A Co-operative Program Between

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Development of Livestock Feeding Systems For Grain Screenings

Can grain screenings from seed cleaning operations and grain elevators be used as an economical five-stock feed? In 1996, PAMI and the Department of Poultry and Animal Science, University of Saskatchewan with support from the Saskatchewan's Agriculture and Development Fund and the Saskatchewan Wheat Pool set out to find the answer.

The Saskatchewan grain industry produces 600,000 tonnes of grain screenings each year. Grain companies and seed cleaning plants are making this product available to livestock producers as feed. But to optimize the nutrient value to animals, processing by grinding or rolling is required. In addition, grain and weed seeds must be rendered nonviable.

Two limitations currently make the use of grain screenings for feed a challenge:

1. Commercial processing is not a service currently available to all producers in some regions.
2. A low weight per volume ratio makes the transportation of unprocessed screenings over long distances uneconomical.

Grain companies and seed cleaning plants are making grain screenings available to livestock producers as feed.
-Photo courtesy Saskatchewan Wheat Pool

Are There Other Means of Processing That Could Make Use of Screenings at the Farm or Feedlot?

To get all the information required, the investigation focused on the following objectives:

1. Identify optimum mechanical treatments for grain screenings to reduce seed germination and to retain or improve feeding characteristics and value.
2. Determine the most effective means of processing by conducting livestock digestibility trials and germination tests on grain screenings.
3. Analyse the nutrient value of grain screenings and make recommendations on the marketability of grain screenings.

Our test samples were representative of coarse cereal (wheat) screenings and were collected from eleven grain terminals throughout Saskatchewan.

At a glance...

The processing of grain screenings is required to optimize utilization by livestock.

If coarse screenings (> than a #9 screen) are available, processing at the farm level would require a screening process plus:

1) fine grinding of the fine fraction (to kill weed seeds) and the addition of water or silage to bind the fines to the ration for feeding.
2) coarse grinding the coarse and medium fractions prior to feeding to optimize feed utilization.

Screenings could also be separated at the source (terminal/cleaning plant) to produce:

1) a fine (< than a #7 screen) fraction best suited for pelleting or for sale to a processing enterprise.
2) coarse and medium frations suitable for on-farm processing by grinding or rolling.

It is necessary to process cereal screenings to obtain adequate feed utilization by livestock and to kill weed seeds present in the fine fractions.

Table 1. Protein, oil, and fibre contents in weed seeds (Tkachuk and Mellish, 1976), dry matter basis.

Weed Seed	Protein (%)	Oil (E.E.)*	Crude Fibre (%)
Wild Mustard	26.30	38.8	11.9
Stinkweed	22.60	34.0	
Flixweed	28.72	38.3	7.6
Wild buckwheat	9.98	2.1	9.0
Field dock	14.14	2.4	20.1
Wild oat groats	21.49	1.6	2.6
Green foxtail	16.66	6.2	10.4
False ragweed	19.74	31.8	28.2
Lambs quarters	18.42	8.4	12.8
Redroot pigweed	16.45	6.8	12.7
Wild oat	13.50	4.3	14.5

** E.E. stands for Ether Extract*

A Valuable Source of Nutrients

Grain screenings (often referred to as dockage at the elevator) are the portion of crop which remains after the grain has been cleaned. Screenings consist of whole and damaged kernels of the parent grain along with other volunteer grains and oilseeds and weed seeds, vegetative material such as stems, pods and chaff, and dirt, dust, and other foreign material.

It's a common misconception that grain screenings are low in nutrient content and contain large amounts of anti-nutritional and or toxic compounds. While screenings from an individual load or source may pose some toxicity concerns, commercial screenings are a mixture of many sources of grains and tend to dilute out toxic effects.

From a nutrition standpoint, the protein and fibre contents of screenings may actually be significantly higher than that expected in pure cereal grains. The higher oil content of many weed seeds and volunteer oilseeds in the sample provides added energy, and the weed seeds also contain significant nutrients provided they can be made accessible to the animal. (Table 1)

What's the Effect on Livestock?

Processing of screenings for ruminants, or other livestock, is necessary to destroy weed seeds, to allow mixing with other feeds and, most importantly, to aid in digestion. For example, processing canola, mustard and other small hard-coated seeds ruptures or destroys the seed coat, making the nutrients inside available to the animal.

The particle size produced by processing has the greatest influence on rumen response to feeding screenings. Finer particles, particularly of starchy materials which rapidly ferment in the rumen, can lead to bloating, acidosis, and/or reduced feed intake and feed efficiency in ruminants. For this reason, and for ease of handling, the finer particles in grain screenings are often commercially processed into pellets.

However, ruminant diets will tolerate a certain amount of unpelleted fine particles, provided that the coarser portions of the diet are balanced and sufficiently coarse to promote an even rate of fermentation and to buffer the rumen (re-

Categorizing Screenings

The Canadian Grain Commission separates coarse

1) Number 1 feed screenings - over 35% of the parent material and limits on specific types of weed seeds.
2) Number 2 feed screenings - over 15% of the parent material.
3) Refuse screenings - less than 15% of the parent material and greater allowances on problem weed seeds.

Table 2. Intake and digestibility of processed grain screenings by cattle and sheep.

Item	Cattle	Sheep
Dry matter intake (kg/day)	8.5	2.3
Dry matter intake (% of body weight	2.2	4.3
Nutrient digestibility %		
Dry matter	68.4	66.6
Crude protein	75.6	74.1
Neutral detergent fibre	32.9	29.4
Acid detergent fibre	24.5	25.6
Energy	68.6	69.8
D.E. (M. cal/k g)	3.3.	3.3

duce acid build-up). Particle size is less of an issue with non-ruminants such as swine, so if the feed is suitable for ruminants, it will be suitable for swine.

Feeding Trials

Two trials were conducted by the Animal Science Department at the University of Saskatchewan to evaluate the effect of processing on digestibility of screenings and the effect on rumen function of increasing amounts of processed grain screenings (finely ground and pelleted) in the diet.

In one trial, steer calves were fed four diets: unprocessed canola screenings, processed canola screenings (ground and pelleted), chopped alfalfa-brome-hay/barley tallow (processed), and processed alfalfa-brome/barley tallow (ground and pelleted). The canola screenings were well suited to this study because the fine fraction was characteristically similar to that found in cereal grain screenings, but present in greater quantity.

Processing the canola screenings had a major positive effect on utilization of dry matter, crude protein, acid detergent fibre, fatty acid, and gross energy. There was increased protein and fatty acid digestibility while the fibre fractions changed little, if any. The digestible energy increase was 23.6% higher than the unprocessed canola screenings.

Processing the alfalfa-brome-hay/barley diets had little or no effect on digestibility.

In the second trial, regular barley and thin barley (barley screenings from a malting operation) were processed with a roller mill and fed to sheep. While the thin barley was lower in energy and dry matter digestibility than the regular barley, it was shown that the thin barley could be processed by regular rolling to produce a feed which would be between that of a good oat grain and regular barley.

Within the same set of trials, processed grain screenings were tested for intake and digestibility with both cattle and sheep (Table 2). The result was a high energy content and relatively high digestibilities, making processed grain screenings a valuable feed source.

Results of these trials indicate that processing of screenings is needed to fully utilize feed.

Particle Size and Composition

Samples collected from each of the eleven locations were screened and sorted into fine, medium and coarse particle-size fractions (groupings). The reasons for these sizings were that they best represented sizes of cereal and oil seed grains now routinely being processed. This number of fractions could also be adapted to a processing system without added complicated equipment, and in terms of particle size and processing, they would provide a processed feed that could be related to known digestion rates and rumen funciton.

The coarse screenings were larger than a Number 9 screen, while medium particles fell through a Number 9 screen, and fine fraction fell through a Number 7 screen. After sorting, all fractions were analyzed for nutrient content. Then, screened fractions from the various terminals were combined into fine, medium, and coarse fractions.

The coarse particle fraction had the highest vegetative content (stems, chaff, and pods) and also the most parent grain or larger whole seeds. Its relatively high NFE (nitrogen-free extract) and lower fat content indicates considerable starch, as well as a TDN (Total Digestable Nutrients) content indicative of grain plus chaff and larger weed seeds.

The medium fraction was similar in composition to the coarse, except that slender or cracked cereal kernels and weed seeds such as wild oats were also present. The nutrient composition closely resembled the coarse fraction.

The finer fraction had higher protein and higher fat content than the others because of a higher percentage of smaller weed seeds and mustards or canola.

Processing of the Fractions

The particle size of grain screenings required for ruminants should be as large as possible but still be processed enough to optimize nutrient uptake by the animal and destroy seed viability. Therefore, decisions should be based on particle size and not chemical composition. The amount of fine material tolerable in the diet will vary depending on the amount and composition of other feed ration components.

The screenings fractions were processed through various settings on roller mills and screen sizes with hammermills. The settings chosen estimated what might be expected from farm-milled processing. Cracking rolls were set at 0.051 mm, 0.66 lmm and 1.245 mm, and flaking rolls set at 0.076 mm, 0.712 mm and 1.245 mm. Five hammermill screens were tested with sizes ranging from 5/64 in to 5/16 in. (Table 3)

Hammermilling the coarse and medium fractions with a 1.4 inch screen resulted in almost 50% of the material being reduced to fine particles. The use of 1/4 inch screens at the farm level is common, particularly for swine feed.

The roller mills and the flaking rollers also produced fines during processing, but at a lower proportion of total than the hammermill. For this reason, rolling is preferred over hammermilling for ruminants diets because of fewer fines. Both, though, are found to be suitable for feed ration processing under farm conditions.

Seed Viability

After processing, all samples were tested for seed germination. For the coarse fraction, the 1/4 inch hammermill size was adequate to render seeds nonviable. For the cracking rolls, the gap had to be 0.051 mm or less and flaking rolls had to be set at 0.712 mm to render seeds nonviable.

For the medium fraction, hammermilling through a 3/16 inch screen was needed to destroy seed viability. For cracking rolls, 0.051 mm gap setting or smaller is needed and for the flaking rolls a gap between 0.076 and 0.712 mm is needed. (Table 4)

Table 3. Particle size distribution after processing.

Processor *Screen Type*	**Hammer Mill** *Screen Size (in)*			**Cracking Rolls** *Roller Gap (mm)*			**Flaking Rolls** *Roller Gap (mm)*		
Coarse #10 and up	**5/16**	**1/4**	**3/16**	**1.245**	**0.661**	**0.051**	**1.245**	**0.712**	**0.076**
Coarse	22%	8%	6%	16%	19%	27%	33%	52%	61%
Medium	57%	45%	38%	50%	42%	29%	49%	30%	20%
Fine	21%	47%	56%	34%	40%	45%	18%	17%	19%
Medium #7 & #8	**5/16**	**1/4**	**3/16**	**1.245**	**0.661**	**0.051**	**1.245**	**0.712**	**0.076**
Course	3%	3%	0%	4%	8%	5%	11%	18%	40%
Medium	51%	46%	26%	56%	47%	32%	52%	46%	25%
Fine	46%	51%	74%	40%	45%	63%	37%	36%	35%
Fine #6	**5/16**	**1/4**	**3/16**		**0.661**	**0.051**		**0.712**	**0.076**
Coarse	0%	0%	0%		0%	0%		0%	2%
Medium	0%	0%	0%		0%	0%		8%	26%
Fine	100%	100%	100%		100%	100%		91%	72%

Table 4. Number of seeds germinating from a 25 gm sample.

Processor *Screen Type*	**Hammer Mill** *Screen Size (in)*					**Cracking Rolls** *Roller Gap (mm)*			**Flaking Rolls** *Roller Gap (mm)*		
Coarse (#10 and up)	**5/16**	**1/4**	**3/16**	**1/8**	**5/64**	**1.245**	**0.661**	**0.051**	**1.245**	**0.712**	**0.076**
Coarse	62	22	27	-	-	70	72	50	75	9	8
Medium	90+	64	38	-	-	200*	115	30	>100	37	2
Fine	-	>300*	-	160+	40	-	400*	300*	-	300	130

* *Estimated*

For the fine fractions, none of the roller processing was adequate to destroy seed viability. Only hammermilling through a 5/64 inch screen is adequate but this has the disadvantage of producing an undesirably high percentage of fine particles.

The flaking roller is clearly superior for processing the coarse and medium fractions, producing a minimum of fine material even at low levels of weed seed viability.

Hammermilling with a 1/4 inch screen might be acceptable for the coarse and medium fractions, provided the parent screenings comprise primarily the coarse portion (50% or more).

Dealing with the "Fines"

The biggest problem with unpelleted ground screenings is particle separation, which allows overconsumption of fine particles relative to the coarser portions of the diet.

However, finely ground(high water content), non-pelleted screenings can be bound into the diet and kept from separating by adding wet silage to the feed. An earlier study has shown that there were no differences in performance or any problems related to the feed between steers fed pelleted fines and those fed unpelleted fines bound into the feed with silage or water. With this approach, various levels of fines in the diet can be tolerated. However, where cattle are hand-fed, this may not be practical.

Photos Showing Weed Seed Germination Results

Figure 1. Flaking Mill, Coarse Materials, with 0.076 mm gap.

Figure 2. Flaking Mill, Fine Materials, with 0.076 mm gap.

Figure 3. Cracking Rolls, Coarse Materials, with 0.051mm gap.

Figure 4. Cracking Rolls, Fine Materials, with 0.051 mm gap.

Figure 5. Hammer Mill, Coarse Materials, with 1/4 in gap.

Figure 6. Hammer Mill, Fine Materials, with 1/4 in gap.

Recommendations

Processing is required for grain screenings to optimize utilization by the animal. Processing of the coarse and medium fractions by conventional means of grinding and rolling (rolling preferred) was adequate for ruminants. The fine fraction, however, must be fine ground to destroy weed seed viability. To minimize fines in processed screenings for feeding at the farm level, two approaches are suggested resulting from this work.

1) Initial cleaning to separate fines, followed by two-stage processing (grinding and rolling).
2) To accommodate a wide range in the amount of fine material that can be used in feeding, techniques such as liquid addition or silage can be used to bind fines into the overall mixed diet.

The variations in processing and feeding recommendations are numerous. These variations must accommodate a coarse particle size of processed screenings with minimal fines for optimal feed utilization, destroy weed seeds, and be innovative in presentation to the animals. The principles and means to do this have been put forward and require adaptation.

Cattle on feeding trials.

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