# A Survey of Zero-Till Researchers in Western Canada and the Northern States.

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## 1.0 INTRODUCTION

Although many farmers and researchers have little enthusiasm or hope for zero-tillage, the fact remains that zero-tillage may be the ultimate answer for soil conservation. A survey of zero-till farmers in Manitoba and North Dakota conducted in 1986 showed that 90% of the zero-till farmers adopted this practise because it controls soil erosion and conserves soil moisture. Better management of soil water has been identified as a key factor for increasing yield. It has been well documented that summerfallowing and/or excess tillage can lead to soil erosion and soil degradation. It is therefore important that farmers and researchers pay special attention to this concept and strive towards a system of zero tillage. The fact that farmers are already practising zero-tillage means that this approach is feasible, no matter how radical it may seem and therefore warrants special attention from farmers, researchers and policy makers.

Since the annual meetings of the Manitoba-North Dakota Zero Till Farmers Association were being held in Regina this year, we, at the Experimental Farm in Indian Head, wanted to make a contribution. We decided that it would be very useful to put together a list of all zero-till researchers along with a short description of their projects from Manitoba, Saskatchewan, Alberta, North Dakota, South Dakota and Montana. A list was compiled in 1986 for the association but only included researchers from Manitoba and North Dakota. As well, we surveyed all of these researchers in order to put together a list of zero-till research publications and to ask the researchers specific questions about zero-tillage research.

## 2.0 ZERO-TILL SURVEY OF RESEARCHERS

### 2.1 Objectives

There were three main reasons for doing a survey of zero-till researchers. The first reason was to get acquainted with the various zero-till projects underway in the various provinces and states. Secondly, we wanted to take the opportunity of questionning the researchers about zero-tillage. We wanted to get an idea of what their concerns were and what they considered to be the areas in most need of immediate research. Since we are in the process of initiating zero-till research projects at Indian Head, we wanted to get first hand information from

seasoned researchers in zero-tillage as to what aspects of zero-till need to be investigated. Thirdly, a survey of zero-till farmers in the U.S. and Canada was conducted by Dan Redlin, a graduate student in agricultural economics from North-Dakota State University. We wanted to compare the results of his survey with ours in order to determine the similarities and differences between farmers and researchers with respect to zero-tillage.

It is important to find out whether the concerns expressed by the zero-till farmers are the same as the researchers. If they are, then the researchers are in tune with the needs of the farmers but if they are not, then it indicates that the researchers may not be addressing the correct problems or else they don't fully understand what the needs of the zero-till farmers are or else the farmers are not able to convey or identify correctly the production problems associated with zero-till practises.

## 2.2 Details of Survey

The list of zero-till researchers in the three prairie provinces was compiled by requesting from the heads of departments at all the Universities and from the Directors of research stations a list of researchers associated with zero-tillage. The list of researchers from the U.S. was obtained by contacting 1 person from each of the following states: North and South Dakota and Montana. These persons in turn forwarded the list to us. The contact persons from North Dakota, South Dakota and Montana were Dr. Carl Fanning, Dr. Jim Gerwing and Dr. James Bauder, respectively.

The survey questionnaire consisted of 10 questions. The last two questions dealt with a short description of their current research project(s) and a list of their publications (scientific or otherwise). The other 7 questions were as follows:

1. What percentage of your current research time and energy is being spent on zero-till research?

2. Will your current program of research include the same, more or less zero-till research in the future?

3. Are researchers, in your opinion, addressing the correct problems and needs with regard to zero-tillage research?

4. What area(s) of zero-till is (are) in greatest need of research in order to make it a successful production sustem ie: soil physics, soil fertility, soil testing, subsoiling, crop physiology, crop rotations, plant breeding, weed control and management, Entomology, Plant Pathology, Engineering, research funding (private or public), agricultural economics, extension transfer of technology and/or others.

5. Which crops are better or poorly adapted to zero-tillage in

your area?

6. What are the most important factors preventing farmers from adopting a zero-tillage production system?

7. Does selective tillage have a place in a zero-till production system?

8. Is zero-till research worth pursuing?

We took the liberty of addressing another question which we answered from the information given on the questionnaire. This question was whether or not the zero-tillage projects underway were related to winter wheat production. Winter wheat production is in some way a special case of zero-tillage. All the management factors associated with zero-tillage apply in the production of winter wheat but as a rule, the farmers growing winter wheat are usually not tied to a zero-till production system per se. Due to the large amount of research going into winter wheat production, it was felt that this research was applicable to zero-till production and should therefore be included and identified in the survey. The future of zero-tillage may well hinge on the success of winter wheat production. Whether farmers realize it or not, whenever they are seeding winter wheat, they are practising zero-tillage. 23% of all zero-tillage research man-years is associated with winter wheat research.

## 2.3 Analusis of survey results

### 2.3.1 Response by Researchers

A total of 89 zero-till researchers were sent a questionnaire. Of the 89 questionnaires sent out, 78 were replied, giving us a percentage of 87.6. The number of researchers responding from each province and state is given in Table 1. The highest number of researchers replying goes to North Dakota followed by Saskatchewan then Alberta, Montana, Manitoba and South Dakota. Note that in Alberta, Saskatchewan and Montana we were only short by 1 reply. In other words, we had very good response. The poor response from South Dakota is due to an incomplete list of names forwarded to us. Some of the key zero-till researchers were omitted.

### 2.3.2 Number of Researchers By Discipline

The researchers that replied were classified as to disciplines (Table 2). In Table 3, these numbers from Table 2 were converted into man years of zero-till research. The information necessary for this table was obtained from the first question on the survey. Saskatchewan had the most man-years 7.32, followed by North Dakota 3.83, Manitoba 3.19, Alberta 3.15, Montana 2.4 and South Dakota 1.85. The man-years for South Dakota are definitely underestimated given the poor response from the researchers. The researchers from Canada were further subdivided according to institutions. The results are given in

Table 4. Most of the research activity in zero-tillage research is through federal research stations in Saskatchewan and Alberta. Very little activity from the universities in Alberta. In Manitoba, the greater majority of activity was through the university and more specifically the soils department.

Given the long term importance and benefits of soil conservation practises and the large influence that zero-till practises can exert, it seems incredible that in Western Canada as a whole, we can only support a total of approximately 13.66 man-years of research into zero-till. It should also be noted that the same individuals are usually associated with projects dealing with conservation tillage and that both systems are usually studied at the same time and consequently including conservation tillage would not necessarily increase dramatically the total number of individual researchers dedicated to soil conservation as a whole. Given the overwhelming importance of long term soil conservation for sustaining productivity, it is definitely not reflected in the number of research man-years dedicated to it.

When the researchers were asked if their current research program would include more, less or the same amount of zero-till research, 44.9% said the same, 41.0% said more and 14.1% said less. When asked if researchers were addressing the correct problems in zero-tillage research, 67.9% of them said yes and 15.4% of them said no and 16.7% did not respond. The most common reason for not responding was that they were not informed well enough to answer that question.

Interesting comments were included for question #3. The most frequent comment was that zero-tillage research involves long term projects and because of the high costs associated in maintaining such agronomic projects, there needs to be better co-ordination between disciplines. The more areas covered, the better the overall conclusions drawn and the greater the chances of identifying positive and negative interactions resulting from the adoption of a zero-till production system. There is great need of a systems approach and the integration of concepts from the various disciplines. As one researcher commented: "Co-ordination of any of these activities using a team approach is as important as the activities themselves".

Another frequent comment is that a lot of research is associated to fads. Many times research priorities are established by granting agencies that sometimes have little input from researchers and producers.

Other comments included:

"We know zero-till is feasible: need more research aimed at lowering costs".

"Economics of zero-till need more work".

"Have all the problems been identified"?

"More work needs to be done on crop physiology and variety development".

"Need more work on fertility and fertilizer placement".

"More disease resistance".

"Too much emphasis on soil compaction without knowing if it affects yield".

"Too much emphasis on machinery or engineering and not enough on soil fertility and biology".

"Limitations in research funds".

### 2.3.3 What are the areas in greatest need of research?

Question #4 asked the researchers which areas were in greatest need of research. A list of areas was included with the question and the researchers were asked to mark those areas in greatest need. No allowance was made for priorizing the areas and consequently the analysis is based on the number of times a given area was checked off. Table 5 lists all the areas, the frequency for each and the conversion of frequencies to percentages. The areas identified in greatest need of research were weed control and management followed by soil fertility/fertilizer placement, crop rotations, research funding, agricultural economics and engineering (equipment design).

Examination of Table 3 reveals that only 2.15 man-years are dedicated to weed control and management out of a possible total of 22.1 man-years which represents less than 10% of all man-years totalled over provinces and states. Yet this particular area is considered by researchers as the most important area to address presently. Any gains made in this area will have a strong influence on the adoption of zero-tillage by farmers because it is also identified as the area in greatest need of information from the zero-till producers point of view, as will be seen later. The next most important area is soil fertility and fertilizer placement. The number of man-years addressing this problem is 5.83 which represents 26.4% of the total man-years, a reasonable amount of activity.

The next area of concern was crop rotations. What this means is that the right crop rotation may alleivate many management problems associated with zero-tillage such a weed control and trash management. This problem would most likely be addressed by agronomists in the area of crop management. A total of 1.69 man-years is addressing crop management but not necessarily investigating crop rotations, representing 7.6% of the total man-years. A small number considering the importance given by researchers. The next area of concern to researchers was research funding which goes without explanation.

From Table 5, the areas of importance can be subdivided into four groups. Group I includes areas 1-4, Group II areas 5-6, Group III areas 8-10 and Group IV area 11. Group I represents the most important areas in need of research and accounts for 9.7 man-years or 43.8%. Even if this percentage seems reasonable, in terms of allocation of existing zero-till research time, this value is greatly influenced by the large activity in the soil fertility/fertilizer placement area.

In a nutshell, these statistics indicate that even if reserchers are aware of which area is the most important, it is not reflected in the current zero-till research. A greater awareness and co-ordination is required by policy makers, directors, managers, researchers, planners and others in order that topics as important as soil conservation be addressed properly and that funds be appropriated initially according to the most important areas as identified by researchers and producers. Researchers must also make an effort in avoiding duplication of research. There needs to be better coordination of research activity. The other indication is that zero-till research may not be the correct way of addressing soil conservation and that minimum tillage or conservation tillage are the areas to be addressed because they are more likely to be adopted by producers. I would argue strongly against this for the simple reason that understanding a zero-tillage crop production system would also address the present questions addressed by researchers pertaining to reduced and conservation tillage. It is better to strive to understand the ideal system and include a flexible tillage option where it need be rather than assume at the start that tillage will always be required on a yearly basis. The other reason that this may not be so is that 91.9% of the researchers said that zero-tillage research was worth pursuing and only 2.6 said it wasn't worth while.

The major comments expressed by researchers with this question was that a lot of the current research in zero-tillage was very fragmented and that an integrated approach is required because of the wide range of problems experienced when adopting a zero-tillage system. There is great need in developing a production package which brings all factors together and address the positive and negative interactions that may result from adopting a zero-tillage production system.

### 2.3.4 Crops and Zero-tillage

In question 5, researchers were asked to identify which crops are well adapted or poorly adapted to zero-tillage. The crops identified as well adapted or poorly adapted to zero-tillage were the cereals (spring wheat, winter wheat, corn and barley). As a rule the oilseeds were considered poorly adapted although 9% felt sunflowers and flax were well adapted. No one considered the pulses as well adapted to zero-tillage. Most did not respond or else considered them poorly adapted.

As a rule, only those crops used in current zero-till research projects were considered well adapted (spring and winter wheat, barley). Judging from the zero-till bibliography submitted by the researchers, there is not enough information to say which crops are well or poorly adapted to zero-tillage. As one researcher commented, none of the crops should be poorly adapted providing proper rotations, seeding equipment and good crop management is used.

### 2.3.5 Researchers' Reasons As To Why Farmers Are Not Adopting Zero-Tillage

Question #6 asked researchers what are the most important factors preventing farmers from adopting a zero-tillage production system. A list of reasons is given in Table 6 and compared to results from a survey of zero-till farmers (Redlin, 1987). Both groups identified weed control and herbicide costs as the most important factors.

Given that there is no discrepancy in what farmers and researchers view as the most important area to research, the fact remains that weed control and management are the areas least researched given the number of man-years involved (Table 3).

Researchers have identified fertilizer placement as the second most important area to study (57.7%) and 35.7% of the farmers list fertilizer placement as a reason why they are not adopting zero-tillage practises. Yet only 6.4% of the researchers feel fertility and fertilizer placement is a reason why farmers are not adopting zero-tillage. A total of 26.4% of the zero-till research man-years is dedicated to soil fertility/fertilizer placement. Why then is fertilizer still an issue? This is because the only way to solve this problem is to adopt an interdisciplinary approach. This problem will best be addressed if a soil scientist joins forces with an engineer and an agronomist. There exists a large amount of information on fertilizer form and placement for conventional cropping systems (Harapiak et al., 1986) yet very little information exists on how to deal with the problem of fertilizer form and placement in the context of conservation and zero-tillage cropping systems.

Both groups agree that higher management skills are required. They also point out that peer pressure and the resistance to change are big deterrents to adopting some zero-till practises.

There were some notable discrepancies between farmers and scientists as to why zero-tillage is not practised on a wider scale. 40.7% of the farmers claim that insect problems and plant diseases increase yet only 2.6% of the researchers think so. 37% of the farmers think crop residues is a problem yet none of the researchers expressed it. 14.8% of the farmers think yields are lower yet only 5.1% of the researchers expressed that concern.

### 2.3.6 Selective Tillage and the future of Zero-Tillage research

Another question asked was whether or not selective tillage has a place in a zero-till production system. 85.9% of the researchers said yes, 5.1% said no and 9.0% did not respond to this question. There were many comments included with this question. Many felt that tillage would only be required if a specific problem arose and that the only possible and economical solution is some tillage. Examples given were weed control when herbicide costs are prohibitive, certain soil conditions (compacted soils), wet seedbed in the spring, mix-in the top soil layer in order to get a better nutrient distribution in the soil profile and fertilizer banding. Others felt that tillage would be required in the transition from a conventional-till to a zero-till situation. Tillage should provide a better balance from an agronomic and economic point of view and should be looked at as a management tool in a zero-tillage production system.

The last question was whether zero-till research was worth preserving. 91.0% of the researchers agree that we should pursue this area of research. Many of the researchers commented that zero-tillage would be a major contributor to the control of soil erosion. They felt it was important to emphasize the advantages of the zero-tillage system in the context of an overall scheme for crop production. Some of them also felt that zero-tillage will never succeed unless researchers from various disciplines sit down and design experiments together that will address the problems raised by farmers and researchers ie: fewer sites but a more thorough study at each site.

### 2.3.7 Summary

This study can be summarized in a few words. The researchers and farmers agree on which areas of zero-tillage are in greatest need of research. However, when you look at where the research effort is being spent, only a small percent of the total effort is actually directed toward the area in greatest need ie: weed control and management. The research establishment must therefore determine how much effort should be spent on soil conservation and from there base their priorities on the needs expressed by farmers and researchers alike.

Another important factor to consider is that nearly all currently active agricultural scientists were trained in conventional tillage systems. It is very dangerous to compare conventional-tillage and zero-tillage at the present time because very few scientists have any experience in zero-tillage and also the availability of appropriate zero-tillage seeders for research purposes is limited. In many cases, scientists were using improper equipment when comparing zero-tillage to conventional tillage and consequently the conclusions drawn from their studies may in a way be incorrect. Conducting zero-tillage research requires dramatic changes in the way to look at crop production. Every step in the production cycle has to be re-evaluated.

If soil conservation is the issue, then developing research programs with zero-tillage as the goal is justified. As well, if an organised farmer group such as "The Manitoba-North Dakota Zero-Till Farmers Association" can attract 1000 farmers at its annual meetings, then the goal of establishing zero-tillage as the main production system in Saskatchewan may not be too idealistic.

As one researcher commented to me: "Zero-tillage farming may become the only rational means of farming large acreages of Saskatchewan's fragile soils".

## 3.0 LITERATURE CITED

Harapiak, J.T., R.M.N. Kucey and Don Flaten. 1986. Nitrogen sources and placement in wheat production. in A.E. Slinkard and D.B. Fowler. 1986. Wheat Production in Canada: A Review. University of Saskatchewan, Saskatoon,SK. S7NOWO.

Redlin, D. 1987. Analysis of 1986 Survey of U.S. and Canadian Zero-Till Farmers. MSc Thesis. North Dakota State University.

Table 1: The number of questionnaires sent out and received for each province and state.

| | Sent Out | Received | % Received |
|---|---|---|---|
| Alberta | 15 | 14 | 93.3 |
| Manitoba | 9 | 7 | 77.8 |
| Saskatchewan | 23 | 22 | 95.6 |
| North Dakota | 16 | 16 | 100 |
| South Dakota | 15 | 9 | 60.0 |
| Montana | 11 | 10 | 90.9 |
| Total | 89 | 78 | 87.6 |

Table 2: Number of zero-till scientists in each province or state according to discipline.[1]

| | AB | MB | SK | ND | SD | MT | Total |
|---|---|---|---|---|---|---|---|
| Administration | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Agronomy | | | | | | | |
| Conservation Tillage | 1 | 0 | 0 | 1 | 1 | 1 | 4 |
| Tillage | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Crop Management | 1 | 1 | 7 | 2 | 0 | 0 | 11 |
| Variety Testing | 0 | 0 | 0 | 3 | 0 | 1 | 4 |
| Plant Pathology | 2 | 0 | 0 | 2 | 1 | 0 | 5 |
| Plant Breeding | 0 | 0 | 1 | 1 | 1 | 0 | 3 |
| Forage | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Agricultural Economics | | | | | | | |
| Farm Management | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Economics | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Agricultural Engineering | | | | | | | |
| Design | 0 | 1 | 3 | 0 | 0 | 1 | 5 |
| Testing | 1 | 1 | 2 | 0 | 0 | 0 | 4 |
| Agricultural Meteorology | 1 | 0 | 0 | 1 | 0 | 0 | 2 |
| Entomology | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Extension | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| Nematology | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Plant Physiology | | | | | | | |
| Water Relations | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Soils | | | | | | | |
| Fertility | 5 | 3 | 3 | 0 | 2 | 2 | 15 |
| Water Management | 0 | 0 | 1 | 0 | 0 | 2 | 3 |
| Physics | 1 | 0 | 1 | 0 | 0 | 0 | 2 |
| Management | 0 | 1 | 0 | 2 | 1 | 0 | 4 |
| Weed Science | | | | | | | |
| Control | 2 | 0 | 2 | 1 | 1 | 0 | 6 |
| Total | 14 | 7 | 22 | 15 | 8 | 10 | |

[1] These results are based on the numbers of questionnaires that were received.

Table 3: Numbern-years involved in zero-till research in each province or state according to discipline.

| | Province or State[1] | | | | | | |
|---|---|---|---|---|---|---|---|
| | AB | MB | SK | ND | SD | MT | Total |
| Administration | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Agronomy | | | | | | | |
| Conservation Tillage | 0.20 | 0.00 | 0.00 | 0.75 | 0.20 | 0.30 | 1.45 |
| Tillage | 0.00 | 0.00 | 0.00 | 0.00 | 0.60 | 0.00 | 0.60 |
| Crop Management | 0.25 | 0.10 | 1.27 | 0.07 | 0.00 | 0.00 | 1.69 |
| Variety Testing | 0.00 | 0.00 | 0.00 | 0.23 | 0.00 | 0.10 | 0.33 |
| Plant Pathology | 0.05 | 0.00 | 0.00 | 0.30 | 0.10 | 0.00 | 0.45 |
| Plant Breeding | 0.00 | 0.00 | 0.90 | 0.15 | 0.10 | 0.00 | 1.15 |
| Forage | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Agricultural Economics | | | | | | | |
| Farm Management | 0.00 | 0.00 | 0.10 | 0.00 | 0.00 | 0.05 | 0.15 |
| Economics | 0.00 | 0.00 | 0.10 | 0.00 | 0.00 | 0.00 | 0.10 |
| Agricultural Engineering | | | | | | | |
| Design | 0.00 | 0.10 | 1.29 | 0.00 | 0.00 | 0.45 | 1.84 |
| Testing | 0.25 | 0.60 | 0.97 | 0.00 | 0.00 | 0.00 | 1.82 |
| Agricultural Meteorology | 0.50 | 0.00 | 0.00 | 0.15 | 0.00 | 0.00 | 0.65 |
| Entomology | 0.00 | 0.00 | 0.00 | 0.50 | 0.00 | 0.00 | 0.50 |
| Extension | 0.00 | 0.00 | 0.00 | 0.20 | 0.00 | 0.00 | 0.20 |
| Nematology | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.05 |
| Crop Physiology | | | | | | | |
| Water Relations | 0.00 | 0.00 | 0.10 | 0.00 | 0.00 | 0.00 | 0.10 |
| Soils | | | | | | | |
| Fertility | 0.95 | 1.79 | 1.99 | 0.00 | 0.30 | 0.80 | 5.83 |
| Water Management | 0.00 | 0.00 | 0.40 | 0.00 | 0.00 | 0.70 | 1.10 |
| Physics | 0.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 |
| Management | 0.00 | 0.60 | 0.00 | 0.58 | 0.25 | 0.00 | 1.43 |
| Weed Science | | | | | | | |
| Control | 0.45 | 0.00 | 0.30 | 0.90 | 0.50 | 0.00 | 2.15 |
| Total | 3.15 | 3.19 | 7.42 | 3.83 | 2.10 | 2.40 | 22.09 |

[1] These results are based on the number of questionnaires that were received.

Table 4. Number of zero-till research man-years by institution for Western Canada.

| Institution | Provinces | | | Total |
|---|---|---|---|---|
| | Manitoba | Saskatchewan | Alberta | |
| University | 1.89 | 2.26 | 0.05 | 4.20 |
| Federal | 0.60 | 4.09 | 2.85 | 7.54 |
| Private | 0.10 | 0.95 | 0.00 | 1.05 |
| Provincial | 0.60 | 0.02 | 0.25 | 0.87 |
| Total | 3.19 | 7.32 | 3.15 | 13.66 |

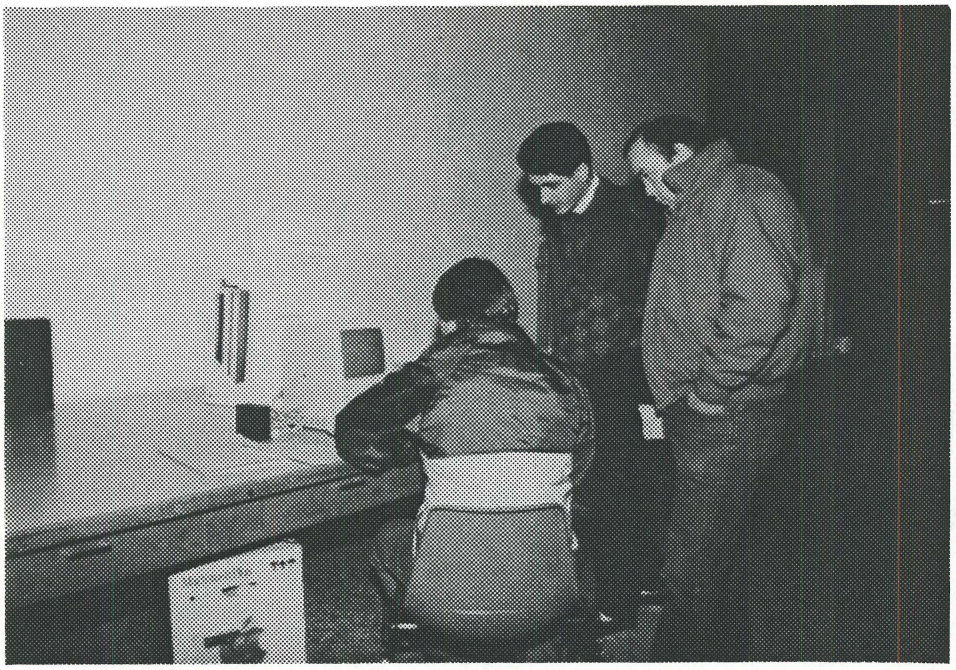
Table 5. List of areas in greatest need of research for a successful zero-till production system according to the number of researchers responding.

| Areas | Percent | Frequency |
|---|---|---|
| 1 Weed control and management | 61.5 | 48 |
| 2 Soil fertility (includes fertilizer placement) | 57.7 | 45 |
| 3 Crop rotations | 53.8 | 42 |
| 4 Research funding (private and public) | 50.0 | 39 |
| 5 Agricultural economics | 42.3 | 33 |
| Engineering (equipment design) | 42.3 | 33 |
| 6 Plant Pathology | 35.9 | 28 |
| 7 Extension and technology transfer | 29.5 | 23 |
| 8 Soil Physics(soil structure) | 26.9 | 21 |
| Soil testing | 26.9 | 21 |
| 9 Entomology | 24.4 | 19 |
| 10 Crop physiology | 24.4 | 19 |
| 11 Subsoiling | 15.4 | 12 |

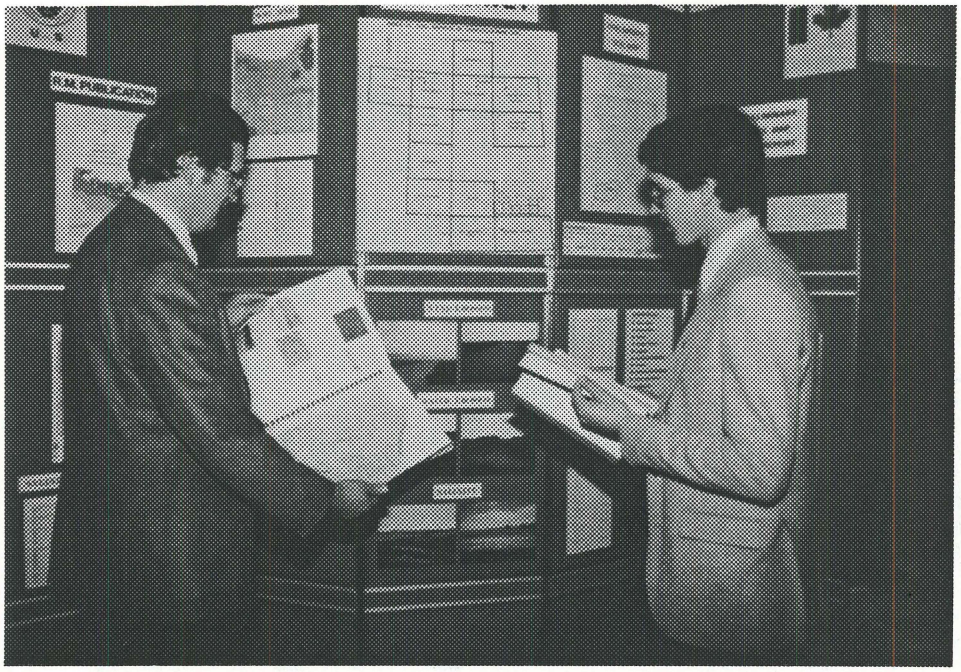
[1] The wording of the question did not allow the opportunity of rating the areas according to priority. The analysis simply gives a measure of the amount of times the area in question was checked on the list. The maximum number for any area would be 76, corresponding to the total number of researchers replying.

Table 6. Comparison of reasons between farmers and researchers as to why farmers are not adopting zero-tillage.

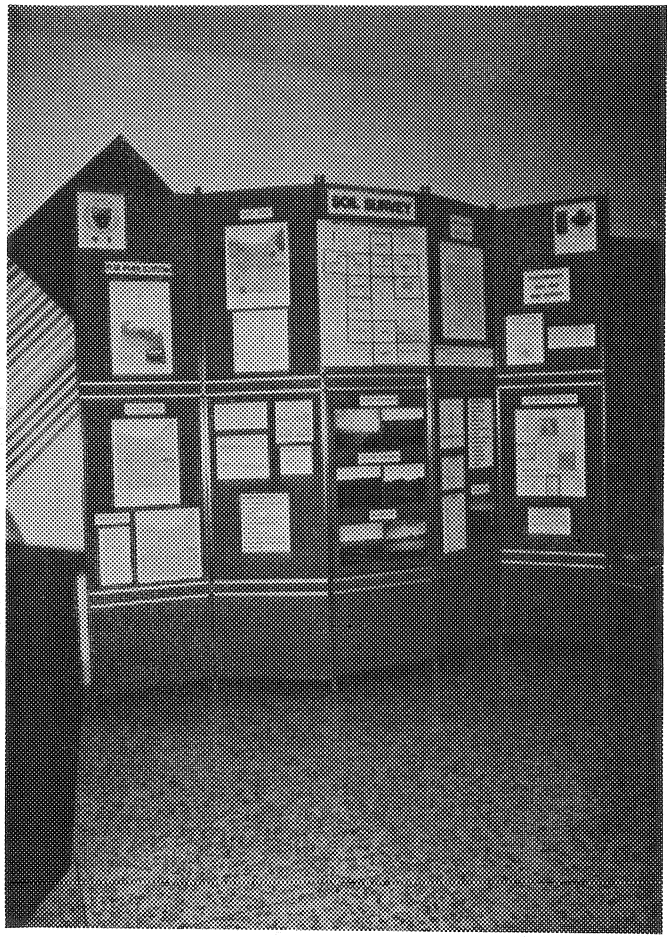
| Reasons | Percent | |
|---|---|---|
| | Farmers | Researchers |
| 1 Necessary chemicals too costly | 89.0 | 34.6 |
| 2 Unable to control weeds | 57.1 | 28.2 |
| 3 Equipment too costly | 57.1 | 20.5 |
| 4 Increased problems with diseases and insects | 40.7 | 2.6 |
| 5 Residue Management | 37.4 | 0.0 |
| 6 Fertilizer Placement | 35.7 | 6.4 |
| 7 Management skills required | 35.2 | 19.2 |
| 8 Peer pressure | 24.2 | 21.8 |
| 9 Management information package | 23.1 | 14.1 |
| 10 Lower yields | 14.8 | 5.1 |
| 11 Greater use of herbicides is detrimental to the environment | 9.3 | 1.3 |
| 12 Wet fields in the spring delays seeding | 6.0 | 2.2 |
| 13 Conventional-till mind set | 2.7 | - |



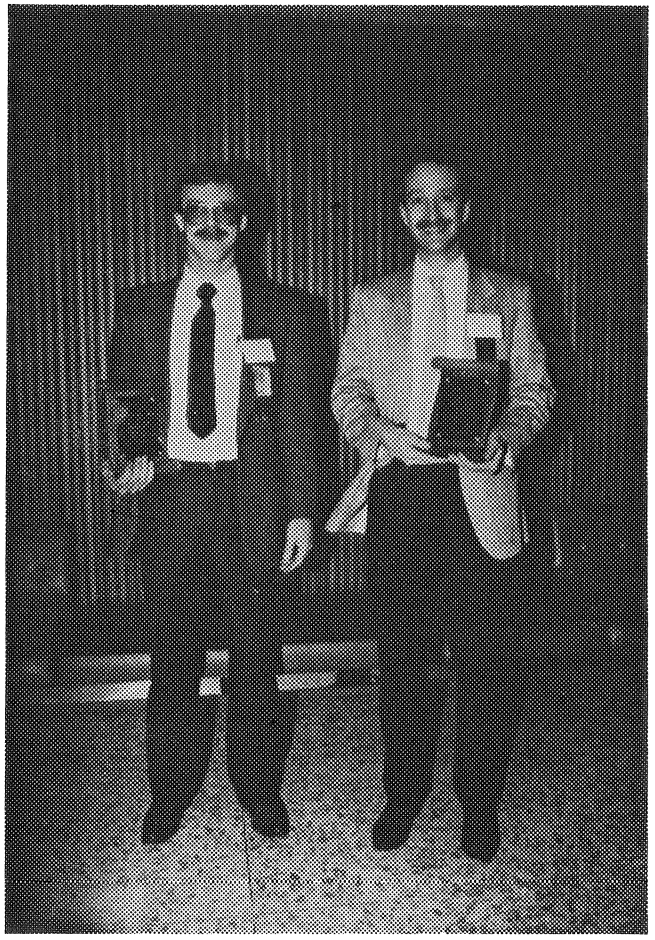
Participants at the Soils and Crops Workshop were able to gain information from the displays.



The soil survey display at the workshop featured information relating to the latest Saskatchewan Survey.



The displays and posters provided additional information to participants at the workshop.



Brent McLennan (left) Larry Luba Winners of the graduate paper presentation competition sponsored by Esso. Larry won the best graduate paper in soils and Brent the best graduate paper in crops.