Species for Revegetation: Legumes

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There are three general categories or types of plants that are used for revegetation.

GRASSES are the most-commonly seeded plants in revegetation programs. They belong to the Gramineae family, produce large amounts of biomass, and are adapted to initiate regrowth rapidly after mowing or grazing. Most of the grasses have a fibrous root system which helps hold soil particles and control erosion.

FORBS are another category of plants. They are also termed herbs or flowering plants. Forbs usually have broad leaves, showy flowers, and a branching taproot system. Forbs are further divided into classes as legumes or non-legumes.

LEGUMES are forbs (flowering herbaceous plants) that belong to the Leguminosae (Fabaceae) family. Legumes are especially important and desirable for revegetating mined lands because the majority of them form a symbiotic association with bacteria of the genus *Rhizobium*. Certain strains of *Rhizobium* infect the roots of specific legumes to form nodules, and it is in the nodule that atmospheric nitrogen gas is fixed by the plant and incorporated into plant proteins. Grasses growing with legumes may also benefit from the nitrogen fixed by legumes through recycling of the decomposing legume plant material.

NONLEGUMINOUS FORBS are also broad-leaved plants with showy flowers. Examples of nonleguminous plants used in revegetation are buckwheat *(Fagopyrum sagittatum)*, sunflowers *(Helianthus spp.)*, and Japanese fleeceflower *(Polygonum cuspidatum)*.

TREES and SHRUBS are the last category. They are used when commercial woodland or wildlife habitat land uses are desired on the site after mining.

This paper will identify forage legumes used in revegetation programs in the eastern U.S., discuss their adaptations and uses on surface-mined lands, and describe some basic seeding techniques for legumes.

Several forage legumes have been grown successfully on mined lands in the East. Table 1 shows a list of forage legumes generally available for use on disturbed areas and gives some general characteristics for each. The table shows the common and scientific name, and its principal cultivars.

A cultivar is derived from *cultivated variety* and has distinguishing morphological or physiological characteristics which make it more adapted to certain environmental conditions or locations. The plant's life cycle, season of growth, origin, seeding rate, and soil/site tolerances are also shown. A few of the more important legumes are described in more detail.

ALFALFA *(Medicago sativa)* is probably the best known and widely-used forage legume in the U.S. It grows well on a wide range of soils and climates but requires good soil fertility (especially phosphorus), non-acid conditions, and good drainage. Use of alfalfa in the Appalachian Coal Region is most likely limited to areas where low sulfur coal seams and overburdens have been disturbed. It produces high amounts of biomass by itself or in mixtures, and has a deep, taproot system which makes it somewhat drought resistant.

Table 1. Forage Legumes available for use in revegetation programs in the eastern U.S.

Common Name (Scientific Name)	Principal Cultivars	Life Cycle [1]	Season 0f Growth	Origin [2]	Seeding Rate Alone lbs. PLS/ac	Ease of Establishment
Alfalfa *(Medicago sativa)*	Pioneer 524 Hi-Phy *Classic *DeKalb 120 *Saranac AR Arc Vernal	P	Cool	I	15-20	Good
Alsike Clover *(Trifolium hybridum)*	Aurora	P	Cool	I	5-10	Good
Crimson Clover *(Trifolium incarnatum)*	Dixie Auburn	A	Cool	I	10-15	Good
Red Clover *(Trifolium pratense)*	*Arlington Mammoth Dollard Midland Lakeland *Kenland Pennscott Norlac *Kenstar Chesapeake	P	Cool	I	10-12	Good
White (Ladino) Clover *(Trifolium repens)*	*Ladino Merit Pilgrim	P	Cool	I	1-5	Good
Crownvetch *(Coronilla varia)*	*Penngift *Chemung Emerald	P	Cool	I	1-5	Fair
Flatpea *(Lathyrus sylvestris)*	Lathco	P	Warm	I	25-30	Poor
Common Lespedeza *(Lespedeza striata)*	*Kobe Tenn. 76	A	Warm	I	10-15	Good
Korean Lespedeza *(Lespedeza stipulacea)*	Climax Iowa 6 Rowan	A	Warm	I	10-15	Good
Sericea Lespedeza *(Lespedeza cuneata)*	Interstate Serala Appalow Caricea	P	Warm	I	10-20	Fair
Cicer milkvetch *(Astragalus cicer)*	Cicar Lutana	P	Cool	I	10-15	Fair
White Sweetclover *(Melilotus alba)*	Spanish Evergreen Cumino Hubam Polara	B	Cool	I	5-10	Good
Yellow Sweetclover *(Melilotus. officinalis)*	Madrid Goldtop Yukon	B	Cool	I	5-10	Good
Trefoil, Birdsfoot *(Lotus corniculatus)*	*Fergus *Empire Cascade Granger Tana *Viking Douglas Maitland Mansfield Dawn *Norcen	P	Cool	I	10-15	Good
Vetch,hairy *(Vicia villosa)*		A	Cool	I	20-30	Good

[1] P - perennial, A - annual, B - biennial
[2] N - native, I - introduced
* Commonly used cultivar

Persis -tence	Drought	Cold	Acid	Salt	High water	Precip. Range (in.)	Lower pH Limit	Comments
Good	Good	Good	Poor	Fair	Fair	15-20	6.0	Minesoil pH must be maintained above 6. Phosphorus needed in high quantities. Good drainage required.
Poor	Fair	Good	Fair	Fair	Good	15-40	5.0	Adapted to cool, moist sites. Used in pasture mixtures. Wildlife food. Generally dies in 2 yrs.
Fair	Poor	Good	Fair	Fair	Fair	14-50	5.0	Winter annual legume. Reseeds itself.
Fair	Poor	Good	Fair	Fair	Fair	20-50	5.0	Used for erosion control. Short-lived perennial, but reseeds itself. Requires high phosphorus levels.
Good	Poor	Fair	Fair	Fair	Good	18-45	5.5	Sod-former. Used in pasture mixtures for erosion control, soil improvement, and wildlife. Phosphorus and calcium levels critical.
Good	Poor	Fair	Fair	Fair	Good	18-45	5.0	Generally slow establishing. Commonly seeded with ryegrass or rapid establishing species.
Good	Good	Good	Good	Fair	Fair	20-50	4.5	Slow establishment, but has hardy rhizomes. Drought & acid resistant.
Fair	Fair	Fair	Good	Poor	Fair	25-45	4.5	Forage legume under trees. Establishes quickly and reseeds itself.
Fair	Fair	Fair	Fair	Poor	Fair	25-50	5.0	Not as acid-tolerant as Kobe. Reseeds itself, establishes quickly.
Good	Fair	Fair	Good	Fair	Fair	25-50	4.5	Tolerant of low fertilty sites. Long term erosion protection. Tends to choke out other vegetation. Woody after first year.
Good	Fair	Good	Poor	Fair	Fair	12-40	5.0	A long-lived rhizomatous, legume adapted to dry sites. Non-bloating.
Fair	Good	Good	Poor	Fair	Fair	14-40	5.5	Grows in early spring. Has a large taproot.
Fair	Good	Good	Poor	Fair	Fair	14-45	5.5	More drought tolerant and competitive than white.
Good	Fair	Fair	Good	Good	Fair	18-45	4.5	Grows well in mixtures. Non- bloating and rhizomatous.

RED CLOVER *(Trifolium pratense)* is a very important legume in the northeastern U.S. and is used for hay, pasture, soil improvement, and erosion control. It has a deep, taproot system, but also maintains a branching root system near the surface. Red clover should be seeded with long-lived grasses because it tends to die back after two years. It, like most legumes, grows best where high amounts of phosphorus and calcium are present in the soil.

WHITE CLOVER *(Trifolium repens)* is extensively-used for pasture and in seeding mixtures for disturbed land in the East. It is almost always seeded with a companion grass, and has a deep taproot system that may or may not persist from year and year. Ladino is the most widely-seeded white clover.

CROWNVETCH *(Coronilla varia)* has become a widely-used perennial legume for seeding disturbed lands because it provides continuous, maintenance-free cover for erosion control. It is used on roadbanks and other sites highly susceptible to erosion. Plants can be established by seeds, rhizomes, or crowns. Crownvetch is slow to establish, but after the first year, it will gradually increase until it may suppress associated vegetation three or four years after initial establishment. It has a deep penetrating taproot with many lateral branching roots. Crownvetch should always be seeded with other rapidly establishing grasses or legumes.

FLATPEA *(Lathyrus sylvestris)* is a long-lived, viney legume that provides good ground cover. Establishment is slow but once established it suppresses other vegetation. It is drought resistant and tolerant of acid soil conditions. Flatpea is normally used to control erosion on highly sloping areas. There has been some concern that flatpea may be toxic to cattle at certain times during its life cycle, but I cannot find references to confirm it.

SERICEA LESPEDEZA *(Lespedeza cuneata)* is still used for revegetation on highways and mined lands to control erosion and to improve the soil. Most lespedeza species are adapted to low pH, infertile soils. Stand establishment may be slow but, during the next two to four years, it becomes the dominant species by forming dense stands. Sericea is being seeded less on disturbed lands because it has little value for wildlife, and pure stands often become a fire hazard in the fall. The main advantage of sericea is that it provides a permanent cover with little or no maintenance.

SWEETCLOVERS, yellow *(Melilotus officinalis)*, and white (M. alba), are used extensively in western reclamation due to their drought resistance and soil-building capabilities, but also have been used in the east. They are generally considered intolerant of acid soils. They generally complete their life cycle in two years but usually reseed themselves.

BIRDSFOOT TREFOIL *(Lotus corniculatus)* is a common forage legume seeded with Ky-31 tall fescue *(Festuca arundinacea)* on surface-mined lands in West Virginia. It grows on poorly-drained, droughty, infertile, acid, and even alkaline soils. Birdsfoot develops a deep, taproot system with lateral roots and is useful for erosion control and forage. In some cases, birdsfoot does not establish until a year after the initial seeding.

SEEDING TECHNIQUES

Legumes grow best in soils that are moderately well to well-drained, non-acid (pH greater than 6.0), and contain sufficient quantities of phosphorus and calcium. It is necessary to add lime and fertilizer when minesoil conditions are not favorable. Inoculation of legume seeds with the appropriate strain of *Rhizobium* is important (see "The Use of Legumes in Mined land Reclamation", *Green Lands 16(2):35-37, 1986).* It is important because the wrong strain will not infect the roots and hence, will not fix nitrogen from the atmosphere.

Pure live seed (PLS) refers to the portion of a lot of seed that is live seed (capable of germination) of the desired kind. Germination tests should have been conducted on the seed and the test results must be printed on the seed label. Purity of the seed has also been determined and is printed on the label.

Percent PLS (% PLS) is determined by multiplying the percent of pure seed (% Purity) by the germination percentage (% Germination) and dividing by 100. Legume seeds commonly have seed lots with high purity, low germination, and a high percent of dormant seeds. Low germination and high dormancy in legume seeds is explained by the complex seed coats that surround them. Blocking mechanisms within the seed are broken only when certain environmental conditions (temperature and moisture) or chemicals are applied to the seed coat.

Preconditioning seed in cool, moist conditions to promote germination is called stratification. For this reason, dormant seeds may germinate several years after the initial seeding due to natural stratification in the soil. Scarifying legume seeds may also help germination.

Seed quality and price are important when estimating costs of reclamation. This can be accomplished in the following manner.

Example: You decide to seed Tall Fescue and Birdsfoot Trefoil at 20 and 10 lbs per acre, respectively on a 25 acre mine site. Seed can be purchased from either Company A or B. They quote you the following seed information over the telephone.

Table 2	Company A		Company B	
Species	TF	BT	TF	BT
% Purity	90	80	95	90
% Germ	80	55	85	60
Cost per lb.	75¢	$2.75	90¢	$3.00

You need to calculate the PLS percentage and then the PLS seeding rate with this particular lot of seed from each company. Percent germination times percent purity divided by 100.

Table 3	Company A		Company B	
	TF	BT	TF	BT
%PLS	72	44	81	54
Desired PLS Rate	20	10	20	10

Only 72% of the tall fescue seed from Company A is pure seed, so in reality you must seed 20/.72 or approximately 28 lbs per acre of this company's tall fescue seed to attain your desired seeding rate. You then calculate the amount of total bulk seed you would need for the job and the cost.

Table 4	Company A		Company B	
	TF	BT	TF	BT
Seed needed (lbs. per acre)	28	23	25	19
Lbs. for 25 acres	700	575	625	475
Cost per lb.	75¢	$2.75	90¢	$3.00
Seed Cost	$525	$1581	$562	$1425
Total Cost	$2106		$1987	

So if you thought you could save a little money by buying the cheaper seed from Company A, get your calculator out and think again.

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