



Economics of Conservation Tillage

There are many potential economic advantages for reducing the number of tillage operations for crop enterprises. These include: 1) lower fuel costs due to fewer trips over the field, 2) reducing the amount of tillage equipment needed, which results in lower machinery investment, 3) lower labor requirements, which reduce hired labor costs or free up operator time for other farm operations, 4) reducing soil loss from water and wind erosion, and 5) conserving soil moisture. In the late 1970s and early 1980s much of the interest in conservation tillage was sparked by increasing fuel costs, but today much more emphasis is being placed on conservation tillage as a means of reducing soil erosion.

TILLAGE SYSTEMS OVERVIEW: PROS AND CONS

Tillage systems most commonly used in Pennsylvania include conventional, minimum, and no-till. In other parts of the country, ridge-till and mulch-till have gained some popularity, but to date have not found widespread usefulness here. General considerations of the first three systems are outlined below. It also is possible to rotate tillage strategies.

Conventional Tillage

Conventional tillage involves the use of a moldboard plow as the primary tillage tool followed by multiple trips with secondary tillage tools like disks, harrows, and field cultivators. The purpose of the moldboard plow is to pulverize and invert the soil, which buries crop residue, aerates the soil, helps control crop pests, incorporates fertilizers, and provides a good seedbed for better germination. Moldboard plowing has heavy draft requirements and generally is done at a speed of 3 to 4 miles per hour. Therefore, moldboard plowing requires

more fuel and labor and larger tractors than minimum tillage or no-till systems. After moldboard plowing, secondary tillage operations are used to prepare the ground for planting. In Pennsylvania, this generally means disking one or more times to break up soil clods, close air pockets, firm the seedbed, and kill weeds.

Major drawbacks of conventional tillage are the additional trips across the field, higher labor, fuel, and machinery costs, potential negative impact on timeliness, and long-term potential for soil compaction. From a conservation standpoint, increased tillage tends to reduce crop residue on the soil surface, which increases the potential for erosion, decreases soil organic matter and moisture, and may adversely affect soil structure and tilth.

Minimum Tillage

Minimum tillage generally refers to a set of tillage operations in which moldboard plowing is replaced by chisel plowing or additional disking, which is less disruptive to the soil. Chisel plows break and shatter the soil, but do not turn the soil over like a moldboard plow. Therefore, most of the crop residue is left on the soil surface when chisel plowing. Crop residues left on the surface retain soil moisture and help reduce soil erosion. The number of trips across the field are decreased, reducing both the potential for soil compaction and the cost of producing the crop. Minimum tillage can be an effective way to reduce labor requirements and costs for seedbed preparation if the number of secondary tillage operations are kept to a minimum.

No-Till

No-till is the practice of planting without any seedbed preparation. Rather than a number of trips across the field, as under

either conventional or minimum tillage, no-till planting is accomplished in one pass. The associated benefits are similar to those discussed when comparing minimum tillage to conventional tillage, but to a greater extent: greater erosion control, better soil moisture conservation, reduced soil compaction, increased time savings, reduced fuel requirements, and less wear and tear on equipment. Pulling a no-till planter through crop residue requires more draft than a standard planter on a conventional or minimum till seedbed, but this is compensated by the elimination of all field preparation activities.

No-till does not necessarily mean that there are no subsequent field operations after planting. These may include some cultivation, fertilization, or spraying, for instance, so compaction effects are not completely avoided. In some cases, the combination of heavy traffic at harvest, manure spreaders, and driving on wet soil can actually cause increasing subsoil compaction over the years, especially on certain soil types. For more information on compaction, consult other publications in this series.

Rotated Tillage Strategies

Just as crop rotation is an important management technique to enhance production, reduce pests, and decrease risk, rotating the type of tillage used can be beneficial. If you have access to different types of equipment for tillage and/or planting, rotating tillage can help to break weed cycles, as well as stimulate different soil processes.

Decisions as to what type of tillage to use in any given year will depend on what crop you are planting and on the existing weed problems in your field. Some farmers have found it beneficial to plow their no-till fields every three to five years. Tillage helps release nutrients

tied up in soil and helps reduce perennial weed problems that can build up in continuous no-till situations. By no-tilling in fields that were typically plowed every year, you can save fuel and labor with considerably fewer passes over the field. In addition, you can begin to build up organic matter when the soil is not heavily tilled.

COMPARING THE ECONOMIC COMPONENTS OF TILLAGE SYSTEMS

When evaluating whether a particular tillage system will work for you, the expected costs associated with each set of practices must be considered. How well each system works will depend upon multiple factors and will result in different fixed and variable costs and gross returns.

A good source of information on the differences in the cost of production by tillage practice can be found in the Pennsylvania Five Acre Corn Club annual summaries. Budget data from 1990 to 1994 indicates that some of these cost differences are evident (Table 1). The annual summary of the budget data

breaks entries into three tillage classes: conventional tillage if a moldboard plow was used, reduced tillage if chisel plows or multiple diskings were used, and no-till if no land preparation was done before planting. During this four year period, data from 340 farmers was collected, with 177 using conventional tillage, 108 using reduced tillage, and 55 using no-till.

Seed, fertilizer, and lime expenses were similar across the three tillage systems. Seed costs were slightly higher and fertilizer costs were slightly lower in no-till. The difference in seed cost may relate to either higher seeding rates to compensate for possible poor germination because of lower soil temperatures, or to planting conditions that lead to poor seed coverage. In each of these four years, no-till had the largest plant population of the three systems. Reduced fertilizer costs in no-till systems resulted primarily from lower expenses for pre-plant and starter fertilizer than systems using conventional and minimum tillage.

Pesticide costs are where some of the major differences in cost between the tillage systems become most evident.

Table 2. Average corn yield for three tillage systems, Pennsylvania Five Acre Corn Club, 1987-95 (bu/A).

Year	Conventional tillage	Reduced tillage	No-till
1987	147.5	142.8	140.8
1988	122.0	133.6	115.9
1989	134.6	145.6	151.4
1990	147.2	158.8	167.7
1991	142.3	131.8	121.9
1992	156.3	166.9	171.2
1993	150.5	148.6	160.7
1994	170.6	170.9	156.9
1995	145.5	152.4	150.3
Average	146.3	150.2	148.5
Average yield	Number of years		
Highest	2	3	4
Middle	3	5	1
Lowest	4	1	4

Herbicide costs are slightly higher in reduced tillage compared to conventional, but are \$8.51 per acre higher (+47%) in no-till than in conventional. Insecticide data show that reduced tillage farmers spent about \$2 per acre more than conventional or no-till farmers. Machinery operating expenses (fuel, lubrication, repairs, and maintenance) show similar costs for conventional and reduced tillage, but are \$7.59 per acre lower (-36%) for no-till. Overall, total variable costs are fairly similar, with conventional tillage being \$4 to \$8 less per acre, on average, than the others.

The major difference in profitability between the three systems comes not from average yield differences (which are within 2 bushels of one another) or variable costs, but from the difference in machinery fixed cost. Machinery ownership costs conventional and reduced tillage farmers \$17 to \$20 per acre more (+70 to 85%) than no-till farmers. Having a slightly higher yield and lower total costs made no-till the most profitable system (on average!) for this five-year period.

Table 1. Tillage system cost of production and profitability, Pennsylvania Five Acre Corn Club, 1990-94.

Item	Conventional tillage (\$/A)	Reduced tillage (\$/A)	No-till (\$/A)
<i>Selected variable costs</i>			
Seed	\$23.30	\$23.06	\$24.41
Fertilizer	\$44.22	\$45.99	\$40.03
Lime	\$9.77	\$8.37	\$9.27
Herbicides	\$18.16	\$18.81	\$26.67
Insecticides	\$4.97	\$6.90	\$4.71
Machinery operating	\$21.20	\$21.50	\$13.61
Custom hire	\$6.65	\$7.29	\$13.30
Total variable costs	\$154.13	\$162.63	\$158.39
<i>Fixed costs</i>			
Machinery ownership	\$43.99	\$40.69	\$23.89
Total costs	\$198.13	\$203.32	\$182.27
Returns to land and management	\$186.77	\$187.12	\$208.51
Yield (bu/A)	149.5	147.8	149.8

Table 3. Cost of tillage and planting operations (\$/A).^a

Operation	Equipment size	Tractor variable	Fixed costs	Equipment variable	Fixed costs	Labor cost	Total cost	Custom rate
Moldboard plowing	5-btm	3.81	3.99	1.92	4.31	4.40	18.43	11.40
Chisel plowing	12 ft	2.86	2.99	.79	1.42	3.30	11.36	10.60
Disking	12 ft	1.53	1.48	1.41	3.76	2.20	10.38	9.20
Field cultivating	12 ft	1.53	1.48	.98	1.81	2.20	8.00	8.20
Springtooth harrowing	12 ft	1.53	1.48	1.00	1.65	2.20	7.86	7.40
Conventional planting	6-row	2.51	2.53	1.78	4.57	3.10	14.49	11.50
No-till planting	6-row	3.00	3.02	1.99	5.11	3.70	16.83	13.60
Row cultivating	6-row	1.39	1.34	1.45	2.69	2.00	8.88	8.20
Boom spraying	30 ft	.97	.94	.50	.93	1.82	5.16	6.80

^aOperator labor is charged at \$10/hour and fuel at \$1.00/gallon.

Depreciation is figured on a straight-line basis for a farm with 150 acres of corn.

Yield Variability

One of the most frequently asked questions about alternative tillage systems is what impact they have on yield. In areas with adequate and timely precipitation, conventional tillage has been shown to have a fairly consistent yield advantage over no-till. In areas with a greater drought potential, no-till systems have been shown to have a yield advantage over conventional systems.

From the experience of the farmers in the Pennsylvania Five Acre Corn Club over the past nine years, it appears that reduced tillage and no-till had a slight yield advantage over conventional tillage (Table 2). Although the average difference is small (less than 4 bushels), the year-to-year variability appears to be quite different for each system. No-till, for example, showed a pattern of either having the highest or lowest yield in a given year. Reduced tillage consistently yielded in the middle. Conventional tillage showed a little less variability than no-till, but it also did not show as much potential for consistently high yields. Of course, this data is no guarantee that a given tillage system will perform the same way on your farm.

In selecting a tillage system, consider your attitude towards yield variability and production risk. Trading off some

profit potential for less production variability is a commonly used agricultural risk management strategy.

Machinery and Labor Costs

Data from the Five Acre Corn Club indicates that the biggest differences in cost between tillage systems are those related to machinery operation and ownership. The Five Acre Corn Club data, however, lacks the necessary detail to make comparisons among the tillage systems. First, the data does not break down costs by type of equipment or operation. Second, it does not account for labor requirements and costs. In Table 3, the costs of various field operations are listed on a per acre basis for various pieces of medium-sized equipment. Other sizes of the same types of equipment would have different costs. For larger equipment, you would have higher depreciation costs, but lower labor costs. For smaller equipment, you would have lower depreciation costs, but higher labor costs.

Fuel costs per acre do not vary greatly depending on equipment size. In Table 3, machinery costs are broken down into five categories: tractor variable, tractor fixed, equipment variable, equipment fixed, and labor. Tractor and equipment variable costs include the cost of repairs and maintenance and fuel for the tractor.

Table 4. Examples of tillage system costs and labor requirements.

Field operation	Cost (\$/A)	Labor (hrs/A)
<i>Conventional tillage</i>		
Moldboard plow	18.43	.44
Disk (x2)	20.76	.44
Harrow	8.00	.22
Spray	5.16	.18
Plant	14.49	.31
Total, conventional	\$66.84	1.59
<i>Reduced tillage</i>		
Chisel plow	11.36	.33
Disk (x2)	20.78	.44
Spray	5.16	.18
Plant	14.49	.31
Total, reduced	\$51.79	1.26
<i>No-till</i>		
Spray (x2)	10.32	.36
No-till plant	16.83	.37
Total, no-till	\$27.15	.73

Fixed costs are the cost of depreciation, shelter, and insurance. Labor costs are based on the amount of field time required to complete the operation. Repair and fuel costs are estimated using engineering data on tractor and equipment performance.

An example of the cost of field operations for each of the three tillage systems is given in Table 4. In this example, conventional tillage consists of moldboard plowing, two diskings, and harrowing, while the minimum tillage consists of plowing and two diskings. No-till means no seedbed preparation and direct planting into crop residue. Each system had one spray for preemergence weed control and no-till had an additional burndown herbicide application. Other operations that could be added would be for post-emergence weed control (either with herbicides or the row cultivator) or insect control.

From this example, it is obvious that conventional tillage, according to these assumptions, costs much more than ei-

ther reduced or no-till and also requires a lot more labor. Labor requirements for no-till are less than half those for the conventional tillage example. This labor advantage has benefits from both a timeliness and labor management standpoint. If limited time is available for field operations because of weather or other demands, no-till may allow for more optimal corn planting. Even when field conditions are favorable for tillage operations, no-till can save a significant amount of time that could be used more profitably.

It also is important to compare the cost of machinery ownership to custom hire or other arrangements. It is possible that many field operations could be custom hired at a lower cost than doing them on-farm. If labor savings are a critical issue, custom hire may be a better solution than changing the tillage system.

Timeliness

The variable weather patterns that occur during the spring can often make it difficult to predict how well planting will proceed. Wet weather can delay field operations and cause planting to occur later than the optimal planting period. Such a delay can have a large effect on crop production and often can require rethinking of cropping plans.

Some ways to counter the time crunch in the spring include custom hiring of some operations like manure hauling or herbicide spraying or by reducing or eliminating tillage operations where possible. Fewer field days are needed to plant a crop under reduced tillage or no-till. In addition, no-till planting can be done on fields that are too wet for tillage operations. Corn planted after the optimal planting period (the last week of April and the first week of May), generally experiences a decline in yield of about one bushel per acre per day past optimum planting. At a certain point, revising crop choices may be the best alternative. Substitution crops like soybeans or sorghum are less sensitive to late planting than corn. From a profitability or feed production standpoint, however, corn planted during the optimal

planting period exceeds that of any other alternative crop by a wide margin.

Pest Management Costs

In Pennsylvania, the conventional tillage system is popular with many farmers because it helps control weeds, insects, and diseases. For adequate pest control in conservation tillage systems, more attention to crop rotation and pest scouting may be necessary. Occasionally, there is also a need for increased pest control treatments.

Weeds

In reduced tillage systems, higher herbicide rates are often required because crop residue left on the surface may interfere with the activity of preemergence herbicides. Volunteer corn can be a serious problem in minimum tillage if field losses were high during the previous year. If high field losses occur, gleaning or no-tilling the fields is recommended.

Weed management under no-till is more complicated than under conven-

Table 5. Cost of selected burndown, preemergence, and postemergence herbicides in corn.^a

Herbicide	Herbicide cost (\$/unit)	Low rate	High rate	Unit	Cost range	
					Low	High
<i>Burndown</i>						
Gramoxone Extra 2.5S	3.95	1.5	3	pt	5.93	11.85
Roundup 4S	5.60	0.75	8	pt	4.20	44.80
Bladex 4L	6.25	1.3	4.8	qt	8.13	30.00
<i>Preplant/preemergence</i>						
Atrazine 4L	3.15	1	2	qt	3.15	6.30
Bladex 4L	6.25	1.2	4	qt	7.50	25.00
Dual 8E	8.05	1.5	3	pt	12.08	24.15
Frontier 7.5E	0.90	13	25	oz	11.70	22.50
Harness Plus 7E	9.30	1.25	3	pt	11.63	27.90
Lasso-MT	6.90	2	4	qt	13.80	27.60
Lorox 50DF	10.50	0.7	1	lb	7.35	10.50
Princep 4L	2.10	1	2	pt	2.10	4.20
Prowl 3.3E	6.20	1.8	4.8	pt	11.16	29.76
Pursuit 2AS	4.90	4	4	oz	19.60	19.60
Surpass 6.4E	8.40	1.5	3	pt	12.60	25.20
<i>Postemergence</i>						
2,4-D amine	1.55	0.5	1	pt	0.78	1.55
Accent 75DF	29.00	0.67	0.67	oz	19.43	19.43
Banvel 4S	9.85	0.5	1	pt	4.93	9.85
Basagran 4S	8.80	1.5	2	pt	13.20	17.60
Beacon 75DF	27.20	0.76	0.76	oz	20.67	20.67
Buctril 2E	7.10	1	1.5	pt	7.10	10.65
Stinger 3S	58.95	0.25	0.66	pt	14.74	38.91

^aThis information is provided for planning purposes only; not all alternatives or combinations are listed. Check with your agricultural input supplier on the availability and cost of individual herbicides. Prices do not reflect discounts or price incentives which may exist. In addition, the cost of surfactants and crop oil concentrates (if needed) have not been included.

tional or minimum tillage. Because tillage operations are not used to reduce weed populations, producers depend on herbicides to a much greater degree. In particular, certain perennial weeds including brambles, sumac, orchardgrass, curly dock, wirestem muhly, and hemp dogbane can become problematic. Burndown applications of paraquat, glyphosate, or cyanazine are typically substituted for tillage to achieve initial weed control. Paraquat and cyanazine are used to help control annual weeds, and glyphosate is used to kill sod and improve grass control. Post emergence herbicides are also more likely to be required under no-till. The costs of selected burndown, preemergence, and post emergence herbicides are listed in Table 5.

Increased use of specific crop rotations to suppress weeds in reduced tillage situations is often a viable strategy to help control weeds. For a complete listing of weed management alternatives, consult the Penn State Agronomy Guide, a cooperative extension agent, a crop consultant, or an agricultural input supplier. Other publications in this series contain additional information on weed control under reduced tillage.

Insects and Slugs

Pest populations should be monitored more closely under no-till. Because no-till increases crop residue and soil moisture, it changes the overwintering sites and microenvironment experienced by insects and slugs. For example, substantial increases in the population of black cutworms, stalk borers, and armyworms are possible in no-till corn. Because of these pests, insecticide use is more common in no-till corn than in other production systems. The insecticide costs for controlling these pest ranges from just over \$5 to almost \$23 per acre depending on the pest, insecticide, and application rate (Table 6).

Other insects that could increase in population in no-till systems include corn earworm, European corn borer, wireworms, seed corn maggots, and white grubs. Slugs, although not a widespread problem, are also more likely to

Table 6. Cost of pesticide applications for black cutworm, stalk borer, armyworms, and slugs.^a

Pest/pesticide	Pesticide cost (\$/unit)	Low rate	High rate	Unit	Cost range	
					Low	High
CUTWORM						
<i>Insurance treatments</i>						
Lorsban 15G	1.70	6.7	13.5	lb	11.39	22.95
Asana XL	1.05	5.8	9.6	oz	6.09	10.08
Dyfonate 15G	1.65	6.7	6.7	lb	11.06	11.06
Ambush 2.0 EC	0.85	6.4	12.8	oz	5.44	10.88
Pounce 3.2 EC	1.35	4	8	oz	5.40	10.80
Force 1.5G	1.80	6.5	8.1	lb	11.70	14.58
<i>Responsive treatments</i>						
Sevin 4F	2.80	2	4	pt	5.60	11.20
Lorsban 4E	5.90	2	3	pt	11.80	17.70
Asana XL	1.05	5.8	9.6	oz	6.09	10.08
PennCap M	2.95	2	4	pt	5.90	11.80
Ambush 2.0 EC	0.85	6.4	12.8	oz	5.44	10.88
Pounce 3.2 EC	1.35	4	8	oz	5.40	10.80
COMMON STALK BORER						
Lorsban 4E	5.90	2	3	pt	11.80	17.70
Asana XL	1.05	5.8	9.6	oz	6.09	10.08
Ambush 2.0 EC	0.85	6.4	12.8	oz	5.44	10.88
Pounce 3.2 EC	1.35	4	8	oz	5.40	10.80
TRUE ARMYWORM						
<i>Insurance treatments</i>						
Furadan 4F	15.45	1	1	qt	15.45	15.45
Lorsban 4E	5.90	1	2	pt	5.90	11.80
Asana XL	1.05	5.8	9.6	oz	6.09	10.08
Ambush 2.0 EC	0.85	6.4	12.8	oz	5.44	10.88
Pounce 3.2 EC	1.35	4	8	oz	5.40	10.80
<i>Responsive treatments</i>						
Lorsban 4E	5.90	1	2	pt	5.90	11.80
Asana XL	1.05	5.8	9.6	oz	6.09	10.08
Malathion 57% EL	2.35	1.5	2	pt	3.53	4.70
Lannate 90SP	18.20	0.3	0.5	lb	4.55	9.10
Ambush 2.0 EC	0.85	6.4	12.8	oz	5.44	10.88
Pounce 3.2 EC	1.35	4	8	oz	5.40	10.80
SLUGS						
Deadline bullet	1.55	10	40	lb	15.50	62.00

^aThis information is provided for planning purposes only; not all alternatives are listed. Check with your agricultural input supplier on the availability and cost of individual pesticides. Prices do not reflect discounts or price incentives which may exist. In addition, the cost of adjuvants (if needed) have not been included.

be a problem in no-till fields. The cost of control for slugs is high, varying from \$15.50 to \$62 per acre (Table 6). For a complete listing of pest management alternatives consult the Penn State Agronomy Guide, a cooperative extension agent, a crop consultant, or an agricultural input supplier.

Diseases

Certain diseases may also be a problem in no-till corn, especially in continuous corn. Increased crop residue, shade, and moisture provide a favorable environment for certain disease pathogens to thrive and overwinter.

Effects on Soil

Soil Moisture

Proper soil moisture conditions are critical for no-till planting because planting when the soil is too wet or too dry may result in a poor stand and potential yield loss. Wet soils are often cooler in the spring and may result in slow or poor germination. If soil moisture conditions are successfully managed, a potential benefit of conservation tillage is that more soil moisture is conserved for crop use. Conservation of soil moisture is a major consideration for farmers in the Great Plains using a wheat-fallow rotation, where the land lies fallow every other year to store up adequate soil moisture. In Pennsylvania, the moisture conserving nature of conservation tillage may reduce the variability of crop yields on droughty soils or help farmers withstand periodic droughts.

Soil Erosion

The economic benefits of soil conservation are the most difficult to assess. The erosion of topsoil will eventually affect the ability of some land to produce crops. Erosion control is a long term benefit that may not have measurable impacts for many years. Researchers who study the effect of erosion on crop yields usually report their results for 50 or 100 year time horizons. Productivity losses depend to a large extent on the initial quality of the soil resource and the slope of the land. For example, most

soils with slopes of 0 to 2 percent will experience a loss in productivity of less than 1 percent over a fifty year time horizon. The same soils on a 6 to 12 percent slope, however, may experience a loss in productivity of 15 to 20 percent during a similar time period. Other soils are so deep that a similar amount of erosion will cause little drop in productivity over a 50 or 100 year time horizon.

Soil erosion rates alone are not a good indicator of damage to productivity. Lost nutrients from crop lands are valued at over \$1 billion per year. If we assume all these nutrients come from cropland, that amounts to over \$3 per acre in lost nutrient value. Replacing these nutrients with chemical fertilizers means increased variable costs of production. In addition, soil loss from agricultural lands has been estimated to cause in excess of \$2 billion annually in downstream damages.

In the end, how you value erosion control depends on your own resource situation. Soil erosion usually is not a short-term productivity question. Some suggest that technological advances will overcome the negative effect of topsoil loss, while others predict that productivity will be permanently affected unless stringent measures are used to stop erosion. Conservation compliance is an example of a governmental approach to alleviating the erosion problem. Failure to comply with conservation requirements could result in the loss of farm program benefits either now or in the future. These types of policies impact both costs and returns, and participation must be evaluated on an individual basis.

PRODUCTION DECISION MAKING

Two important economic questions are raised when comparing tillage systems. First, does it really pay to use a tillage system other than the one currently in use? Second, if it is economical to switch, which system would be the best? Changing tillage systems will have an impact on both the variable and fixed costs of production. Variable costs are those that vary with the level of production and are dependent on the system of

production. Examples of variable costs that would change depending on the tillage system are fuel, labor, and pest control costs. Fixed costs are those which are incurred because of the ownership of an asset. They cost the farmer regardless of the level of production. Examples include depreciation, interest, taxes, insurance, shelter, and land. In the case of tillage systems, the major differences in fixed costs are for equipment. There are major differences in the types of tillage equipment and size of tractors needed for different tillage systems. Therefore, machinery costs are a major consideration when comparing tillage systems.

Enterprise Budgets

The first step to understanding how tillage systems affect profitability is to know your production costs. An enterprise budget can help you determine these production costs. Enterprise budgets are most often developed for a single, representative acre, but could be developed for fields or crops. An enterprise budget details all the receipts and costs associated with producing a particular crop. The first step is detailing the receipts or sources of income for the enterprise. In the case of corn, the source of income may include the value of grain, silage, and stover; each of which has a different yield and market price. It is important to include all sources of income. The second step is to enumerate the costs of all the inputs used in the production of the crop. This step includes both the variable costs (sometimes called cash or out-of-pocket expenses) and the fixed cost. The major consideration in figuring fixed costs is depreciating fixed assets (for example, machinery) over their economic life rather than the number of years allowed for under the tax law. Depreciation rules for tax purposes allow for either a 7- or a 10-year recovery period, while farm machinery is often used for 15, 20, or 30 years (the "economic life" of the machine).

Enterprise budgets are published by Cooperative Extension in many states as planning tools that provide producers

Figure 1. Partial budgeting format.

PROPOSED CHANGE:

Additional costs (\$)

Additional income (\$)

Reduced income (\$)

Reduced costs (\$)

Total additional costs and reduced income

(\$)

Total additional income and reduced costs

(\$)



-

(\$)

NET CHANGE IN PROFIT

=

(\$)

INTANGIBLES (+):

INTANGIBLES (-):

with general information for several different uses. They do not apply directly to individual farms or specific locations and should only be used as guides for preparing budgets for your individual situation. Users should think of these budgets as first approximations and make appropriate adjustments to reflect their particular growing conditions and production systems. Budgets for corn grain, corn silage, and soybeans for conventional tillage, reduced tillage, and no-till can be found in the Penn State Agronomy Guide.

Partial Budgeting

An economic tool for comparing tillage system benefits and costs is partial budgeting. Partial budgeting is a farm management technique used to examine the profitability of incremental changes in the production technology, size or scale of operation, or product mix. A partial budget contains only those income and cost items that will change if the proposed change is undertaken. Only the changes in income and expenses are used for a partial budget analysis, not the total values. The final result is an estimate of the increase or decrease in profit attributable to the change. Decreased revenues and increased costs are subtracted from

increased revenues and decreased costs to identify the net effect of the change. The four questions you should ask when preparing a partial budget are:

- What new or additional cost(s) will be incurred?
- How much current income will be lost or reduced?
- What new or additional income will be received?
- Which current cost(s) will be reduced or eliminated?

The first two questions identify changes that will reduce profit by increasing costs or reducing income. The second two questions identify changes that will increase profit by increasing income or reducing costs.

A widely used partial budget format can be found in Figure 1. This budget will help organize the cost and income change data relating to the four partial budgeting questions. In the case of tillage systems, the new or additional costs that may be incurred include the costs of additional equipment or more closely monitoring pest populations (question 1). These costs may take the form of additional inputs, equipment, and managerial time. Current income that may be reduced might take the form of changes in

crop rotation or harvest method (question 2). New or additional income may take the same form. For example, before changing tillage systems, we may have had a different timeliness and yield potential, which might mean we are reducing our income due to having lower yield or quality. For question 3, however, we would be increasing our income potential by having more of some other farm product to market. For question 4, current costs may be reduced because of changing input and machinery usage. The information in Tables 2, 3, 5, and 6 are a useful starting point for answering some of these questions.

Because all decisions also have non-economic aspects, it is important to list the intangible considerations. Possible considerations might include family goals (e.g., more vacation time) or production philosophies (e.g., the use of low-input production methods). These considerations might also have positive and negative aspects. In some situations, intangibles may carry a greater weight in the decision-making process than purely economic factors.

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