ZERO TILLAGE: THE MANITOBA EXPERIENCE

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Zero tillage, as it pertains to Manitoba, refers to the planting of a crop into undisturbed stubble land with a minimum of soil disturbance, and chemical weed control where necessary.

The sequence of events in any one zero tillage crop year starts with the harvest of the preceeding crop and ends with the harvest of the crop in question. The major events are outlined in the following table:

Time Period	Operations
September - October	Trash management Fall weed control
October	Soil testing
May - June	Fertilizer application Seeding Initial weed control (total burn off)
June	Post emergence weed control
September - October	Harvest

FALL PROGRAM - Three operations must be carried out in the fall if successful zero tillage crop production is to be carried out the following year.

1. Trash management - Proper trash management is essential to ensure satisfactory planting the following spring. The goal is to have the crop residue chopped and evenly distributed across the soil surface. This can be accomplished by means of a properly adjusted straw chopper and tyne harrowing. Care must be taken not to cause soil disturbance during the harrowing operation.

An alternative method of trash management involves straw removal. This is suited to extremely heavy trash conditions, or to situations where there is a use for the removed crop residue. Experience has shown that most trash conditions can be handled without trash removal.

2. Fall weed control - Although fall weed control does not differ significantly from that used under conventional systems, it is more critical under zero tillage. Firstly, perennial weeds (quack grass, Canada thistle, sow thistle, dandelions) must be controlled. Standard recommendations are available for this purpose. Secondly, winter annual weeds (stinkweed, shepherd's purse, flixweed) must be controlled, because, if left until seeding time, these weeds will become resistant to herbicide applications. Again, standard recommendations are available for this purpose.

Under conditions of heavy growth of volunteer crops, it may be desirable to carry out a control program in the fall. Fortunately, in most cases, control will not be required since the volunteer stand will die off over winter.

3. Soil testing - Soil testing procedures are not different under zero and conventional tillage, but for reasons to be given later, it is essential that soil testing be carried out to determine the additional nutrient requirements.

CROPPING SEASON PROGRAM - If the previous three operations have been carried out adequately, then the following steps should lead to a successful crop.

1. Fertilizer application - Variable responses to nitrogen and phosphorous fertilizer have been reported from zero tillage research trials around the world. Frequently it has been stated that more nitrogen is required under zero tillage. Phosphorous requirements are generally reported to be similar under zero and conventional tillage.

Nitrogen response trials were conducted in Manitoba in 1972. Yield results for one location are reported in the following table:

N (kg/ha)	Wheat (kg/ha)		Barley (kg/ha)	
	Zero tillage	Conventional	Zero tillage	Conventional
0	2533	2863	3599*	4664
34	2930*	3300	4352	4869
67	3474	3468	5337	5482
101	3588	3347	5385	5493
134	3656*	3259	5482	5541
202	3965*	3219	5337	5477
269	3730*	3273	5229	5525
LSD (.05) within treatment	228	228	488	488

* different compared to the cultivated treatement

The above data was taken from a site in the first year of zero tillage management. A trial on a site under four years of zero tillage showed the same trend but results were not significant due to variability at the site.

For cereal crops, low nitrogen fertility will cause zero tillage to yield lower than conventional tillage crops, while near recommended nitrogen application rates, yields will be similar and at higher rates, there is a potential for increased yields.

The following practices should be followed with zero tillage.

a) Cereal Grains - All phosphate and potash, and nitrogen when possible, should be placed in the seed row for most efficient use of the fertilizer. The total amount of seed placed fertilizer must not exceed 195 kg/ha. Up to 45 kg. of actual nitrogen per ha (not more than 20 kg/ha of actual nitrogen in the urea form) may be placed with the seed. Urea or urea phosphate fertilizers should not be placed with the seed on coarse textured soils and should not be placed with the seed on any soil under a dry seed bed condition. Additional fertilizer requirements should be placed away from the seed by sidebanding or broadcasting and applied as close to the time of seeding as possible.

b) Rapeseed - No more than 20 kg/ha of phosphate should be placed in the seed row. At rates greater than 20 kg/ha, phosphate should be sidebanded about 2.5 cm. beside and below the seed row. To avoid seed injury, any nitrogen in excess of 7 kg/ha and all potash should be placed away from the seed by sidebanding or broadcasting. Nitrogen should be applied as close to time of seeding as possible.

c) Flax - To avoid seed injury, all fertilizer material should be placed away from the seed by sidebanding or broadcasting. Flax often does not respond to fertilizer phosphate unless the phosphate is banded about 2.5 cm. directly below the seed row. It may be advisable to attempt flax production under zero tillage only on soils testing high in available phosphate.

Post-emergence application of nitrogen (dry or solution) has given good response in many instances - extremely dry conditions following application may be exception. Fall broadcasting of dry or solution nitrogen sprayed on zero tillage mulch would expose the nitrogen to greater possible losses between the time of application and time of seeding. The zero tillage concept probably does not favor the use of anhydrous ammonia as a consequence of soil disturbance during the application which may increase weed problems.

2. Initial weed control - It is essential that any weed growth present at the time of seeding be destoryed or weeds will have a head start on the crop, will compete vigorously, and will be difficult to control with post emergence herbicides. If no weed growth is present at seeding time, then this segment of the program is not required.

Timing of herbicide application may vary slightly, either before or after seeding. Later applications will allow more weeds to emerge so that they will be controlled. However, later application also increases the risk of delayed treatment due to weather conditions. The most practical timing seems to be within a day or two of seeding. If poor weather conditions are expected, this time interval should be shortened, or the herbicide should be applied before seeding.

3. Seeding - Accurate seed placement at a proper depth is essential for successful production under zero tillage. For cereal and small seeded crops, the triple disc drill system has proved most suitable.

Emergence under zero tillage has been favourable in Manitoba trials. Three years of data at three locations are summarized in the following table:

Year	Site	Emergence (plants/1.5 m of row)							
		Wheat		Barley		Flax		Rape	
		ZT	C	ZT	C	ZT	C	ZT	C
1	1	44*	51	32	33	95	86	37	34
	2	60	62	40	41	87	106	54	43
	3	42	43	28	28	75	76	24	22
2	1	60*	49	27*	22	118*	87	11*	8
	2	61*	52	27	26	132*	90	24*	16
	3	57*	45	34*	28	108*	75	49*	33
3	1	65*	51	58	51	176*	77	58	49
	2	65*	57	58*	48	193*	115	55*	36
	3	58	59	70	75	161	164	57	56

* different compared to the cultivated treatment

The above data indicates that superior crop stands are frequently obtained under zero tillage. Differences were not associated with the first year of production, probably because of very favourable seedbed moisture conditions in 1969.

With zero tillage, the superior emergence, combined with more rapid early plant growth results in a heavy vegetative crop cover. This rapid growth is illustrated by the following data:

Crop	Week after emergence	Dry vegetative growth (g/30 cm row)	
		Zero tillage	Conventional
Wheat	2	1.1*	0.6
	4	6.0*	3.0
	6	25.5*	12.8
	8	40.8*	23.6
Barley	2	3.1*	0.7
	4	17.2*	6.2
	6	38.9*	18.7
	8	49.6*	31.2
Rape	2	1.6*	0.4
	4	10.5*	5.4
	6	15.1	16.3
	8	24.2*	19.1

* different compared to the cultivated treatment

It is possible that this heavier early growth provides for increased yield potential but, if nutrients are limiting, the amount of nutrients used to produce the stand reduces the amount available to contribute to yield and consequently grain yields may be reduced.

4. Post emergence herbicides - Since soil incorporated herbicides cannot be used under zero tillage, and pre emergent herbicides are generally ineffective under Manitoba conditions, selective weed control

must be achieved with post emergence herbicides only. This limits the selection of herbicides available but for crops such as wheat, barley, oats, flax and rapeseed, alternative herbicides can be used. For crops where post emergence herbicides are not available, zero tillage crop production is not presently feasible.

In planning selective weed control for zero tillage (or any tillage system) the weed problems should be identified, and the cropping rotation should be selected to allow for adequate herbicide applications.

YIELD RESULTS - Yield is the final measure of any production system. Results from three years of trials were as follows:

Year	Site	Yield (kg/ha)							
		Wheat		Barley		Flax		Rape	
		ZT	C	ZT	C	ZT	C	ZT	C
1	1	2654	2392	2905	2954	903	759	682	600
	2	2896	2414	2513	2421	351	320	1535	1227
	3	965	765	462	503	597	798	579	577
2	1	a/	a/	a/	a/	a/	a/	a/	a/
	2	1996	1996	2141	1818	575	433	605	347
	3	2106	2003	2813	3287	991*	853	930*	468
3	1	2634	2547	2448*	3067	865	759	792	990
	2	1620	1438	1953	1953	984*	784	1513	1320
	3	1781	1996	2911	3228	1135*	872	b/	b/

* different compared to the cultivated treatment
a/ no yields as a result of hail damage
b/ no yields as a result of severe shattering

Under the management conditions of the trials wheat yields did not differ between the tillage treatments. Barley yield was reduced under zero tillage in one case where nitrogen was a limiting factor. Flax yieled higher in three instances, and rape higher in one instance under zero tillage.

The above results were taken from research trials. Can similar results be expected under commercial conditions? In 1977 thirteen Manitoba farmers cooperated with the Manitoba Department of Agriculture to evaluate zero tillage on a commercial scale.

Results were encouraging. When all steps in the recommendation program were carried out, adequate yields were obtained. The main factors causing problems in order of importance were:

1. trash management
2. drill modification
3. fall weed control (perennials)

At six locations, split fields allowed a yield comparison between convential and zero tillage. Yield results were as follows:

Location	Crop	Yield (kg/ha)		Comment
		Zero Tillage	Conventional	
Hartney	wheat	1552	1704	A
Hargrave	wheat	2199	2263	B
Kola	barley	1680	1518	C
Virden	wheat	1651	1106	D
Minnedosa	rapeseed	1120	1120	E
Killarney	rapeseed	672	1680	F

Comments

A - Uneven stand. Seeded with unmodified press drill.
B - Difference not significant.
C - Slight increase with zero tillage.
D - Increase under zero tillage due to moisture conservation and reduced green foxtail population.
E - No difference.
F - Zero tillage yield reduced by volunteer barley and severe injury from heavy dalapon application.

In conclusion, experimental and commercial evaluations indicate that zero tillage is an acceptible alternative to conventional methods of crop production. Successful production requires careful planning, adherence to recommendations, and above all, fall selection of fields to be cropped under zero tillage next year.