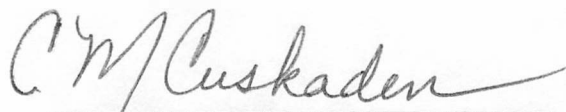
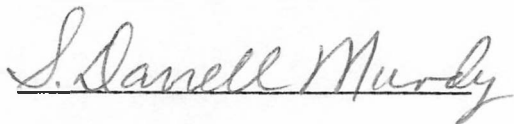
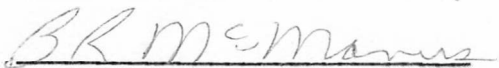


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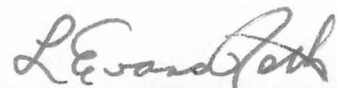
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IDENTIFICATION AND ECONOMIC ANALYSIS OF
ALTERNATIVE SOYBEAN PRODUCTION SYSTEMS

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

William Alan Miller

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ABSTRACT

The objectives of this study were to identify alternative soybean production systems used by Tennessee farmers in 1976 based on alternative combinations of cropping practices and planting methods and to develop estimates of the resource requirements and the costs and returns of each identified cropping-planting system.

A mail survey of randomly selected West Tennessee farm operators was used to identify the following six soybean cropping-planting systems: (1) single crop-row crop, (2) single crop-grain drill, (3) single crop-broadcast, (4) double crop-row crop, (5) double crop-grain drill, and (6) double crop-no till. Comparison of the six systems involved tabulation of survey data pertaining to soybean acreages, soybean and wheat yields, soybean row spacings, soybean seeding rates, and the use of implements and production practices.

Analysis of survey data primarily involved selection of a representative set of implements and production practices for each system. Enterprise budgets were developed for the use of the six cropping-planting systems on each of two sizes of farms utilizing the selected sets of implements and production practices.

Based on the budgets developed in this study, the double crop-row crop system was the relatively most profitable system. The relatively most profitable single crop system was the single crop-grain drill system. Only the single crop-broadcast system was relatively less profitable than the single crop-row crop system, which was the most prevalent system.

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CHAPTER I

INTRODUCTION

The production of soybeans for beans is Tennessee's most important crop production enterprise. Soybean production has exceeded the production of all other crops in Tennessee both in terms of total harvested acreage and total value of production each year since 1971 (Table 1). In 1976, Tennessee farmers harvested 1.8 million acres of soybeans valued at over 255 million dollars.¹ Soybeans accounted for 39.3% of the cash receipts from farm marketings of Tennessee crops and 19.1% of the cash receipts from all farm marketings that year.² The total Tennessee production of 40.5 million bushels of soybeans in 1976 ranked tenth largest among all states in the United States and accounted for approximately 3.2% of the total U.S. production of over 1.2 billion bushels of soybeans harvested for beans (Table 2).

Soybean acreage in Tennessee more than doubled during the decade from 1966 through 1976, while during the same period the value of Tennessee soybean production increased approximately 4.3 times. The most important factor responsible for the increase in soybean acreage was a long term adjustment to the expansion of demand for soybeans.³ These increases

¹Tennessee Agricultural Statistics, Annual Bulletin, T-14, Tennessee Crop Reporting Service, 1977.

²Ibid.

³Herbert W. Brown, Soybeans: Acreage Response to Price and Farm Program Changes, ERS-473, Economic Research Service, USDA, July, 1971, p. 14.

TABLE 1. Harvested Acreage and Value of Production of Major Tennessee Crops (1960-1976)

Year	Harvested Acreage (1000 acres)					Value of Production (1000 dollars)				
	Soybeans	Corn	Cotton	Tobacco	Wheat	Soybeans	Corn	Cotton	Tobacco	Wheat
1960	394	1,354	512	74	137	18,085	59,134	101,437	70,004	5,820
1961	463	1,002	538	80	148	23,122	50,411	106,074	89,379	6,734
1962	463	882	538	85	107	24,170	42,671	101,542	84,043	4,701
1963	528	856	504	84	125	28,607	54,442	122,526	88,385	6,405
1964	586	852	502	76	160	34,504	52,185	114,498	86,357	6,891
1965	732	792	499	69	147	41,285	55,884	104,261	85,336	5,721
1966	871	768	365	61	140	59,112	55,112	50,470	80,824	7,078
1967	1,115	783	236	58	294	67,736	53,127	24,085	74,686	12,877
1968	1,150	658	360	59	273	57,719	40,375	45,972	85,101	9,479
1969	1,125	605	400	59	175	62,370	40,729	51,704	78,478	7,219
1970	1,150	569	390	54	187	73,796	39,688	51,987	79,557	8,770
1971	1,219	675	425	52	234	91,279	46,170	81,886	79,983	12,468
1972	1,298	480	485	57	240	116,223	55,776	83,542	93,853	10,982
1973	1,570	533	440	51	144	202,185	95,684	97,686	89,440	12,544
1974	1,520	570	510	57	325	225,674	117,870	76,647	123,202	32,516
1975	1,850	615	315	66	310	213,675	100,737	64,692	138,472	27,677
1976	1,800	715	370	68	335	255,150	146,861	78,849	163,529	37,805

^aTobacco acreage was rounded to the nearest thousand acres.

Sources: Tennessee Agricultural Statistics, Annual Bulletin T-12, Tennessee Crop Reporting Service, Nashville, Tennessee, 1975; and Tennessee Agricultural Statistics, Annual Bulletin T-14, Tennessee Crop Reporting Service, Nashville, Tennessee, 1977.

TABLE 2. Rank of States Producing Soybeans for Beans in 1976

Rank	State	Production (1000 bu.)
1	Illinois	249,480
2	Iowa	199,950
3	Indiana	111,520
4	Ohio	95,040
5	Missouri	84,000
6	Arkansas	82,080
7	Mississippi	71,500
8	Minnesota	66,440
9	Louisiana	63,000
10	Tennessee	40,500
11	Kentucky	28,890
12	Alabama	28,080
13	North Carolina	24,640
14	South Carolina	21,420
15	Georgia	20,445
16	Nebraska	19,600
17	Kansas	12,975
18	Michigan	11,583
19	Texas	9,022
20	Virginia	8,159
21	Maryland	7,375
22	Florida	6,578
23	Oklahoma	5,500
24	Delaware	4,920
25	South Dakota	4,607
26	Wisconsin	3,344
27	New Jersey	3,312
28	North Dakota	1,838
29	Pennsylvania	1,450
30	New York	312
U.S.		1,287,560

Source: Crop Production, 1977 Annual Summary, Crop Reporting Board, SRS, USDA, Washington, D.C., January 16, 1978.

in demand were such that from 1949 through 1973 soybeans maintained an almost continuous advantage over major competing U.S. crops. Since 1974, however, the combined effects of changing price relationships between competing U.S. crops, increasing competition from soybean production in other countries, and the increase in production of substitute oil crops have altered the demand situation for U.S. soybeans.^{4,5} These factors may be largely responsible for the fluctuations in the level of soybean acreage and value of production in Tennessee since 1974.

The production of soybeans for beans in Tennessee is heavily concentrated in the western part of the state. Farmers harvested 730,000 acres of soybeans in the six counties of Tennessee Crop Reporting Service District 1 and 722,000 acres in the twelve counties of Tennessee Crop Reporting Service District 2 in 1976 (Table 3). These 18 counties accounted for 80.7% of the total harvested acreage and 79.2% of the total bushels of soybeans produced for beans in Tennessee in 1976.

I. JUSTIFICATION

Tennessee farmers utilize a variety of alternative soybean production systems to produce soybeans as a single crop and as the second crop

⁴W. A. Boutwell, H. M. Harris and D. Kenyon, Competition Between Soybeans and Other Crops in Major U.S. Regions, ERS-588, Economic Research Service, USDA, Washington, D.C., April 1975.

⁵Alan S. Walter, Intercountry Competition in the Production and Export of Soybeans, ERS-610, Economic Research Service, USDA, Washington, D.C., August 1975.

TABLE 3. Distribution of Soybean Production in Tennessee by Crop Reporting Service Districts in 1976

District	Soybean Production				Number of Counties In District	Number of Counties Which Harvested 100 Acres or More
	Acres		Bushels			
	(000)	%	(000) ^a	%		
1	730	40.6	16,613	41.0	6	6
2	722	40.1	15,463	38.2	12	12
3	160	8.9	3,877	9.6	15	15
4	87	4.8	2,157	5.3	18	18
5	80	4.4	1,887	4.7	16	15
6	21	1.2	504	1.2	28	20
Total	1,800	100.0	40,500	100.0	95	86

^aSoybean production was rounded to the nearest thousand bushels.

Source: Tennessee Agricultural Statistics, Annual Bulletin T-14, Tennessee Crop Reporting Service, Nashville, Tennessee, 1977.

in a double cropping combination. Both of these cropping practices are utilized in West Tennessee, as well as in other areas of Tennessee, but the single cropping practice is considerably more prevalent.

A soybean production system consists of the particular combination of individual cultural practices and tillage operations utilized prior to harvest on a soybean field. Farmers may use one or more of these systems on their farms. Traditionally, Tennessee producers have utilized the conventional type of soybean production system which employs the plow-disk-harrow tillage sequence along with the row-crop planting method and mechanical cultivation. A slightly modified conventional production system involving the addition of chemical weed control methods is currently recommended for corn, cotton, and single crop soybean production in Tennessee by the University of Tennessee Institute of Agriculture.⁶

Technical developments in recent years have increased the number of viable soybean production alternatives available to producers. Two main developments in recent years are now giving crop producers more alternatives in tillage.⁷ One is the variety of new designs in farm machinery. The other big development has been the improvement of herbicides to control grass and weeds. The full impact of these developments on Tennessee soybean production has not yet been determined.

⁶Wayne T. Flinchum, Soybean Production in Tennessee, Tennessee Agricultural Extension Service Publication 421, Knoxville, Tennessee, May 1976.

⁷Tillage Alternatives, "Narrative Guide for Filmstrip and Slide Set C-188," Cooperative Extension Service, USDA, Washington, D.C., July 1972.

II. OBJECTIVES

The original objectives guiding this research were to identify alternative soybean production systems used by Tennessee farmers in 1976 and to evaluate the resource requirements and relative profitability of identified alternatives.

The concept of systems analysis in crop production, i.e., the study of a production system by breaking the system into its component parts, was utilized in refining the guiding objectives as follows:

1. Identify alternative soybean production systems used by Tennessee farmers based on alternative combinations of cropping practices and planting methods.
2. Determine the farm sizes, yields, and other characteristics associated with the use of each cropping-planting system identified.
3. Identify the production practices and tillage operations used with each identified cropping-planting system.
4. Select a representative production system, i.e. specify one set of commonly utilized production operators, implements, and practices, for each identified cropping-planting system.
- (5) Develop estimates of the resource requirements and the costs and returns of each identified soybean production system.

III. PROCEDURES

The primary data required by objectives 1, 2, and 3 were obtained from a randomly selected sample of farm operations by means of a mailed questionnaire. All information requested by the questionnaire pertained to the 1976 crop year.

Tennessee Crop Reporting Service Districts 1 and 2 were selected as the sample area due to the heavy concentration of soybean production in West Tennessee.⁸ The sample was drawn from the Farm Universe List maintained by the Tennessee Crop Reporting Service in cooperation with the Tennessee Agricultural Extension Service. Utilizing a computerized randomizing procedure, an employee of the Tennessee Crop Reporting Service drew the names of 2044 farm operators from the population of farm operators in the sample area. This sample accounted for approximately 11% of the estimated total population of farm operators in Districts 1 and 2.⁹

Of the 2044 questionnaires mailed to farm operators, 166 were completed and returned by farmers that produced soybeans for beans. Only data compiled from these 166 questionnaires were utilized to satisfy objectives 1, 2, and 3 of this research.

The responses by soybean producers were reasonably well distributed by county within the sample area (Table 4). More important, though, was the fact that for the most part the percentage of the total number of these responses accounted for by each county compared favorably

⁸Farm operators in 17 counties in these two districts were surveyed in this study. Crop Reporting Service Districts 1 and 2 contain 18 counties, but Lake County was accidentally omitted when the sample was drawn and the error was not detected until the survey results were analyzed.

⁹This particular estimate of the total population of farm operators in Crop Reporting Service Districts 1 and 2 was provided by Robert Hobson, Agricultural Statistician in charge of the Tennessee Crop Reporting Service, and was based on the 1976 Farm Universe List. The list has been revised downward in numbers since that time.

TABLE 4. Distribution of Soybean Producer Responses and Farms Producing Soybeans in the Sample Area by County

County	Soybean Producer Responses		Farms Producing Soybeans	
	Number ^a	%	Number ^b	%
Carroll	5	3.03	658	6.84
Chester	13	7.88	361	3.75
Crockett	8	4.85	481	5.00
Dyer	8	4.85	660	6.86
Fayette	9	5.45	358	3.72
Gibson	15	9.09	1185	12.33
Hardeman	7	4.24	277	2.88
Haywood	10	6.06	526	5.47
Henderson	11	6.67	476	4.95
Henry	7	4.24	553	5.75
Lauderdale	8	4.85	507	5.27
McNairy	9	5.45	647	6.73
Madison	21	12.73	524	5.45
Obion	9	5.45	669	6.96
Shelby	7	4.24	305	3.17
Tipton	6	3.64	452	4.70
Weakley	12	7.27	975	10.14
Total ^c	165	99.99	9614	99.97

^aData from 166 questionnaires were considered in this report but one questionnaire did not report the county in which the producer operated.

^bSource: Census of Agriculture 1974, State Reports: Tennessee, United States Census Bureau, Washington, D.C., June 1977. This was the number of farms producing soybeans for beans in each county.

^cThe sums of the percentage columns do not equal 100% due to rounding error.

with the percentage of the total number of farms producing soybeans for beans in the sample area accounted for by each county. The reason this was thought to be important was that one would expect to find certain cropping practices concentrated in certain physiographic regions within the sample area. For example, one might expect to find double cropping practiced primarily in wheat producing regions within the sample area.

The questionnaire used in this study was designed to facilitate the break-down of alternative soybean production systems on the basis of different cropping practice-planting method combinations. Respondents were asked to indicate those cropping-planting systems they used on their farms by selecting from among the eight predetermined combinations listed on the questionnaire.¹⁰ The predetermined cropping-planting combinations were selected on the basis of conversations with farmers and University of Tennessee Agricultural Research and Extension Personnel, review of popular farm publications, and review of previous research. Having identified the systems they utilized, respondents were then asked to provide selected information pertaining to their use of each of these systems. The collected data were summarized and organized into tabular form to facilitate reporting and comparisons.

In order to accomplish objective 4, survey data were used as the basis for selecting a representative set of soybean production operations for each identified cropping-planting system. The selection

¹⁰The predetermined cropping-planting alternatives were: (1) single crop-row crop, (2) single crop-grain drill, (3) single crop-no till, (4) single crop-broadcast, (5) double crop-row crop, (6) double crop-grain drill, (7) double crop-no till, and (8) double crop-broadcast.

process consisted of identifying the set of specific implements and production practices most often used to produce soybeans with each cropping-planting system and determining the modal number of times each selected implement or practice was normally used per soybean field. Implement combinations were also taken into account in determining representative production operations for each soybean cropping-planting system.

The selection of representative implements and practices consisted of two steps. The production operations used in each soybean cropping-planting system were determined first. Seven types of production operations were identified a priori as feasible components of pre-harvest soybean production. These seven operations included: (1) pre-tillage field preparation, (2) primary tillage, (3) secondary tillage, (4) seedbed conditioning, (5) cultivation, (6) chemical weed control, and (7) chemical disease control. Each implement or practice listed on the survey questionnaire was then assigned to one of the above seven types of soybean production operations, e.g., subsoilers, offset disks, moldboard plows, and chisel plows were designated as primary tillage implements. If more than 50% of the farmers utilizing a given cropping-planting system reported using implements or practices assigned to a particular type of production operation, that operation was included as a component of that cropping-planting system.

Specific implements and practices were selected to comprise each cropping-planting system following the identification of the representative production operations for each system. The implement or practice used

most often by soybean producers to perform a given representative production operation in a cropping-planting system was selected as representative of that cropping-planting system.

Enterprise budgeting techniques were applied to develop estimates of the costs and returns associated with alternative cropping-planting systems. Data used in the budgeting analysis were obtained from both the primary and various secondary data sources. Secondary data utilized in budgeting included agricultural engineering data and Agricultural Extension Service recommendations pertaining to material inputs.

IV. REPRESENTATIVE NATURE OF THE SURVEY RESULTS

The random sampling technique and relatively large sample size were utilized in an attempt to insure that the information obtained would be representative of all soybean production in the West Tennessee study area. While 166 responses were probably sufficient for identifying alternative cropping-planting systems, for reflecting the variety of soybean production practices, and for evaluating the relative importance of each identified system, caution should be exercised before drawing inferences about the production practices, yields, and other characteristics of less prevalent systems because of the paucity of observations. Inferences drawn from the data presented in this report were intended to apply specifically only to soybean production in the study area. However, the sample area accounts for the majority of soybean production in Tennessee and should, therefore, reflect the majority of production systems utilized in the state.

V. REVIEW OF PREVIOUS RESEARCH

Data obtained from both sample surveys and experimental plot studies have been used to evaluate soybean production practices, costs, and returns. Several previous research reports influenced the conceptual development of this study. No study was found which dealt specifically with identifying and evaluating alternative soybean cropping-planting systems, but researchers in several states have developed estimates of the costs and returns of both single cropping soybeans and double cropping wheat and soybeans based on the use of conventional production practices.

Bauer^{11,12} reported the costs and returns of single crop soybeans produced on five-acre plots at five Tennessee Agricultural Experiment Station locations in 1971 and 1972. Soybeans were produced using one system of soybean production consisting of production practices recommended by the University of Tennessee, Institute of Agriculture. The specific objective of this research was to evaluate soybean production costs and returns on soils representing specific geographic and physiographic regions within the soybean producing areas of the state.

¹¹Larry L. Bauer and Joseph A. Brasher, Costs and Returns of Soybean Production on Experiment Station Plots, 1971, Tennessee Agricultural Experiment Station Progress Report 82, Knoxville, Tennessee, April-June 1972, p. 21.

¹²Larry L. Bauer and James Culver, Costs and Returns of Soybean Production on Experiment Stations, 1972, Tennessee Agricultural Experiment Station Progress Report 87, Knoxville, Tennessee, July-September 1973, p. 2.

Research undertaken in Missouri¹³ since 1975 has utilized large-scale production experiments involving a complete line of full-scale farm equipment to study the production of single crop soybeans. Alternative soybean production systems consisting of various combinations of four variables: (1) tillage, (2) row width, (3) planting date, and (4) weed control are being analyzed. The objective of this research is to evaluate the effect of alternative soybean production systems on yields, income, and energy utilization.

Wolf and Leary¹⁴ selected commonly used soybean production practices from among those practices reported by producers surveyed in the Macon Ridge area of Louisiana and utilized the selected production practices in developing estimates of costs and returns for high and low yield producers of single crop soybeans.

Wolf, Vidrine, and Martinez¹⁵ used input-output data obtained from a survey of Southwest Louisiana soybean producers to develop estimates of

¹³David R. Johnson and Maurice R. Gebhardt, "A Systems Approach to Soybean Production," Soybean News, National Soybean Crop Improvement Council, Urbana, Illinois, October 1975.

¹⁴Willard F. Wolf and Patrick D. Leary, Effects of Production Practices on Soybean Yields, Costs, and Returns, Macon Ridge Area, Louisiana, Louisiana State University, Department of Agricultural Economics Research Report 497, Baton Rouge, Louisiana, December 1975.

¹⁵Willard F. Wolf, Blake J. Vidrine, and Adolf Martinez, Costs and Returns for Soybeans, Southwest Louisiana Rice Area, Projections for 1977, Louisiana State University, Department of Agricultural Economics Research Report 512, Baton Rouge, Louisiana, December 1976.

the costs and returns of producing single crop soybeans utilizing two alternative planting methods. The two planting methods analyzed were conventional planting with a row crop planter and planting with a grain drill.

Paxton¹⁶ reported using the enterprise budgeting technique to estimate soybean production costs and returns for 1977 in Louisiana. Information utilized in budgeting concerning cultural practices, input use, and machinery complements, was obtained from a survey of farmers in all major cotton producing areas of the state. Paxton presented this data in the report along with methods for determining machinery use and costs per acre.

¹⁶Kenneth W. Paxton, Cotton and Soybean Production Costs and Returns, Estimates for Louisiana for 1977, Louisiana State University, Department of Agricultural Economics Research Report 515, Baton Rouge, Louisiana, March 1977.

CHAPTER II

SELECTED CHARACTERISTICS OF FARMS PRODUCING SOYBEANS.

This chapter reports results of the mail survey described in Chapter I with regard to data gathered on acreages, tenure patterns, and soybean cropping-planting systems on farms producing soybeans. Only data from questionnaires completed by 166 West Tennessee farm operators who reported producing soybeans for beans in 1976 were considered.

I. TOTAL, CROP, AND SOYBEAN ACREAGE

The soybean producers sampled operated a total of 55,385 acres of owned and rented land of which approximately 86.4% , or an average of 305 acres per farm, was planted in crops in 1976 (Table 5). An average of 225 acres, or approximately 73.8% of the average acreage in crops, was planted in soybeans.¹ Observations of both the cropped acreage and the soybean acreage on individual farms ranged from 3 to 3600 acres.

II. LAND TENURE PATTERNS

Three patterns of farmland tenure were reported by farm operators responding to the survey. Respondents farms were: (1) owned, (2) rented,

¹Examination of individual questionnaires revealed that the percentage of cropped acreage planted in soybeans on individual farms ranged widely from a low of 8.5% to a high of 100%.

TABLE 5. Total Land Operated, Land in Crops, and Land in Soybeans on Farms Producing Soybeans in West Tennessee, 1976

Acreage Item	Number of Farms Reporting ^a	Total Acreage	Average Acreage Per Farm ^b	Range of Acreage Per Farm	
				Minimum	Maximum
Total Land Operated	157	55,385	353	9	3600
Land in Crops	157	47,834	305	3	3600
Land in Soybeans	161	36,195	225	3	3600

^aFour farm operators did not report total land operated or land in crops.

^bAverage acreages were rounded to the nearest whole number.

and (3) owned-rented. Data on the three tenure patterns are summarized in Table 6 in terms of two criteria for comparing their relative importance. These criteria are the total incidence of each tenure pattern and the total cropped acreage associated with each tenure pattern.

Farms comprised entirely of rented land accounted for the smallest number of farms, but not the smallest number of acres in crops. In contrast, farms comprised entirely of owned land accounted for the largest number of farms, but the smallest number of acres in crops was attributable to these farms. The average acreage in crops on farms composed entirely of rented land was considerably larger than the average acreage in crops on farms made up entirely of owned land. Farms consisting of a combination of both owned and rented land were only slightly less prevalent than farms comprised entirely of owned land, but the average cropped acreage on the owned-rented farms was approximately the same as the average cropped acreage on farms composed entirely of rented land.² The owned-rented tenure pattern was the most important pattern of farmland tenure observed on farms producing soybeans based on acreage in crops.

III. SOYBEAN CROPPING-PLANTING SYSTEMS

As stated in Chapter I, soybean producers were asked to indicate which of eight predetermined cropping practice-planting method combinations they utilized in 1976. Each respondent reported utilizing one or

²Approximately 58.7% of the reported acreage in crops on the owned-rented farms was rented.

TABLE 6. Land Tenure Patterns on Farms Producing Soybeans in West Tennessee, 1976

Tenure Pattern	Farms Producing Soybeans		Acres of Cropland		
	No.	%	Total	% of Total	Per Farm ^a
Owned	69	44.5	6,394	13.4	93
Rented	20	12.9	9,600	20.1	480
Owned-Rented	66	42.6	31,659	66.4	480
Total	155 ^b	100.0	47,653	99.9 ^c	307

^aAverage acreages in cropland were rounded to the nearest whole number.

^bTwo farms included in the summary of land in crops in Table 5 were omitted from this table because land tenure information was not reported by the farm operators.

^cA percentage total equal to less than 100.0% resulted from rounding error.

more of six of the eight alternatives. The six cropping-planting systems used by the 166 soybean producers who responded to the survey were:

(1) single crop-row crop, (2) single crop-grain drill, (3) single crop-broadcast, (4) double crop-row crop, (5) double crop-grain drill, and (6) double crop-no till. None of the respondents reported utilizing either the single crop-no till or the double crop-broadcast alternatives listed on the questionnaire.

Incidence of Identified Systems on Farms

The majority of soybean producers reported utilizing only one soybean cropping-planting system in 1976 (Table 7). Of the 166 producers reporting, 80.7% utilized only one cropping-planting system on their farms, whereas 15.1%, 3.6%, and 0.6% of the producers used two, three, and four systems, respectively.

The single crop-row crop system was the most frequently reported soybean production system. This system was used by 72.3% of all farm operators reporting soybean production and by 89.6% of the farm operators producing soybeans using only one cropping-planting system.

Half of the 32 producers who reported more than one soybean cropping-planting system on their farms used only one planting method to produce both single crop and double crop soybeans. Therefore, 150, or just over 90% of all farm operators reporting soybean production used only one planting method. The remaining 16 farm operators used two planting methods to produce single crop and/or double crop soybeans.

Only one cropping practice was used by 84.9% of all soybean growers

TABLE 7. Number and Type of Soybean Production Systems Used by West Tennessee Farmers, 1976

No. of Systems Per Farm	Description of Observed Systems or Systems Combinations on Farms ^a	Farms Producing Soybeans		
		No. Reporting	% of Group Subtotal	% of Total
1	S.C. - R.C.	120	89.6	72.3
	S.C. - G.D.	5	3.7	3.0
	S.C. - B.C.	1	.7	.6
	D.C. - R.C.	6	4.5	3.6
	D.C. - N.T.	2	1.5	1.2
	Subtotal	134	100.0	80.7
2	S.C. - R.C. + S.C. - G.D.	4	16.0	2.4
	S.C. - R.C. + S.C. - B.C.	3	12.0	1.8
	S.C. - R.C. + D.C. - R.C.	15	60.0	9.0
	S.C. - R.C. + D.C. - G.D.	1	4.0	.6
	S.C. - R.C. + D.C. - N.T.	1	4.0	.6
	S.C. - G.D. + D.C. - G.D.	1	4.0	.6
	Subtotal	25	100.0	15.1
3	S.C. - R.C. + S.C. - G.D. + D.C. - R.C.	4	66.7	2.4
	S.C. - R.C. + S.C. - G.D. + D.C. - G.D.	1	16.7	.6
	S.C. - R.C. + D.C. - R.C. + D.C. - N.T.	1	16.7	.6
	Subtotal	6	100.1 ^b	3.6
4	S.C. - R.C. + D.C. - R.C. + S.C. - G.D. + D.C. - G.D.	1	100.0	.6
	Subtotal	1	100.0	.6
	Total	166		100.0

^aEach system consists of one cropping practice combined with one planting method. The codes used to designate cropping practices are: S.C. = single crop, and D.C. = double crop. The codes used to designate planting methods are: R.C. = row crop, G.D. = grain drill, B.C. = broadcast, and N.T. = no till. Thus, the code S.C. - R.C. represents a single crop-row crop system of soybean production. A combination of systems indicates that soybeans were produced by two or more different cropping-planting systems on a given farm. Combinations of systems are indicated in the table by the (+) sign.

^bOne percentage subtotal does not equal 100.0% due to rounding error.

responding to the survey. Only single crop soybeans were produced by over 94% of the farmers who reported using only one cropping practice on their farms.

Relative Importance of the Six Utilized Systems

An implicit objective of this study was to gauge the level of use of the alternative soybean cropping-planting systems, and by so doing, determine the relative importance of each system. The extent to which each system was utilized in 1976 was measured both in terms of the total incidence of each system and the total soybean acreage planted with each system.³ Table 8 illustrates the relative importance of each of the six alternative systems in terms of these two measures.

The single crop-row crop combination was by far the most important cropping-planting system utilized. This system accounted for 73.3% of the 206 total systems observations and 79.5% of the total soybean acreage planted on farms analyzed in this study. The two other relatively important systems were the single crop-grain drill and double crop-row crop systems which accounted for 7.8% and 13.1% of the total number of systems observations, respectively. Although the double crop-row crop system was reported more frequently than the single crop-grain drill system, the single crop-grain drill system was used to plant approximately 2.4 times more soybean acreage than the double crop-row crop system.

³Table 8 illustrates the total incidence of each of the six soybean cropping-planting systems as opposed to the incidence of these systems on farms, which was illustrated in Table 7. Since more than one system was utilized on 19.3% of the farms, there were several more systems observations than farm observations.

TABLE 8. Incidence of Soybean Cropping-Planting Systems and Soybean Acreage Planted by Cropping-Planting System in West Tennessee, 1976

Cropping-Planting System	Incidence of Systems		Soybean Acreage Planted	
	No. of Observations	% of Observations	No. of Acres	% of Total Acres
Single Crop				
Row Crop	151	73.3	29,776	79.5
Grain Drill	16	7.8	4,929	13.2
Broadcast	4	1.9	87	.2
Double Crop				
Row Crop	27	13.1	2,070	5.5
Grain Drill	4	1.9	207	.6
No Till	4	1.9	364	1.0
Total	206	99.9 ^a	37,433 ^b	100.0

^aA percentage total equal to less than 100.0% resulted from rounding error.

^bAcreage data in this table were corrected for missing observations by assuming that missing soybean acreage observations for any cropping-planting system were equal to the average of available soybean acreage data for that cropping-planting system.

The single crop-broadcast, double crop-grain drill, and double crop-no till systems each accounted for only 1.9% of the total number of cropping-planting systems observations. None of these three systems was used to plant more than 1.0% of the total soybean acreage analyzed in this study.

CHAPTER III

YIELDS AND CULTURAL PRACTICES

Soybean producers were asked to provide information on the yields they obtained and on characteristics of selected cultural practices they used with each of the six alternative cropping-planting systems. The requested information was primarily related to soybean production; however, small grain yields were also included for the double crop systems. A comparison of yields and selected cultural practices associated with the different soybean production systems used by West Tennessee farmers in 1976 is presented in this chapter.

I. YIELDS

Soybean producers were asked to estimate the average per acre yields they obtained with each cropping-planting system they utilized. Producers were requested to differentiate between soybean yields produced on owned land and soybean yields produced on rented land. Estimates of the average small grain yields produced while utilizing double crop systems were also obtained, but they were not differentiated by land tenure. All yield data are summarized in Table 9. The average yields presented for some systems may not be representative due to the small number of observations available.

Soybean Yields

The variation in the average soybean yields reported by producers utilizing different cropping-planting systems was not nearly as great as

TABLE 9. Soybean and Wheat Yields Per Acre by Cropping-Planting System, 1976

Cropping-Planting System	Owned Land				Rented Land				Total Land in Soybeans		Wheat ^a			
	No. of Observations	Avg. Yield (bu.)	Yield Min.	Range Max.	No. of Observations	Avg. Yield (bu.)	Yield Min.	Range Max.	No. of Observations	Avg. Yield (bu.)	No. of Observations	Avg. Yield (bu.)	Yield Min.	Range Max.
Single Crop														
Row Crop	117	26.8	10	46	69	25.5	10	43	147	26.3			N.A.	
Grain Drill	9	29.9	25	42	8	26.3	15	40	13	28.2			N.A.	
Broadcast	2	20.5	11	30	2	26.5	15	38	3	23.5			N.A.	
Double Crop														
Row Crop	19	29.5	10	50	9	29.3	20	50	22	29.4	23	35.9	17	55
Grain Drill	0	0.0	0	0	2	24.0	18	30	2	24.0	4	37.5	20	50
No Till	3	22.3	10	32	1	20.0	0	0	4	21.8	4	31.0	25	44

^aWheat yield data are not applicable to single crop systems, as is indicated in the table.

the range in yields reported by producers utilizing a given system. The greatest difference in overall average soybean yields between any two of the six systems was 7.6 bushels per acre. Soybean yields obtained by individual producers differed as much as 40 bushels per acre with the double crop-row crop system. The smallest yield range observed was 12 bushels per acre with the double crop-grain drill combination. However, only two yield observations for this system were available.

The variation in the average soybean yields obtained utilizing alternative cropping-planting systems was very similar on both owned land and rented land. The maximum difference in average yields between any two of the six systems was approximately 9.4 and 9.3 bushels per acre on owned and rented land, respectively. However, average soybean yields for a given production system were lower on rented land than on land which was owned in all cases which could be compared except one. The amount by which average yields on land which was owned exceeded those on rented land varied by cropping-planting system, but for no system was the difference greater than 3.6 bushels per acre.

The systems producing the highest reported yields tended also to produce the lowest yields. Reported yield extremes were not consistently related to whether the planted land was owned or rented.

Small Grain Yields

Soybean producers who used a double crop system in 1976 were asked to report the type of crop they produced prior to planting soybeans and to estimate the average yield of that crop. All reporting soybean

producers who utilized double crop systems in 1976 produced wheat in the first crop in the double crop sequence. However, one of these soybean producers reported utilizing the double crop-row crop system to produce an oat-soybean combination in addition to the wheat-soybean double crop combination.¹

The average wheat yields associated with the three double crop systems ranged from 31.0 to 37.5 bushels per acre. The average wheat yields obtained with the double crop-row crop and double crop-grain drill systems differed by only slightly more than one and one-half bushels per acre, but the average wheat yield obtained utilizing the double crop-no till system was considerably lower. The difference between the average wheat yields for the double crop-grain drill and double crop-no till systems was considerably less than the range in reported wheat yields associated with any given double crop system.

II. CULTURAL PRACTICES

The soybean row spacings and seeding rates associated with each cropping-planting system were compiled from survey responses based on the number of cropping-planting systems observations. Differences in soybean row spacings and seeding rates between the six systems appeared related to the planting method, as might be expected, since row spacings are

¹The oat-soybean double crop combination was not treated in this report as a separate cropping-planting system observation, since the producer in question used exactly the same soybean production and cultural practices to produce soybeans with both oats and wheat.

constrained by the type of planting implement selected and since seeding rates are a function of width of row, size of seed, and germination of seed.²

Row Spacings

Soybean row spacings reported by producers were distributed around a single most commonly used spacing for those systems utilized by a fairly large number of producers (Table 10).³ The most commonly reported row spacings were identical for the single crop-row crop and double crop-row crop systems.

The ranges of reported row spacings were similar for those pairs of systems utilizing the same planting method. For example, row spacings ranged from 28 to 40 inches for the single crop-row crop system and from 32 to 40 inches for the double crop-row crop system. On the other hand, the ranges of reported row spacings were noticeably different among those systems utilizing different planting methods.

One important result of the row spacing analysis was the absence of certain responses from the survey data. For instance, few respondents who used the two row crop systems had adopted the use of narrow row

²Flinchum, op. cit., p. 14.

³Considering the fact that the largest discontinuity in the range of row spacings for another system was three inches, the 36 inch row spacing reported by one producer who utilized the double crop-no till system looks completely out of place. Row spacings associated with this system were expected to range from 15 to 24 inches.

TABLE 10. Incidence of Different Soybean Row Spacings by Cropping-Planting System, 1976

Row Spacing (inches)	Single Crop			Double Crop		
	Row Crop	Grain Drill	Broadcast	Row Crop	Grain Drill	No Till
	No. of Observations	No. of Observations	No. of Observations ^a	No. of Observations	No. of Observations	No. of Observations
6		2			1	
7		5				
8		2				
9		1			1	
10		1				
19						1
20						1
22						1
28	1					
32	1			1		
34				1		
36	25			7		1
38	93			14		
39	1					
40	8			1		

^aThe survey question concerning row spacings was not applicable to the single crop-broadcast system.

planters, i.e, planters with row widths ranging from 28 to 34 inches.⁴ Also, none of the respondents who utilized the grain drill planting method had increased row spacings by stopping up alternating planting units of the implement.⁵ This practice may become popular as the soybean planting capabilities of the grain drill are improved.

Seeding Rates

The University of Tennessee Agricultural Extension Service recommended in 1976 that producers plant from 40 to 50 pounds of soybean seed per acre when planting 40 inch rows and from 85 to 90 pounds of soybean seed per acre when either planting with a seven inch drill or broadcasting.⁶ The average number of pounds of soybean seed planted per acre by farmers responding to the survey who used the two row crop systems were 47 and 50 pounds for the single crop and double crop systems,

⁴Row crop planters with row spacings in this range, particularly the 30 inch row width, have been available on the market the last few years and studies concerned with comparing yields obtained with 30 inch rows versus 40 inch rows have been carried out in several states.

⁵The practice of altering the row spacing on grain drills was first mentioned to this author by Dr. Elmer Ashburn, Associate Professor of Plant and Soil Science, Tennessee Agricultural Extension Service Specialist Staff. This practice apparently represents a relatively recent development in soybean production techniques, which may explain why none of the mail survey responses indicated the use of this practice.

⁶Flinchum, op. cit., p. 14. The recommended seeding rates were for small-seeded varieties of soybeans. These rates should be increased by about 15 pounds per acre for large-seeded soybean varieties.

respectively (Table 11). Average soybean seeding rates for the three narrow row systems and the one broadcast system ranged from 71 to 78 pounds per acre. Thus, the observed average seeding rates were within the range recommended by the University of Tennessee for the single crop-row crop and double crop-row crop systems, but were somewhat below the recommended range for the other four cropping-planting systems.

The range of reported soybean seeding rates associated with each of the six cropping-planting systems was considerable. Reported seeding rates for the two grain drill systems were as much as 50 pounds per acre below the minimum recommended rate. Reported seeding rates for the two row crop systems were as much as 40 pounds per acre above the maximum recommended rate.

TABLE 11. Average Soybean Seeding Rate Per Acre by Cropping-Planting System, 1976

Cropping- Planting System	Seeding Rate			
	No. of Observations	Mean (lbs.)	Range (lbs.)	
			Min.	Max.
Single Crop				
Row Crop	118	47	12	90
Grain Drill	13	78	35	120
Broadcast	2	75	60	90
Double Crop				
Row Crop	22	50	40	90
Grain Drill	3	71	35	90
No Till	3	75	60	90

CHAPTER IV

SOYBEAN PRODUCTION PRACTICES

The pre-harvest soybean production practices utilized with each of the six alternative cropping-planting systems in 1976 are discussed in this chapter. Three types of pertinent data are reported: (1) the implements and production practices used, (2) the number of times specified implements and production practices were normally used on individual soybean fields, and (3) the extent to which producers combined specified implements during individual trips across their soybean fields.

I. IMPLEMENTS AND PRODUCTION PRACTICES USED

Producers specified the implements and production practices they used with each cropping-planting system based on a predetermined list of implements and production practices included on every questionnaire. Almost all of the 166 soybean producers who returned questionnaires provided this type of information for the systems they utilized.¹ The analysis in this chapter of implements and production practices used in soybean production is based on the assumption that if any information about implement or practice use was provided, it was complete. That is, all implements and production practices used were reported.² Implements

¹Of the total of 206 cropping-planting systems observations reported in Chapter II, 200 included specification of the soybean production implements and practices utilized.

²The procedure used to determine the types of operations commonly

and practices were grouped together by the type of operation that could be used to perform, and both the reported incidence of each type of operation as a component of different cropping-planting systems and the reported frequency with which particular implements and practices were used to perform each operation were analyzed.³

Pre-Tillage Field Preparation

The practice of pre-tillage field preparation was used with every one of the six cropping-planting systems (Table 12).⁴ However, only with the double crop-row crop and double crop-grain drill systems were pre-tillage field preparation practices performed by over half of the producers who specified the implements and practices they used for each system.

Three pre-tillage field preparation practices were used with the double crop-row crop system: (1) cutting straw residue with either a stalk cutter or a rotary mower, (2) burning straw residue, and (3) baling

used with each system made this assumption necessary (see Chapter V). Examination of individual questionnaires indicated that this assumption was not always entirely justified, e.g., several producers reported either the type(s) of herbicide(s) or the herbicide application implement(s) they used, but not both.

³The seven types of soybean production operations referred to here were delineated in Chapter I.

⁴The use of a pre-tillage field preparation practice with the double crop-no till system was not an expected result of this survey. Survey data indicated that straw residue was baled on only 5.5% of the soybean acreage planted using the double crop-no till system. Probably only a small percentage of the straw on this acreage was removed, while the remaining straw residue was left to provide cover for planting no till soybeans.

TABLE 12. Pre-Tillage Field Preparation Practices Used by West Tennessee Farmers for Soybean Production by Cropping-Planting System, 1976^a

Item	Single Crop						Double Crop					
	Row Crop		Grain Drill		Broadcast		Row Crop		Grain Drill		No Till	
	Producers Reporting		Producers Reporting		Producers Reporting		Producers Reporting		Producers Reporting		Producers Reporting	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Implement and Practice Use	148	100.0	16	100.0	3	100.0	26	100.0	4	100.0	3	100.0
Pre-Tillage Field Preparation Practices	29	19.6	1	6.3	1	33.3	20	76.9	4	100.0	1	33.3
Stalk Cutter or Rotary Mower	29	19.6	1	6.3	1	33.3	5	19.2	0	0.0	N.A.	
Burn Straw	N.A.		N.A.		N.A.		14	53.8	4	100.0	N.A.	
Bale Straw	N.A.		N.A.		N.A.		6	23.1	1	25.0	1	33.3

^aThe sum of the percentages of producers who reported using various types of pre-tillage field preparation practices does not always equal the percentage who reported the use of pre-tillage field preparation because some producers reported using more than one type of pre-tillage field preparation practice. N.A. indicates not applicable.

straw residue.⁵ Two of these practices, burning straw and baling straw, were used with the double crop-grain drill system.

The predominant pre-tillage field preparation practice used with both the double crop-row crop and double crop-grain drill systems was burning. All four producers utilizing the latter system reported burning straw.⁶ Baling was the second most important pre-tillage field preparation practice for both systems.

Combinations of pre-tillage field preparation practices were used on some farms on which the double crop-row crop and double crop-grain drill systems were utilized. However, specific combinations of pre-tillage field preparation practices used by producers were not analyzed.

Primary Tillage

Although primary tillage was not used in the double crop-no till system because of the necessity of maintaining cover for no till soybean production, it was used by over half of those procedures utilizing each of the other five cropping-planting systems except the double crop-grain drill system (Table 13). Only half of those producers who utilized the double crop-grain drill system used a primary tillage tool.

The relative importance of the four primary tillage tools varied

⁵Survey data indicated that straw residue was burned on 30.9%, and baled on 14.4%, of the soybean acreage planted with the double crop-row crop system.

⁶Survey data indicated that 95.2% of the soybean acreage planted with the double crop-grain drill system was burned to remove straw residue.

TABLE 13. Primary Tillage Implements Used by West Tennessee Farmers for Soybean Production by Cropping-Planting System, 1976^a

Item	Single Crop						Double Crop					
	Row Crop		Grain Drill		Broadcast		Row Crop		Grain Drill		No Till	
	Producers Reporting		Producers Reporting		Producers Reporting		Producers Reporting		Producers Reporting		Producers Reporting	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Implement and Practice Use	148	100.0	16	100.0	3	100.0	26	100.0	4	100.0	3	100.0
Primary Tillage Implements	129	87.2	14	87.5	3	100.0	20	76.9	2	50.0	N.A.	
Subsoiler	10	6.8	2	12.5	0	0.0	1	3.8	0	0.0	N.A.	
Chisel Plow	72	48.6	8	50.0	2	66.7	5	19.2	0	0.0	N.A.	
Moldboard Plow	72	48.6	5	31.3	2	66.7	12	46.2	1	25.0	N.A.	
Offset Disk	9	6.1	2	12.5	0	0.0	4	15.4	1	25.0	N.A.	

^aThe sum of the percentages of producers who reported using various types of primary tillage implements usually does not equal the percentage who reported the use of primary tillage because some producers reported using more than one type of primary tillage implement. N.A. indicates not applicable.

by cropping-planting system. Producers who utilized the single crop-grain drill system most often used a chisel plow for primary tillage, and producers utilizing the double crop-row crop system most often used a moldboard plow. Use of chisel plows was reported by the same percentage of producers as reported using moldboard plows for both the single crop-row crop and single crop-broadcast systems of soybean production, and these two plows were the most important primary tillage implements used with each of these two systems. Two primary tillage tools were used with the double crop-grain drill system: (1) the moldboard plow and (2) the offset disk. However, only one observation of the use of each of these two implements was reported. The double crop-grain drill system was the only applicable system for which no combinations of primary tillage implements were reported.

Secondary Tillage

Secondary tillage was used as part of the soybean production process by over 88.5% of the producers utilizing each cropping-planting system except the double crop-no till system (Table 14). A tandem disk was the secondary tillage tool used by most producers and was the only secondary tillage implement utilized with the single crop-broadcast and double crop-grain drill systems. Some producers used more than one particular secondary tillage tool with the single crop-row crop, single crop-grain drill, and double crop-row crop systems.

Seedbed Conditioning

Implements designed for seedbed conditioning were used by more

TABLE 14. Secondary Tillage Implements Used by West Tennessee Farmers for Soybean Production by Cropping-Planting System, 1976^a

Item	Single Crop						Double Crop					
	Row Crop		Grain Drill		Broadcast		Row Crop		Grain Drill		No Till	
	Producers		Producers		Producers		Producers		Producers		Producers	
	Reporting		Reporting		Reporting		Reporting		Reporting		Reporting	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Implement and Practice Use	148	100.0	16	100.0	3	100.0	26	100.0	4	100.0	3	100.0
Secondary Tillage Implements	139	93.9	15	93.8	3	100.0	23	88.5	4	100.0	N.A.	
Tandem Disk	124	83.8	15	93.8	3	100.0	21	80.8	4	100.0	N.A.	
Powered Rotary Tiller	4	2.7	0	0.0	0	0.0	3	11.5	0	0.0	N.A.	
Spring-Tooth Harrow	7	4.7	1	6.3	0	0.0	2	7.7	0	0.0	N.A.	
Field Cultivator	42	28.4	1	6.3	0	0.0	6	23.1	0	0.0	N.A.	

^aThe sum of the percentages of producers who reported using various types of secondary tillage implements does not always equal the percentage who reported the use of secondary tillage because some producers reported using more than one type of primary tillage implement. N.A. indicates not applicable.

than half of the soybean producers who used the single crop-row crop, single crop-grain drill, single crop-broadcast, and double crop-row crop systems (Table 15). A do all was the implement most often used to perform this type of operation by those producers who used the three single crop systems. A roller harrow was the seedbed conditioning implement most commonly used with the double crop-row crop system.

Cultivation

Almost all producers who utilized a row crop planting system cultivated soybeans to control weeds (Table 16). Cultivation was not applicable for the double crop-no till system, and it would cause too much damage to the plant population to be used under normal circumstances with grain drill and broadcast planting methods.⁷

The row crop cultivator was the predominant cultivation implement used. Just over 99% of the producers who cultivated single crop soybeans and almost 96% of the producers who cultivated double crop soybeans utilized a row crop cultivator to perform this operation. The rotary hoe was the other implement used for cultivation, but it was used by only 11.9% and 16.7% of the producers who cultivated single crop and double crop soybeans, respectively. Differences in the percentage of producers using each of these two tillage tools may have been due to the fact that

⁷A greater number of producers may have used a rotary hoe than is evident from the data, since the rotary hoe may have been used by producers to salvage soybean stands in fields where the seedbed surface crusted over after planting. A rotary hoe may have been used at times to perform this type of salvage operation on fields of drilled or broadcast planted soybeans.

TABLE 15. Seedbed Conditioning Implements Used by West Tennessee Farmers for Soybean Production by Cropping-Planting System, 1976^a

Item	Single Crop						Double Crop					
	Row Crop		Grain Drill		Broadcast		Row Crop		Grain Drill		No Till	
	Producers Reporting		Producers Reporting		Producers Reporting		Producers Reporting		Producers Reporting		Producers Reporting	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Implement and Practice Use	148	100.0	16	100.0	3	100.0	26	100.0	4	100.0	3	100.0
Seedbed Conditioning Implements	129	87.2	12	75.0	2	66.7	21	80.8	2	50.0	N.A.	
Spike-Tooth Harrow	40	27.0	3	18.8	0	0.0	3	11.5	1	25.0	N.A.	
Cultipacker	12	8.1	0	0.0	0	0.0	3	11.5	0	0.0	N.A.	
Cultimulcher or Roller Hoe	37	25.0	1	6.3	0	0.0	9	34.6	0	0.0	N.A.	
Do All	61	41.2	10	62.5	2	66.7	8	30.8	1	25.0	N.A.	

^aThe sum of the percentages of producers who reported using various types of seedbed conditioning implements usually does not equal the percentage who reported the use of seedbed conditioning because some producers reported using more than one type of seedbed conditioning implement. N.A. indicates not applicable.

TABLE 16. Cultivation Implements Used by West Tennessee Farmers
for Soybean Production by Cropping-Planting System, 1976^a

Item	Single Crop						Double Crop					
	Row Crop		Grain Drill		Broadcast		Row Crop		Grain Drill		No Till	
	Producers		Producers		Producers		Producers		Producers		Producers	
	Reporting		Reporting		Reporting		Reporting		Reporting		Reporting	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Implement and Practice Use	148	100.0	16	100.0	3	100.0	26	100.0	4	100.0	3	100.0
Cultivation Implements	126	85.1	N.A.		N.A.		24	92.3	N.A.		N.A.	
Row Crop Cultivator	125	84.5	N.A.		N.A.		23	88.5	N.A.		N.A.	
Rotary Hoe	15	10.1	N.A.		N.A.		4	15.4	N.A.		N.A.	

^aThe sum of the percentages of producers who reported using each type of cultivation implement does not equal the percentage who reported using cultivation because some producers reported using more than one cultivation implement. N.A. indicates not applicable.

double crop soybeans must often be planted later than single crop soybeans.

Chemical Weed Control

Two types of information about chemical weed control practices were obtained from soybean producers: (1) the types of herbicides used and (2) the herbicide application implements used. Analysis of this information was complicated by the fact that several respondents reported only one of these two types of information.

Types of herbicides. Over half of the producers utilizing each cropping-planting system indicated the types of herbicides they used to control weeds in soybeans (Table 17). The four types of herbicides used by soybean growers were: (1) preplant, (2) preemergence, (3) postemergence, and (4) burndown. Preemergence and postemergence herbicides were used with all six systems. Preplant herbicides were used with every system except the double crop-no till system. Burndown herbicides were used exclusively with the double crop-no till system.

The relative importance of the types of herbicides used varied by cropping-planting system. A burndown herbicide was applied by 100% of the producers of double crop-no till soybeans who indicated the types of herbicides they used with that system. Producers who utilized the single crop-row crop, single crop-broadcast, and double crop-grain drill systems most often reported using preplant herbicides to control weeds in soybeans. However, the use of preemergence and postemergence herbicides was also reported quite often in relation to each of these three systems. Producers who utilized the single crop-grain drill system reported using

TABLE 17. Types of Herbicides Used by West Tennessee Farmers for Soybean Production by Cropping-Planting System, 1976^a

Item	Single Crop						Double Crop					
	Row Crop		Grain Drill		Broadcast		Row Crop		Grain Drill		No Till	
	Producers Reporting		Producers Reporting		Producers Reporting		Producers Reporting		Producers Reporting		Producers Reporting	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Implement and Practice Use	148	100.0	16	100.0	3	100.0	26	100.0	4	100.0	3	100.0
Types of Herbicides ^b	110	74.3	11	68.8	3	100.0	14	53.8	3	75.0	2	66.7
Preplant	78	52.7	5	31.3	2	66.7	8	30.8	2	50.0	N.A.	
Preemergence	47	31.8	6	37.5	1	33.3	9	34.6	1	25.0	1	33.3
Postemergence	43	29.1	4	25.0	1	33.3	9	34.6	1	25.0	1	33.3
Burndown	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	66.7

^aThe sum of the percentages of producers who reported using various types of herbicides does not equal the percentage who reported the use of herbicides because some producers used more than one type of herbicide. N.A. indicates not applicable.

^bThe number of producers reporting the use of herbicides in this table does not agree with the number of producers reporting the use of herbicide application implements presented in Table 18, because some soybean growers responding to the survey provided information on only one of these two items.

preemergence herbicides more often than any other type of herbicide, but the use of preplant and postemergence herbicides was reported almost as often. An identical number of producers indicated using preemergence and postemergence herbicides with the double crop-row crop system, and these two types of herbicides were the most frequently reported types of herbicides used with that system.

The difference between the number of soybean producers reporting the use of herbicides and the total number of observations of the types of herbicides used indicates that combinations of different types of herbicides were used with all six cropping-planting systems.⁸ For example, almost twice as many observations of the use of different types of herbicides were reported by producers who used the double crop-row crop system than the number of producers reporting herbicide use.

Herbicide application. Considerable diversity was observed in terms of the herbicide application implements utilized with each cropping-planting system for which there were more than a few observations (Table 18). However, the tractor-propelled broadcast sprayer was the most important application implement based on the number of producers reporting

⁸Just over 71% of the producers who indicated using herbicides with the double crop-row crop system utilized combinations of two or three types of herbicides on their soybean fields. Over half of the producers who indicated using herbicides with each of the other five systems applied only one of the four types of herbicides on their soybean fields. The single most often reported herbicide combination utilized with the double crop-row crop system was a combination of preplant and postemergence herbicides.

TABLE 18. Herbicide Application Implements Used by West Tennessee Farmers for Soybean Production by Cropping-Planting System, 1976^a

Item	Single Crop						Double Crop					
	Row Crop		Grain Drill		Broadcast		Row Crop		Grain Drill		No Till	
	Producers		Producers		Producers		Producers		Producers		Producers	
	Reporting		Reporting		Reporting		Reporting		Reporting		Reporting	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Implement and Practice Use	148	100.0	16	100.0	3	100.0	26	100.0	4	100.0	3	100.0
Herbicide Application ^b Implements	124	83.8	8	50.0	3	100.0	15	57.7	1	25.0	3	100.0
Broadcast Sprayer	69	46.6	9	56.3	0	0.0	9	34.6	1	25.0	3	100.0
High Clearance Sprayer, S.P.	17	11.5	2	12.5	2	66.7	1	3.8	0	0.0	0	0.0
Aerial Sprayer	4	2.7	1	6.3	0	0.0	0	0.0	0	0.0	0	0.0
Band Sprayer	43	29.1	N.A.		N.A.		4	15.4	N.A.		0	0.0
Directed Sprayer	36	24.3	N.A.		N.A.		6	23.1	N.A.		1	33.3
Broadcast Spreader	41	27.7	2	12.5	2	66.7	4	15.4	0	0.0	N.A.	

^aThe sum of the percentages of producers who reported using various herbicide application implements usually does not equal the percentage of producers who reported the use of herbicide application implements because some producers reported using more than one herbicide application implement. N.A. indicates not applicable.

^bThe number of producers reporting the use of herbicides in Table 17 does not agree with the number of producers reporting the use of herbicide application implements presented in this table, because some soybean growers who responded to the survey provided information on only one of these two items.

its use for every system except the single crop-broadcast system. The self-propelled high clearance sprayer and the broadcast spreader⁹ were each used by the same percentage of producers utilizing the single crop-broadcast system and they were the only herbicide application implements reported by producers utilizing that system.

Chemical Disease Control

Crop rotations, planting resistant soybean varieties, and the use of nematicides are methods available for controlling soybean crop disease caused by nematodes. The use of a nematicide was the only soybean disease control measure considered in this study. Use of a nematicide is the least desirable of these three control measures because of the cost and extra time involved in nematicide application. Unfortunately, the first two methods of control are not always feasible.

Approximately 4.1% of the soybean producers who utilized the single crop-row crop system used a nematicide, whereas 12.5% of the producers utilizing the single crop-grain drill system and 3.8% who utilized the double crop-row crop system used a nematicide (Table 19). None of the producers utilizing the three least prevalent systems of soybean production reported using a nematicide.

The three methods of nematicide application reported by soybean growers were: (1) broadcasting, (2) applying in-the-row with a row crop planter, and (3) knifing-in the nematicide under-the-row. Broadcasting was the only nematicide application practice used by those producers

⁹A broadcast spreader was used to spread fertilizer coated with a preplant herbicide.

TABLE 19. Nematicide Application Methods Used by West Tennessee Farmers for Soybean Production by Cropping-Planting System, 1976^a

Item	Single Crop						Double Crop					
	Row Crop		Grain Drill		Broadcast		Row Crop		Grain Drill		No Till	
	Producers		Producers		Producers		Producers		Producers		Producers	
	Reporting		Reporting		Reporting		Reporting		Reporting		Reporting	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Implement and Practice Use	148	100.0	16	100.0	3	100.0	26	100.0	4	100.0	3	100.0
Nematicide Application Methods	6	4.1	2	12.5	0	0.0	1	3.8	0	0.0	0	0.0
Broadcast	1	0.7	2	12.5	0	0.0	1	3.8	0	0.0	N.A.	
Planter Applied	5	3.4	N.A.		N.A.		0	0.0	N.A.		0	0.0
Knifed-In	2	1.4	N.A.		N.A.		0	0.0	N.A.		N.A.	

^aThe sum of the percentages of producers who reported using various nematicide application methods does not always equal the percentage who reported the use of nematicides because some producers reported using more than one nematicide application method. N.A. indicates not applicable.

who used a nematicide with the single crop-grain drill and double crop-row crop systems. Planter application was the nematicide application method most often used with the single crop-row crop system.

II. NUMER OF TIMES IMPLEMENTS AND PRACTICES WERE USED

Considerably fewer producers reported the number of times they used specified implements and practices to produce soybeans than reported the types of implements and production practices they used for soybean production.¹⁰ Information on the number of times producers reported using each implement and production practice on their soybean fields was analyzed by determining the most common number of times (mode) specific implements and practices were used in each cropping-planting system (Tables 20 and 21).

Modal observations of the number of times implements and practices were used per soybean field varied between cropping-planting systems only in relation to four items¹¹: (1) the offset disk used for primary tillage, (2) the tandem disk used for secondary tillage, (3) the field cultivator

¹⁰Growers responding to the survey provided information on the number of times they used specific implements and practices for only 105 of the 200 cropping-planting systems observations for which they reported the types of implements and production practices they used. Differences between soybean fields in soil types, weed problems, and other factors which producers must contend with probably made estimation of this information difficult.

¹¹This statement applies only to those implements and practices which were used with more than one system.

TABLE 20. Number of Times Implements and Practices Were Used by West Tennessee Farmers Per Field for Single Crop Soybean Production by Planting Method, 1976

Item	Row Crop			Grain Drill			Broadcast		
	Mode ^a	No. Re- porting Mode	Total No. Re- porting ^b	Mode	No. Re- porting Mode	Total No. Re- porting	Mode	No. Re- porting Mode	Total No. Re- porting
Number of Times Implements and Practices Were Used Per Field			77			11			2
Pre-Tillage Field ^c Preparation									
Stalk Cutter or Rotary Mower	1	10	10	0	0	0	1	1	1
Primary Tillage									
Subsoiler	1	5	5	0	0	0	0	0	0
Chisel Plow	1	34	37	1	7	8	1	1	1
Moldboard Plow	1	38	38	1	3	3	1	2	2
Offset Disk	1,4 ^d	2	5	4	1	1	0	0	0
Secondary Tillage									
Tandem Disk	2	28	67	3	4	9	2,3 ^e	1	2
Powered Rotary Tiller	1	2	3	0	0	0	0	0	0
Spring-Tooth Harrow	1	2	2	1	1	1	0	0	0
Field Cultivator	2	7	19	1	1	1	0	0	0
Seedbed Conditioning									
Spike-Tooth Harrow	1	9	17	2	1	1	0	0	0
Cultipacker	1	4	4	0	0	0	0	0	0
Cultimulcher or Roller Harrow	1	18	20	0	0	0	0	0	0
Do All	1	30	34	1	8	8	1	1	1

TABLE 20 (continued)

Item	Row Crop			Grain Drill			Broadcast		
	Mode ^a	No. Re- porting Mode	Total No. Re- porting ^b	Mode	No. Re- porting Mode	Total No. Re- porting	Mode	No. Re- porting Mode	Total No. Re- porting
Cultivation									
Row Crop Cultivator	2	25	61		N.A. ^f			N.A.	
Rotary Hoe	1	7	8		N.A.			N.A.	
Chemical Weed Control									
Type of Herbicide									
Preplant	1	31	31	1	4	4	1	1	1
Preemergence	1	27	27	1	5	5	1	1	1
Postemergence	1	25	28	1	4	4	1	1	1
Burndown	0	0	0	0	0	0	0	0	0
Application Implement									
Broadcast Sprayer	1	26	34	1	7	7	0	0	0
High Clearance Sprayer, S.P.	1	6	6	1	1	1	1	1	1
Aerial Sprayer	1	2	2	0	0	0	0	0	0
Band Sprayer	1	26	27		N.A.			N.A.	
Directed Sprayer	1	17	17		N.A.			N.A.	
Broadcast Spreader	1	22	22	1	2	2	1	1	1
Nematicide Application									
Method									
Broadcast	0	0	0	1	1	1	0	0	0
Planter Applied	1	3	3		N.A.			N.A.	
Knifed-In	1	1	1		N.A.			N.A.	

^aThe mode is the most frequent (or most common) value reported by producers for the number of times specified implements and production practices were used per soybean field.

TABLE 20 (continued)

^bThe total number of producers reporting varied by implement or practice as well as by cropping-planting system. The number of observations for a particular implement or practice used with a particular system was never greater than the total number of observations for that system. However, because more than one implement or practice was often used to perform a given type of production operation by some of the producers who utilized that operation in a given system, the total number of observations for each type of operation may exceed the total number of observations for each system.

^cProducers were not asked to report the number of times the pre-tillage field preparation practices of burning and baling were used per soybean field, since these practices would normally be used only once per field.

^dThere were two modes for use of the offset disk with the single crop-row crop system, and each was reported by two producers.

^eThere were two modes for use of the tandem disk with the single crop-broadcast system, and each was reported by one producer.

^fN.A. indicates not applicable.

TABLE 21. Number of Times Implements and Practices Were Used by West Tennessee Farmers
Per Field for Double Crop Soybean Production by Planting Method, 1976

Item	Row Crop			Grain Drill			No Till		
	Mode ^a	No. Re- porting Mode	Total No. Re- porting ^b	Mode	No. Re- porting Mode	Total No. Re- porting	Mode	No. Re- porting Mode	Total No. Re- porting
Number of Times Implements and Practices Were Used Per Field			11			2			2
Pre-Tillage Field ^c Preparation									
Stalk Cutter or Rotary Mower	1	2	2	0	0	0		N.A. ^d	
Primary Tillage									
Subsoiler	0	0	0	0	0	0		N.A.	
Chisel Plow	1	4	4	0	0	0		N.A.	
Moldboard Plow	1	4	4	1	1	1		N.A.	
Offset Disk	1	2	2	1	1	1		N.A.	
Secondary Tillage									
Tandem Disk	2	8	11	1,3 ^e	1	2		N.A.	
Powered Rotary Tiller	1	2	2	0	0	0		N.A.	
Spring-Tooth Harrow	0	0	0	0	0	0		N.A.	
Field Cultivator	2	2	2	0	0	0		N.A.	
Seedbed Conditioning									
Spike-Tooth Harrow	2	1	1	1	1	1		N.A.	
Cultipacker	0	0	0	0	0	0		N.A.	
Cultimulcher or Roller Harrow	1	5	5	0	0	0		N.A.	
Do All	1	4	4	1	1	1		N.A.	

TABLE 21 (continued)

Item	Row Crop			Grain Drill			No Till		
	Mode ^a	No. Re- porting Mode	Total No. Re- porting ^b	Mode	No. Re- porting Mode	Total No. Re- porting	Mode	No. Re- porting Mode	Total No. Re- porting
Cultivation									
Row Crop Cultivator	2	5	8		N.A.			N.A.	
Rotary Hoe	1	1	1		N.A.			N.A.	
Chemical Weed Control									
Type of Herbicide									
Preplant	1	3	3	1	2	2		N.A.	
Preemergence	1	4	4	1	1	1	1	1	1
Postemergence	1	6	6	1	1	1	1	1	1
Burndown	0	0	0	0	0	0	1	1	1
Application Implement									
Broadcast Sprayer	1	4	4	1	1	1	1	2	2
High Clearance Sprayer, S.P.	1	1	1	0	0	0	0	0	0
Aerial Sprayer	0	0	0	0	0	0	0	0	0
Band Sprayer	1	3	3		N.A.		0	0	0
Directed Sprayer	1	5	5		N.A.		0	0	0
Broadcast Spreader	1	2	2	0	0	0		N.A.	
Nematicide Application									
Method									
Broadcast	0	0	0	0	0	0		N.A.	
Planter Applied	0	0	0		N.A.		0	0	0
Knifed-In	0	0	0		N.A.			N.A.	

^aThe mode is the most frequent (or most common) value reported by producers for the number of times specified implements and production practices were used per soybean field.

TABLE 21 (continued)

^bThe total number of producers reporting varied by implement or practice as well as by cropping-planting system. The number reporting for a particular implement or practice used with a particular system was never greater than the total number of observations for that system. However, because more than one implement or practice was often used to perform a given type of production operation by some of the producers who utilized that operation in a given system, the total number of observations for each type of operation may exceed the total number reporting for each system.

^cProducers were not asked to report the number of times the pre-tillage field preparation practices of burning and baling were used per soybean field, since these practices would normally be used only once per field.

^dN.A. indicates not applicable.

^eThere were two modes for use of the tandem disk with the double crop-grain drill system, and each was reported by one producer.

used for secondary tillage, and (4) the spike-tooth harrow used for seed-bed conditioning. All but two implements and practices were most often used either once or twice per soybean field, and the majority of them were used only once. Modal observations of the number of times an implement or practice was used per field by soybean producers exceeded two only for the offset disk and the tandem disk used with some cropping-planting systems.

III. IMPLEMENT COMBINATIONS

Two questions were included in the survey questionnaire which were designed to reflect the extent to which producers combined various implements in the process of producing soybeans. Producers were asked to report an estimate of both the usual number of implements they combined during individual trips across their soybean fields with each cropping-planting system they utilized and the greatest number of implements they combined for any one trip across their soybean fields with each system.

Over 80% of the responding producers utilizing each cropping-planting system usually pulled one implement at a time (Table 22). One was also the greatest number of implements pulled over soybean fields during any one soybean production trip by over half of the responding producers who utilized each system except the double crop-row crop system. The most common response by producers who utilized the double crop-row crop system regarding the greatest number of implements combined per trip was two. Over 60% of the producers who utilized the double crop-row crop system combined two or more implements during at least one trip over their soybean fields.

TABLE 22. Usual and Greatest Number of Implements Combined Per Trip Across Fields by West Tennessee Farmers for Soybean Production by Cropping-Planting System, 1976

Number of Implements Combined Per Trip	Single Crop						Double Crop					
	Row Crop		Grain Drill		Broadcast		Row Crop		Grain Drill		No Till	
	Producers		Producers		Producers		Producers		Producers		Producers	
	Reporting		Reporting		Reporting		Reporting		Reporting		Reporting	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Usual												
1	95	82.6	12	92.3	3	100.0	18	85.7	3	100.0	4	100.0
2	11	9.6	0	0.0	0	0.0	2	9.5	0	0.0	0	0.0
3	7	6.1	0	0.0	0	0.0	1	4.8	0	0.0	0	0.0
4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
5	1	0.9	1	7.7	0	0.0	0	0.0	0	0.0	0	0.0
6	1	0.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Totals ^a	115	100.1	13	100.0	3	100.0	21	100.0	3	100.0	4	100.0
Greatest												
1	51	50.5	9	75.0	2	100.0	7	38.9	2	66.7	3	75.0
2	33	32.7	2	16.7	0	0.0	9	50.0	1	33.3	1	25.0
3	9	8.9	0	0.0	0	0.0	1	5.6	0	0.0	0	0.0
4	4	4.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
5	2	2.0	0	0.0	0	0.0	1	5.6	0	0.0	0	0.0
6	2	2.0	1	8.3	0	0.0	0	0.0	0	0.0	0	0.0
Totals ^a	101	100.1	12	100.0	2	100.0	18	100.0	3	100.0	4	100.0

^aPercentage totals do not always sum to 100.0% due to rounding error.

CHAPTER V

THE SELECTION OF REPRESENTATIVE IMPLEMENTS AND PRODUCTION PRACTICES

One of the objectives of this study was to select a set of soybean production observations and production implements and practices representative of those reported by producers using each of the six identified cropping-planting systems. The purpose of this procedure was to derive a base for developing estimates of pre-harvest soybean production costs for each alternative system. Data presented in Chapter IV pertaining to the implements and production practices used with each soybean production system served as the primary basis for selecting representative production operations and representative implements and production practices for each system. The modal number of times implements and production practices were used with each soybean production system was used to establish the level of implement and practice use in the enterprise budgets developed for that system. Information on implement combinations reported by soybean producers was also considered in the selection of representative implements and production practices for each cropping-planting system. In addition, information from University of Tennessee resource persons, secondary data, and primary data not reported in Chapter IV were utilized in selecting the representative implements and production practices used in budgeting.

1. REPRESENTATIVE IMPLEMENT AND PRACTICE SELECTION PROCEDURE

The basic concept underlying the selection of each set of soybean production implements and practices was used by Woolf and Leary¹ to develop budgets for soybean production in Louisiana. They determined the frequency of use of selected soybean production practices by a sample of growers. Common practices were then selected for the purpose of budgetary analysis. A production practice was considered common if over half of the surveyed producers reported using that practice.

An important difference between this study and the study by Woolf and Leary was the amount of detail requested in the data collected. An important assumption underlying this study was that the use of specific alternative implements and practices would affect the resource requirements, costs, and returns of soybean production. Therefore, the farm operators surveyed in this study were asked to indicate the specific implements and practices they used to produce soybeans with each cropping-planting system. In contrast, the Woolf and Leary study only considered the effect of different types of production operations, e.g., deep tillage, on the costs and returns of soybean production.² Seven soybean production operations were identified and used in the initial stage of determining

¹Woolf and Leary, op. cit., p. 31.

²They assumed that the following implements were suitable for deep tillage: (1) moldboard plow, (2) chisel plow, (3) breaking disc, (4) hipping ridger, (5) middle buster, and (6) subsoiler.

representative implements and production practices for each cropping-planting system. These seven operations were: (1) pre-tillage field preparation, (2) primary tillage, (3) secondary tillage, (4) seedbed conditioning, (5) cultivation, (6) chemical weed control, and (7) chemical disease control. Each implement and production practice on the survey questionnaire was then assigned to the production operation it could most appropriately be used to perform.

The procedure utilized by Woolf and Leary for selecting common production practices was applied in this study to determine which of the above seven pre-harvest soybean production operations were commonly used in each cropping-planting system. However, the Woolf and Leary selection procedure was refined in this study by adding a second step. The second step involved selecting the specific implement or practice which was used most often by soybean producers to perform those production operations which were commonly used in the production of soybeans with each of the six cropping-planting systems.

II. SELECTION OF SPECIFIC REPRESENTATIVE IMPLEMENTS AND PRACTICES

The actual selection of representative implements and practices included two steps. First, a decision was made concerning which types of pre-harvest soybean production operations would be included in developing enterprise budgets for each of the six soybean production systems. If over half of the total number of producers indicating the implements and practices they used with a given cropping-planting system performed a

particular type of pre-harvest production operation, then the implements or practices used to perform that operation were considered during the second step of the selection procedure. If not, that particular type of operation was excluded from further consideration with respect to the cropping-planting system in question. Second, the implement or practice used most often by producers to perform each type of operation included in a given cropping-planting system was included in the representative set of implements and production practices for that system. The representative implements and practices selected for each system are summarized in Tables 23 and 24.

Planting was a necessary operation in each soybean production system, and planting methods were used to differentiate between alternative soybean production systems in this study. The type of planting implement used was made very clear on the questionnaire form with respect to all systems except the broadcast system. Producers utilizing the broadcast planting method were asked to indicate whether they used a spinner-type seeder or aerial seeding. Two soybean producers provided the requested information and they indicated using a spinner seeder.³

III. DETERMINATION OF THE NUMBER OF TIMES REPRESENTATIVE IMPLEMENTS AND PRACTICES WERE USED PER SOYBEAN FIELD

After the representative implements and practices were selected,

³One additional producer reported using a spinner seeder to plant beans which were later harvested for hay. Data from this particular questionnaire were not analyzed in this study.

TABLE 23. Representative Implements and Practices Used by West Tennessee Farmers for Single Crop Soybean Production by Planting Method, 1976

Type of Operation	Row Crop		Grain Drill		Broadcast	
	Implement or Practice	Times Used Per Field	Implement or Practice	Times Used Per Field	Implement or Practice	Times Used Per Field
Pre-Tillage Field ^a Preparation						
Primary Tillage	Moldboard Plow ^b or Chisel Plow	1	Chisel Plow	1	Moldboard Plow ^b or Chisel Plow	1
Secondary Tillage	Tandem Disk	2	Tandem Disk	3	Tandem Disk	2 ^c
Seedbed Conditioning	Do All	1	Do All	1	Do All	1
Planting	Row Chop Planter	1	Grain Drill	1	Spinner Seeder ^d	1
Cultivation	Row Crop Cultivator	2				
Chemical Weed Control	Broadcast Sprayer + Preplant Herbicide	1	Broadcast Sprayer + Preemergence Herbicide	1	Broadcast ^e Spreader + Preplant Herbicide	1
Chemical Disease Control						

^aLess than half of the producers who reported the implements and practices they used to produce soybeans by each single crop system used pre-tillage field preparation practices. Therefore, the pre-tillage field preparation operation was not included as a component of any of these three cropping-planting systems. This same reasoning applied when other production operations were not included for a given planting method.

TABLE 23 (continued)

^bThe same number of producers reported utilizing each of these two implements with each of the two systems in question. The use of both of these implements on individual farms was quite common. Producers using both of these implements on their farms often indicated in some manner that they were not used on the same fields. Survey data indicated that relatively more soybean acreage planted with the single crop-row crop system was chisel plowed than moldboard plowed, and more soybean acreage planted with the single crop-broadcast system was moldboard plowed. However, selection for budgeting was based on the fact that the use of chisel plows was reported more often on larger farms, whereas the use of moldboard plows was reported more often on smaller farms. Therefore, the moldboard plow was selected as the only primary tillage implement used in developing enterprise budgets for single crop soybeans planted by both the row crop and broadcast methods on farms with 305 acres of cropland. And the chisel plow was selected as the only primary tillage implement used in developing enterprise budgets for single crop soybeans planted by both of these methods on large farms.

^cThere were two modes for use of the tandem disk with the single crop-broadcast system. The modal observation of two was selected for budgeting the number of times the tandem disk was used for secondary tillage in the production of single crop-broadcast soybeans because two was the most common number of times the tandem disk was used by soybean producers reporting the number of times they used implements and production practices when all cropping-planting systems observations were combined.

^dPlanting implements used in soybean production were determined before producers were surveyed for all planting methods except broadcasting. All planting implements were assumed to be used only once per field for soybean production.

^eThe same number of soybean growers reported using a high clearance self-propelled sprayer as reported using a broadcast spreader. However, the broadcast spreader was used in developing cost estimates for this system since survey data indicated that the spreader was used on more soybean acreage than the sprayer.

TABLE 24. Representative Implements and Practices Used by West Tennessee Farmers for Double Crop Soybean Production by Planting Method, 1976

Type of Operation	Row Crop		Grain Drill		No Till	
	Implement or Practice	Times Used Per Field	Implement or Practice	Times Used Per Field	Implement or Practice	Times Used Per Field
Pre-Tillage Field ^a Preparation	Burn Straw	1	Burn Straw	1		
Primary Tillage	Moldboard Plow	1				
Secondary Tillage	Tandem Disk	2	Tandem Disk	2 ^b		
Seedbed Conditioning	Cultimulcher	1				
Planting ^c	Row Crop Planter	1	Grain Drill	1	No Till Planter	1
Cultivation	Row Crop Cultivator	2				
Chemical Weed Control	Broadcast Sprayer + Preplant Herbicide ^d	1	Broadcast Sprayer + Preplant Herbicide	1	Broadcast Sprayer + 1 Burndown Herbicide	
	Cultivator Mounted ^e Directed Sprayer + Postemergence Herbicide					
Chemical Disease Control						

^aNo attempt was made to estimate the cost of burning an acre of straw residue. Less than half of the producers who reported the implements and practices they used to produce soybeans with the double crop-no till system used pre-tillage field preparation practices. Therefore, the pre-tillage field

TABLE 24 (continued)

preparation operation was not included as a component of that cropping-planting system. This same reasoning applied when other production operations were not included for a given planting method.

^bUsing the tandem disk two times for secondary tillage was selected for budgeting the double crop-grain drill system because two was the most common number of times the tandem disk was used by soybean producers reporting the number of times they used implements and production practices when all cropping-planting systems observations were combined. Two was also the average of the two modal observations for the number of times the tandem disk was used per field by farmers producing soybeans with the double crop-grain drill system.

^cPlanting implements used for soybean production were determined before soybean growers were surveyed for all double crop systems. All planting implements were assumed to be used only once per field for soybean production.

^dThis system was unique in that over half of the producers who used herbicides with this system used more than one type. The analysis of herbicide use in Chapter IV (pp. 34-58) indicated that the use of preemergence and postemergence herbicides was reported by the same number of soybean growers using the double crop-row crop system and that these two types of herbicides were reported more frequently than any other types. However, specific combinations of herbicides were not analyzed in Chapter IV and examination of individual questionnaires indicated that the most frequently used combination of herbicides for the double crop-row crop system was a preplant herbicide with a postemergence herbicide. Therefore, both preplant and postemergence herbicides were included in the enterprise budgets developed for the double crop-row crop system.

^eUse of a cultivator mounted directed sprayer does not involve any additional trips across soybean fields, since the directed spraying would be done during one of the two soybean cultivation trips included in the double crop-row crop production system. No attempt was made in the mail survey used in this study to obtain information about specific implement combinations used by soybean producers. Information obtained from conversations with University of Tennessee Agricultural Extension Service and research personnel and personal judgment served as the basis for selecting this particular implement combination for use in budgeting. The cultivator-directed sprayer implement combination is consistent with the use of a postemergence herbicide in the double crop-row crop system and with the analysis in Chapter IV (pp. 34-58) of the greatest number of implements combined per trip across soybean fields reported by producers who used this cropping-planting system.

the number of times each of them was normally used per field for soybean production was determined. The modal number of times each implement or practice representative of a given cropping-planting system was used per field by soybean producers using that system was selected as the level of implement and practice use in the enterprise budgets developed for the system in question.

IV. COMBINATION OF SOYBEAN PRODUCTION IMPLEMENTS

Combining soybean production implements reduces the number of pre-harvest soybean production trips required per soybean field. Therefore, implement combinations should influence the resource requirements, costs, and returns associated with soybean production. Unfortunately, the space limitations imposed due to utilizing a mail questionnaire prohibited a detailed accounting of the specific implements combined for soybean production by cropping-planting system. However, producers were queried concerning the usual and the greatest number of implements they combined per trip over their soybean fields for each cropping-planting system they used. These two types of data, along with information gleaned from conversations with University of Tennessee Agricultural Extension Service and research personnel, were used to determine which of the representative implements in each cropping-planting system (Tables 23 and 24) would be combined during individual trips across soybean fields when enterprise budgets for the six soybean production systems analyzed in this study were developed.

Apparently the practice of combining implements for individual

pre-harvest soybean production trips was generally far less prevalent than the practice of pulling only one implement per trip. However, enough producers utilizing the double crop-row crop system reported combining two implements per trip during at least one trip over their fields to justify accounting for one combination of two implements in budgeting, but even the producers who utilized this system usually only pulled one implement per trip.

Some feasible combinations of two implements which could have been used in budgeting were: (1) broadcast sprayer and tandem disk, (2) directed sprayer and row crop cultivator, (3) planter mounted band sprayer and row crop planter, and (4) tandem disk and spike-tooth harrow, among others. Combinations of herbicide application implements with other implements are probably more commonly used by soybean producers than combinations of tillage and planting implements since tillage implements are generally not as readily combined with other tillage implements or with planting implements due to engineering and other difficulties. The combination of implements selected for use in developing enterprise budgets for the double crop-row crop system consisted of a directed sprayer and a row crop cultivator.

V. PROBLEMS ENCOUNTERED IN USING THE SELECTION PROCEDURE

A major problem encountered in using the procedure outlined in this chapter to select a representative set of implements and practices for each cropping-planting system was the small number of observations available for some systems. This was especially true of the single crop-

broadcast, double crop-grain drill, and double crop-no till systems.

Another problem encountered was the considerable diversity associated with the specific implements and practices used to perform some types of production operations with certain cropping-planting systems.⁴ In several instances the effectiveness of the criterion for selecting representative implements and practices was reduced due to the fact that the item most frequently used to perform a given production operation was used only slightly more frequently by soybean producers than some other implement or practice which could be used to perform that same operation. Two alternative implements or practices which could be used to perform one type of production operation were each used by the same number of soybean producers in some instances necessitating the use of some representative implement selection criterion other than the implement most commonly used.

⁴Problems of this nature encountered in using the selection procedure and the ways they were handled are discussed in detail in the footnotes accompanying Tables 23 and 24.

CHAPTER VI

BUDGETING

Enterprise budgets were developed for the six alternative soybean cropping-planting systems. Whenever possible, data obtained from the mail survey served as the basis for developing estimates of the costs and returns associated with each system. Data from published and unpublished sources and information provided by various knowledgeable persons consulted during the study were also utilized.

Budgets representative of each cropping-planting system were developed for two different sizes of soybean production operations. The reason for this was that while the average acreage cropped by survey respondents was 305 acres, 36 farms larger than the average accounted for 72% of the total soybean acreage planted. The average cropped acreage on these 36 farms was 991 acres. An average of 225 acres of soybeans was produced by all soybean growers returning questionnaires, and an average of 724 acres was produced on the 36 large farms.¹

Variations in resource requirement and cost estimates between two budgets based on one particular system at two different size levels resulted from differences in the size of the associated power and machinery

¹Although all six systems were observed on both large farms and average sized farms, only the single crop-row crop and the single crop-grain drill systems were used singly to produce 724 or more acres of soybeans. The single crop-broadcast and the double crop-grain drill systems were normally used on relatively small acreages in 1976. Neither of these two systems was used to plant over 100 acres of soybeans on any one farm.

complements and from any differences in pre-harvest soybean production operations. Except where otherwise noted, the representative implements and production practices selected in Chapter V were used for budgeting purposes and the same type of implements and practices were assumed in budgeting for both average and large sized farms.

The purpose of budgeting was to provide a guide for comparing the relative profitability of the six systems at each of the two size levels. Budgeting efforts were directed toward establishing the correct relationships between the cost estimates for different systems at a given size level. Establishing the correct relationship between the two size levels and developing exact absolute cost estimates for each size level were less important considerations.

I. REVENUES

Estimates of revenues per acre budgeted for each system are based on the overall average yields per acre for each system derived from the survey data and expected product prices. Wheat and soybean prices used are the same as those presented in the Farm Planning Manual² which are projected prices intended to reflect average or normal prices over a five year period. Both yield and price variations influence the revenues obtained with different systems, but only yields vary between systems.

²Robert M. Ray and Herbert N. Walch, Farm Planning Manual, Tennessee Agricultural Extension Service Publication EC-622, Knoxville, Tennessee, April 1978.

II. INPUT PRICES

Prices of material inputs such as herbicides and fuels were either obtained from various secondary sources or from the Tennessee Farmers Cooperative. Oftentimes, these prices were for specific trade name items and for this reason specific trade names appear in the budgets. In many cases one item was selected from several recommended alternatives. This was particularly true with regard to herbicides. When other sources for material input prices were used these were footnoted in the budgets.

The prices of all power and most machinery items were obtained from the Farm Planning Manual. Prices of implements not available from this source were obtained from other secondary sources.

III. COST ASSUMPTIONS

Only soybean seed, tillage, planting, and weed control costs were allowed to vary between cropping-planting systems. Soybean fertilization and liming costs were assumed to remain the same for all systems and farm sizes. Soybean harvesting and transportation costs were assumed to remain the same between all systems for a given farm size. Bulk spreading of fertilizer and lime was assumed and the application cost was included in the fertilizer prices used in the budgets. Similarly, the application cost of bulk spreading a preplant herbicide-fertilizer combination for the single crop-broadcast system was included in the price of the fertilizer with which the herbicide was mixed.

Wheat production costs were also kept the same between the three double crop systems for a given farm size. Wheat production costs were

based on the operations and input usage outlined in Appendix Table A1.

IV. POWER AND MACHINERY MANAGEMENT

Machinery management principles such as those outlined by Bowers³ were used to determine machinery size and power unit requirements for the two different farm sizes used in budgeting. Typical machinery performance data used to implement these principles were obtained from the Agricultural Engineers Yearbook⁴ and other secondary sources and are summarized in Appendix Table A2.

The size of each machine and implement used, excluding tractors and trucks, was based on soybean acreage, the number of days suitable for field work available during various stages of the soybean production process, and the supply of labor available during these stages. Excess implement capacity was allocated to take into account the fact that slightly more than 25% of the average cropped acreage on each of the two different sizes of farms was not planted in soybeans. An implicit assumption was that none of the items included in the machinery complements selected for each farm size was designed solely for use in soybean production.

One farm operator was assumed to supply all labor available on

³Wendell Bowers, Fundamentals of Machine Operation: Machinery Management, John Deere Service Publication, Moline, Illinois, 1975.

⁴1977 Agricultural Engineers Yearbook, "Agricultural Machinery Management Data," American Society of Agricultural Engineers, St. Joseph, Michigan, May 1977.

average sized farms. A two-man labor force was assumed on large farms. No hired labor was budgeted in either situation. Therefore, the net return per acre to each cropping-planting system on large farms includes a return to a two-man labor supply.

Estimates of the number of days suitable for field work in 1976 were based on weather data in the Weekly Weather and Crop Bulletin.⁵ The following estimates of time available for field work were derived for three critical soybean production periods: (1) 11 days for pre-tillage field preparation and primary tillage, (2) 23 days for all other pre-plant operations and planting, and (3) 32 days for the soybean harvesting period. Each of these estimates was then reduced by 25% to provide capacity for farming acreage not planted in soybeans.⁶ Twelve hours a day were assumed usable for field preparation and planting operations, and ten hours a day were assumed usable for soybean harvesting operations. Thus, the total hours assumed available for field work during the three critical soybean production periods were: (1) 99 hours for primary tillage, (2) 207 hours for other field preparation operations and planting, and (3) 240 hours for harvesting. However, only 90% scheduling efficiency in keeping implements and machines working in the field was assumed.

⁵Weekly Weather and Crop Bulletin, "State Summaries of Weather and Agriculture," U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service; and U.S. Department of Commerce, Environmental Data Service, Washington, D.C.

⁶The average soybean acreage on both average and large farms was almost 75% of the average croppable acreage on these farms.

Therefore, only 89.1 hours, 186.3 hours, and 216.0 hours available in the three respective periods were actually used in calculating machine and implement sizes.

Two tractors per farm were assumed in budgeting soybean production costs on average size farms in this study.⁷ A larger number of tractors was assumed necessary for large farms. Therefore, three tractors were arbitrarily assigned to this size of farm.⁸

Tractor horsepower requirements were based on the width and type of implements selected for soybean production. Since the size of tractors selected for use on a given size of farm did not vary between cropping-planting systems, one main tractor that would be large enough to meet the power demands and field work time limitations of the most restrictive implement used with any one of the six systems was selected for each farm size. For example, a moldboard plow wide enough to plow all soybean acreage within the allotted time, assuming typical draft, operating speed, and field efficiency, was used as the basis for computing the horsepower requirements of the main tractor on the average sized farm. The size of other tractors selected was intended to complement the main tractor by

⁷Census of Agriculture 1974, State Reports: Tennessee, United States Census Bureau, Washington, D.C., June 1977. The average number of wheel tractors per farm on those farms in the study area with annual sales of \$2500 or more was two. The average size of these farms was 279 acres.

⁸Only two tractors were required with the double crop-grain drill and double crop-no till systems on large farms. Therefore, production costs for these two systems reflect only two tractors instead of three. The 80 drawbar horsepower tractor was not used with these two systems because neither the seedbed conditioning operation nor the cultivation operation was commonly used with either of these systems. The 80 drawbar horsepower tractor was assigned for use with only the seedbed conditioning and cultivation implements.

being well suited to perform operations for which the main tractor was not well suited. The combination of sizes and types of implements used with tractors of a specific size was the same for all six cropping-planting systems, unless noted otherwise.

Personal judgment was an integral part of the application of machinery management principles and techniques. The possibility of judgment errors should be recognized particularly with respect to the selection of a power and machinery complement for each farm size. Even though the same amount of soybean acreage was assumed in constructing budgets for the six cropping-planting systems of a given size, considerable variation existed between systems in relation to timeliness and horsepower requirements. For example, the difference in timeliness between a single crop and a double crop system would be considerable. Similarly, the difference in horsepower requirements between the double crop-row crop system and the double crop-no till system would be considerable.

V. MACHINERY COSTS

Machinery cost data are summarized in Appendix Table A2. Both variable costs per hour and fixed costs per acre are summarized, as well as data and assumptions pertaining to their estimation.

Variable Costs

Variable machinery costs consisted of the sum of the repair, fuel, oil, and filter costs associated with the use of each tractor, combine, truck, and implement. Variable machinery costs per acre were ultimately

based on the amount of time machinery was used per acre, but originally variable costs were computed on an hourly basis. Hourly variable costs were calculated for each machine and implement and are assembled in Appendix Table A4.

The variable costs of performing various soybean production operations with various implements and implement combinations, excluding tractor cost, on the two sizes of farms analyzed in this study are summarized in Appendix Table A5. The variable costs per acre of all implements utilized for pre-harvest soybean production with a given cropping-planting system were summed from this table to determine the variable cost listed under "Implements" in the enterprise budget for that system.

Fixed Costs

Fixed machinery costs consisted of the depreciation and insurance costs associated with ownership of each tractor, combine, truck, and implement. Annual fixed power and machinery costs were computed and are summarized in Appendix Table A6. The annual fixed cost associated with the ownership of each machine was converted to a per acre basis by allocating equal increments to each acre of soybeans produced. Not enough was known about the use of land not used for soybean production to base fixed power and machinery costs per acre on either croppable acreage or total acreage. However, soybean acreage accounted for close to 75% of the croppable acreage on both average and large sized farms, and the relative level of these costs associated with each system on a given farm size should not have been affected by the decision to allocate them to soybean acreage.

VI. BUDGETING FORMAT

The budgeting format used in this study included the separation of cost estimates into variable and fixed cost components. Variable costs consisted of all out-of-pocket costs, which included both materials costs and machinery costs. Fixed costs consisted exclusively of machinery costs.

Labor, capital, land, and management were treated as residual recipients of income in the budgets. However, charges for capital and labor were deducted, so that a net return to land and management could be derived for each system at each size level. The charges assigned to capital and labor were the same as those used in the soybean and the wheat-soybean budgets presented in the Farm Planning Manual.⁹ The enterprise budgets representing each of the six soybean production systems on the two sizes of farms analyzed in this study are presented in Appendix Tables A7-A18.

Although overhead, risk, and uncertainty were not specified as residual income recipients, they should be considered as such along with land and management. Overhead costs, such as those for the use of pickup trucks and other items which may be used with several different farm enterprises, and possibly for nonfar activities, are difficult to allocate to the soybean production enterprise. And, given the nature of crop production, producers must receive a return to risk and uncertainty over the long run in order to continue using resources for soybean production. No attempt

⁹Ray and Walch, *op. cit.*, pp. 32 and 42. The charge assigned to each of these resources should be determined by its value in its best alternative use.

was made in this study to itemize the cost of overhead, risk, and uncertainty in the soybean enterprise budgets. Therefore, the net return to land and management specified in the budgets includes a return to each of these three factors also.

VII. BREAK-EVEN SOYBEAN PRICES

Break-even soybean prices were computed for each system at each size level and are presented in Appendix Tables A19 and A20. The break-even soybean prices required to cover variable costs, variable and fixed costs, and variable and fixed costs plus charges to the capital and labor resources used in production were computed. The latter price represents the soybean price required to return a zero net return to land and management. Wheat and soybean yields and wheat prices used in calculating break-even soybean prices were the same as those used in the enterprise budgets developed for each system.

VIII. COST VARIATION

Only certain costs varied between cropping-planting systems and the values budgeted for those costs per acre are compiled in Table 25 along with capital and labor charges per acre for each soybean production system. Differences in soybean herbicide costs between systems exceeded differences in soybean seed costs between systems and differences in the costs of each of these two inputs between systems were greater than differences in either variable or fixed tractor and implement costs between systems. The extent of variation in tractor and implement costs between systems was

TABLE 25. Selected Out-of-Pocket Costs, Fixed Tractor and Implement Costs, and Capital and Labor Charges by Farm Size and Cropping-Planting System

Item	Farm Size (acres)	Single Crop			Double Crop		
		Row Crop	Grain Drill	Broadcast	Row Crop	Grain Drill	No Till
		-----(\$ per acre)-----					
Selected Out-of-Pocket Costs							
Soybean Seed	305	7.05	11.70	13.50	7.50	10.65	11.25
	991	7.05	11.70	13.50	7.50	10.65	11.25
Soybean Weed Control (Herbicide)	305	5.25	9.38	5.33	9.23	5.25	15.22
	991	5.25	9.38	5.33	9.23	5.25	15.22
Tractors and Implements ^a	305	8.31	6.31	5.18	11.28	5.72	4.94
	991	5.84	5.27	3.61	8.02	4.30	3.47
Fixed Tractor and Implement Costs ^a	305	13.97	12.28	11.63	15.89	11.11	12.74
	991	8.16	7.84	7.30	8.73	5.07	5.56
Capital and Labor Charges ^b	305	18.92	18.83	17.46	29.38	23.87	24.73
	991	12.07	12.15	10.97	19.76	16.41	17.44

^aVariable and fixed tractor and implement costs for both soybeans and wheat production are included for all double crop systems. Wheat production costs do not vary between double crop systems on a given size farm. Fixed tractor costs only vary between systems on large farms. Only two tractors were used in budgeting costs for the double crop-grain drill and double crop-no till systems on large farms instead of the three tractors assumed for other cropping-planting systems on large farms.

^bCapital and labor charges for wheat production are included for the double crop systems.

greater for variable costs than for fixed costs.

Differences in the charges for capital and labor between systems exceeded the differences in herbicide costs between systems. The capital and labor charge for the double crop-row crop system was \$11.92 per acre greater than for the single crop-broadcast system on farms of average size.

Capital and labor charges were always higher for double crop systems than for single crop systems on farms of the same size. This relationship was expected, since substantially more operating capital and labor time were required with double crop systems. The extent of variation in capital and labor charges between the three single crop systems was less than between the three double crop systems.

IX. VARIATION IN RESOURCE REQUIREMENTS

Data pertaining to the resource and input requirements of alternative cropping-planting systems are presented in Table 26. Resource and input requirements vary between cropping-planting systems at a given size level because of differences in the cropping practices, production operations, and specific implements and practices utilized in each system. Differences in operating capital, investment capital, labor, and fuel requirements for the six cropping-planting systems analyzed may explain why some systems were not used by many soybean producers in 1976.

The highest total operating capital requirements on each of the two sizes of farms were budgeted for the double crop-no till system. The total amount of operating capital required for the double crop-no till system

TABLE 26. Capital, Labor, and Fuel Requirements by Farm Size and Cropping-Planting System

Item	Farm Size (acres)	Single Crop			Double Crop		
		Row Crop	Grain Drill	Broadcast	Row Crop	Grain Drill	No Till
Capital (dollars)							
Operating	305	10,121	13,484	10,886	20,786	19,348	21,551
	991	29,952	41,782	33,065	62,780	59,491	66,543
Initial Investment	305	61,200	57,600	57,002	65,160	55,139	58,559
	991	103,865	101,751	99,043	107,731	82,637 ^a	86,113 ^a
Labor (hrs./acre)							
Soybean Field Preparation ^b and Planting	305	1.28	1.37	1.14	1.29	.68	.56
	991	.65	.88	.62	.65	.41	.46
Total	305	3.10	2.61	2.31	4.91	3.55	3.40
	991	1.93	1.71	1.51	3.33	2.63	2.71
Fuel (gal./acre)							
	305	12.78	11.06	10.32	21.50	16.52	15.34
	991	10.51	10.31	8.63	18.51	15.14	13.93

^aThe total initial capital investment in each of these two systems was lower than for other systems on large farms because two tractors were budgeted with these systems instead of the three budgeted for other systems on large farms.

^bThe production operations included in soybean field preparation and planting were: (1) primary tillage, (2) secondary tillage, (3) seedbed preparation, (4) preplant herbicide application, and (5) planting. The time required to do any other type of operation, such as burning straw or preemergence herbicide application, was not included. Soybean field preparation and planting was the only item in the table from which wheat resource requirements were excluded.

was \$11,430 more than that required with the single crop-row crop system on the 305 acre farm, and the difference in operating capital requirements between these two systems on large farms was \$36,591. Differences in operating capital requirements between double crop and single crop systems take on added significance when the increased risk involved in the use of double crop systems is considered.¹⁰

Investment capital requirements varied as much as \$10,021 between systems on the 305 acre farm and as much as \$25,094 between systems on the 991 acre farm. The double crop-row crop system required the largest initial investment for each farm size. Otherwise, the relationship between the single crop and double crop systems observed in relation to operating capital requirements did not hold for capital investment requirements, i.e., the investment capital requirements were not consistently higher for double crop systems than for single crop systems.

Both the labor required for soybean field preparation and planting per acre and the total labor required per acre varied considerably between alternative cropping-planting systems. The labor required for soybean field preparation and planting for each of the six systems on a given size farm should be inversely related to the timeliness of soybean planting. The timeliness of planting soybeans is a particularly important consideration for double crop producers because they must prepare and plant soybean fields quickly, especially if wheat harvesting is delayed for any

¹⁰Double crop soybeans often must be planted after the optimum planting date. Consequently, the yields obtained with double crop systems may be lower than those obtained with single crop systems.

reason.

Fuel usage figures presented in Table 26 include fuel used for the production, harvesting, and transportation of soybeans for all systems, and for the production, harvesting, and transportation of wheat for double crop systems. Fuel requirements per acre for all cropping-planting systems were lower on large farms than on farms of average size. The single crop-broadcast system of soybean production had the lowest fuel requirements per acre among the six cropping-planting systems analyzed and the no till planting system had the lowest fuel requirements per acre among the three double crop systems.

CHAPTER VII

SUMMARY AND IMPLICATIONS

I. SUMMARY

Data obtained by mail questionnaire from 166 West Tennessee farm operators who reported producing soybeans for beans in 1976 were used to identify soybean production systems used by Tennessee farmers and to evaluate the resource requirements and the net returns of the alternative systems identified. Six alternative soybean production systems were identified based on various combinations of cropping practices and planting methods. The six cropping-planting systems in the order of their importance, based on the number of producers using them, were: (1) single crop-row crop, (2) double crop-row crop, (3) single crop-grain drill, (4) double crop-no till, (5) double crop-grain drill, and (6) single crop-broadcast. Enterprise budgets were developed for each of the six cropping-planting systems on two representative farms based on information obtained from soybean producers responding to the mail survey. One representative farm was based on the average size of farms operated by soybean producers and contained 305 acres of cropland on which 225 acres of soybeans were produced. The other representative farm was based on 36 farms which were larger than the average size of farms operated by soybean producers and contained 991 acres of cropland on which 724 acres of soybeans were produced.

A two-step procedure was used to identify which of seven pre-harvest soybean production operations were commonly used as components of each cropping-planting system and to identify the specific implements and/or production practices most often used to perform each pre-harvest production operation commonly used with each cropping-planting system. The set of implements and practices selected as being representative of each system was utilized along with survey data pertaining to wheat and soybean yields and soybean seeding rates in developing enterprise budgets for each system.

The net return to land and management per acre of soybeans produced on the average size farm was: (1) \$105.75 for the double crop-row crop system, (2) \$97.13 for the double crop-grain drill system, (3) \$55.57 for the single crop-grain drill system, (4) \$54.87 for the double crop-no till system, (5) \$48.71 for the single crop-row crop system, and (6) \$34.75 for the single crop-broadcast system. The net return to land and management per acre of soybeans produced on the large farm was: (1) \$137.34 for the double crop-row crop system, (2) \$123.25 for the double crop-grain drill system, (3) \$82.43 for the double crop-no till system, (4) \$77.66 for the single crop-grain drill system, (5) \$75.19 for the single crop-row crop system, and (6) \$57.45 for the single crop-broadcast system. The net returns to land and management for double crop systems included a return from both wheat and soybeans. Differences in yields between systems were the most important factor determining their relative profitability.

Soybean cropping-planting systems which had high net returns to land and management tended to have higher capital and/or labor requirements

than other systems. For example, the highest net return per acre for a single crop system was for the single crop-grain drill system, but this system required more labor for soybean field preparation and planting than any of the other five cropping-planting systems. Also, operating capital requirements for the single crop-grain drill system were higher than for either of the other two single crop systems. Similarly, the highest net return per acre for a double crop system was for the double crop-row crop system, but that system required a higher initial capital investment and more total hours of labor per acre than any of the other five cropping-planting systems.

II. IMPLICATIONS FOR SOYBEAN PRODUCERS

Traditionally, Tennessee farmers have produced soybeans with a single crop-row crop system roughly equivalent to the one analyzed in this study. Developments in soybean production technology and improvements in herbicides have made other soybean production systems feasible for use in Tennessee. The use of five cropping practice-planting method combinations, in addition to the single crop-row crop system, by soybean producers in Tennessee was documented in this study. The enterprise budgets developed in this study provide information which should be useful to Tennessee farmers in deciding which soybean cropping-planting system or systems to use.

Based on the enterprise budgets developed in this study, the double crop-row crop system of soybean production will give farmers a higher net return to land and management than any other system analyzed. These

enterprise budgets indicate that net returns from single crop-grain drill soybean production are greater than from any other single crop system analyzed and that four of the systems of soybean production analyzed have higher net returns to land and management than the single crop-row crop system.

However, soybean growers should base the decision of whether to use a cropping-planting system other than the conventional single crop-row crop system on more than the net returns budgeted for each system in this study. Some factors other than the net returns budgeted for each soybean production system which will influence the choice of systems to use on a given farm are discussed below.

Producers should consider differences in the general applicability of different soybean production systems. For example, the desirability of using systems other than the row crop system in fields severely infested with problem weeds, such as johnsongrass, would be highly questionable because of the greatly increased risk of obtaining poor soybean yields. Farmers should also consider the applicability of producing wheat in a given field before using double crop systems.

A producer should consider the resource situation on his farm before choosing a soybean production system. If either capital or labor is the most limiting resource for a given farm situation, the cropping-planting system which gives the highest net return to the most limiting resource should be selected. For example, if labor required for soybean field preparation and planting is the most limiting resource, the double crop-grain drill system would be the best alternative, because it returns more

for each hour of labor required for soybean field preparation and planting per acre than any of the other five cropping-planting systems.

Producers should recognize that soybean yields obtained with a given system will vary from year-to-year and that the degree of this variation differs by production system. Therefore, farmers should formulate expectations regarding the yield variation associated with alternative soybean production systems and determine the amount of yield variation they are willing, and able, to accept before choosing a production system for their farms.

The soybean enterprise budgets developed in this study are static and do not reflect yield variations which could be expected over time. However, an analysis of soybean yields required for various production systems to provide a return to land and management equivalent to the return to those factors from the traditional single crop-row crop production system should give farm operators an indication of the degree of soybean yield variation they could accept with systems other than the traditional one and receive the same level of income. For example, a farm operator producing 225 acres of single crop-row crop soybeans which yielded 26.3 bushels per acre and sold for \$5.50 per bushel could obtain the same net returns to land and management per acre from: (1) 24.7 bushels of soybeans per acre with the single crop-grain drill system, (2) 32.9 bushels of soybeans per acre with the single crop-broadcast system, (3) 13.6 bushels of soybeans per acre with the double crop-row crop system, (4) 12.0 bushels of soybeans per acre with the double crop-grain drill system, and (5) 19.4 bushels of soybeans per acre with the

double crop-no till system. The soybean production systems which require a lower soybean yield than 26.3 bushels per acre to obtain the same net returns to land and management as could be obtained with the single crop-row crop system require a higher level of management, however.

Finally, the enterprise budgets developed in this study do not account for differences in goals and planning horizons between farm operators. For example, soil erosion is a serious problem in West Tennessee, and the use of clean tillage systems of soybean production, such as the conventional single crop-row crop system, contributes to the erosion problem. Soybean producers who want to minimize soil loss from their soybean fields should consider the double crop-no till system. The broadcast and grain drill systems of soybean production should also be more effective in minimizing soil erosion than the row crop production system.

Many soybean producers may continue to use the single crop-row crop system of soybean production even though the enterprise budgets developed in this study indicate that four other soybean production systems have higher net returns to land and management. One possible reason that farmers may continue to produce soybeans with the single crop-row crop system of soybean production is that it is generally considered applicable to a wider range of field conditions than any of the alternative cropping-planting systems. In addition, producers may consider the single crop-row crop system to have less yield variation and to require less intensive management than other systems analyzed in this study.

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APPENDIX

TABLE A1. Assumed Production Operations and Material Inputs for Wheat Production

Input or Operation	Units	Amount
Seed	bu.	1.50
N	lb.	50.00 ^a
P ₂ O ₅	lb.	50.00
K ₂ O	lb.	30.00
Disk	trip	2.00
Drill	trip	1.00
Combine	trip	1.00
Haul	hr.	.47 ^b

^aApproximately 30 pounds of N would be used for top dressing in late winter with the other 20 pounds applied before planting. The cost of fertilizer applications was included in the prices of the fertilizers used, and no operator labor or tractor time was expended.

^bSource: Robert M. Ray and Herbert N. Walch, Farm Planning Manual, Tennessee Agricultural Extension Service Publication EC 622, Knoxville, Tennessee, April 1978.

Source: Raymond E. Cobble, Growing Wheat in Tennessee, Tennessee Agricultural Extension Service Publication 576, Knoxville, Tennessee, March 1978.

TABLE A2. Machinery Performance Data

Machinery Item	Width (feet)	Speed (mph)	Field Efficiency	Machine Hours Per Acre ^a	Labor Hours Per Acre ^b
Moldboard Plow	5.3	4.5	.80	.43	.54
Chisel Plow	16.0	4.5	.80	.14	.23
Chisel Plow	7.0	4.5	.80	.33	.41
Tandem Disk	21.0	4.5	.80	.11	.14
Tandem Disk	12.0	4.5	.80	.19	.24
Do All	20.0	4.8	.80	.11	.14
Do All	13.0	4.8	.80	.17	.21
Cultimulcher	20.0	4.8	.80	.11	.14
Cultimulcher	12.0	4.8	.80	.18	.23
Row Crop Planter	19.0	5.0	.63	.14	.18
Row Crop Planter	12.7	5.0	.63	.21	.26
Grain Drill	12.0	6.2	.75	.15	.19
Grain Drill	8.8	6.2	.75	.20	.25
Spinner Seeder	20.0	4.0	.68	.15	.19
No Till Planter	9.5	4.5	.63	.31	.39
No Till Planter	6.3	4.5	.63	.46	.58
Row Crop Cultivator	19.0	3.8	.76	.15	.19
Row Crop Cultivator	12.7	3.8	.76	.23	.29
Trailered Sprayer	24.0	4.5	.75	.10	.13
Mounted Sprayer	21.0	4.5	.60	.15	.19
Directed Spray Rig	19.0	3.8	.67	.17	.21
Directed Sprayer	12.7	4.0	.68	.24	.30
Combine	15.0	2.8	.75	.26	.33
Combine	10.0	2.8	.75	.39	.49

^aMachine hours per acre were calculated using the following formula:

$$\text{Machine Hours Per Acre} = \frac{1.0}{(\text{Width} \times \text{Speed} \times \text{Field Efficiency})/8.25}$$

Source: Kenneth W. Paxton, Cotton and Soybean Production Costs and Returns, Estimates for Louisiana for 1977, Louisiana State University, Department of Agricultural Economics Research Report No. 515, Baton Rouge, Louisiana, March 1977, p. 8.

^bLabor hours per acre were computed as follows:

$$\text{Labor Hours Per Acre} = 1.25(\text{Machine Hours Per Acre})$$

TABLE A3. Machinery Cost Data

Machinery Item	Size	New Cost	Expected Life (yrs.)	Repairs % of New Cost	Annual Hours of Use ^a	Annual Fixed Cost Per Acre ^b	Variable Cost Per Hour ^c
Tractor	125 DHP ^d	18,643	10	60	440	2.70	6.19
Tractor	80 DHP ^d	13,550	10	60	300	1.97	5.13
Tractor	70 DHP ^d	11,796	10	60	410	5.50	3.91
Tractor	45 DHP ^d	8,411	10	60	310	1.22	2.95
Tractor	34 DHP ^d	6,562	10	60	160	3.06	3.51
Moldboard Plow	4 X 16 in.	1,872	10	60	130	.88	.86
Chisel Plow	16 ft.	2,523	10	60	140	.37	1.08
Chisel Plow	7 ft.	880	10	60	100	.41	.53
Tandem Disk	21 ft.	3,633	10	40	325	.53	.45
Tandem Disk	12 ft.	2,467	10	40	175	1.16	.56
Do All	20 ft.	2,946	10	40	110	.43	1.07
Do All	13 ft.	1,609	10	40	50	.76	1.29
Cultimulcher	20 ft.	3,400	10	40	110	.50	1.24
Cultimulcher	12 ft.	2,887	10	40	55	1.36	2.10
Row Crop Planter	6 X 38 in.	2,950	10	40	140	.43	.84
Row Crop Planter	4 X 38 in.	3,045	10	40	65	1.43	1.87
Grain Drill	20 X 7 in.	3,164	10	40	220	.46	.58
Grain Drill	15 X 7 in.	2,114	10	40	90	1.00	.94
Spinner Seeder	600 lb. ^e	514	9	20	150	.08	.08
Spinner Seeder	600 lb. ^e	514	9	20	45	.27	.08
No Till Planter	12 X 19 in.	3,357	10	40	305	.49	.25
No Till Planter	8 X 19 in.	3,465	10	40	140	1.63	.44
Row Crop Cultivator	6-row	2,415	10	60	295	.35	.99
Row Crop Cultivator	4-row	1,669	10	60	140	.79	.49
Trailered Sprayer	24 ft.	675	8	60	30	.39	1.69

TABLE A3 (continued)

Machinery Item	Size	New Cost	Expected Life (yrs.)	Repairs % of New Cost	Annual Hours of Use ^a	Annual Fixed Cost Per Acre ^b	Variable Cost Per Hour ^c
Mounted Sprayer ^f		800	8	60	320	.12	.19
Mounted Sprayer Boom	21 ft.	200	8	60	150	.04	.10
Directed Spray Rig	6-row	200	8	60	170	.04	.09
Directed Sprayer	4-row	550	8	60	75	.32	.55
Combine	15 ft. S.P.	26,827	8	40	385	4.82	11.91
Combine	10 ft. S.P.	21,000	8	40	180	12.13	10.07
Grain Trucks (2) ^g	2-Ton	10,500	10	60	315	1.52	5.56
Grain Truck	2-Ton	10,500	10	60	215	4.90	6.49

^aAnnual hours of tractor and truck use were estimated by: (1) determining the tractor time per acre accumulated using each tractor with each system, (2) computing the average amount of time each tractor was used with the six systems, (3) multiplying the average computed by relevant croppable acreage (305 acres on small farms and 991 acres on large farms), and (4) multiplying the resulting annual hours of tractor use by a factor of 1.25 thereby allocating extra hours of use for farm work other than field crop production. The annual hours of use were always rounded to the nearest multiple of five. Annual hours of use for all items other than tractors and trucks were calculated in the same manner except that the multiplication factor was dropped due to the assumption that these items were used solely in the production of field crops.

^bAnnual fixed costs were computed in Appendix Table A6. Annual fixed costs were divided by the relevant number of acres planted in soybeans on a given size of farm (225 acres on small farms and 724 acres on large farms) to compute annual fixed costs per acre.

^cVariable costs per hour of use were determined in Appendix Table A4.

TABLE A3 (continued)

^dFigures for tractor sizes are approximately equivalent to maximum drawbar horsepower ratings at 75% load.

^eThe same size spinner seeder was used with both farm sizes. The annual fixed cost per acre of using this planting implement was lower for the large farm size than for the small farm size.

^fThis item refers to the saddle tanks and sprayer pump to be used in combination with the mounted sprayer boom or the cultivator mounted, directed spray rig on large farms.

^gTwo trucks of the size specified in the table were assumed for large farms.

TABLE A4. Hourly Variable Costs^a

Machinery Item	Size	Repairs	Fuel	Oil and Filters	Variable Cost Per Hour
Tractor	125 DHP	2.54	3.44	.21	6.19
Tractor	80 DHP	2.71	2.28	.14	5.13
Tractor	70 DHP	1.73	1.98	.20	3.91
Tractor	45 DHP	1.63	1.20	.12	2.95
Tractor	34 DHP	2.46	.95	.10	3.51
Moldboard Plow	4 X 16 in.	.86			.86
Chisel Plow	16 ft.	1.08			1.08
Chisel Plow	7 ft.	.53			.53
Tandem Disk	21 ft.	.45			.45
Tandem Disk	12 ft.	.56			.56
Do All	20 ft.	1.07			1.07
Do All	13 ft.	1.29			1.29
Cultimulcher	20 ft.	1.24			1.24
Cultimulcher	12 ft.	2.10			2.10
Row Crop Planter	6 X 38 in.	.84			.84
Row Crop Planter	4 X 38 in.	1.87			1.87
Grain Drill	20 X 7 in.	.58			.58
Grain Drill	15 X 7 in.	.94			.94
Spinner Seeder	600 lb.	.08			.08
No Till Planter	12 X 19 in.	.25			.25
No Till Planter	8 X 19 in.	.44			.44
Row Crop Cultivator	6-row	.99			.99
Row Crop Cultivator	4-row	.49			.49
Trailer Sprayer	24 ft.	1.69			1.69
Mounted Sprayer Tank		.19			.19
Mounted Sprayer Boom	21 ft.	.10			.10
Directed Spray Rig	6-row	.09			.09
Directed Sprayer	4-row	.55			.55
Combine	15 ft. S.P.	3.48	4.47	.45	11.91
Combine	10 ft. S.P.	5.83	3.85	.39	10.07
Grain Trucks (2)	2-Ton	2.00	3.24	.32	5.56
Grain Truck	2-Ton	2.93	3.24	.32	6.49

^aThe hourly variable costs incurred while using the different implements and tractors were the sum of the hourly repairs, fuel, oil, and filter costs, which were computed as follows:

$$\text{Repairs} = \frac{\text{New Cost} \times \text{Repairs \% of New Cost}}{\text{Expected Life (yrs.)} \times \text{Annual Hours of Use}}$$

TABLE A4 (continued)

Fuel = Consumption of Fuel Per Hour X Fuel Price Per Gallon
Oil and Filter = Total Fuel Cost X .10 for tractors below 80 DHP
.10 for trucks and combines
.06 for tractors 80 DHP and above

Assumptions: All tractors have diesel engines.
Trucks and combines have gasoline engines.

Diesel Fuel = \$.43 per gallon (less tax)

Gasoline = \$.47 per gallon (less tax)

Assumed Fuel Consumption Per Hour:	125 DHP	8.0 gals./hr.
	80 DHP	5.3 gals./hr.
	70 DHP	4.6 gals./hr.
	45 DHP	2.8 gals./hr.
	34 DHP	2.2 gals./hr.
	2-Ton Truck	6.9 gals./hr.
	15 ft. S.P. Combine	9.5 gals./hr.
	10 ft. S.P. Combine	8.2 gals./hr.

Sources: Robert M. Ray and Herbert N. Walch, Farm Planning Manual, Tennessee Agricultural Extension Service Publication EC-622, Knoxville, Tennessee, April 1978; Doane's Agricultural Report, Reference Volume, Doane Agricultural Service, Inc., St. Louis, Missouri.

TABLE A5. Information Used to Calculate the Variable Costs Per Acre of Implement Use

Implement(s) ^a	Size	Associated Power Units (DHP)	Machine Hours Per Acre Per Trip ^b	Variable Cost Per Hour ^c	Variable Cost Per Acre Per Trip ^d
305 Acre Farm					
Moldboard Plow	4 X 16 in.	70	.43	.86	.37
Chisel Plow	7 ft.	70	.33	.53	.17
Tandem Disk	12 ft.	70	.19	.56	.11
Do All	13 ft.	70	.17	1.29	.22
Cultimulcher	12 ft.	70	.18	2.10	.38
Row Crop Planter	4 X 38 in.	34	.21	1.87	.39
Grain Drill	15 X 7 in.	34	.20	.94	.19
Spinner Seeder	600 lb.	34	.15	.08	.01
No Till Planter	8 X 19 in.	34	.46	.44	.20
Row Crop Cultivator	4-row	70	.23	.49	.11
Trailer Sprayer	24 ft.	34	.10	1.69	.17
Row Crop Cultivator + Directed Sprayer	4-row	70	.24	1.04	.25
991 Acre Farm					
Chisel Plow	16 ft.	125	.14	1.08	.15
Tandem Disk	21 ft.	125	.11	.45	.05
Tandem Disk + Mounted Sprayer ^e	21 ft.	125	.15	.74	.11
Do All	20 ft.	80	.11	1.07	.12
Cultimulcher	20 ft.	80	.11	1.24	.14
Row Crop Planter	6 X 38 in.	45	.14	.84	.12
Grain Drill	20 X 7 in.	45	.15	.58	.09

TABLE A5(continued)

Implement(s) ^a	Size	Associated Power Units (DHP)	Machine Hours Per Acre Per Trip ^b	Variable Cost Per Hour ^c	Variable Cost Per Acre Per Trip ^d
Spinner Seeder	600 lb.	45	.15	.08	.01
No Till Planter	12 X 19 in.	45	.31	.25	.08
Row Crop Cultivator	6-row	80	.15	.99	.15
Mounted Sprayer	21 ft.	45	.15	.29	.04
Row Crop Cultivator + Directed Sprayer	6-row	80	.17	1.27	.22

^aThe specific types of implements used with each system and the number of times they were used per field were specified in Tables 23 (pp. 63-64) and 24 (pp. 65-66) and Appendix Table A1.

^bWhen two implements were combined during one trip over soybean fields, the machine hours per acre per trip (see Appendix Table A2) for the more time consuming implement was used.

^cWhen two implements were combined, their variable costs per hour (see Appendix Table A3) were summed to obtain the figure shown in the table.

^dThe variable costs per acre shown in the above table do not include the variable costs of using the associated power units.

^eThis combination of implements included in budgeting the costs of implement use on large farms for systems with which a preplant herbicide was used was selected based on conversations with University of Tennessee Agricultural Extension Service and research personnel.

TABLE A6. Annual Fixed Costs^a

Machinery Item	Size	Depreciation	Insurance	Annual Fixed Cost
Tractor	125 DHP	1864.30	93.22	1957.52
Tractor	80 DHP	1355.00	67.75	1422.75
Tractor	70 DHP	1179.60	58.98	1238.58
Tractor	45 DHP	841.10	42.06	883.16
Tractor	34 DHP	656.20	32.81	689.01
Moldboard Plow	4 X 16 in.	187.20	11.23	198.43
Chisel Plow	16 ft.	252.30	15.14	267.44
Chisel Plow	7 ft.	88.00	5.28	93.28
Tandem Disk	21 ft.	363.30	21.80	385.10
Tandem Disk	12 ft.	246.70	14.80	261.50
Do All	20 ft.	294.60	17.68	312.28
Do All	13 ft.	160.90	9.65	170.55
Cultimulcher	20 ft.	340.00	20.40	360.40
Cultimulcher	12 ft.	288.70	17.32	306.02
Row Crop Planter	6 X 38 in.	295.00	17.70	312.70
Row Crop Planter	4 X 38 in.	304.50	18.27	322.77
Grain Drill	20 X 7 in.	316.40	18.98	335.38
Grain Drill	15 X 7 in.	211.40	12.68	224.08
Spinner Seeder	600 lb.	57.11	3.08	60.19
No Till Planter	12 X 19 in.	355.70	20.14	355.84
No Till Planter	8 X 19 in.	346.50	20.79	367.29
Row Crop Cultivator	6-row	241.50	14.49	255.99
Row Crop Cultivator	4-row	166.90	10.01	176.91
Trailered Sprayer	24 ft.	84.38	4.05	88.43
Mounted Sprayer Tank		80.00	4.80	84.80
Mounted Sprayer Boom	21 ft.	25.00	1.20	26.20
Directed Spray Rig	6-row	25.00	1.20	26.20
Directed Sprayer	4-row	68.75	3.30	72.05
Combine	15 ft. S.P.	3353.38	134.14	3487.52
Combine	10 ft. S.P.	2625.00	105.00	2730.00
Grain Trucks (2)	2-Ton	1050.00	52.50	1102.50
Grain Truck	2-Ton	1050.00	52.50	1102.50

^aAnnual fixed cost equaled the sum of the depreciation expense plus the insurance expense which were computed as follows:

Depreciation = New Cost/Expected Life

Insurance = (New Cost/2) X Insurance Rate

TABLE A6 (continued)

Insurance Rates: \$10.00 per \$1000.00 invested in self
propelled machinery
\$12.00 per \$1000.00 invested in other
machinery

Source of insurance rates and cost computation formulas: Herbert
N. Walch, Unpublished Data, Tennessee Agricultural Economics Extension
Service, Knoxville, Tennessee, 1977.

TABLE A7. Estimated Costs and Returns Per Acre Utilizing the Single Crop-Row Crop System on the 305 Acre Farm

Item	Description	Unit	Quantity	Price	Amount
REVENUE					
Soybeans		bu.	26.30	5.50	144.65
COSTS					
Variable					
Seed		lb.	47.00	.15	7.05
Fertilizer	P ₂ O ₅	lb.	40.00	.18	7.20
	K ₂ O	lb.	40.00	.09	3.60
Lime	3 Tons Every 4 Years	ton	.75	10.00	7.50
Weed Control					
Preplant	Treflan	pt.	1.50	3.50	5.25
Tractor	70 DHP	hr.	1.44	3.91	5.63
	34 DHP	hr.	.31	3.51	1.09
Combine	10 ft. S.P.	hr.	.39	10.07	3.93
Truck	2-Ton	hr.	.33	6.49	2.14
Implements ^a					1.59
	Total Variable Costs				44.98
Fixed					
Tractor	70 DHP	acre	1.00		5.50
	34 DHP	acre	1.00		3.06
Combine	10 ft. S.P.	acre	1.00		12.13
Truck	2-Ton	acre	1.00		4.90
Implements		acre	1.00		5.41
	Total Fixed Costs				31.00
	Total Variable and Fixed Costs				75.98
	Net Return to Land, Labor, Capital, and Management				68.67
Interest					
Operating					
Capital	6 mos. at 9%	acre	1.00		2.03
Fixed Capital	12 mos. at 7.5%	acre	1.00		10.20 ^b
	Net Return to Land, Labor, and Management				56.44
Labor		hr.	3.09	2.50	7.73
	Net Return to Land and Management				48.71

^aThe specific types of implements used with this system and the number of times each was used per field were specified in Table 23 (pp. 63-64). Information in Appendix Table A5 was used to determine the variable

TABLE A7 (continued)

cost of using these implements.

^bThis represents an average investment of \$136 per acre of soybeans. The interest charge per acre on fixed capital and the annual fixed costs per acre were computed using 225 acres of soybeans as the acreage base.

TABLE A8. Estimated Costs and Returns Per Acre Utilizing the Single Crop-Grain Drill System on the 305 Acre Farm

Item	Description	Unit	Quantity	Price	Amount
REVENUE					
Soybeans		bu.	28.20	5.50	155.10
COSTS					
Variable					
Seed		lb.	78.00	.15	11.70
Fertilizer	P ₂ O ₅	lb.	40.00	.18	7.20
	K ₂ O	lb.	40.00	.09	3.60
Lime	3 Tons Every 4 Years	ton	.75	10.00	7.50
Weed Control					
Preemer-					
gence	Lasso ^a	qt.	2.50	3.75	9.38
Tractor	70 DHP	hr.	1.07	3.91	4.18
	34 DHP	hr.	.30	3.51	1.05
Combine	10 ft. S.P.	hr.	.39	10.07	3.93
Truck	2-Ton	hr.	.33	6.49	2.14
Implements ^b					1.08
	Total Variable Costs				51.76
Fixed					
Tractor	70 DHP	acre	1.00		5.50
	34 DHP	acre	1.00		3.06
Combine	10 ft. S.P.	acre	1.00		12.13
Truck	2-Ton	acre	1.00		4.90
Implements		acre	1.00		3.72
	Total Fixed Costs				29.31
	Total Variable and Fixed Costs				81.07
	Net Return to Land, Labor, Capital, and Management				74.03
Interest					
Operating					
Capital	6 mos. at 9%	acre	1.00		2.33
Fixed Capital	12 mos. at 7.5%	acre	1.00		9.60 ^c
	Net Return to Land, Labor, and Management				62.10
Labor		hr.	2.61	2.50	6.53
	Net Return to Land and Management				55.57

^aThe specific preemergence herbicide or herbicides used with this system should be selected for specific weed or grass problems which are present. Therefore, herbicide costs for this system can vary considerably.

TABLE A8 (continued)

^bThe specific types of implements used with this system and the number of times each was used per field were specified in Table 23 (pp. 63-64). Information in Appendix Table A5 was used to determine the variable cost of using these implements.

^cThis represents an average investment of \$128 per acre of soybeans. The interest charge per acre on fixed capital and the annual fixed costs per acre were computed using 225 acres of soybeans as the acreage base.

TABLE A9. Estimated Costs and Returns Per Acre Utilizing the Single Crop-Broadcast System on the 305 Acre Farm

Item	Description	Unit	Quantity	Price	Amount
REVENUE					
Soybeans		bu.	23.50	5.50	129.25
COSTS					
Variable					
Seed		lb.	90.00 ^a	.15	13.50
Fertilizer	P ₂ O ₅	lb.	40.00	.18	7.20
	K ₂ O	lb.	40.00	.09	3.60
Lime	3 Tons Every 4 Years	ton	.75	10.00	7.50
Weed Control					
Preplant	Treflan	pt.	1.50	3.50	5.25
Custom Rate ^b		load	.01	7.50	.08
Tractor	70 DHP	hr.	.98	3.91	3.83
	34 DHP	hr.	.15	3.51	.53
Combine	10 ft. S.P.	hr.	.39	10.07	3.93
Truck	2-Ton	hr.	.33	6.49	2.14
Implements ^c					.82
	Total Variable Costs				48.38
Fixed					
Tractor	70 DHP	acre	1.00		5.50
	34 DHP	acre	1.00		3.06
Combine	10 ft. S.P.	acre	1.00		12.13
Truck	2-Ton	acre	1.00		4.90
Implements					3.07
	Total Fixed Costs				28.66
	Total Variable and Fixed Costs				77.04
	Net Return to Land, Labor, Capital, and Management				52.21
Interest					
Operating					
Capital	6 mos. at 9%	acre	1.00		2.18
Fixed Capital	12 mos. at 7.5%	acre	1.00		9.50 ^d
	Net Return to Land, Labor, and Management				40.53
Labor		hr.	2.31	2.50	5.78
	Net Return to Land and Management				34.75

^aSource: 1976 Field Crops Seeding Guide, Tennessee Agricultural Extension Service Publication 378, Knoxville, Tennessee, February 1976.

TABLE A9 (continued)

^bTreflan or Tolban was custom applied by spraying onto fertilizer at a rate of \$7.50 per load of any size. A 4-Ton load of fertilizer was assumed.

^cThe specific types of implements used with this system and the number of times each was used per field were specified in Table 23 (pp. 63-64). Information in Appendix Table A5 was used to determine the variable cost of using these implements.

^dThis represents an average investment of \$126.67 per acre of soybeans. The interest charge per acre and the annual fixed costs per acre were computed using 225 acres of soybeans as the acreage base.

TABLE A10. Estimated Costs and Returns Per Acre Utilizing the Double Crop-Row Crop System on the 305 Acre Farm

Item	Description	Unit	Quantity	Price	Amount
REVENUE					
Wheat		bu.	35.90	2.75	98.73
Soybeans		bu.	29.40	5.50	161.70
	Total				260.43
COSTS					
Variable					
Seed	Wheat	bu.	1.50	7.55	11.33
Seed	Soybeans	lb.	50.00	.15	7.50
Fertilizer	N	lb.	50.00	.20	10.00
	P ₂ O ₅	lb.	90.00	.18	16.20
	K ₂ O	lb.	70.00	.09	6.30
	3 Tons Every 4 Years	ton	.75	10.00	7.50
Lime					
Weed Control					
Preplant	Treflan	pt.	1.50	3.50	5.25
Post-emergence	Premerge-Directed ^a	gal.	.50	7.95	3.98
Tractor	70 DHP	hr.	1.84	3.91	7.19
	34 DHP	hr.	.51	3.51	1.79
	10 ft. S.P.	hr.	.78	10.07	7.85
Combine					
Truck	2-Ton	hr.	.80	6.49	5.19
Implements ^b					2.30
	Total Variable Costs				92.38
Fixed					
Tractor	70 DHP	acre	1.00		5.50
	34 DHP	acre	1.00		3.06
Combine	10 ft. S.P.	acre	1.00		12.13
Truck	2-Ton	acre	1.00		4.90
Implements		acre	1.00		7.33
	Total Fixed Costs				32.92
	Total Variable and Fixed Costs				125.30
	Net Return to Land, Labor, Capital, and Management				135.13
Interest					
Operating					
Capital	9 mos. at 9%	acre	1.00		6.24
Fixed Capital	12 mos. at 7.5%	acre	1.00		10.86 ^c
	Net Return to Land, Labor, and Management				118.03
Labor					
		hr.	4.91	2.50	12.28
	Net Return to Land and Management				105.75

TABLE A10 (continued)

^aThe specific postemergence herbicide used with this system should be selected for specific weed or grass problems which are present. Over-top application of the postemergence herbicides Dyanap or Basagran may become more important than directed application of postemergence herbicides in the near future.

^bThe specific types of implements used in budgeting costs for this system and the number of times each was used per field were specified in Table 24 (pp. 65-66) and Appendix Table A1 (p. 96) Information in Appendix Table A5 (p. 103-104) was used to determine the variable cost of using these implements.

^cThis represents an average investment of \$144.80 per acre of soybeans. The interest charge per acre on fixed capital and the annual fixed costs per acre were computed using 225 acres of soybeans as the acreage base.

TABLE A11. Estimated Costs and Returns Per Acre Utilizing the Double Crop-Grain Drill System on the 305 Acre Farm

Item	Description	Unit	Quantity	Price	Amount
REVENUE					
Wheat		bu.	37.50	2.75	103.13
Soybeans		bu.	24.00	5.50	132.00
	Total				<u>235.13</u>
COSTS					
Variable					
Seed	Wheat	bu.	1.50	7.55	11.33
Seed	Soybean	lb.	71.00	.15	10.65
Fertilizer	N	lb.	50.00	.20	10.00
	P ₂ O ₅	lb.	90.00	.18	16.20
	K ₂ O	lb.	70.00	.09	6.30
Lime	3 Tons Every 4 Years	ton	.75	10.00	7.50
Weed Control					
Preplant	Treflan	pt.	1.50	3.50	5.25
Tractor	70 DHP	hr.	.76	3.91	2.97
	34 DHP	hr.	.50	3.51	1.76
Combine	10 ft. S.P.	hr.	.78	10.07	7.85
Truck	2-Ton	hr.	.80	6.49	5.19
Implements ^a					<u>.99</u>
	Total Variable Costs				<u>85.99</u>
Fixed					
Tractor	70 DHP	acre	1.00		5.50
	34 DHP	acre	1.00		3.06
Combine	10 ft. S.P.	acre	1.00		12.13
Truck	2-Ton	acre	1.00		4.90
Implements		acre	1.00		<u>2.55</u>
	Total Fixed Costs				<u>28.14</u>
	Total Variable and Fixed Costs				114.13
	Net Return to Land, Labor, Capital, and Management				121.00
Interest					
Operating					
Capital	9 mos. at 9%	acre	1.00		5.80
Fixed Capital	12 mos. at 7.5%	acre	1.00		<u>9.19^b</u>
	Net Return to Land, Labor, and Management				106.01
Labor					
		hr.	3.55	2.50	<u>8.88</u>
	Net Return to Land and Management				<u>97.13</u>

TABLE A11 (continued)

^aThe specific types of implements used in budgeting costs for this system and the number of times each was used per field were specified in Table 24 (pp. 65-66) and Appendix Table A1 (p. 96). Information in Appendix Table A5 (pp. 103-104) was used to determine the variable cost of using these implements.

^bThis represents an average investment of \$122.53 per acre of soybeans. The interest charge per acre on fixed capital and the annual fixed costs per acre were computed using 225 acres of soybeans as the acreage base.

TABLE A12. Estimated Costs and Returns Per Acre Utilizing the Double Crop-No Till System on the 305 Acre Farm

Item	Description	Unit	Quantity	Price	Amount
REVENUE					
Wheat		bu.	31.00	2.75	85.25
Soybean		bu.	21.80	5.50	119.90
	Total				<u>205.15</u>
COSTS					
Variable					
Seed		bu.	1.50	7.55	11.33
Seed		lb.	75.00	.15	11.25
Fertilizer	N	lb.	50.00	.20	10.00
	P ₂ O ₅	lb.	90.00	.18	16.20
	K ₂ O	lb.	70.00	.09	6.30
Lime	3 Tons Every 4 Years	ton	.75	10.00	7.50
Weed Control					
Burndown	Paraquat	qt.	1.00	8.39	8.39
Preemergence	Lorox	lb.	1.50	3.51	5.27
Surfactant	.5% by Volume ^b	qt.	.61	2.56	1.56
Tractor	70 DHP	hr.	.38	3.91	1.49
	34 DHP	hr.	.76	3.51	2.67
Combine	10 ft. S.P.	hr.	.78	10.07	7.85
Truck	2-Ton	hr.	.80	6.49	5.19
Implements ^c					.78
	Total Variable Costs				<u>95.78</u>
Fixed					
Tractor	70 DHP	acre	1.00		5.50
	34 DHP	acre	1.00		3.06
Combine	10 ft. S.P.	acre	1.00		12.13
Truck	2-Ton	acre	1.00		4.90
Implements		acre	1.00		4.18
	Total Fixed Costs				<u>29.77</u>
	Total Variable and Fixed Costs				125.55
	Net Return to Land, Labor, Capital, and Management				79.60
Interest					
Operating					
Capital	9 mos. at 9%	acre	1.00		6.47
Fixed Capital	12 mos. at 7.5%	acre	1.00		9.76 ^d
	Net Return to Land, Labor, and Management				<u>63.37</u>
Labor		hr.	3.40	2.50	8.50
	Net Return to Land and Management				<u>54.87</u>

TABLE A12 (continued)

^aA preemergence herbicide was included based on University of Tennessee recommendations. Source: Wayne T. Flinchum, Soybean Production in Tennessee, Tennessee Agricultural Extension Service Publication 421, Knoxville, Tennessee, May 1976, p. 22.

^bA rate of 40 gallons of water per acre was assumed. All three items listed under "weed control" were tank mixed and applied together.

^cThe specific types of implements used with this system and the number of times each was used per field were specified in Table 24 (pp. 65-66) and Appendix Table A1 (p. 96). Information in Appendix Table A5 (pp. 103-104) was used to determine the variable cost of using these implements.

^dThis represents an average investment of \$130.13 per acre of soybeans. The interest charge per acre on fixed capital and the annual fixed costs per acre were computed using 225 acres of soybeans as the acreage base.

TABLE A13. Estimated Costs and Returns Per Acre Utilizing the Single Crop-Row Crop System on the 991 Acre Farm

Item	Description	Unit	Quantity	Price	Amount
REVENUE					
Soybeans		bu.	26.30	5.50	144.65
COSTS					
Variable					
Seed		lb.	47.00	.15	7.05
Fertilizer	P ₂ O ₅	lb.	40.00	.18	7.20
	K ₂ O	lb.	40.00	.09	3.60
Lime	3 Tons Every 4 Years	ton	.75	10.00	7.50
Weed Control					
Preplant	Treflan	pt.	1.50	3.50	5.25
Tractor	125 DHP	hr.	.40	6.19	2.48
	80 DHP	hr.	.41	5.13	2.10
	45 DHP	hr.	.14	2.95	.41
Combine	15 ft. S.P.	hr.	.26	11.91	3.10
Truck	2-Ton	hr.	.33	5.56	1.83
Implements ^a					.85
	Total Variable Costs				41.37
Fixed					
Tractor	125 DHP	acre	1.00		2.70
	80 DHP	acre	1.00		1.97
	45 DHP	acre	1.00		1.22
Combine	15 ft. S.P.	acre	1.00		4.82
Trucks (2)	2-Ton	acre	1.00		3.04
Implements		acre	1.00		2.27
	Total Fixed Costs				16.02
	Total Variable and Fixed Costs				57.39
	Net Return to Land, Labor, Capital, and Management				87.26
Interest					
Operating					
Capital	6 mos. at 9%	acre	1.00		1.86
Fixed Capital	12 mos. at 7.5%	acre	1.00		5.38 ^b
	Net Return to Land, Labor, and Management				80.02
Labor		hr.	1.93	2.50	4.83
	Net Return to Land and Management				75.19

TABLE A13 (continued)

^aThe specific types of implements used with this system and the number of times each was used per field were specified in Table 23 (pp. 63-64). Information in Appendix Table A5 (pp. 103-104) was used to determine the variable cost of using these implements.

^bThis represents an average investment of \$71.73 per acre of soybeans. The interest charge per acre on fixed capital and the annual fixed costs per acre were computed using 724 acres of soybeans as the acreage base.

TABLE A14. Estimated Costs and Returns Per Acre Utilizing the Single Crop-Grain Drill System on the 991 Acre Farm

Item	Description	Unit	Quantity	Price	Amount
REVENUE					
Soybeans		bu.	28.20	5.50	155.10
COSTS					
Variable					
Seed		lb.	78.00	.15	11.70
Fertilizer	P ₂ O ₅	lb.	40.00	.18	7.20
	K ₂ O	lb.	40.00	.09	3.60
Lime	3 Tons Every 4 Years	ton	.75	10.00	7.50
Weed Control					
Preemergence	Lasso ^a	qt.	2.50	3.75	9.38
Tractor	125 DHP	hr.	.47	6.19	2.91
	80 DHP	hr.	.26	5.13	1.33
	45 DHP	hr.	.15	2.95	.44
Combine	15 ft. S.P.	hr.	.26	11.91	3.10
Truck	2-Ton	hr.	.33	5.56	1.83
Implements ^b					.55
	Total Variable Costs				49.54
Fixed					
Tractor	125 DHP	acre	1.00		2.70
	80 DHP	acre	1.00		1.97
	45 DHP	acre	1.00		1.22
Combine	15 ft. S.P.	acre	1.00		4.82
Trucks (2)	2-Ton	acre	1.00		3.04
Implements		acre	1.00		1.95
	Total Fixed Costs				15.70
	Total Variable and Fixed Costs				65.24
	Net Return to Land, Labor, Capital, and Management				89.76
Interest					
Operating					
Capital	6 mos. at 9%	acre	1.00		2.23
Fixed Capital	12 mos. at 7.5%	acre	1.00		5.27 ^c
	Net Return to Land, Labor, and Management				82.26
Labor					
		hr.	1.84	2.50	4.60
	Net Return to Land and Management				77.66

TABLE A14 (continued)

^aThe specific preemergence herbicide or herbicides used with this system should be selected for specific weed or grass problems which are present. Therefore, herbicide costs for this system could vary considerably.

^bThe specific types of implements used with this system and the number of times each was used per field were specified in Table 23 (pp. 63-64). Information in Appendix Table A5 (pp. 103-104) was used to determine the variable cost of using these implements.

^cThis represents an average investment of \$70.27 per acre of soybeans. The interest charge per acre on fixed capital and the annual fixed costs per acre were computed using 724 acres of soybeans as the acreage base.

TABLE A15. Estimated Costs and Returns Per Acre Utilizing the Single Crop-Broadcast System on the 991 Acre Farm

Item	Description	Unit	Quantity	Price	Amount
REVENUE					
Soybeans		bu.	23.50	5.50	129.25
COSTS					
Variable					
Seed		lb.	90.00 ^a	.15	13.50
Fertilizer	P ₂ O ₅	lb.	40.00	.18	7.20
	K ₂ O	lb.	40.00	.09	3.60
Lime	3 Tons Every 4 Years	ton	.75	10.00	7.50
Weed Control					
Preplant	Treflan	pt.	1.50	3.50	5.25
Custom Rate ^b		load	.01	7.50	.08
Tractor					
	125 DHP	hr.	.36	6.19	2.23
	80 DHP	hr.	.11	5.13	.56
	45 DHP	hr.	.15	2.95	.44
Combine	15 ft. S.P.	hr.	.26	11.91	3.10
Truck	2-Ton	hr.	.33	5.56	1.83
Implements ^c					.38
	Total Variable Costs				<u>45.67</u>
Fixed					
Tractor					
	125 DHP	acre	1.00		2.70
	80 DHP	acre	1.00		1.97
	45 DHP	acre	1.00		1.22
Combine	15 ft. S.P.	acre	1.00		4.82
Trucks (2)	2-Ton	acre	1.00		3.04
Implements		acre	1.00		1.41
	Total Fixed Costs				<u>15.16</u>
	Total Variable and Fixed Costs				60.83
	Net Return to Land, Labor, Capital, and Management				68.42
Interest					
Operating					
Capital	6 mos. at 9%	acre	1.00		2.06
Fixed Capital	12 mos. at 7.5%	acre	1.00		<u>5.13^d</u>
	Net Return to Land, Labor, and Management				<u>61.23</u>
Labor					
		hr.	1.51	2.50	<u>3.78</u>
	Net Return to Land and Management				<u>57.45</u>

TABLE A15 (continued)

^aSource: 1976 Field Crops Seeding Guide, Tennessee Agricultural Extension Service Publication 378, Knoxville, Tennessee, February 1976.

^bTreflan or Tolban was custom applied by spraying onto fertilizer at a rate of \$7.50 per load of any size. A 4-Ton load of fertilizer was assumed.

^cThe specific types of implements used with this system and the number of times each was used per field were specified in Table 23 (pp. 63-64). Information in Appendix Table A5 (pp. 103-104) was used to determine the variable cost of using these implements.

^dThis represents an average investment of \$68.40 per acre of soybeans. The interest charge per acre on fixed capital and the annual fixed costs per acre were computed using 724 acres of soybeans as the acreage base.

TABLE A16. Estimated Costs and Returns Per Acre Utilizing the Double Crop-Row Crop System on the 991 Acre Farm

Item	Description	Unit	Quantity	Price	Amount
REVENUE					
Wheat		bu.	35.90	2.75	98.73
Soybeans		bu.	29.40	5.50	161.70
	Total				<u>260.43</u>
COSTS					
Variable					
Seed	Wheat	bu.	1.50	7.55	11.33
Seed	Soybean	lb.	50.00	.15	7.50
Fertilizer	N	lb.	50.00	.20	10.00
	P ₂ O ₅	lb.	90.00	.18	16.20
	K ₂ O	lb.	70.00	.09	6.30
Lime	3 Tons Every 4 Years	ton	.75	10.00	7.50
Weed Control					
Preplant	Treflan	pt.	1.50	3.50	5.25
Postemer- gence	Premerge ^a Directed	gal.	.50	7.95	3.98
Tractor	125 DHP	hr.	.62	6.19	3.84
	80 DHP	hr.	.43	5.13	2.21
	45 DHP	hr.	.29	2.95	.86
Combine	15 ft. S.P.	hr.	.52	11.91	6.19
Truck	2-Ton	hr.	.80	5.56	4.45
Implements ^b					1.11
	Total Variable Costs				<u>86.74</u>
Fixed					
Tractor	125 DHP	acre	1.00		2.70
	80 DHP	acre	1.00		1.97
	45 DHP	acre	1.00		1.22
Combine	15 ft. S.P.	acre	1.00		4.82
Trucks (2)	2-Ton	acre	1.00		3.04
Implements		acre	1.00		2.84
	Total Fixed Costs				<u>16.59</u>
	Total Variable and Fixed Costs				103.33
	Net Return to Land, Labor, Capital, and Management				157.10
Interest					
Operating					
Capital	9 mos. at 9%	acre	1.00		5.85
Fixed Capital	12 mos. at 7.5%	acre	1.00		5.58 ^c
	Net Return to Land, Labor, and Management				<u>145.67</u>
Labor					
		hr.	3.33	2.50	8.33
	Net Return to Land and Management				<u>137.34</u>

TABLE A16 (continued)

^aThe specific postemergence herbicide used with this system should be selected for specific weed or grass problems which are present. Overtop application of the postemergence herbicides Dyanap or Basagran may become more important than directed application of postemergence herbicides in the near future.

^bThe specific types of implements used in budgeting costs for this system and the number of times each was used per field were specified in Table 24 (pp. 65-66) and Appendix Table A1 (p. 96). Information in Appendix Table A5 (pp. 103-104) was used to determine the variable cost of using these implements.

^cThis represents an average investment of \$74.10 per acre of soybeans. The interest charge per acre on fixed capital and the annual fixed costs per acre were computed using 724 acres of soybeans as the acreage base.

TABLE A17. Estimated Costs and Returns Per Acre Utilizing the Double Crop-Grain Drill System on the 991 Acre Farm

Item	Description	Unit	Quantity	Price	Amount
REVENUE					
Wheat		bu.	37.50	2.75	103.13
Soybeans		bu.	24.00	5.50	132.00
	Total				235.13
COSTS					
Variable					
Seed	Wheat	bu.	1.50	7.55	11.33
Seed	Soybean	lb.	71.00	.15	10.65
Fertilizer	N	lb.	50.00	.20	10.00
	P ₂ O ₅	lb.	90.00	.18	16.20
	K ₂ O	lb.	70.00	.09	6.30
	3 Tons Every 4 Years	ton	.75	10.00	7.50
Lime					
Weed Control					
Preplant	Treflan	pt.	1.50	3.50	5.25
Tractor	125 DHP	hr.	.48	6.19	2.97
	45 DHP	hr.	.30	2.95	.89
Combine	15 ft. S.P.	hr.	.52	11.91	6.19
Truck	2-Ton	hr.	.80	5.56	4.45
Implements ^a					.44
	Total Variable Costs				82.17
Fixed					
Tractor	125 DHP	acre	1.00		2.70
	45 DHP	acre	1.00		1.22
Combine	15 ft. S.P.	acre	1.00		4.82
Trucks (2)	2-Ton	acre	1.00		3.04
Implements		acre	1.00		1.15
	Total Fixed Costs				12.93
	Total Variable and Fixed Costs				95.10
	Net Return to Land, Labor, Capital, and Management				140.03
Interest					
Operating					
Capital	9 mos. at 9%	acre	1.00		5.55
Fixed Capital	12 mos. at 7.5%	acre	1.00		4.28 ^b
	Net Return to Land, Labor, and Management				129.83
Labor		hr.	2.63	2.50	6.58
	Net Return to Land and Management				123.25

TABLE A17 (continued)

^aThe specific types of implements used in budgeting costs for this system and the number of times each was used per field were specified in Table 24 (pp. 65-66) and Appendix Table A1 (p. 96). Information in Appendix Table A5 (pp. 103-104) was used to determine the variable cost of using these implements.

^bThis represents an average investment of \$57.07 per acre of soybeans. The interest charge per acre on fixed capital and the annual fixed costs per acre were computed using 724 acres of soybeans as the acreage base.

TABLE A18. Estimated Costs and Returns Per Acre Utilizing the Double Crop-No Till System on the 991 Acre Farm

Item	Description	Unit	Quantity	Price	Amount
REVENUE					
Wheat		bu.	31.00	2.75	85.25
Soybeans		bu.	21.80	5.50	119.90
	Total				205.15
COSTS					
Variable					
Seed	Wheat	bu.	1.50	7.55	11.33
Seed	Soybean	lb.	75.00	.15	11.25
Fertilizer	N	lb.	50.00	.20	10.00
	P ₂ O ₅	lb.	90.00	.18	16.20
	K ₂ O	lb.	70.00	.09	6.30
Lime	3 Tons Every 4 Years	ton	.75	10.00	7.50
Weed Control					
Burndown	Paraquat	qt.	1.00	8.39	8.39
Preemer- gence ^a	Lorox	lb.	1.50	3.51	5.27
Surfactant	.5% by Volume ^b	qt.	.61	2.56	1.56
Tractor	125 DHP	hr.	.22	6.19	1.36
	45 DHP	hr.	.61	2.95	1.80
Combine	15 ft. S.P.	hr.	.52	11.91	6.19
Truck	2-Ton	hr.	.80	5.56	4.45
Implements ^c					.31
	Total Variable Costs				91.91
Fixed					
Tractor	125 DHP	acre	1.00		2.70
	45 DHP	acre	1.00		1.22
Combine	15 ft. S.P.	acre	1.00		4.82
Trucks (2)	2-Ton	acre	1.00		3.04
Implements		acre	1.00		1.64
	Total Fixed Costs				13.42
	Total Variable and Fixed Costs				105.33
	Net Return to Land, Labor, Capital, and Management				99.82
Interest					
Operating					
Capital	9 mos. at 9%	acre	1.00		6.20
Fixed Capital	12 mos. at 7.5%	acre	1.00		4.46 ^d
	Net Return to Land, Labor, and Management				89.16
Labor		hr.	2.69	2.50	6.73
	Net Return to Land and Management				82.43

TABLE A18 (continued)

^aA preemergence herbicide was included based on University of Tennessee recommendations. Source: Wayne T. Flinchum, Soybean Production in Tennessee, Tennessee Agricultural Extension Service Publication 421, Knoxville, Tennessee, May 1976, p. 22.

^bA rate of 40 gallons of water per acre was assumed. All three items listed under "weed control" were tank mixed and applied together.

^cThe specific types of implements used with this system and the number of times each was used per field were specified in Table 24 (pp. 65-66) and Appendix Table A1 (p. 96). Information in Appendix Table A5 (pp. 103-104) was used to determine the variable cost of using these implements.

^dThis represents an average investment of \$59.47 per acre of soybeans. The interest charge per acre on fixed capital and the annual fixed costs per acre were computed using 724 acres of soybeans as the acreage base.

TABLE A19. Break-Even Soybean Prices on the 305 Acre Farm by Cropping-Planting System

Cropping-Planting System	Soybean Yield (bu.)	Wheat Yield (bu.) ^a	Variable Cost		Variable and Fixed Costs		Variable and Fixed Costs, and Capital and Labor Charges	
			Production Cost Per Acre ^b	Break-Even Soybean Price (bu.)	Production Cost Per Acre ^b	Break-Even Soybean Price (bu.)	Production Cost Per Acre ^b	Break-Even Soybean Price (bu.)
Single Crop								
Row Crop	26.3	N.A.	44.98	1.71	75.98	2.89	95.94	3.65
Grain Drill	28.2	N.A.	51.76	1.84	81.07	2.87	99.53	3.53
Broadcast	23.5	N.A.	48.38	2.06	77.04	3.28	94.50	4.02
Double Crop								
Row Crop	29.4	35.9	92.38	^c	125.30	.90	154.68	1.90
Grain Drill	24.0	37.5	85.99	^c	114.13	.46	138.00	1.45
No Till	21.8	31.0	95.78	.48	125.55	1.85	150.28	2.98

^aWheat was not produced with single crop systems; a wheat price of \$2.75 per bushel was assumed for double crop systems.

^bThe production cost per acre includes both wheat and soybean costs for double crop systems.

^cGross returns from wheat production covered the variable costs of both wheat and soybean production.

TABLE A20. Break-Even Soybean Prices on the 991 Acre Farm by Cropping-Planting System

Cropping-Planting System	Soybean Yield (bu.)	Wheat Yield (bu.) ^a	Variable Cost		Variable and Fixed Costs		Variable and Fixed Costs, and Capital and Labor Charges	
			Production Cost Per Acre ^b	Break-Even Soybean Price (bu.)	Production Cost Per Acre ^b	Break-Even Soybean Price (bu.)	Production Cost Per Acre ^b	Break-Even Soybean Price (bu.)
Single Crop								
Row Crop	26.3	N.A.	41.37	1.57	57.39	2.18	69.46	2.64
Grain Drill	28.2	N.A.	49.54	1.76	65.24	2.31	77.34	2.74
Broadcast	23.5	N.A.	45.67	1.94	60.83	2.59	71.80	3.06
Double Crop								
Row Crop	29.4	35.9	86.74	^c	103.33	.16	123.09	.83
Grain Drill	24.0	37.5	82.17	^c	95.10	^c	111.51	.35
No Till	21.8	31.0	91.91	.31	105.33	.92	122.72	1.72

^aWheat was not produced with single crop systems; a wheat price of \$2.75 per bushel was assumed for double crop systems.

^bThe production cost figures shown in the table include both wheat and soybean production costs for double crop systems.

^cGross returns from wheat production covered the variable costs of both wheat and soybean production.

VITA

William Alan Miller was born in Bedford, Indiana on July 6, 1953. He attended Burris Elementary and Junior High School in Mitchell, Indiana and was graduated from Mitchell High School in June 1971. The following August he entered Indiana University, and in May 1975 he received Bachelor of Arts degrees in both Economics and the Study of Religions. In September 1975 he accepted a research assistantship from the Department of Agricultural Economics at the University of Tennessee, Knoxville, and began studying toward the Master of Science degree. All work for this degree was completed in June 1978.

Alan married the former Maggie Schindler of Evansville, Indiana on May 11, 1974.