TOWARD AN INFORMATION SYSTEM FOR GUIDING RESEARCH IN THE SOYBEAN PRODUCTION ECONOMY

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The soybean economy experienced balanced growth in both total demand and total supply since the early 1940's, but in recent years encountered excess production. Since the soybean economy is effectively interdependent with that of corn, cotton, and rice, programs for these commodities must be tailored to current and potential conditions relating to soybeans. Detailed analyses of sources of increased production, of associated inter-regional effects, and of production alternatives in the soybean area are needed to provide basic information for formulation of new programs. My primary purpose is to discuss the need for expanded research on soybean production patterns. However, most of the emphasis, herein is on developing a comprehensive information framework as an initial step to accomplish the research task.

OVERPRODUCTION

The current need for expanded research on soybean production patterns has resulted, in part, from the overproduction of recent years. Soybeans rose from relative obscurity in the 1940's to third among U.S. cash crops in 1968. Fortunately, this expansion of production was paralleled by expanding world markets for protein and oil so that prices remained stable or even increased. However in recent years, United States farmers produced more soybeans than could be used at support levels by responding partly to the favorable price situation guaranteed by support level, and partly to the high market prices engendered by the apparent food crisis of the summer of 1966. Since 1966, there has been an accumulation of stocks on hand and the amount has been increasing rapidly. The amount reached 322 million bushels, far above the level needed.

The rate of increase in soybean utilization has slowed somewhat in recent years. On the domestic scene, potential development of substitutes in consumption, such as modified-protein corn and cereal crops, and synthetic amino acids and urea supplements, suggest possible long-range problems in the utilization area. Production increases in crops that compete for oil and meal markets appear likely. The 1969 U.S. cotton program permitted an increase in cotton acreage but poor yields reduced cottonseed production 8 percent. Resources were freed for flax production by a reduction in the wheat crop under the wheat program. Increased domestic production of other oilseed crops could also occur. Sunflower, for example, is currently being produced experimentally on farms in the Red River Valley area, Mississippi River Delta area, and in the Southeast. Estimates of the 1968 sunflower acreage in the Delta ranged up to 40,000 acres.

Relatively high United States prices provide an umbrella that encourages increased production of substitute oilseed crops in various parts of the world. Soybean oil was priced out of the dollar export market in the last two years and USDA reports indicate that 85 percent of the oil exported from the 1968 crop was under Public Law 480. The European Common Market is considering an internal consumption tax to discourage the use of soybean products, especially margarine made from soybean oil, which competes with butter and other dairy products in excess supply in ECM countries [5].

IMPACT ON FARM PROGRAMS

One of the major side effects of Federal farm commodity programs for feed grains and cotton is their influence on the production of substitute commodities. Soybeans serve as the common denominator in crop production for much of the Eastern half of the United States. Usually, they have played a secondary role to a major traditional crop – either corn, cotton, or rice, depending on the region. Each of these major crops has experienced an excess pro-

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duction problem which eventually resulted in output controls through programs designed to limit the land input. It has been possible to set the provisions of the control programs for these crops with the knowledge that soybean production as a substitute would absorb much of the loss to individuals from limiting the main enterprise. The wide divergence between support and open market cotton prices has resulted in almost complete compliance. In contrast, the closer relationship between market and support prices for corn, among feed grains, has meant that noncompliance is profitable for larger groups of corn producers. Thus, the relationship between the cotton program and acreage of soybeans would probably be more definite than that between the corn program and soybean acreage.

The development and implementation of new policies generates increased requirements for information on the regional and interregional aspects of soybean production. Research is needed to evaluate the consequences of alternative policies as they affect the interrelationship of soybeans with competing crops.

CURRENTLY AVAILABLE INFORMATION

There is some information currently available on relevant aspects of production patterns. This information serves some immediate needs and also serves to point up the need for more in-depth analyses in these areas. One of these areas is the development of new land for soybean production. The development of new acreage for soybean production occurred to some extent in all soybean producing regions, but the greatest concentration occurred in the Southeastern region of the United States. In addition to acreage reclaimed from permanent pasture and idled land in the Southeast, over 4 million acres of woodland were cleared from 1962 through 1968. (Estimate based on unpublished data obtained from the State offices of the Soil Conservation Service.)

Farmers' expectations, arising from relatively high soybean prices and a favorable outlook, made investment in land clearing feasible during the 1960's. In Louisiana, for example, soybean acreage increased from 216,000 acres in 1960 to 1,436,000 acres in 1968. Much of this increase occurred from the clearing of woodland in the delta parishes. New technology in clearing and drainage made possible reclamation of an acre at a cost of about $75. Assuming recent soybean prices and a return on investment (land plus clearing cost) of 5 percent, it has been possible to recover the clearing costs in as few as 2½ years (Table 1). If the annual appreciation in land values is assumed equal to the required rate of return on owned capital, then the "excluded" column in Table 1 is appropriately interpreted as an "included" figure. A 5 percent annual appreciation rate would not be unrealistic for the delta area [3].

This example serves to point up the relevancy of acreage availability for soybeans and competing crops. In fact, it appears that a general land supply study is very relevant. It has been estimated that about 300 million acres of class I, II, and III land (suitable for continuous cropping with appropriate conservation practices) in addition to the 342 million now in use, is available for potential crop production [4]. There is an "income threshold" which, once crossed, will cause this land to be developed and brought into production. Obviously, this threshold was crossed in the Mississippi River Delta with recent soybean prices. Institutional developments, primarily future U. S. land policy, will determine the occur-

TABLE 1. YEARS REQUIRED TO RECOVER INVESTMENT IN LAND CLEARING AT VARYING SOYBEAN PRICES, MISSISSIPPI RIVER DELTA AREA

Price/bu.	Bu./Ac. yield	Gross return	Return to land and management	5%[a] return on investment	Net	Years required to recover investment with return on owned capital	
						Included	Excluded
2.50	30	75.00	44.36	13.75	30.61	2.5	1.7
2.25	30	67.50	36.86	13.75	23.11	3.2	2.0
2.00	30	60.00	29.36	13.75	15.61	4.8	2.6
1.75	30	52.50	21.86	13.75	8.11	9.2	3.4

[a]$200 land + $75 clearing cost.

rence and rate of this new land development. A general cropland retirement program, for instance, could cause rapid expansion in land development. Thus, there appears to be numerous questions in this area of potentially available cropland toward which research could be directed. This research would hopefully provide answers for and insight into such questions as: What is the regional availability of potential cropland? What is the quality of such land? What are the levels of the commodity "income thresholds" necessary to cause this land to be brought into production? How do institutional factors impede or facilitate this development?

SHIFTS IN PRODUCTION PATTERNS

Another area in which some information is available is that concerned with shifts in soybean production patterns over time. The original soybean producing area in the United States was Central Illinois. Total soybean production has grown steadily since the crop took its foothold. It has moved to expand from the original core at a steady rate. The bean has become acclimated over a wide expanse of geography. A combination of improved varietal adaptations and of limitations on other crops has pushed soybeans into a wide area from the Gulf to the Great Lakes and the Atlantic to the Plains.

Relative shifts in regional production have occurred and are continuing to occur. Many States which were insignificant producers 15 years ago are now rather important. In amounts, the Central Corn Belt continues to dominate and Illinois retains its longtime first position, accounting for about 20 percent of the total U. S. production, Table 2. The top ten States, which include six from the Corn Belt and four from the rice and cotton areas, account for 85 percent of the total U.S. production. These current rankings are the result of widely divergent growth rates over the past 15 years. The Central Corn Belt States of Illinois, Indiana, and Ohio were, and are, very important, and have increased production for the period but their relative shares have declined. Minnesota follows a similar pattern. Iowa and Missouri, on the other hand, are large volume States which have expanded production at rates slightly faster than the national average. Nebraska production has expanded slightly faster than the national average rate but from a limited base. Although expansion has been at a rapid rate, the Delta States of Louisiana and Mississippi still have a small share of U. S. production. Arkansas production and shares are between these extremes.

These alterations in the production pattern that have occurred in the past 15 years are partly the result of crop substitution. A farmer's selection of crops is primarily dependent on two criteria: technical and natural resources available and the financial returns from crop sales. Technological effects have been a major factor in crop substitution. As the yield of one crop increases relative to another, given prices and costs, the physical substitution ratio dictates that more acreage should be devoted to the crop with the more rapidly increasing yield. This situation has occurred in the Eastern Corn Belt where, over time, corn yields have increased relative to soybean yields. In Illinois, for example, the relative yield of corn to soybeans was 2.41 for the period 1955-59 and increased to 3.12 in 1965-67 (Table 3). However, in the Western Corn Belt, and along the northern fringes, soybean varieties have increasingly become adapted and grower skills have improved. Corn yields have increased relatively less. Of course, much of the increased corn yield is the result of higher fertilization rates and part of the widening ratio in relative yields (gross returns) is offset by increases in difference in production costs.

Differences within and among areas in substitution relationships have significant implications. Given changes in technological, policy, or other variables, the competitive positions of crops in large geographic areas may be altered, thus, influencing regional specialization. Hieronymus [2] has suggested the hypothesis that current forces are likely to move soybean production South from the Corn Belt. Research results that provide insight into these relationships would assist policymakers in evaluating the impact of given program alternatives.

AN INFORMATION SYSTEM

As with most new areas of emphasis, it is difficult to choose a sub-problem for study due to the uncertainty of the relevance scale and the researchability of various alternatives. It, thus, seems wise to suggest reconnaissance, systematic assembly, and evaluation of what we know as a first step. ERS personnel in the Farm Production Economics Division stationed at Purdue University are starting with the concept of an information system of aggregate soybean production and will later turn to more in-depth analysis of questions left unanswered. In the process, a more or less general description of the soybean economy will emerge and its availability for later analyses may be as valuable an output as conclusions from later specific studies.

An information system may be defined as a logically organized body of procedures which processes input or stored data having specified characteristics [1]. Its purposes, in the context of our use, are (1) to supply information needed for input into research projects, (2) to reveal gaps in the data matrix, and (3) to process such data and feed the relationships de-

TABLE 2. CHANGES IN AMOUNT AND SHARE OF SOYBEAN PRODUCTION BY STATES, 1954-1968.

By States	1968 Rank in Amount	1968 Rank in % Increase	1968 Production Million bushel	1968 Production % share of U. S. total	1968 as a percent of 1954-1968 average Amount	1968 as a percent of 1954-1968 average Share
More Production, Larger Share						
Louisiana	9	1	33.6	3.1	345.6	210.7
Alabama	14	2	13.0	1.2	277.3	169.1
Texas	20	3	5.9	0.5	275.9	168.3
Georgia	18	4	8.3	0.8	270.1	164.7
Kentucky	15	5	12.8	1.2	231.7	141.2
Florida	24	6	3.0	0.3	219.6	133.9
Mississippi	8	7	53.0	4.9	211.6	129.0
Tennessee	10	8	25.1	2.3	211.6	129.4
Oklahoma	21	9	4.0	0.4	209.5	127.7
Nebraska	12	10	19.1	1.8	207.5	126.5
Kansas	11	11	22.7	2.1	192.7	117.5
Iowa	2	12	180.2	16.7	185.5	113.2
Missouri	3	13	100.5	9.3	173.3	105.7
South Dakota	19	14	6.2	0.6	169.6	103.4
Michigan	17	15	11.7	1.1	168.5	102.7
More Production, Smaller Share						
Ohio	7	16	68.3	6.3	161.6	98.6
Arkansas	5	17	84.9	7.9	156.3	95.3
Wisconsin	23	18	3.2	0.3	151.2	92.2
Indiana	4	19	93.4	8.7	141.8	86.4
Illinois	1	20	205.3	19.0	140.4	85.6
Minnesota	6	21	77.6	7.2	140.3	85.6
North Dakota	22	22	3.3	0.3	118.4	72.2
North Carolina	13	23	15.8	1.5	117.9	71.9
South Carolina	16	24	12.2	1.1	117.6	71.7

TABLE 3. CHANGES IN RELATIVE YIELDS OF CORN AND SOYBEANS, SELECTED STATES, 1955-1967

State	1955-59	1960-64	1965-67
Illinois	2.41	2.90	3.12
Indiana	2.46	2.86	3.26
Iowa	2.57	2.58	3.12
Louisiana	1.30	1.40	1.61
Missouri	2.23	2.50	2.81
Nebraska	1.83	2.10	2.89

rived back into the system. An information system, as defined above, is broader than an information retrieval system. The latter acts as a reservoir for accumulation and storage of bodies of data. The primary distinction is the type of output provided. An information system provides more information than was initially placed in it, because it includes the analysis function.

The exact nature of such an effort remains somewhat vague, and will necessarily be developed further as research progresses. One can best view it mainly as a skeleton on which to build context. It appears that a considerable part of the initial information assembly should be devoted to compiling in one place the various statistical series that are available, and to combining and integrating results from regional adjustment projects of the past decade, from enterprise cost analysis and farm accounting in various States, from farm practice economic studies, from such efforts as the USDA-Iowa State Interregional competition models of Heady et al, and from FPED's Aggregate Production Analysis Team (APAT) project.

Thus, our initial effort will be one of information assembly and reconciliation. Though complex analytical models would undoubtedly be useful if realistically constructed, it is suggested that the payoff from an information system will be reflected both in enhanced ability to answer immediate policy questions and through contribution to design of more useful analytic tools.

PROBLEM AREAS

At this point in time, there are several questions which are obvious and which could profitably undergo analysis. Clearly the problems are too numerous for us alone. Among them are:

1. To determine the current marginal rates of substitution in production between soybeans and corn, cotton, and rice and to determine the changes over time within and among producing regions.

2. To isolate the effects of past yield improvements in corn, soybean, and cotton production and predict the effects of projected yield improvements.

3. To determine the supply curve for the various components (cleared land, yield increase, shift from other crop) of increased soybean production under conditions of declining soybean prices.

4. To determine the effects of historic feed grain and cotton commodity programs on location of soybean production.

5. To determine the effects of a general land retirement program without individual commodity controls on the production mix of corn, cotton, and soybeans.

Efforts in ERS, at Purdue University, will be concentrated first on the substitution question.

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