

Ontario Forage Masters Competition Self Assessment Package

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Ontario Forage Masters Competition

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Introduction

In fields across Ontario and around the world, a near-miraculous transformation – photosynthesis – occurs every day. Plant leaves swivel towards the sun, harvesting light to produce sugars and starches, forming the basis of the food, fibre and fuel we all rely on. Farmers, especially forage producers, are privileged to have a ringside seat on this process. They steward this ongoing transformation, and reap the bounty that flows from it.

Across Canada, almost 40 percent of the country's farmland grows forages, making it the largest acreage devoted to any single crop.

The Forage Masters competition is designed to enhance that stewardship and boost that bounty. Whether harvested as hay, ensilage, or pasture, perennial forages are a key building block for Ontario agriculture. Boosting the success of Ontario's forage producers not only maintains this basic sector and the industries that rely on it, but helps build the soil, improve water quality, store carbon, and provides green space and wildlife habitat.

This initiative, produced by the Ontario Soil and Crop Improvement Association with the help of specialists from the Ontario Ministry of Agriculture, Food and Rural Affairs and with contributions from experts in the private sector, shines the spotlight on forages. It offers a checklist of basic best practices, and a scorecard for hay and ensiled forages. The goal is to improve forage management, help farmers grow and harvest more productive crops, and make the most of their nutrients through effective storage and feeding. The result is a stronger forage sector – a stronger backbone for Ontario agriculture, and a farm landscape that is more prosperous, and sustainable.

Directions

Step One - Read through all three modules in the Self-Assessment. There are 45 detailed descriptions in all. Rank the forage management practices currently used on your farm for each of the statements with "Best," "Good" or "Needs Improvement." - Choose the statement that most closely aligns with your practices. This is an assessment of your farm's forage management practices (not pasture management), and is not necessarily those specific to a single field. If there are individual descriptions that do not apply to your operation, please skip them, your overall score will be adjusted accordingly. For example, if you are a forage producer but do not have livestock, you can ignore the questions that pertain to feeding. Or another example, if you produce dry hay only, skip the descriptions that pertain to haylage. This is an educational exercise intended to boost awareness and increase adoption of best management practices. Be honest, and choose the ranking that best aligns with your practice.

Step Two - Transfer your responses for each statement to the Self-Assessment Summary Sheet on pages 26, 27 and 28 and provide responses to the additional questions about your farm operation. These are necessary to apply the scoring. The Forage Master Competition is open to all Ontario forage producers.

Step Three - Forward the 3-page Self-Assessment Summary by email to the OSCIA Guelph office before July 15 at ForageMaster@ontariosoilcrop.org . The responses will be evaluated and a confidential aggregate score will be sent back to each participant.

Module 1

Forages: generating more “green”

Verdant stands of forage are more than eye-pleasing additions to the landscape. Grasses and legumes are the essential building block of your livestock ration, a key contributor to soil health, a fertility boost for the crops that follow, and a perennial cash generator for farms that sell hay. In short, forages are a long-term investment in the farm’s health. But like so many investments, forages generate larger dividends when the initial deposit is made with care, and the principal is tended with diligence.

A. Fertility

Hay is a demanding crop, one that makes annual withdrawals from the soil’s nutrient bank. Every tonne of dry matter of alfalfa/grass hay hauled from your field takes just over six kilograms (13.5 lbs) of P205 phosphate fertilizer and almost 25 kg (54 lbs) of K20 potash fertilizer with it. If soil fertility is not topped up, yields will decline. Not surprisingly, tired old hayfields require a significant amount of fertilizer or manure when it’s time to renovate and reseed.

A better option is to make an ongoing investment in fertility, through regular soil tests, appropriate applications of manure or fertilizer, and if possible, incorporating nitrogen-fixing legumes into the stand. Boosting fertility to optimal levels fuels vigorous growth, and helps suppress weeds. As stands mature, healthy, resilient forages are better able to resist or tolerate pests and disease.

On acidic soils below pH 6.5, tilling in the appropriate amount of agricultural lime will reduce acidity, and at the same time improve soil structure, make phosphorus more available, improve forage palatability and boost microbial activity. Populations of nitrogen-fixing rhizobia, for example, increase as pH nears the neutral range (pH 7).

What you can do:

Test forage fields for soil pH, phosphorus (P), and potassium (K), every three years, or more frequently on sandy soils, or before a change in the crop rotation. Try to take samples at consistent times and places, and look for trends across many years. Is fertility on the farm improving, or being run down?

The ideal is to build and maintain phosphorus and potassium at optimal levels: 12-30 parts per million (ppm) for P, 120-250 ppm for K if this is practical. Some soils are very low testing naturally.

Where possible, eliminate the need for nitrogen fertilizer by maintaining 50 percent legumes in the stand. While nitrogen fertilizer boosts protein levels in grasses, it also promotes the growth of grasses over legumes. The best economic choice is to sow mixtures with at least 50 per cent legumes, and maintain that level through crop rotation.

Supply nutrients by applying manure or other soil amendments.

Time fertilizer and manure applications to maximize plant uptake and eliminate nutrient loss. When it comes to incorporating nitrogen or manure, for example, a half-inch of rain is almost as effective as tillage.

On acidic soils, incorporate the appropriate amount and type of lime to boost soil pH to 5.5 or more for grass stands, and 6-6.5 for legumes and mixed stands. Apply dolomitic lime to remedy a magnesium deficiency, and calcitic lime on other soils.

Module 1 Forages: generating more “green”

Questions:

i. Soil Testing

☐ Best: Fields are tested every three years (two years on sandy soils),
and/or before rotation to a different crop (such as corn, soy, canola or cereals, or back to forages),
and sample size is less than 25 acres
and at least two core samples are taken per acre
and representative soil samples at the same time of the year,
and where possible, several years of tests are used to establish soil fertility trends.

☐ Good: Fields are tested every 4-5 years, or before rotation into new crop or renovation of forage stand
and sample size is less than 25 acres
and 1-2 core samples are taken per acre
and representative soil samples are taken at the same time of the year.

☐ Needs Improvement: Soil is infrequently or not tested, sample sizes are larger than 25 acres, with no consistent approach to sampling.

ii. Test parameters

☐ Best: Fields are tested for pH, P and K, with tests taken at consistent times of the year (every August, for example.)

☐ Good: Fields are tested for pH, P and K when time allows.

☐ Needs Improvement: Fields are not tested.

iii. Fertility management

Could be fertilized at rates according to either the sufficiency approach (OMAFRA recommendations in Agronomy Guide) or the build-up and maintenance approach.

☐ Best: Phosphorus is maintained at 12-30 ppm, potassium is maintained at 120-250 ppm.

☐ Good: P and K occasionally applied to stands where it generates an economic response (less than 12 ppm for P, less than 120 ppm for K.)

☐ Needs Improvement: P and K are applied without a soil test, or at levels that fall below recommendations, or at levels that exceed 30 ppm for P, 250 ppm for K.

iv. Nitrogen

☐ Best: On grass stands, (and stands with less than 1/3 legumes) nitrogen is applied to OMAFRA suggestions of 23 kg/tonne (45 pounds per ton) of expected dry matter yield,
or 60 kg/ha on fields with 1/3 to 1/2 legumes
or legume content of stand is high enough (50 percent) to supply N.

☐ Good: Legume content is below 50 percent, but efforts are made to boost legumes by applying N.

☐ Needs Improvement: Nitrogen is applied without regard to crop requirements, or based on above-average yield expectations, or no N applied to grass stands.

v. Timely application

☐ Best: Nitrogen is applied as early as possible in the spring, and then after mowing if additional cuts are contemplated, and phosphorus is applied at tillage, or banded as a starter fertilizer 5 cm below seed at seeding, or broadcast with K,
and potassium is incorporated with tillage or broadcast within the six weeks before the critical fall harvest period. Fertility treatments of Sulphur and Boron may also be applied to alfalfa.

☐ Good: N, P and K are broadcast when forages are actively growing.

☐ Needs Improvement: Nutrients are applied when forages are dormant.

vi. Applying manure or other soil amendments

☐ Best: Spreading equipment is calibrated, and manure is tested to deliver known amount of nutrients to field,

and when soil tests exceed 30 ppm of phosphorus, P is applied only to meet crop nutrient removal,

and fertilizer rates are reduced by the amount of nutrients applied in manure.

☐ Good: Soil tests results are either not known or referenced, and spreader is not calibrated, but operated to manufacturer’s instructions,

and manure value is calculated based on published Ontario average,

and fertilizer rates are reduced by the amount of nutrients applied in manure.

☐ Needs Improvement: Manure is spread without reference to soil tests, crop requirements, or nutrient value, and spreader is not calibrated.

B. Seed selection

Ask yourself: do you take the same care with seed selection as you do when buying bulls or rams? Given the importance and longevity of your forage selection, choosing the right species and cultivars is at least as important as selecting the correct livestock genetics. Key factors include productivity and palatability, winter hardiness, the ability to cope with drought or poor drainage, soil acidity, regrowth, and maturity – not to mention the nutritional benefits of the overall forage mixture. Alfalfa, for example, won’t persist on acidic, poorly-drained ground, but bird’s-foot trefoil will. Some cultivars of orchard grass mature later than others, better matching the maturity of the alfalfa. Other cultivars are more or less disease or pest-resistant: examples are potato leafhopper resistant alfalfa and aphanomyces root rot resistant alfalfa.

While you’re considering the right legumes for your farm, check with your seed dealer to ensure the seed is pre-inoculated. To effectively fix nitrogen, legumes must be colonized by the correct strain of rhizobial bacteria. If the same legume has recently grown in your fields, there should be sufficient bacteria to do the job. If the alfalfa is not pre-inoculated, applying the right inoculant is good insurance (note: most alfalfa is pre-inoculated).

Finally, alfalfa can’t be seeded into an existing stand, thanks to the plant’s “autotoxicity” – its ability to chemically inhibit new alfalfa plants. If a stand of alfalfa must be replaced, rotating into another crop, legume or annual forage for at least a year allows these autotoxins to dissipate, and alfalfa can be re-established.

What you can do:

Select suitable species with the help of the OMAFRA guide at:
http://www.omafra.gov.on.ca/english/crops/pub811/3species.htm

Check the field’s pesticide history to ensure there are no residual impacts to harm the new stand.

Choose forage species and cultivars that meet nutritional requirements of livestock, together with the maturity date and regrowth to match the harvest program (for example, single-cut beef versus three-cut dairy, or species that can be grazed as well as hayed.)

Select forage mixture with nutritional profile suited to your livestock (high-legume mixtures with good protein levels for dairy animals, or grassier mixtures for horses.)

Choose cultivars with appropriate winter hardiness, disease, and pest resistance.

When sowing legumes into fields where same species hasn’t grown recently, use seed inoculated with the correct strain of rhizobium, (if available.)

Where possible, buy certified seed to reduce weed problems and guarantee selected traits.

Questions:

i. Species Selection

☐ Best: Species are carefully selected to meet livestock nutritional needs, field and environmental conditions.

☐ Good: Suitable “off-the-shelf” forage mixtures are chosen.

☐ Needs Improvement: A standard mixes are used across the farm, regardless of field and environmental conditions.

ii. Cultivar selection

☐ Best: Cultivars are selected to meet farm’s climatic, pest and disease conditions, as well as maturity date and regrowth characteristics for harvesting program.

☐ Good: Cultivars are winter hardy, meet basic needs of harvesting program (such as the need to provide late-season grazing, or multiple cuts of high-protein hay.)

☐ Needs Improvement: Common seed is used, or no consideration is given to traits of individual cultivars.

iii. Certified seed

☐ Best: Certified (meeting CFIA standards for germination and weed seed content) seed, from appropriate species and cultivars, is bought whenever possible.

☐ Good: Certified seed is used for particularly important cultivars.

☐ Needs Improvement: Seed source and/or quality unknown.

iv. Inoculants

☐ Best: Appropriate inoculants (when available) are used on all legumes.

☐ Good: Appropriate inoculants (when available) are used for legumes not recently grown in the field.

☐ Needs Improvement: Inoculants are never applied.

C. Stand Establishment

Despite changes to farm technology, the keys to forage establishment remain the same: good seed-to-soil contact, proper seed placement, and a reasonably fine, firm seedbed. Close contact between seed and soil allows moisture to migrate to the seed for good germination. Seed depth is equally important. Seeds buried too deeply in a fluffy seedbed may never emerge, or emerge too weak to grow vigorously, while seeds left on the surface run the risk of drying out and dying. Fields worked too finely may form a crust after rain, while “lumpy” ground produces uneven seedling emergence.

In Ontario, spring is the most reliable time for seeding perennial forage stands, but summer seeding can also work well. Even so, it’s important to watch the forecast. Extreme weather -- flooding rains, drought, or extended periods of hot or cold temperatures -- will delay germination or kill seedlings.

Finally, the traditional use of companion or “nurse” crops – typically a cereal such as oats – seeded with the forage can sometimes be a mixed blessing. The companion crop helps suppress weed growth and offers the producer a return during the year of establishment, but can reduce the growth and productivity of the forage stand, often into subsequent years. Cereal companion crops should be harvested at boot-stage as forage, rather than letting the cereal mature and then combining and baling straw.

What you can do:

Use the “boot test”: If the seedbed is sufficiently firm, your boots should make a 1-centimetre impression. Sinking too deeply? Firm the bed by packing ahead of the drill.

Calibrate drill or seeder for correct depth and seeding rate. The general rule is to seed forages to depths of 6-12 millimetres (one quarter of an inch to half an inch) in clay and loam, and 12-18 millimetres (half an inch to three-quarters of an inch) on sandy soils. If in doubt, check proper depth for each species.

Conventional seed drills and no-till drills and Brillion-type packer seeders offer better control over seeding depths than airflow and spinner-type broadcast seeders. Airflow seeders offer more even distribution of seeds than spinner-type broadcast seeders. Adjusting seeding depth is important when using conventional drills, and may require packing both before and after. Industry recommendations indicate no-till drills do the best at seed placement and depth control. Airflow boom spreaders require good seedbed preparation and packing following seeding. Varying seed weights, air resistance, and wind make uniform coverage difficult with a spinner-type broadcaster making them generally not recommended, but sowing fine seeds separately from coarse ones helps, as does a shallow harrow to bury seed and roll the ground after sowing.

Harvest the companion crop as silage at the boot stage.

Questions:

i. Seedbed

☐ Best: Seedbed is fine and firm (meets the boot test),

or for no-till drills, field is weed-free, competition is controlled by herbicide or other means, and residue is penetrated by drill.

☐ Good: Seedbed is soft, but firmed by packing or rolling after seeding.

☐ Needs Improvement: Seedbed is lumpy or fluffy, and not packed,

or for no-till drills, competition is not controlled, residue is heavy, harbours pests, and is not penetrated by drill.

ii. Seed depth and seeding rate

☐ Best: No-till drill or conventional drill, or packer-seeder is calibrated to correct depth and seeding rate. Seedbed is packed.

☐ Good: Airflow seeder is calibrated and seedbed is harrowed and packed.

☐ Needs Improvement: Spinner-type broadcast seeder is used, drill or packer-seeder or airflow seeder is not calibrated, or seed is broadcast on surface without harrowing and rolling.

iii. Companion crops

☐ Best: Companion crops are spring-seeded, harvested in early boot stage for silage, N fertilization is reduced or limited, and reduce seeding rate applied.

☐ Good: Companion crops are spring-seeded and harvested early for silage.

☐ Needs Improvement: Companion crops are harvested as grain and straw.

D. Stand maintenance

As the Roman agriculturalist Columella wrote almost two millennia ago, the “eyes and footsteps of the master” are the “things most salutary to the land.”

Despite the advent of drones and satellite images, Columella’s words still ring true. Eyes and footsteps are still a farmer’s best tools for scouting forages, and from those surveys flow the management plans that ensure continued productivity.

Regular field surveys will uncover thin and bare patches, or signs of winterkill. In the spring, counting the number of alfalfa plants within a square foot helps decide whether to maintain the stand or plan its replacement. At the same time, digging up a few plants and slicing their roots offers a quick gauge of alfalfa health.

By noting new weed outbreaks, growers can control pests when they’re minor headaches, rather than full-blown migraines. Signs of nutrient deficiency – yellowing and stunting from lack of nitrogen or sulpher, small light dots near the edges of alfalfa leaflets for potassium deficiency, yellow or red upper leaves from lack of boron – indicate the need for soil or plant tissue tests, and a closer look at the fertility program. There are few options to control weeds in an established stand. Good weed control is important throughout the crop rotation and at forage establishment.

Some insect-caused loss is unavoidable, but recognizing common pests helps producers spot outbreaks and determine whether controls are necessary. The potato leafhopper, for example, feeds on fluids in the alfalfa leaf, injecting a toxin that hampers the plant’s ability to photosynthesize sugars and transpire moisture. In severe infestations, the leafhopper not only damages leaves and reduces yield and plant vigor, but lowers crude protein levels in harvested alfalfa.

What you can do:

Scout forages regularly. Use your eyes and feet to search for bare or thin spots, areas where forages are shorter or stunted, and regions that lack a uniform mixture of the species you’ve sown. Assess and investigate problem zones for evidence of winterkill, soil compaction, erosion, poor drainage, fertility or pest problems.

Rotate old, thin, winterkilled, diseased stands and reseed a new field in the rotation.

In the spring, assess alfalfa stands by counting plants within a square foot. Consider replacing an older stand with fewer than 430 stems per square metre (40 stems per square foot).

Survey alfalfa roots and crowns for health and vigour: dig out a few plants and slice the roots lengthwise. Healthy crowns are large, symmetrical, and feature many shoots. Healthy roots are white and creamy, and their skin resists peeling. Diseased roots are discoloured and spongy.

Survey weed pressure. Become familiar with common weeds on your farm. Examples include: dandelions, plantain, burdock, fleabane, thistles, chickweed, bedstraw, etc. Watch for and identify new and expanding weeds.

Scout for disease, insects and insect damage, using the OMAFRA forage scouting calendar: http://www.omafra.gov.on.ca/english/crops/pub811/3other.htm Become familiar with common pests on your farm, potentially including potato leaf hopper, slugs, alfalfa blotch miner, snout beetle, European skipper, etc. For scouting techniques and management strategies, see OMAFRA’s Forage Insects and Pests:

http://www.omafra.gov.on.ca/english/crops/pub811/13forage.htm#table13-5

Questions:

i. Scouting program

☐ Best: Fields are routinely scouted, on foot, throughout growing season,

and scouting is based on OMAFRA calendar,

and alfalfa stands are counted, and visually inspected for crown and root health.

☐ Good: Fields are scouted occasionally during the growing season.

☐ Needs Improvement: Fields are rarely scouted, or surveyed from the tractor seat.

ii Stand thickness, health and vigour

☐ Best: Full canopy intercepts 95 per cent of light available, no bare patches are visible. Minimum 430 alfalfa stems per square metre (40 stems per square foot).

☐ Good: Thin or bare patches are isolated and sporadic,

and plans are underway to remedy thin spots (overseeding, improved fertility.)

☐ Needs Improvement: Extensive bare or thin patches. Alfalfa count is less than 430 stems per square metre (40 stems per square foot) with slow regrowth after cutting.

iii. Fertility and field conditions

☐ Best: Fields are regularly soil-tested, plants are regularly scouted for signs of nutrient deficiency, **and** fields are scouted for evidence of erosion, compaction, and uneven distribution of nutrients.

☐ Good: Fields are regularly soil-tested, occasionally scouted for signs of nutrient deficiency, erosion, compaction, unequal distribution of nutrients.

☐ Needs Improvement: Fields are rarely scouted, or inspected from tractor seat.

iv. Weed scouting

☐ Best: Fields are regularly scouted for weed pressure and emergence of new weeds,

and fields have minor or isolated weed populations, no poisonous or noxious weeds,

and control plan is in place.

☐ Good: Fields are scouted to assess weed populations,

and fields have growing weed pressures or new emerging weeds,

and control plan is in development.

☐ Needs Improvement: Fields are not scouted, fields are weedy, no control plan is in place or contemplated.

v. Weed control

☐ Best: All options for control and timing for best results are assessed. Where possible, cultural controls are used, including increased fertility, timely clipping or grazing, crop rotation, and limited spot-treatment by herbicides,

and environmental impacts are considered when selecting herbicides (including toxicity, residue, effects on non-target crops, animals, etc.)

☐ Good: Crop rotation and herbicides are main control methods,

and environmental impacts are considered when selecting herbicides (including toxicity, residue, effects on non-target crops, animals, etc.)

☐ Needs Improvement: Weeds are not controlled, or herbicides are selected based solely on price and effectiveness on target species.

vi. Insect control (Potato leafhopper, alfalfa weevil, etc.):

☐ Best: Control is initiated only when pest population is large enough to do damage above economic injury threshold,

and all options are assessed, including non-chemical controls (including resistant cultivars, crop rotation, biological control)

and environmental impacts are considered when selecting insecticides (including toxicity, residue, impacts on non-target species, etc.)

☐ Good: Chemical control is the only method considered,

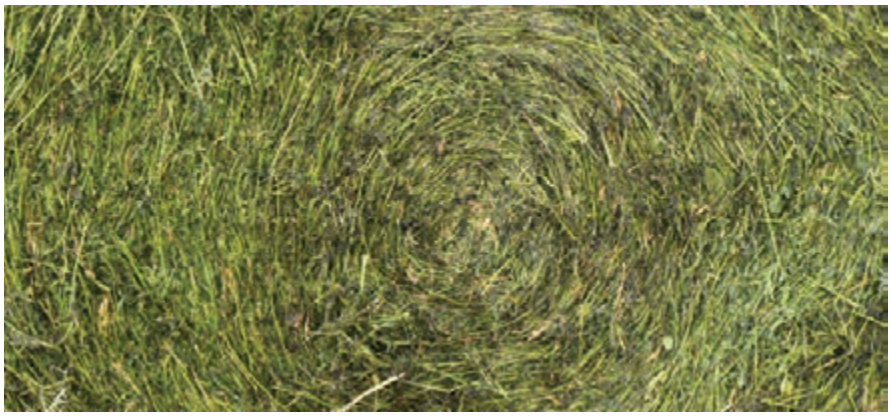
and control is initiated when pest population is large enough to do damage above economic injury threshold,

and environmental impacts are considered when selecting insecticides (including toxicity, residue, impacts on non-target species, etc.)

☐ Needs Improvement: Insects are not controlled, or controlled without reference to economic injury thresholds,

and chemicals are selected based solely on price and effectiveness on target species.

Module 2



Hay Harvesting, Storage, and Feeding

Baseball great Yogi Berra said it best: “It ain’t over ‘till it’s over,” and the statement is as true in the hayfield as it is on the ball diamond. Every haymaker knows the job isn’t done until the last bale is fed or sold. Fifteen to thirty percent – and sometimes more – of the crop can be lost in harvesting, storage, and feeding. By sweating the details, producers can maximize the amount of forage fed or sold, limit losses, and bulk up the farm’s bottom line.

A. It’s all about timing

Timing is everything in the hayfield, because grasses and legumes lose nutritional value but gain yield and fibre as they mature. Once alfalfa starts to bud, the legume sheds two-tenths of a percent of protein and four-tenths of a percent of digestibility every day.

That’s why every hay season is a campaign against both the weather, and the clock. You need 3-5 sunny, breezy days to cut hay and get it off the field, but you also require forage with the right mix of nutritional value and yield for your livestock or hay customers. Dairy animals demand young, highly nutritive forages with a high proportion of legumes. The rule of thumb for them is to cut legumes by mid-bud stage, and grasses in the boot stage, just before the head emerges. Horses and beef cattle can make do with more mature, or grassier hay. Sheep and goats are somewhere in the middle, but they’re choosy eaters who prefer leaves to stems.

Deciding when to mow also depends on the timing and number of future cuts. Plants draw on root reserves as they grow. If forages are cut too early and too often, they’ll drain those valuable reserves. When frequent or fall cutting empties the stand’s fuel tank, or the insulating layer of snow is disturbed by winter traffic, plants become weaker, less productive, and less able to survive the winter.

What you can do:

1. Keep a close eye on the weather and crop development.
2. Maintain and ready equipment.
3. For dairy producers seeking premium quality alfalfa haylage, consider timing the cut by monitoring crop digestibility (usually measured as a percentage of Neutral Detergent Fibre, or NDF) by sending “scissor cut” forage samples for lab analysis, or using a PEAQ “Predictive Equations for Alfalfa Quality” stick for in-field estimates.
4. Cut early enough to ensure quality is sufficient for your livestock. (See the information box “For the Birds.”) Beef producers may not require forages with the same level of protein and digestibility as their dairy counterparts, but all stock require good-quality hay during part of their reproductive and growth cycles, including late gestation, early lactation, and as part of growing/finishing rations.
5. Leave enough leaf area to fuel regrowth, especially for grasses and bird’s-foot trefoil, by mowing at 7-10 cm. Give alfalfa stands sufficient time to recover and build root reserves (typically 30-40 days.)

6. Promote winter hardiness by avoiding mowing during critical fall harvest period for alfalfa and clovers. (Note: The critical fall period begins about a week earlier for bird's-foot trefoil than for alfalfa.)
7. Limit or avoid traffic on the field (especially on alfalfa) in the period after baling, as well as traffic that compacts snow cover during the winter.

For the birds

The Forage Masters program focuses on the direct benefits of forages, but well-managed forages provide tremendous indirect gains, too. Hayfields and pastures are part of a broader working countryside. Along with the fodder they produce, grasslands make for a green and pleasant landscape, maintain soil-building ground cover, and provide space for birds and wildlife.

Although these benefits are hard to calculate in dollar terms, they're very real. A rich and diverse collection of birds makes agricultural grasslands a more appealing place to work (and probably helps control pests, as well.) Yet many of the birds that rely on Ontario's agricultural and natural grasslands have been in decline. Ontario's bobolink population has fallen by 88 percent over the past 40 years, while eastern meadowlarks, savannah sparrows and barn swallow numbers are down nearly 70 per cent. Bobolinks, eastern meadowlarks and barn swallows have all been designated as threatened species in Ontario, while the grasshopper sparrow is a species of special concern. Forages play a key role in maintaining these species, and forage management may help reverse the decline.

What you can do:

- Keep your eyes and ears open. What birds use your fields? Where are they? Are there fields the birds seem to prefer?
- Consider forage mixtures that provide good livestock nutrition and valuable bird habitat. Birds dislike stands of alfalfa and reed canary grass, preferring timothy, bromes and fescues. If possible, limit alfalfa to about 25 percent of the mix.
- Many species (including bobolinks and meadowlarks) nest and rear young in June. Haying during June is apt to kill 90 percent or more of the birds in the field, destroying nests and leaving nestlings exposed to predators, including gulls and ravens. Give the birds a break by starting the harvest on fields they don't favour. If possible, harvest prime bird habitat in early-to-mid-July.
- Use late-cut hay for animals that don't require as much protein, including horses and beef cattle.
- Cut headlands early, and then the centre of fields – where birds are more likely to nest – later.
- Birds tend to prefer taller areas in older hayfields. Cut newer fields earlier, older fields later.

For more information, and to develop your own grassland bird conservation plan, read "Farming with Grassland Birds – A guide to making your hay and pasture bird friendly," produced by the Ontario Soil and Crop Improvement Association with support from Environment Canada, 2016.

Questions:

i. Timing the cut(s) for dairy haylage

☐ Best: Mowing is timed for optimal mix of nutrition, yield and plant health with use of scissor test/PEAQ.

☐ Good: Mowing is timed by stage of plant development (for example: legumes in mid-bud, grasses in boot.)

☐ Needs Improvement: Mowing takes place when operator is available.

ii. Harvest planning

☐ Best: Mowing is planned to harvest species as they mature (as a typical example, early orchard grass, then tall fescue, then timothy.)

☐ Good: Mowing is planned for convenient movement of equipment and removal of bales.

iii. Critical fall harvest period to accommodate risk factors

☐ Best: Mowing does not occur during critical fall harvest period for legumes.

☐ Good: Mowing is avoided during critical fall harvest period, except when necessary. (For example, to make up for a shortfall in feed.)

☐ Needs Improvement: Mowing takes place without regard to critical fall harvest period.

iv. Maintaining root reserves for regrowth and winter hardiness

☐ Best: Mowing is planned to rebuild alfalfa root reserves (alfalfa is allowed to reach full bloom once.)

☐ Good: Mowing allows significant buildup of reserves (typically 28-30 days after last cut.)

☐ Needs Improvement: Mowing takes place without regard to root reserves

v. Mowing height for grass regrowth

☐ Best: Mower is set about 10 cm above the surface to encourage regrowth.

☐ Needs Improvement: Mowing height is routinely below 7 cm.

B. Get it dry

The old saying, “making hay while the sun shines,” remains as true as ever. Succulent green forage, freshly cut, runs about 80 per cent moisture. But conventional hay can’t be baled and stored until moisture drops below 20 percent. In humid regions of Ontario, quick drying is a challenge.

Growers can speed drying by working with plant biology. Like people, plants respire, burning stored carbohydrates to grow, move, and repair tissue. After mowing, respiration continues until hay dries to about 40 percent. Farmers can shorten this period – and lose fewer sugars and starches to respiration – with wide swaths that allow the hay to dry more rapidly. Plants also cool themselves during the daylight hours by releasing moisture through stomates – tiny, mouth-like holes on the leaves that open in the light. Leaving a wide, open swath triggers the stomates to open, and jump-starts drying.

Researchers in western Canada and the U.S. have found that hay cut in the late afternoon holds more sugars. But in humid Ontario, late-day cutting probably increases respiration losses. A better option may be to promote rapid drying by mowing earlier in the day. Techniques include wider swaths – shown to reduce drying time by up to 40 percent – cutting at 7-10 cm to keep the swath off the ground, and proper conditioning to crimp the stems in the hay, and release tightly-held moisture in the stems.

When hay lies in dense, humid swaths, or is baled too damp or "tough," molds, microbes and fungi feast on the forage's starches and sugars. Heating, triggered by microbial growth in wet bales, may tie up proteins, making them unavailable to livestock even though they'll still show up in as crude protein in a forage test (look for a test that measures digestible protein). Preserve these nutrients by promoting rapid drying, and baling at the right moisture.

Haying in the rain

Into every hay season a little (and sometimes a lot) of rain must fall. Rain leaches soluble carbohydrates and some minerals out of the forage, prolonging respiration, boosting microbial activity and mold growth, and hiking leaf loss when the forage is raked or tedded. Legume hay, and hay that's already partially dry are hardest hit by rain. Heavy rain also has a greater impact on digestibility than on protein levels. In a Wisconsin study, alfalfa hit by an inch of rain a day after cutting lost up to 22 per cent of its dry matter. Alfalfa exposed to 1.6 inches of rain over several days lost up to 44 per cent of its dry matter.

What you can do:

1) Lay out the swath as widely as possible, or ted the hay to spread it out after mowing.
2) For alfalfa, adjust roll conditioner for a clearance of 1.6-2.4 mm (1/16-3/32 of an inch). Crimp stems every 3-5 inches, so that 90 per cent of stems are cracked or crimped. First-cut, grassier hay may require more roller tension.
3) Allow air movement beneath the swath by mowing 7-10 cm off the ground.
4) Rake at 30-40 percent moisture. Ted alfalfa at more than 50 percent moisture.
5) Bale at correct moisture: about 12-15 percent for large square bales, 12-15 percent for hard core large round bales, 13-16 per cent for soft core large round bales, and 15-18 percent for small squares.
6) Control implement speed to limit leaf loss. For rotary rakes, minimize rotation versus ground speed. For balers, synchronize ground speed and power takeoff RPM so windrow flows into baler pickup, without bunching or being yanked in by tines. In round balers, each rotation has the potential to shatter leaves. In thin crops, reduce the number of rotations required by combining windrows. Balers that tie or wrap bales more quickly (with fewer rotations) reduce leaf loss.
7) Consider using proprionate hay preservatives to bale hay at higher moisture levels without spoilage.
8) Limit weathering by removing and storing dry hay soon after baling.

How dry is dry?

As a general rule, hay that's ready to bale features stems that break (rather than bend or flex) when bent or twisted by hand. Because hand tests require experience, moisture testers – available as hand-held models or in the baling chamber (usually as part of a propionic acid system) – offer a useful second opinion. Testers determine moisture levels by measuring the electrical conductivity of the hay (the damper the hay is, the more conductive it is.) As with hand testing, it's important to survey the crop widely enough to find the dampest zones. If the hay in the damp areas is dry, the rest should be ready to go.

For a definitive moisture test, use a microwave oven. When the dew is off the swath, grab a handful of hay, place it on a paper plate and weigh it on a kitchen scale. Carefully record the weight, then microwave the hay on high for 30 seconds. Record the second weight and repeat the process until the weights stop falling. Then subtract the last weight from the first one, divide the difference by the original weight, and multiply by 100. The result is the hay's moisture content.

Questions:

i. Swath width

☐ Best: Swath is laid out as widely as possible, or tedded after mowing to extend swath as close to full width of mower as possible.

☐ Good: Swath width is laid out as widely as tractor tires permit.

☐ Needs Improvement: Swath width is set for narrow, heavy swath.

ii. Conditioning

☐ Best: Conditioner rollers are inspected and adjusted to crop mowed, as per manufacturer's instructions.

☐ Good: Conditioner rollers are inspected and set annually.

☐ Needs Improvement: Conditioner rollers haven't been set since the mower left the factory.

iii. Raking

☐ Best: Hay is raked at 30-40 percent moisture, rotary rake is set to minimize revolutions versus ground speed; tines are adjusted to clear ground.

☐ Good: Hay is raked at 30-40 per cent moisture.

☐ Needs Improvement: Hay is raked at high rotary speed, at less than 30 percent moisture.

iv. Baling

☐ Best: Swaths are combined (if necessary) to match baler capacity, reducing leaf loss at the baler intake. Tractor ground speed and baler PTO speeds are managed to prevent hay bunching or being pulled into intake.

☐ Good: Swaths are thin and baled without regard to hay flow and baler intake speed.

☐ Needs Improvement: Round baler chamber is left to rotate when not harvesting or applying twine/net wrap.

v. Bale transport

☐ Best: Dry bales are removed from field within 3 days after baling or as soon as bales can be safely placed under cover.

☐ Good: Bales are removed from field before significant weathering and placed under cover.

☐ Needs Improvement: Bales are left in field for extended time, or through all or part of the winter.

C. Storing and feeding hay

There's no denying the sense of relief when the baler is parked and hay season is "over." But the hard work of preventing losses during storage and feeding still remains. If moisture spoils the outside 10 cm on a 5-foot (1.5 m) round bale, almost a third of the hay is wasted. Round bales stored outside on the ground and without cover can lose up to half their feed value, through spoilage and reduced digestibility. Those same bales, fed on the ground without a feeder can lose another 40-odd per cent of their dry matter.

Preventing these losses comes at a cost for buildings, tarpaulins, and bale handling. Research in this area is conflicting, but permanent hay storage structures may pay for themselves over 15-20 years, while tarping bales or storing on crushed stone will yield short-term paybacks.

Storage poses a two-fold challenge: first, you have to get the hay dry enough to bale and allow it to "breathe" in storage. Hay baled at more than 20 per cent moisture will continue to respire, producing heat and moisture. When wet bales are packed into a mow, they offer ideal conditions for bacterial growth. As microbial populations explode, they churn out more heat, carbon dioxide and moisture, spurring yet more growth. It's a chain reaction that ruins hay, and could trigger a catastrophic hay fire. (See information box: hay fires.)

Ventilation is a concern in any storage system. Hay baled at or below 20 percent will continue to dissipate moisture over the coming months, as the hay dries to 15 percent or less. Because hay baled with propionate preservatives may have higher moisture levels, it will release significant amounts of moisture in storage.

The second challenge is to keep water off the hay once it's dry. Round bales shed some rain, but uncovered bales are exposed to a lot of moisture – an inch of rainfall on a six-by-six bale amounts to 85 litres of water dumped on that hay. Hay also wicks moisture out of the ground, spoiling the bottom part of the bale. Stored indoors or out, it's best if bales are kept off damp surfaces, (on a layer of coarse stone, pallets, etc.) and under cover, with good ventilation.

At feeding time, the use of a well-designed feeder will ensure those hard-won nutrients make it into your livestock, rather than being trampled into the ground.

What you can do:

1. Monitor bale moisture (and if necessary, temperature) during baling, before storage, and in initial stages of storage.
2. Keep track of different types of hay as they're stored, to facilitate forage tests and feeding or sales.
3. Store bales off the ground, using coarse stone, pallets, tires, rails, waste hay, etc.
4. Store bales under cover, with sufficient ventilation for moisture to escape.
5. Minimize losses in round bales stored in the open by butting faces of bales together, and aligning bales in north/south rows, with space between rows for good ventilation and exposure to sunlight.
6. Losses are greater when round bales are left in the open with round sides touching.
7. Feed hay in well-designed feeders.

Hay fires

Reduce spoilage and the threat of fire by ensuring hay is baled dry, and giving tough bales time to sweat before storage. Dry bales will respire and warm slightly during the first 3-7 days after baling. Wet bales (over 25 per cent moisture) will heat during the first six weeks of storage. Danger signs include "hot silage", pipe tobacco, or caramel-like odours, or heat or steam coming from gaps between bales. Use a hand-held tester to track bale moisture and temperature. For deep-seated heating in the mow, drive a copper or metal pipe deep into the hay, and lower a candy thermometer on a wire into the pipe to monitor temperatures. A lower-tech option is to drive the pipe in, leave it in place for an hour, then pull it out. If the pipe is too hot to hold, the hay is dangerously warm.

- *65 C (150 F): Hay is entering danger zone, with potential for fire. Monitor temperatures.*
- *77 C (170 F): Constant monitoring is required. Use probe to find hotspots in the hay.*
- *80 C (175 F): Hot spots are likely. Close doors and limit drafts to avoid ventilating hidden fires.*
- *82 C (180 F): Notify fire department and insurer. Plan to remove animals and equipment from storage area if heating continues.*
- *88 C (190 F): Under supervision of fire dept., plan to quickly remove hay a safe distance from other buildings.*

Questions:

i. Planning for storage

☐ Best: Bales are sampled for moisture and signs of heating before being stored. Dry bales are placed in storage. Warm or wet bales are left outside until safe to store.

☐ Good: Bales are checked for moisture and heating in storage.

☐ Needs Improvement: Bales are placed in storage without checking for moisture or heating.

ii. Inventory

☐ Best: Hay is segregated by type and quality, tested for nutrition, and stored so it's easy to retrieve.

☐ Good: Hay is stored as harvested, allowing early and late-cut hay to be retrieved for feeding and nutritional testing.

☐ Needs Improvement: Hay is stored without regard for type, quality, and harvest date, and fed as retrieved.

iii. Storage

☐ Best: Dry bales are placed under cover, with sufficient ventilation, and protected from ground moisture.

☐ Good: Round bales are stored without cover on well-drained site, in north/south-oriented rows, with flat faces butted together,

or, dry bales are placed under cover, with sufficient ventilation, but no protection provided from ground moisture.

☐ Needs Improvement: Square bales are stored without cover. Round bales are stored without cover, with sides touching.

iv. Feeding

☐ Best: Hay is fed in hay-saving cone or ring feeders.

☐ Good: Hay is fed in trailer or cradle feeders or "bale grazed" on fields that benefit from the nutrients.

☐ Needs Improvement: Hay is fed without a feeder.

D. Scoring your hay

Animal performance and customer satisfaction may be the best ways to gauge good hay, but a simple first-hand inspection offers quick guide to forage quality. Here's what to look for:

Stage of Maturity:

Look for: Legumes in mid-to-late bud, grasses in boot stage. Soft leaves and stems.

Less desirable: Legumes in full flower or seedpods. Grass heads fully developed or seed formed. Stems coarse and brittle.

Leaf to stem ratio:

Desirable: Since most proteins and carbohydrates are in leaves, look for forage where leaves represent 40-50 percent of hay, and leaves are attached to stems.

Less desirable: Leaves are shattered and broken, with a high proportion of stems.

Colour and odour:

Desirable: Bright green, with a clean, sweet, "new-mown hay" scent.

Less desirable: Hay is pale or sun-bleached, yellowed or brown. Visible dust or mold (grayish-white or black.) Musty, silage or caramel-like odour.

Different strokes for different folks (and their livestock.)

All hay is not created equal, but that's probably a good thing. Nutritional requirements differ among species, and vary throughout the lives and reproductive cycles of individuals animals. Dry beef cows, for example, can clean up mediocre hay, while the nutritional requirements of lactating dairy cattle demand the good stuff.

Dairy cattle, sheep and goats: Lactating animals require soft and leafy high-legume hay (in some cases 75 percent or more legumes,) cut early to mid-bloom.

Sheep and goats: These selective eaters pick out leaves and avoid coarse stems. They require good-quality hay (similar to dairy standards) during late gestation, when growing lambs and kids restrict rumen capacity.

Beef cattle: Large rumen capacity and lower milk output allow cattle fare well on grassy hay, cut in late boot or early head. Growing, early lactation, and forage-finished animals benefit from more legumes in the mix. Dry cows can subsist on more mature forage. Experts suggest the volume of hay being consumed is more important than maximizing quality for some classes of beef animals.

Horses: Pleasure horses typically have lower nutrient requirements so owners will prefer more mature, grassier hay. Owners of racing horses or broodmares prefer hay with a higher percentage of alfalfa. In all cases horse hay should be green and free of dust and mould. (Horses fed dusty hay are prone to chronic respiratory illness.) Avoid forage mixtures with alsike clover (associated with liver damage and sensitivity to sunlight in horses). High amounts of red clover in the forage also complicate haymaking for horses, as the fine hairs, called trichomes, break off during raking and baling, making dusty hay.

The scratch factor

When selecting hay, consider its "scratch factor". Ruminant livestock eat until forage stimulates or "scratches" the rumen wall, triggering rumination. Soft, leafy forages allow the animal to get a good bellyful of hay before rumination kicks in. Coarse, stemmy hay is scratchier, triggering rumination before the gut is full. The result is reduced feed intake and poorer productivity.

Module 3

Ensiling: Haylage, corn silage, and baleage

Silage has been around a long time, judging from an ancient Egyptian mural depicting workers packing sorghum into a stone silo. In Roman times, Teutonic tribes stashed green fodder in pits, sealed with dung. By the 19th century, their German and Austrian descendants were using pits and silos to make "sour-hay", fermenting sugar beet tops and leaves, or even experimenting with corn, then considered a risky grain crop in northern areas.

Now ensiling – fermenting forages inside an air-tight sealed container – is a common way to preserve forage. Hay maintains its feed value because it's too dry to support the moulds and bacteria that cause spoilage. But silage prevents spoilage by helping bacteria consume oxygen and ferment sugars into acids, pickling the forage. If hay is the beef jerky of forage, then silage is sauerkraut for ruminants.

As a bonus, ensiled forages are quicker to harvest and offer sharply lower harvesting losses (typically less than 15 percent) than hay. If silage is properly made and carefully fed, storage and feeding losses are similar to or lower than hay. And while ancient silage must have been the product of much trial and error, modern technology and a better understanding of microbiology makes it possible to reliably "pickle" forages.

A. Timing and moisture: making the formula work

Plant sugars and moisture are building blocks for the acidic "juice" that ensiles the crop, so timing the cut and getting the right moisture levels are crucial steps towards successful silage. Cutting the crop at the right time delivers appropriate nutrition to your stock, but also ensures sufficient sugar levels for effective fermentation. At the same time, proper moisture promotes rapid and effective ensiling. The result is fodder that will remain stable within the silo, bunker, or wrapped bale for months.

The best crops for ensiling are carbohydrate-rich species (typically two parts carbohydrates to one part protein,) with high sugar levels to fuel the conversion to lactic acid. Good examples are corn, sorghum, sudan grass, pearl millet, cereals, and forage grasses. Succulent grasses and annual cereals contain more sugars than legumes, while the protein in legumes buffers pH, causing slower fermentation. But with care, legumes can be successfully ensiled.

For "haylage" made from grasses and legumes, cutting time is similar to early, high-quality hay. (Mature grasses have fewer sugars, so later-cut hay is more difficult to ensile.) Cereals should be cut at the boot stage or at the flag leaf stage for a higher quality forage, while corn is usually cut when whole-plant moisture is 60-70 per cent.

Depending on the mode of ensiling, these forages will need to be dried down to 40-70 percent moisture (see Recommended Silage Moisture), in a process that will require several hours – and sometimes a day or more – of wilting before harvest and ensiling. Corn, on the other hand, is usually direct-cut and harvested at 60-70 percent whole-plant moisture. Whatever the crop, too much moisture leads to a less-successful fermentation and possible spoilage. (See chart, What's wrong with my silage?) Too little moisture can also cause incomplete fermentation, forage heating, and in extreme cases, silo fires result. If silage heats to just 40 C, the result is lost and indigestible protein.

Module 3 Ensiling: haylage, corn silage, and baleage.

What you can do:

- Follow similar preparations and planning for hay, (see Hay Harvest, Storage and Feeding, pg.9) Closely observe weather and crop development, ready equipment, and develop a cutting plan for appropriate forage regrowth and winter hardiness.
- Time the cutting of perennial forages by monitoring crop digestibility. Time the cutting of direct-cut forages, notably corn, by monitoring moisture levels.
- Lay the forage out in a wide swath. Allow wet crops time to wilt to appropriate moisture. Wisconsin researchers cite wide swaths (70 percent or more of the cutting width) as the single most important factor in rapid wilting. Quick drying minimizes the loss of sugars to respiration for successful ensiling.
- Adjust rakes and tedders to clear the ground, keeping dirt and manure out of the silage. (For this reason, rotary rakes are the best choice, and wheel rakes a concern.) Avoid fields that have had solid manure applied since last cut. Clostridial bacteria in the manure and earth can contaminate silage, producing butyric acid and a "rancid" odour.
- Harvest crop at the right moisture for the type of ensilage contemplated. Wrapped large bale silage is on the dry side of the spectrum. Bagged silage or horizontal (bunker) silos are on the wet side.
- Harvest rained-on or overly dry forage as hay. Rain reduces the sugars needed for proper fermentation and inoculates the forage with less efficient naturally occurring bacteria, while forage that's too dry lacks the juice for good fermentation.

Recommended Silage Moisture

Wrapped baleage: From about 40 percent -55 percent moisture.
Oxygen-limiting silos: 50-60 percent moisture.
Conventional upright silos: 60-65 percent.
Horizontal or bunker silos: 60-70 percent.
Bag silos: 60-70 percent.

Questions:

i. Timing the cut(s)

☐ Best: Mowing is timed for optimal mix of nutrition, yield, plant health, and sugar content, with use of scissor test/PEAQ,

and, for corn, correct moisture for harvest is determined based on whole plant moisture test.

☐ Good: Mowing is timed by stage of plant development (legumes in mid-bud, grasses in boot, cereals in dough stage),

and, for corn, harvest between one-half and two-thirds milk line;

or, for corn, check with seed representative for hybrid-specific milk line recommendations. (See box: determining moisture for corn silage.)

☐ Needs Improvement: Mowing takes place when operator is available;

or, when forage is overly mature;

or, for corn silage, harvest takes place without regard to crop moisture level.

ii. Swath width

☐ Best: Swath is laid out as widely as possible, or tedded after mowing to extend swath as close to full width of mower as possible.

☐ Good: Swath width is laid out as widely as tractor tires permit.

☐ Needs Improvement: Mower is set for narrow, heavy swath.

iii. Raking/tedding

☐ Best: Baler/harvester has wide enough pickup to harvest forage left unraked, in wide swath,
or, windrow merger is used to combine swaths.

☐ Good: Rotary rake or tedder is adjusted so tines clear the field surface and avoid gathering soil, manure, or, other foreign matter in the forage.

☐ Needs Improvement: Rake or tedder is not properly adjusted,
or, wheel rake is used.

iv. Moisture

☐ Best: Forage is checked for appropriate moisture level before harvesting,
and, and forage that is rained on or too dry is left for hay.

☐ Needs Improvement: Forage is not checked for moisture,
or, forage is harvested too wet or too dry for successful ensiling.

How moist is moist? Determining moisture for ensiling

The "milk line" guide for corn silage.

Corn is a carbohydrate-rich crop that's relatively easy to ensile when direct-harvested at high moisture levels. But to avoid nutrient losses, environmental damage and threats to silo structure caused by seepage, it's best to ensile at 60-65 per cent whole plant moisture for tower silos and below 70% moisture for horizontal silos.

The "milk line," the division between the solid and liquid portions of the drying kernel, offers a guidepost for harvest. After the kernel dents, a whitish line – easily seen if you break the cob in half – progresses across the kernel towards the cob. The traditional approach is to harvest when the milk line is one half to two-thirds of the way to the cob. But silage and grain corn hybrids vary on the breakdown between stalk and grain moisture, so it's best to ask your seed company representative for precise recommendations.

Finally, the milk line is not always a reliable guide when the crop is drought stressed (and has few or no cobs) or frost-damaged.

Sampling for moisture

Laboratory oven drying analysis, heat-type (Koster) moisture testers or the kitchen microwave oven offer a more precise guide to whole plant corn moisture. Collect ten representative plants from the field (avoiding headlands) and finely chop in harvester or yard chipper. Send a sample to the lab, use the Koster test, or microwave, using the same approach as for hay. (See Hay Harvest, Storage and Feeding, pg.9) Beware: your microwave or Koster may underestimate silage moisture by 2-3 percent. Once milk line is at 20 percent, silage dries at roughly 0.5 percent a day.

"Grab tests" for haylage

Haylage and Baleage makers can also use microwaves, Koster machines, and probe-type moisture testers, but hand tests, backed up by experience, offer a good in-field guide. Grab a handful of the forage, and squeeze and pack it into a ball:

- *If water is easily squeezed out and forage holds its ball shape: Moisture is probably greater than 80 percent.*
- *If juice just barely runs out, and forage holds its shape: About 75-80 percent.*
- *If little or no juice seeps out and forage holds its shape: About 70-75 percent.*
- *If no juice seeps out, and forage ball "unfurls" or falls apart slowly: 60-70 percent.*
- *If no juice seeps out, forage ball springs apart rapidly: Moisture is less than 60 percent.*

As the harvest continues, watch for signs your forage is becoming too dry to ensile, including large clouds of dust billowing out of forage wagons as they're loaded.

B. Harvesting and ensiling

Successful ensiling occurs when moist, carbohydrate-rich forage is packed into a tightly sealed anaerobic (oxygen-free) environment, creating perfect conditions for microbes to ferment and preserve the forage.

First, plant respiration and rapid microbial growth consume the remaining oxygen, bringing on speedy fermentation and limiting dry matter losses or "shrink" to 12-15 percent. Next, anaerobic bacteria undergo their own population explosion, converting plant sugars and starches into (ideally) lactic acid, some acetic acid, and other components. As pH falls 3.8-4.5 (usually higher for wrapped bales), this pickled forage becomes a stable product that can be stored in an oxygen-free container, including a silo, bunker, or wrapped bale.

Harvesting and packing are crucial steps. Chopped fodder is easier to pack into the silo, and dense packing squeezes air out of the silage, reducing the amount of sugars and starches lost to plant respiration. Chopped particles also create more surface area for microbial activity, exposing silage to the pickling effect of the acidic juices. As a bonus, firmly packed silage inhibits air entry when the silo is opened for feeding.

Equally important is rapid filling, tight packing, and sealing of the ensiling "container," especially for bunker silos. Packing squeezes out trapped air, while a good seal prevents air from causing spoilage. Uncovered silos suffer losses of 30 per cent dry matter or more as exposed silage spoils and rain leaches organic acids and nutrients.

In the case of wrapped bales, the plastic film acts as the silo. Because the forage is harvested full-length from a mower, it's crucial to make firm, tight bales, creating an airtight container with thorough wrapping and sufficient plastic. (Helpful technology: silage balers with pre-cutter knives reduce fibre length, making for tighter bales and more rapid fermentation while net wrap can contain forage stems reducing punctures in the plastic wrap.)

What you can do:

- Chop forage to the appropriate length, typically 10 millimetres (about three-eighths of an inch) for haylage and corn silage, and 19 millimetres (three-quarters of a inch) for silage put through a kernel processor.
- Make silage bales tight and firm. Balers equipped with precutters help make tighter bales that ensile more rapidly.
- Fill silos rapidly.
- Thoroughly pack bunkers, filling from back to front on a 1:4 slope, in layers no greater than 15 centimetres (six inches), with sufficient tractor weight and packing time to achieve 17 pound DM per cubic foot for corn silage and 15 pounds per foot in haylage. (This is not as easy as it sounds: A University of Wisconsin found only a third to half of farmers surveyed were approaching these densities in their corn silage bunkers.) Pay extra attention to the top and sides of the bunker – typically the zones with the least density – by packing them with a narrow-wheeled, heavy tractor.
- Seal silos tightly. For bunkers, use UV-protected silage-grade 6-8 mil white plastic, held firmly in place so the wind can't lift the plastic. Seal plastic seams with sandbags, agricultural lime, or sand/soil.
- Wrap bales thoroughly, with a minimum of six mils, eight mils for dryer baleage. • Silage additives and inoculants, (such as Lactobacillius, the bacterium that produces lactic acid) may promote fermentation especially in crops harvested in difficult or marginal conditions, including high-protein forages, crops that are too dry, harvested in cold weather, or with some rain.
- Monitor silos and wrapped bales for holes, punctures, and signs of leakage. Repair or reseal.

Questions:

i. Chopping and forage length

☐ Best: With the exception of wrapped bales, forage is chopped to about 10 mm for haylage/corn silage or 19 mm for corn silage with a kernel processor;

or, silage baler is equipped with pre-cutter.

☐ Good: Baleage is cut at an early stage (early to mid-bud, boot stage).

☐ Needs Improvement: Forage and corn silage is chopped significantly shorter or longer than 10 mm (except for 19 mm for corn with a kernel processor.) Baleage is too mature.

ii. Filling and packing

☐ Best: Tower silos are filled as rapidly as possible (within three days for conventional silos), compacted and capped;

and, bunkers are filled within three days, and thoroughly packed by heavy equipment, filled from back to front on a 1:4 slope, in 15-cm layers, with extra attention to top and sides of the pile;

or, baleage is baled with a slow ground speed, to produce tight bales;

and, bales are wrapped within two hours in hot weather, 4-12 hours in cooler weather.

☐ Needs Improvement: Silo filling is prolonged for days;

or, bunkers are filled in layers greater than 15 cm and insufficiently packed;

or, forage is baled too rapidly, producing loose, spongy bales that "squat" and settle.

iii. Sealing

☐ Best: Silos are rapidly and tightly sealed. Bunkers are covered with 6-8 mil white UV-protected plastic, weighed down for a firm, airtight seal. Wrapped bales (especially if they contain drier forage) are wrapped with 8 mils of plastic.

☐ Good: Baleage is wrapped with at least 6 mils of plastic.

☐ Needs Improvement: Silos are not rapidly and tightly sealed. Covers on bunkers are not sufficiently tight, (rippling and billowing in the wind.) Baleage is wrapped with less than 6 mils of plastic, and shows signs of mold and spoilage.

C. Storage and feeding

Whether it's a conventional silo, a bunker, or plastic wrap, once air penetrates the ensiling container, it kick-starts aerobic decomposition, fueling the growth of yeasts and moulds that consume the nutrients and transform the feed into an unpalatable mess. Some air penetration is accidental, from rodents or other wildlife chewing or pecking off plastic wrap or the wind blowing off a cover. But there's also unavoidable exposure when the silo is opened to feed livestock.

At least some of these losses can be limited through a combination of vigilance, flexibility, and appropriate technology. On the flexibility side, cool weather suppresses microbial action. Warmer weather boosts microbial populations and increases losses. When it's warmer, silage must be fed more rapidly to reduce spoilage.

Oxygen-limiting tower silos tend to have the lowest losses – typically 6-13 percent according to a Wisconsin paper – while uncovered silage stacks can lose more than 50 percent of their feed. Silage bales fed without a feeder are prone to the same wastage problems as dry hay, with the added losses that come if the forage begins to spoil and become unpalatable. Placing silage bales in a ring feeder trims losses from about 50 percent (compared with no feeder) to 10-20 percent, and less than 10 per cent using an elevated wagon–type feeder.

Meanwhile, vigilance ensures the integrity of silos, seals and wraps. Regular silo inspections will pinpoint leaks and punctures, and help spot potential structural problems.

What you can do:

- Give silage/haylage sufficient time to fully ferment – usually a minimum of 3 weeks (longer is better) before feeding it.
- If possible, site silos and bagged haylage storage areas more than 150 metres from nearest surface water, and more than 90 metres from well. (EFP Fourth Edition, Worksheet 10, question 2, pg. 127).
- Regularly inspect silos, bunkers, and wrapped bales for signs of seepage and deterioration, punctures, faulty seals, etc. Repair structures, punctures and seals as soon as possible.
- While seepage can be avoided or reduced with proper harvest moistures, a seepage management system prevents significant environmental pollution.

- Discourage rodents and other wildlife by clearing or trimming vegetation around silos, bunkers, or where wrapped bales are stored.
- Store individually wrapped bales on their flat side, where plastic is thicker. Place wrapped bales and bagged forage on firm, drivable surfaces, without sharp stones that could puncture or tear plastic.
- Maintain a tight, smooth silage face to reduce air penetration. In bunkers, shear off only the silage required for feeding by using a silage facer or scraping down the face with a bucket, rather than lifting up.
- Keep ahead of spoilage by feeding more haylage and silage in warm weather. Feed-out rates should be at least 5 cm per day in winter, 7-10 cm per day during the summer for tower silos, and at least 10-15 cm per day for bunkers. Silage bales should be consumed within a day or two.
- Feed silage bales in feed-saving feeders.
- If possible, keep plastic clean and dry and recycle silage bags and bale wrap.

Silo safety checklist

- *Check wooden doors for rot and physical damage.*
- *Ensure bolts are tight. Check for corrosion.*
- *Evaluate corrosion and damage to door steps and latches.*
- *Cast iron hinge eyes should be tightened and assessed for corrosion.*
- *Check concrete door frames for deterioration and physical damage.*
- *Ensure doors seat properly in frames, and latches work effectively.*
- *Replace wire rope on the unloader, if signs of wear are evident.*
- *Ensure ladders are in good condition. Outside ladders should be fitted with structurally sound safety cages to prevent falls.*

Source: Workplace Safety and Prevention Services

Silo Gases

Fermentation produces a witches' brew of harmful gases, including nitrogen and carbon dioxides, nitric oxide and nitrogen tetroxide. Silo gases killed at least eight people on Ontario farms from 1990 to 2008, with another 18 hospitalized after exposure to silo gases. Of all the toxins farmers were exposed to in that survey, silo gas triggered the most hospital admissions.

Avoid becoming a statistic with good health and safety planning and practices. Nitrogen dioxide, for example, is most dangerous during the first 12-60 hours after silo filling. Avoid exposure during this initial period and following weeks, with thorough ventilation:

- *Open windows and outside doors of the silo room, augment air movement with fans.*
- *If the silo adjoins a barn or other building, dissipate gas by blowing air through the feed room.*
- *A box duct extending from a fan extending down to 150 mm above the feed room floor will exhaust silo gas.*
- *Keep doors closed and the roof panel open for more effective ventilation.*
- *Post warning signs and emergency contacts.*
- *Barricade enclosed silo areas to prevent entry.*
- *Keep a hatch door open close to the level of silage in the silo.*
- *Keep people out of the silo, and away from the area when filling or emptying.*

For additional information, including entry protocols for silos, see Silo Safety, Health and Safety Ontario: ***www.wsps.ca/WSPS/media/Site/Resources/.../Silo_Safety_Final.pdf***

Module 3 Ensiling: haylage, corn silage, and baleage.

Questions:

i. Maintenance and Inspection

☐ Best: Silos, covers, and bagged/wrapped haylage are regularly inspected throughout the storage time for structural integrity, tight seals, and punctures;

and, seals are made airtight as necessary, punctures are taped etc.;

and, plans for repairs/relining are made as necessary.

☐ Good: Silos, covers, bagged/wrapped haylage are inspected for structural integrity, tight seals, and punctures before and after filling, and at feed-out;

and, seals are made airtight as necessary, punctures taped, etc.;

and, plans for repairs/relining are made as necessary.

☐ Needs Improvement: Silos, covers, bagged/wrapped haylage are not regularly inspected for structural integrity, tight seals and punctures;

and, repairs are made on an ad hoc basis.

ii. Seepage Management (adapted from EFP Fourth Edition, Worksheet 10, question 6, pg. 128.)

☐ Best: Well-maintained seepage management system contains and stores silo seepage and contaminated runoff;

or, no seepage occurs.

☐ Good: Concentrated seepage is contained, while diluted seepage/runoff is channeled through well-maintained vegetated filter strip or permanently vegetated area, at least 150 m from surface water or surface tile inlets.

☐ Needs Improvement: Seepage not managed;

or, seepage drains into field drainage system;

or, seepage discharged within 150 m of surface water or surface tile inlets.

iii. Storage and silo areas

☐ Best: Areas around silos and storage areas are trimmed and landscaped to prevent flooding and discourage rodents and other wildlife;

and, wrapped/bagged haylage is stored on a smooth, well-drained, all-weather surface (gravel, filter cloth, etc.);

and, individually wrapped round bales are stored with the flat side on the ground;

and, sufficient layers of plastic are used to ensure exclusion of the air.

☐ Good: Areas around silos and storage areas are occasionally trimmed, landscaped to prevent flooding; and, wrapped/bagged haylage is stored on a smooth, well-drained area.

☐ Needs Improvement: Areas around silos and storage areas are not trimmed and landscaped;

or, are prone to flooding;

or, wrapped/bagged haylage is stored on rough, stony, or muddy ground.

iv. Feed-out

☐ Best: Feed-out is rapid enough to minimize spoilage and wastage;

and, a smooth, firm silage face is maintained;

and, well-designed feeders are used.

☐ Good: Feed-out aims to reduce spoilage and waste when possible;

and, a smooth, firm silage face is maintained;

and, feeders are used.

☐ Needs Improvement: Feed-out is too slow, leading to obvious spoilage losses;

or, silage face is crumbly and fractured;

or, feeders are poorly adapted to silage, or no feeders are used.

v. Waste Plastic (adapted from EFP Fourth Edition, Worksheet 6, question 3, pg. 65)

☐ Best: Plastics are kept clean and dry, sorted into similar types, and recycled.

☐ Good: When recycling is not available, plastics go to an approved landfill.

☐ Needs Improvement: Plastics are dumped, buried, burned on the farm;

or, stored long-term on the farm

What's wrong with my silage?

When haylage is spoiled, it's often a good news/bad news story. The bad news – the nasty odour and appearance of the feed – is obvious. But the stench also offers clues to what went wrong, In order to verify the problem, a sample can be sent to a laboratory for a fermentation analysis which may help prevent future mishaps.

1. *The problem: Rancid or fishy odours.*

   The culprits: Butyric acid produced by Clostridial bacteria, often in overly-wet silage. Clostridia probably hitchhiked into the forage on soil, mud or manure, was tossed into the windrow by the rake, or possibly hitchhiked on tires used to pack the bunker. High butyric acid levels in silage cause reduced intakes and butterfat depression in dairy cattle.

2. *The problem: Mouldy silage, musty odour.*

   The culprits: Extended aerobic conditions, low moisture, slow feed-out, or poor silage face management.

3. *The problem: Vinegar-like odour.*

   The culprit: Ascetic acid. Optimal silage contains lactic and ascetic acid in a 3:1 ratio, but crops with lower sugar and moisture levels can produce too little lactic and too much ascetic acid. A commercial inoculant may boost lactic acid production.

4. *The problem: Sweet, fruity odour.*

   The culprit: Ethanol, produced by yeasts during a slower-than-optimal fermentation.

5. *The problem: Ammonia-like odour.*

   The culprit: Excessive protein breakdown, possibly triggered by Clostridia, or a pH that's too high for stable ensiling.

6. *The problem: Caramel/tobacco odours.*

   The culprit: Overly-dry forage, triggering heating and possible loss of digestible protein.

Scoring your silage/haylage

Stage of maturity

Haylage

Desirable: No legume flowers or grass heads.

Undesirable: Fully mature grass heads, legumes flowering or in seed.

Corn silage

Desirable: Kernels bright, full, well-dented, with as much grain content as possible.

Undesirable: Corn is immature, with milky kernels or no kernels.

Moisture and Condition

Desirable: Silage/haylage is slightly moist.

Undesirable: Silage/haylage is wet, or sheds water when squeezed, or is spongy and dry, with potential for mold or heating.

Odour

Desirable: Sharp, tangy, slightly acidic odour.

Undesirable: "Rancid", burnt, caramel, tobacco, moldy, musty, or yeasty odours.

Length of cut

Desirable:

Haylage: About 10 mm or more, some longer fibres. (Baleage will be longer.)

Corn silage: About 10 mm or more, 19 mm for silage processed with kernel processor.

Undesirable: Forage that is too fine (around 5 mm or less) or too course (25 mm or more, except baleage.)

Colour

Desirable:

Hayage: Light brown to greenish-brown.

Corn silage: Yellow-green or bright olive-green.

Undesirable: Very dark brown, black, moldy.

Purity

Desirable: No stubble, trash, manure or soil, or weeds.

Undesirable: Silage or haylage is contaminated with other plant or soil materials, manure or trash.

Forage Master Competition Self-Assessment Summary

Please transfer your response for each statement in the self-assessment, to the Evaluation Summary sheet and respond to the additional questions about your farm operation. The Evaluation Summary sheets can be forwarded to Guelph OSCIA to be confidentially scored. Each participant will be provided their aggregated score.

1. Briefly describe your farm operation and the goals of your forage program. Please indicate the livestock type that are fed forage produced on the farm, and the types of forage produced (dry hay, haylage, etc.)
   If no livestock are on the farm, please indicate.

2. To complete the submission, you are asked to submit a copy of the most recent results of a soil analysis and a feed analysis. The provision of these two items will also factor into the aggregate score achieved. Please check in the boxes below if the items have been provided.

   i. Most recent soil test result ☐ ii. Most recent feed analysis ☐

3. Please describe briefly if you are doing something truly innovative in your forage management program that was not revealed through the Self-Assessment.

4. What did you like best about completing the Forage Master Self-Assessment?

5. Do you have any suggestions for improving the Forage Master Self-Assessment or how the competition is delivered across the OSCIA regions?

Name: _____ Farm Business Name: _____

Mailing Address: _____

County/District: _____ Email: _____

Forage Master Competition Self-Assessment Summary

Module 1 – Forages: generating more "green"

		Best	Good	Needs Improvement
A.	**Fertility**			
	i. Soil testing	☐	☐	☐
	ii. Test parameters	☐	☐	☐
	iii. Fertility management	☐	☐	☐
	iv. Nitrogen	☐	☐	☐
	v. Timely application	☐	☐	☐
	vi. Applying manure or other soil amendments	☐	☐	☐
B.	**Seed Selection**			
	i. Species selection	☐	☐	☐
	ii. Cultivar selection	☐	☐	☐
	iii. Certified seed	☐	☐	☐
	iv. Inoculants	☐	☐	☐
C.	**Stand Establishment**			
	i. Seedbed	☐	☐	☐
	ii. Seed depth and seeding rate	☐	☐	☐
	iii. Companion crops	☐	☐	☐
D.	**Stand Maintenance**			
	i. Scouting program	☐	☐	☐
	ii. Stand thickness, health and vigour	☐	☐	☐
	iii. Fertility and field conditions	☐	☐	☐
	iv. Weed scouting	☐	☐	☐
	v. Weed control	☐	☐	☐
	vi. Insect control: (Potato leafhopper, alfalfa weevil, etc.)	☐	☐	☐

Module 2 – Hay harvesting, storage, and feeding

A.	**It's All About Timing**			
	i. Timing the cut(s) for dairy haylage	☐	☐	☐
	ii. Harvest planning	☐	☐	
	iii. Critical fall harvest period to accommodate risk factors	☐	☐	☐
	iv. Maintaining root reserves for regrowth and winter hardiness	☐	☐	☐
	v. Mowing height for grass regrowth	☐		☐

Module 2 – Hay harvesting, storage, and feeding

	Best	Good	Needs Improvement
B. Get It Dry			
i. Swath width	☐	☐	☐
ii. Conditioning	☐	☐	☐
iii. Raking	☐	☐	☐
iv. Baling	☐	☐	☐
v. Bale transport	☐	☐	☐
C. Storing and Feeding Hay			
i. Planning for storage	☐	☐	☐
ii. Inventory	☐	☐	☐
iii. Storage	☐	☐	☐
iv. Feeding	☐	☐	☐

Module 3 – Ensiling: haylage, corn silage, and baleage

	Best	Good	Needs Improvement
A. Timing and moisture: making the formula work			
i. Timing the cut(s)	☐	☐	☐
ii. Swath width	☐	☐	☐
iii. Raking/tedding	☐	☐	☐
iv. Moisture	☐		☐
B. Harvesting and Ensiling			
i. Chopping and forage length	☐	☐	☐
ii. Filling and packing	☐		☐
iii. Sealing	☐	☐	☐
C. Storage and feeding			
i. Maintenance and inspection	☐	☐	☐
ii. Seepage management	☐	☐	☐
iii. Storage and silo areas	☐	☐	☐
iv. Feed-out	☐	☐	☐
v. Waste plastic	☐	☐	☐

Name: _____ Farm Business Name: _____

Mailing Address: _____

County/District: _____ Email: _____