Evaluating Tillage Options for Your Farm

GHG Taking Charge Team Factsheet

Your tillage system is important to the long-term sustainability of the farm enterprise. Matching a crop tillage system that is suited to your farm resources can provide both economic and environmental benefits. It is important to evaluate your land and determine what options would be appropriate.

Several questions have arisen regarding new approaches or options in tillage systems compared to a conventional system. This factsheet will look at some alternatives to conventional tillage and evaluate the advantages and disadvantages associated with each as they apply to field crops in New Brunswick. The economics of each tillage approach is closely related to the soil, climate, and topography of the production field.

What are the options?

Tillage options range from no-till, with minimal soil disturbance, through to conventional tillage with plowing, disking, cultivating, and planting. Conservation tillage is a reduced tillage system that reduces the number of land preparation passes, and increases surface residues to greater than 30% after planting, to protect soil and conserve water losses. There are many combinations and variations between conventional and no-till.

Generally, if the soil and its water management properties including topography are well suited, reduced tillage can save time, save fuel, reduce soil loss, and improve soil structure and water retention compared with a conventional tillage system. However it can present challenges if careful attention is not given to residue management, proper seeding, crop rotation, weed control, fertility, and pH management. Poorly drained or compacted soils are limiting factors in applying no-till or reduced tillage options. Implementing reduced or no-till will often require a transitional period. Starting with your best fields will allow you to gain experience in dealing with surface residue levels.

A healthy soil improves yields

What are the advantages and disadvantages of reduced tillage?

Advantages

- ✓ Potentially higher profits primarily from reduced inputs including fuel, machinery and labour costs.
- ✓ Reduced land degradation, erosion and runoff.
- ✓ Improvements to soil (structure, organic matter), improved moisture retention and sustainable yields, particularly in dry years.
- ✓ Less leaching of nutrients and chemicals.
- ✓ Comparable yields over time, but equal or more $/acre.
- ✓ Improved harvest conditions as a result of increased load bearing capacity of soil.

Disadvantages

- ✓ Not suited to poorly drained land.
- ✓ Higher initial investment in equipment, particularly if no-till approach used.
- ✓ Will require increased weed control management and herbicide use.

What are the key elements to evaluate when considering reduced tillage options?

Each of the following elements are important in a conventional tillage system, however introducing a reduced tillage system requires particularly good soil suitability information and subsequent management:

- ✓ Land suitability (including an assessment of fields to determine their suitability for reduced tillage)

- ✓ Soil type, drainage, compaction, erosion potential
- ✓ Crop selection
- ✓ Crop rotation
- ✓ Residue management
- ✓ Weed management
- ✓ Nutrient management
- ✓ Insect and disease management

Land Suitability

Soil type is very important to the success of reduced and no-till management. It is particularly important under our New Brunswick climatic conditions where abundant rainfall and cool temperatures in the spring and early season can impact field operations, germination and plant establishment. The following provides general information on the suitability of reduced tillage systems for various soil textures. It is strongly recommended that producers evaluate each field for its specific suitability.

Coarse textured soils: Sandy and sandy loam soils are characterized as droughty and are susceptible to erosion. They do dry quickly in the spring and may be planted earlier. Moisture retention is a concern and, as a result, these soils can benefit from reduced tillage. Leaving plant residues can reduce runoff, improve infiltration and reduce evaporation. No-till and reduced tillage are expected to equal or improve yield potential compared with conventional tillage on these excessively drained soils.

Medium textured soils: Medium textured soils under reduced tillage tend to provide increased yields compared to both no-till and conventional tillage. Special attention is needed in the spring to confirm that soils are ready for tillage. It is important to dig down to the depth of tillage and to see if the soil is friable enough. In general, no-till seeding may be done 2-3 days earlier than plowing can be done in conventional tillage systems because no-till seeding is done at a shallower depth. This earlier seeding may provide a slight yield advantage. Soil temperatures of 10^{o}C or higher would still be needed for corn production.

Fine textured soils: Reduced tillage may be successful only on the well-drained clay loams of these fine textured soils. No-till may have comparable yield potential with conventional tillage, and has the added benefit of improved soil erosion control. No-till systems require the use of tillage coulters. It is important to include a deep-rooted crop in rotations on these soils.

Note: On some of the heavier dykeland soils, no-till has been successful with small grains. No-till under these circumstances avoids bringing saline subsoil to the surface for mixing with topsoil. As well, it helps retain the form of dales reducing maintenance cost to re-shape them. (Rodd et al. 2002)

Very fine textured soils: These soils are susceptible to compaction and are late to warm up. Reduced tillage and no-till may not be suited to imperfectly drained soils of this texture. Fall plowing may be the only alternative open to producers. This introduces some risk of soil erosion, but this risk can be reduced by plowing on the contour with 10-15 cm (4-6") ridge heights.

Crop Selection

Crops selected for reduced or no-till systems must first have an adequate length of growing season to reach economic yields, therefore proper hybrid and variety selection for our climate is important. Field preparation, residue management, planting and nutrient supply must ensure good germination and growth. Weed, insect and disease management must be understood and addressed in the production system. Reduced tillage systems rely on optimal crop rotations and therefore careful crop selection is required.

Crop Rotation

Crop rotation is one of the keys to sustainable production and is very important in reduced tillage systems. They improve soil structure, soil organic matter and drainage. Crop rotations also increase moisture availability, reduce soil erosion, help control weeds and reduce dependence on herbicides, help control insects and diseases, and enhance soil nutrient status. They also enhance carbon storage and reduce carbon dioxide (CO_2) emissions. In addition to these many agronomic and environmental benefits, they can provide varying sources of income and help with time management by distributing the workload.

Residue management

Conventional tillage is used to reduce surface residues and prepare the field for planting. However, the long term impacts of this activity can result in significant annual soil losses, especially if done up and down slope in the fall. Previous studies in New Brunswick indicate a major impact of reducing soil loss as a result of residue cover. These studies further demonstrated that no-till, and reduced tillage systems such as use of a chisel plow, can reduce soil losses dramatically compared with conventional mouldboard plowing. At harvest, especially in small grains, even distribution of straw and chaff across the full width of the combine is essential in no-till.

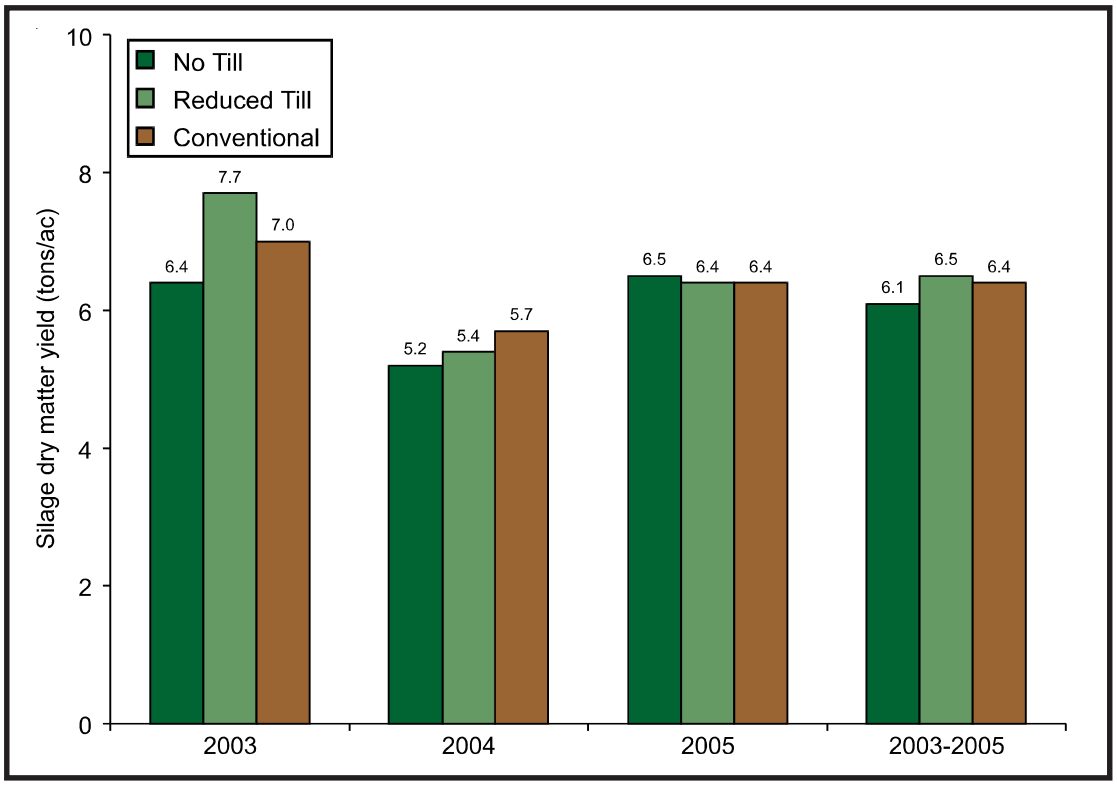

Figure 1. Silage corn yield under three tillage systems, averaged across sites.

Weed management

A weed management plan should be in place specifically tailored to the crop selection, the land suitability and tillage option chosen. An integrated approach to weed management and crop rotation is essential. In no-till, we see a shift in weed types from annuals to perennials. The use of herbicide tolerant crop varieties will allow for broader weed control options.

Insect and disease management

Just as in conventional tillage, an integrated pest management system includes careful selection of crop varieties or hybrids and use of crop rotation and crop scouting strategies to interrupt disease and insect life cycles. In reduced tillage with less cultivation, it is even more important to obtain good control particularly in the early stages of establishing a conservation tillage program.

Nutrient management

Manure can still be used in no-till systems, especially if injected. Manure injection also cuts down on ammonia losses. Under no-till, manure is trapped in place by surface residue, and this will increase manure infiltration into the root zone. On the other hand, no-till may present some risk with regard to manure entering soil macropores and making its way to drain-tile lines. This risk should be a consideration in environmental farm planning, and in outlet design and location.

Less runoff and more consistent supply of nutrients to the crop can result from improved soil quality. Some nutrients may accumulate at the soil surface over time under no-till. As well, New Brunswick soils are acidic in nature. Ammonia-based fertilizers will also contribute to soil acidity. Conventional tillage may then be required every 3-4 years to incorporate lime and redistribute nutrients within the root zone. This may also break up weed patterns. For example, if a dairy producer has been growing corn on the same land for 3 years and wants to move to alfalfa, conventional tillage could be used to incorporate lime and surface accumulated nutrients such as phosphorous. The alfalfa legume crop will fix nitrogen from the atmosphere and will reduce the requirement for ammonia based fertilizers.

Costs and Benefits

Recent results from the Greenhouse Gas Tillage Project in New Brunswick across several sites and conditions have indicated that in general, yields between the two systems have been comparable (Figure 1) and that there are some cost savings in favour of a reduced tillage system. Crop production costs for the two tillage systems are compared in Table 1. The major advantages of no-till are decreased labour requirements in the spring and decreased capital outlay for equipment. The increased herbicide costs under no-till are partially offset by fuel savings.

Table 1. Comparison of crop production costs per acre under conventional and no-till systems in 2005

	Feed Barley		Silage Corn	
	Conventional	**No-till**	**Conventional**	**No-till**
Operating Costs :				
Herbicide	$8.00	$30.00	$20.00	$42.00
Fuel	$18.00	$9.00	$26.10	$13.05
Machinery	$20.00	$10.00	$24.50	$12.25
Interest	$8.03	$8.23	$17.15	$16.97
Total	**$54.03**	**$57.23**	**$87.75**	**$84.27**
Fixed Costs :				
Machinery depreciation	$32.50	$24.38	$42.50	$28.05
Machinery investment	$12.00	$9.00	$15.00	$9.90
Total	**$44.50**	**$33.38**	**$57.50**	**$37.95**
Total Operating & Fixed Costs	**$98.53**	**$90.61**	**$145.25**	**$122.22**
Labour	**$22.00**	**$16.50**	**$32.00**	**$24.00**
TOTAL COSTS	**$120.53**	**$107.11**	**$177.25**	**$146.22**
Savings per acre from no-till	**$13.42**		**$31.03**	

Note 1: Assume management practices result in equivalent yields.
Note 2: Rock picking costs are not considered.

Although the benefits above are predominately short term, the successful implementation of reduced tillage systems can contribute to a more sustainable future for the agricultural industry. Proper site selection and planning are important to achieve the benefits of reduced tillage systems.

Contacts

For more information, please contact your local Crop Development Officer (1-888-NBAGRIC or 1-888-622-4742) or Soil Management Specialist (1-506-453-2109) with the New Brunswick Department of Agriculture and Aquaculture, or contact your Agri-environmental club coordinator.

References

Conservation Tillage. Factsheet, Land Resources Branch, New Brunswick Dept. of Agriculture. www.gnb.ca/0173/30/0173300002-e.asp

Nolan, S., D. Aspinal, J.Heard. 1990. Suitability of Conservation Tillage Systems to Ontario Soil Types. Ontario Ministry of Agriculture and Food. Agdex 512.

Toner, P. 2006. Crop Residue & Tillage Roughness Management. GHG Taking Charge Team Fact Sheet, NBSCIA.

Price, M., P. Toner, G. Sweetland. 2004. Conservation Tillage Options for Improved Forage Production. New Brunswick Dept. of Agriculture, Fisheries and Aquaculture. NBSCIA Fact Sheet.

Rodd, A.V. et al. 2002. Zero Tillage on the Dykelands, Fact or Fantasy? Agriculture and Agri-Food Canada Factsheet, Crops and Livestock Research Centre, Charlottetown, PEI, Nappan, NS.

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Greenhouse Gas Mitigation Program for Canadian Agriculture
Programme d'atténuation des gaz à effet de serre pour l'agriculture canadienne

Canadian Cattlemen's Association

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