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Combine Performance Clinic

What's Coming

All about getting the most from crop and combine

- Loss and Productivity
- Combine Basics
- Adjustment
- Loss – measuring, understanding

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Loss is extremely important or should be to combine operators and farm owners. Combine operation is a balance between profits which include operating costs that are made up of time, labor, machine cost and of course seed loss, which must always be balance against productivity and the need to get the crop harvested within the ideal window of opportunity.

Why worry about loss?

Cost Saving by Increasing Productivity

•Harvesting cost, per bushel, decreases as productivity increases

Example:

- Average cost of combine = $300 per hour
- @ 4 mph in 30 ft. cut = 14.5 ac/h
- @ 50 bu/ac = 725 bu/h = $0.414/bu
- @ 5 mph in 30 ft. cut = 18.2 ac/h
- @ 50 bu/ac = 909 bu/h = $0.330/bu
- = 8.4 cents/bu decrease = on 150 acres = $630 saving

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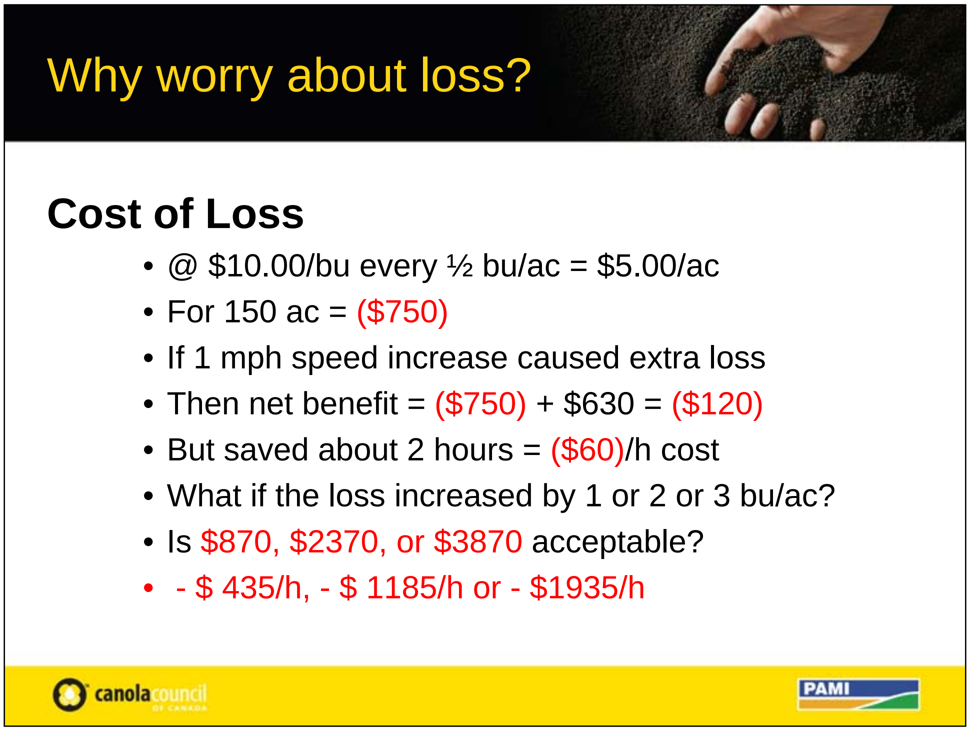
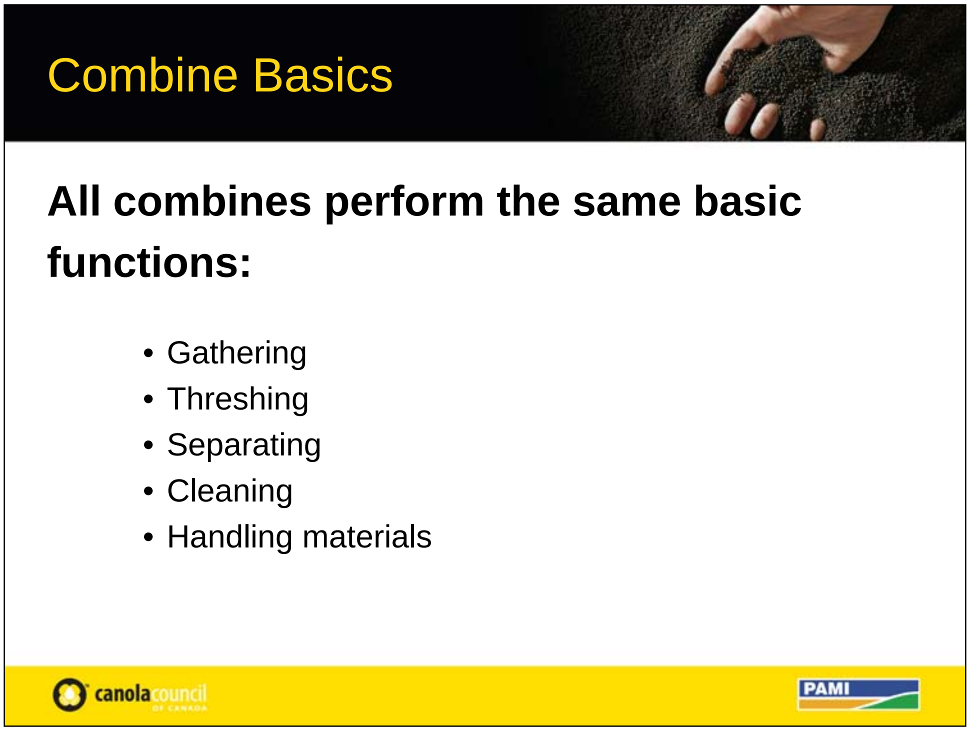
We recognize the economic impact of increasing productivity since machine cost will be amortized over more crop harvested.



On the opposite side of the equation we also recognize that increasing productivity (harvesting rate) is closely linked to increased seed loss. Increased loss means decreased profit potential. Loss is throwing money away!



All combines perform the same basic functions of Gathering which is getting the crop into the combine, Threshing to dislodge the seed from the plant, separating to get the seed removed from the main stems, cleaning which captures the seed separate from the chaff and material handling that moves the seed to the holding tank and from the combine to an exit point and includes moving tailings and conveying straw and chaff which often is chopped and spread.

Gathering starts with cutting the crop whether with a windrower or direct cut header. At this point things happen that will affect combine performance. That includes the suitability of the amount of crop for the combine that will be used, how much variation there is in crop mass, how smoothly the crop flows which is effected by cutting, reel input, conveying , opening, as well as speed, lean of the crop, wind and what effect the roller has.

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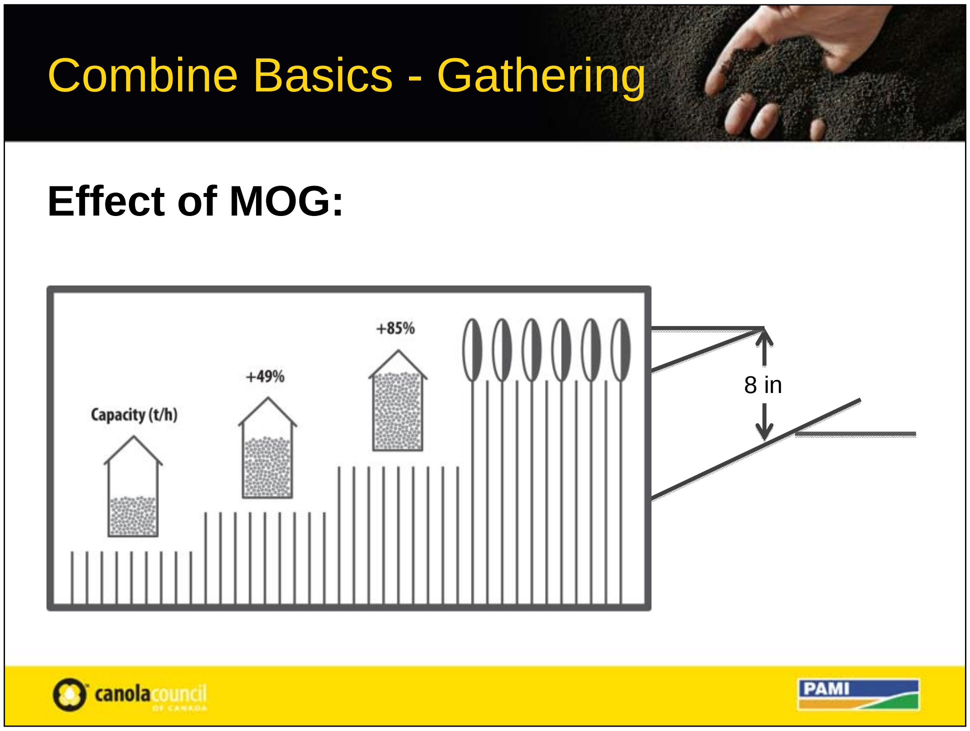
Single axial rotor combines prefer narrower windrows due to limited feeder width and in-feed challenges at the rotor. Conventional (wide cylinders) and twin rotors like wider windrows to spread out crop across cylinder width and to provide separate streams to each of the twin rotors especially like the loose center.



Combine capacity is generally a factor of the MOG that is taken in with the grain. As such reducing the straw means you get to go faster to reach the critical MOG throughput. This means a higher grain capacity.

The more uniform the crop flow the better the combine will perform. A wide variation in feedrate will not produce a same average feedrate as when feeding is very uniform. Once a combine's system is overloaded, it takes time to recover and under loading can not be adjusted for quickly enough for variations occurring over a short distance.

Even a uniform windrow is no guarantee of uniform feeding. Pickup adjustment can significantly effect crop feeding. Adjustments such as pick-up Angle, picking and transfer belt speed, auger speed, auger finger timing, auger height and fore-aft adjustment, auger stripper position and adjustment, auger float and auger flighting all can cause breaks in other wise uniform crop flow.

If crop flows smoothly to the feeder there is still a chance that it will slip or bunch due to improper chain adjustment, poor feeder bar condition, rust or dirt on the feeder floor, obstructions in the stone trap, worn beater or impeller wings, or the wrong ones for the crop, worn rotor impeller fins or in-feed flighting , worn rasp bars or concave inlet obstruction can cause uneven material flow.

Combine Basics - Gathering

Picking

Head first (cereals)

- Picks better
- Feeds better
- Threshes better

Canola different?

- Threshing - n/a
- Picking - not issue
- Feeding – yes
- Causes break In flow

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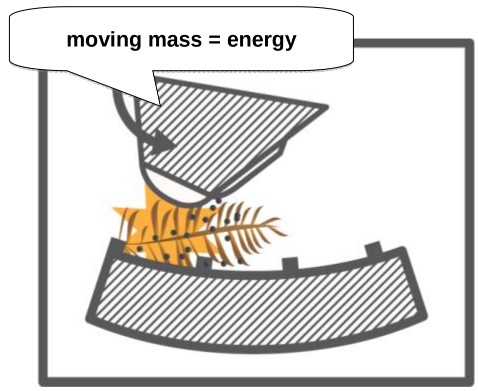
Everyone who has combined recognizes that windrows require "head first" feeding. Windrows pick easier and cleaner, feed better and thresh better.
Next time you are windrowing canola pay attention to how the windrow is being formed. Typically when crop is heavy it may not have a particular direction as it comes out of the windrower. As is often the case a swath roller is towed behind the windrower and it pushes the windrow to make the heads point forward. When combining the combine typically follows the direction of the windrower. Now the windrow is being picked up backwards. Because canola is such a bushy crop there is no problem picking it. However, if you wathch closely you will see the windrow break apart unless the combine is traveling at a speed where the windrow is being pushed all the way to table auger. If combine speed is such that the pickup is pulling at the crop the breaks will be prominent. These breaks can effect combine performance and it is worth trying picking the windrow in the opposite direction for more uniform feeding.

Before the combine can do the rest of its basic functions it first has to thresh the seed from the pods or head. The sooner this happens the better. The problem is that too aggressive threshing can result in seed damage, so it is important to understand the mechanism of threshing.

Combine Basics - Threshing

Threshing

- Impact?
- Rubbing?
- Crop on crop?
- Crushing?
- Energy Transfer - YES
  - Mass in motion
  - Cylinder / rotor



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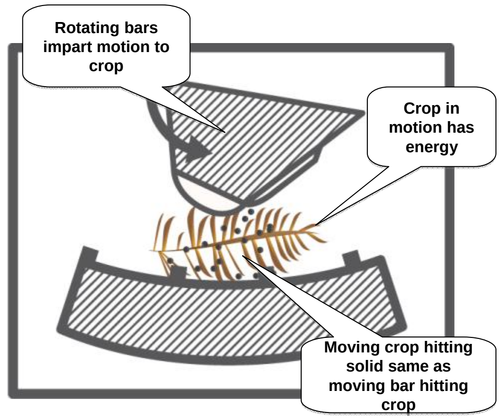
Over the years there has been debate as to how threshing actually takes place and which is the best method. The theories include impact, rubbing, combing, crop on crop, compression and so on. In reality it is likely that some of everything goes on at one time or another. What is indisputable is that threshing only occurs when there is a transfer of energy. Energy comes from mass in motion. All of the initial energy thus comes from the cylinder or rotor.

Combine Basics - Threshing

Threshing

- •Rasp bars move crop
- •Crop in Motion = energy
- •Crop hits solid concave



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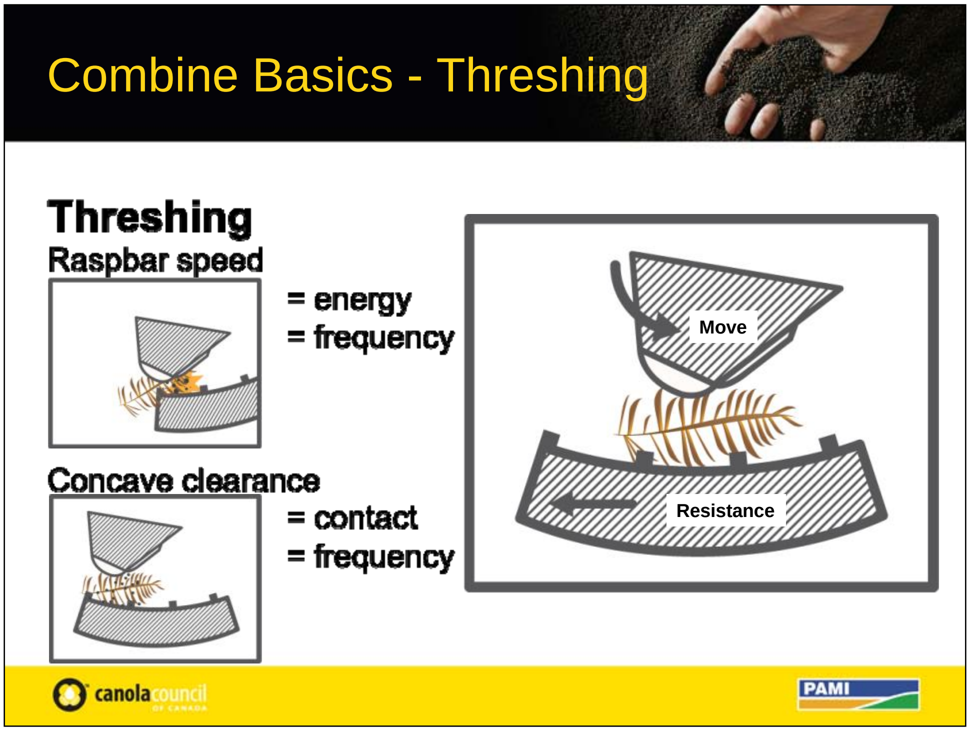
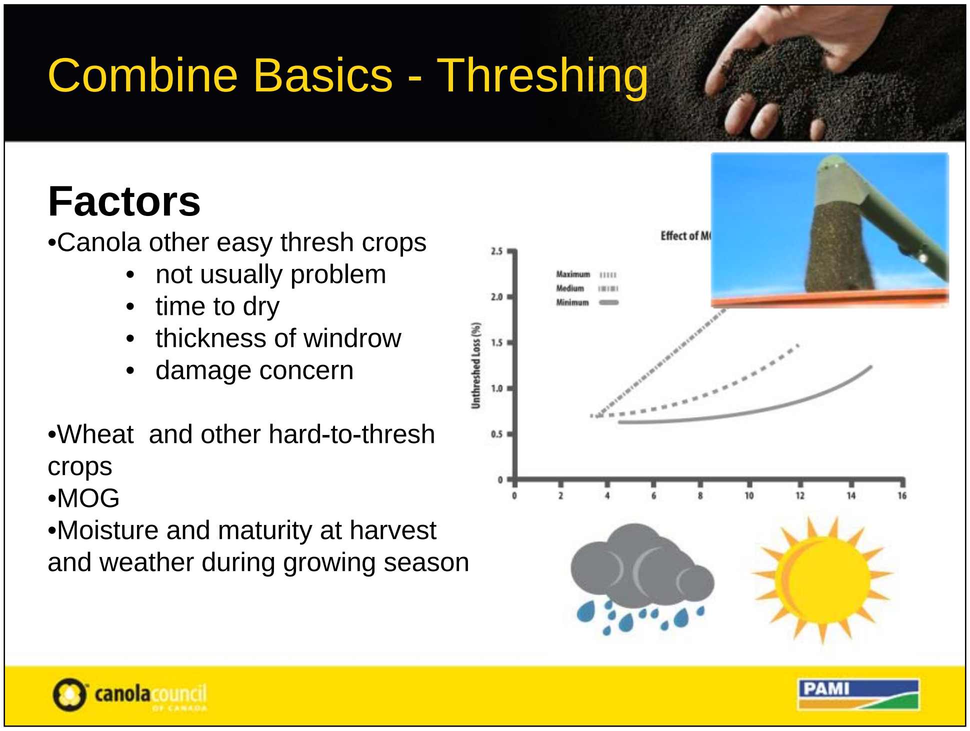
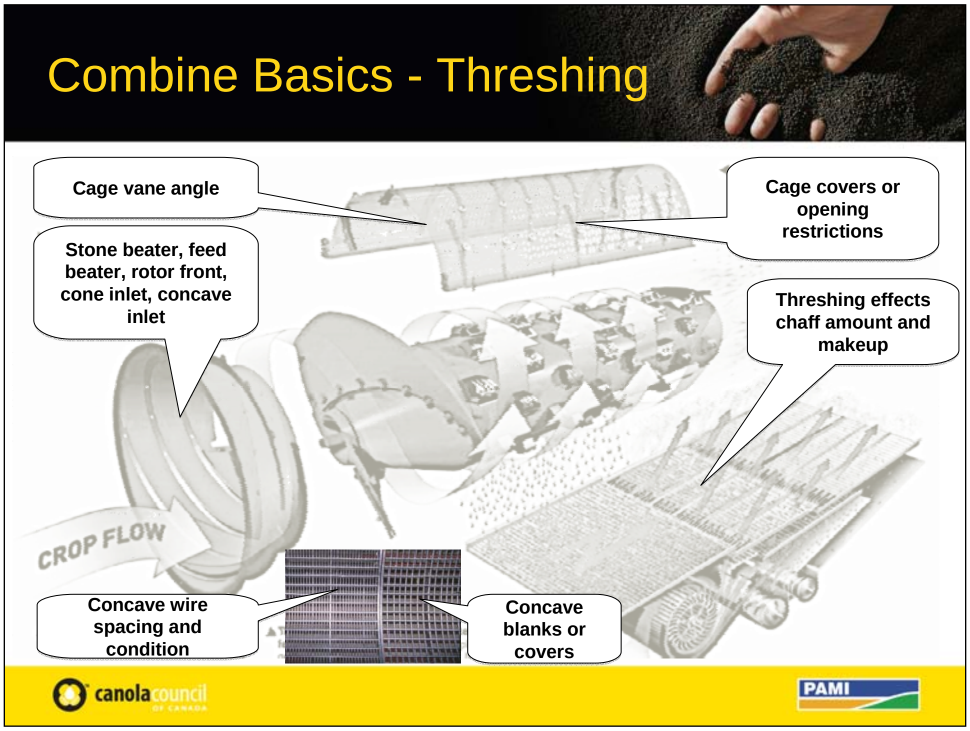
We know there is energy transfer when the fast moving bars contact the slow moving crop. We also know that when the crop flows and crashes into a stationary bar again energy is transferred to threshing the seed from the head or pods.



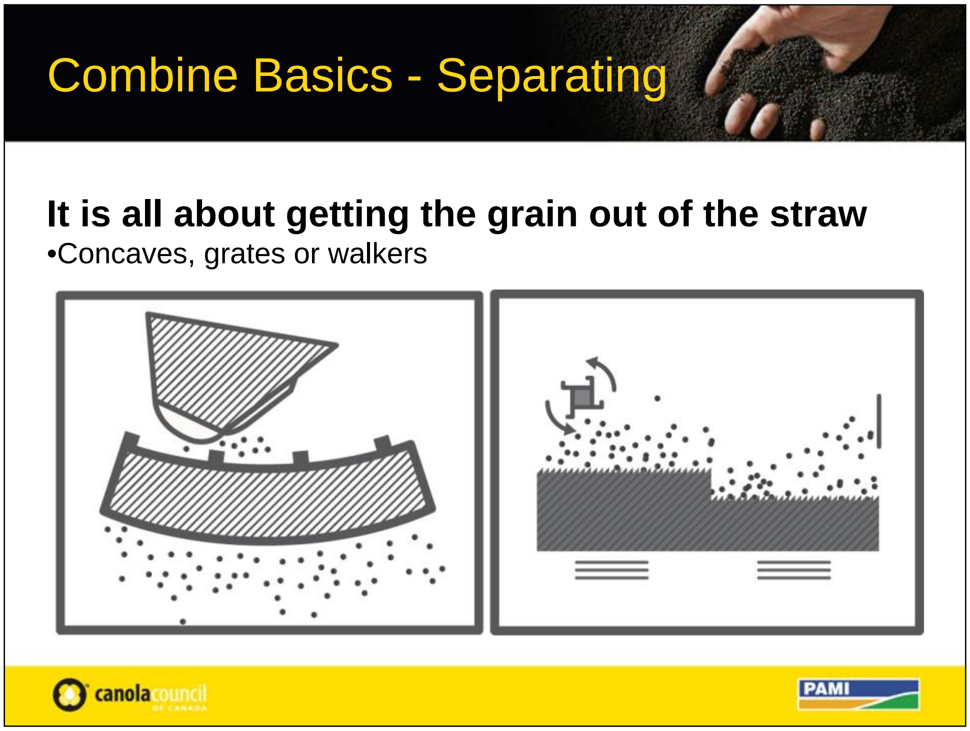
We know that threshing bar speed inputs the energy and also determines the frequency the bars pass a given point that affects the odds of crop being impacted. The concave provides restriction to crop flow as well as the anvil to hammer the crop against. Increased resistance also will increase the frequency of contact.



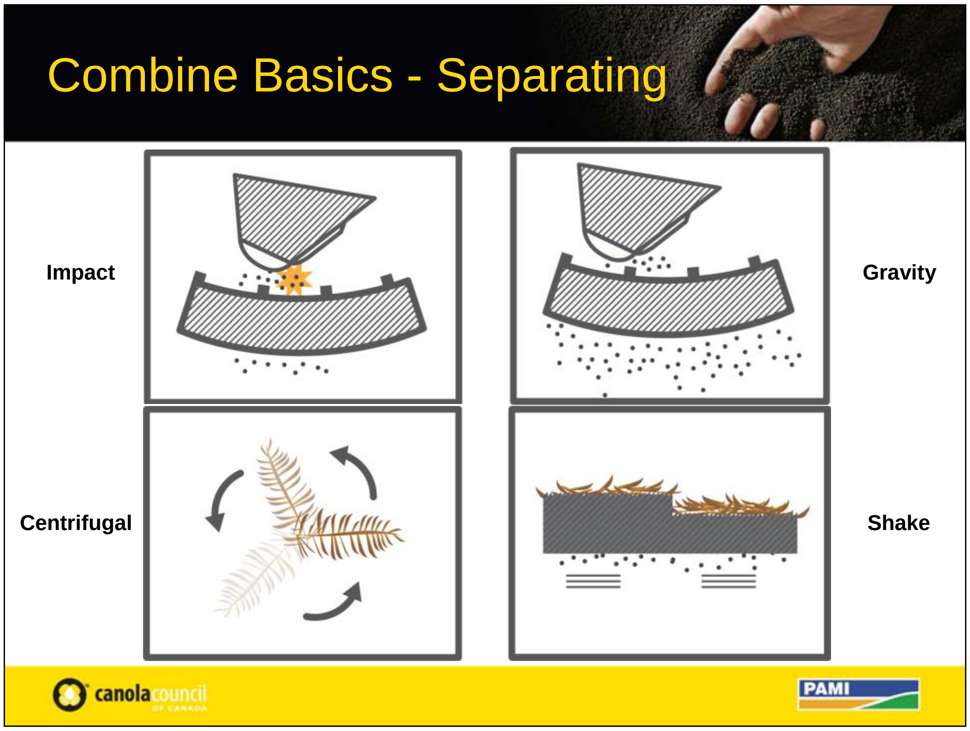
In canola threshing is usually not an issue with a lot of threshing taking place just in getting the crop to the threshing elements. Canola thresh ability depend upon how well cured the crop is and that may depend upon the crop maturity at the time of cutting, windrow density, and the weather. Threshing can be a problem if pods are rubbery or if the septum that divides the rows of seed stays attached on one side carrying a half a pod of seed.



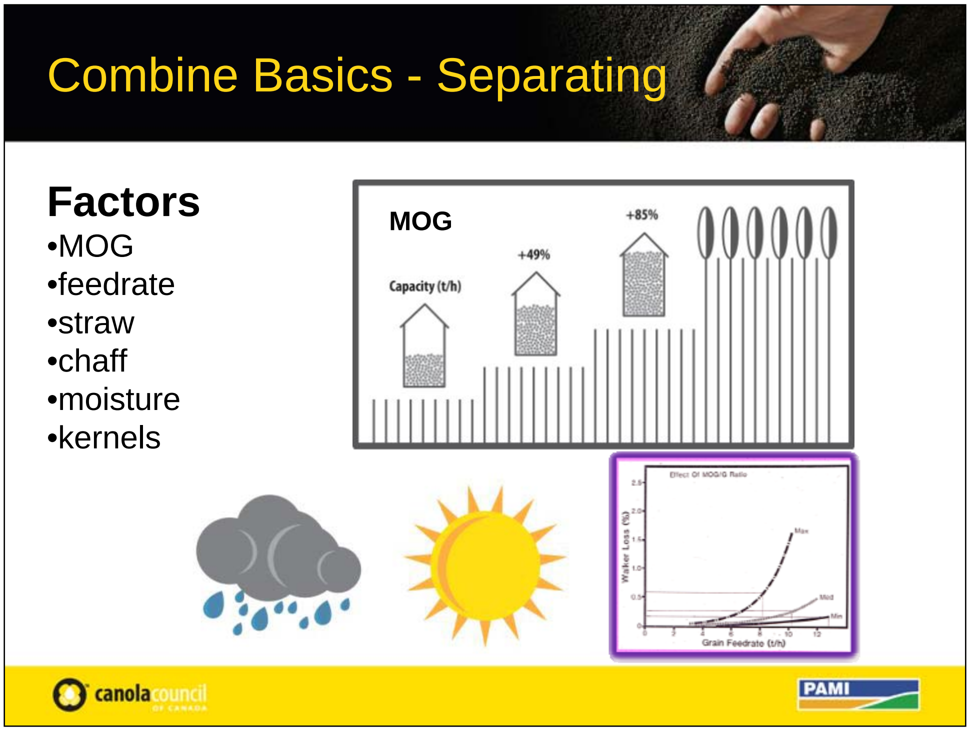
There are many mechanical factors that effect threshing. Everything from the rotor impellers to the concaves. Rotor cage vanes and cage covers or interrupters can effect threshing just as the concave design and concave blanks can. Threshing ultimately effects the amount of chaff and the makeup of the chaff.
threshing



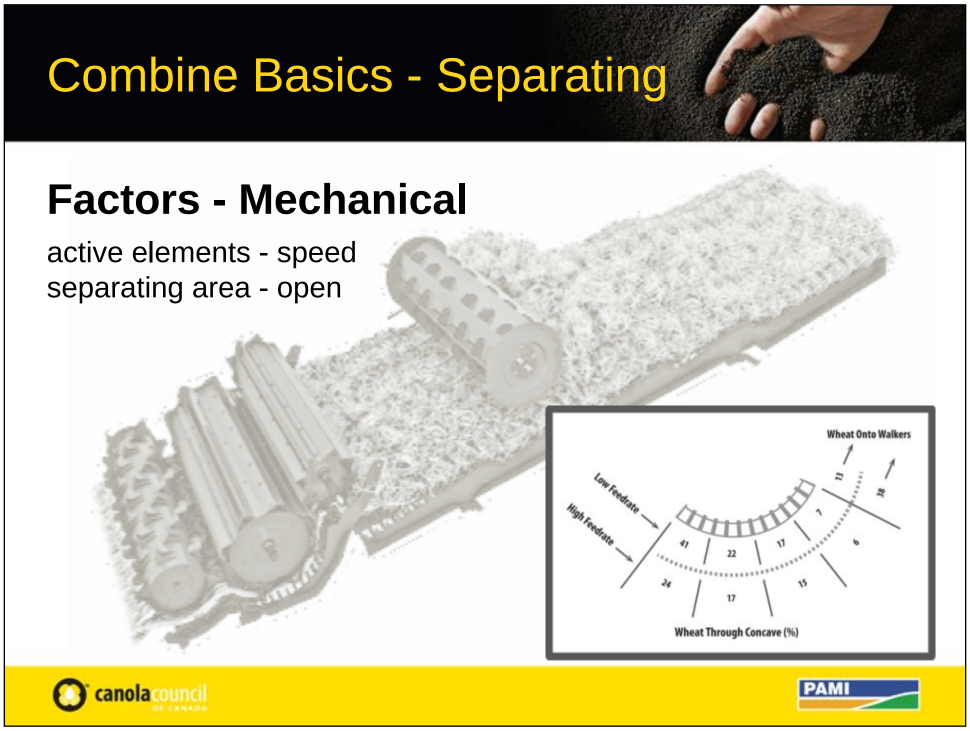
Once threshing starts to take place, separation also starts. Threshing keeps the MOG on one side of a medium and grain passes through.



Separating has several factors that can assist grain on its way. The include impact, gravity, centrifugal and shaking

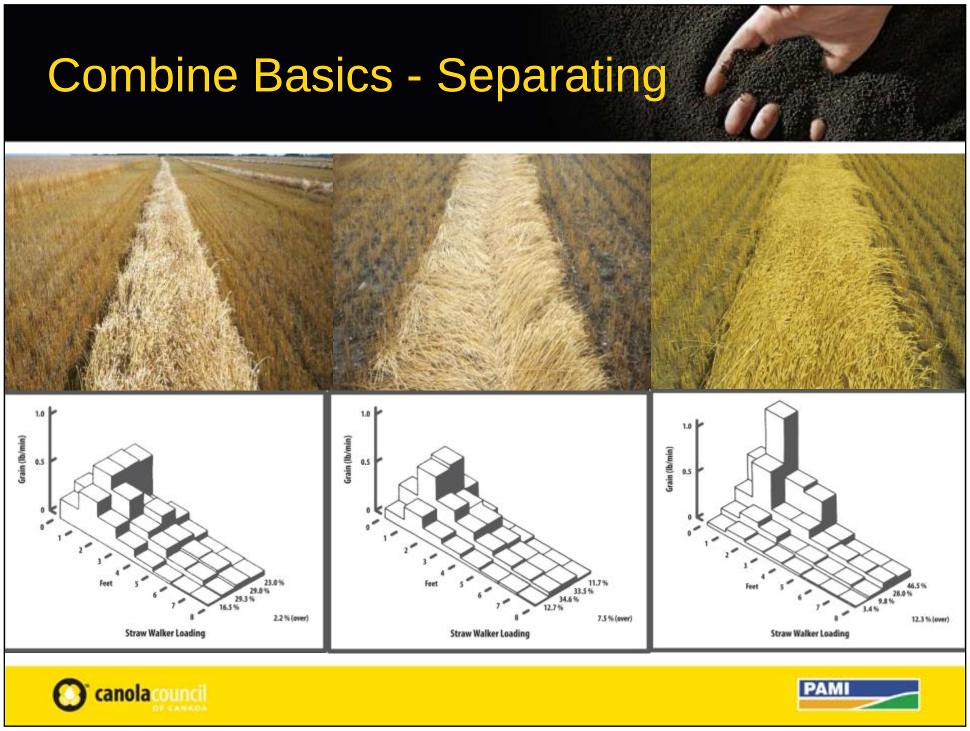


Some of the most influential factors that effect separation include MOG/G ratio, MOG feedrate, straw condition , chaff, moisture and kernel characteristics

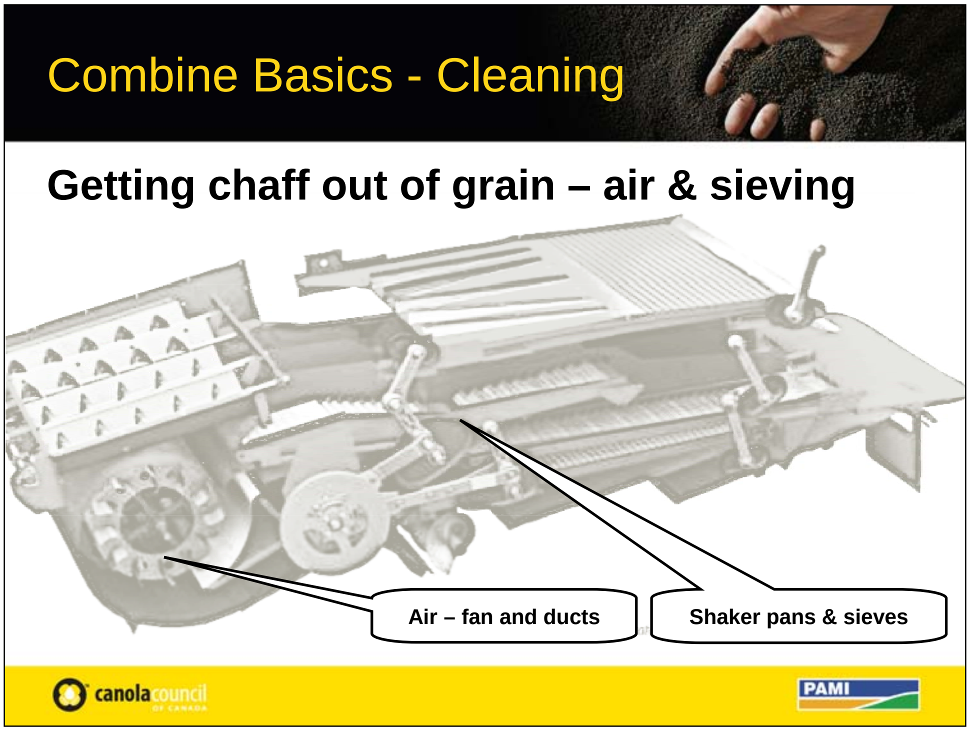


Separation is most efficient when under active elements such as cylinder and concave. It is important to recognize that separation is highest when the grain to MOG ratio is highest and the crop is moving slowly.

Head placement and distribution play a role especially in conventional combines.

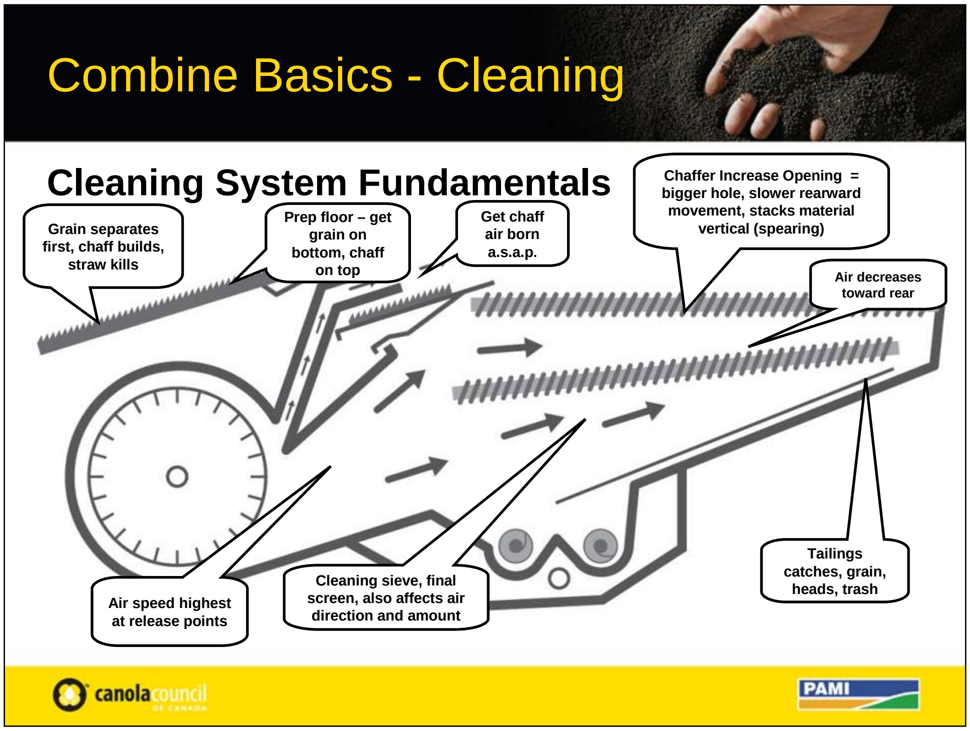


Uniform head distribution provides optimum separation at the concave and walkers. Concentrating the heads either in the middle or at the side and separation limits are reached sooner than at the rest of the available area. The result is much higher loss at the same overall feedrate.

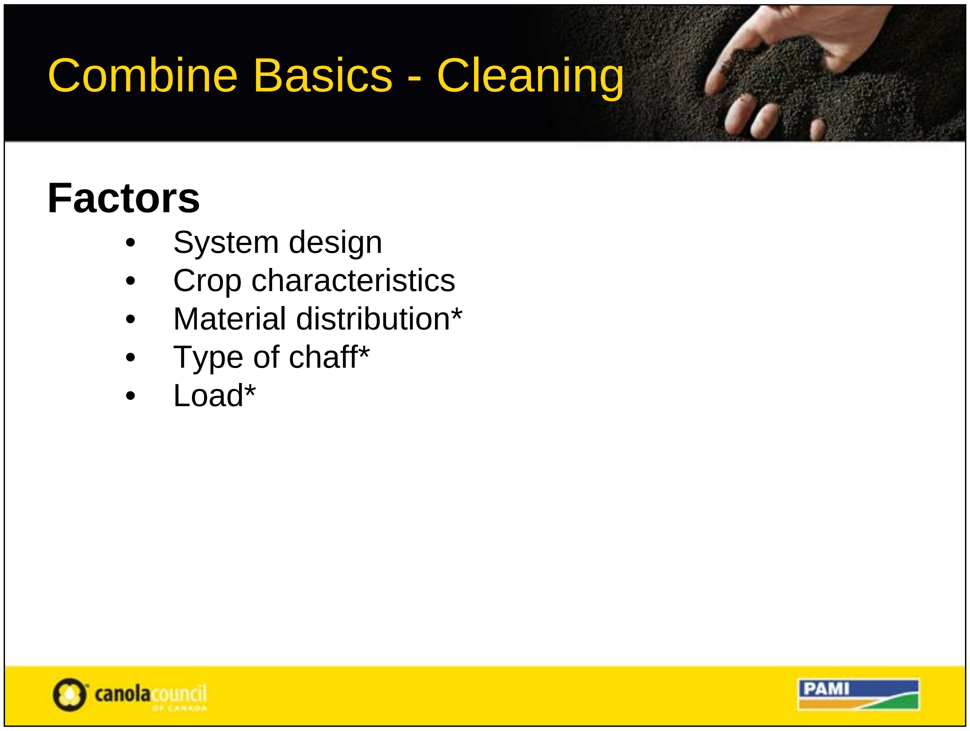


There are two main mechanical features that effect cleaning they are the air and the sieves.

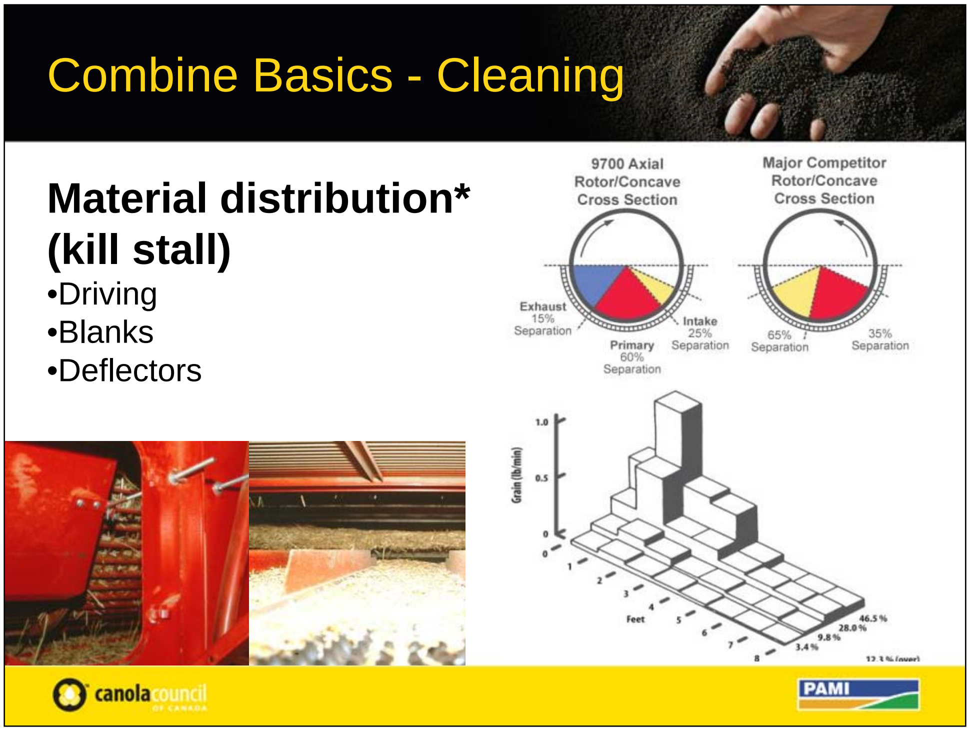
The fan provides the air velocity and volume (higher velocity = higher volume). The sieves provide and perforated medium that has mechanical conveyance and tossing and the opening also provides air direction control.



Some important information about cleaning system components. Grain pans, preparation floors not only convey crop but also shake the grain to the bottom because you can blow through grain, but you cant blow chaff through grain. Pre cleaners use air to get chaff to the top and air born. The fan provides the strongest blasts at release points. The chaffer sieve provides winnowing action, rearward material movement and separation area. Air velocity tends to decrease farther back along the chaffer to progressively let lighter particles drop through. The lower the louver opening the faster the crop travels and more "hard" surface that is projected. The tailings section or the rear section of the chaffer sieve is for catching unthreshed heads. It also catches grain and chaff depending upon air from below and opeining. The cleaning sieve is the "go-no-go" gate. It also has mechanical travel function to move grain back. Any trash or larger pieces are sent to the tailings.

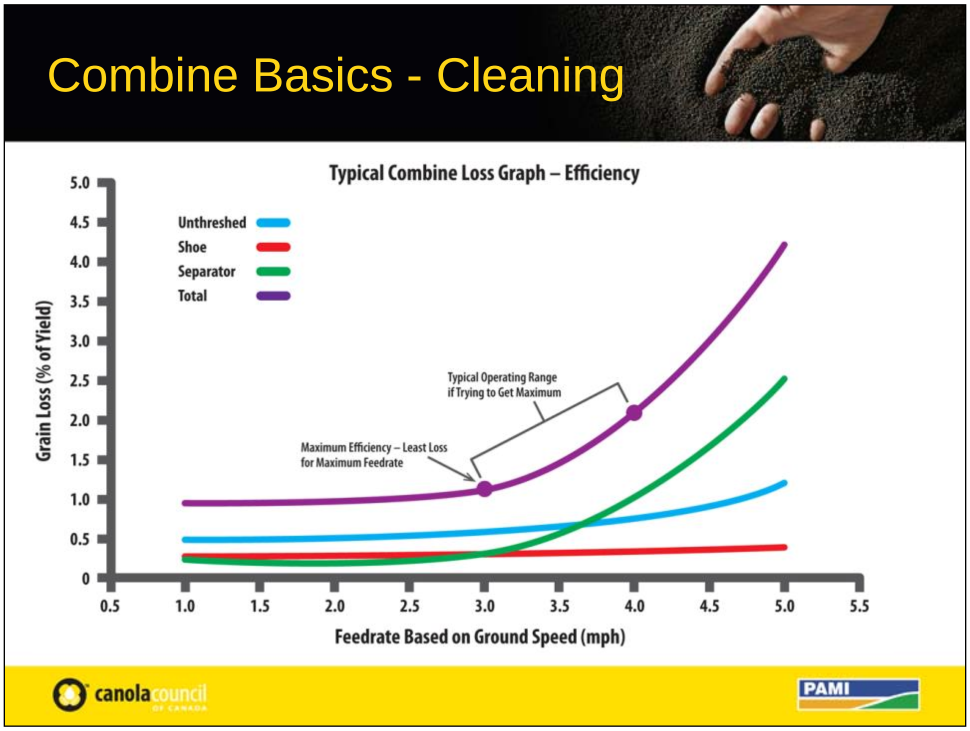


Every cleaning system is subject to the integrity and efficiency of its design –some good – some not. Each system may respond differently to changing crop characteristics and conditions. All systems are effected by uneven material distribution. Cleaning systems are chaff dependent not only as a function of load but also by the chaff composition and characteristics.

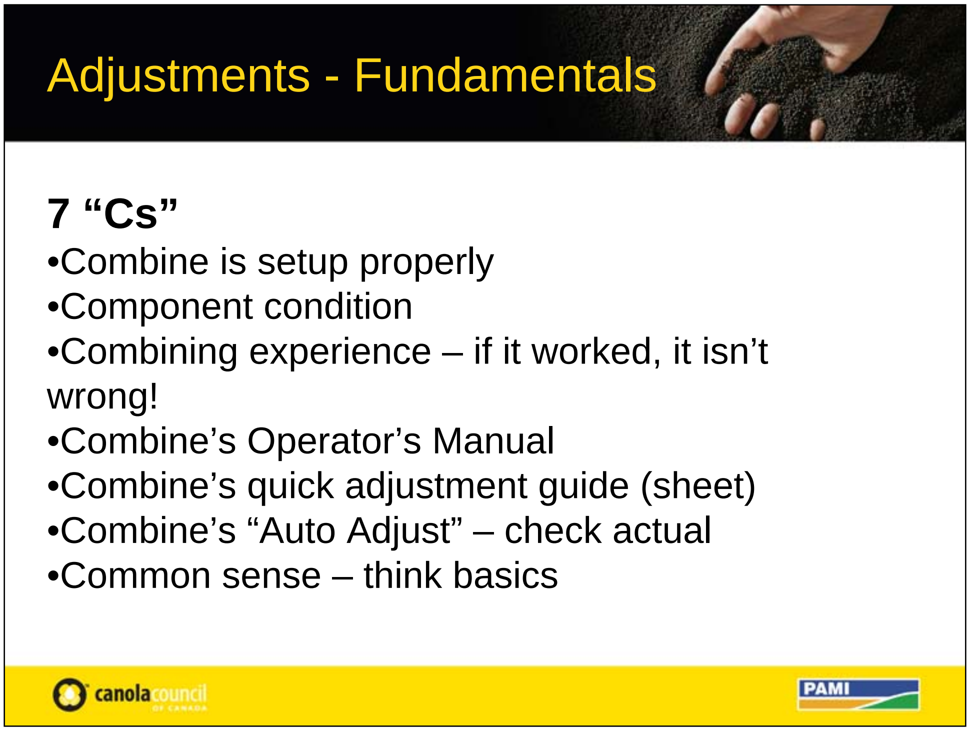


All cleaning systems are sensitive to crop distribution that includes the grain and the chaff, especially as how the distribution aligns with air distribution. This might be a result of driving, feeding or machine design. The kill stall works well for most rotary combines. This means stopping the combine as quickly as possible under load.

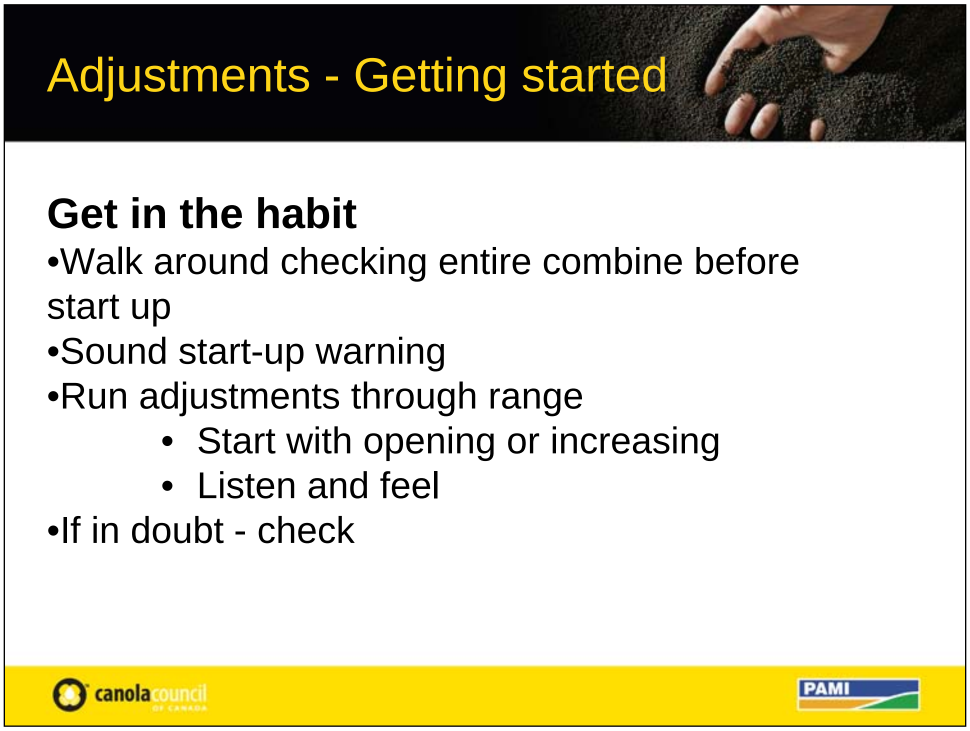
When we talk about chaff type or composition the key factors is how well it responds to an air blast. Chaff that is light and dry often is removed entirely by air. Chaff that has green weeds, straw and is moist or sticky often won't fluidize well (suspend in the air stream). Chaff riding on the chaffer sieve typically caries grain. The consistency of chaff can be dependent upon which wire spacing a concave has. The other main challenge for a cleaning system is side slope that tends to overload the don hill side of the cleaning system.



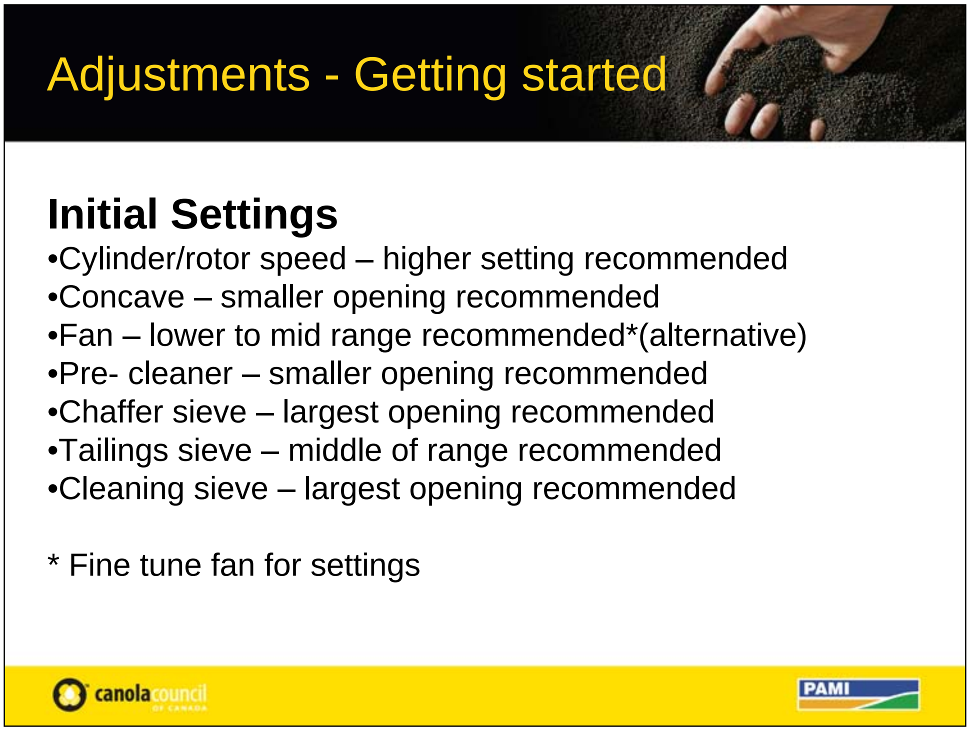
Cleaning systems tend to be chaff feedrate dependent. Eventually as feedrate increases it becomes less efficient and begins loosing seed. In the worst case, an overloaded system will fail to function and seed pours over.



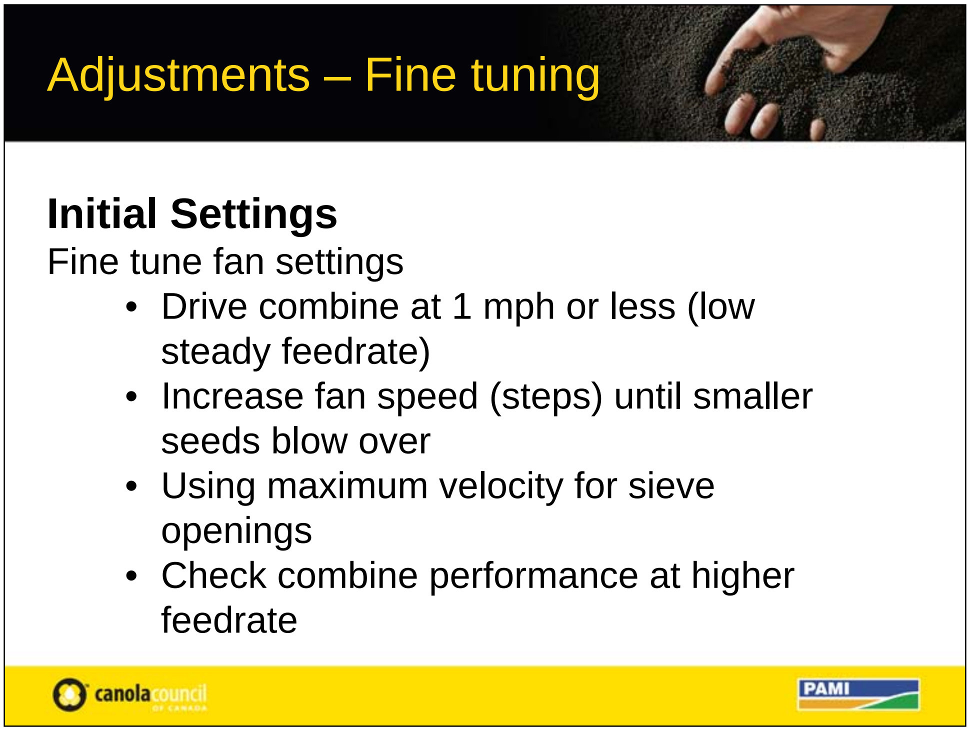
As we move onto adjustments there are several considerations that must be addressed or else adjustments are likely to be less effective or ineffective.



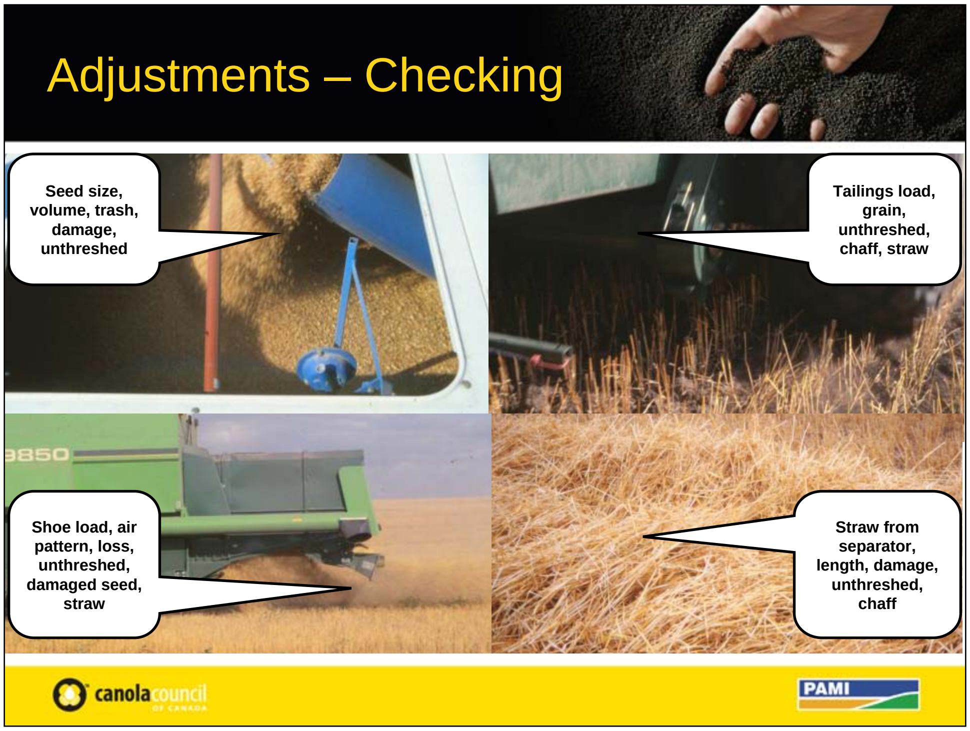
Before adjusting it is wise to develop a routine that eliminates issues before they become problems. Check your combine before start up to ensure all doors are shut and access panels are in place. Make sure there are no mechanical issues such as loose hangers, damages belts or chains, missing parts etc. look for plugged components and anything that appears out of the ordinary.



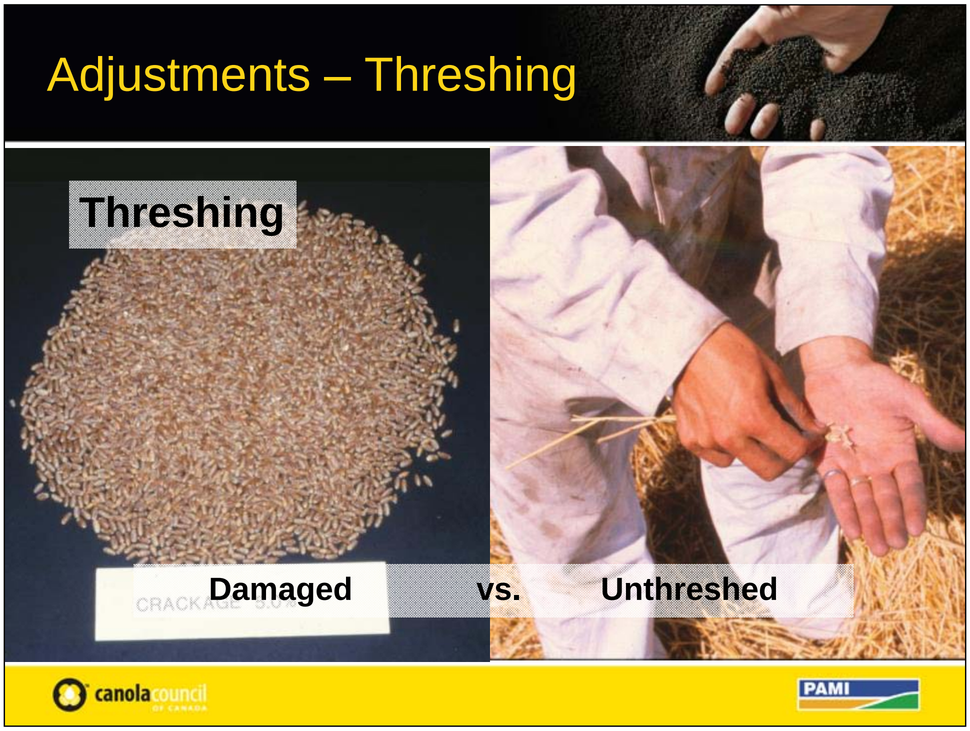
When it comes to getting started use your best judgment when following the manufactures' recommended settings and set on the cautious side.



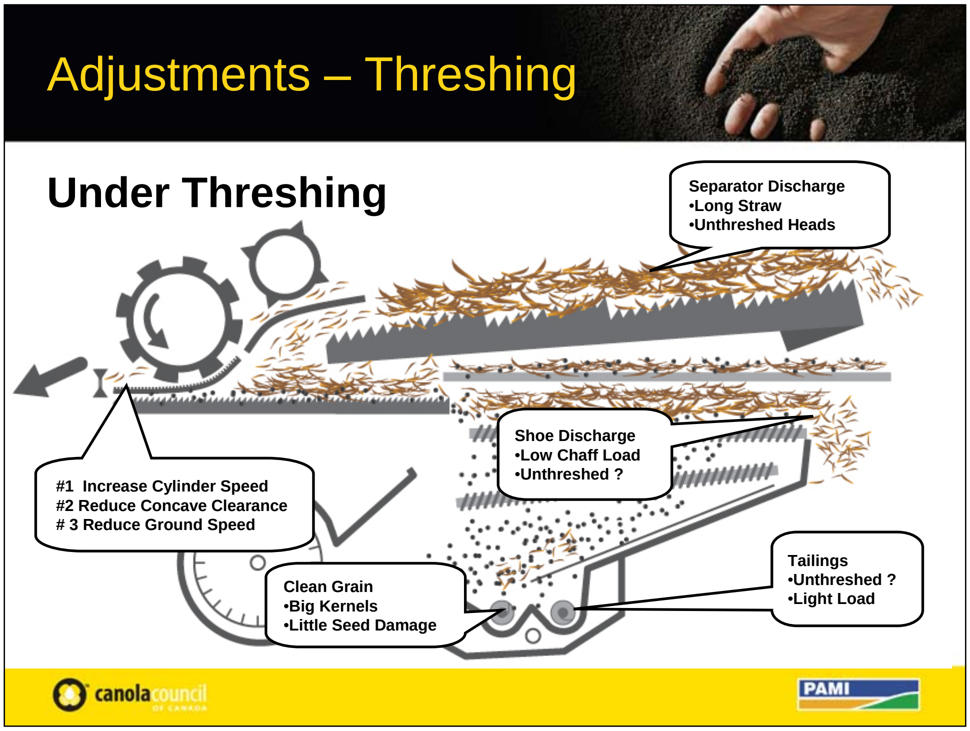
I have found that this technique works quite well for honing in the cleaning system, specifically the fan setting.



Once you start into crop ensure that you run long enough to allow components to stabilize and then check combine performance. Check the grain flow and ask is it appropriate, are there a range of kernel size, is the grain fit, how much and what type of trash is present. If you can check tailings look for grain, chaff, and unthreshed heads as well as damaged grain and straw. Note how the material is coming off the shoe and sample material across the upper air stream looking for seed damage, and type of chaff. Check across the chaff discharge off the end of the chaffer sieve. Again look for loss, grain damage, chaff type straw, weed seeds etc. Finally check the straw off the separator, looking at the straw condition, test its strength and note its maturity and for signs of unthreshed seed.

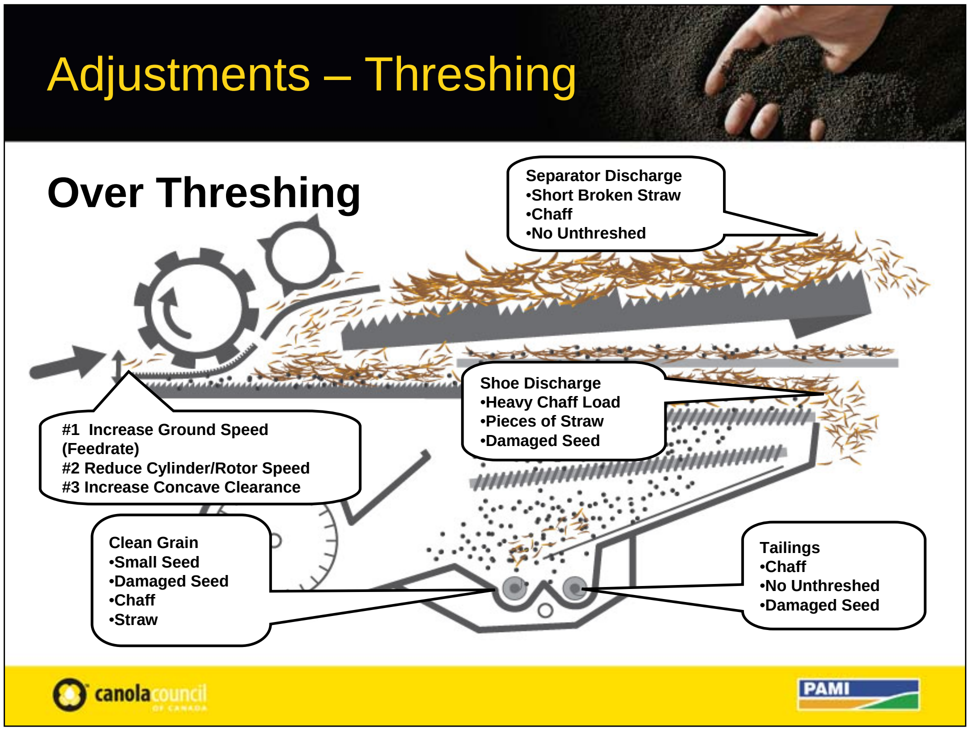


Your first concern is to analyze threshing. The considerations are the balance between seed damage and unthreshed seed. The easier a crop is to thresh the more complete the threshing should be without a lot of seed damage. Hard to thresh crops usually end up being a compromise between some damage and some unthreshed seed.

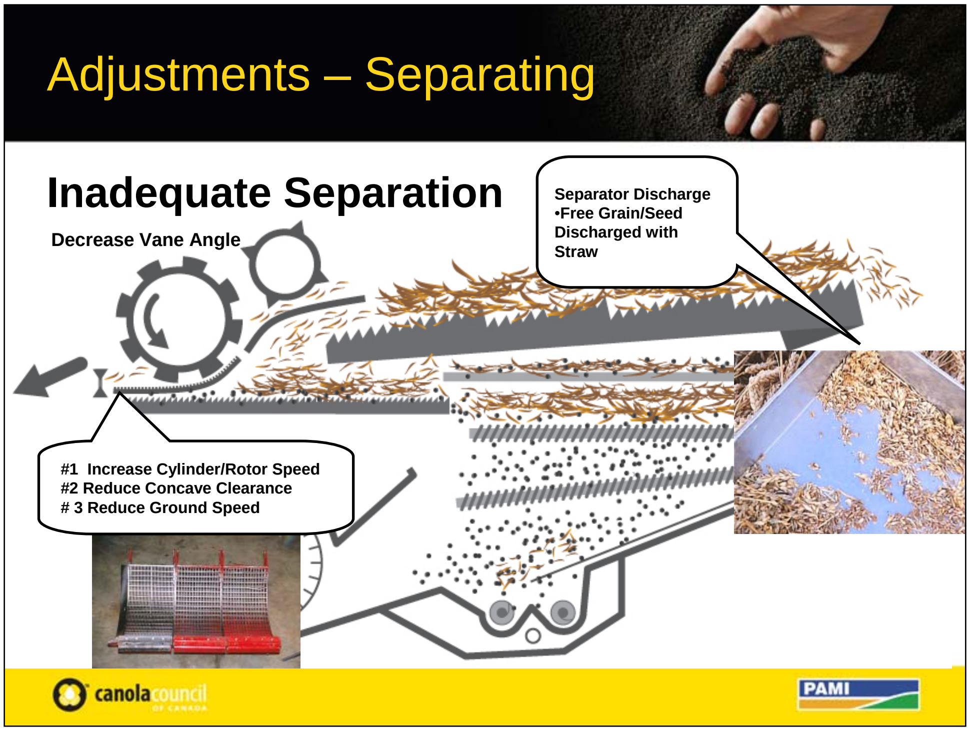


The signs that might indicate under threshing is that the grain sample may have mostly large kernels, the kernels are undamaged even though the crop may traditionally be considered hard to thresh. There may be part heads in with the grain. The tailings may or may not have unthreshed heads but should not have excessive chaff. The shoe chaff load will be light and there should be very little straw in the chaff. There may be some unthreshed but there should not be any damaged seed. The straw will be long and damage will be relatively low. There will be seed still left in heads attached to the straw.

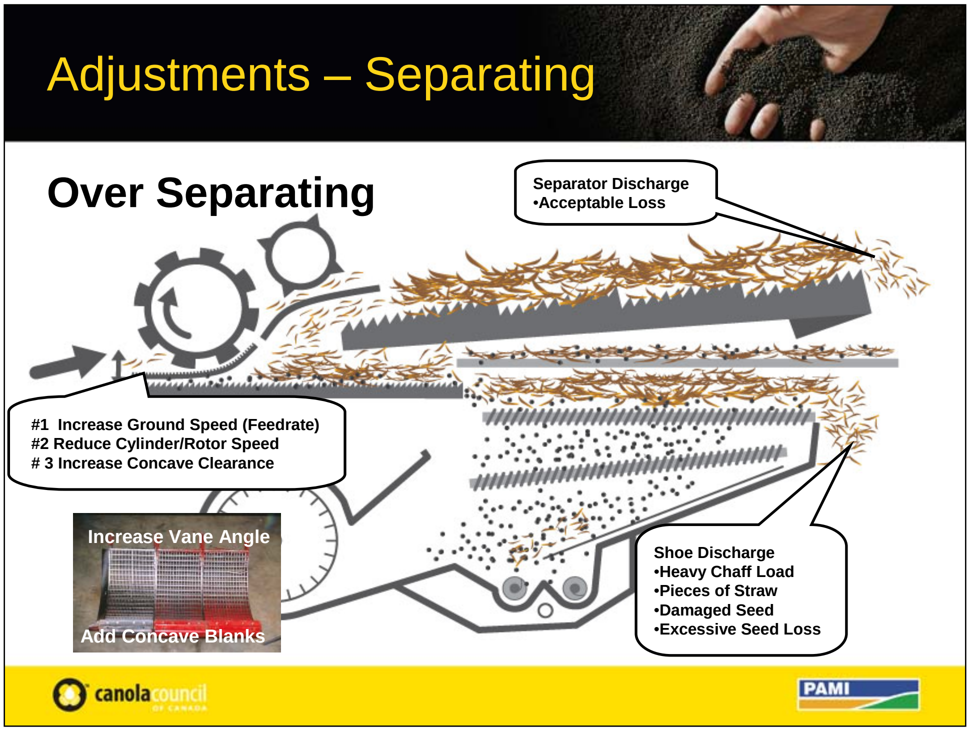
The appropriate adjustment will be to increase the cylinder/rotor speed first, followed by decreasing the concave opening. As a final option reduce feedrate.



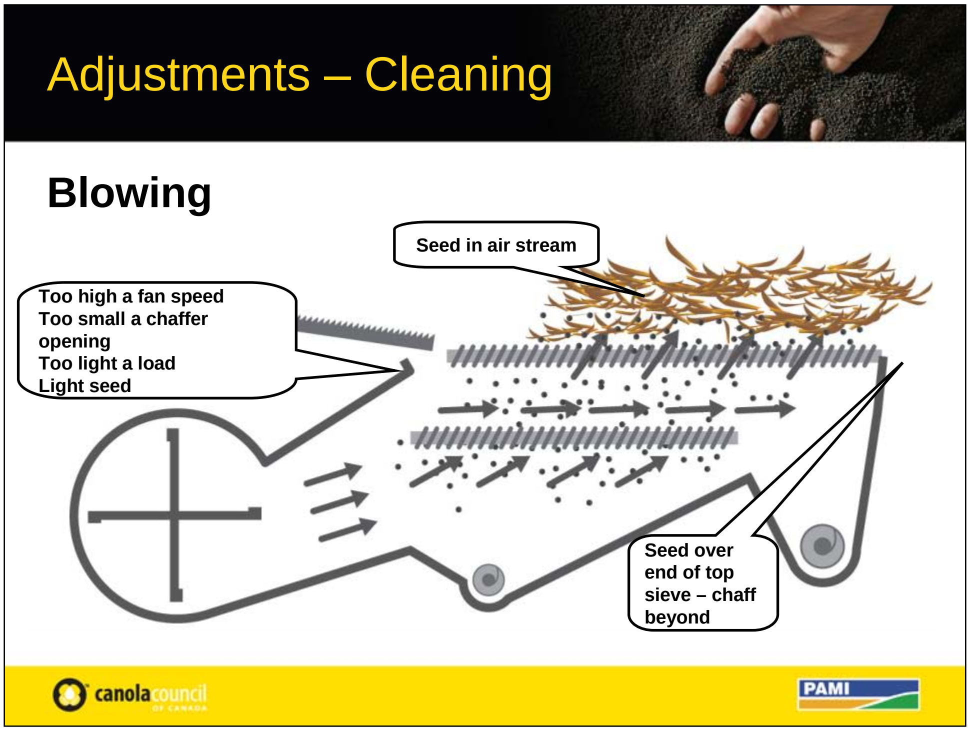
When over threshing is the problem and losses are not a problem then drive a faster. Typically however, the worst problem will be either grain damage or unthreshed. In his case increase cylinder/rotor speed, followed by tighter concave clearance.



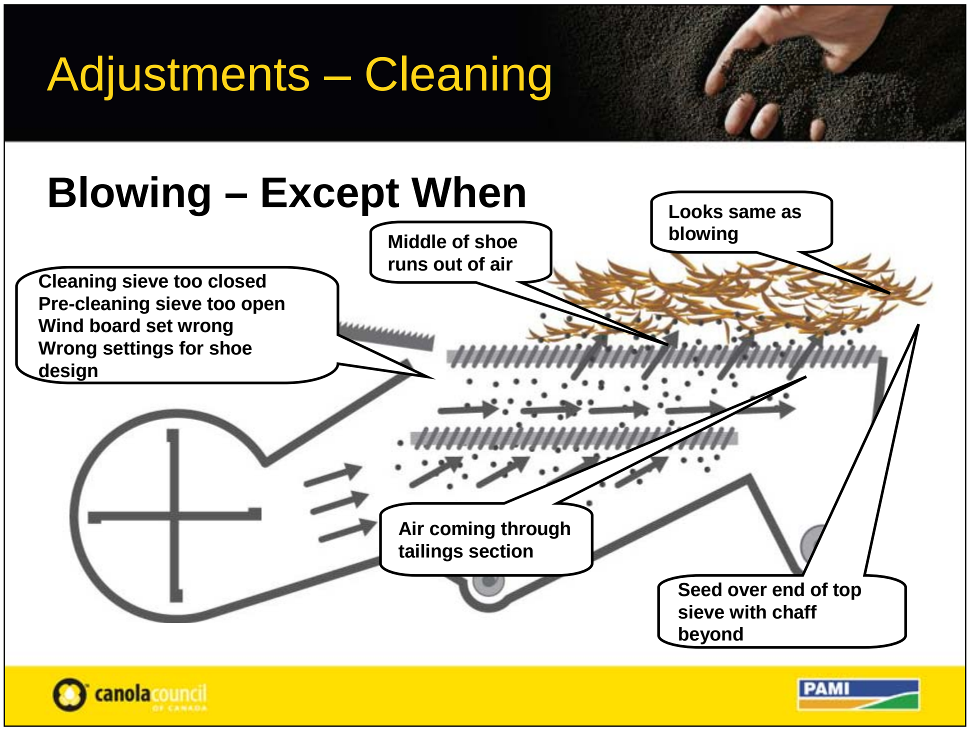
Inadequate separation simply means too much separator loss! You can choose to increase threshing settings based upon threshing results. This means increasing cylinder/rotor speed, decreasing concave clearance or decreasing feedrate. If these aren't desirable options increase concave separating open area by changing to wide spaced wire concaves or pulling wires. Another option is decrease the concave age vane angle .



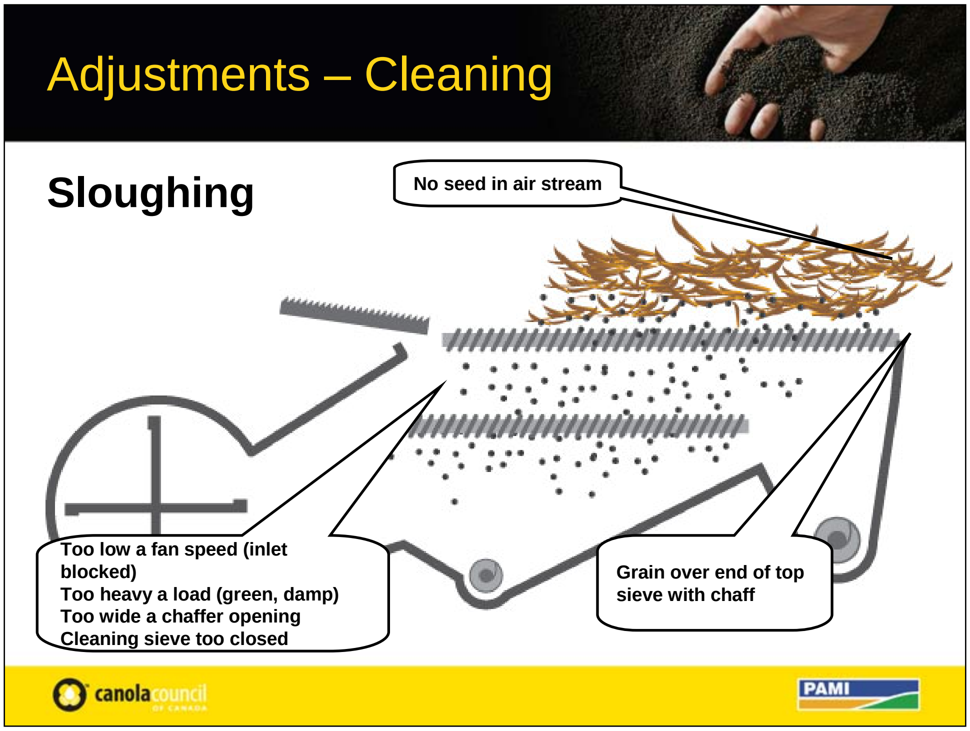
Is there such a thing as over separating? You can't save too much grain but you can separate too much chaff, to the point where it effects cleaning. Normal adjustment might include increasing feedrate, slowing the cylinder/rotor speed and opening the concave. I may also include changing to narrow wire spaced concaves, blanking portions of the concaves or separating grates or advancing the cage vanes.



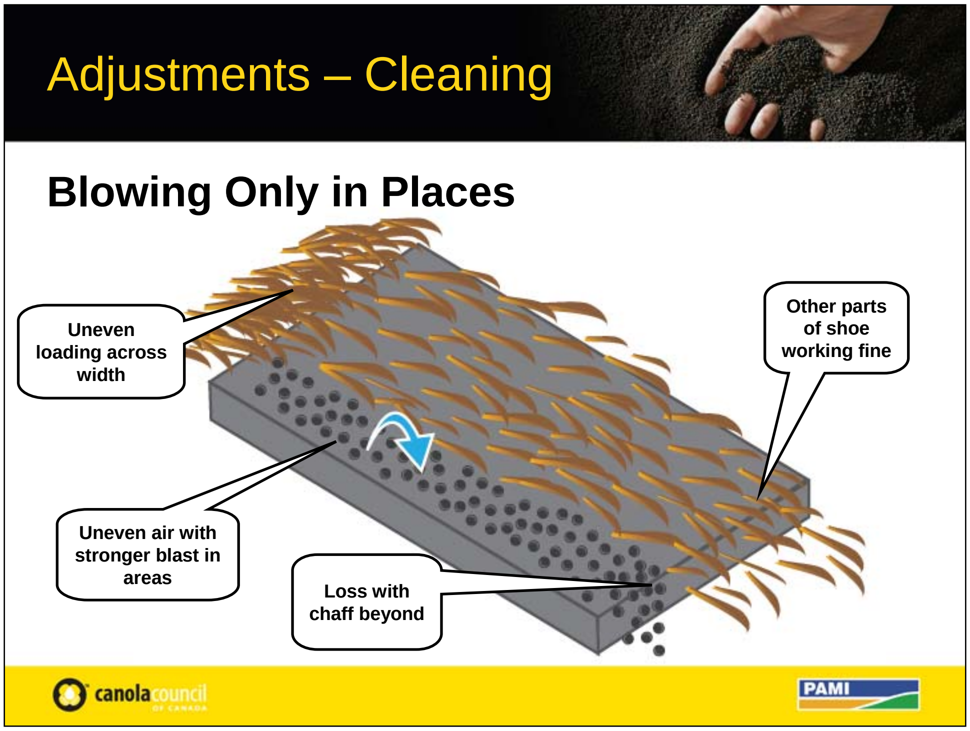
The cleaning shoe can loose grain in several different manners. One way is referred to as "blowing" seed over. It is characterized by the seed dropping off the end of the top sieve but the chaff is blown above and beyond. This basically happens when there is too high an air velocity. This causes grain to travel over the top sieve without falling through.



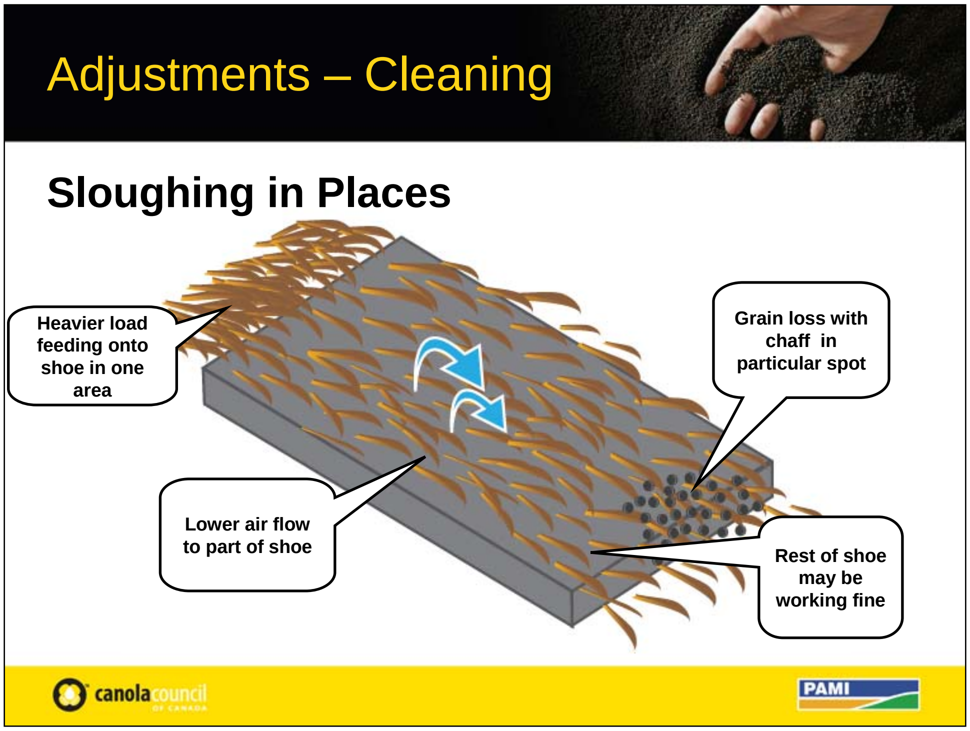
When is blowing not blowing? It may look like blowing but the reason the grain is getting to the back is because it has settled onto the top sieve and rode back. This may be from a loss of air in the mid section of the top chaffer sieve due to the precleaner being too far open, the bottome cleaning sieve closed too much a windboard set incorrectly or poor design.



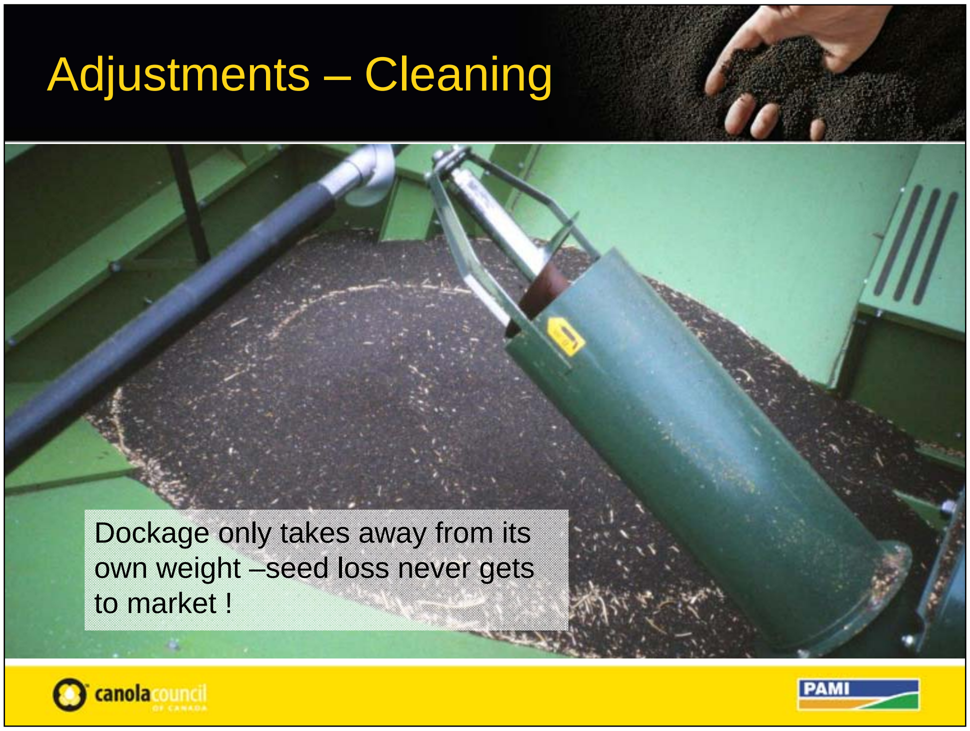
Sloughing is characterized by the grain and chaff dropping together off the end of the top sieve. There can be several causes from anything that decreases air, to heavy chaff.



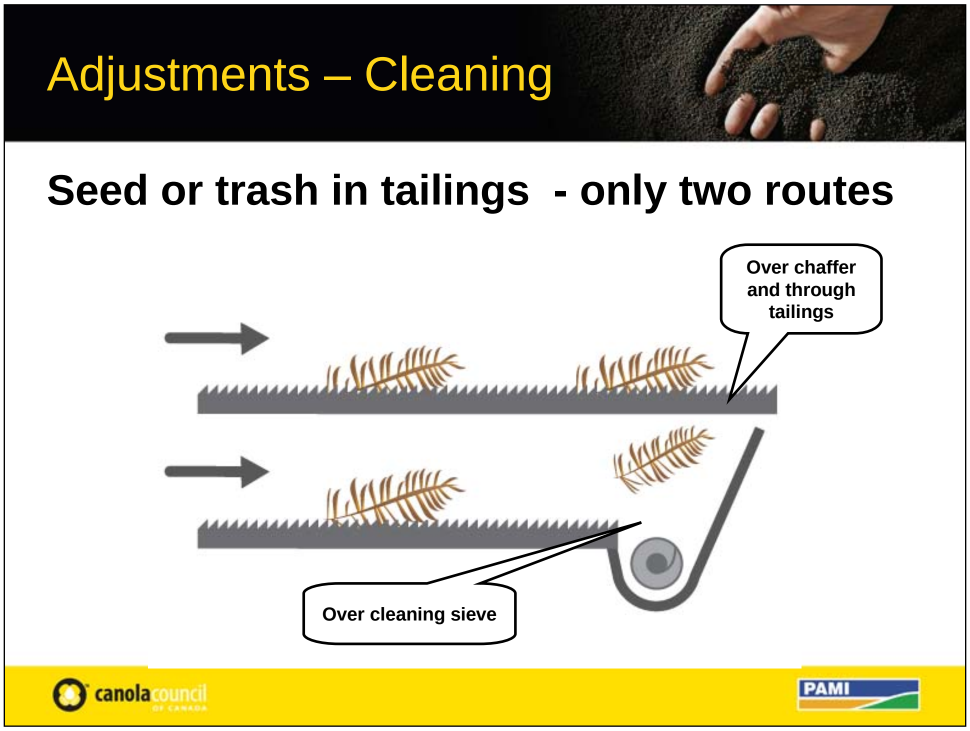
You are lucky if the above conditions occur across the width of the shoe in a uniform manner. It is far more likely and troublesome if blowing occurs on a portion of the cleaning system. It may be due to a stronger air blast or just a lighter chaff load. Redistributing the load is the best option.



Similarly, sloughing will occur when there is a low air flow section or too much chaff load. Redistributing the load is the best option.

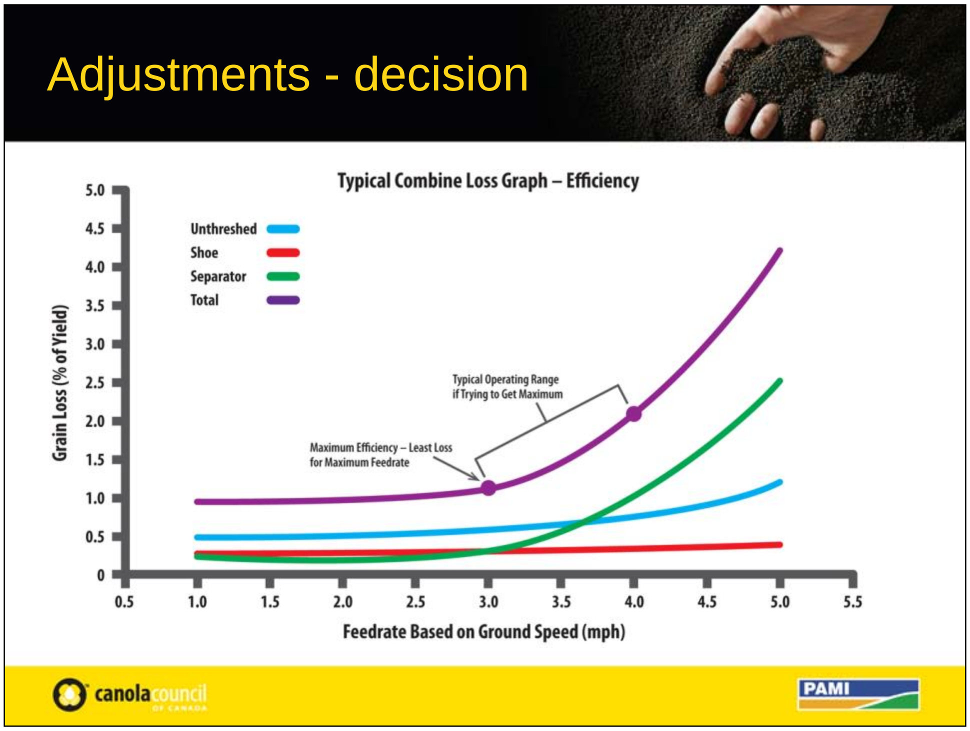


Cleaning the sample to the desired level tends to be individual preference but running too much clean grain through the tailings usually results in extra seed damage, and you might only ever see half of the damage if at all. So far dockage is just subtracting junk from its own weight so you are not out anything.

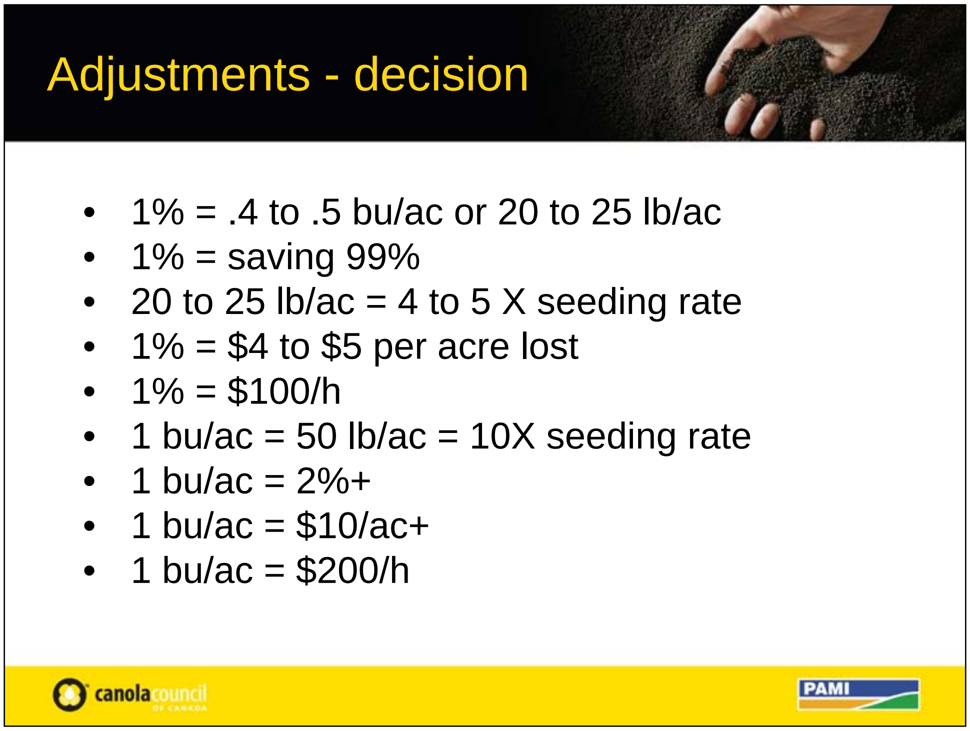


An overloaded tailings whether it is trash (chaff) or grain you need to identify how it got there so that you can address it with the proper adjustment. There are only two ways, it travels over the chaffer sieve and falls through the tailings sieve or it falls through the chafer sieve and travels over the cleaning sieve and dumps into the tailings. Close the tailings sieve off to determine which route it is following.

When do you stop adjusting and get on with harvesting?

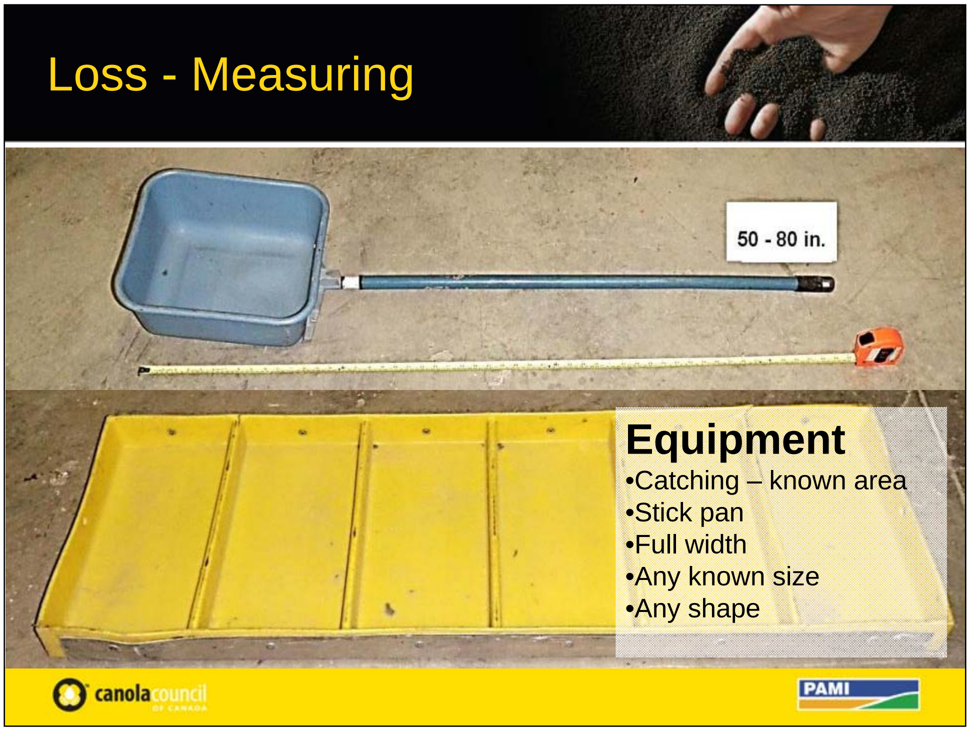


The decision on where losses are acceptable and at what speed should the combine be run should be based upon understanding your combines loss response to feedrate. This graph shows a typical set of loss curves. The curves could represent any function depending upon the crop. In some crops, such as canola, the green curve could very well be for the cleaner and the blue the separator and the red the unthreshed. However it is the total loss curve that determines at what speed can you get the most efficiency or the most reasonable productivity.



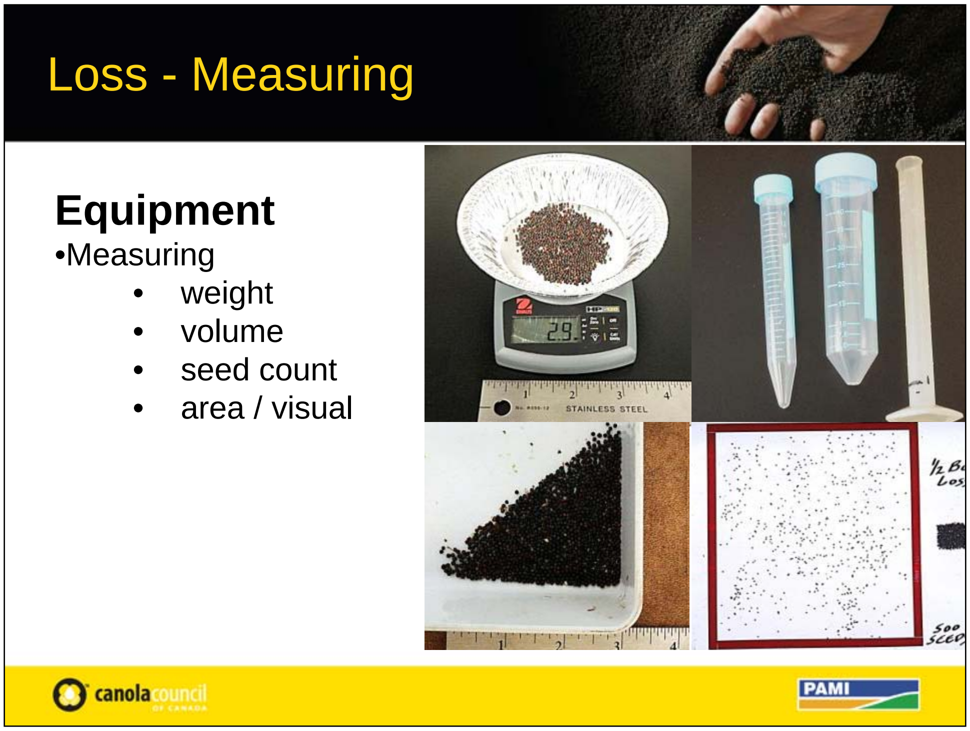
These numbers represent some factors that you need to consider when deciding upon how much loss you are willing to accept

Although we have talked about loss and its impact on the combine we haven't talked about how you measure loss. You need two essential components. First you will need equipment to capture the loss and you need a technique to deploy the equipment, separate the loss and measure it.



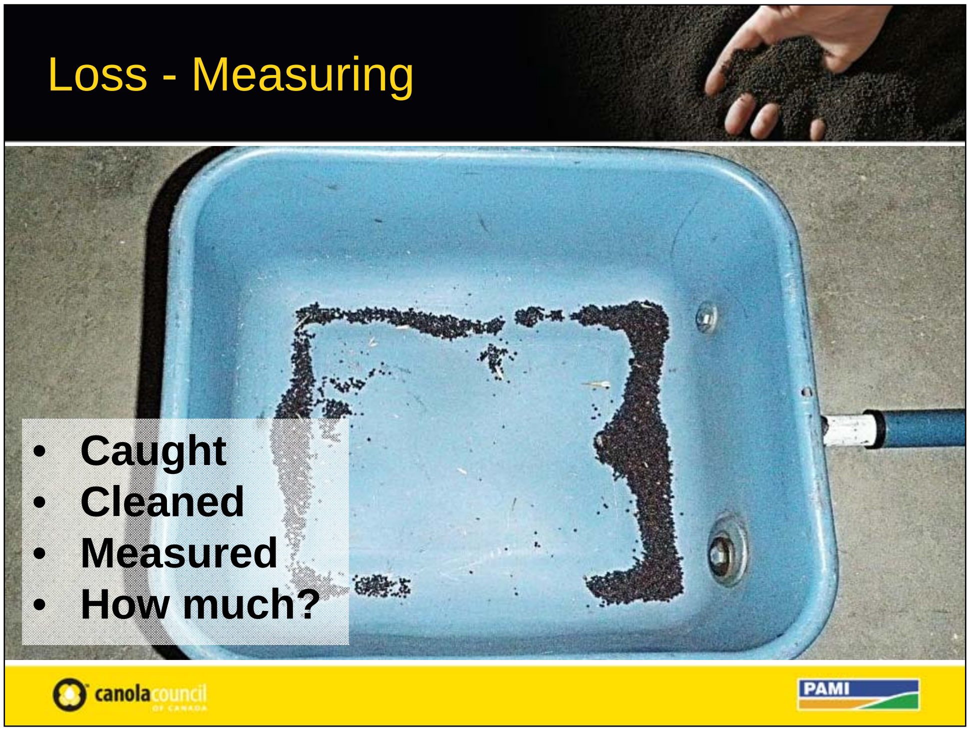
The you need to be able to catch material discharged from you combine. We refer to this as the catch pan. The only real requirement is that you know the area of the pan. Smaller pans of about 1ft square are easier to handle while large pans provide a more representative sample.

Once you catch a sample you have to get to the clean seed. Cleaning is made easier if you have (dockage) screens and some portable fan to blow out chaff and dirt. For large samples you can go to a tub and leaf blower or even a portable cleaner (Clipper fanning mill)



Measuring loss means establishing a quantitative amount. There are various means including weighing, volume in a marked container, and area (visual) and seed count which is not practical for canola when loss is not close to negligable.

For loss collections to provide reasonable representation the combine's straw and chaff choppers/spreaders must be out of the way so that the combine discharges directly onto the ground. The pan must be placed ahead of where the discharge will land so that as the combine moves forward the discharge lands in the pan.

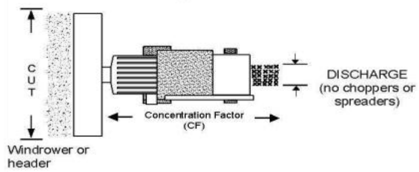


Once the collection has been caught and cleaned the loss has to be calculated in terms that are meaningful.

Loss - Measuring

Combine Seed Loss Guide

A method for determining seed loss from your combine based on weight, volume, or kernels.



STEP 1 Find your CF—in this table

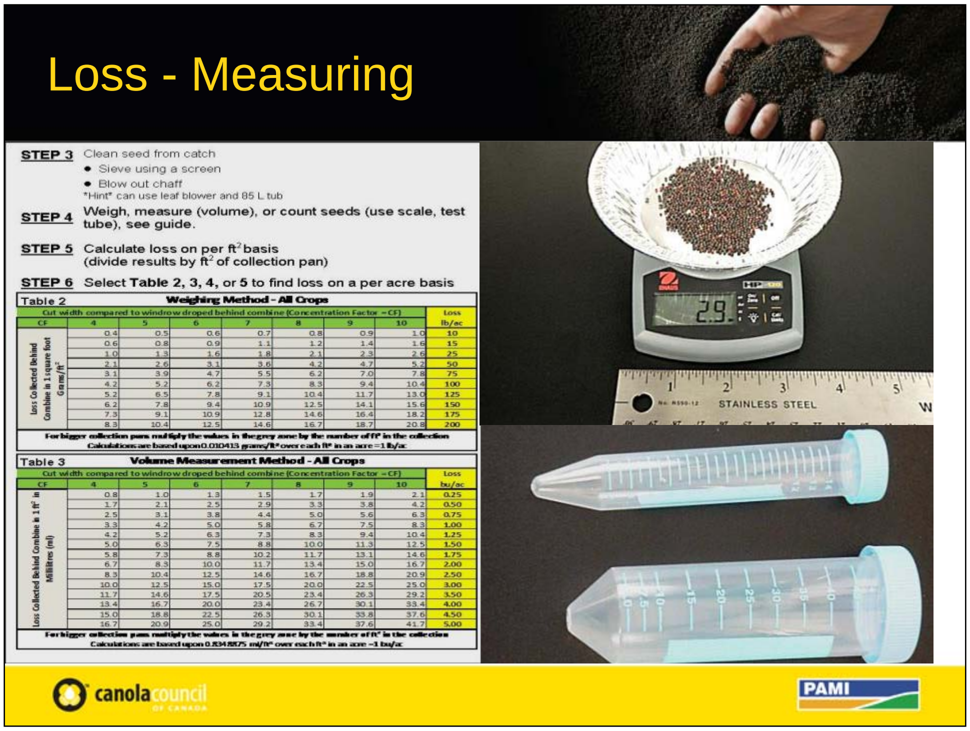
Common Ratios of Width of Cut to Width of Discharge (Concentration Factor)					
	Width of Discharge from Rear of Combine (ft)				CF
	3	4	5	6	(X)
Width of Cut (ft)	12	16	20	24	4
	15	20	25	30	5
	18	24	30	36	6
	21	28	35	42	7
	24	32	40	48	8
	27	36	45	54	9
	30	40	50	60	10

STEP 2 Collect a Sample from discharge of known area

Be Careful Be Safe

Continue steps on next page

The loss guide provides simple steps to help you find a loss value. The first step is to recognize how much material has been concentrated into the width of the combine's discharge. The example shows that for a discharge width of 5 ft in the column below at 31 ft of cut the ratio is closest to 6 times. This can also be calculated by dividing the cut width of 30 ft by the discharge width of 5 ft which equals a ratio of 6.



The measured loss now has to be converted to a loss per square foot. If your pan was 1 sq ft then simply look for that number under the column with the closes concentration number , in this case 6. If the pan was 4 square feet, then the weight or volume needs to be divided by 4.

Table 2 and table 3 provide numbers that represent the measured loss per square ft and convert it to a loss per acre.

Loss - Measuring

Table 2 — Weighing Method - All Crops

Loss Collected Behind Combine in 1 square foot Grams/ft²	Cut width compared to windrow droped behind combine (Concentration Factor = CF)							Loss
CF	4	5	6	7	8	9	10	lb/ac
	0.4	0.5	0.6	0.7	0.8	0.9	1.0	10
	0.6	0.8	0.9	1.1	1.2	1.4	1.6	15
	1.0	1.3	1.6	1.8	2.1	2.3	2.6	25
	2.1	2.6	3.1	3.6	4.2	4.7	5.2	50
	3.1	3.9	4.7	5.5	6.2	7.0	7.8	75
	4.2	5.2	6.2	7.3	8.3	9.4	10.4	100
	5.2	6.5	7.8	9.1	10.4	11.7	13.0	125
	6.2	7.8	9.4	10.9	12.5	14.1	15.6	150
	7.3	9.1	10.9	12.8	14.6	16.4	18.2	175
	8.3	10.4	12.5	14.6	16.7	18.7	20.8	200

For bigger collection pans multiply the values in the grey zone by the number of ft² in the collection
Calculations are based upon 0.010413 grams/ft² over each ft² in an acre = 1 lb/ac

canola council OF CANADA — PAMI

Again pick column #6 as that represent the concentration factor. Find a loss in column #6 that is close to the measured 3gm/sq ft. Move across the yellow column and read the loss in lb/ac. You can also see how you can work backwards to find a loss that will correspond to what you feel is an acceptable loss limit. For example if you set a limit of ½ bu/ac or 25 lb the on that line under the #6 column you see that your target loss should be only 1.6 gm/sq ft or if you are using a 4 sq ft pan, 6.4 gm.

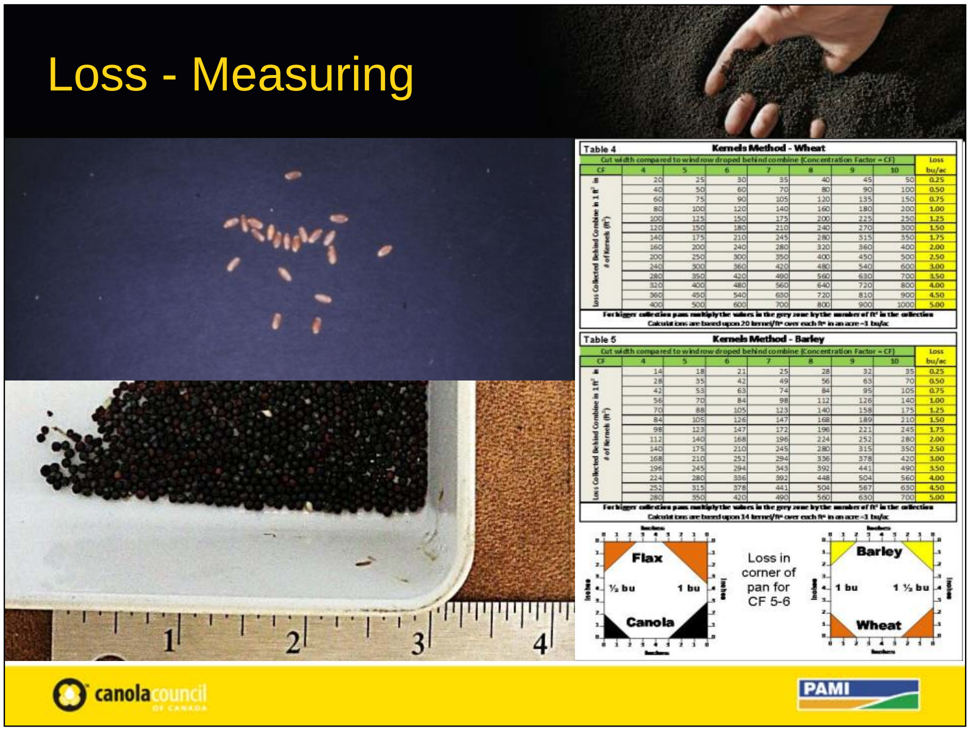


Table 4 — Kernels Method - Wheat

Loss Collected Behind Combine in 1 ft² in # of Kernels (ft²)	Cut width compared to windrow droped behind combine (Concentration Factor = CF)							Loss
CF	4	5	6	7	8	9	10	bu/ac
	20	25	30	35	40	45	50	0.25
	40	50	60	70	80	90	100	0.50
	60	75	90	105	120	135	150	0.75
	80	100	120	140	160	180	200	1.00
	100	125	150	175	200	225	250	1.25
	120	150	180	210	240	270	300	1.50
	140	175	210	245	280	315	350	1.75
	160	200	240	280	320	360	400	2.00
	200	250	300	350	400	450	500	2.50
	240	300	360	420	480	540	600	3.00
	280	350	420	490	560	630	700	3.50
	320	400	480	560	640	720	800	4.00
	360	450	540	630	720	810	900	4.50
	400	500	600	700	800	900	1000	5.00

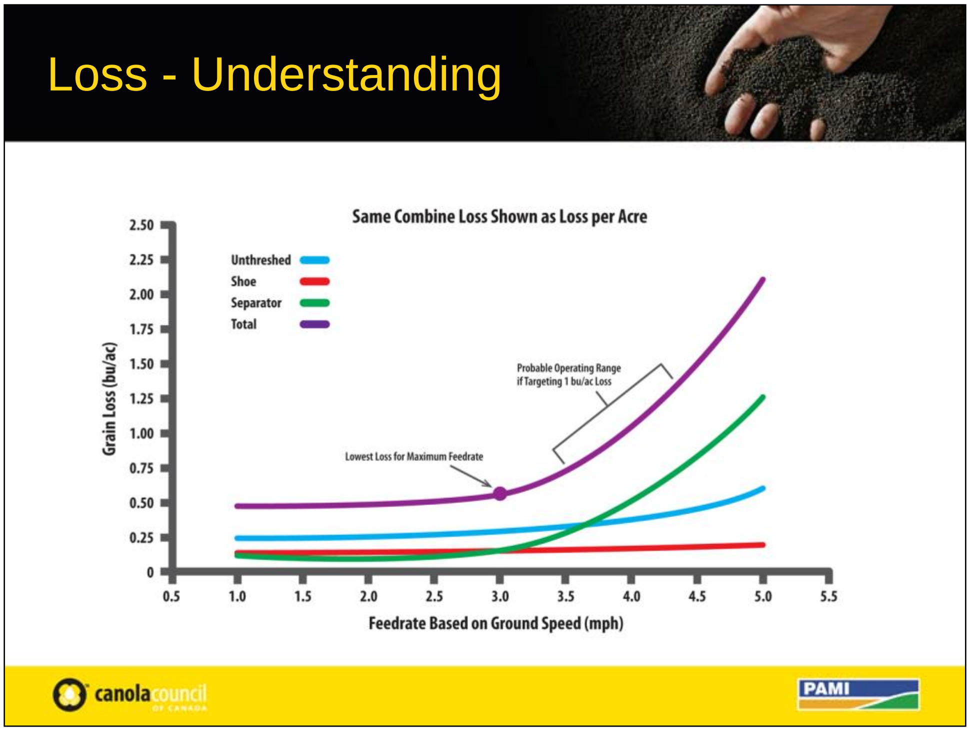
For bigger collection pans multiply the values in the grey zone by the number of ft² in the collection
Calculations are based upon 20 kernel/ft² over each ft² in an acre =1 bu/ac

Table 5 — Kernels Method - Barley

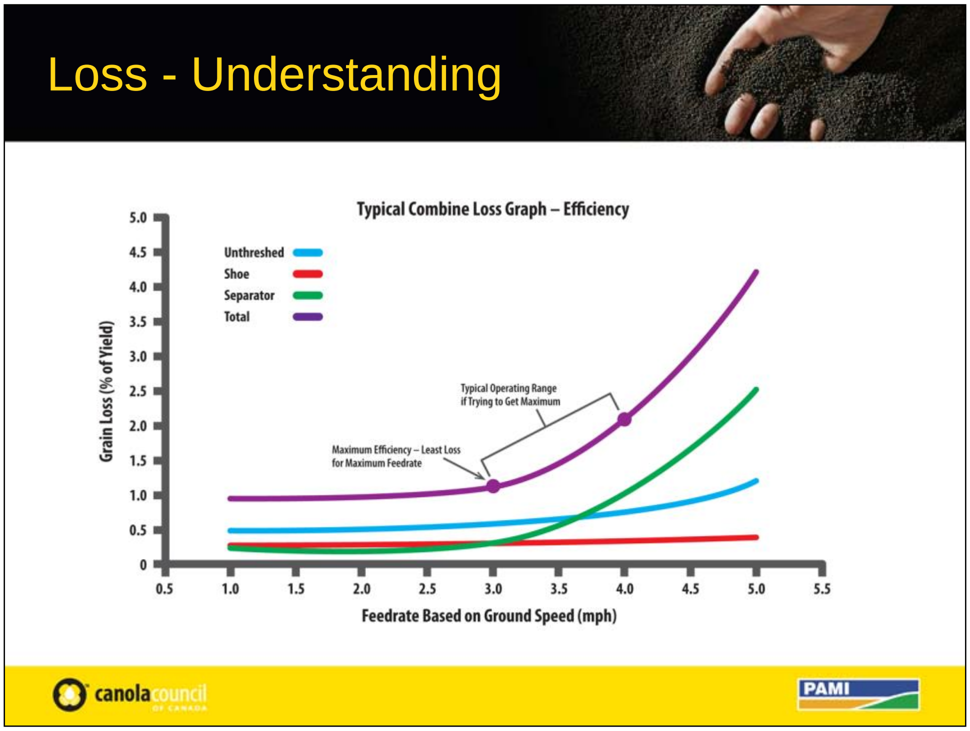
Loss Collected Behind Combine in 1 ft² in # of Kernels (ft²)	Cut width compared to windrow droped behind combine (Concentration Factor = CF)							Loss
CF	4	5	6	7	8	9	10	bu/ac
	14	18	21	25	28	32	35	0.25
	28	35	42	49	56	63	70	0.50
	42	53	63	74	84	95	105	0.75
	56	70	84	98	112	126	140	1.00
	70	88	105	123	140	158	175	1.25
	84	105	126	147	168	189	210	1.50
	98	123	147	172	196	221	245	1.75
	112	140	168	196	224	252	280	2.00
	140	175	210	245	280	315	350	2.50
	168	210	252	294	336	378	420	3.00
	196	245	294	343	392	441	490	3.50
	224	280	336	392	448	504	560	4.00
	252	315	378	441	504	567	630	4.50
	280	350	420	490	560	630	700	5.00

For bigger collection pans multiply the values in the grey zone by the number of ft² in the collection
Calculations are based upon 14 kernel/ft² over each ft² in an acre =1 bu/ac

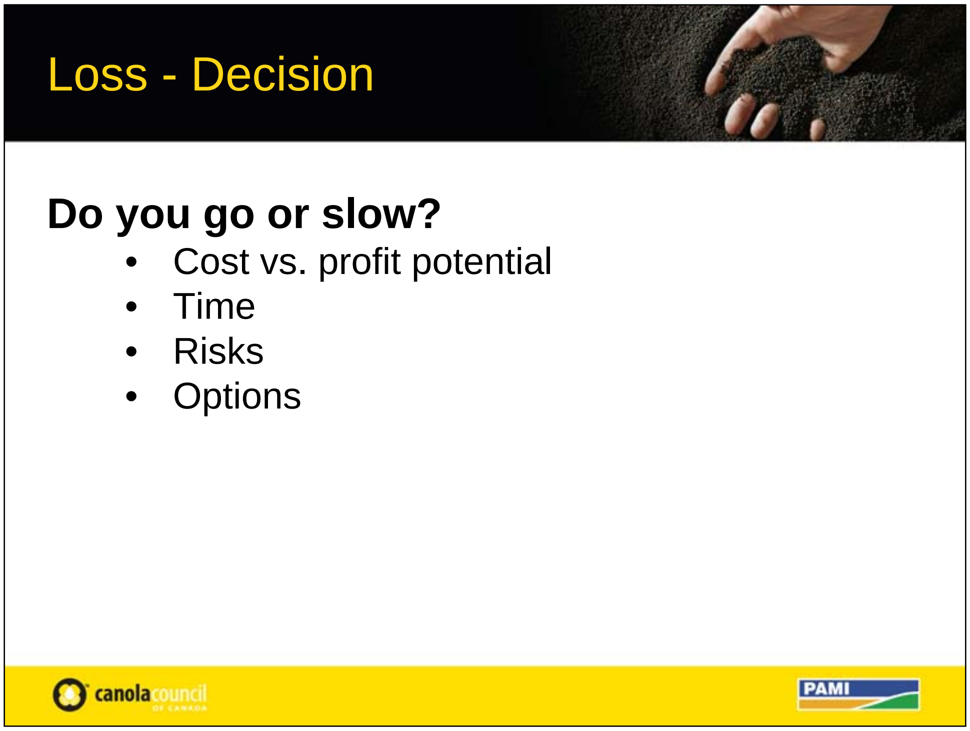
The other charts can be used for visual reference. It is not as accurate but requires less equipment. A toonie is about 1 sq inch.



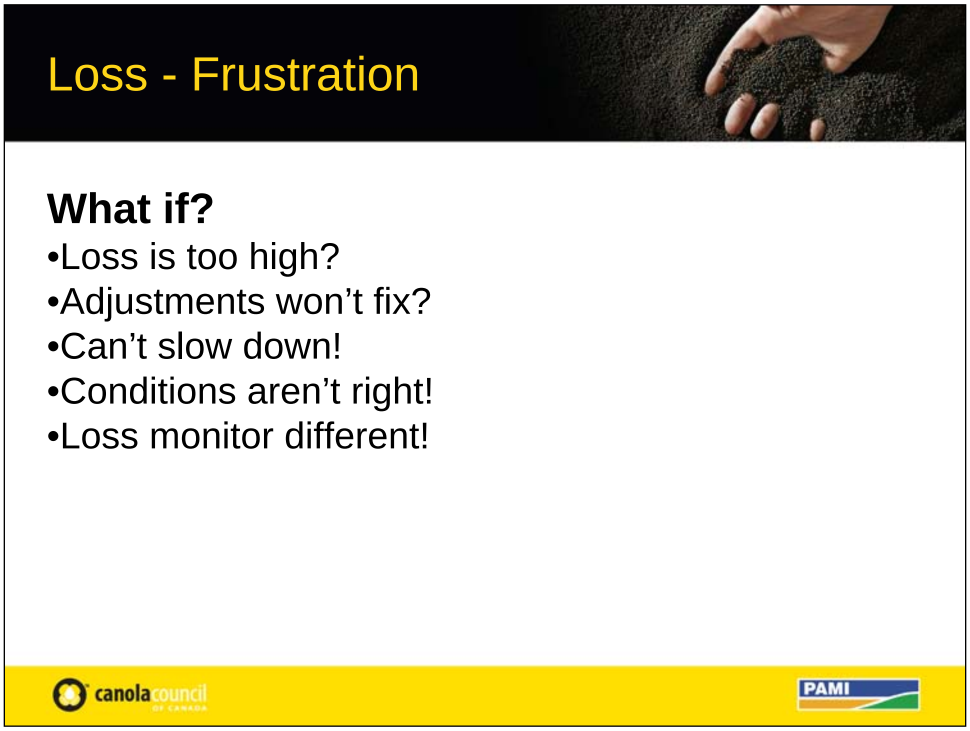
You will need to check losses at different feedrates to get an understanding of how your combine responds.



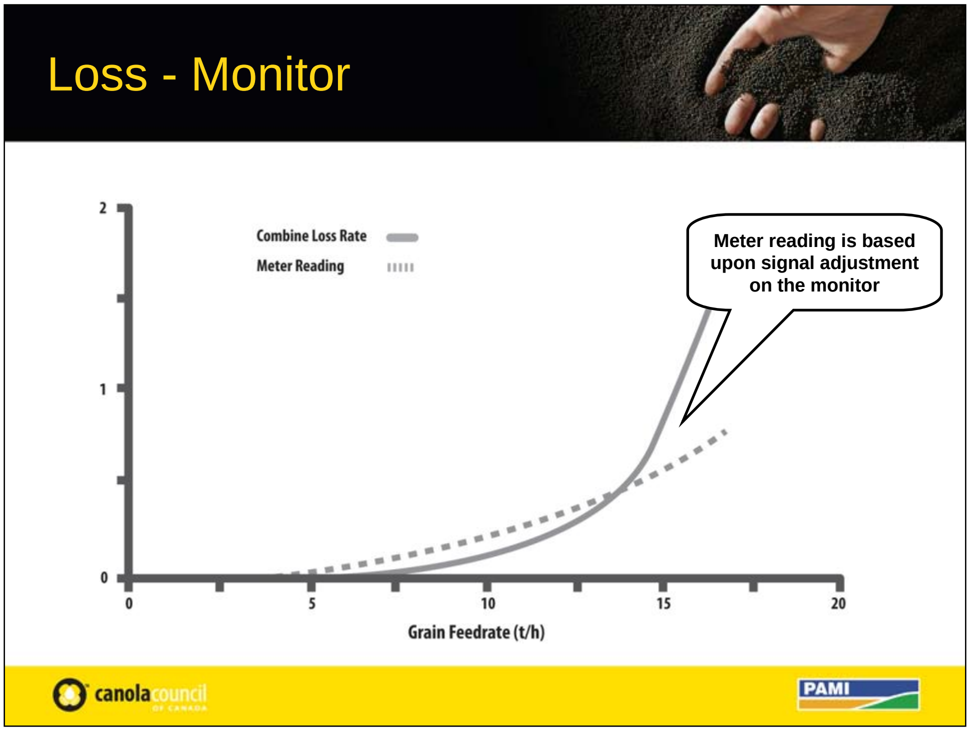
Once you know how the combine responds you can decide what is efficient or the "sweet spot".



Then you have to decide on the balance of productivity vs. profit. Consider the factors.

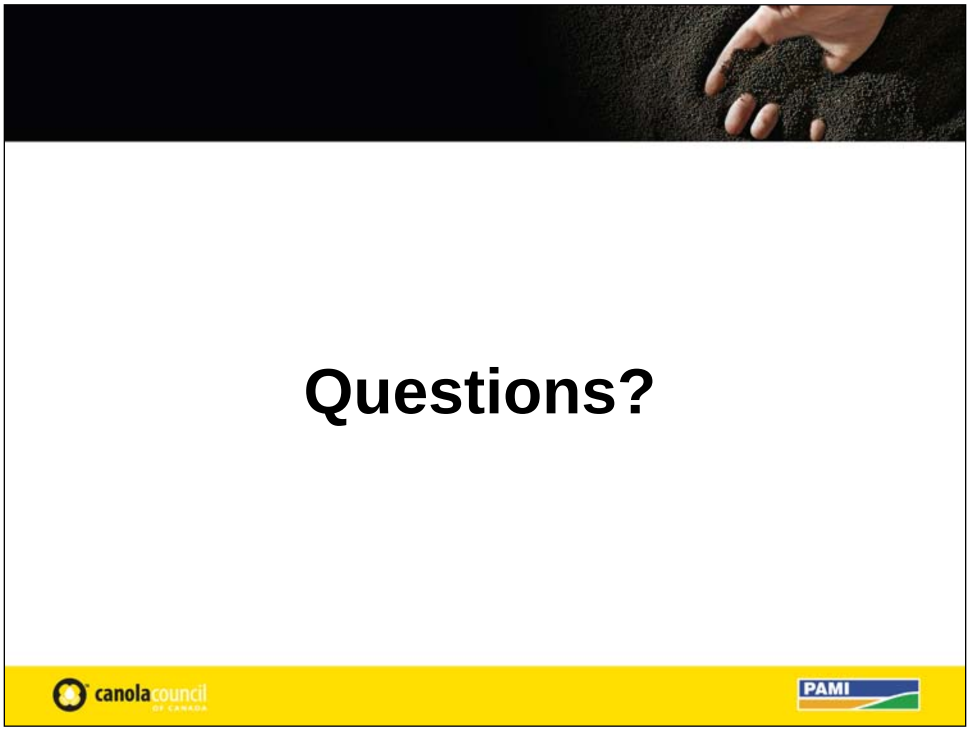


There will be times when you can’t get loss to the level that you would like and that is when it gets really frustrating. Good luck!



Loss and loss monitors have been inextricably ties together. Loss monitors must be calibrated to be at all useful. Still they can fool you!

Above all else, when you are out there, be safe
Protect yourself
Let others know what you will be doing
Don’t take chances



- Questions