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Developing a Sampling Protocol to Enhance the Profitability of Flax Straw Processing

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Flax Production in Canada

- The Canadian Prairie provinces are world's largest producer and exporter of flaxseed.
- 600,000 to 900,000 ha of flax grown annually on the Prairies.
- Est. 500,000 to 1 million tonnes of straw produced annually (800 - 1600 kg/ha).

Current Uses of Prairie Flax Straw

- Most is burned or chopped and spread.
- Schweitzer-Mauduit Canada Inc. (SMI) annually processes 80 - 120,000 tonnes for cigarette paper (10-15% of total).
- Small-scale uses - plastic composites, specialty paper, paper recycling (fibre).
  - animal bedding (shives).

Bast Fibre Content of Flax Straw

- Bast fibre content in oilseed varieties can range from near 0-25% depending on variety and growing conditions (10-20% is common).

- Bast fibre content in fibre varieties (currently not grown on the prairies) tends to be more consistent and ranges from 18-40% (25-30% is most common).

Why Fibre Content of Straw is Important - Example

Revenue				
Ave. value of fibre fob SK factory	**C$/t**	600	600	600
Cost of straw				
Straw collection costs		- 45	- 45	- 45
Payment to farmers		- 5	- 5	- 5
Processing cost		- 25	- 25	- 25
Total cost of straw	**C$/t**	**- 75**	**- 75**	**- 75**
Fibre content of straw		**5%**	**15%**	**25%**
Straw needed to give 1 tonne of fibre		20.0	6.7	4.0
Cost of I tonne of fibre	**C$/t**	**- 1,500**	**- 500**	**- 300**
Gross margin	**C$/t**	**- 900**	**100**	**300**

What is Needed to Improve Field Selection

- Inexpensive, quick and accurate method of testing fibre content.

- Inexpensive, quick and accurate method of collecting samples from flax fields and bales.

Progress in Testing Fibre

- Biolin Research, working with USDA lab in Georgia, is developing a Near-InfraRed (NIR) method of testing unretted flax straw for fibre content.

- Biolin Research has developed a manual method of determining fibre content that is used as a check of the NIR method.

Progress in Field Sampling

As far as we know, there has been no previous research into developing methods for collecting statistically valid representative composite samples of flax from fields and bales.

Importance of Proper Sampling Methods

"If samples are not representative and taken in an unbiased manner, testing them is useless. Sampling methods and systems for fibre raw material require more careful design than those for most bulk materials, because its inherent variability is higher. "

Fuller, S. "Fibre Raw Material Quality Control." *Properties of Fibrous Raw Materials and Their Preparation for Pulping* (Vol. 1). Editors: Kocurek and Stevens. 1983 (p. 145).

Research Project

- *Developing a Sampling Protocol to Enhance the Profitability of Flax Fibre Processing.*
- Carried out in 2002/2003 by Biolin Research Inc.
- Funded by the Saskatchewan Flax Development Commission and the Agriculture Development Fund of SAFRR.
- Schweitzer-Mauduit Canada Inc. arranged fields and bales for sampling.

Specific Objectives

- Develop analytical framework and protocols for collecting representative composite samples of flax fields, groups of bales, or single bales.

- Minimize number of sub-samples required to produce representative composite samples to reduce cost of sampling.

Sample Collection

- In the fall of 2002, Biolin collected 30 flax straw samples from each of seventeen fields in the Redvers area of southeast Saskatchewan.
- One quarter square meter of straw was collected for each sample.
- Biolin collected 6 samples from each of 20 flax bales from each of 4 fields.

Laboratory Testing

- Sub-samples of each sample were scanned with an NIR machine to determine bast fibre content.
- 100 sub-samples were tested for bast fibre content using the manual fibre extraction method.
- Straw and seed yield were calculated.

Statistical Analysis

- Calculated the average bast fibre content, standard deviation (SD) and coefficient of variation (CV) of each group of samples from a field or group of bales.

- Determined the number of sub-samples necessary to produce statistically valid composite samples of fields, groups of bales or single bales for various CVs.

Test Results From One Field

	Mean	SD	CV
Sample Weight	47 g	11.8 g	27.5%
Bast Fibre Content	13.5%	1.69%	11.7%
Seed Yield(bu/acre)	22 bu	7.0 bu	34.0%

Fibre Contents of Field and Bale Samples From the Same Field

Mean Bast Fibre Content (%)

Field	Field Samples	Bale Samples	% Increase
1	11.8	18.9	+60%
2	10.6	17.7	+67%
3	12.8	19.6	+53%
4	13.2	19.9	+51%
Mean	**12.1**	**19.0**	**+58%**

Effect of Sample Position on Mean Fibre Content in Bale Sampling

Sample Position	Mean Fibre Content (%)
Left - round surface	19.4
Right – round surface	19.4
Left – butt surface	19.1
Right – butt surface	19.0
Left – interior core	18.8*
Right – interior core	18.7*
Mean	**19.0**

Effect of CV and SD on # of Field Sub-Samples Needed for Statistical Validity

13.2% Mean Bast Fibre Content

Desired CV (%)	Number of Sub-Samples Required		
	SD = 2.6	SD = 3.6	SD = 1.6
5	447	862	170
10	113	216	43
15	50	96	19
20	28	54	11
25	18	35	7
30	13	24	5

Relationship Between CV and Number of Samples Required

- The lower the CV, the more truly representative the composite sample.
- The lower the desired CV value, the more sub-samples must be taken.
- The more variability in the field, the more sub-samples must be taken for any desired CV.

Sampling Protocols

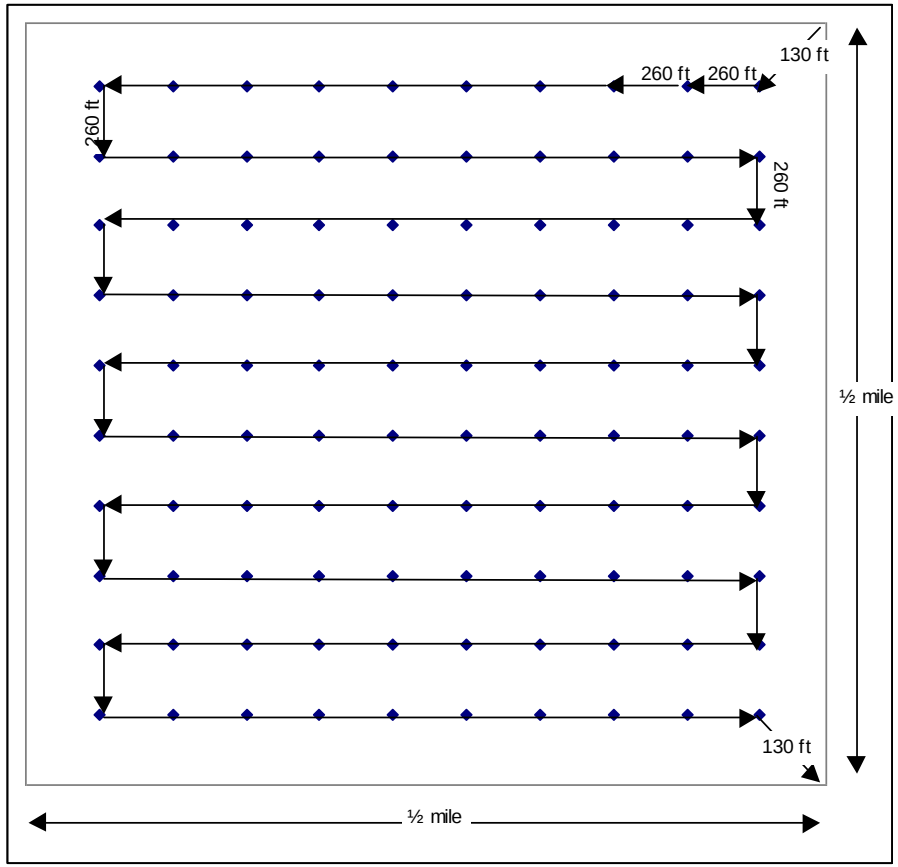
Field and bale sampling protocols were developed based on the number of samples required for the CV desired.

of Sampling Sites and Stems Needed for a Representative Field Sample

Desired CV (%)	# of Sampling Sites	# of Stems/Site*
20	50	8
15	100	4
10	200	2

*If number of stems = about 400 there will be enough for testing and re-testing.

Sampling Protocol for 100 Samples per Quarter Section



of Samples Needed per Bale When Sampling 20+ Bales

Field	Desired CV		
	10%	15%	20%
1	6	3	2
2	8	4	2
3	4	2	1
4	4	3	2
Mean	**5.5**	**3.0**	**1.75**
Min.	**4**	**2**	**1**
Max.	**8**	**4**	**2**

of Samples Needed When Testing a Single Bale

	Desired CV		
	10%	**15%**	**20%**
Min. needed	1	1	1
Max. needed by 50% of bales	3	1	1
Max. needed by 80% of bales	6	3	1
Max. needed by 90% of bales	8	4	2
Max. needed by 95% of bales	11	5	3
Max. needed	18	7	4

Economic Considerations When Sampling

- Single composite samples of a field or group of bales are desired to reduce the cost of testing.
- Number of sub-samples taken to produce composite samples should be as low as possible to reduce cost of sampling.
- Different sampling strategies will be developed for different needs.

Quick Field Sampling Strategy

- Pull handfuls of stems at five field sites.
- Rub stems together and tug on ends.
- If straw at four or five sample sites is hard to break, it likely has high fibre content. If straw easily breaks at several sampling sites, it likely has low fibre content.

If Straw is Not Clearly Low or High Fibre

- Walk field in a zig-zag pattern, stop 25 times and take 6 straws at each stop.
- Accuracy will improve by walking a tighter grid pattern and taking 3 stems at 50 sites.
- This will accumulate about 150 stems. Reducing the total accumulated stems speeds up the collection process slightly but will not provide any backup samples for re-testing.

Limitations of Study

- Sampling protocols are based only on information from the Redvers, SK area.
- Sampled fields were in the black soil zone and were neither extremely flat nor extremely hilly.
- There is only one year of data.

Limitations of Study

- Originally collecting only 30 samples per field may cause an underestimation of the variability in fields in the Redvers area, given the high CVs in the test results.
- 30 samples was based on the upper end of the range suggested for soil sampling - 5 to 30 samples per field - since no other good information was available.

Limitations of Study

Bales from only four fields were sampled. The bales were collected from some fields before Biolin staff could take samples and rain prevented the baling of other fields.

Immediate Benefits of Field and Bale Sampling Protocols

- Straw processors can begin to develop strategies for sampling fields and bales based on the results of the study.
- Increased ability to identify high fibre fields, resulting in more fibre per tonne of straw processed and lowered costs of collection and processing.

Future Benefits of Field and Bale Sampling Protocols

- Improve transparency of transactions between buyers and sellers of flax straw. Farmers producing higher fibre content straw should get a higher price.

- Provide processors with a cheap and reliable tool to improve fibre yield and/or consistency of products.

Future Benefits of Field and Bale Sampling Protocols

- Contribute to knowledge about effects of variety choice, location of production, agronomic practices.
- Can be used to develop an American Society of Testing and Materials (ASTM) industry-accepted "guideline" for taking straw samples from flax fields and bales.

Proverb

- "A person with one watch always knows what time it is."
- "A person with two watches always searches to identify the correct one."
- "A person with ten watches is always reminded of the difficulty in measuring time."

Levine et al. Statistics for Managers. Prentice-Hall, 2002 (p. 19).

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Any Questions?

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