Crop Residue Levels and Seeding Systems in Saskatchewan
Results of a PFRA Survey, 1997-2002

Key Findings

- Over the past 6 years there has been a clear trend towards more standing stubble remaining after seeding. This is due to the increased adoption of conservation seeding systems (CSS), which involve little or no tillage and lower soil disturbance during seeding operations.
- The increase in crop residue levels after seeding has been much less than the increases in standing stubble or CSS. This is mainly because of declining yields and straw production due to drought during the 6 year period that the survey was carried out.
- Despite the lack of data regarding soil and landscape factors that affect erosion at each survey site, it is estimated that a significant percentage of sites are susceptible to at least moderate erosion potential. This conclusion is largely from the fact that almost half of all seeded fields in 2002 had flat stubble and less than 500 lb/acre of residue cover.
- Conservation seeding systems are effective in increasing residue cover for cereal and oilseed residues. However, this is not the case with chemfallow and pulse residue, since over half of these fields have < 500 lb/acre of residue cover after seeding using CSS. This is mainly due to higher weathering losses during chemfallow, and lower residue production with pulses. Therefore, producers who practice chemfallow or grow pulses need to consider other management practices in addition to CSS, such as field shelterbelts and narrower field widths.

Introduction

Between 1997 and 2002 Prairie Farm Rehabilitation Administration (PFRA) conducted an annual spring survey of over 4000 annually cropped fields across Saskatchewan. Each year the same fields were visited, shortly after crop emergence in mid June. The objectives of the survey were to gather information on seeding systems, crop rotations, residue levels, and other data. This information is useful to assess the adoption of annual cropping practices which help to conserve soil and water resources, and protect the quality of water and air in the environment. This report provides results on crop residue levels and their relationship to seeding systems and wind erosion risk. To our knowledge the PFRA survey is the most extensive survey of its kind in Saskatchewan, and possibly Canada.

Importance of Crop Residue Cover

Maintaining crop residues on the soil surface is one of the most effective ways to prevent soil erosion and conserve soil moisture for crop growth. Crop residue is most easily conserved by minimizing soil disturbance during tillage and seeding operations. Minimal soil disturbance contributes to further benefits of carbon sequestration and reduction of greenhouse gases.

Measuring Crop Residue Cover

Two types of data were collected to evaluate crop residue cover: the amount of crop residue and the condition or orientation of the stubble portion of crop residue.

For the purposes of the survey the stubble portion is defined as the part of the plant that remains standing and anchored to the soil immediately after harvest. Between harvest and the subsequent seeding operation, stubble may be disturbed by field operations which tilt or flatten it. Three classes of stubble condition were used based on the percentage of stubble that was standing or flat (Table 1). Stubble condition at each field site was determined by visual assessment.

Table 1. Definition of Stubble Condition

Condition Class	% Standing	% Flat
Standing	> 66	< 33
Mixcd	33 – 66	33 – 66
Flat	< 33	> 66

The amount of crop residue was evaluated using seven classes based on pounds per acre and percent groundcover. These are defined in Table 2. Amount of crop residue at each site was determined by visual assessment of percent groundcover. However, proper assessment of this variable required training using measurement tools such as a rope with evenly marked intervals for making residue counts, or a set of photos with known residue amounts. Proper use of these methods required that the residue all be oriented as flat, not standing. Therefore, it was necessary in fields with considerable standing stubble to flatten a small area before making an assessment.

Table 2. Definition of Amount of Crop Residue

Residue Amount Class	pounds / acre	% ground cover
1	< 251	< 12.5
2	251 – 500	12.5 – 25
3	501 – 1000	25 – 50
4	1001 – 1500	50 – 70
5	1501 – 2000	70 – 80
6	2001 – 4000	80 – 95
7	> 4000	> 95

Stubble Condition

From 1997 to 2002 there is a clear trend towards less flat stubble and more mixed and standing stubble, as shown in Figure 1. This trend is essentially the same as the trend away from high disturbance seeding and more conservation seeding systems (ie. moderate and low disturbance seeding), as shown in Figure 2. These trends almost mimic each other because stubble condition is the primary indicator of seeding system. For example, as soil disturbance increases there is more stubble that is flattened. Nevertheless, PFRA staff also considered other factors such as row spacing, seed spread, packing system, and residue amount in assessing seeding system The only exception to the trends indicated in these figures was in 1999, when a wet spring caused many producers to do more tillage to control weeds.

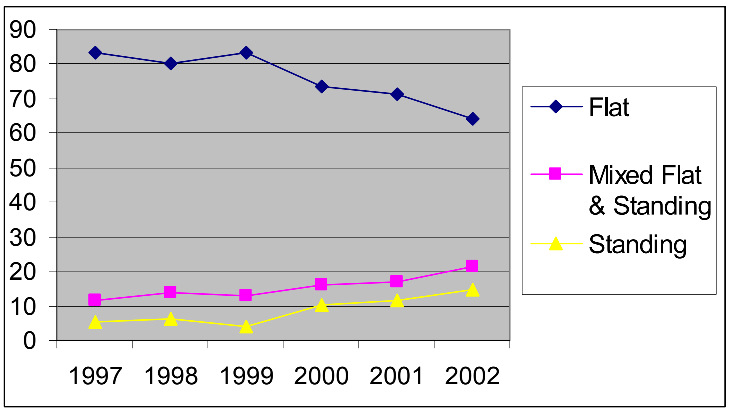

Figure 1. Stubble Condition on All Seeded Fields (% of Fields)

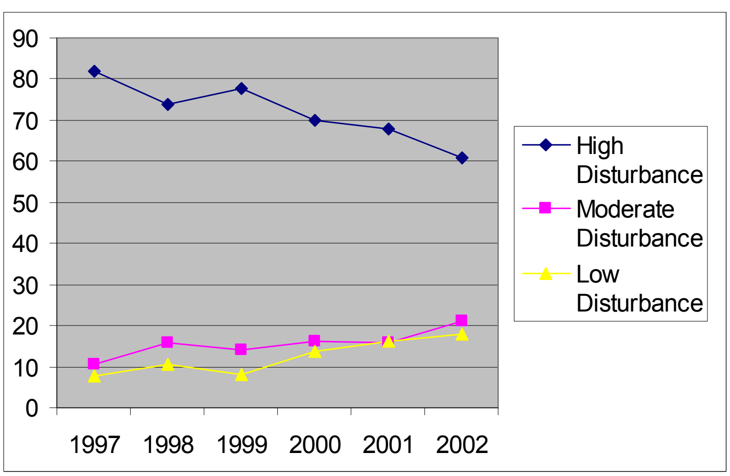

Figure 2. Seeding System on All Seeded Fields (% of Fields)

Crop Residue Amount

As shown in Figure 3, crop residue amount varies considerably each year, but for all years there are many more fields in the lower residue amount classes. In fact in all years the majority of fields have less than 500 lb/acre. Nevertheless, there appears to be a very subtle shift over time towards increasing residue amounts. This is more obvious when one calculates the weighted average of residue cover remaining for all seeded fields within each year, as shown in Figure 4.

Increasing residue amount is consistent with the trend toward conservation seeding systems and standing stubble. However, the positive change in residue amount is not near as large as the other trends. This suggests that there may be some other factors preventing residue levels from increasing more during this period. A major factor may be the amount of residue that was produced during this period.

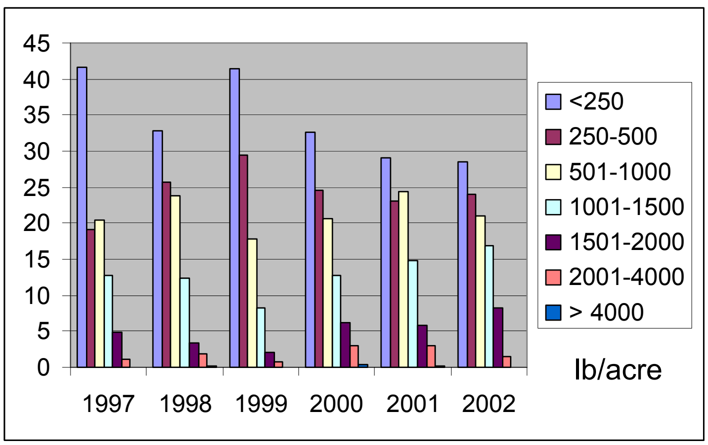

Figure 3. Residue Amount on All Seeded Fields (% of Fields)

For the purposes of proper comparison, the amount of residue produced, as shown in Figure 4, is actually from the previous year fall harvest, but reported in the next calendar spring. One can see that the largest increase in residue production from 1999 to 2000 corresponds to the largest increase in residue remaining after seeding. Also, despite significant declines in residue production for 1998, 2001, and 2002, the residue remaining increased slightly or remained constant. The only exception to these trends is in 1999 as discussed earlier, when more tillage and soil disturbance due to wet soil conditions caused a significant decline in residue remaining after seeding. Therefore (ignoring the 1999 exception) if residue production had been more consistent during this period one would have expected even higher increases in crop residue level, possibly to the same extent as the trends toward more conservation seeding systems and standing stubble.

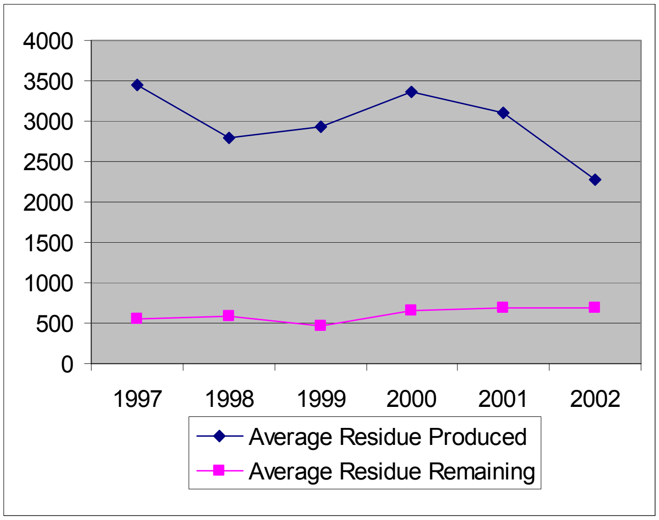

Figure 4. Average Crop Residue Produced at Harvest and Remaining After Seeding

Notes: Average crop residue produced is a weighted average estimate based on acreages and yields of various crop types (Source: Saskatchewan Agriculture, Food, and Rural Revitalization) and typical straw grain ratios (Source: PFRA). A number of factors may influence residue production such as growing conditions and type of crops grown. Mostly likely, drought has been a major factor. While the types of crops grown has varied, the net effect of this factor is probably quite small. For example, while low residue producing crops such as pulses have increased, fallow has decreased. Cereal and oilseeds have remained more constant.

Average crop residue remaining is a weighted average of data provided in Figure 3.

Stubble Condition and Crop Residue Amount Interaction

Since both stubble condition and crop residue amount are affected significantly by soil disturbance, it is not surprising that they are closely related. For example, for the 2002 data, as one goes from flat to standing stubble condition, the amount of residue increases (Figure 5). This has significant impact on erosion potential, as discussed in the next section.

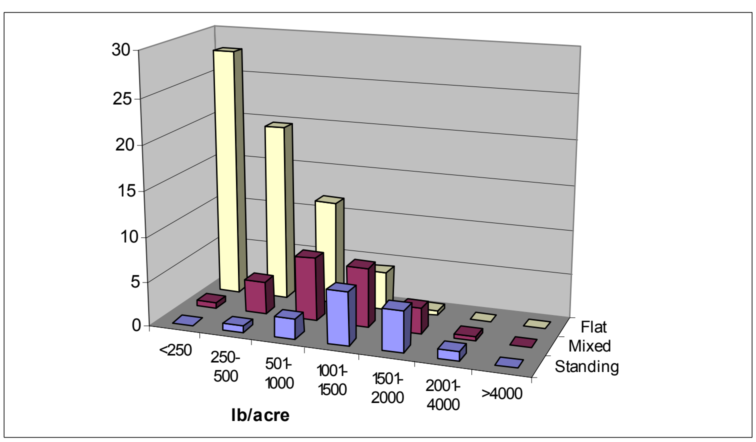

Figure 5. Percent of 2002 Seeded Fields in Various Combinations of Stubble Condition & Residue Amount

Factors Affecting Erosion Potential

Potential for soil erosion is influenced by a number of factors, some which can be managed by a producer and some which cannot. Unmanageable factors include soil texture, field slopes, surface roughness, and weather conditions. Manageable factors include the type and amount of crop residue, and stubble condition. In the case of wind erosion these factors have been evaluated in various experiments. Based on these experiments the Wind Erosion Equation (WEE) was developed to estimate erosion potential under a wide range of conditions.

Figure 6 provides some results of the WEE for various crop residue and stubble conditions, under a baseline erosion potential of moderate. The baseline erosion potential assumes no residue cover and is based on the cumulative impact of unmanageable factors, mentioned above. One can see that erosion potential is generally reduced as residue amounts increase and stubble condition changes from flat to standing. Nevertheless, the tallest bars in the graph indicate that the erosion potential remains unchanged at moderate, suggesting that these combinations of residue types and amounts have little impact in reducing wind erosion. Overall, oilseed and pulse residues provide less protection from wind erosion than cereal residues, mainly because the residue portion that passes through and is spread by the combine is much finer. With pulse residues, stubble condition has no impact on erosion potential because pulses are cut very close to soil surface leaving very little stubble height.

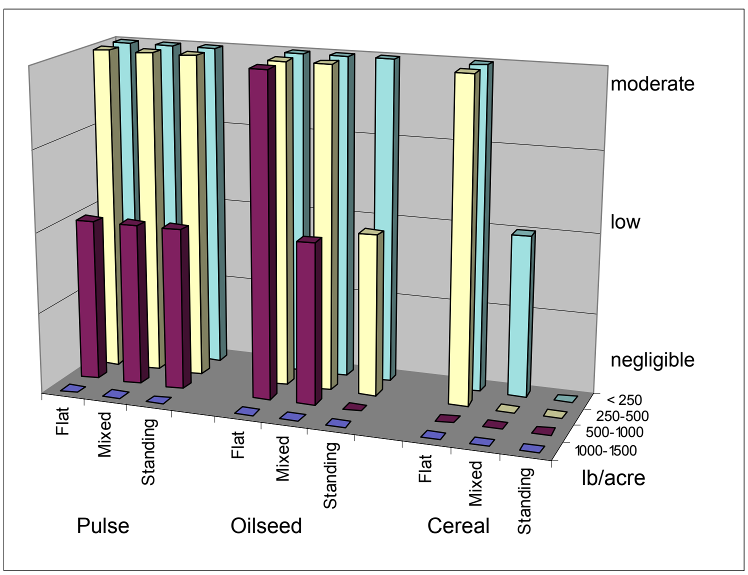

Figure 6. Effectiveness of Various Crop Residue Types, Residue Amounts, and Stubble Conditions on Reducing Erosion for Sites having a Baseline Erosion Potential of Moderate.
Note: A moderate baseline erosion potential is determined by soil, landscape, and climate factors. Oilseed does not include flax.

Figure 7 provides some additional results of the WEE to show how erosion potential can vary significantly for different baseline conditions under similar management. For example, erosion potential for < 500 lb/acre of flat pulse residue can vary from negligible to severe depending on the baseline erosion potential. This example also shows the amount of pulse residue required to reduce erosion potential to low levels for different baseline conditions. Therefore, the WEE is a useful tool that enables producers to consider all of these factors in designing appropriate management practices to minimize erosion.

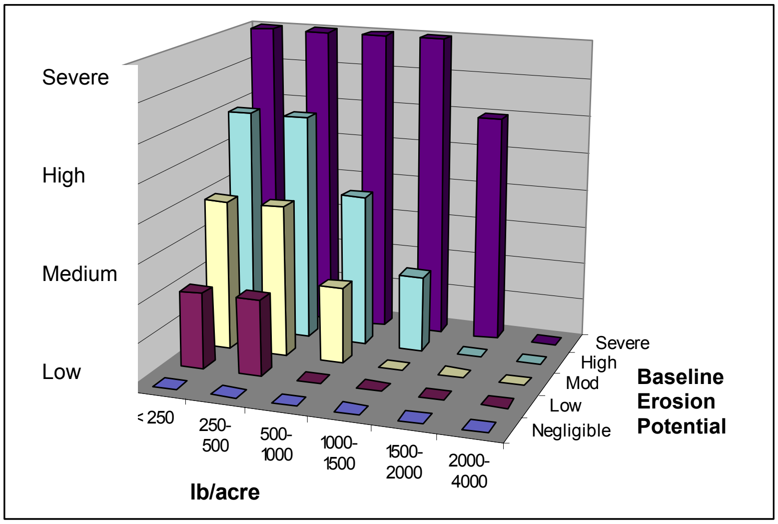

Figure 7. Effectiveness of Various Amounts of Flat Pulse Residue in Reducing Erosion Potential for Different Baseline Conditions (based on soil, landscape, and climate characteristics)

Estimating Erosion Potential

The amount of erosion which actually occurs is determined by the severity of weather conditions when the soil is exposed. The net result is that serious erosion is infrequent, but when it happens crop yields are reduced and soil productivity is impaired.

While it is impossible to predict these infrequent erosion events, the WEE provides a reasonable methodology for estimating erosion potential. Data on baseline conditions is not available for the sites surveyed by PFRA, so it is not possible to estimate erosion potential at each site. However, we are able to make some meaningful comments about erosion potential from the survey data.

From Figure 6 one can conclude that there is moderate or higher wind erosion potential for all residue types where the stubble condition is flat, the amount of residue is less than 500 lb/acre, and the baseline soil erosion potential is moderate or greater. From Figure 5 one can see that almost half of all seeded fields in 2002 met this residue and stubble condition.

Not all of the survey sites would be located on fields with a moderate, high or severe baseline condition, therefore, the percentage of sites susceptible to at least moderate erosion would be less. However, there are also other sites with other residue or stubble characteristics that would also be susceptible to erosion. For example, as shown in Figure 6, fields with mixed or standing pulse or canola stubble may also be susceptible to at least moderate erosion. Also, as shown in

Figure 7, sites with more than 500 lb/acre may be susceptible if the baseline erosion potential is high or severe and the residue type is pulse.

A key conclusion is that, despite the increased adoption of conservation seeding systems over the past 7 years, a significant percentage of annual cropped fields were susceptible to wind erosion in the spring of 2002. The next section explores to what extent lower disturbance seeding has helped to reduce erosion potential, and some of the reasons why some lower disturbance seeded fields are still susceptible to erosion.

Interrelationships between Crop Residue, Seeding Systems, Crop Type, and Erosion Potential

As shown in Figure 8, the majority of high soil disturbance seeded fields have less than 500 lb/acre of residue cover, regardless of the previous crop type. Assuming that most of these fields would have flat stubble condition (see Figure 5), one can conclude that a significant percentage of these fields would be susceptible to wind erosion.

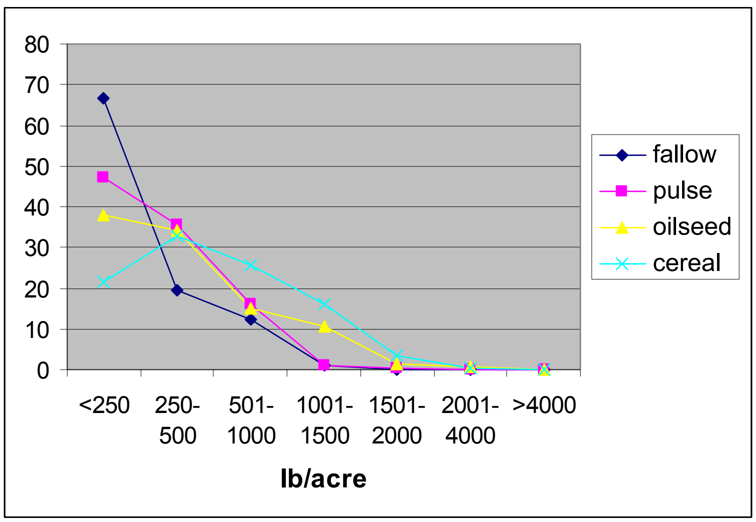

Figure 8. Percent of 2002 High Disturbance Seeded Fields in various Residue Amount Classes for Four Previous Crop Types.

Nevertheless, the previous crop type also has a significant impact on residue levels. As expected previously fallow fields would have the least residue due to significant losses from tillage and weathering. Differences between cereal, oilseed, and pulse previous crop types is mainly due to two factors, the amount of crop residue produced and the rate of residue weathering. While these factors are also dependant on local weather conditions, Table 3 illustrates how these two factors generally result in the lowest residue levels for pulses and the highest for cereals.

Table 3. 2001 Residue Production and Relative Weathering Rates for Three Crop Types

Crop Type	2001 Average Residue Produced (lb/acre)	Relative Weathering Rate
cereals	2681	slow
oilseeds	1866	moderate
pulses	1212	fast

Source: SAFRR (yield data), PFRA (straw/grain ratios and weathering rates)

Comparison of Figures 8 and 9 shows to what extent conservation seeding systems (CSS) are effective in conserving crop residue. While CCS is effective in reducing the percentage of fields in the < 500 lb/acre categories for previous cereal and oilseed crop types, such is not the case with fallow and pulses. The reasons of lower residue production and higher weathering rates can explain this trend.

Therefore, one can conclude that lower disturbance seeding of cereal and oilseed residues will result in lower erosion potential, especially when one also considers that the stubble condition will usually be mixed or standing. Conversely, a much higher percentage of fallow and pulse residues will be susceptible to erosion, especially when one also considers that pulse stubbles are much shorter and that fallow stubble will usually be mixed rather than standing due to high rates of weathering. It should be noted that virtually all lower disturbance seeding after fallow, involved the use of herbicides during the fallow period (ie. chemfallow). Even under these conditions stubble often does not remain standing as a result of weakening due to weather.

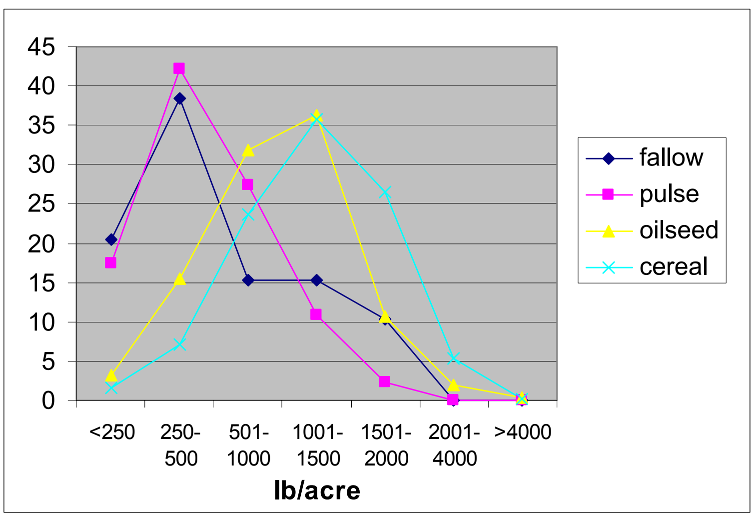

Figure 9. Percent of 2002 Conservation Seeded (Lower Disturbance) Fields in various Residue Amount Classes for Four Previous Crop Types.

These results show that in some cases producers must consider other management practices in addition to conservation seeding systems to prevent soil erosion. This is especially true when growing pulses or using low disturbance seeding after chemfallow. Other practices could include field shelterbelts and narrower fields.

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