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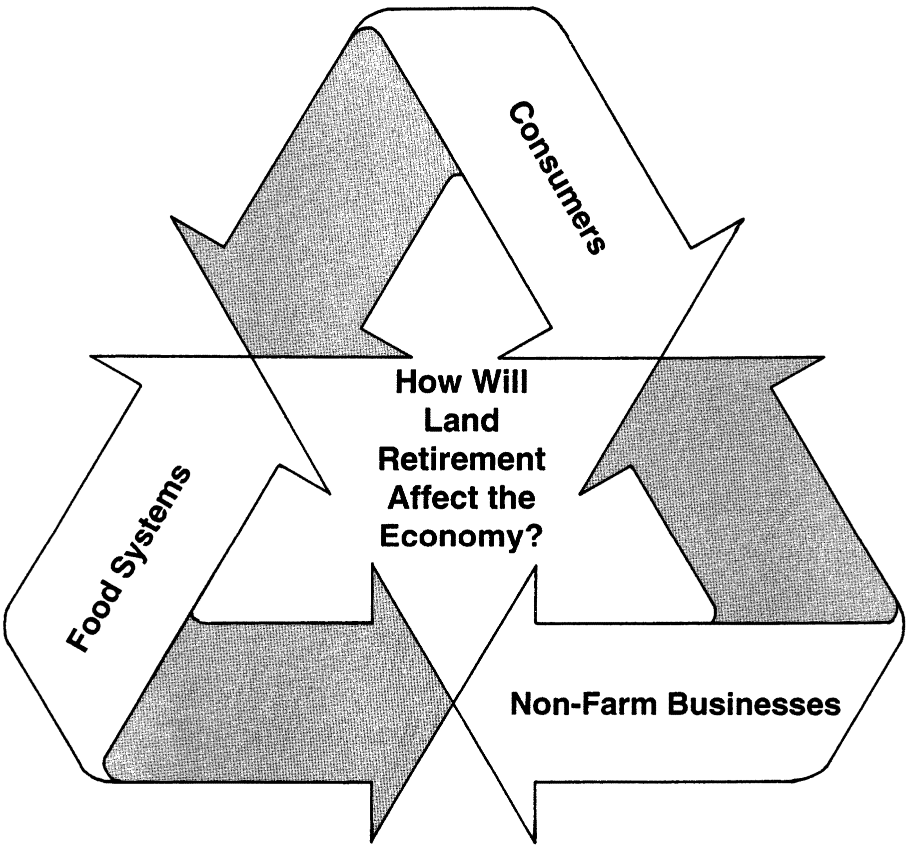

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Development Of A Regional Inter-Sectorial Impact Simulator (RISIS)

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Introduction

The economic linkages between production agriculture and the input supply (upstream) and output marketing (downstream) industries determine how large and small changes in agricultural production affect the rest of the economy. The changes stemming from large or permanent economic shocks or policy changes can be significantly different from those which are small or temporary. For example, a minor change temporarily reducing commodity acreage to limit government stock accumulation such as a paid land diversion tends to have little effect on employment and income in the rest of the economy. But a substantial change in farm policy, such as the Conservation Reserve Program (CRP) or the Whole Herd Dairy Buy-out, affects the entire economy. They force cutbacks or expansions in industries linked either directly or indirectly to agricultural production while producing significant changes in household consumption industries.

The total economic activity generated as a result of agriculture represents approximately 18 percent of the U.S. Gross National Product (GNP) and 21.3 million jobs. Actual crop and livestock production activities produce only a fraction of this income and the associated jobs, leading to only two percent of GNP and 2.7 million jobs in 1984. The upstream activities that accompany the production of agricultural commodities (purchases of equipment, supplies, feed, seed, fertilizer, labor, and financing) account for an additional two percent of GNP and two million jobs. The remaining 14 percent of GNP and 16.6 million jobs generated by agriculture is attributable to the downstream activities (transport, storage, processing, manufacture, distribution, and sale of agricultural products) (Harrington, Schluter and O'Brien).

Rural communities are particularity sensitive to policies which affect agriculture because their economies are highly dependent upon agricultural production as the main source of employment and income. Agricultural production therefore serves as the economic backbone for many rural communities, with the remaining economic activity being generated largely by the household consumption and service sectors which support it.

This remaining activity is the result of farmers, their families and workers in the upstream and downstream industries spending their incomes for food, goods, recreation, and private and public services. Supplying each of these commodities generates further employment and income, because workers in household consumption and service sectors of the economy also spend their incomes for goods and services. These expenditures in turn generate further economic activity, with the entire process repeating itself, ad infinitum.

Agricultural land-use policy decisions will therefore have effects, both positive and negative, on a region's economy. To determine the effects of these decisions, the economic impacts must be traced from the reduction in crop production (direct impacts), to the reduction in the associated agricultural input and processing industries (indirect impacts), to the goods and services industries providing support to the agricultural industries (induced impacts). All of these inter-industry effects should be considered when evaluating potential policy changes. Unfortunately, the impacts from the indirect and induced effects can be difficult to observe and measure.

Input-output (I/O) analysis is one effective means to make a complete measurement of the economic impacts of such policy changes. The value of input-output analysis lies partly in its explicit incorporation of the indirect and induced economic effects, making them both obvious and measurable. The USDA Forest Service has developed a computer-based system called IMpact analysis for PLANning (IMPLAN), which utilizes input-output analysis procedures capable of estimating inter-industry economic impacts (Alward and Palmer). IMPLAN, because it is based on county-level data, is of sufficient depth and breadth of detail to be of particular value in the economic analysis of changes in agricultural and rural policy. Specifically, the model can be used to provide important insights to the structural changes that may occur in regional economies as a result of changes in the nation's economic policies.

Analysis with IMPLAN involves several complicated and detailed steps for each period or option examined. Thus, an analysis involving several options may become time consuming and expensive. For this reason, it is not always practical to use IMPLAN to conduct repeated examinations of the economic effects of different policy decisions. Fortunately, it is possible to construct spreadsheets suitable for performing repeated policy analyses by using the response coefficients from a single iteration of IMPLAN. These spreadsheets can be constructed to be used for almost any level of aggregation of the national economy.

By using a spreadsheet model constructed from the response coefficients estimated by IMPLAN to analyze similar policy options, a researcher can: 1) substantially reduce the time needed to conduct the analysis, 2) lower the computing costs, 3) and facilitate summary and analysis of the results. With a spreadsheet model it is possible to quickly execute complete analyses of the likely changes in economic activity that will result from alternative agricultural/land-use policy decisions. The spreadsheet models, therefore, reduce the expenditure of time and resources necessary to utilize IMPLAN'S comprehensive and economy-wide analytical system.

This paper is meant to provide researchers with the information necessary to construct spreadsheet models that will enable them to analyze the local, regional, and national effects of changes in economic policy. The remainder of the paper will describe IMPLAN, give instructions on the development of a spreadsheet model, and provide an example of its use.

General Description of IMPLAN

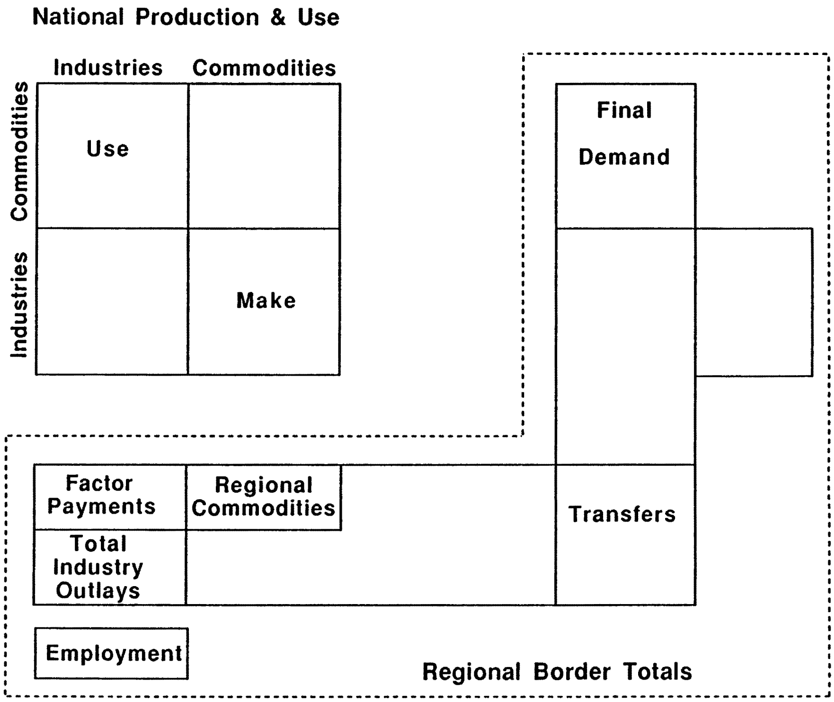
IMPLAN is a non-survey based, input-output (I/O) model composed of two major components: a "non-survey" data base of regional economic statistics and a data reduction procedure. A distinguishing feature of IMPLAN is the data base which permits the development of regional I/O accounts for areas as small as a single county and as large as the nation. This data base provides gross estimates of an area's final demands, final payments, total industry outputs, and total industry outlays. The data reduction procedure derives the inter-industrial upstream and downstream linkages.

A "non-survey" data base is developed by collecting data from a variety of sources to obtain final demands and payments, and total industry outputs and employment. Because of disclosure rules, non-survey data often provides incomplete and frequently inconsistent coverage when a single firm can be identified from the data. The "RAS" procedure is used to estimate missing, incomplete or withheld data items. A biproportional balancing technique is applied to eliminate both incomplete data and accounting inconsistencies to produce a complete and consistent non-survey data set (Alward and Palmer, 1985).

The second component, the data reduction procedure, is used by IMPLAN (version 2) to derive the I/O accounts: the inter-industrial production accounts and the domestic trade accounts. These accounts include inter-industrial trade. IMPLAN I/O accounts are distinguished from standard I/O accounts because they include both the outlays for inputs by downstream industries and the distribution of earnings among industries. The IMPLAN I/O accounts are based on Make and Use tables (Figure 1), strict accounting balances established in the development of the non-survey data, and the assumption that the industry production technology is known. The industry production technology assumption implies that either an industry's technical input function (the technical coefficients) is identical to the input function given for the industry group by the national I/O accounts, or that the user knows these production technologies.

The Make table (or matrix) describes the downstream linkages, while the Use table (or absorption matrix) describes the upstream linkages. The columns in the Make table describe the industries required to produce a commodity, while the rows describe the commodities produced by an industry. The columns in the Use table describe the commodities required as inputs for an industry, while the rows describe the industries

Figure 1. Schematic of IMPLAN Data



which utilize a particular commodity as an input (Miller and Blair, 1985). These tables provide a detailed description of the economy by separating production activities (industries) from the products they produce (commodities).

The accounting balances utilize regressions based on regional purchasing coefficients (RPCs). The RPCs represent the percentage of the total inputs of each industry purchased within the region. The RPCs eliminate trade limitations associated with traditional commodity balance techniques. Traditional supply-demand pooling or commodity balance techniques force local supply to satisfy local demand. These techniques cause the region to import commodities to meet excess demand or to export surplus production. The techniques are subject to several limitations dealing with trade; e.g., cross-hauling. These traditional techniques are, however, used as an upper limit on the regression-based regional purchase coefficients.

The strength of I/O models is their ability to examine the economic impacts on an area caused by changes in final demand. The upstream linkages are the principal elements used to examine these impacts. The linkages are developed by multiplication of the Make and Use matrices or their transposes. Industry by industry, industry by commodity, commodity by industry, or commodity by commodity linkages can be developed by using different combinations of the Use and Make matrices and their transposes (e.g. the Make matrix times the Use matrix will produce the industry by industry linkages).

The I/O model represents a specific point in time where each sector's output is just equal to the demand for its output. The demand for a sector's output can be divided into final demand and intermediate demand. Final demand normally refers to the consumption activities of government, households, exports, investment and/or inventory. Intermediate demand refers to outputs produced by one sector and used by other sectors as inputs. In the simplest form, the I/O can be described by the following set of equations.

$$\begin{aligned} x_1 &= a_{11}x_1 = a_{12}x_2 + \ldots + a_{1n}x_n + f_1 \\ x_2 &= a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n}x_n + f \qquad (1) \\ &\vdots \\ x_n &= a_{n1}x_1 + a_{n2}x_2 + \ldots + a_{nn}x_n + f_n \end{aligned}$$

where x_i is the value of output for the ith sector, f_i is the final demand for the ith sector, and $a_{ij}x_j$ is sector j's intermediate demand for sector i output. The coefficients aij are called the technical coefficients and indicate the demand for sector i's output per unit of sector j output. By definition,

$$\sum_{j=1}^{n} a_{ij} \leq 1.$$

Equation 1 can be rewritten in more compact, matrix notation as follows:

$$\begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ & & \vdots & \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix} + \begin{bmatrix} f_1 \\ f_2 \\ \vdots \\ f_n \end{bmatrix} \qquad (2)$$

or

$$X = AX + F \qquad (3)$$

Solving equation 3 for sectorial output results in the familiar inverse form of the I/O model:

$$X = [I - A]^{-1}F \qquad (4)$$

where $[I - A]^{-1}$ is the matrix of input-output multipliers.

Equation 4 shows that sectorial output in an I/O model is determined by the product of final demand and the multiplier matrix. Because of the linearity of the I/O model, equation 4 is also the basic equation for calculating impacts. The vector of sectorial outputs in the absence of any policy change ($X_{without}$) provides the base from which the difference in the corresponding output vector in the presence of a policy change (X_{with}) may be calculated to provide an estimate of the effect of a change in policy.

$$\begin{aligned} X_{with} - X_{without} &= [I - A]^{-1}F_{with} - [I - A]^{-1}F_{without} \\ &= [I - A]^{-1}(F_{with} - F_{without}) \qquad (5) \end{aligned}$$

Thus, a change in final demand represents a change in the level of output defined by $F_{with} - F_{without}$, holding prices constant. A change in the level of total gross output for an industry may occur from either a change in intermediate demand or a change in final demand. Intermediate demand may change for an industry with no change in final demand, but a change in final demand must be accompanied by a change in intermediate demand. A change in final demand with the associated change in intermediate demand will lead to a change in Total Gross Output (TGO). Given a change in final demand for a commodity, the I/O model through its description of the upstream linkages (A matrix) in an economy, will estimate the amount of sales and purchases required to meet the new demand.

A policy which changes the level of output for an industry does not necessarily create an equivalent change in final demand for the industry. The industry TGO must be separated into final demand and intermediate demand components. The policy impact may change either or both components, but the change in final demand used to obtain the economy wide impacts must include only the final demand change associated with the change in TGO. If a change in final demand equivalent to the actual change of TGO is used, the change in intermediate demand will be counted twice. Figure 2 provides an illustration of a three-sector model. The intermediate demand for industry A is 10, 15 and 1 for industries A, B and C, respectively. Industry A also requires 10, 5 and 7 units of input from industries A, B anc C, respectively. Total intermediate demand for industry A output is 26 units and total final demand for industry A is 21 units, for a TGO of 47 units. A policy-induced change in TGO of 10 units may affect both final and intermediate demand directly (tax on all output from industry A), only final demand (tax or household consumption of A outputs), or only intermediate demand (tax on industry B inputs).

An increase in final demand of 5 units for products of industry A will have a direct impact on industries A, B and C. The dollar amount of inputs required from industries A, B and C to produce a dollar value of A can be determined from the I/O technical coefficients. The technical coefficients are determined by dividing the entries in column A by the total gross outlays (minus the inventory adjustment). The direct technical coefficients are provided in Table 1.

Table 1. Direct Technical Coefficients

	A	B	C
A	.22	.33	.03
B	.11	.09	.23
C	.15	.04	.27

Figure 2. Hypothetical Transactions Table Industry Purchasing

	Intermediate Demand			Final Demand					
Outputs[1] → / ↓ Inputs[2]	A	B	C	Gross Inventory accumulation (+)	Exports to foreign countries	Government purchases	Gross private capital formation	Households	Total Gross Output
(1) Industry A	10	15	1	2	5	1	3	10	47
(2) Industry B	5	4	7	1	6	3	4	17	47
(3) Industry C	7	2	8	2	3	1	3	5	31
Gross Inventory Depletion (-)	1	2	1	0	1	0	0	0	5
Imports	2	1	3	0	0	0	0	2	8
Payments to Government	2	3	2	3	2	1	2	12	27
Depreciation Allowances	1	2	1	0	0	0	0	0	4
Households	19	18	8	1	0	8	0	1	55
Total Gross Outlays	47	47	31	9	17	14	12	47	224

Source: Miernyk

The five-unit increase in final demand for A's output will require 1.09 units (.22•5) of A, .55 units (.11•5) units of B and .75 units (.15•5) of B. The increased demand for output from B (.55 units) and C (.75 units) required to produce 5 units of A will further increase economic activity. To produce an additional .55 units of B will require .18, .05 and .02 units from A, B and C, respectively. To produce an additional .75 units of C will require .03, .18 and .20 units of A, B, and C, respectively. The sum of the direct impacts (increased output from A, B and C to produce five additional units of A) and the indirect impacts (additional output of A, B and C to provide inputs to A, B, C) represent the increase in intermediate demand. Thus, the total increase in intermediate demand due to an increase in final demand for A of five units is 1.29, .77 and .99 for industries A, B and C, respectively. Thus, TGO (final demand plus intermediate demand) has increased by 6.29, .77 and .99 for industries A, B and C, respectively. Induced impacts (increased output from A, B and C required to provide the inputs for the new output generated by indirect impacts) have not been included to simply the problem. However, the problem clearly illustrates the difference between TGO and Final demand. In this example, a 6.29-unit increase in TGO is equivalent to a five-unit change in final demand.

Analyses, using technical coefficients or multipliers and response coefficients, are used to summarize the estimated economic impacts of changes in final demand. I/O models utilize sets of multipliers for total business output, income (both personal and total), value added, and employment to estimate the changes. IMPLAN calculates both Type I and Type III multipliers. Type I (output) multipliers show the relationship between the output sold by an individual sector and the total output produced in the economy resulting from the sales by that sector. Specifically, it is the ratio of direct plus indirect output to the direct output. Type I multipliers can be calculated for personal income, total income, value added and employment. Type III multipliers describe the relationship between the sales of a single industry and the total output produced in an economy (including direct, indirect, and induced output) resulting from those sales. Type III multipliers assume that changes in spending in an economy can be characterized by the average per capita expenditures. This assumption seems reasonable when dealing with both households and industries.

Analyzing Inter-Industry Impacts of Land-Use Policies

Land is the principal input in agricultural production. As such, any public policy which affects its use will affect agricultural production. As mentioned previously, agricultural production is an intricate part of the U.S. economy and thus a change in agricultural production will change the distribution and mix of economic activities. Thus, land-use policies will have important inter-industry implications at every level of economic aggregation.

A. Land Use Policies

Until 1933, the public policy choice was to rely on the market for most agricultural production and land-use decisions. Some difficulties were acknowledged, and there were efforts to improve the market's performance, but the market itself was generally considered the best possible way to allocate resources, guide consumption and reward private endeavor. The Great Depression brought in a new group of activists interested in relief, reform and recovery which produced the Agricultural Adjustment Administration. Confronted with a 56 percent drop in farm prices between 1929 and 1932, a gross income cut in half, a net income which declined from $6.3 billion to $1.9 billion, a negative return to labor and management, and the formation of the dust bowl from fragile prairies, the first land-use policies were put into place by the Agricultural Marketing Agreement Act in 1937 and have been in place since.

Generally, land-use policies of the past and present can be placed into two groups; 1) actual restrictions on land use such as zoning, easements, and erosion limits, and 2) restrictions on production from the land such as production or marketing quotas, set-asides and diversions, and tax incentives. The effect of any of these policies however, can always be traced through a familiar path. Changes in land use beget changes in the level and/or pattern of production which may affect the economic structure of specific communities, industries within the agricultural sector and the general economy.

Although reduced production is often accompanied by a price increase, maintaining total revenue in a community, the level of inputs supplied, output processed and employment necessary to facilitate the supply of inputs and the processing of outputs will decrease. Reduced employment in farm-related activities shrinks the demand for non-farm commodities and services supplied through local businesses, causing further reductions in employment levels. The continuous effect on employment throughout the economic community, region or nation can be determined using employment multipliers captured by inter-industry production functions intrinsic to input-output models.

The reduced production most often associated with land-use policies is seldom the only traceable economic impact. Most frequently, society provides incentives to producers to comply with land use policies, providing these producers with an increase in disposable incomes. The increase in disposable income may change the quantity and/or mix of goods and services purchased, increasing employment in non-agricultural sectors.

Although the level of employment associated with agricultural output and personal incomes provides an indication of the economic activity in local communities, the number and size of related industries required to support the production of agricultural products is not given. Agribusinesses and other providers of local goods and services have developed a certain size which provides a given level of service at a minimum cost. These economies of size have been achieved over long periods based upon a given level of employment in their respective areas. Thus, it is conceivable that reduced employment and agricultural production could be reduced to such a level that input suppliers, output processors and other providers of local goods and services may relocate to new economic centers. These may be located at greater distances from the farm, increasing the cost to farmers of procuring these goods and services and causing further decline in agricultural production (as farmers abandon non-profitable enterprises).

Further, as a local community loses employment and businesses as a result of a reduction in agricultural production, the tax base for that community is also reduced. The current level of public services provided is based upon the level of revenue existing prior to the reduction in output. In order to maintain the current level of public services in the face of declining businesses and employment, an increase in per capita tax is required. A more probable alternative would be the reduction in services provided. Because the I/O contains constant returns to scale (see model limitations), a constant reduction in services is assumed. Thus, the impacts of reduced crop production on local economies may be underestimated.

Input-output models can be constructed to capture the impacts of land-use policies throughout the economy, but assume a constant industry and economy structure. By separating the impacts of land-use policies into their initiating factors (reduced production of current output, increased output of new output, change in incomes) and summarizing the impacts of each throughout the economy, response coefficients are developed to allow simple and consistent estimates of changes in land-use policies.

B. Creating Input-Output Response Coefficients

Response coefficients are calculated in the same manner as traditional multipliers but are simply aggregated technical coefficients. The computation of response coefficients for policy analysis takes advantage of two assumptions: 1) the predicted responses (in terms of output, etc.) of the I/O model are linear given a Leontief multiplier inverse, and 2) the composition (the expenditure patterns) of the changes in final demand are fixed for a given policy, regardless of the magnitude of the change in final demand. As a result of these assumptions, the response predicted (employment, output, income, etc.) for any given policy will vary only in magnitude. The composition of the final demand vector depends on the commodities directly affected by the change in final demand, and the percentage of the change in final demand spent on each commodity. Using these assumptions, response coefficients can also be developed for changes in household consumption.

Technical coefficients are first determined for each commodity by changing the final demand for each of the following commodities: cotton, food grains, feed grains, tobacco, oil bearing crops, pasture, hay, lumber, and pulp and paper, by a pre-specified dollar value (eg. $100,000). Technical coefficients are also calculated for the establishment of hay, pasture, or timber by changing the final demand for the purchase of the inputs required from the downstream industries to produce $100,000 of establishment activity. As described in an earlier section, response coefficients are created by adjusting technical coefficients to define the change in economic activity attributable to a final demand induced change in TGO. Economic impacts are determined by multiplying the actual dollar value of change in final demand (resulting from the policy) by the response coefficients. For instance, developing response coefficients for activities which do not exist as an industry in the I/O requires proportioning the $100,000 change in the activity among the inputs. A change in the final demand for this set of inputs is then used to create a set of technical coefficient tables which are then aggregated together, forming a single table of response coefficients.

The response coefficients were calculated using a Type III multiplier algorithm. This algorithm starts with the base year data, which includes vectors of total gross output (TGO), value-added components (VA), and employment. The response coefficients for each of the agricultural commodities is multiplied by their base year data vectors, yielding the direct effect of the change in final demand on each commodity's TGO, VA, and employment. The total direct effects for TGO, VA and employment are obtained by summing the elements in each vector.

The indirect effects can be calculated by multiplying the vector of TGO direct effects by the Leontief inverse to obtain a vector that contains the sum of the direct and indirect TGO effects, and then subtracting the vector of direct TGO effects. This generates a vector of the indirect TGO effects. The indirect effects of a change in final demand on VA and employment are found by multiplying the base year vectors for employment and VA by the transpose of the indirect TGO effects vector. The sum of the elements for the VA and employment vectors gives the total indirect effect.

The calculation of the response coefficients for induced effects begins by estimating the change in employment resulting from the total indirect and direct change. The change in employment is multiplied by the population-employment ratio, which identifies the change in population in the analysis area caused by the direct and indirect production effects. This population change is then multiplied by the average per capita consumption (the amount of purchases from each sector in the analysis area for 1982). This identifies the change in final demand resulting from the change in population. The change in final demand is then multiplied by the Leontief inverse of the open model, which gives the change in total output. This process is repeated until the change in population is less than some predefined level which signals the process to stop. The changes in each repetition are summed producing a total induced effect.

The sum of total direct, indirect, and repetitively-computed induced effects produces the response coefficients for the total economic effects. This is referred to as a *model shock* because an initial change produces the repetitive impacts described above.

IMPLAN is used as the source for developing response coefficients characterizing the distributional effect of the total changes in economic activity due to agricultural policy. The response coefficients developed not only provide the total direct, indirect, induced effects, but also depict their distribution among industries in the analysis area. These response coefficients allow policy makers to examine the economic effects of changes in the crop acreage for cotton, food grains, feed grains, tobacco, oil-bearing crops, hay, pasture, or lumber. Through IMPLAN, these economic effects can be identified for any region in the United States.

Model Limitations

While the computation and summary of response coefficients provides a quick and relatively simple means for consistently estimating the economy-wide impacts of land use policies, the methodology is not without certain inherent problems. These problems are common to any analyses performed using I/O rather than problems specific to this response coefficient methodology and are based upon several basic assumptions including:

1. Constant returns to scale. The linear form of the I/O model means a proportionate change in use of all inputs leads to exactly the same proportionate change in output. By the same token, a change in sectorial output leads to an exactly proportionate change in demand for all inputs used by the sector. The importance of this assumption lies in its ruling out both economies and diseconomies of scale. While this is a reasonable approximation for small impacts, it is less reasonable for large impacts.
2. Zero elasticity of substitution. All inputs are required in fixed proportions. As with the assumption of constant returns to scale, the assumption of a zero elasticity of substitution is most plausible when modeling small impacts. However, the presence of substitution possibilities among inputs makes it less tenable when very large or long-run changes are analyzed.
3. Constant relative prices. By definition, the technical coefficients are fixed ratios of values, while the assumption of zero elasticity of substitution means input quantities are

required in fixed proportions. For both of these conditions to hold, relative prices of sectorial output must be constant. As with the previous two assumptions, this is much more palatable for short-run impacts than for long-run impacts.

4. Infinite elasticity of supply for primary factors. Primary factors do not appear in any of the above equations, implying that the supply of primary factors is never a constraint on production. Because sufficient supplies of labor, capital, and all non-produced inputs such as water and land are assumed to be available at constant prices, I/O models are demand-driven rather than supply-constrained.
5. Constant technology. The I/O model was constructed based upon structural relationships present in the economy in 1977. The current I/O model has imposed the national account data for 1982 on the 1977 structural model. Increases in productivity since 1982 or structural change within the economy since 1977 are not captured. Assuming productivity gains have been achieved and production efficiencies have been obtained through a changing structure, the impact estimated by this model overstates the true impacts.
6. Absence of inter-regional trade flows. National policy impacts measured in a region capture only the impacts of the policy within the region. An industry or sector within a region may be as much or more affected by outside impacts as by impacts within. The absence of inter-regional trade flows will tend to create an understatement of the impacts measured by regional analysis. For instance, estimating economic impacts in the corn belt region of a national policy which reduces feed grain production, will measure only the effects of the reduced feed grain production in that area. The corn belt economy will not be affected by reduced feed grain production in other regions when the corn belt I/O is used.
7. Static Impacts. The effect of a change in final demand will be a change in the level of employment. A resulting reduction in employment does not indicate where the newly unemployed may be gainfully re-employed. A resulting

increase in employment assures new labor supplies have been identified, rather than the creation of competition with alternative employers for a fixed level of employment.

Crop Production Response Coefficients

The commodities included in IMPLAN include cotton, food grains, feed grains, tobacco, and oil-bearing crops. Response coefficients are calculated for these commodities by shocking the model (eg., by applying a per-unit change of $100 million in final demand). In this case, the expenditure pattern of a commodity (e.g. feed grains) is assumed to be representative of the component crops (e.g. barley, corn, oats and sorghum). If the expenditure pattern for the commodity in the region being modeled is not representative of a component crop, then it can be altered by determining the percent change in the final demand of direct upstream industries.

Response Coefficients for Cover-establishment Activities

In IMPLAN, the cover-establishment activities (hay, pasture, timber) are components of the agricultural services industry. Because cover-establishment activities constitute only a small portion of the agricultural services industry, the expenditure pattern for establishing a cover crop differs from the aggregate expenditure pattern for the full agricultural services industry. For this reason, the $100-million change in final demand must be proportioned to the direct upstream industries. Proportioning uses the fact that establishing a cover crop of hay, pasture, or timber requires the purchase of a bill of goods from sectors within the analysis area.

The proportioning of final demand is achieved in a three-step process. First, gross expenditures for new industry or activity are calculated by multiplying total industry output (TIO) by the percentage of total outlays the new industry spends for each input (total absorption coefficient). That is, the new industry or activity may require only a portion of another industry's output.

This method basically develops a production function for the new industry or activity by allocating the $100-million dollar change in final demand for the new industry to several industries. Next, the net expenditures for the industry are calculated by multiplying gross expenditures by the percentage of total requirements for inputs purchased within a region (regional purchase coefficient). Finally, net expenditures are divided by the TIO to determine proportioning. Then, if necessary, proportions are gathered according to a user's aggregation of industrial sectors. This procedure develops expenditure patterns for each of the cover establishment activities. The $100 million is proportioned to upstream industries using the proportions calculated, and the response coefficients are then estimated. Similar methods may be used to summarize response coefficients associated with recreation or hunting activities.

Personal Consumption Expenditure Response Coefficients

Response coefficients for personal consumption expenditures are calculated using personal expenditures for the population receiving $10,000 to $30,000 per year. These personal expenditures are treated as if spent in fixed proportions to acquire each of the various commodities within the analysis area. To calculate response coefficients, a $100-million change in farm income is proportioned among the various industries within the economy in a procedure similar to that just described in developing cover-establishment response coefficients. Gross expenditures are set equal to personal consumption expenditures (PCE) for the population with incomes between $10,000 and $30,000, and the PCE expenditures are summed. Expenditures for non-competitive imports are deleted by setting the expenditures on commodities not present in local industries to zero. Percentages spent on commodities are calculated by dividing gross expenditures by the sum of the PCE expenditures. If necessary, the percentages can be aggregated to correspond with the user's industrial specifications. The $100 million is proportioned by the percentages calculated and the response coefficients are then estimated.

Alternative Production Activity Response Coefficients

To permit the examination of the economic impacts of changes in production from forest and pasture land, response coefficients were estimated for hay, pasture, and timber production. Response coefficients are calculated using a $100 million change in final demand for hay, pasture, lumber, and pulp and paper.

The Spreadsheet Impact Model

The spreadsheet model RISIS is structured to capture the economic effects of three aspects of land-use programs: 1) changes in crop production; 2) changes in household consumption expenditures; and 3) movements in land use between crop production alternative uses (haying, grazing and forest land) and non-use. Response coefficients generated by IMPLAN can be placed into one of these categories.

The most obvious impact of a land-use program is the changes in crop production it causes. Changes in harvested acreage associated with most land-use policies will have direct, indirect and induced impacts on the economy. IMPLAN simulates the impacts of these changes by shocking the final demand for crop production on these harvested acres. Subsequent economy-wide changes in activity are captured by response coefficients for the industries in the economy.

Analysis of specific policy changes are performed in RISIS by changing final demand for commodities and using IMPLAN-generated response coefficients to estimate economic impacts. A change in the value of final demand is multiplied by response coefficients for each industry to produce the total change in economic activity for each industry as a result of the policy.

Land-use policies also have impacts on household consumption of goods and services. Cash payments to program participants, increased incomes due to commodity price increases, and/or increased incomes resulting from reduced taxes associated with lower income support payments or reduced local services, may act as a stimulant for economic activity. This occurs because a portion of these revenues will be spent on additional goods and services. IMPLAN can generate response coefficients for industries whose final demand would be affected by these household expenditures. The spreadsheet model can use these coefficients to calculate economic changes in household incomes resulting from the land-use program.

Land use or acreage reduction policies usually take land out of commodity production and place it into an alternative use. A land-use program may therefore shift the supply of crops or products consumed. For example, placing the retired land into hay or pasture can increase the supply of livestock feed available, which in turn increases the supply of retail livestock products. This also can increase household income of livestock producers by reducing input costs (pasture). Thus, a land-use policy that resulted in an increase in marketable hay and pasture would be expected to have an effect on livestock consumption. A similar effect would be expected if the land-use policy changes the quantity of acreage devoted to marketable lumber or pulpwood.

The spreadsheet model can be used to calculate changes in economic activity due to changes in the value of hay, pasture, lumber or pulpwood production caused by a land-use policy. These economic effects are estimated by using IMPLAN to generate response coefficients for crop production and income-related (government payment) consumption activities, incorporating these coefficients into the spreadsheet model, and linking the response coefficients with changes in the value of production.

Land-use policy can also effect economic activity by requiring specific changes in cropland use. Soil conservation objectives often require the establishment of a conservation-related cover crop. The establishment of a cover crop on acreage removed from crop production will result in the purchase of a different set of inputs than that required for crop production activities. The establishment of a cover crop will therefore have different direct, indirect, and induced economic impacts than will crop production. The spreadsheet model can be used to calculate changes in economic activity associated with cover crop establishment in a manner analogous to that used for crop production activities and household consumption expenditures.

Figure 3 contains a hypothetical spreadsheet model which will be used to demonstrate how changes in the final demand are used to estimate the economic impact of land-use policies. This spreadsheet model is a simplified version of the RISIS model and is intended solely to identify the principles involved in its construction and use. The general structure of the RISIS model is displayed in Figure 4. Note that the data base has been constructed so the same industry groups are listed in the same order for each sector, as are the response columns (final demand, TGO, etc.). Each element in the table is a response coefficient obtained from IMPLAN (see above). There is also a table containing a summary of total economic activity for the region. This table provides a base that can be used to calculate the percentage change resulting from a change in agricultural policy.

The Program Input/Crop Production Section

This section of the spreadsheet allows the analyst to enter the impacts of a specific policy or set of policies, including: changes in the barley, corn, cotton, oats, rice, sorghum, soybeans, tobacco and wheat acreage harvested; changes in government program payments, and changes in land-use expenditures (Table 2). Since the IMPLAN response coeffi-

Table 2. Structure of the Input Section of RISIS

COMMODITY	ACRES	PRICE	YIELD	VALUE (MM$)
BARLEY	XXX	XXX	XXX	XXX
COTTON	XXX	XXX	XXX	XXX
CORN	XXX	XXX	XXX	XXX
OATS	XXX	XXX	XXX	XXX
RICE	XXX	XXX	XXX	XXX
SORGHUM	XXX	XXX	XXX	XXX
TOBACCO	XXX	XXX	XXX	XXX
WHEAT	XXX	XXX	XXX	XXX
FEED GRAINS[1]	XXX			XXX
FOOD GRAINS[2]	XXX			XXX
FARM INCOME				
RENTAL PAYMENTS	XXX	XXX		XXX
ESTABLISHMENT				
PASTURE	XXX	XXX		XXX
FOREST	XXX	XXX		XXX

[1] Sum of Barley, Corn, Oats, and Sorghum.
[2] Sum of Rice and Wheat.

cients are generated by shocking the final demand for both agricultural commodities and consumption activities, the program changes must also be expressed as changes in the value of final demand. The Program Inputs section calculates the changes using: 1) acreage planted, crop yields, and commodity prices; 2) the expenditures required to change the land-use and government program payments, given the above changes in commodity acreage, and 3) per acre expenditures to establish an alternative use.

The change in the value of each crop listed in Figure 3 can be calculated in a separate column using the equation,

Change in Value = (change in acres) * Price * Yield.

The Input section of RISIS (Table 2) contains: 1) the change in market value of food and feed grain production, 2) the change in annual net farm income attributable to government program payments, and 3) the change in market value of cover establishment activities (changes associated with alternative land uses are not included here). The data in Figure 3 indicates the program being examined will remove seven million acres from food grain production and 15 million acres from feed grain production. Multiplying each acreage reduction by the corresponding yield and price produces the change in final demand associated with the program ($858 million for food grains and $2,520 million for feed grains). From Table 2, it can be seen that the acreages and yields for food and seed grains are weighted sums of the component crops. Government payments associated with the program are $990 million, ($45 per acre at 22 million acres).

The change in the value of food and feed grain production is a direct shock to the crop industries. This shock results in indirect and induced shocks to the industrial sectors listed in the Production Response Coefficients section of the model (Figure 3). The magnitude of these effects are calculated using the Production Response Coefficients. The Production Response Coefficients portion of Figure 3 contains coefficients similar to those generated by IMPLAN. The Production Impact for TGO is calculated by multiplying the food grain response coefficients by the change in value of food grain production, multiplying the feed grain response coefficients by the change in the value of feed grain production, and summing the two products. The Production Effect for employment is calculated in an identical manner. For instance, an $8.58 million change in the production of food grains will result in a $26.61 million change in total gross output from the agricultural input sector and a loss of 336.62 jobs.

Figure 3 also demonstrates how the changes in final demand for the establishment and consumption sectors are calculated. Information on the acreage enrolled in the CRP, rental payments per acre, number of acres going into forests and pasture, and cost per acre of establishing cover crops

Figure 3. A Hypothetical, Simplified I/O Impact Simulator

A. Program Input:

	Acreage (Mil A)	Yield (BU/A)	Price ($/BU)	Value (100 Mil$)
Food Grains...	7	35	3.50	8.58
Feed Grains...	15	80	2.10	25.20
	(MIL A)		($/Acre)	(100 Mil$)
Government Payments...	22		45.00	9.90

B. Production Response Coefficients:

	Food Grains: Total Gross Output	Food Grains: Employment	Feed Grains: Total Gross Output	Feed Grains: Employment
1) Ag Inputs	0.87	9.81	0.76	10.02
2) Food Grains	103.15	1171.67	0.04	0.30
3) Feed Grains	0.05	0.25	103.15	1171.67
4) Manufacturing	0.25	3.65	0.31	4.32
5) Household Expenditures	2.90	88.34	2.55	77.03

D. Production Impacts:

	Total Gross Output (100 Mil $)	Employment (#)
1) Ag Inputs	26.61	336.62
2) Food Grains	885.42	10054.50
3) Feed Grains	2599.78	29528.23
4) Manufacturing	10.04	140.16
5) Household Expenditures	89.10	2698.67

C. Consumption Response Coefficients:

	Total Gross Output	Employment
1) Ag Inputs	0.02	2.23
2) Food Grains	2.23	2.63
3) Feed Grains	0.06	0.26
4) Manufacturing	1.75	3.28
5) Household Expenditures	7.71	235.14

E. Consumption Impacts:

	Total Gross Output (100 Mil $)	Employment (#)
1) Ag Inputs	0.20	2.28
2) Food Grains	2.29	26.04
3) Feed Grains	0.56	2.57
4) Manufacturing	17.35	32.47
5) Household Expenditures	76.34	2327.89

(1/) The effect of this hypothetical program on total gross output (TGO) in the Ag Inputs sector is calculated as follows:

Food Grain Production Impact	=	8.58	•	0.87	=	7.46
Feed Grain Production Impact	=	25.20	•	0.76	=	19.15
Total Production Impacts	=	7.46	+	19.15	=	26.62
Consumption Impacts	=	9.90	•	0.02	=	0.20
Total Program TGO Impacts	=	26.62	+	0.20	=	26.82

F. Total Program Impacts:

	Total Gross Output (100 Mil $)	Employment (#)
1) Ag Inputs	26.82 (1/)	338.90
2) Food Grains	887.71	10080.54
3) Feed Grains	2600.34	29530.80
4) Manufacturing	27.39	172.63
5) Household	165.44	5026.56
Expenditures	3708.00	45149.00

(either trees or various grasses), is used to calculate total value of rental payments and establishment costs entering the economy. These calculations are made by multiplying acres by the value of the rental payment, and multiplying acres times establishment costs.

Response Coefficients Section

The Response Coefficients section consists of three sets of tables, one for each area of economic activity being studied. The three sets of tables are: 1) crop or commodity production directly affected by the program, 2) household consumption, and 3) forest and pasture establishment activities. Crop production activities include cotton, feed grains, food grains, oil bearing crops, and tobacco sectors. Consumption activities include those expenditures made by households as a result of the direct receipt of income. IMPLAN generates Consumption Response Coefficients by shocking upstream industries with a $100-million change in final demand for personal consumption. The personal consumption production function is represented by the expenditure pattern of an average household with $10,000 - $30,000 of 1982 income. Consumption Effects are calculated by multiplying these response coefficients by the change in the value of government payments. Total Effects are equal to the sum of Production Effects and Consumption Effects. The common factor within the sets of tables is the type of economic activity. Each table has the same structure, a row for each industry (or industrial grouping) and a set of columns for final demand, total gross output, employee income, property income, total income, value added and employment.

The Program Impact Section

In this section the effect of land-use changes on the economy is estimated for the three types of economic activity used in the Response Coefficients section: production, consumption, and establishment. This is done by first estimating the effect of the program on each industry within a sector, then summing the effects of the program over all sectors. By examining the changes that occur within and across industries, the impact of a program can be ascertained.

As in the spreadsheet model presented in Figure 3, the effect of a land-use program on a sector is estimated by multiplying the change in the final demand for a sector times the response coefficients associated with that sector. For example, all response coefficients in the table for the forest establishment sector are multiplied by the change in final demand for forest establishment, the response coefficients table for cotton is multiplied by the change in final demand for cotton, etc.

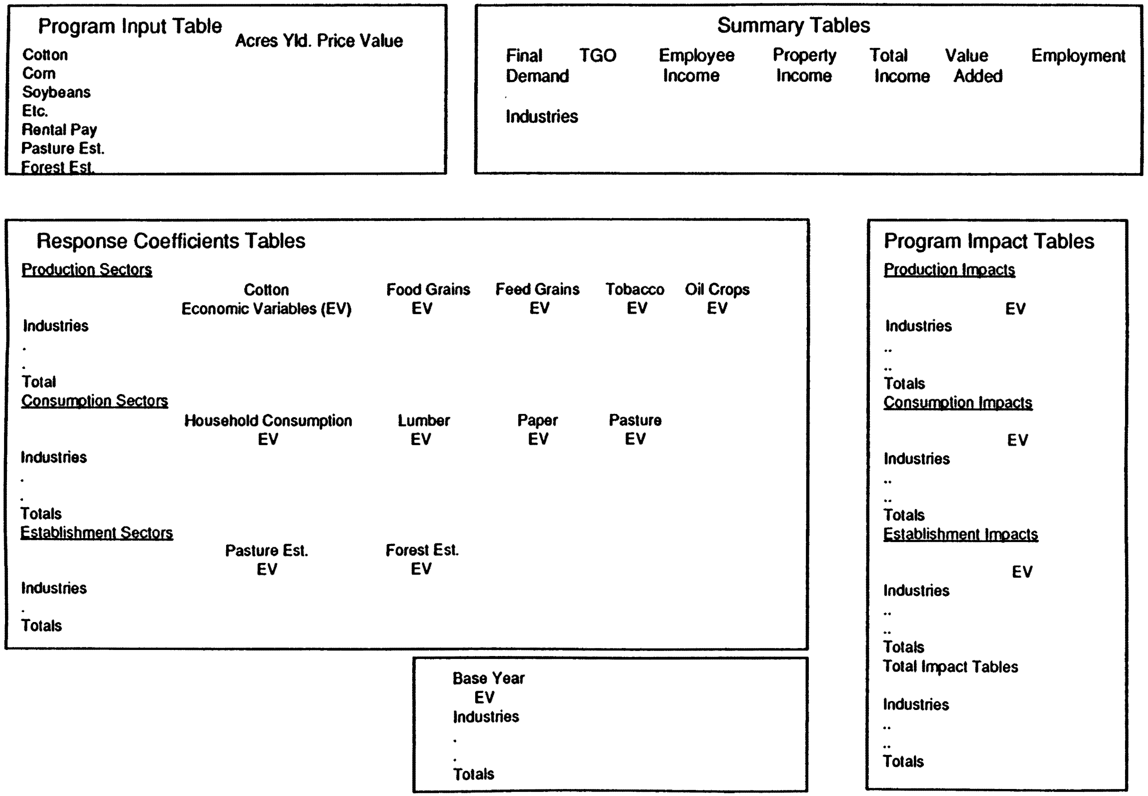
The sum of the changes in individual industries or groupings of industries within the production, consumption, and establishment activities is an estimate of the land-use program's economic impact. This sum is calculated in a program impact table for each of the three economic activities (see Figure 4). Each cell in these tables contains the sum of the program effects for a specific industry and economic variable. Thus, the impact tables for the production, consumption, and establishment act to accumulate the effects on economic variables within industries.

A fourth table is used to aggregate the effects of the program on the broad economic activities into a Regional Impact Table (Figure 4). Care must be taken during the aggregation to assure that the sign of the changes in each composite is consistent with the estimated changes in final demand. In the case of a land retirement program, the equation for each cell in the Regional Impact Table would be:

CONSUMPTION + ESTABLISHMENT - PRODUCTION,

the assumption being that while the final demand for establishment and consumption increases, the final demand for crop production decreases.

Figure 4. General Structure of RISIS
(Each Region)



The Summary Tables Section

The Summary Tables permit you to aggregate the individual industrial sectors contained in the Regional Impact Table into broader industrial sectors (Figure 3). These broader aggregates are defined by the user to obtain the appropriate level of detail for the questions being asked. The aggregation is done by simple summation. For instance, if you are interested in a crop sector but not in the individual crops, you can sum the cell values from the cotton, feed grains, tobacco, food grains, and other crops sectors to create an agricultural production sector.

Depending on the needs or desires of the user, any number of summary tables can be constructed. For instance, a summary table that expresses changes in economic activity on a percentage basis might be useful. To do this, include a table in the spreadsheet that reports economic activity from a base year. This table can then be used as the denominator for percentage change calculations.

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THE OKLAHOMA

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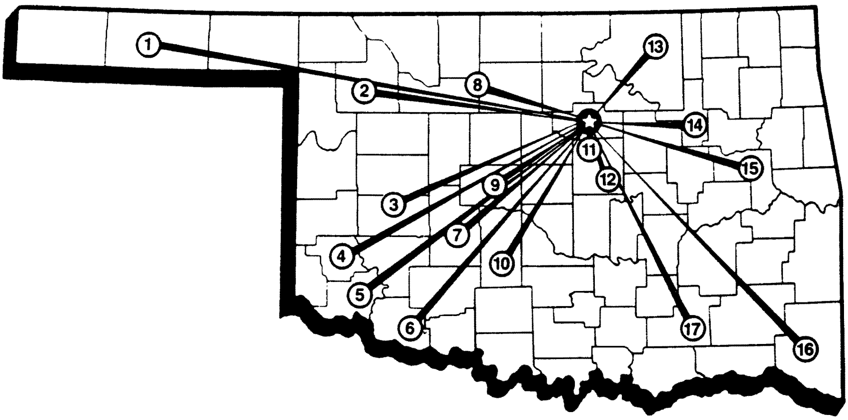

✪ Main Station – *Stillwater and Lake Carl Blackwell*

1. Panhandle Research Station – *Goodwell*
2. Southern Great Plains Field Station – *Woodward*
3. Marvin Klemme Range Research Station – *Bessie*
4. Sandyland Research Station – *Mangum*
5. Irrigation Research Station – *Altus*
6. Southwest Agronomy Research Station – *Tipton*
7. Caddo Research Station – *Ft. Cobb*
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