Atlantic Forage Guide

This guide has been prepared to replace the forage portion of the **Atlantic Field Crops Guide**. This guide was prepared through the contributions of members of the Forage and Corn Variety Evaluation Task Group. This Task Group of the Atlantic Field Crops Committee operated under the authority of the former Atlantic Provinces Agricultural Services Coordinating Committee, members of this group included Field Crop Extension representatives from Prince Edward Island and New Brunswick, the Nova Scotia Agricultural College, the Crops and Livestock Research Centre of Agriculture and Agri-food Canada and private sector employees involved in the promotion of forages in the region.

Forage and Corn Variety Evaluation Task Group
Atlantic Canada

Introduction

A forage program must supply high quality feed year around. No single forage species or mixture will supply the total forage requirement of a livestock farm. The crop grown and storage method is unique to each farm since the choice is based on capital, equipment, land, labor, time of year forage is required, size of operation, type of livestock, and personal likes and dislikes. On most farms, the forage program will use several perennial and some annual species as hay or silage, pasture and zero-graze.
Production of good quality forages requires the forage crop to be managed as intensively as other high yielding crops. Proper management of forages includes variety selection, fertilization, pest control, cutting frequency, and fall management of the forage.
Good forage management must be based on the climate, soils, and end use of the forage for each farm. Forage production is an important part of feed production plan in livestock enterprises.

Forage Establishment

Perennial forage plants must develop sufficient size and root reserves to survive winter temperatures and regrow the following spring.
Spring seeded forages should have adequate development to overwinter well and also provide 2 to 3 t/ha of dry matter in the seeding year. Seeding forage legumes in late summer and fall is not recommended due to insufficient time for adequate seedling development. Timothy and bromegrass, sown in time to develop at least four leaves per stem before overwintering, have survived the winter.

Seedbed Preparation

Small seeded legumes and grasses require a fine, firm seedbed in order to get uniform planting depth and germination. Overworking the soil or use of large tillage equipment may result in a very loose seedbed that needs to be firmed with a cultipacker or roller before seeding. Working the soils too early, when the soil is too wet, can lead to crusting and water logging which cause poor emergence of legumes and grasses.

Seeding Method

The small forage seeds should be distributed uniformly and covered with 1 cm of soil. If the soil is extremely dry, a slightly deeper placement into moist soil may be beneficial. Either a drill or cultipacker seeder (e.g. Brillion) may be used. Cultipacker seeders place the seed uniformly in the upper I cm of soil and firm the seedbed immediately after planting. Many drill seeders allow the placement of fertilizer in bands below the seed. This is beneficial as seedlings require phosphorous. Seed tubes can be attached to the drill to place the seed directly over the band of fertilizer for maximum benefit.

Inoculation of Legumes

Legume seed must be inoculated with the proper *Rhizobium* inoculant before planting. The inoculant contains bacteria which form nodules on the roots of legumes to fix nitrogen from the air. The correct inoculant must be chosen for each legume. Packets of commercially available inoculant contain live bacteria and should be stored in a cool dark place.
Ensure that inoculant is fresh by checking the expiry date on package. Instructions on applying the inoculant on seed should be followed carefully for best results. Seed that has been inoculated and stored should be re-inoculated to ensure viable bacteria are on each seed at planting.
The only time producers do not need to inoculate is when planting preinoculated seed before its expiration date.
In some fields with recent histories of alfalfa or other legumes may not benefit from inoculation, but it is difficult to identify those fields before planting. After emergence, inoculation is risky, difficult, and expensive.

Coated Seed

Coatings used on forage seed contain various combinations of inoculating bacteria, lime, nutrients and bonding agents. Coatings are intended to improve emergence and establishment of forage stands. Coating can be an effective but usually unnecessary measure to ensure good inoculation of legume seed. Carry over coated seed should be re-inoculated to ensure the presence of live bacteria in the year of seeding.

Coated seeds are larger than uncoated seeds therefore, a kilogram of coated seed contains fewer seeds than an equal weight of uncoated seed. To plant recommended rates of seed, the setting on the seeder may have to be adjusted.
Coated seed may have a role in assisting in the reintroduction of legumes into pastures or hay fields particularly in reduced tillage situations.

Weed Control

Weed control is the process of limiting weed growth and invasion to allow efficient and profitable forage production. Total weed eradication is expensive and not necessary for forage production. A weed control program should be designed to reduce the weed population to a level that is not economically damaging.
Weed control is an integral part of crop production. A good program starts by identifying the problem. Knowing what weeds are present in the crop allows selection of the most effective control. Take an inventory of the type and severity of weeds in the forage crop before harvest.
Divide the weeds into groups such as annuals and perennials; which should include both grasses and broadleaf weeds. This should be done on a yearly basis, as it allows evaluation of the current program and provides information that may necessitate changes in that program. In addition, indicate the severity of infestation of various weeds by the use of categories such as: rare, scattered, occasional, common and/or abundant.
A successful weed control program will consist of two or more types of control, since relying

on one control program will usually allow some weeds to escape. Types of control generally fall into four (4) main categories, namely: mechanical or physical, cultural or management, biological and chemical.

Mechanical weed control is effective in new forage stands. Clipping the field in late June or early July removes the weed flowers and allows the forage to grow. This gives some control of annual weeds, but will not control perennial weeds such as quackgrass or milkweed. Mechanical weed control methods also include most of the cultivations done to prepare the seedbed.

Cultural weed control is the practice of growing a healthy, vigorous forage crop that will out-compete weeds. All practices that improve crop growth will help reduce weed populations. Choose a well adapted variety, lime and fertilize as recommended by a soil test, plant as early as possible and fertilize older stands. A vigorously growing legume or grass crop leaves little space for weeds.

Biological weed control is practiced to some extent in areas of the Maritimes to control specific weeds by the introduction of specific diseases and insects. Insects are the most effective, an example being the introduction of the Cinnabar Moth to control tansy ragwort.

Chemical weed control involves the use of herbicides which inhibit the growth of unwanted plants. Herbicides are specific as to the weeds controlled, stage of crop and weed development, time and rate of application, and method of application. Herbicides are recommended only for uses and methods of application specified on the label. Always read the label and follow the instructions. Herbicides should not be the only weed control method. Use them as part of a weed control strategy and in conjunction with sound crop management practices. For more information consult Publication 75 - Guide to Weed Control.

Direct Seeding

New forage seedings can be established without a companion or cover crop. Direct seeded forage will normally yield one cut the first year, although it will be only about 50% of a crop in production year. In good years, alfalfa planted in late April or early May can be harvested in July, and again before the recommended last date of cut.

Adequate fertility, especially phosphorous, is important to direct seeded stands. Using a seed drill to band forage seed over a fertilizer containing phosphates aids seedling growth.

Underseeding/Cover Crops/Companion Crops

Underseeding forage with a cereal companion crop is a traditional practice for many farmers in the Atlantic region. When successful, underseeding offers advantages such as reduced erosion and weed growth. Harvesting cereal crop early for silage improves seedling growth and establishment of forage grasses and legumes. The cereal companion crop can be harvested for grain, if the weed control is good and combining occurs early enough for the forage crop to develop properly before winter.

Problems can occur when cereals compete with forages for sunlight, nutrients, and water. Grass and legume seedlings can die or lack vigour to develop into strong stands. Competition from companion crop and tardy removal of straw are common reasons for failed establishment of forage stands. Experience has shown that red clover, timothy and ryegrasses establish better in underseeded situations than alfalfa and most other grasses.

Fertilizing Forages

General

Forage crops require large amounts of nutrients for high yields.

Soil tests provide fertilizer and lime recommendations to produce the highest economic yields when accompanied by good management. A soil test should be taken every two to three years to maintain a productive forage stand. If the stand is 60% or greater in legumes, a boron test should be requested. If low soil micronutrient levels are a concern, appropriate test is recommended.
Fertilizer cost is reduced and yields increased by liming the soil. Research shows that forage yields are almost doubled when equivalent fertilizer is applied to a soil at a pH of 6.2, compared to an acid soil with a pH of less than 5.4.

Fertilizing in the Seeding Year

Always apply lime and fertilizer based on a soil test.

Limestone should be applied the fall before seeding and worked into the soil in quantities sufficient to raise the pH to required levels. There are differences in the sensitivity of forage species to soil pH as indicated in Table 1. Choose dolomitic limestone if your soil requires magnesium.

Table 1. Forage species sensitivity to soil pH.

Sensitive to acidity , soil pH 6.5 or greater	Low tolerance to acidity, soil pH 6.0 or greater	Moderate tolerance to acidity, soil pH 5.5 or greater
Alfalfa	Kentucky bluegrass	Alsike clover
Smooth bromegrass	White clover	Birdsfoot trefoil
Sweet clover	Orchardgrass	Meadow fescue
	Red clover	Redtop
	Ryegrasses	Reed Canarygrass
	Timothy	Tall fescue

General guidelines for fertilizing forages in the year of seeding appear in Table 2. Phosphorous is very important to ensure good root development and seedling establishment. Banding phosphorus 2 cm below the forage seed is beneficial if soils are low in phosphorus.

Nitrogen is required by all forage seedlings. Legumes need nitrogen to promote growth until they become nodulated and can fix their own nitrogen. Excess nitrogen applied in the fall may aggravate winter injury and will be lost by leaching.

Forage crops use more potassium than any other element. Potassium aids plants in resisting disease, insects, drought, cold hardiness, and sugar transport.

Table 2. Fertilizing forages in seeding year, general guidelines. Forage sown alone or with companion cereals, forage broadcast seeded.

Time	Nutrients, kg/ha			Example analysis	Rate, kg/ha
	N	P_2O_5	K_2O		
Before seeding[z]	15-25	60-120	60-120	5-20-20	300-500
Topdress grasses, 3-5 leaf stage	35-50	0	0	34-0-0	100-150
In mid-August, after 1st harvest -legume dominant swards -grass dominant swards	 0 35-55	 30 15-20	 100 35-55	 0-10-30 18-6-18	 300 200-300

[z] For band seeding, broadcast half of fertilizer before seeding and half of fertilizer can be applied in band. Use the higher rate in fields infrequently fertilized and limed in past.

Boron should be applied to legumes in the seeding year at rates recommended by a soil test. Excess applications may retard or even kill the forage seedlings. A soil test for boron on alfalfa should be taken every two to three years. Forage crops may be deficient in other micronutrients such as zinc, see Crop Micronutrients in Atlantic Canada, Publ. 537-86.

Manure is a source of organic matter and nutrients. Manure should be viewed as a resource which may be utilized to reduce the amount of commercial fertilizer required. The best time of applying manure is before seeding when manure can be incorporated in soil. See Table 3 for information on the value of common manures.

Table 3. Average dry matter and nutrient concentrations of manures on Nova Scotia farms

Manure type	Consistency	Dry matter, kg/t	Total N, kg/t	Ammonium N, kg/t	P_2O_5 kg/t	K_2O kg/t
Dairy	Liquid	88	3.1	1.5	1.6	3.4
	Semi-solid	157	4.4	1.8	2.5	4.7
	Solid	218	5.0	1.5	3.0	5.8
Beef	Semi-solid	126	2.7	0.8	1.2	3.8
	Solid	214	4.4	1.0	2.2	5.3
Swine	Liquid	53	2.5	1.7	1.9	1.1
	Semi-solid	152	5.3	2.4	5.0	2.2
	Solid	240	7.6	3.0	4.7	5.4
Poultry	Liquid	171	7.7	4.1	5.4	3.1
	Semi-solid	318	15.2	6.6	13.5	7.0
	Solid	706	33.9	8.4	25.1	15.9

[Z] Modified from Brenton and Mellish (1996)

Fertilizing Established Stands

Forage stands lacking adequate fertilization will become unproductive, thin out rapidly and revert back to less productive native swards. Following a balanced fertility program (see Table 4) will help ensure longevity of the sown species. To maintain established forage stands for hay and silage:

(1) Fertilize annually at recommended rate with potassium, an essential nutrient in maintaining all forage stands.

Table 4. Fertilization of established forage stands

Timing	Nutrients, kg/ha			Example analysis	Rate, kg/ha
	N	P_2O_5	K_2O		
Harvest for silage or hay					
Over 60% legumes					
-Spring, growth starts	10	20	60	5-10-30	200
-After cut 1	0	30	90	0-10-30	300
-At start of fall rest period	0	0	90	0-0-60	150
30 to 60% legumes					
-Spring, growth starts	45	20	45	18-6-18	250
-After cut 1	45	20	45	18-6-18	250
-At start of fall rest period	10	20	60	5-10-30	200
Over 70% grass					
-Spring, growth starts	75	25	75	18-6-18	400
-After cut 1	65	20	65	18-6-18	350
-At start of fall rest period	45	15	45	18-6-18	250
Pasture					
Over 60% legumes					
-Mid-June, late July, early September	0	15	45	0-10-30	150
30-60% legumes					
-early spring, mid June, late July,early September	35	10	35	18-6-18	200
Over 70 % grasses					
-early spring	60	0	0	34-0-0	175
-mid-June, late July,	45	15	45	18-6-18	250
-early September	25	10	25	18-6-18	150

(2) While phosphorus is most essential in the seeding year, a small amount is required annually

(3) Nitrogen is required for pure grass stands or mixtures with less than 50% legume. Apply fertilizer containing nitrogen in early spring and again after each cut. With several forms of nitrogen fertilizer now available, it is commonly recommended that a urea based nitrogen fertilizer be used for spring/first cut applications. Less volatile forms, such as ammonium nitrate or calcium ammonium nitrate based nitrogen fertilizers, are recommended for use during times of high potential evaporative loss (late June - September). Fertilizer should be applied not less than four to five weeks before harvest to ensure proper conversion to protein in the plant.

(4) Where manure is applied, reduce the rate of fertilization according to the kind of manure and rate of application (Table 3).

(5) When older grass swards lose productivity, it may be more economical to reseed to a legume or legume-grass mixture than to continue high nitrogen applications.

Fertilizing Pastures

Forages used for pasture have similar nutrient requirements as those grown for hay or silage. However, in well managed pastures a significant amount of nutrients can be supplied by the grazing animal in the form of manure and urine. Commercial fertilizer can be used to stimulate early growth.

Once again, a regular soil testing schedule allows you to monitor the nutrient levels of individual fields and provide a cost effective method of tailoring fertility applications. Along with Table 4, the following may prove helpful in assisting in the development of your own individual fertility program.

Timing of fertilizer applications, particularly nitrogen, can greatly influence pasture growth. An early spring application of nitrate fertilizer stimulates growth while soil temperatures are low and soil bacteria that release and convert nitrogen to the nitrate form are not yet active. Intensively managed pastures produce high yields particularly in early season and it will usually be necessary to harvest some of the forage as hay or silage.

For many grass pastures, split applications of nitrogen will result in better grass growth and more efficient use of applied fertilizer. It is important to balance nutrient applications to reduce problems such as grass tetany. When grasses are heavily fertilized, especially with potassium in early spring, it is important to use dolomitic limestone to minimize the chances of hypomagnesaemia (grass tetany) developing in grazing stock. Split applications of potassium (depending on soil test) may be helpful in producing forage with a satisfactory potassium magnesium balance and preventing grass tetany. In some pasture situations, especially where white clover is being encouraged, supplemental applications of phosphorus may be recommended.

Insects

European Skipper is found in most parts of the region. The adult is an orange-brown butterfly with a 3 cm wing spread. It congregates in damp places and skips about hay fields in mid-summer. The larvae are light green up to 2 cm long caterpillars when fully grown, and are usually found in May within rolled timothy leaves where they feed. Leaf margins become irregularly notched, and when the larvae are abundant, they defoliate timothy and other grasses such as orchardgrass, perennial ryegrass and meadow fescue. They will also feed on leguminous plants when other food is scarce.

Heavy European Skipper infestations will result in decreased yields of timothy. Fields should be checked for the presence of these caterpillars in late May or early June, when leaves are first rolled into tubes. If extensive damage occurred in the year previous, or if there are 65 or more caterpillars per square meter, the field should be treated with an insecticide. During some years, early cutting will reduce the damage, and cutting hay before mid-June should help prevent build-up of the pest.
An introduced virus is providing control of the European Skipper in Prince Edward Island.

Alfalfa Blotch Leaf Miner is a pest of alfalfa and present in most alfalfa growing areas. Mined leaflets frequently shatter and heavy pinhole damage from feeding causes necrosis of parts of leaflets and nutritional loss.

The adult leaf miner is a small black fly which emerges in late May. It is best identified by the numerous pinhole punctures it makes in alfalfa leaflets when it feeds and lays eggs. After the eggs hatch, the developing maggots or miners feed inside the leaflets, eating away the center part and producing mines or tunnels that terminate in blotches. The maggots then drop to the soil and pupate. The insect's life cycle takes about a month to complete and there are three generations per growing season in this region.

In the first crop, damage may be reduced by early cutting, but subsequent infestations do not correspond to cutting dates.

Introduced and native parasites of the leaf miner are providing control of the pest. Chemical control is not recommended.

Armyworm Localized armyworm outbreaks can occur. Maintain a close watch in late June and July, especially in grass fields. Armyworms are best detected by examining crops just before sunset. At this time the caterpillars are often visible on the plants.

Control consists of either cutting the crop immediately or chemical control. Use of chemical control may limit the use of the forage – always read the label.

Diseases

All forage legumes and grasses grown in the Atlantic Region are susceptible to diseases.

The prevalence of diseases depends on many factors, including the presence of sources of infection as well as favorable temperature and moisture conditions.

Legume Diseases – Some of the diseases which affect one or more forage legume crops in the Atlantic Region include root and crown rots, common leaf spot, black stem, downy mildew, powdery mildew, northern anthracnose, sooty blotch, clover phyllody and nematode diseases.

Verticillium wilt of alfalfa has been identified in various locations in Atlantic Canada. Verticillium wilt is a serious disease because of its potential to reduce alfalfa plant populations and thereby the quality and quantity of forage harvested. Verticillium wilt is spread by sowing contaminated seed or by moving infected plant parts from one field to another on harvesting equipment. Long term control of this disease can be achieved through the use of alfalfa cultivars which are resistant to the effects of the verticillium organism. Resistant cultivars suitable for use in the Atlantic Provinces are listed in Publication 100A, Forage Guide to Variety & Mixture Selection.

Grass Diseases – Brown stripe, eyespot and brown spot are a few of the diseases affecting forage grasses in the region. Each disease is caused by a different organism and the symptoms differ ranging from decayed roots, to spots on the stems and leaves, to replacement of flower petals by leaves.

Control of diseases affecting forage crops is best achieved by prevention, and it is seldom necessary or economical to use chemicals. Good farm practices - use of resistant or tolerant cultivars when available, crop rotation, crop sanitation, and recommended cultural practices - help reduce the incidence of disease. Delayed cutting is the management factor which is most serious in the build-up of diseases on forage crops.

Harvest Management

Harvesting should be timed to maximize forage yield and quality while assuring stand survival over a period of years.

Table 5. Average optimum dates for first cut of forage grasses and legumes in production years

	Very early	Early	Medium	Late
Climatic zone	Orchardgrass Bromegrass Kentucky bluegrass	Timothy, early Reed canarygrass Alfalfa, early Fescues	Timothy, medium Red clover, double cut Alsike clover Alfalfa	Timothy, late Red clover, single cut Birdsfoot trefoil Perennial ryegrass
1	June 1-8	June 6-13	June 11-18	June 15-22
2	June 9-16	June 14-21	June 19-26	June 23-30
3	June 17-24	June 22-29	June 27-July 4	July 1-8
4	June 25-July 2	June 30-July 7	July 5-12	July 9-16
5	July 3-	July 8-	July 13-	July 17-

Good quality is obtained if the forage crop is harvested when the legume portion is at the bud to 10% bloom stage (Table 5). Cutting at this stage allows for up to three harvests per season before September I in some parts of the Maritimes. Increases in quality feed as a result of a three cut system must be balanced against additional harvest costs compared to a two cut system and possible reductions in stand longevity.

When the entire forage crop on a farm is planted to one crop or mixture, the crop must be cut within a week to get top quality feed. To increase the period of time that forage crops are at the desirable stage of growth, a range of species or cultivars can be planted. Select the legumes on the basis of maturity, (see Publication 100A), and match the grass (species and cultivar) to the legume. Keep in mind the length of time to harvest all the forage on a farm, the soil, climate, and other characteristics of each field when selecting the species.

The leaves of a legume forage crop contain approximately 70% of the protein. It is important that they not be lost during harvest. Cutting with mower-conditioners, tedding soon after cutting and harvesting as silage are methods which reduce potential leaf loss. For hay systems, raking at or near 40% moisture content and baling at slightly higher moisture levels (i.e. 25% moisture) plus the use of effective preservatives or barn dryers are methods to reduce leaf shattering. Windrow inverters are capable of moving and inverting windrows of nearly dry forage with little leaf loss to improve drying.

Fall Management

Legumes and grasses store food reserves in the fall. These reserves are stored as starch in the roots and are used as the winter energy supply and to provide the energy for spring growth. High levels of stored reserves are required to make the plants resistant to winter temperatures.

Root reserves are accumulated and stored in the fall during a period called the CRITICAL FALL REST PERIOD. Cutting during the critical fall rest period lowers root reserves, weakens plants, and increases the chance of winterkill .

For long life of perennial stands, and for the fastest growth the following spring, do not cut or graze alfalfa or other perennials after the critical date in your area.

Pasture Management

Good pasture is the result of good management of both the forages and the animals.

Grazing management plays a role in optimizing forage yields, maximizing longevity of-improved pasture species and maintenance of sward quality. Pasture species benefit from short periods (one to several days) of heavy grazing followed by a recovery period to provide regrowth. The recovery period will vary through the season but on average will be twice as long by August 1 as it is on June 1. Pasture legumes like white clover and birdsfoot trefoil are a valuable feed component and thus the pasture should be managed to ensure their survival.

Although recently seeded pastures with improved forage species will give the greatest yield response to applied fertility, the yield of older permanent pastures can often be increased by applications of fertilizer or manure.

Annual crops such as kale, rape, stubble turnips and ryegrass produce high quality grazing during the middle and latter parts of the grazing season.

Further information on pastures and annual forage crops is presented in other publications available from your Crops Specialists.

Forages for Soil Improvement

The rotation of crops on land in a more or less regular order or sequence is a practice that should be adopted by all farmers. Forages fit well into such rotations because they improve soil structure, reduce soil erosion, break insect and disease cycles, and will add organic matter to the soil. If a legume is used further benefit will come from nitrogen fixed by the legume.

Alfalfa grown with a grass is a good rotation crop where a long term productive forage is required and where conditions such as good soil drainage and soil pH of 6.0 or greater is maintained. Red clover, usually mixed with timothy and meadow fescue, is another good break or rotation crop especially where soil conditions are not suitable for alfalfa production. Sweet clover is yet another legume which may be beneficial in improving soil structure due to its potential to develop a deep tap root. However, sweet clover is less suited for forage production than either red clover or alfalfa.

Italian and Westerwolds (annual) ryegrasses are also useful forage species to control

soil erosion, add organic matter and improve soil structure. Annual ryegrasses are poor hosts for the root lesion nematode and are not hosts for the clover and northern root knot nematodes, so growing the ryegrasses in rotations may alleviate these pest problems. As a late season pasture or cover crop, Italian ryegrass can be underseeded to cereal crops. Annual ryegrasses may also be direct seeded in the spring to provide pasture and/or silage. If silage is to be harvested, a Westerwolds ryegrass should be sown. Additionally, annual ryegrasses can be sown until early August for erosion control. The establishment of summer seedings may be hindered by lack of soil moisture.

Table 6. Root mass of grasses and legumes in the top 15 cm of soil in the year of seeding, Charlottetown, PEI

Species	Cultivar	Dry root mass, t/ha
Italian ryegrass	Lemtal	3-5
Italian ryegrass	Maris Ledger	3-5
Westerwolds ryegrass	Promenade	3-5
Westerwolds ryegrass	Aubade	2-3
Red clover		1.5-2.5
Alfalfa		1.5-2.5
Barley		1.0-1.5

Perennial Forage Species

Choosing a Mixture

A good forage program begins with selection of the proper legume and grasses to suit conditions under which the mixture will be grown. See publication 100A, Forage Guide to Variety & Mixture Selection, for the latest recommendations on varieties and mixtures. Simple mixtures using one legume and one or two grasses are recommended as they can be more productive than more complex mixtures. In a complex mixture, the competitive strength of the species is often not related to the forage yield. Strong competition from a low-yielding species will depress the total yield of the stand. Pure seedings of a legume or grass are recommended only when field conditions are well suited for the species and the farmer has experience growing the crop.

Choose the legume first. Legumes are beneficial as they contain more protein than grasses and they improve the soil by fixing nitrogen. Including legumes in the rotation makes this fixed nitrogen available to subsequent crops as well as improving

soil structure and increasing organic matter. The legume chosen is determined by the drainage, winter hardiness, intended use, and desired duration of stand. Fertility and soil pH can be improved to suit the species. Choose the grass to complement the legume from the list of recommended mixtures. Choose specific cultivars.

Red Clover *(Trifolium pratense)*

Red Clover is a biennial or short-lived perennial. It is more tolerant to low pH and variable drainage than alfalfa. Red clover yields well in the year following seeding. Red clover is difficult to make into hay and is more easily managed as silage. Timothy is the best grass to mix with red clover for stored feed. Red clover is not recommended in pasture mixtures as it has a short life and does not tolerate close and frequent grazing well. Red clover should not be included in alfalfa/grass mixtures as it competes strongly with alfalfa during the seeding year resulting in a thin stand of alfalfa.

Red clover is available as double cut (D.C.) or single cut (S.C.) types. Double cut red clover reaches the cutting stage about ten days before single cut and has a stronger, more vigorous regrowth. Single cut red clover with very late timothy (eg. Farol) makes a suitable mixture for delayed harvest in July; this produces a high yield with medium quality for growers harvesting one crop in a season. Red clover makes an excellent plough-down or green manure crop. If direct seeded in early spring of a favorable year, red clover will produce a four tonne/hectare hay crop in late July and a further two tonne of top growth and two tonne of roots by late fall.

Alfalfa *(Medicago sativa)*

Alfalfa is a high yielding forage legume that produces nutritious feed. This legume should be grown in protected fields with good drainage, high content of soil nutrients and soil pH 6.3 or greater. Best results are obtained when the seed is treated with specific inoculant for alfalfa.

Alfalfa can be grown alone or mixed with grasses. Addition of a grass to an alfalfa stand often reduces heaving, icing, and lodging while slowing weed encroachment. Companion grass also provides assurance of forage production when there is severe winterkill of legumes. Alfalfa persists under good field conditions from two to five years. In most areas, alfalfa persists better under two than three harvest systems.

White Clover *(Trifolium repens)*

White Clover is first and foremost a pasture species. It is the most important pasture legume in Atlantic Canada supplying significant amounts of palatable nutritious grazing.

Due to its low growth habit and its persistence under grazing, white clover is frequently included in pasture mixtures with orchardgrass, fescues, perennial ryegrass, timothy or reed canarygrass.

There are three types of white clover classified on the basis of leaf size. The small leaved white clovers are typified by “wild” or naturalized white clovers found in many old pastures. The small size of these plants restricts their forage production but these types are very persistent particularly under continuous grazing.

The intermediate type is typified by the cultivars Sonja and Milkanova. White clovers of this class are included in improved pasture mixtures because they show superior forage production and nitrogen fixation compared to “wild” types.

Ladino type clovers have large leaves. Ladino clovers are more productive but are frequently shorter lived than the wild and intermediate type white clovers. They are recommended in haylage mixtures particularly on soils with variable drainage. This legume is difficult to wilt properly for hay.

Whenever white clover is included in a pasture or pasture seed mixture, management plays a key role. Grazing pasture swards down to 6-8 cm, ensuring adequate recovery after grazing and maintaining fertile soil conditions are favorable conditions for maintaining white clover.

Birdsfoot Trefoil *(Lotus corniculatus)*

Trefoil-based mixtures can be used for pasture, stored feed, or green chop, and under proper management can have a long life span. Trefoil is well adapted to pasturing as it does not cause bloat, and is a good legume for fields that are difficult to plow and reseed. Trefoil should not be grazed until 25 to 30 cm high in the spring. For best results, use rotational grazing and prevent the animals from grazing the stand too low. Trefoil requires the same fall rest period as alfalfa. Yields will be reduced in succeeding years if trefoil is harvested or grazed during the critical fall harvest period. As a stored feed, trefoil matures later than other legumes and maintains feed value well.

Trefoil is slow to establish and does not tolerate shading at the seedling stage. Direct seeding gives best results if weeds are controlled. If trefoil is underseeded to cereals, the cereal should be seeded at no more than 50 kg/ha and removed early as green chop. Trefoil must be inoculated with the correct Rhizobium bacteria for vigorous stands.

Birdsfoot trefoil does not compete vigorously with grasses and weeds, nor does it persist well under intensive grazing. When successfully established, however, trefoil will often perform better than other legumes in areas of low fertility and under poor drainage.

Alsike Clover (*Trifolium hybridum*)

Alsike clover is a medium height clover with smaller leaves and flowers than Ladino. Alsike can grow on wet, acid soils but it does not tolerate drought and hot weather. Yields can be high on fertile soils under favorable climatic conditions. Alsike clover is a short-lived legume and it is, therefore, not recommended for perennial mixtures.

Sweet clover (*Melilotus alba*)

Sweet clover is a tall, biennial legume. The main use of sweet clover is for soil improvement as it has a deep penerating tap root. Sweet clover is adapted to a wide range of soil and climatic conditions. It does not, however tolerate acid soils. Sweet clover contains coumarin which may cause “sweet clover bleeding disease” in livestock. Low coumarin cultivars are available but they may not be sufficiently winterhardy in Atlantic Canada. The seed coat of sweet clover is hard and scarified seed should be sown. The proper strain of Rhizobium bacteria must be used when inoculating seed.

Timothy *(Phleum pratense)*

Timothy is a widely grown forage grass in Atlantic Canada. Timothy is the most winterhardy forage species in this region and it persists for long periods under good management. It tolerates acid, wet soils. Both yield and quality improve when timothy is grown on well drained soils with a pH of 6 or higher. Timothy is relatively easy to establish and maintain, and it is compatible with forage legumes. When cut at the boot to early heading stage, it produces good quality forage. Applying N-P-K fertilizer is essential for maintaining timothy. Fertilizing in spring and after harvest boosts the growth of timothy. Regrowth of timothy tends to be slow, particularly under dry and hot climatic conditions due to a shallow root system. Good second crops can be obtained if the first crop is removed at early heading stage, and fertilizer high in nitrogen is applied. Crude protein content depends largely on the maturity of timothy and rate of applied nitrogen fertilizer.

Cultivars are available in a range of maturities so that the harvest periods can be spread out while maintaining optimum quality.

Smooth bromegrass *(Bromus inermis)*

Smooth bromegrass is an excellent companion for alfalfa in a hay or haylage system. Bromegrass has early maturity, good yield, and regrowth, especially on droughty soils. It forms a strong sod and fills in as the alfalfa thins out. Bromegrass has good regrowth in a two cut system but may have poor persistence in a three cut system.

Bromegrass has a deep root system and requires deep, well drained soils. It spreads by short rhizomes and requires high amounts of nitrogen if grown as a pure stand or after alfalfa has thinned out of a mixture. Bromegrass provides early pasture

and will regrow to provide good late pasture.

Meadow bromegrass *(Bromus riparius)*

Meadow bromegrass is a reduced creeping type of bromegrass with many basal leaves. Meadow bromegrass regrows rapidly after defoliation and it is suitable for pasture. It has more uniform seasonal growth than smooth bromegrass, particularly in July and August. Meadow bromegrass has performed well in field experiments but there is limited on-farm information available on this grass in Atlantic Canada.

Orchardgrass *(Dactylis glomerata)*

Orchardgrass is an early maturing, aggressive grass which can be used for stored feed, green chop, or pasture. Because of a late May to early June heading date, and rapid regrowth, it should be seeded alone, or with aggressive legumes such as alfalfa or Ladino clover. Orchardgrass must be cut just as heads emerge from the boot as quality decreases rapidly after heading.

Orchardgrass requires well drained soils to give top yields. Surface drainage is necessary as ice or flooding will kill orchardgrass. In some cases, heavy applications of nitrogen fertilizer in the spring may help orchardgrass to recover from winter injury

Meadow Fescue *(Festuca pratensis)*

Meadow fescue, a perennial bunchgrass that grows 35 to 75 cm tall, is adapted to the same climate and soil as timothy but yields best on deep, fertile soils. It will tolerate wet soils with proper care and fertilization. Meadow fescue is a good grazing grass and is used primarily for pastures, generally in mixtures. Meadow fescue is commonly grown for stored feed in mixtures with timothy and legumes such as red clover. Meadow fescue has increased in popularity over the past few years because of its versatility, tolerance to variable drainage and its ability to regrow better than timothy during the mid-summer period.

Perennial Ryegrass *(Lolium perenne)*

Perennial ryegrass is a high quality forage that makes an excellent pasture for grazing animals. It is a very rapid growing species that requires fertile soil, ample moisture and a mild climate.

Perennial ryegrass is a bunchgrass with a relatively shallow root system which can make it quite unproductive during hot weather if moisture is limiting.

The high nutritive value of perennial ryegrass and fast establishment makes it an excellent addition to a pasture mixture.

Due to the susceptibility of currently recommended perennial ryegrasses to winter

injury, it is advised that this grass not be the main grass of a mixture, except where relatively mild winter conditions exist.

Reed Canarygrass *(Phalaris arundinacea)*

Reed canarygrass is a tall, wide leaved plant. It will tolerate excess moisture (even flooding) and low pH, but produces high yields on well drained, fertile soils. Reed canarygrass loses quality rapidly after heading. If grazed at immature stage or cut at boot stage, it produces high forage yields with good quality. Mature grass will be poorly utilized and will result poor animal intake and performance.

Low intake and lack of palatability in reed canarygrass have been associated with mildly toxic alkaloids contained in the plant. Recent plant breeding work has produced several new varieties with low alkaloid contents and improved animal acceptability. Seed of this crop does not retain its germination in storage as well as most other grasses. Carry-over seed should not be planted without first having it tested for germination.

Tall Fescue *(Festuca arundinacea)*

Tall fescue is a deep-rooted, long-lived perennial, tolerant to imperfect drainage, adapted to most soils, and resistant to trampling. It is basically a bunch grass but frequent mowing or grazing will produce an even sod.

Tall fescue is adapted to pasture, or stored feed. Both palatability and quality is improved if the fescue is cut early and grazed at young, immature stage. Tall fescue makes a good fall pasture as growth is adequate and quality is maintained at that time of year. New cultivars of fescue and fescue-cross hybrids may improve livestock acceptance of this productive grass.

Redtop *(Agrostis spp.)*

Redtop is a perennial grass with fine leaves and stems which forms a loose sod. Redtop will grow on low fertility, acid, and poorly drained soils but yields are low. Redtop is ready for grazing about the same time as timothy. Quality is less than bluegrass grown under similar conditions, and yield is lower. The major use of redtop is pasture mixes but it can be used for stored feed on poor soils.

Redtop is often included in mixtures for ditch banks and grass waterways to prevent erosion.

Kentucky bluegrass *(Poa pratensis)*

Kentucky bluegrass is an adapted grass that grows wild in pastures throughout Atlantic Canada. Bluegrass has a dense shallow root system and produces lush

palatable herbage. Bluegrass grows aggressively in the spring. In summer the growth of bluegrass depends on adequate moisture and timely fertilizer applications. Pasture production can be enhanced by good management practices such as controlled grazing and fertilization.

The dense root system and creeping growth habit make bluegrass an option as a bottom grass in horse pastures and to provide protection against erosion of banks.

Recent research has identified high yielding bluegrass cultivars which have been developed for silage and pasture use, see Publication 100A.

Creeping Red Fescue *(Festuca rubra)*

Creeping red fescue is a low growing creeping grass that spreads vigorously. On ditch banks, terraces, or steep slopes, the roots hold the soil while the thatch of top growth slows water movement and protects the soil surface.

Creeping red fescue can be established on most soils with good fertility. It makes a good addition to pasture mixes as a “bottom-grass” as it tolerates heavy animal traffic.

Annual Forage Crops

Most of the forage in the region is currently supplied by perennial legumes and grasses. Annual forages can be grown to supplement perennial forage species or as emergency crops to provide forage after winterkill of perennial species.

Annual forages can provide nutritious feed in late season and, in particular, during the critical fall harvest period of legumes. When selecting an annual forage crop, one must consider the cost of working the land, the time of year the annual forage is produced, the yield and the end use of the forage. Annual forage crops fit in rotations with perennial legumes, cash crops and pastures.

Persian Clover *(Trifolium resupinatum)*
Persian clover is an annual legume under Atlantic Canadian conditions. It may be grown in mixtures with annual ryegrass for pasture or silage. Proper inoculation is required as this is a new clover for this region.

Berseem clover (*Trifolium alexandrinum*)
Berseem (also called Egyptian) clover is an annual, cool season legume. It is an upright growing legume which produces a nutritious crop. It regrows rapidly if cut or grazed just before blooming. Berseem produces large biomass for plow-down in rotations. Berseem clover requires specific seed inoculant.

Italian and Westerwolds Ryegrass *(Lolium multiflorum)*

Italian and Westerwolds ryegrasses seeded early in the spring will provide high quality forage from mid-July to late fall. Ryegrass should be seeded at 15-35 kg/ha and fertilized at seeding, in July, and in August for maximum yields. Nitrogen in particular is essential for high yields. Italian rye-grass is suitable for pasture, while Westerwolds ryegrasses may be used for stored feed and pasture. Sowing oats or barley at 50-70 kg/ha with annual ryegrass will increase the first crop which can be harvested for silage at boot stage of cereal. For additional information see Agriculture Canada publication 1859, Annual ryegrasses in Atlantic Canada.

Cereals

Cereals, either winter or spring, can be utilized for supplemental grazing or harvested as a silage crop. Sow cereals at rates recommended for grain production. Cereal-field pea mixtures, oats, barley or triticale should be sown at 80-100 kg/ha and field peas at 50-60 kg/ha.

Grazing

Spring cereals can be seeded from early spring until late July to provide grazing approximately six weeks from planting. Winter cereals seeded in late summer can also provide some fall grazing. Seeding winter cereal earlier than recommended for grain production could increase fall grazing at the risk of increasing disease pressure in the cereal crop. Winter cereals also may be grazed in early spring. Use of cereals as a grazing crop is usually more expensive than using annual forages such as ryegrass, kale, rape or permanent pasture.

Silage

Small grains (cereals) make good silage; fermentable carbohydrate levels are high, buffering capacity is low and moisture content may be reduced by wilting. Cereals and cereal+field pea mixtures should be harvested at boot stage for lactating dairy cows, and at early heading for other cattle.

Forage crops are frequently undersown with a cereal cover crop. Harvesting the cereal as a silage crop reduces the chance of forage stand damage due to competition and lodging. Early removal of the cereal crop as silage will also provide a longer fall growing period for the new forage crop.

Cereal-field pea mixtures may be grown for supplementary forage. Oats, barley or triticale should be sown at 80-100 kg/ha and field peas at 50-60 kg/ha.

Green Fodder Crops

Green fodder crops encompass the forage brassicas such as kale, rape and stubble

turnips plus fodder beets. These crops provide superior late season supplementary grazing due to their high yields and feed quality. These crops also represent a viable way of extending the grazing season into the late fall. Forage brassicas require strip or small paddock grazing for efficient utilization.

Extensive cultivar evaluation has been carried out in this region and the following species can be recommended. See publication 100A for currently recommended cultivars.

Kale *(Brassica oleracea)*
Kale requires a long growing season for the crop to fully develop (90-100 days). It is frost hardy making it suitable for grazing up to December.

Forage Rape *(Brassica napus)*
Rape grows faster than kale and produces a leafy crop for late season consumption. Feeding rape to milking cows may taint milk.

Stubble Turnips *(Brassica rapa)* and Hybrids
Stubble turnips are fast-growing, with large leaves and a root bulb. About 3/4 of the root bulb is above ground and is readily grazed by livestock. The hybrids are more leafy but have no, or very small, root bulbs. The hybrids are also suitable for green manuring.

Fodder Beets *(Beta vulgaris)*
Fodder beets are a high yielding crop with high energy content. A large portion of the production of this crop is contained in the root. Fodder beets can be grazed or the bulbs harvested for storage. Approximately 4-6 kg of fodder beet can replace 1 kg of rolled barley.

Further information on the above crops is available from your local crops specialists.