoma's Economy: 2000." Department of Agricultural Economics, Food and Agricultural Research and Technology Center Oklahoma State University.

Stallmann, J. I., G. Evans, B. Schwart, L. Jones, and J. Siedert. 2001. "The Economic Impacts of a Cheese Plant and Diaries in the Panhandle of Texas." Faculty Paper Series 01-07, Department of Agricultural Economics, Texas A&M University System, May.

Wagner, J. E., S. Deller, and G. Alward. 1997. "Estimating Economic Impacts Using Industry and Household Expenditures." *Journal of the Community Development Society* 28(2):79–102.

Woods, T. and H. Hoagland. 2000. "Diversifying Agricultural Systems: An External Analysis of State Value-Added Programs." *Journal of Food Distribution Research* 31(1):204–214.

Figure 1. Input-Output Flow Chart with Mathematical Notation.

	Purchasing sectors				Final	Total
	(1)	(2)	(3)	(4)	demand	output
Producing sectors						
(1)	X_{11}	X_{12}	X_{13}	X_{14}	Y_1	X_1
(2)	X_{21}	X_{22}	X_{23}	X_{24}	Y_2	X_2
(3)	X_{31}	X_{32}	X_{33}	X_{34}	Y_3	X_3
(4)	X_{41}	X_{42}	X_{43}	X_{44}	Y_4	X_4
Primary inputs						
(1) Households	Y_{h1}	Y_{h2}	Y_{h3}	Y_{h4}	Y_h	R_h
(2) Other primary inputs	Y_{o1}	Y_{o2}	Y_{o3}	Y_{o4}	Y_o	R_o
Total	X_1	X_2	X_3	X_4	Y	

Source: Doeksen and Schreiner (1974).