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South Dakota Farmer-Based Reduced Till Crop Budgets

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by

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SOUTH DAKOTA FARMER-BASED REDUCED TILLAGE CROP BUDGETS[1]

by Donald C. Taylor, Thomas L. Dobbs, and James H. Shriver

The use of reduced tillage practices in the U.S. has expanded a great deal over the past 15 years (USDA, 1986). In 1985, roughly a quarter of South Dakota's corn acreage was reported to be under reduced tillage (Szmedra and Delvo, 1986). A 1985 survey by South Dakota State University (SDSU) showed 69% of the farmer respondents to be using some type of reduced tillage on at least part of their acreage (Allen, 1987).

Primary motivations for farmers adopting reduced tillage practices are to reduce machine costs, conserve moisture, and control soil erosion losses. Problems of weed control are usually accentuated under reduced tillage. Greater expenditures for chemical weed control are almost inevitable with reduced tillage. Some studies show interconnections between reduced tillage and fertilizer nutrient requirements.

OVERVIEW: SDSU ECONOMICS RESEARCH ON REDUCED TILLAGE

These and other economic aspects of reduced tillage have been under study in the SDSU Economics Department since 1982.[2] This research has been undertaken in three phases.

Phase I involved the development of synthesized budgets for four crops grown under three tillage systems (Allen, 1984 and 1985). Phase II involved a mail survey of nearly 1,000 reduced tillage farmers in South Dakota to determine the nature of reduced tillage practices being followed, perceived benefits of and problems with reduced tillage, and other aspects of actual farmer experience with reduced tillage in the state (Allen, 1987;

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[1]There is no one, commonly accepted definition of "reduced tillage". In some definitions, primary attention is given to the percentage of soil surface covered by crop residue after planting. In others, primary attention is given to the nature and number of land preparation field operations. For the survey on which most of the results in this report are based, "reduced tillage" farmers are interpreted to be those who do not use a moldboard plow in land preparation.

[2]Soil erosion losses, however, have not been part of the research on reduced tillage economics. Research on reduced tillage has also been undertaken in SDSU's Plant Science and Agricultural Engineering Departments [e.g., Beck and DeBoer, 1988a and 1988b].

Dobbs and Taylor, 1987).[3]

In this report, the results of a Phase III follow-up and more intensive personal interview survey with 23 of the mail survey respondents are reported.[4] The characteristics of the sampled farms and farmers are briefly described. Detailed cost-of-production budgets for the individual reduced tillage farmers are presented.

Farmers in Phase II with low per-acre machine costs and not using the moldboard plow (as indications of following reduced tillage practices) were primary candidates for selection as Phase III respondents. Attention in selection was also given to covering four crops--namely, spring wheat, winter wheat, soybeans, and corn--in somewhat geographically disperse regions of the state.[5] The following numbers of farmers in the following regions were selected for each crop (see Figure 1 for an indication of the location of each Phase III respondent):

-Spring wheat: 1 northeast, 4 east north central, and 1 northwest;

-Winter wheat: 2 northeast, 2 east north central, 1 southwest central, and 2 southwest;

-Corn: 2 southeast and 1 south central; and

-Soybeans; 4 east central and 3 southeast.

The survey was planned by Dr. Herb Allen and Graduate Assistant Jim Shriver. The interviews were undertaken by Jim Shriver, in regard to 1986 reduced tillage practices, during June-November 1987.

CHARACTERISTICS OF THE SAMPLED FARMS

The total size per farm for the 23 respondents ranges from 160 to 11,520 acres and averages 1,765 acres; the median farm

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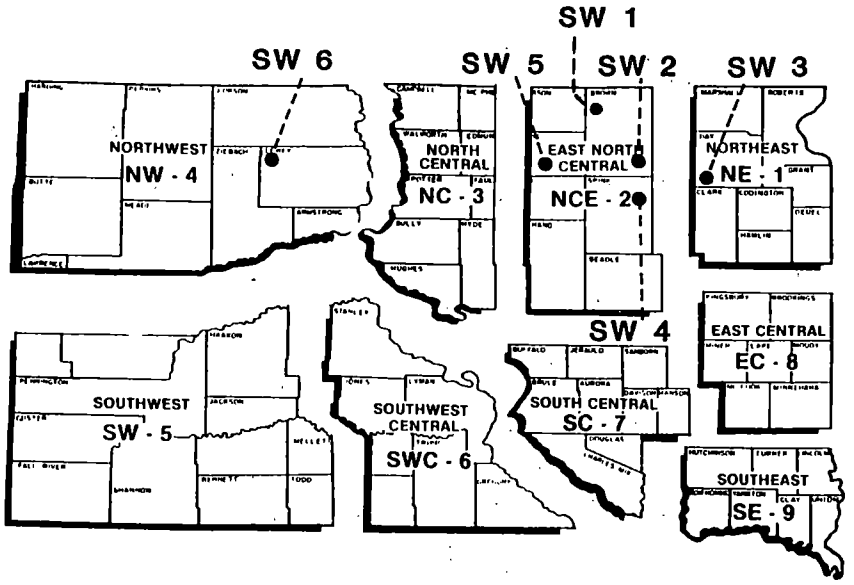
[3]A Plant Science Masters thesis was also developed in connection with the Phase II study (Hutchinson, 1987).

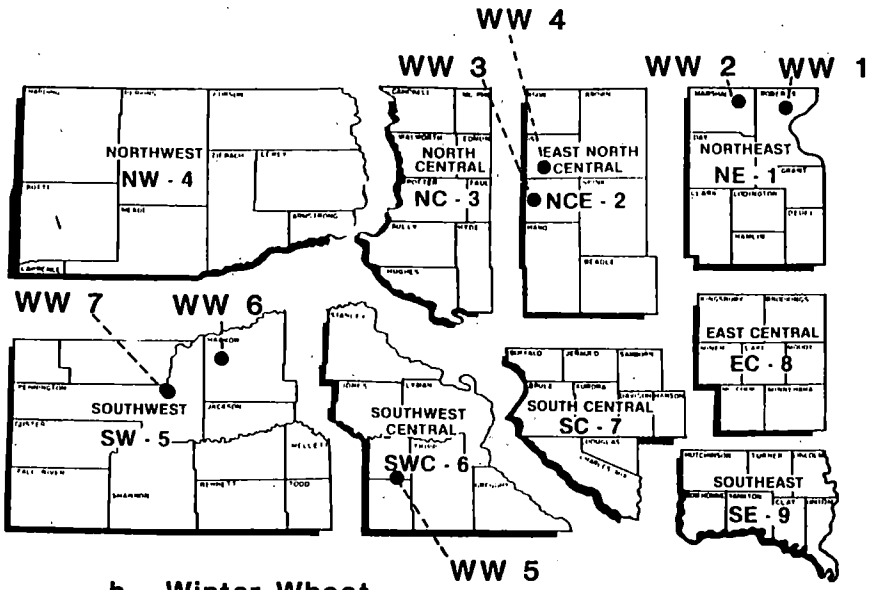
[4]See Annex A for a copy of the survey questionnaire. Data for 23 crop budgets were obtained through the survey. Two of the budgets were from the same farmer. To simplify the text, however, reference is made to the crop budgets as if they were derived from "23" surveyed farmers.

[5]While the farmers were selected, in concept, to represent South Dakota's reduced tillage farmers, statistically randomized procedures were not employed in their selection. In essence, then, the 23 crop budgets presented and discussed in this report represent 23 "case studies".

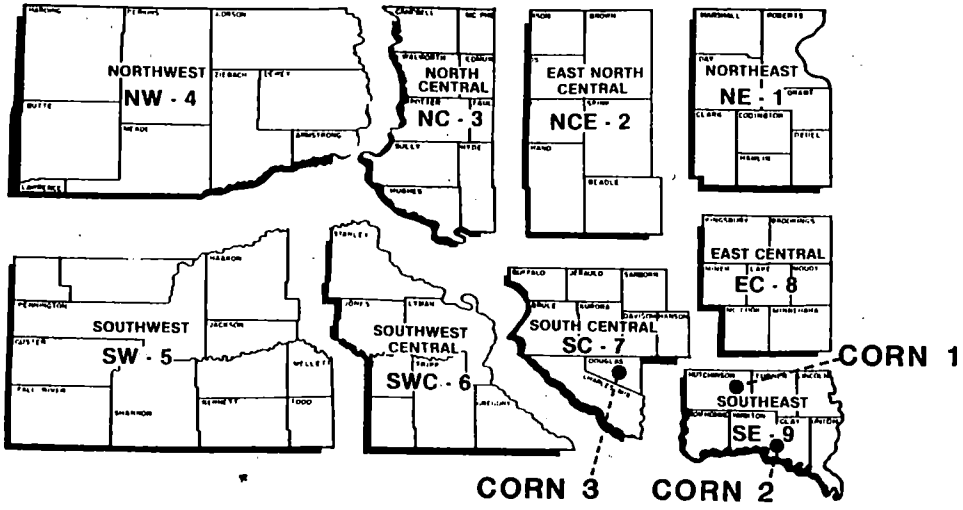
Figure 1. Location of surveyed Phase III reduced till farmers, by region and crop.



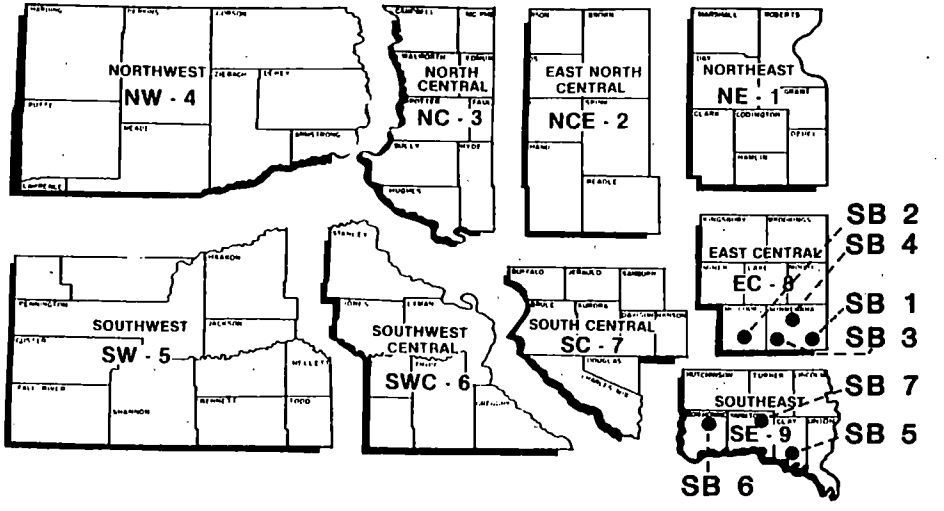
a. Spring Wheat



b. Winter Wheat



c. Corn



d. Soybeans

Note: The regional map used in this figure is taken from Pflueger (1985).

size is 1,200 acres. The total acres of cropland per farm range among the 23 respondents from 150 to 3,110 and average 945; the median cropland acreage per farm is 675 acres. The surveyed farms are definitely above-average in size for the state (USDC, 1984)--with respect to averages, by 50% for total farm size and by 70% for total cropland per farm.

The respondents have been in farming for an average of 20 years. The shortest period is 3 years, and the longest is 40 years. The most important means of the surveyed farmers getting started in farming is family help, followed by commercial bank loans, working as farm laborers, and renting land (Annex B, Table 1).

Of the total cropland on the 23 surveyed farms, 46% is in small grains, 30% is in corn and soybeans, and the remaining 24% is in other crops or government program set-aside (Annex B, Table 2). The proportions of small grains on the **wheat farms** (60%, 62%) and of row crops on the **corn and soybean farms** (70%, 82%) expectedly differ from the respective averages for all farms in the survey.

The principal crop rotations on the surveyed farms are as follows (Annex B, Table 3):

-Winter wheat farms: small grain (1 to 3 years)-fallow, with at least one small grain being wheat;

-Spring wheat farms: corn or soybeans-small grain (1 or 2 years, usually spring wheat)-summer fallow; and

-Corn and soybean farms: a corn-soybean rotation.

Five of the 23 respondents, or 22% of them, are full-owners of the land they operate. About 40% of South Dakota's farmers are full-owners (USDC, 1984), thereby suggesting that the degree of land tenancy for the survey respondents is above-average relative to that in general in the state.[6] Of the total land operated by the 23 respondents, 63% is owned and 37% is rented (Annex B, Table 4). Within the sample, land ownership is greatest for the corn farmers (78%) and lowest for the spring wheat farmers (37%). The reported cropland cash rent for the winter and spring wheat farms ranges among respondents from $18/acre to $34/acre and averages $24/acre.

A government program base is established for an average of 662 acres per surveyed farm. This base constitutes 89% of the acreage not devoted to soybeans and alfalfa on the respondents'

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[6]The greater degree of land tenancy on the survey respondents' farms is undoubtedly related to the previously-mentioned above-average operated acreage on the survey respondents' farms.

farms (Annex B, Table 5).[7] This percentage is highest for the winter wheat farms (98%) and lowest for the spring wheat farms (69%).

The average **per-acre crop yields** reported by the respondents in 1986 (Annex B, Table 6) are above those reported on the average in the state in 1986 (SDASS, 1988). The percentages that survey respondents are above-average range from 4% for winter wheat to 25% for corn and 95% for alfalfa. The **government program base yields** for the respondents (Annex B, Table 7) for oats are about the same as those for acres reported as actually harvested by respondents in 1986, but for the other three crops they are considerably less than the reported 1986 actual yields. The 1986 actual-base yield differential for the 3 crops ranges from 8% for wheat to 40% for corn.

About 87% of the total cropland operated by the 23 survey respondents in 1986 was under reduced tillage. This percentage for the spring and winter wheat farms is about 75, whereas 100% of the cropland for the corn and soybean respondents was under reduced tillage in 1986. There is some tendency for the smaller surveyed farms to have higher percentages of cropland under reduced tillage (Annex B, Table 8).

Twenty of the 23 surveyed farmers had established reduced tillage practices on their farms prior to 1984. Sixteen of them have had at least 95% of their cropland under reduced tillage continuously since 1983. Only two of the respondents had less land under reduced tillage in 1986 than in 1983; one shifted from having 100% to 80% of his cropland under reduced tillage, the other from 50% to 15%.

The major influence for farmers to adopt reduced tillage practices was friends and neighbors (Annex B, Table 9). Farm magazine articles and the Soil Conservation Service also exercised important influences. In adopting reduced tillage practices, one-third of the spring and winter wheat farms modified their crop rotation plans. None of the corn or soybean farmers reported doing so, however.

Twenty two of the 23 surveyed farmers believe that adopting reduced tillage practices reduces labor requirements, helps to conserve moisture, and lowers fuel costs (Annex B, Table 10). Roughly three-fourths or more of the respondents also believe that reduced tillage farming leads to higher yields, is more profitable than conventional farming, and involves lower machine and overall direct costs of production. On the other hand, only

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[7]The 89% represents the average government base acreage for the 23 surveyed farms (662 acres) as a percent of the total operated acreage minus the area in soybeans and alfalfa (from Annex B, Table 2, 944 acres minus 125 acres of soybeans and 77 acres of alfalfa = 742 acres).

4 (18%) of the respondents believe that reduced tillage practices help control diseases and pests. Except for a somewhat stronger opinion here that reduced tillage leads to higher yields, these findings are generally similar to those from the earlier SDSU mail survey (Allen, 1987).

The major problem associated with reduced tillage reported by the surveyed farmers is weed control (Annex B, Table 11).[8] The average importance ratings for new machine investment costs being too high and increased chemical use being undesirable are high, but the views of different farmers are wide-ranging. At the other extreme, about three-fourths of the respondents indicated that fertilizer and weed control techniques and crop loss risks are relatively unimportant problems.

REDUCED TILLAGE CROP BUDGETS

In this section, detailed cost-of-production crop budget spread sheets for each of the individual crops and farmers are presented and briefly discussed. The general procedures and assumptions used in developing the budgets are first indicated.

General procedures and assumptions

The three crop inputs of central concern in this study are machinery, pesticides, and fertilizer. The procedures and assumptions for developing the crop budget coefficients for each of these three inputs--such as seed, interest, labor, land ownership, and overhead costs--are outlined in this section. The procedures and assumptions for handling the other crop inputs are indicated in Annex C. Finally, in this section, the bases for determining the crop yields used in various break-even analyses are outlined.

Machinery. The first step in developing the machinery cost coefficients for the crop budgets was to describe the pre-harvest field operations undertaken by each farmer on his/her reduced tillage crop. This included identifying the reported operations for each of the following categories of field work (see the top panels of Tables 1, 3, 5, and 7):

-Fallowing practices;
-Land preparation;
-Planting;
-Pesticide application;
-Fertilizer application; and
-Field cultivation (row crops).

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[8]Specific issues in regard to weed control are knowing which chemicals and the amounts of chemicals to use and how future crop plans may be affected by chemical residues.

A common implement (of a given size) was assumed to be used by all farmers for each field operation. For each non-self-propelled implement, the minimum tractor horsepower requirement was determined [based on Dobbs, Thaden, and Peckham (1987) and machine manufacturer recommendations]. A list of the 15 implements assumed to be used in crop production by the surveyed farmers is shown in Annex D, Table 1. Common implements were assumed for each farmer so that the calculated machine cost differences among farmers would reflect tillage practice differences and not also individual farmer machinery ownership management differences.

The following categories of machine expenditures are covered in the machine cost budgeting:

-Direct costs: (1) fuel and lubrication, (2) repairs, and (3) labor; and

-Overhead costs: (1) interest, housing, and insurance and (2) depreciation.

The basic procedures underlying the calculation of these different types of cost coefficients are outlined in Allen (1986).

Seven of the implements and the 8 tractors (each with a different horsepower rating) assumed to be used in our reduced tillage study were also used in the SDSU Economics Department companion "alternative farming systems" study. The cost coefficients for the 7 implements and the 8 tractors were taken directly from Dobbs, Thaden, and Peckham (1987) and the "Detailed Support Tables" accompanying that publication. In some cases in that study, cost coefficients were drawn directly from Allen (1986). In other cases, the authors updated machine purchase costs and included implements not covered by Allen (1986).

In developing cost coefficients for the 8 implements assumed in our study which were not included in the Dobbs, Thaden, and Peckham (1987) study, we used the same procedures as those used by Dobbs, et al. The purchase cost information and other assumptions for each of these 8 implements are outlined in Annex D, Table 2.

To obtain the costs for each field operation, crop, and farmer, the various categories of cost for each implement were combined with the corresponding costs for the tractor assumed to power the implement. To obtain the total machine costs to include in the budget for each crop and farmer, the machine costs for each applicable field operation were aggregated with one another. The end-result is the total per-acre cost for each of the five categories of machine expense that are included in the respective crop budget spread sheets (see Tables 2, 4, 6, and 8).

Four additional items arose in determining the pre-harvest

machine cost coefficients.

1. Some field operations involved two pieces of equipment being pulled in tandem by one tractor in one pass over the field. In such cases, the tractor horsepower was modified as necessary, and the costs for that tractor were combined with those for the two separate pieces of equipment.

2. In cases where fertilizer and/or herbicides were applied with planting equipment and/or row crop field cultivators, we assumed that the basic planting and field cultivation equipment included fertilizer and herbicide attachments and, thus, that no added fertilizer and herbicide application costs were required. When fertilizer and/or herbicides were applied with chisel plows or disks, 10% of the plow or disk repair and overhead costs (to account for added machine accessories) and 10% of the plow or disk labor costs (to account for added machine servicing time) were added to cover the extra costs for fertilizer and herbicide application.

3. When respondents reported a "1%" spot spray coverage, we assumed costs for the spot spray application of 2% of (a) the normal total field per-acre chemical costs and (b) the normal machinery application and related labor costs.

4. For custom hired fertilizer and herbicide applications, the custom application rates reported by Thaden (1987) were used to represent the machinery portion of the overall custom hire charge reported by respondents.

Pesticides. None of the 23 survey respondents reported using insecticides or fungicides on their reduced till crops. This section, therefore, is limited to herbicides.

Because of the multiplicity of herbicide brand names and the fact that most brand-name chemicals can be purchased in more than one form, a vast detail of information was involved in the process of developing the per-acre herbicide chemical costs for each farmer and crop. Whenever farmers themselves applied herbicides and the physical quantities of the specific herbicides were clearly reported by the farmers, these quantities were valued at common, farm-level, 1986 prices (Annex D, Table 3). In a few instances, however, the reported data had to be refined and/or supplemented with information from the State Cooperative Extension Service Weeds Specialist.

Four farmers custom hired the application of herbicides. Their reported custom rates reflected combined chemical and application costs. In the budgeting, a common application rate of $2.50/acre was assumed for the application cost (Thaden, 1987). The difference between the reported custom rate and this application cost was used to represent the herbicide chemical cost in the crop budgets for these four farmers.

The reported herbicides used, the application rates, and the timing of application (pre-plant versus post-emergence) for each crop and farmer are shown in the lower panels of Tables 1, 3, 5, and 7. The respective total herbicide chemical costs per acre are shown directly in the crop budget spread sheets (Tables 2, 4, 6, and 8).

Fertilizer. The quantities of fertilizer reported by different farmers were all converted to per-acre elemental nutrient (fertilizer analysis) application rates (nitrogen = N, phosphorus = P_2O_5, potassium = K_2O). These quantities for each crop and farmer are shown in the crop budget spread sheets (Tables 2, 4, 6, and 8). The number of fertilizer applications (ranging from none for 8 farmers[9] to 2 applications for 3 farmers) and their timing, relative to planting, are shown in Tables 1, 3, 5, and 7. Those applications sequentially listed in the tables before "with planter" should be interpreted as pre-plant applications, and those listed following "with planter" should be interpreted as post-emergence, top-dress applications.

As with pesticides, common prices were assigned to the fertilizers used by different farmers. Taking into account fertilizer nutrient price data reported in Dobbs, Weiss, and Leddy (1987), USDA (1988), and local supplier prices, the following prices per pound of elemental nutrient for 1986 were determined and used in the budgets:

-Anhydrous ammonia (gaseous) N $0.13;
-Dry N $0.19;
-Liquid N $0.22;
-P_2O_5 $0.18; and
-K_2O $0.13.

For custom hire applications of fertilizer, the custom application rates reported by the farmers were used in the crop budgets.

Crop yields. The primary basis for determining the crop yields to include in the individual crop budgets was the 5-year county average (for 1982-86) pertaining to each surveyed farmer as reported by the South Dakota Agricultural Statistical Service (SDASS, 1988). In some cases, particularly for soybeans, the yields for 1986 reported by respondents and 1986 regional yields as reported in Pflueger (1985) were also taken into consideration. These were the "baseline" yields used in the preparation of the individual crop budgets presented in this report. In the follow-up sensitivity analysis, attention was also focused on the 1986 yields and government program crop base yields, as reported by the individual respondents in the survey.

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[9]Four soybean farmers, 3 winter wheat (following fallow) farmers, and 1 spring wheat farmer reported using no fertilizer.

Budget presentation

To aid in interpreting the cost coefficients in the reduced tillage crop budgets, the pre-harvest field operations and chemical weed control practices for the four crops--namely, spring wheat, winter wheat, corn, and soybeans--are summarized in Tables 1, 3, 5, and 7, respectively. The budgets for the different farmers for each crop are numbered serially. For example, budgets are presented for six spring wheat farmers, namely, SW1, SW2, ..., and SW6.

Immediately following the field operation-weed control table for each crop is the budget spread sheet for that crop (Tables 2, 4, 6, and 8). The individual spread sheets consist of two sections. The first is a data input section comprised of six parts:

-Crop yield;
-Direct (non-harvest) production costs, covering such items as seed, fertilizer, fuel and lubrication, machinery repair, and labor;[10]
-Machinery overhead;
-Other farm overhead;
-Custom harvest machine hire; and
-Land ownership cost factors.

The second section in the spread sheet conveys the input summary and results. Among other things, it shows per-acre costs for each crop and farmer for the following categories of expenses:

-Total direct non-harvest costs;
-Pre-harvest production costs excluding land;
-All production costs excluding land; and
-All production and land costs.

Each succeeding expense category includes one or more additional cost item, as shown by the consecutive cost items included in the budgets.

The spread sheets also show break-even, per-bushel costs of production for three of the four expense categories. The costs are "break-even" from the standpoint that "returns above costs" are earned if crop market prices exceed the respective break-even costs--given the assumed yields--and that "revenue shortfalls" are incurred if crop market prices are less than the break-even costs.

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[10]The first category of labor in the crop budget spread sheets covers machine labor and the second the hand weeding of soybeans.

Table 1. Spring wheat, pre-harvest field operations and chemical weed control practices.

Pre-harvest field operations

	SW1	SW2	SW3	SW4	SW5	SW6
	----------Times over----------					
Fallow						
Chisel plow		2	3			
Rod weeder		1				
Land preparation						
Tandem disk	1			1		1
Chisel plow		1			1	1
Field cultivator	1[a]					
Spike harrow				1		
SUB-TOTAL TILLAGE OPERATIONS	**2**	**4**	**3**	**2**	**1**	**2**
Planter						
Press drill	1[a]	1		1		1
Air seeder			1		1	
Herbicide application						
Spray coupe	1		2	1		
Custom hired		1				
Fertilizer application						
With disk				1		
With chisel plow						1
Custom hired		1				
With planter			1		1	1
TOTAL FIELD OPERATIONS	**3**	**7**	**6**	**4**	**2**	**3**

[a]A tandem field operation.

Chemical weed control practices (per acre)

SW1: post-emergence, 3/4 lb 2,4-D, 2 oz. Banvel
SW2: post-emergence, 2,4-D and Banvel, custom hired
SW3: pre-plant, 1 pt Banvel; post-emergence, 2 1/2 pt One-Shot
SW4: post-emergence, 1 pt 2,4-D and 1/8 pt Banvel
SW5 and SW6: None

Table 2. Spring wheat budget spread sheet.

INPUT SECTION	SW1	SW2	SW3	SW4	SW5	SW6
YIELD:						
Estimated grain yield (bu./ac.)	21	31	34	28	22	24
DIRECT (non-harvest) COSTS:						
Seed ($/ac.)	$7.10	$7.10	$7.10	$7.10	$7.10	$5.75
Dry nitrogen (lb. N/ac.)	0.0	12.6	18.0	0.0	0.0	7.2
($/lb.)	$0.19	$0.19	$0.19	$0.19	$0.19	$0.19
Anhydrous nitrogen (lb. N/ac.)	0.0	0.0	0.0	0.0	0.0	30.0
($/lb.)	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13
Liquid nitrogen (lb. N/ac.)	0.0	0.0	0.0	50.0	36.0	0.0
($/lb.)	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22
Phosphorus (lb. P2 05/ac.)	0.0	32.2	40.0	0.0	0.0	18.4
($/lb.)	$0.18	$0.18	$0.18	$0.18	$0.18	$0.18
Potassium (lb. K2 0/ac.)	0.0	0.0	6.0	0.0	0.0	0.0
($/lb.)	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13
Herbicide ($/ac.)	$2.25	$5.00	$19.29	$2.26	$0.00	$0.00
Crop insurance ($/ac.)	$2.07	$1.91	$2.07	$1.76	$2.32	$2.59
Storage ($/bu.)	$0.11	$0.11	$0.11	$0.11	$0.11	$0.11
Drying ($/bu.)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Pre-harvest custom machine hire:						
Fertilizer application ($/ac.)	$0.00	$2.25	$0.00	$0.00	$0.00	$0.00
Herbicide application ($/ac.)	$0.00	$2.50	$0.00	$0.00	$0.00	$0.00
Fuel and lubrication ($/ac.)	$1.55	$3.95	$3.55	$1.61	$1.51	$2.19
Machinery repair ($/ac.)	$3.41	$4.78	$4.38	$3.15	$2.60	$3.58
Period of crop operating loan (months)	6	6	6	6	6	6
Annual interest rate (%)	12.00	12.00	12.00	12.00	12.00	12.00
Labor 1 (hrs./ac.)	0.28	0.61	0.52	0.34	0.22	0.38
($/hr.)	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00
Labor 2 (hrs./ac.)	0.00	0.00	0.00	0.00	0.00	0.00
($/hr.)	$4.00	$4.00	$4.00	$4.00	$4.00	$4.00
MACHINERY OVERHEAD:						
Int., Housing, & Ins. on mach. ($/ac.)	$5.44	$7.98	$7.92	$4.89	$3.80	$5.71
Depreciation on mach. & equip. ($/ac.)	$5.25	$6.99	$7.14	$4.63	$3.51	$5.24
OTHER FARM OVERHEAD ($/ac.)	$5.00	$8.00	$8.00	$5.00	$5.00	$4.50
CUSTOM HARVEST MACHINE HIRE:						
Swathing ($/ac.)	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00
Combining ($/ac.)	$13.00	$13.00	$13.00	$13.00	$13.00	$13.00
Hauling ($/ac.)	$1.42	$2.09	$2.30	$1.89	$1.49	$1.62
LAND OWNERSHIP COST FACTORS:						
Land value ($/ac.)	$345.00	$345.00	$320.00	$290.00	$230.00	$215.00
Real estate tax rate (%)	1.50	1.50	1.50	1.50	1.50	1.50
Period to obtain crop (yrs.)	1	2	2	1	1	1

(end of input section)

INPUT SUMMARY AND RESULTS

	SW1	SW2	SW3	SW4	SW5	SW6
YIELD:						
Total yield (bu./ac.)	21	31	34	28	22	24
DIRECT (non-harvest) COSTS:						
Seed ($/ac.)	$7.10	$7.10	$7.10	$7.10	$7.10	$5.75
Fertilizer ($/ac.)	$0.00	$8.19	$11.40	$11.00	$7.92	$8.58
Herbicide ($/ac.)	$2.25	$5.00	$19.29	$2.26	$0.00	$0.00
Crop insurance ($/ac.)	$2.07	$1.91	$2.07	$1.76	$2.32	$2.59
Storage ($/ac.)	$2.31	$3.41	$3.74	$3.08	$2.42	$2.64
Drying ($/ac.)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Pre-harvest custom machine hire ($/ac.)	$0.00	$4.75	$0.00	$0.00	$0.00	$0.00
Fuel and lubrication ($/ac.)	$1.55	$3.95	$3.55	$1.61	$1.51	$2.19
Machinery repair ($/ac.)	$3.41	$4.78	$4.38	$3.15	$2.60	$3.58
Interest on non-labor and non-harvest direct costs ($/ac.)	$1.12	$2.35	$3.09	$1.80	$1.43	$1.52
Labor charge ($/ac.)	$1.67	$3.68	$3.13	$2.05	$1.33	$2.27
Total direct (non-harvest) costs ($/ac.)	$21.48	$45.11	$57.75	$33.81	$26.63	$29.12
Costs/bu. of yield ($)	$1.02	$1.46	$1.70	$1.21	$1.21	$1.21
MACHINERY OVERHEAD:						
Int., Housing, & Ins. on mach. ($/ac.)	$5.44	$7.98	$7.92	$4.89	$3.80	$5.71
Depreciation on mach. & equip. ($/ac.)	$5.25	$6.99	$7.14	$4.63	$3.51	$5.24
Total machinery overhead ($/ac.)	$10.69	$14.97	$15.06	$9.52	$7.31	$10.95
OTHER FARM OVERHEAD ($/ac.)	$5.00	$8.00	$8.00	$5.00	$5.00	$4.50
PRE-HARVEST PRODUCTION COSTS EXCLUDING LAND ($/ac.)	$37.17	$68.08	$80.81	$48.33	$38.94	$44.57
Costs/bu. of yield ($)	$1.77	$2.20	$2.38	$1.73	$1.77	$1.86
TOTAL HARVESTING COSTS ($/ac.)	$19.42	$20.09	$20.30	$19.89	$19.49	$19.62
ALL PRODUCTION COSTS EXCL. LAND ($/ac.)	$56.59	$88.17	$101.11	$68.22	$58.43	$64.19
LAND OWNERSHIP COSTS ($/ac.)	$25.88	$51.75	$48.00	$21.75	$17.25	$16.13
ALL PRODUCTION AND LAND COSTS ($/ac.)	$82.46	$139.92	$149.11	$89.97	$75.68	$80.31
Costs/bu. of yield ($)	$3.93	$4.51	$4.39	$3.21	$3.44	$3.35

(end of summary section)

Table 3. Winter wheat, pre-harvest field operations and chemical weed control practices.

Pre-harvest field operations	WW1	WW2	WW3	WW4	WW5	WW6	WW7
	----------Times over----------						
Fallow							
Chisel plow					3	4	3
Tandem disk					1		
Skid sprayer in pick-up							1
Land preparation							
Chisel plow					1	1	2
Rod weeder					1		1[c]
SUB-TOTAL TILLAGE OPERATIONS	0	0	0	0	6	5	6
Planter							
Press drill					1	1	
Air seeder	1	1	1	1			1
Herbicide application							
Spray coupe		2		1		1	
Skid sprayer in pick-up	1						1
Spot spray		1			1		
Custom hired	1		2				
Fertilizer application					b		
With planter	1		1	1			
With herbicide							
Spray coupe		1					
Custom hired	1		1	1			
TOTAL FIELD OPERATIONS	4	4[a]	4	3	7[a]	7	8

[a]Plus one spot spraying.
[b]Livestock manure was applied to part of the field.
[c]The rod weeding was done in tandem with one of the chisel plowings.

Chemical weed control practices (per acre)

WW1: pre-plant, 1 pt Round-Up, 1 pt Estron 99; post-emergence, 1/2 lb 2,4-D, custom hired
WW2: pre-plant, 6 oz Round-Up (mixed with 1 qt/acre of ammonium sulfate to enhance the effectiveness of Round-Up because "hard" water being used), 6 oz 2,4-D; post-emergence 3/4 pt MCP; spot spray, 1/25 oz Banvel, 1/3 oz 2,4-D
WW3: pre-plant, Landmaster, custom hired; post-emergence, Tordon, custom hired
WW4: post-emergence, 1/2 pt Banvel
WW5: spot spray, 1/25 oz Banvel, 1/3 oz 2,4-D
WW6: post-emergence, 1/3 oz Glean
WW7: fallow, 1 lb Atrazine; post-emergence, 1/2 lb 2,4-D

Table 4. Winter wheat budget spread sheet.

INPUT SECTION	WW1	WW2	WW3	WW4	WW5	WW6	WW7
YIELD:							
Estimated grain yield (bu./ac.)	39	39	29	31	37	35	36
DIRECT (non-harvest) COSTS:							
Seed ($/ac.)	$6.35	$6.35	$6.25	$6.35	$5.15	$3.90	$3.90
Dry nitrogen (lb. N/ac.)	100.0	0.0	46.0	46.0	0.0	0.0	0.0
($/lb.)	$0.19	$0.19	$0.19	$0.19	$0.19	$0.19	$0.19
Anhydrous nitrogen (lb. N/ac.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
($/lb.)	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13
Liquid nitrogen (lb. N/ac.)	0.0	26.0	9.0	10.7	0.0	0.0	0.0
($/lb.)	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22
Phosphorus (lb. P2 05/ac.)	40.0	0.0	30.6	36.3	0.0	0.0	0.0
($/lb.)	$0.18	$0.18	$0.18	$0.18	$0.18	$0.18	$0.18
Potassium (lb. K2 0/ac.)	20.0	0.0	0.0	0.0	0.0	0.0	0.0
($/lb.)	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13
Herbicide ($/ac.)	$13.28	$6.53	$8.50	$3.55	$0.20	$5.45	$3.04
Crop insurance ($/ac.)	$3.22	$3.22	$1.91	$2.41	$3.08	$2.36	$2.36
Storage ($/bu.)	$0.11	$0.11	$0.11	$0.11	$0.11	$0.11	$0.11
Drying ($/bu.)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Pre-harvest custom machine hire:							
Fertilizer application ($/ac.)	$2.00	$0.00	$2.00	$2.00	$0.00	$0.00	$0.00
Herbicide application ($/ac.)	$2.50	$0.00	$5.00	$0.00	$0.00	$0.00	$0.00
Fuel and lubrication ($/ac.)	$0.61	$0.63	$0.52	$0.56	$5.45	$5.65	$5.71
Machinery repair ($/ac.)	$1.88	$2.12	$1.82	$1.92	$6.11	$6.26	$5.90
Period of crop operating loan (months)	6	6	6	6	6	6	6
Annual interest rate (%)	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Labor 1 (hrs./ac.)	0.14	0.19	0.10	0.13	0.83	0.78	0.78
($/hr.)	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00
Labor 2 (hrs./ac.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
($/hr.)	$4.00	$4.00	$4.00	$4.00	$4.00	$4.00	$4.00
MACHINERY OVERHEAD:							
Int., Housing, & Ins. on mach. ($/ac.)	$2.30	$3.20	$2.11	$2.47	$11.09	$11.35	$11.07
Depreciation on mach. & equip. ($/ac.)	$2.29	$3.24	$2.07	$2.45	$9.79	$9.95	$9.79
OTHER FARM OVERHEAD ($/ac.)	$5.00	$5.00	$5.00	$5.00	$8.00	$8.00	$8.00
CUSTOM HARVEST MACHINE HIRE:							
Swathing ($/ac.)	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00
Combining ($/ac.)	$13.00	$13.00	$13.00	$13.00	$13.00	$13.00	$13.00
Hauling ($/ac.)	$2.63	$2.63	$1.96	$2.09	$2.50	$2.36	$2.43
LAND OWNERSHIP COST FACTORS:							
Land value ($/ac.)	$385.00	$385.00	$245.00	$230.00	$180.00	$160.00	$160.00
Real estate tax rate (%)	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Period to obtain crop (yrs.)	1	1	1	1	2	2	2

(end of input section)

INPUT SUMMARY AND RESULTS

	WW1	WW2	WW3	WW4	WW5	WW6	WW7
YIELD:							
Total yield (bu./ac.)	39	39	29	31	37	35	36
DIRECT (non-harvest) COSTS:							
Seed ($/ac.)	$6.35	$6.35	$6.25	$6.35	$5.15	$3.90	$3.90
Fertilizer ($/ac.)	$28.80	$5.72	$16.23	$17.63	$0.00	$0.00	$0.00
Herbicide ($/ac.)	$13.28	$6.53	$8.50	$3.55	$0.20	$5.45	$3.04
Crop insurance ($/ac.)	$3.22	$3.22	$1.91	$2.41	$3.08	$2.36	$2.36
Storage ($/ac.)	$4.29	$4.29	$3.19	$3.41	$4.07	$3.85	$3.96
Drying ($/ac.)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Pre-harvest custom machine hire ($/ac.)	$4.50	$0.00	$7.00	$2.00	$0.00	$0.00	$0.00
Fuel and lubrication ($/ac.)	$0.61	$0.63	$0.52	$0.56	$5.45	$5.65	$5.71
Machinery repair ($/ac.)	$1.88	$2.12	$1.82	$1.92	$6.11	$6.26	$5.90
Interest on non-labor and non-harvest direct costs ($/ac.)	$3.78	$1.73	$2.73	$2.27	$1.44	$1.65	$1.49
Labor charge ($/ac.)	$0.83	$1.13	$0.61	$0.78	$5.00	$4.68	$4.67
Total direct (non-harvest) costs ($/ac.)	$67.53	$31.73	$48.75	$40.88	$30.50	$33.80	$31.03
Costs/bu. of yield ($)	$1.73	$0.81	$1.68	$1.32	$0.82	$0.97	$0.86
MACHINERY OVERHEAD:							
Int., Housing, & Ins. on mach. ($/ac.)	$2.30	$3.20	$2.11	$2.47	$11.09	$11.35	$11.07
Depreciation on mach. & equip. ($/ac.)	$2.29	$3.24	$2.07	$2.45	$9.79	$9.85	$9.79
Total machinery overhead ($/ac.)	$4.59	$6.44	$4.18	$4.92	$20.88	$21.30	$20.86
OTHER FARM OVERHEAD ($/ac.)	$5.00	$5.00	$5.00	$5.00	$8.00	$8.00	$8.00
PRE-HARVEST PRODUCTION COSTS EXCLUDING LAND ($/ac.)	$77.12	$43.17	$57.93	$50.80	$59.38	$63.10	$59.89
Costs/bu. of yield ($)	$1.98	$1.11	$2.00	$1.64	$1.60	$1.80	$1.66
TOTAL HARVESTING COSTS ($/ac.)	$20.63	$20.63	$19.96	$20.09	$20.50	$20.36	$20.43
ALL PRODUCTION COSTS EXCL. LAND ($/ac.)	$97.75	$63.80	$77.89	$70.89	$79.88	$83.46	$80.32
LAND OWNERSHIP COSTS ($/ac.)	$28.88	$28.88	$18.38	$17.25	$27.00	$24.00	$24.00
ALL PRODUCTION AND LAND COSTS ($/ac.)	$126.63	$92.67	$96.26	$88.14	$106.88	$107.46	$104.32
Costs/bu. of yield ($)	$3.25	$2.38	$3.32	$2.84	$2.89	$3.07	$2.90

(end of summary section)

Table 5. Corn, pre-harvest field operations and chemical weed control practices.

Pre-harvest field operations

	C1	C2	C3
	----Times over----		
Land preparation			
Tandem disk	1		
Chisel plow	1		1
Field cultivator	1		1[a]
Spike harrow			1[a]
SUB-TOTAL TILLAGE OPERATIONS	**3**	**0**	**2**
Planter			
Row crop conventional	1		1
Ridge till		1	
Herbicide application			
With fertilizer	1		
With planter			1
With cultivator		1	1
Fertilizer application[b]			
With chisel plow			1
Fertilizer spreader (broadcast)	1		
Custom hired		1	
Field cultivation			
Row crop conventional	2		
Ridge till		2	
TOTAL FIELD OPERATIONS	**7**	**4**	**3**

[a]A tandem field operation.
[b]These are all pre-plant fertilizer applications.

Chemical weed control practices (per acre)

C1: pre-plant, 6 pt Eradicane
C2: post-emergence, 1/4 lb Banvel, 1 pt 2,4-D
C3: pre-plant, 2 lb Lasso; post-emergence, 1/4 lb Banvel, 1 pt 2,4-D

Table 6. Corn budget spread sheet.

INPUT SECTION	Corn 1	Corn 2	Corn 3
YIELD:			
Estimated grain yield (bu./ac.)	66	85	58
DIRECT (non-harvest) COSTS:			
Seed ($/ac.)	$16.00	$16.00	$12.00
Dry nitrogen (lb. N/ac.)	70.0	54.0	0.0
($/lb.)	$0.19	$0.19	$0.19
Anhydrous nitrogen (lb. N/ac.)	0.0	0.0	100.0
($/lb.)	$0.13	$0.13	$0.13
Liquid nitrogen (lb. N/ac.)	0.0	0.0	0.0
($/lb.)	$0.22	$0.22	$0.22
Phosphorus (lb. P2 05/ac.)	36.0	138.0	0.0
($/lb.)	$0.18	$0.18	$0.18
Potassium (lb. K2 0/ac.)	0.0	0.0	0.0
($/lb.)	$0.13	$0.13	$0.13
Herbicide ($/ac.)	$16.13	$3.15	$4.85
Crop insurance ($/ac.)	$4.44	$3.41	$4.80
Storage ($/bu.)	$0.11	$0.11	$0.11
Drying ($/bu.)	$0.15	$0.15	$0.15
Pre-harvest custom machine hire:			
Fertilizer application ($/ac.)	$0.00	$2.00	$0.00
Herbicide application ($/ac.)	$0.00	$0.00	$0.00
Fuel and lubrication ($/ac.)	$3.80	$3.02	$2.18
Machinery repair ($/ac.)	$4.45	$4.09	$2.84
Period of crop operating loan (months)	6	6	6
Annual interest rate (%)	12.00	12.00	12.00
Labor 1 (hrs./ac.)	1.08	0.65	0.49
($/hr.)	$6.00	$6.00	$6.00
Labor 2 (hrs./ac.)	0.00	0.00	0.00
($/hr.)	$4.00	$4.00	$4.00
MACHINERY OVERHEAD:			
Int., Housing, & Ins. on mach. ($/ac.)	$9.98	$8.82	$6.48
Depreciation on mach. & equip. ($/ac.)	$9.32	$8.35	$6.16
OTHER FARM OVERHEAD ($/ac.)	$5.50	$5.50	$5.00
CUSTOM HARVEST MACHINE HIRE:			
Swathing ($/ac.)	$0.00	$0.00	$0.00
Combining ($/ac.)	$16.00	$16.00	$16.00
Hauling ($/ac.)	$4.46	$5.74	$3.92
LAND OWNERSHIP COST FACTORS:			
Land value ($/ac.)	$450.00	$625.00	$330.00
Real estate tax rate (%)	1.50	1.50	1.50

(end of input section)

INPUT SUMMARY AND RESULTS

	Corn 1	Corn 2	Corn 3
YIELD:			
Total yield (bu./ac.)	66	85	58
DIRECT (non-harvest) COSTS:			
Seed ($/ac.)	$16.00	$16.00	$12.00
Fertilizer ($/ac.)	$19.78	$35.10	$13.00
Herbicide ($/ac.)	$16.13	$3.15	$4.85
Crop insurance ($/ac.)	$4.44	$3.41	$4.80
Storage ($/ac.)	$7.26	$9.35	$6.38
Drying ($/ac.)	$9.90	$12.75	$8.70
Pre-harvest custom machine hire ($/ac.)	$0.00	$2.00	$0.00
Fuel and lubrication ($/ac.)	$3.80	$3.02	$2.18
Machinery repair ($/ac.)	$4.45	$4.09	$2.84
Interest on non-labor and non-harvest direct costs ($/ac.)	$4.91	$5.33	$3.29
Labor charge ($/ac.)	$6.49	$3.91	$2.94
Total direct (non-harvest) costs ($/ac.)	$93.16	$98.11	$60.98
Costs/bu. of yield ($)	$1.41	$1.15	$1.05
MACHINERY OVERHEAD:			
Int., Housing, & Ins. on mach. ($/ac.)	$9.98	$8.82	$6.48
Depreciation on mach. & equip. ($/ac.)	$9.32	$8.35	$6.16
Total machinery overhead ($/ac.)	$19.30	$17.17	$12.64
OTHER FARM OVERHEAD ($/ac.)	$5.50	$5.50	$5.00
PRE-HARVEST PRODUCTION COSTS EXCLUDING LAND ($/ac.)	$117.96	$120.78	$78.62
Costs/bu. of yield ($)	$1.79	$1.42	$1.36
TOTAL HARVESTING COSTS ($/ac.)	$20.46	$21.74	$19.92
ALL PRODUCTION COSTS EXCL. LAND ($/ac.)	$138.42	$142.52	$98.54
ANNUAL LAND OWNERSHIP COSTS ($/ac.)	$33.75	$46.88	$24.75
ALL PRODUCTION AND LAND COSTS ($/ac.)	$172.17	$189.39	$123.29
Costs/bu. of yield ($)	$2.61	$2.23	$2.13

(end of summary section)

Table 7. Soybean pre-harvest field operations and chemical weed control practices.

Pre-harvest field operations	SB1	SB2	SB3	SB4	SB5	SB6	SB7
	Times over						
Land preparation							
Tandem disc	2		2	2[a]	1		3
Field cultivator		1	1		2		
Spike harrow				2[a]			
Corn stalk chopper					1		
SUB-TOTAL TILLAGE OPERATIONS	2	1	3	2	4	0	3
Planter							
Row-crop conventional	1	1	1		1		1
Ridge till						1	
Press drill				1			
Herbicide application							
With disc	1		1	1			1
With planter						1	
Skid-sprayer in pick-up				1[b]		1	
Custom hired					1		
Fertilizer application							
Custom hired	1			1			
With planter		1					
Field cultivation							
Row crop conventional	1	2	1		3		1
Ridge till						2	
TOTAL FIELD OPERATIONS	5	4	5	4[c]	9	4	5

[a]A tandem field operation.
[b]Only one-fifth of the field was sprayed.
[c]Plus spraying of one-fifth of the field.

Chemical weed control practices (per acre)

SB1: pre-plant, 3/4 pt Sencore, 1 1/1 pt Treflan
SB2: none
SB3: pre-plant, 1 3/4 pt Treflan
SB4: pre-plant, 1 pt Treflan; post-emergence, 1 pt Basegran (one-fifth of field)
SB5: pre-plant, 3/4 pt Prowl, custom hired
SB6: pre-plant, 2 1/2 lb Lasso; post-emergence, 1 pt Basagran
SB7: pre-plant, 1 1/2 lb Treflan

Table 8. Soybeans spread sheet.

INPUT SECTION	SB1	SB2	SB3	SB4	SB5	SB6	SB7
YIELD:							
Estimated grain yield (bu./ac.)	38	28	38	38	35	26	30
DIRECT (non-harvest) COSTS:							
Seed ($/ac.)	$11.50	$11.50	$11.50	$11.50	$12.00	$12.00	$12.00
Dry nitrogen (lb. N/ac.)	0.0	0.0	0.0	9.0	0.0	0.0	0.0
($/lb.)	$0.19	$0.19	$0.19	$0.19	$0.19	$0.19	$0.19
Anhydrous nitrogen (lb. N/ac.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
($/lb.)	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13
Liquid nitrogen (lb. N/ac.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
($/lb.)	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22
Phosphorus (lb. P2 05/ac.)	44.0	32.2	0.0	23.0	0.0	0.0	0.0
($/lb.)	$0.18	$0.18	$0.18	$0.18	$0.18	$0.18	$0.18
Potassium (lb. K2 0/ac.)	60.0	0.0	0.0	30.0	0.0	0.0	0.0
($/lb.)	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13
Herbicide ($/ac.)	$15.12	$0.00	$5.88	$4.68	$9.50	$8.72	$5.04
Crop insurance ($/ac.)	$2.36	$2.64	$2.36	$2.36	$2.36	$2.64	$2.56
Storage ($/bu.)	$0.11	$0.11	$0.11	$0.11	$0.11	$0.11	$0.11
Drying ($/bu.)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Pre-harvest custom machine hire:							
Fertilizer application ($/ac.)	$2.00	$0.00	$0.00	$2.00	$0.00	$0.00	$0.00
Herbicide application ($/ac.)	$0.00	$0.00	$0.00	$0.00	$2.50	$0.00	$0.00
Fuel and lubrication ($/ac.)	$1.97	$2.14	$2.66	$1.87	$4.31	$3.10	$2.49
Machinery repair ($/ac.)	$2.83	$2.93	$3.58	$3.42	$5.19	$4.15	$3.38
Period of crop operating loan (months)	6	6	6	6	6	6	6
Annual interest rate (%)	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Labor 1 (hrs./ac.)	0.63	0.80	0.78	0.39	1.48	0.69	0.73
($/hr.)	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00
Labor 2 (hrs./ac.)	1.00	2.00	1.00	1.00	1.00	1.00	1.00
($/hr.)	$4.00	$4.00	$4.00	$4.00	$4.00	$4.00	$4.00
MACHINERY OVERHEAD:							
Int., Housing, & Ins. on mach. ($/ac.)	$6.88	$6.35	$8.40	$5.73	$10.98	$9.01	$8.30
Depreciation on mach. & equip. ($/ac.)	$6.68	$6.04	$8.06	$5.47	$10.28	$8.57	$8.02
OTHER FARM OVERHEAD ($/ac.)	$5.50	$5.50	$5.50	$5.50	$5.50	$5.50	$5.50
CUSTOM HARVEST MACHINE HIRE:							
Swathing ($/ac.)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Combining ($/ac.)	$17.00	$17.00	$17.00	$17.00	$17.00	$17.00	$17.00
Hauling ($/ac.)	$2.57	$1.89	$2.57	$2.57	$2.36	$1.76	$2.03
LAND OWNERSHIP COST FACTORS:							
Land value ($/ac.)	$615.00	$415.00	$615.00	$615.00	$625.00	$410.00	$500.00
Real estate tax rate (%)	1.50	1.50	1.50	1.50	1.50	1.50	1.50

(end of input section)

INPUT SUMMARY AND RESULTS

	SB1	SB2	SB3	SB4	SB5	SB6	SB7
YIELD:							
Total yield (bu./ac.)	38	28	38	38	35	26	30
DIRECT (non-harvest) COSTS:							
Seed ($/ac.)	$11.50	$11.50	$11.50	$11.50	$12.00	$12.00	$12.00
Fertilizer ($/ac.)	$15.72	$5.80	$0.00	$9.75	$0.00	$0.00	$0.00
Herbicide ($/ac.)	$15.12	$0.00	$5.88	$4.68	$9.50	$8.72	$5.04
Crop insurance ($/ac.)	$2.36	$2.64	$2.36	$2.36	$2.36	$2.64	$2.56
Storage ($/ac.)	$4.18	$3.08	$4.18	$4.18	$3.85	$2.86	$3.30
Drying ($/ac.)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Pre-harvest custom machine hire ($/ac.)	$2.00	$0.00	$0.00	$2.00	$2.50	$0.00	$0.00
Fuel and lubrication ($/ac.)	$1.97	$2.14	$2.66	$1.87	$4.31	$3.10	$2.49
Machinery repair ($/ac.)	$2.83	$2.93	$3.58	$3.42	$5.19	$4.15	$3.38
Interest on non-labor and non-harvest direct costs ($/ac.)	$3.34	$1.69	$1.81	$2.39	$2.38	$2.01	$1.73
Labor charge ($/ac.)	$7.79	$12.80	$8.68	$6.35	$12.88	$8.13	$8.39
Total direct (non-harvest) costs ($/ac.)	$66.81	$42.57	$40.65	$48.50	$54.97	$43.61	$38.88
Costs/bu. of yield ($)	$1.76	$1.52	$1.07	$1.28	$1.57	$1.68	$1.30
MACHINERY OVERHEAD:							
Int., Housing, & Ins. on mach. ($/ac.)	$6.88	$6.35	$8.40	$5.73	$10.98	$9.01	$8.30
Depreciation on mach. & equip. ($/ac.)	$6.68	$6.04	$8.06	$5.47	$10.28	$8.57	$8.02
Total machinery overhead ($/ac.)	$13.56	$12.39	$16.46	$11.20	$21.26	$17.58	$16.32
OTHER FARM OVERHEAD ($/ac.)	$5.50	$5.50	$5.50	$5.50	$5.50	$5.50	$5.50
PRE-HARVEST PRODUCTION COSTS EXCLUDING LAND ($/ac.)	$85.87	$60.46	$62.61	$65.20	$81.73	$66.69	$60.70
Costs/bu. of yield ($)	$2.26	$2.16	$1.65	$1.72	$2.34	$2.56	$2.02
TOTAL HARVESTING COSTS ($/ac.)	$19.57	$18.89	$19.57	$19.57	$19.36	$18.76	$19.03
ALL PRODUCTION COSTS EXCL. LAND ($/ac.)	$105.44	$79.35	$82.18	$84.77	$101.09	$85.45	$79.73
ANNUAL LAND OWNERSHIP COSTS ($/ac.)	$46.13	$31.13	$46.13	$46.13	$46.88	$30.75	$37.50
ALL PRODUCTION AND LAND COSTS ($/ac.)	$151.57	$110.48	$128.30	$130.89	$147.97	$116.20	$117.23
Costs/bu. of yield ($)	$3.99	$3.95	$3.38	$3.44	$4.23	$4.47	$3.91

(end of summary section)

Overview of results

A brief overview of the results for each of the four crops is first presented. This is followed by a simple yield sensitivity analysis.

Spring wheat. The number of field operations for the different reduced till spring wheat farmers ranges from 2 (SW5) to 6 (SW3) and 7 (SW2). Summer fallowing, which involves 3 tillage operations for both farmers, is responsible for the larger total number of field operations for SW2 and SW3.

The pre-harvest production costs excluding land range from $37/acre (SW1) and $39/acre (SW5) to $81/acre (SW3). The low costs for SW1 and SW5 arise primarily because of a combination of relatively low fertilizer and herbicide expenditures and relatively modest machinery expenditures. The high costs for SW3, on the other hand, arise from a combination of relatively high herbicide, fertilizer, and machinery expenditures (including 3 fallowing field operations). The expected trade-off in controlling weeds between machinery and herbicide expenses is not shown with these spring wheat budgets.

The break-even total costs of production for the different farmers range from $3.21/bu (SW4) to $4.39/bu (SW3) and $4.51/bu (SW2). A major contributing factor to the high break-even costs for SW2 and SW3 is inclusion of costs for the summer fallow which preceded the spring wheat crop for each of these two farmers.

> **Special note regarding fallowing:** In addition to fallowing for farmers SW2 and SW3, summer fallowing preceded the winter wheat crop for three winter wheat farmers (WW5, WW6, and WW7). In 4 of these 5 summer fallow situations, the summer fallowing was every second year. In budgeting these 4 common situations, all the costs of the summer fallow clearly had to be combined with the costs for the following wheat crop.
>
> For the fifth farmer (SW3), spring wheat is part of a 4-year rotation, one year of which involves summer fallow. Ali and Johnson (1981) report that the majority of moisture and nitrogen benefits from fallowing accrue to the crop immediately following the fallow. Since spring wheat for SW3 follows the fallow year in rotation, the budgeting procedure adopted for SW3 was to assign all the preceding year's fallow costs to the spring wheat crop. If only one-third of the fallow costs had been assigned to spring wheat, however, the break-even total cost of production for SW3 would have been $3.35/bu rather than $4.39/bu.

Winter wheat. The number of field operations for the different winter wheat farms ranges from 3 (WW4) to 7 (WW5 and WW6) and 8 (WW7). Again, the farmers with the most field operations (all West River) each summer fallowed preceding the planting of their winter wheat crop.

The pre-harvest production costs excluding land, unlike for spring wheat, are not necessarily highest for the summer fallow farmers. These per-acre costs for the fallow farmers range from $59 (WW5) to $63 (WW6), but are as high as $58 (WW3) and $77 (WW1) for the continuous crop farmers. In this case, the high production cost continuous crop farmers have relatively low machinery costs. In the case of winter wheat, the reduced till budgets appear to show evidence of a substitution of chemical for mechanical weed control.

The break-even total costs of production for the different winter wheat farmers range from $2.38/bu (WW2) to $3.25/bu (WW1) and $3.32/bu (WW3). The low break-even costs for WW2 reflect a unique combination of relatively low production costs and a high crop yield. The high break-even costs for WW1 and WW3 reflect most directly the prior-mentioned relatively high herbicide and fertilizer expenditures by these farmers.

Corn. The field operations for the reduced till corn farmers are highly variant. One farmer (C1) has 3 pre-plant tillage operations (following alfalfa), whereas another (C2) has none. The first two corn farmers each use one herbicide application and two post-emergence field cultivations. The third farmer (C3), on the other hand, applies herbicides twice and does no post-emergence field cultivation.

The pre-harvest production costs excluding land range from $79/acre for C3 to around $120/acre for the other two farms. Varying combinations of fertilizer and herbicide expenditures and, to a lesser extent, machinery expenses largely explain these per-acre cost differences.

The break-even total costs of production for C1 ($2.61/bu) are considerably higher than for the other two farmers ($2.23 and $2.13/bu). The higher break-even costs for C1 reflect relatively high per-acre production costs and a relatively modest corn yield. The higher crop yield for C2 almost totally compensates for it having the highest per-acre production costs.

Soybeans. Six of the 7 reduced till soybean farmers use either 4 or 5 field operations in producing their soybeans. The pre-harvest production costs excluding land for the different farmers range from $60/acre (SB2) to $86/acre (SB1). The seventh soybean farmer (SB5) uses 9 field operations, with 4 of those involving land preparation tillage and 3 post-emergence cultivations.[11] The per-acre production costs (for all four major categories of expenses) for this farmer are exceeded by those for only one farmer (SB1), for whom both fertilizer and herbicide expenditures are atypically high (exceeding $15/ acre

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[11]Whether this farmer should be described as a "reduced" till farmer is somewhat open to question. Since he met the formal requirement for reduced tillage in the study of not using a moldboard plow, however, we retained him in the study.

each).

The break-even total costs of production for the different reduced till soybean farmers range from $3.38/bu (SB3) to $4.47/bu (SB6). The relatively low break-even cost for SB3 arises because of relatively modest per acre production costs in combination with a relatively high yield (38 bu/acre). The high break-even cost for SB6 arises most directly from this farmer's low yield (26 bu/acre).

Yield sensitivity analysis. To obtain an idea of the implications of different yields on break-even costs, some simple sensitivity analysis was undertaken. Results were compared when the **"baseline" estimated grain yields** were used in the development of the crop budget spread sheets (Tables 2, 4, 6, and 8) with results when **1986 yields** and **government program crop base yields** reported by the individual respondents in the survey were used.[12]

These comparative yields for the individual farmers are portrayed in Figure 2. The reported 1986 yields for most corn and soybean farmers are higher than the corresponding baseline yields. For most spring wheat farmers, on the other hand, the 1986 yields are less than the baseline yields, and for winter wheat the comparative yield relationships are mixed. The government program crop base yields for winter wheat are lower than corresponding baseline yields, whereas, for spring wheat and corn, the comparative government program crop base-baseline yield relationships are mixed.

The comparative break-even total costs of production for the individual farmers are portrayed in Figure 3. In instances where the 1986 yields or government program crop base yields are less than the baseline estimated grain yields, the break-even production costs--by definition--are higher than in the baseline situations, and vice versa.

The break-even total costs of production with 1986 versus baseline yields are, on the average among farmers for particular crops, 20% higher for spring wheat ($4.57 versus $3.81/bu) and, at the other extreme, 27% less for corn ($1.69 versus $2.32/bu). For individual farmers, the 1986 versus baseline break-even production cost ranges from 69% more for WW4 ($4.81 versus

---

[12]Yield data were not used in the sensitivity analysis for the following situations:

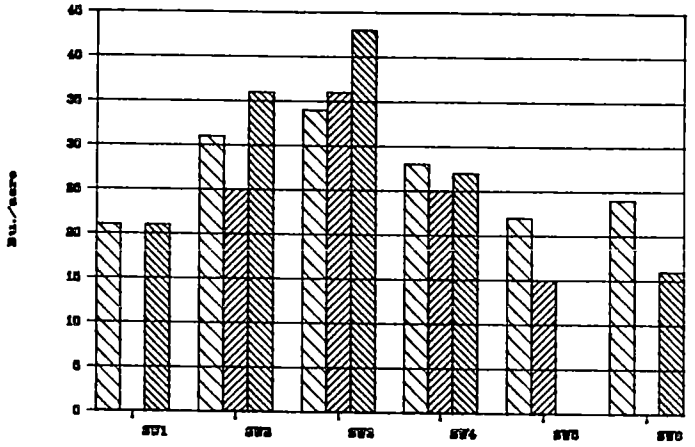
-The reported yield for 1986 for SW1, because wind and rain at harvest time led to an almost total loss of the crop;

-The government program crop base yields for SW5, WW4, and C2, because these farmers do not have an established government program base acreage for these crops;

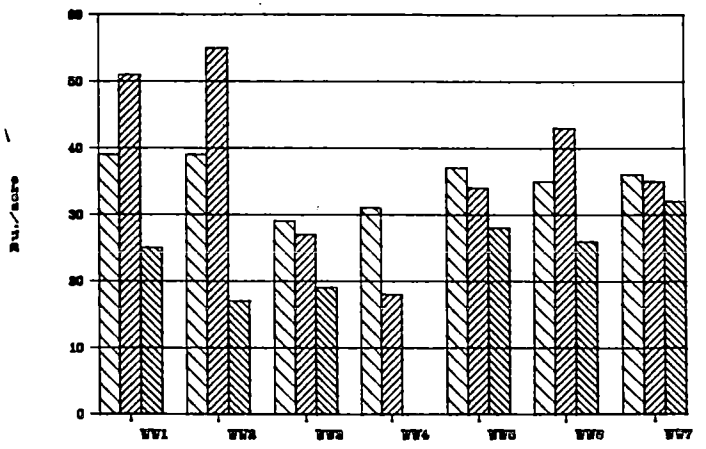
-The reported yield for 1986 for SW6, because mosiac disease caused a total crop loss for this farmer; and

-The government program base yields for soybean farmers, since they do not apply to soybeans.

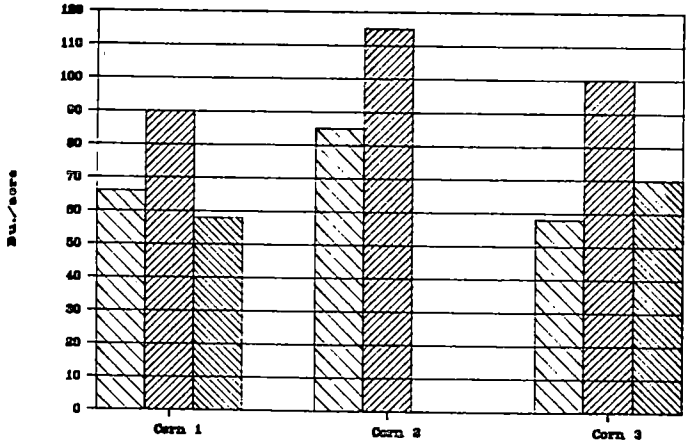
Figure 2. Baseline estimated, 1986 reported, and government program crop base yields; by crop and farmer.



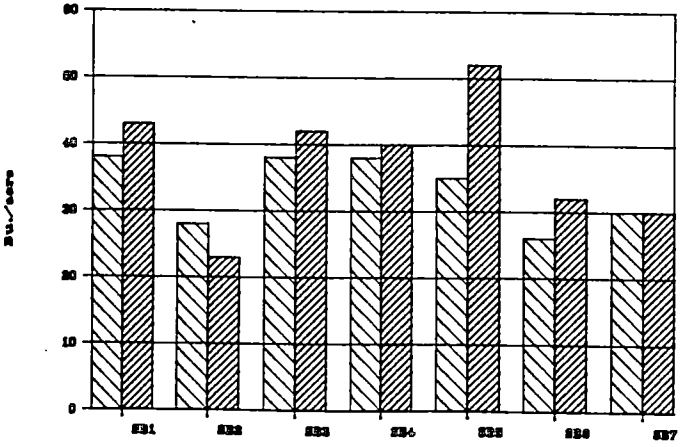
a. Spring wheat



b. Winter wheat



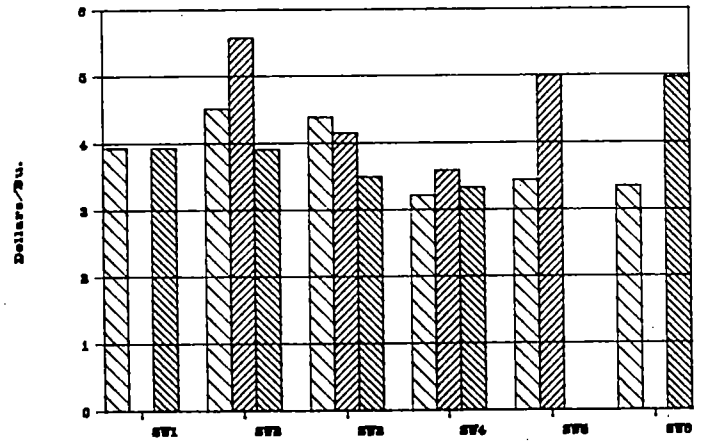
c. Corn



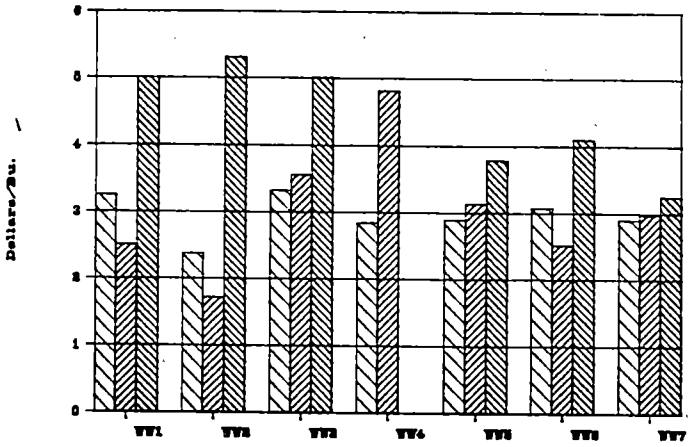
d. Soybeans

Baseline estimated yield 1986 reported yield Government program base yield

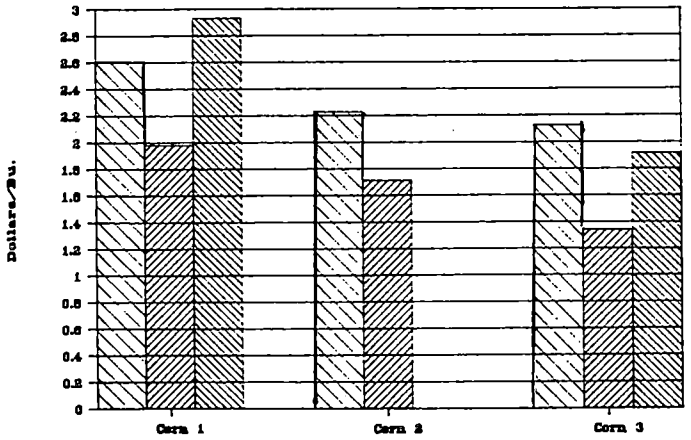
Figure 3. Break-even total costs of production for baseline estimated, 1986 reported, and government program crop base yields, by crop and farmer.



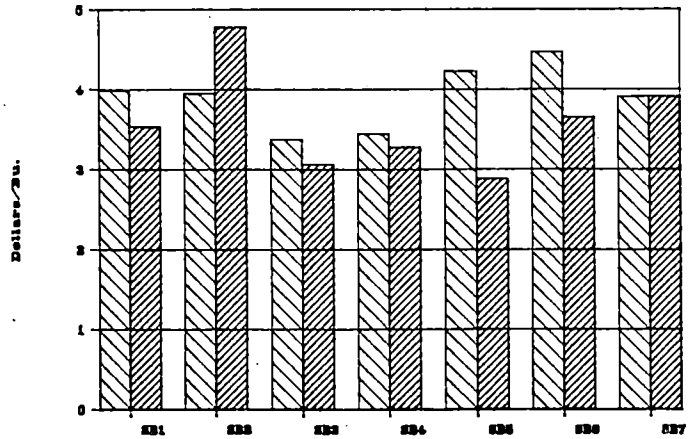
a. Spring wheat



b. Winter wheat



c. Corn



d. Soybeans

Baseline estimated yield 1986 reported yield Government program base yield

$2.84/bu) to 37% less for C3 ($1.35 versus $2.13/bu).

The break-even total costs of production with government program crop base versus baseline yields range, on the average, from 3% greater for spring wheat ($3.92 versus $3.81/bu) to 49% greater for winter wheat ($4.41 versus $2.95/bu). For individual farmers, the government program base yield versus baseline yield break-even production cost ranges from more than double for WW2 ($5.30 versus $2.38/bu) to 21% less for SW3 ($3.49 versus $4.39/bu).

SUMMARY

The summary is based primarily on the results of the Phase III personal interview portion of the "economics of reduced tillage" study. Included in this section, however, are also references to related Phase II results and a finding on the comparative economics of conventional and reduced tillage practices based on the Phase I component of the study.

In interpreting the Phase III results, the reader should bear in mind the relatively small number of "case studies" on which the results are based. These results should be viewed as "indicative" only.

1. The number of pre-harvest field operations undertaken by the different South Dakota reduced tillage (those who do not use a moldboard plow) survey respondents for particular crops varies widely. For small grains, the range among farmers is 2 to 8, with those following summer fallowing definitely tending to use the most total field operations. For row crops, the range is 3 to 9. These differences in field operations arise from differences in prior year crops, soils, weed populations, crop varieties, and managerial philosophies for different reduced till producers.

2. The break-even total costs of production are also quite variant among reduced till farmers for the same crop. The per-bushel break-even costs range from about 25% to 40% higher for high versus low cost producers for the individual crops. Of course, this comparison includes farmers with widely varying growing and soil conditions across the state.

3. In the Phase I budgeting analysis, the costs of production under reduced tillage were compared with corresponding costs under conventional tillage. For the row crops (corn and soybeans), herbicide and insecticide costs were from about 15% to 50% higher with reduced tillage. These costs are higher because of greater weed and insect populations resulting from less cultivation of the soil and more plant residue being left on the soil surface with reduced tillage. Machine costs (e.g., fuel and lube, repair, depreciation), on the other hand, were about 30% less with reduced tillage. The differences in these costs between conventional and reduced tillage small grains (spring wheat and oats) were generally much less than for row crops, however.

4. In response to rather open-ended questions in the Phase III study, the survey respondents provided the following additional insights on their own practical experience with reduced tillage:

-One farmer said: "If you can't afford to buy all the reduced tillage equipment, hire somebody with the latest technology and expertise; don't try to buy equipment and convert your whole farm the first year";

-Several farmers expressed the view that reduced tillage is advantageous during years of below-normal rainfall (because of moisture conservation), but disadvantageous during years of

above-normal rainfall (presumably because of exaggerated weed control problems); and

-One farmer expressed the view that government support programs which often change from year to year complicate managerial decisions on crop rotations and plant protection chemical use.

5. The Phase II and Phase III results show a strong concensus among South Dakota producers that reduced tillage practices result in lower crop labor requirements, conserved soil moisture, and lower fuel costs--in comparison to conventional tillage practices. A solid majority also believe that reduced till production is more profitable and requires lower machine and overall direct costs of production than conventional till production. On the other hand, the study results show weed control to be the major problem associated with reduced tillage. Specific issues in regard to weed control are knowing which chemicals and the amounts of chemicals to use and how future crop plans may be affected by chemical residues.

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ANNEX A

PHASE III REDUCED TILLAGE FARMER SURVEY QUESTIONNAIRE

SOUTH DAKOTA STATE UNIVERSITY

ECONOMICS DEPARTMENT

Schedule no. _____ Enumerator _____

Date _____ County _____

1. Operator _____ Address _____ Zip ____

2. Legal description of land operated:

Owned _____

Rented _____

3. Land Use, 1986

Land Use	All land operated				Type of tillage system
	Acres	Yield	Fertilizer Used Kind	Amount	
Spring Wheat					
Winter Wheat					
Oats					
Barley					
Corn grain					
Silage					
Soybeans					
Alfalfa					
Annual Pasture					
Idle Acres					
TOTAL CROPLAND					

4. Government Program

	Base Acres	Base Yield
Corn		
Wheat		
Oats		
Barley		
Sorghum		

5. Operations on a selected field in 1986
(select a field on which reduced tillage was used in 1986)

A. Identify the soil series in this field _____

B. Was this field on land rented: ____for cash? ____on shares?

C. Field cropping History

	1986	1985	1984	1983
Crop grown				
Acres in field				
Yield per acre				
Fertilizer used				
Tillage system used*				

*Ridge till, mulch till, strip till, no till

D. Operations on this field in 1986
Begin after harvest of preceding crop.
In the operation column fully describe any tandem hookup operations.
Enter all hired operations and the cost of hiring.
Under chemical applied enter full description of kind and amount.

Operation	Date MO	Date YR	Hired Cost	Times Over	Tractor Make & Model	Implement Used	Size
Seedbed Preparation:							
Fertilizer Used							
Chemicals Applied: (rate)							
Planting:							
Cultivation:							

6. Rental Arrangements. (specify, whole farm and identify if the unit includes the field detailed on the previous page).

A. Cash rent.

per acre for cropland _____
per acre for pasture/rangeland _____
for other portions. (building site, etc.) _____

B. Crop share rentals.

Crop grown	Landlord's share	Items furnished by landlord
_____	_____	_____
_____	_____	_____
_____	_____	_____

C. Do your rental agreements impose any specifications for tillage practices that may be used? ____Yes ____No.
If "Yes" explain.

7. Operator's experience

(a) Year started farming _____

(b) How was capital acquired for starting?

Worked as a laborer ____
Rented land ____
Inherited land ____
Family helped ____
Other ____

8. What is your rotation plan? _____

_____

9. Has your adoption of conservation tillage caused you to modify your rotation plan? ____Yes ____No. If yes describe rotation changes.

10. How many acres did you have under reduced tillage in:

1987____ 1986____ 1985____ 1984____ 1983____

Total acres farmed

1987____ 1986____ 1985____ 1984____ 1983____

11. Rank the top three groups in the following list, (with 1 being most important), regarding influence toward your decision to use the conservation tillage system for your land.

____ Farmer friends and neighbors
____ County Extension Agent
____ Farm Magazine Articles
____ Farm Machine Dealers
____ Farm Chemical Dealers
____ Landlord
____ Soil Conservation Service
____ Other (specify) _____.

12. Describe any modifications you have made on machinery and equipment to adapt them to your needs in your conservation tillage use.

13. Describe machinery acquired to meet the needs of conservation tillage.

Item	New/Used	Make and Model	Size	Year	Value
_____	_____	_____	____	____	_____
_____	_____	_____	____	____	_____
_____	_____	_____	____	____	_____

14. Describe machinery disposed of as a result of changing to conservation tillage.

Item	Make and Model	Size	Years Owned	Year Sold	sale Value
_____	_____	____	____	____	_____
_____	_____	____	____	____	_____
_____	_____	____	____	____	_____

15. Field Machinery and Equipment Inventory

Item	Purchased New or Used	Make and Model	Size	Year Bought	
Tractors					
Truck					
Plows					
Chisel					
Stalk shredder					
Disk					
Field cultivator					
Harrows					
Planter					
Drill					
Row cultivator					
Sprayer					
Baler					
Combine					
Corn picker					
Field chopper					
Other					

16. In your opinion what are the benefits of conservation tillage. Circle whether you agree or disagree with the following:

Agree Disagree - Reduces labor requirements

Agree Disagree - Helps control diseases and pests

Agree Disagree - It is more profitable than conventional tillage

Agree Disagree - Machine costs are reduced

Agree Disagree - Fuel costs are lowered

Agree Disagree - Total cash costs are lowered

Agree Disagree - Helps to conserve moisture

Agree Disagree - Yields are usually higher

Agree Disagree - Lender credit is easier to obtain under conservation tillage

17. Please rate each of the following problems as to its' importance so far as conservation tillage is concerned:

1 = not true and not important
10 = very true and very important

(a) Weed control is a special problem 1 2 3 4 5 6 7 8 9 10

(b) The technology is difficult to manage 1 2 3 4 5 6 7 8 9 10

(c) Increased use of chemical is undesireable 1 2 3 4 5 6 7 8 9 10

(d) There are too many problems (i.e., weeds, insects, disease, soil preparation, etc.) 1 2 3 4 5 6 7 8 9 10

(e) New machine investment is too high 1 2 3 4 5 6 7 8 9 10

(f) The use of fertilizer and weed control chemicals is too technical to understand 1 2 3 4 5 6 7 8 9 10

(g) There is a higher risk of crop losses 1 2 3 4 5 6 7 8 9 10

(h) List other problems _____

_____

18. Please comment on the following questions, based on your own experiences.

(a) What do you see as the biggest problem in making a transition from conventional to conservation tillage?

(b) Can you list some things that worked for you and some that did not work?

(c) Have weather conditions, such as drought or excess rain, affected your use of conservation tillage?

(d) Why did you decide to use conservation tillage?

(e) List any benefits from conservation tillage which you believe will prove to be of the greatest value to either an individual farmer or to the agricultural industry and society.

(f) Would you recommend the tillage system you use to a neighbor or friend?

(g) Do you have any additional suggestion, comments or recommendations?

ANNEX B

TABLES REFLECTING CHARACTERISTICS OF THE SAMPLED FARMS

Annex B, Table 1. Means of getting started in farming, by reduced tillage farm crop category, 1986.

	Percent of responses for farmers in each category				
Means	Winter wheat	Spring wheat	Corn	Soybeans	All farms
Family helped	13	18	38	60	29
Commercial bank loan	25	28	25	0	20
Worked as a laborer	19	18	25	0	16
Rented land	19	18	12	10	16
Traded labor for machinery	12	18	0	0	9
Inherited land	6	0	0	10	4
FHA loan	6	0	0	10	4
Other	0	0	0	10	2
TOTAL	100	100	100	100	100

Annex B, Table 2. Cropland use, by reduced tillage farm crop category, 1986.

	Average acreage per reduced tillage farm				
Cropland use	Winter wheat	Spring wheat	Corn	Soybeans	All farms
Row crops					
Corn	86	79	260	260	160
Soybeans	67	115	140	185	125
Sub-total	**153**	**194**	**400**	**445**	**285**
Small grains					
Winter wheat	672	203	0	0	258
Spring wheat	150	223	8	15	109
Barley	124	54	0	24	59
Oats	8	7	0	13	8
Sub-total	**954**	**487**	**8**	**52**	**434**
Alfalfa	178	13	33	50	77
Other cropped land	21	35	0	7	18
Set-aside acres	273	61	45	82	130
TOTAL	1,579	790	486	636	944

Annex B, Table 3. Principal crop rotations, by reduced tillage farm crop category, 1986.

Crop rotation	Percent of farmers with each rotation				
	Winter wheat	Spring wheat	Corn	Soybeans	All farms
Small grain (1 to 3 years)-fallow, with at least one small grain being wheat	86	17	0	0	30
Corn-soybean rotation	0	0	67	57	26
Corn-soybean rotation, with small grain and/or alfalfa incorporated into the rotation	0	17	33	43	22
Corn or soybeans-small grain (1 or 2 years, usually spring wheat) - summer fallow[a]	0	50	0	0	13
Small grain rotation	14	17	0	0	9
TOTAL	100	101[b]	100	100	100

[a]In defining rotations, if a farmer indicated "set-aside" as part of a rotation, the "set-aside" was described the same as if it were fallow.

[b]Exceeds 100, due to rounding in individual categories.

Annex B, Table 4. Total farmland operated, by land tenure and reduced tillage farm crop category, 1986.

Land tenure	Average acreage per reduced tillage farm									
	Winter wheat		Spring wheat		Corn		Soybeans		All farms	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Owned	2,537	68.4	414[a]	36.9	559	77.7	506	62.2	1,128	63.2
Rented	1,175	31.6	707	63.1	160	22.3	307	37.8	656	36.8
TOTAL	3,712	100.0	1,121	100.0	719	100.0	813	100.0	1,784	100.0

[a]One farmer rented out 480 acres. The average acreage owned, inclusive of these rented out acres, is 494.

Annex B, Table 5. Government program base acres by crop and reduced tillage farm crop category, 1986.

	Average base acreage per reduced tillage farm				
Crop	Winter wheat	Spring wheat	Corn	Soybeans	All farms
Corn	135	71	213	273	170
Wheat	925	317	10	31	375
Other small grains	225	62	0	83	110
Other crops	16	9	0	0	7
TOTAL	1,301	459	223	387	662

Annex B, Table 6. Reported crop yields, by reduced tillage farm crop category, 1986.

		Average yield per reduced tillage farm raising the crop				
Crop	Unit/acre	Winter wheat	Spring wheat	Corn	Soybeans	All farms
Winter wheat	bu	32	23	n/a	n/a	29
Spring wheat	bu	24	30	23	41	30
Corn	bu	84	96	101	112	103
Soybeans	bu	37	38	34	36	36
Barley	bu	47	42	n/a	54	48
Alfalfa	ton	3.2	5.0	5.7	5.3	4.9

Annex B, Table 7. Government program base yields, by crop and reduced tillage farm crop category, 1986.

	Average yield per reduced tillage farm in the government program				
Crop	Winter wheat	Spring wheat	Corn	Soybeans	All farms
Corn	48	50	64	75	62
Wheat	26	28	25	25	27
Oats	37	53	n/a	59	52
Barley	35	39	n/a	46	40

Annex B, Table 8. Size of farm versus percent of cropland under tillage, 1986.

Frequency distribution of sampled farms by total cropland acres operated			Percent of cropland in each farm size range under reduced tillage
Farm size range(acres)	No. of farms	Percent of farms	
0-399	5	22	100
400-799	9	39	90
800-1,199	2	9	100
1,200-1,599	4	17	75
1,600 or more	3	13	68

Annex B, Table 9. Relative importance of different influences for farmers to adopt reduced tillage practices, 1986.

	Percent responses of all reduced tillage farmers for indicated rankings		
Influences for adopting reduced tillage	First rank	Second rank	Third rank
Farmer friends and neighbors	48	29	8
Farm magazine articles	17	29	23
Soil Conservation Service	22	6	23
County extension agent	0	6	15
Farm chemical dealer	0	6	15
Farm machinery dealers	0	6	8
Landlords	0	6	0
Other influences	13	12	8
TOTAL	100	100	100

Annex B, Table 10. Farmer opinions on the benefits of reduced tillage, by reduced tillage farm crop category, 1986.

Benefit	Reduced tillage farmer opinions (%)														
	Winter wheat farms			Spring wheat farms			Corn farms			Soybeans farms			All farms		
	Agree	Disagree	No opinion	Agree	Disagree	No opinion	Agree	Disagree	No opinion	Agree	Disagree	No opinion	Agree	Disagree	No opinion
Reduces labor requirements	100	0	0	83	17	0	100	0	0	100	0	0	96	4	0
Helps to conserve moisture	100	0	0	83	17	0	100	0	0	100	0	0	96	4	0
Fuel costs are lowered	100	0	0	100	0	0	100	0	0	86	14	0	96	4	0
More profitable than conventional tillage	100	0	0	83	0	17	100	0	0	86	14	0	92	4	4
Machine costs are reduced	86	14	0	83	17	0	100	0	0	71	29	0	83	17	0
Total cash costs are lowered	71	29	0	83	0	17	67	33	0	86	0	14	78	13	9
Yields are usually higher	71	29	0	83	0	17	67	33	0	71	29	0	74	22	4
Easier to obtain credit under reduced tillage	14	57	29	50	33	17	67	0	33	42	29	29	39	25	26
Help control diseases and pests	14	72	14	17	83	0	33	67	0	14	86	0	18	78	4

Annex B, Table 11. Farmer opinions on problems associated with reduced tillage, farm crop category, 1986.

Problem	Degree of importance of the potential problem to reduced tillage farmer														
	Winter wheat farms			Spring wheat farms			Corn farms			Soybeans farms			All farms		
	Ave. index value	% unimportant	% important	Ave. index value	% unimportant	% important	Ave. index value	% unimportant	% important	Ave. index value	% unimportant	% important	Ave. index value	% unimportant	% important
Weed control is a special problem	7.7	14	71	6.3	0	33	5.3	33	0	6.2	17	50	6.7	13	48
New machine investment is too high	5.9	29	43	4.7	67	33	7.3	0	66	6.7	14	57	6.0	30	48
Increased use of chemicals is undesirable	6.4	29	57	3.0	67	0	6.0	0	33	7.0	14	57	5.9	30	39
Too many weed, insect, disease, soil preparation problems	4.9	29	14	2.8	67	0	3.3	33	0	5.9	14	29	4.4	35	13
Reduced tillage technology is difficult to manage	4.4	43	29	2.8	83	17	4.7	33	33	4.3	57	14	4.0	57	22
Fertilizer and weed control techniques are difficult to manage	2.4	86	14	1.5	100	0	2.0	100	0	5.1	43	43	3.0	78	17
Risk of crop losses is higher	2.3	71	0	1.5	100	0	2.7	33	0	3.6	57	14	2.5	74	4

[a]The "index values" used by farmers to rate the relative importance of potential problems ranged from "1", indicating the absence of a problem, to "10", indicating the presence of an important problem. The "% unimportant" response reflect the sums of "1," "2," and "3" responses. The "% important" reflect the sums of the "8," "9," and "10" responses.

ANNEX C

GENERAL PROCEDURES AND ASSUMPTIONS NON-MACHINERY, PESTICIDE, AND FERTILIZER INPUTS

Information on inputs other than machinery, pesticides, and fertilizers was not requested in the survey questionnaire. The procedures and assumptions used to develop coefficients for these other inputs in the budgets for the different crops and farmers are outlined in what follows. In some cases, the coefficients for given inputs and crops vary among farmers by region and/or yield; in others, the coefficients were assumed to be common for all farmers producing a crop, regardless of the farmer's location or crop yield.

Seed expenses, which vary regionally, were taken directly from Pflueger (1985). **"Other farm overhead expenses"**--which account for farm magazines, farm management services, marketing and credit management, "trips to town," and other farm-level activities--were also taken directly from Pflueger (1985). They vary regionally, by value of crop, and whether or not summer fallowing is involved.

The assumed **storage** ($0.11/bu) and **drying** ($0.15/bu) costs were taken directly from Dobbs, Weiss, and Leddy (1987). The storage costs were based on 18-ft round metal bins with a 4,200 bu capacity. The drying costs include a $0.0041/bu labor charge. Other assumptions taken from this same reference are (1) a 12% annual **interest rate** applied to all direct costs except labor, with an average operating loan period of 6 months, and (2) land **ownership cost factors** for real estate taxes and annual land ownership of 1.5% and 6%, respectively, of the estimated per-acre land values. The estimated per-acre land values were based primarily on Janssen (1986 and 1987).

The amount of **machine operator labor** for each field operation was assumed to be 10% greater than the respective actual field machine time. A wage rate of $6.00/hour was assumed for **machine operator labor.** A wage rate of $4.00/hour was assumed for soybean **hand weeding labor.** These wage rates are the same as those used in Dobbs, Thaden, and Peckham (1987) and in Dobbs, Weiss, and Leddy (1987). They are listed in the crop budget spread sheets for "Labor 1" and "Labor 2," respectively.

Multiple peril federal **crop insurance,** including hail and wind coverage, was assumed to be purchased. The insurance premium for each crop and farmer was based on the location of the farmer, 65% of his/her respective estimated crop yield being insured, the "medium" crop price election, the appropriate fallow or continuous crop rate, and dryland production conditions.

Harvesting was assumed to be custom hired for each crop and farmer. The custom rates of $5/acre for swathing and $13, $16, and $17/acre for combining wheat, corn, and soybeans, respectively, were based on Thaden (1987). Grain hauling was

assumed to be via a 260 bu gravity box; the procedure outlined in Dobbs, Weiss, and Leddy (1987) for relating hauling costs to crop yields was followed in our study.

ANNEX D

TABLES SHOWING THE MACHINERY SPECIFICATIONS AND HERBICIDE PRICES ASSUMED IN DEVELOPING THE CROP BUDGETS

Annex D, Table 1. Common implements assumed to be used by the surveyed reduced tillage farmers.

Implement	Assumed width (feet)	Tractor horsepower requirement
Tandem disk	25	140
Chisel plow	25	220
Field cultivator	23	125
Rod weeder	24	80
Spike tooth harrow	48	180
Stalk chopper	12.5	60
Fertilizer spreader (dry broadcast)	45	60
Press drill	24	125
Air seeder (hoe drill, no-till drill)	28	140
Row crop planter[a]	15	60
Ridge till planter[a]	15	125
Spray coupe	50	[b]
Skid sprayer	40	[c]
Row crop cultivator[a]	15	60
Ridge till cultivator[a]	15	125

[a]Six-30 inch rows.
[b]Self-propelled.
[c]Mounted in a 3/4 ton pick-up.

Annex D, Table 2. Assumed implement purchase costs and other assumptions on implement use, 1986[a]

Implement	Width (feet)	List price ($)	Cost basis ($)	Estimated hours of life	Field speed (mph)	Field efficiency (%)	Hours used annually
Press drill	24	22,900	19,465	1,000	4.0	70	100
Air seeder	28	27,685	24,915	1,000	5.0	70	100
Row crop planter	15	14,245	13,105	1,200	5.0	68	60
Ridge till planter	15	18,745	17,245	1,200	5.0	68	60
Spray coupe	50	11,200	9,800	1,000	9.0	75	50
Skid sprayer	40	3,200	2,880	1,000	9.0	75	50
Row crop cultivator	15	3,172	2,855	2,000	3.8	76	100
Ridge till cultivator	15	8,800	7,920	2,000	3.8	76	100

[a]Analogous data for the other 7 implements and the 8 tractors assumed to be used in this study are found in Dobbs, Thaden, and Peckham (1987). The 8 implements in this table were all assumed to be owned for 10 years.

Annex D, Table 3. Assumed farm-level herbicide prices, 1986.

Herbicide	Price	Herbicide	Price
Atrazine, 90 DF	$ 2.35/lb	MCP, ester	$16.80/gal
Banvel, 4L	56.80/gal	One-shot, 3E	39.00/gal
Basagran, 4L	52.75/gal	Round-up, 3L	82.90/gal
Eradicane, 6.7E	21.50/gal	Sencore, 4L	197.50/gal
Estron 99, 3.8E	10.95/gal	2,4-D, 3.8E	10.95/gal
Glean, 75 DF	16.35/oz	Treflan, 4E	26.90/gal
Lasso, 15G	0.85/lb		

Source: Wrage and Johnson (1987) for all herbicides except "One-shot". A current local supplier price for "One-shot" was obtained, and an appropriate 1988-1986 price adjustment (based on USDA, 1988) was made to the price.