# Forage Seed Production Factsheet for Intermediate wheatgrass, Crested wheatgrass and Meadow bromegrass.

This factsheet is intended as a condensed guide to pedigreed forage grass seed production in Saskatchewan for Intermediate Wheatgrass, Crested Wheatgrass and Meadow Bromegrass. Forage seed producers must apply to become members of the Canadian Seed Growers Association (CSGA) before they can produce and sell pedigreed seed. Pedigreed seed producers must read and understand the CSGA publication "Pedigreed Forage Seed Production" and "Regulations and Procedures for Pedigreed Seed Crop Production (Circular 6-94)". Pedigree seed producers must meet the requirements of the CSGA regulations for forage seed production. Forage seed producers must also meet the requirements of the "Canada Seeds Act and Regulations" that permits the seed to be advertised and sold by variety name. These documents and regulations may be obtained from the Canadian Seed Growers Association (CSGA) and the Canadian Food and Inspection Agency (CFIA). Please contact these agencies directly through their individual web sites or contact Saskatchewan Agriculture and Food. Study the Acts and Regulations that govern Plant Breeders Rights, the Plant Protection Act and the Seed Act. **Make sure you are familiar with the rules and regulations governed by the CSGA and the CFIA for pedigreed seed production in Canada.**

## Intermediate Wheatgrass (*Thinopyrum intermedium*)

Intermediate wheatgrass (IWG) is considered to be a short-lived, creeping-rooted perennial species best adapted to the black, grey and moist dark brown soil climatic zones. The highest seed production will be obtained in areas that receive 350-500 mm annual precipitation. Average seed yield of IWG is 150 kg/ac, but yields have been recorded as high as 400 kg/ac.

## Crested Wheatgrass (CWG)

The most common type of CWG is ***Agropyron cristatum,*** with both diploid ('Fairway' type) and tetraploid varieties available. There is also a tetraploid species, ***Agropyron desertorum***, ('Standard' type), but it is much less commonly grown in western Canada. The tetraploid varieties are taller, with larger heads and seeds than the diploid; thus they require a higher seeding rate. Floret seed set is about 50% for *A. desertorum* and up to 70% in *A. cristatum*. Seed yields are more consistent in areas that receive 350 – 500 mm annual precipitation. In Saskatchewan, the average seed yield of CWG is 150 kg/ac, but yields of 450 kg/ac have been recorded.

## Meadow Bromegrass (*Bromus riparius*)

Meadow Bromegrass (MBr) in best adapted for seed production in the dark brown, black and grey wooded soil climatic zones. MBr is a long-lived, perennial bunch grass that produces a mass of basal leaves. This basal leaf development contributes to its ability to regrow leaf material quickly after being harvested and to its reputation as a grazing grass species. However, this mass of basal leaves often leads to problems at harvest time. MBr leaves have short hairs as long as the margins of the leaves. MBr is winter hardy and moderately tolerant to saline conditions. MBr is drought tolerant but has a low tolerance for spring flooding. Average seed yields in Saskatchewan range between 125 and 150 kg/ha, but yields as high as 350 kg/ha have been recorded. MBr generally produces economical yields for 2 to 3 years; while IWG and CWG will generally produce economical seed yields for four years or more. However, management will ultimately determine the longevity of most forage seed stands.

**Pedigree Grass Seed Field Selection:**

In general, grass species are cross-pollinated by wind and occasionally by insects. Therefore, pedigreed seed production must ensure adequate isolation requirements. The isolation requirements for each species are listed in the Canadian Seed Growers Associations' publication of the regulations and procedures.

Fields selected for pedigree seed production must be free of noxious grassy and broadleaf weeds, especially weeds of similar seed size such as quackgrass, Canada thistle, perennial sow thistle, wild oat, stickseed (blue bur) and Persian darnel. The seeds of these weedy species are extremely difficult to clean out of grass seed lots, and their presence may exclude that seed lot from the Canadian or foreign market.

A seemingly unexpected problem weed in grass crops is wild mustard. At harvest time, the unthreshed wild mustard seeds may lodge in the beak of the wild mustard seedpod and this broken remnant of the pod is nearly impossible to remove. Weeds such as quackgrass, Canada thistle, cleavers, perennial sow thistle and wild mustard are all **Primary Noxious Weeds**. No primary noxious weeds are allowed in any pedigreed seed grade under the Canada Seeds Act. Please refer to the Weed Order of the Canada Seeds Act for a complete list. Secondary noxious weeds like wild oat, Persian darnel, scentless chamomile, stickseed and stinkweed can be tolerated in minimal levels. Other weeds, such as shepherds purse, and other crops, such as crested wheatgrass in meadow brome, are tolerated in higher levels, but any diligent grower would aim to produce the highest quality possible, and will be rewarded financially for it.

**Field Records:**
Accurate records of individual fields are extremely important. Consult your field records for possible herbicide residue, past cropping practices or crop species that may complicate or reduce the likelihood of success. Some examples of herbicides of known detrimental residue effects on perennial grass species are trifluralin products, Atrazine, Princep /simazine, Pursuit, Odyssey and Sencor. For complete up to date information on herbicide action and long-term effects, refer to the yearly provincial **Crop Protection Guide.** Read the information provided in this publication carefully and know each herbicide product's negative and positive attributes before using it in your cropping rotation. **If, after consulting the publication you are still not sure if a particular pesticide product can be safely applied to your crop, have the information verified by the appropriate pesticide control company or forage agrologist.** Grasses should not be sown for 24 months following a spring application, or 30 months following a fall application, of trifluralin herbicides. Dry conditions may increase the soil carry over and therefore increase the time required before it is safe to seed grasses.

**Weed Control:**
Weed control should begin three to four years prior to field selection. An elite pedigreed seed grower is continually vigilant and does not allow weedy species to go to seed to replenish the weed seed bank. Growers should be aware of weedy species' growth curves and periods of the year when problematic weedy species are easiest to control. Consider using integrated cropping methodology such as delayed seeding of wheat and barley, or green manure, green feed or silage crops. These crops will remove weedy species from the fields before the weeds are allowed to produce viable seeds. Ensiling has the advantage of removing weedy plants while still moist and thereby reducing the likelihood of viable seeds being dropped or shattered during the harvesting operation. In addition, ensiling reduces seed viability during the fermenting process and renders most weed seeds non-viable. Ensiling reduces the likelihood of contaminating a field if the manure from cattle fed the forage is spread back on the land. The rumen of cattle could be purged of viable weedy seeds using ensiled forages before they are allowed to graze the residue of grass seed fields after harvest. Avoid applying non-composted manure to fields targeted for pedigree seed production as this may provide sources for weed seed contamination. Crowns and rhizomes from certain perennial grass crops and weedy species will re-establish in the seedling stand. To avoid cross contamination of individual seed fields, equipment must be thoroughly cleaned prior to being moved from one field to the next.

Land must be free of perennial weedy species. Preharvest applications of glyphosate in the preceding crops are effective to control quackgrass, Canada thistle and sow thistle if the

treatment is applied over several years prior to seeding the seed crop. An application of glyphosate prior to seeding or within a few days after seeding, but prior to seedling emergence will also reduce the adverse competitive effect of weedy species.

**For a complete up to date reference on herbicides registered for grassy and broad leaf weed control in forage grass seed crops, refer to the annual Provincial Crop Protection Guide. This publication may be obtained from Saskatchewan Agriculture and Food.**

**Grass Establishment:**
Grass seed crops must not be seeded more than 1 to 2.5 cm (½ to 1 inch) deep into a firmly packed seedbed. The goal is to maximize germination and rapid emergence of seedlings. Research has shown that as seeding depth increases, time to emergence increases and seedling survival and establishment decreases. Therefore, seeding equipment must be well tuned ahead of time and depth control must be maintained accurately throughout the seeding operation. Standing stubble provides a firm seedbed to properly place seeds, provides a microclimate for seed germination and seedling development, and provides protection from wind and water erosion. Using zero-till technology and/or using a stale seedbed are excellent choices and provide additional depth control for most seeding equipment. The sole of your boot should not sink more than 1 cm (1/4 inch) into the soil surface prior to seeding. If using a disc type opener, depth control bands on discs will help maintain shallow seeding depth and will result in a uniform stand.

If seeding into stubble, the previous crop residue must be managed properly before seeding. The straw residue should be removed by baling and the chaff spread evenly by harrows or removed completely using a chaff collector at harvest time. Straw and chaff removal also reduces the weed seed bank in the field.

Research has shown that most grass crops must be sown prior to July 25$^{th}$ if a seed crop is to be expected the following year. In addition, the risks of establishment failure increase substantially as you delay seeding from May 1 to the end of July. However, the soil temperature must have reached at least 4$^{O}$C before the time of seeding or you may have problems with seedling diseases such as root rot and damping off.

Calibrating seeding equipment on the basis of seeds per linear foot of row takes the guesswork out of equipment calibrations. Run the seeding equipment over a sheet of plywood or concrete pad to determine the number of seeds being sown per linear foot of row. The seeder should be calibrated to seed 12-20 seeds per linear foot of seed row. Seeding rates generally decrease as a pedigreed seed producer becomes more experienced at establishing forage grass stands.

Clipping or mowing can be an effective alternative to herbicides to reduce the impact of weedy species within a stand. However, the seed producer must mow low enough to prevent weedy species from producing viable seed. Weedy species can be very adaptive and may begin to grow less upright and more prostrate if only the tops are removed, allowing them to produce viable seed.

**Pre-seeding Fertility:**
Soil sampling is a vital element of all well managed agriculture production systems. Soil sampling will provide a benchmark nutrient level from which to make sound management decisions. In general, 20-40 lb/ac of nitrogen should be applied before seeding on stubble, or 40-60 lb/ac under irrigation. However, excess nitrogen may result in added competition from weeds, which may reduce the competitiveness of very weak forage seedlings. The application of at least 30 lb/ac in the autumn of the year of establishment will promote maximum seed production in the following year. The quantity of fertilizer that can safely be placed in the seed row depends on soil organic matter and clay content, moisture content, interval between

seeding and first precipitation event, row spacing and seed row spread. As the organic matter and clay content increase, risk of fertilizer injury decreases. As the row spacing increases for a given fertilizer rate, the concentration of fertilizer within the seed row increases. Rainfall replenishes the soil moisture and removes fertilizer salts from the immediate vicinity of the seed. The general guideline is to not place any nitrogen (N), potassium (K), or sulphur (S) in the seed row.

Phosphate and K are relatively immobile in the soil and deficiencies are best corrected prior to establishment of the seed crop. Phosphorus is required for strong root growth and plant development. Fields testing less than 6.8 kg P/ac (15 lbs/ac) require 23 to 34 kg $P_2O_5$/ac (50-75 lb/ac). Fields testing less than 90 kg K/ac (200 lb/ac) require at least 45 kg K/ac (100 lb/ac) before sowing the grass.

Sulphur (S) is relatively mobile and deficiencies may be easily corrected provided the deficiency symptoms are recognized soon enough. Fields where canola has been sown previously may be deficient in sulphur.

**Carriers:**
Carriers are essential for bulky, chaffy grasses such as meadow bromegrass. Carriers help to improve seed flow and eliminate bridging in the seed tank. Polymer seed coatings improve seed flow and minimize exposing the operator to seed treatments that may have been applied to the seed. Up to 6.8 kg $P_20_5$/ac (15 lb/ac), or 13 kg/ac (29 lbs/ac) 11-52-0 fertilizer may be added with the seed to improve flow. However, the phosphate carrier is generally mixed with the seed in a ratio of 1.0 kg seed/1.0 kg P fertilizer, but more fertilizer may be required for chaffier seed lots. Seed mixed with phosphate fertilizer may be stored up to 3 weeks under cool, dry conditions before seed viability will begin to decrease. Non-viable grain or vermiculite clay may also be used to improve the seed flow and prevent bridging. An alternative is to only partially fill the seed tank with seed. The seeder can also be fitted with seed tank agitators that will improve seed flow to the outflow tubes.

**Row-spacing:**
Most grass seed crops produce the most seed if sown in rows spaced on 30 to 90 cm (12 to 36 inch) centres. Narrow rows will result in quicker establishment, provide more competition to weedy species and result in higher seed yields in the year following establishment. However, yield will decline quicker as the grass plants begin to compete with each other for nutrients, moisture and sunlight. In general, wider row spacing will result in lower yield in the first year, but higher yields will be maintained in subsequent years. In addition, wider rows reduce seed costs, facilitate row-cropping tillage, and encourage plant tillering and seed head development. However, the limited stubble as a result of wider row spacing may not provide adequate support for the crop swath to facilitate air movement under and through the swath to speed drying. Some producers alternate the row spacing between groups of 3-4 rows on 30 cm (12 inch) row spacing, leaving a 60 to 90 cm (30 to 36 inch) gap and then going back to another 3-4 rows on 30 cm (12 inch) row spacing. This type of seeding pattern will allow the swath to be laid directly and supported by the stubble from the group of 3 to 4 narrower rows at harvest.

**Companion Crops:**
In general, seed yields of grass stands will be higher if a companion crop is not used in the establishment year. Seedlings will grow larger, tiller more and compete more effectively with weeds during establishment if grown without a companion crop. However, if a companion crop is deemed necessary, ensure that the companion crop offers the least amount of competition possible by reducing seeding rate, reducing nitrogen fertility rate and removing it early in the growing season to allow the grass seedlings to become established. Under extreme drought conditions, companion crops will seriously suppress forage seedlings and this may result in complete loss of the stand.

**Disease and Insect Monitoring:**
The most common disease or insect problem in intermediate wheatgrass, crested wheatgrass and meadow bromegrass is silvertop. Silvertop reduces seed yield by prematurely halting seed head development. The seed head emerges from the stem, but turns white and dries up, and is usually caused by insects that puncture the stem. If silvertop infected greater than 10% of the stand in the previous year, it is recommended that the field be sprayed with dimethoate prior to the early boot stage of the grass.

Using resistant cultivars and burning of crop residue after seed harvest will help control leaf spot. Care must be taken to avoid damage to the crowns and bud during the burning operation that could result in reduced seed yield in the following year.

Ergot is a seed borne disease and can be reduced by sanitation and by using ergot-free seed. The sticky honeydew on the surface of ergot-infected florets is spread to healthy florets by insects and rain during flowering. Mowing field edges during flowering will reduce the infection from these adjacent areas. Burning straw residue in the fall after seed harvesting will also reduce the survival of ergot bodies.

Stem or head smut is not common but can occur in meadow bromegrass. The seed may be treated with a fungicide seed treatment if a problem is anticipated. It cannot be controlled by burning, straw residue removal or seed treatments as the pathogen is harboured in underground buds and in the soil. Head smut is primarily seed borne. In meadow bromegrass, affected plants have shortened stems, which bear an erect, compact panicle.

*For more in-depth information regarding forage crop diseases refer to the publication "Diseases of Field Crops in Canada". Editors: K. L. Bailey, B. D. Gossen, R. K. Gugel and R. A. A. Morrall. Third Edition (2003).*

**Preharvest Inspection:**
Pedigreed seed producers must arrange to have their seed fields inspected and will pay inspection and membership fees through the CSGA. Remember to have all seed tags and documentation ready for the inspector at the time of inspection. Two inspections are required annually (a field inspection and seed analysis). The field must be inspected after heading, but before the crop can be swathed, harvested or straight cut or the seed production for that year will not be granted pedigree status.

**Harvest:**
Grasses need about 30 days after flowering for seeds to develop. Hot, dry weather shortens the ripening period, while high fertility and cool, moist conditions will delay maturity. Ripening begins at the top of the stem and proceeds down. Intermediate wheatgrass is ready to swath at the medium to hard dough stage of the seed, which corresponds to seed head moisture content between 50-55%. On the other hand, crested wheatgrass is ready to harvest in the hard dough stage, which corresponds to seed head moisture content between 35-40%. Meadow bromegrass swathing can begin when the seed heads are between 50-55% moisture content. At this stage of development, thumbnail pressure is needed to imprint the seed. Seed heads are getting brittle, the upper part of the stem is turning brown, the top of stem will snap between the fingers and some seed will shatter when the seed head is firmly struck against the palm of the hand.

Forage grass seed crops generally shatter very easily and as such, straight combining these crops has tremendous risks associated with it and timing is critical for success. Despite the risks, some forage grass seed producers prefer to straight combine whenever possible. However, swathing is usually the least risky method of harvesting provided there is enough biomass to form an adequate swath. Straight combine harvesting may be less risky in years of

low seed yield, early maturity or reduced foliage. Swathing at an angle across seed rows will suspend the crop above the ground and allow air to pass through the swath and speed air-drying of the crop. Swathing in early morning, evening or at night when the relative humidity is higher will reduce shattering losses. Seed heads should be laid in the centre of the swath to help retain seed that has shattered during the swathing operation. Shatter can be reduced at swathing time by using minimum reel and draper speed that lays a good swath yet is gentle with the cut material. Most forage grass seed producers suggest keeping the swath cut at a maximum of twenty feet or less. A lighter swath will dry faster than a heavy dense swath. In general 10-12 inch stubble should be left to hold the swath.

There is a danger in swathing meadow bromegrass, due to its ability to regrow, particularly in years with ample June and July moisture. Steps may have to be taken to lift the swath out of the regrowth so that it can dry properly.

Crested wheatgrass is ready for straight cutting at the first hint of seed shatter. Tetraploid types are less prone to seed shatter than are the diploid types. Once seed begins to shatter, the crop must be harvested as soon as possible to prevent complete loss of the seed crop. At this point, the risk of losing the crop from brisk winds or storms is high.

In general, as the swathing time draws near, the seed heads of grass species will begin to brown from the top and proceed down. At swathing time, the stem just below the seed head should begin to turn brown. Seed will shatter when firmly struck against the palm of the hand.

**Pre-swathing Moisture Content:**
To determine the moisture of the seed head (spike or panicle), collect about 100 grams of seed heads by clipping just below the seed heads. Weigh the sample as soon as possible after collecting it. Waiting too long after sampling to obtain the initial weight will increase the error in the final calculation. Dry the sample in a microwave or kitchen oven set at $82^0$C, checking often until the weight remains constant. If using a microwave, placing a glass of water in the microwave along with the seed heads will prevent the sample from burning which increases your error in the final calculation. **If the sample burns during the drying process, you must resample and start all over.** The sample should be weighed every few minutes until the weight of the dry sample remains constant. The dry moisture content of the samples is equal to **___ %Moisture = ([wet weight – dry weight]/wet weight)*100.**

**Combine Settings:**
The grass seed crop is usually ready to harvest 4-7 days after swathing. The combine must be thoroughly cleaned before beginning to harvest. Set the concave opening and cylinder speed so that the lemma and palea (husk) are retained on the seed. Retaining the husk will increase the long-term viability of the seed. In addition, concave setting and cylinder speed will have a significant influence on the amount of straw and debris in the return and on the sieves. This will ultimately influence how clean the seed is in the seed tank and how much viable seed is lost over the return. Very chaffy seed lots dramatically slow down producer handling and the cleaning process in the seed cleaning plant, which can increase conditioning costs. Dockage and seed cleaning costs may increase substantially if the producer tries to thresh out all the seed from heads and prevent all seed from going over the sieves. Therefore, the seed producer will have to strike a balance between the amount of peeled or broken seeds and the ability to properly thresh seed from heads.

The concave should be adjusted so that it minimizes straw breakage so as not to overload the sieves and return. For all grass species the airflow should lift the chaff about 10 cm above the front of the sieve so that the seed can be separated from the chaff. Assess the amount of seed going over the sieve. Generally setting the chaffer at 13-15 mm (1/2-5/8 inch) and the cleaning sieve at 3-6 mm (1/8-1/4 inch) is a good place to start. A judgement call has to be

made between too clean and too dirty and throwing viable seed over the sieve. However, a slow forward speed of 1.5–3 km/hr (1-2 mph) can significantly reduce seed loss during harvest.

| **Table #1 General Combine Settings For Harvesting MBr, IWG or CWG** | | | | | |
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| **Species** | **Fan setting** | **Concave Opening** | **Cylinder Speed** | ***Sieve Opening** | **Comments** |
| **Meadow Bromegrass** | **400-500 rpm with shutters closed** | **1/16 inch** | **850 rpm** | **Top and bottom wider than for wheat** | **Matures 1 week earlier and shatters easier than smooth bromegrass** |
| **Intermediate Wheatgrass** | **400-500 rpm with shutter open 2 inches** | **3/8 inch** | **800 rpm** | **½-5/8 inch on top and 1/8 – ¼ inch on bottom** | **Shatters easily and matures 3 wks later than smooth bromegrass** |
| **Crested Wheatgrass** | **400-500 rpm with shutter closed** | **3/8 inch** | ****800 rpm** | **½-5/8 inch on top and 1/8 – ¼ inch on bottom** | **Shatters easily, especially diploids** |

**Note: * Sieve opening is a balance between overloading the return, allowing too much seed to walk over the sieve and having a clean or dirty sample. Aim for 10 to 15 percent dockage, with few peeled seeds, a very small amount of straw and few partial seed heads.**

****There can be large amounts of "doubles" in some years, which can indicate poor pollination conditions. These doubles can generally be separated in the conditioning process, but increasing cylinder speed by 100 RPM may be more effective.

**Seed Moisture Content at Harvest:**
Generally the forage grass seed can be harvested at up to 20 % moisture content. If the crop is harvested in tough or damp condition, it must be dried soon after harvest to avoid heating, as this will result in lost of seed viability. Many producers use aeration bins, but small lots of seed can be dried by installing aeration tubes in the grain truck used to haul the seed from the field to storage bins.

**Seed Storage and Moisture Content:**
A cautious forage seed grower will do a quick initial cleaning to remove green leaves; insects and chaff on a fanning mill or sieve to reduce the likelihood of heating. The seed must be dried down to moisture content of 10-12% moisture content for short-term storage of one year or less. Drying the seed down to a moisture content of 8-10% will facilitate storage of the seed for one year or more. **A word of caution**, when using a grain drier to dry forage grass seed to these moisture levels, avoid overheating the seed, which will reduce the viability of the seed. The risk of injury from overheating the seed during drying is less at lower moisture contents than when the seed is very damp. In addition, high ambient temperatures in July and August may pose additional risks of heating.

**Handling of Bulky Seed:**
Intermediate wheatgrass and crested wheatgrass flow reasonably well if the dockage is less than 20 %, and in dry condition. But patience is very important with meadow bromegrass, as it is not easy to move. It will not flow out of a hopper bin following aeration; therefore flat bottom bins with access are important. A pitchfork or stick may be necessary when loading, unloading or emptying a bin.

**Post harvest Residue Management:**
Windrow the straw behind the combine and bale and remove from the field soon after seed harvest. It is wise to use a chaff collector behind the combine to collect the chaff, seed and weed seeds that are thrown over the sieves during the harvest operation. Chaff collection will increase the life of the stand by reducing the number of new seedlings established next season and reduce the labour costs rouging out undesirable weedy species. The remaining stubble should be cut to a length of 10-15 cm (4-6 inches) after harvest and the residual removed. If the fall is very dry, a longer stubble length could be maintained until early spring, and then removed.

In meadow bromegrass stands, the stubble should be mowed quite low to remove the basil leaf development that could smother the new tillers that are developing. This residue is generally of very good forage quality and is easily marketed to livestock producers.

**Post-harvest Fertility:**
In order to flower, grass tillers must be exposed to short days and low temperatures (cool short days of fall and long warm days of spring). Tillers must have grown enough to be induced to form seed heads by the correct daylight and temperature for each species.

A soil test should be conducted each fall to show benchmark levels of fertility as basis for fertilizer application rates. Nitrogen promotes tiller development. If moisture is available in early September, 9 to 12 kg/ac N (20 –25 lb/ac) should be applied each fall to promote tiller development and increase the likelihood of the development of seed forming tillers next season. In general, nitrogen applications of 32 to 36 kg N/ac (70-80 lb N/ac) in October will stimulate seed head development in the spring. Alternatively, apply 32-36 kg N/ac (70-80 lb N/ac) in the spring as soon as the land is dry enough to support the weight of the equipment.

Under irrigation, you should expect to apply 100 – 125 lb N/ac. If lodging occurs, reduce the application rate of nitrogen or split the application. The best source of nitrogen is ammonium nitrate (34-0-0), which is highly soluble in water and readily moves in the soil moisture to the plant roots.

Because grasses efficiently absorb water from the soil, ammonium nitrate is not subject to leaching or denitrification, volatilization or absorption to stubble residues. However, urea is cheaper and using a coulter applicator for accurate seed placement will dramatically increase its efficiency. Liquid UAN (28-0-0) is an excellent source of nitrogen, especially if applied under cloudy conditions, either dribbled on the surface or injected with a spoke or coulter applicator. The ammonium in urea (46-0-0) and ammonium sulphate (21-0-0-24) is less accessible to the plant and more vulnerable to loss by volatilization.

**Forage Grass Seed Stand Removal:**
Much of the soil benefits of having forages in rotation are lost if they are not "disposed" of properly. Provided that the seeding equipment used is capable, one of the best methods of killing the stand is with glyphosate, followed by direct seeding into the stand with a competitive, drought resistance crop that you can use herbicide to control volunteer crop. If tillage is used, the number of passes can be reduced with another application of glyphosate. Usually intermediate wheatgrass and crested wheatgrass can be controlled with two applications of glyphosate at 1.5 L/ac, done after harvest and bale removal, and again in the

spring. However, meadow bromegrass is more difficult to kill than intermediate wheatgrass or crested wheatgrass. One option is to spray with 1.5 L/ac in late August, disc it twice in September or October, and spray 1 L/ac again in spring, then cultivate and harrow, followed by seeding. The soil will be dry and nitrogen deficient, but relatively weed free. More research is required to investigate the best possible means of removing forage seed stands quickly and efficiently to facilitate the inclusion of more forage crops in annual crop production systems. Producers should contact their provincial forage specialist to determine the best course of action to follow when removing a forage stand.

**Information for this fact sheet was obtained from the following sources:**
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Dr. Bruce Coulman. Forage Breeder. AAFC. Personal Communication.

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