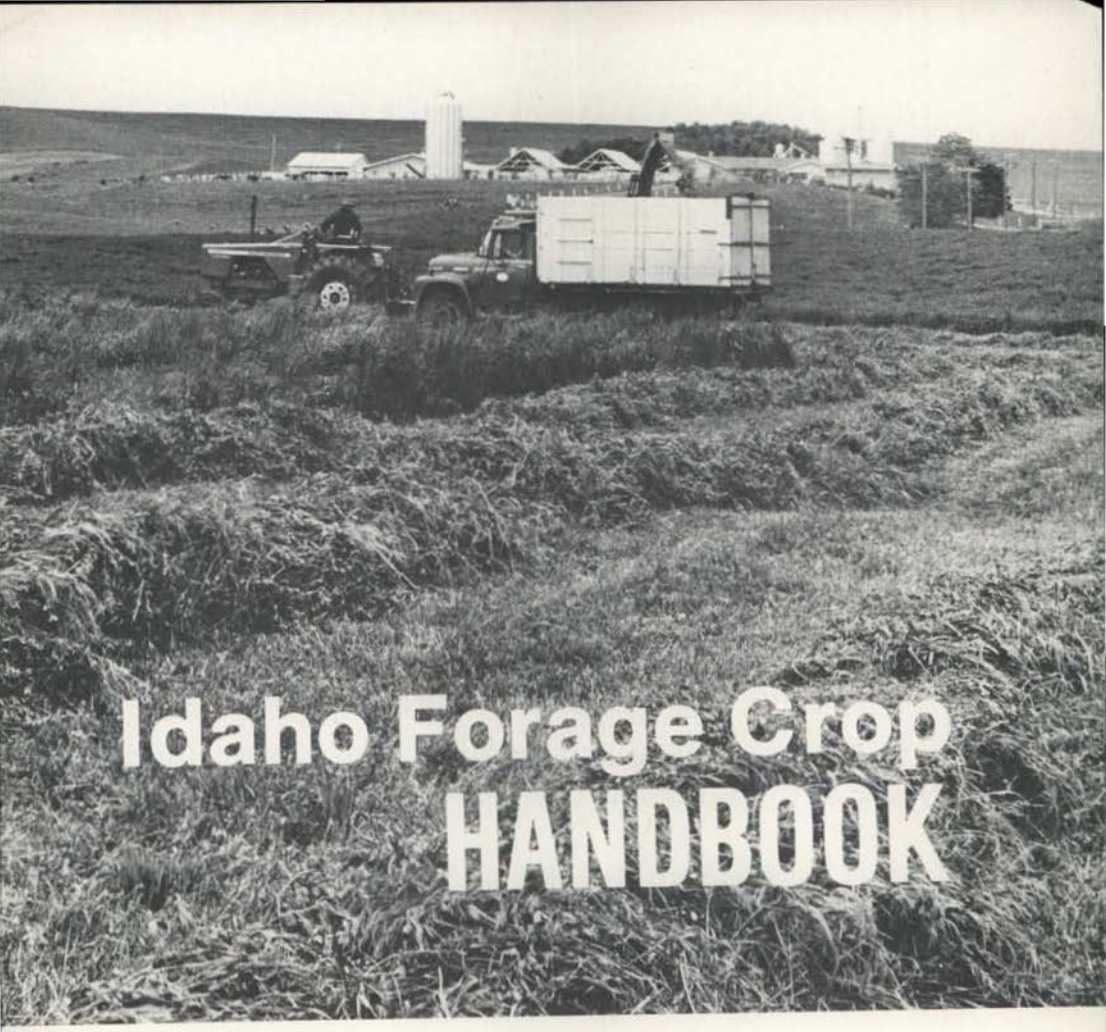

Idaho Forage Crop HANDBOOK

R. D. Ensign
H. L. Harris
Editors

Bulletin No. 547
May 1975

Idaho Agricultural Experiment Station
University of Idaho - College of Agriculture

Contents

Photo Credits — Cover photograph and those on pages 7 and 29 are Idaho Agricultural Experiment Station photographs. Photos on pages 15, 17, 19, 27 and 36 are provided courtesy of the Soil Conservation Service.

The cover photo shows a mixture of Ladak 65 alfalfa and Manchar smooth brome being processed for silage on the University of Idaho farm at Moscow.

Published and distributed by the
Idaho Agricultural Experiment Station
Raymond J. Miller, Director

University of Idaho College of Agriculture
Moscow, Idaho 83843

Idaho Forage Crop Handbook

Edited by

R. D. ENSIGN, Agronomist (forage-turf), Department of Plant and Soil Sciences, University of Idaho College of Agriculture, Moscow.

HAROLD L. HARRIS, Plant Materials Specialist (retired), USDA-SCS Plant Materials Center, Aberdeen, ID.

Contributors

HARRY S. FENWICK, Extension Plant Pathologist, University of Idaho Cooperative Extension Service, Moscow.

DONALD FULTON, State Range Conservationist, USDA-SCS, Boise.

ROGER W. HARDER, Soil Scientist, Department of Plant and Soil Sciences, Moscow.

GALEN M. MCMASTER, Research Agricultural Engineer, University of Idaho Research and Extension Center, Aberdeen.

ROLAND W. PORTMAN, Extension Entomologist (retired), Cooperative Extension Service, Moscow.

RICHARD H. ROSS, Dairy Scientist, Department of Animal Industries, College of Agriculture, Moscow.

HOWARD B. ROYLANCE, Extension Crop Management Specialist, Cooperative Extension Service, Boise.

J. L. SCHWENDIMAN, Plant Materials Specialist, USDA-SCS, Pullman, WA.

PAUL J. TORELL, Research Weed Scientist, University of Idaho Research and Extension Center, Parma.

Introduction

Forage crops are important to the Idaho agricultural economy. Approximately 53 percent of the state's land area is classified as pasture and ranges. In addition much of the forested area is grazed by domestic and wild animals. Approximately 47 percent of the harvested crop land area in Idaho produces improved hay and pasture crops. Expressed in actual on-farm cash value, forage crops rank high among all farm commodities. Forages as pasture and hay rank first among all feed sources in the economy of producing digestible nutrients for livestock. Forage crops are the most economical source — and the main source — of energy (carbohydrates) in livestock rations and they are a vital source of protein, minerals and vitamins necessary for the production of meat, milk and wool.

Most of Idaho's hay, pasture and rangelands are producing far below their potential. Conservative estimates indicate per-acre production of hay and animal products can be increased two- or three-fold by using improved plants and the proven cultural and management techniques. Yields in excess of 1,000 pounds of beef per acre, 17,000 pounds of milk per acre or 7 tons of hay per acre are being obtained with many irrigated forages in Idaho.

Forage crops have many other values in addition to producing food for livestock and wildlife. Grasses and legumes also protect soils from wind and water erosion. The roots help hold the soil in place and improve its structure and water intake rate. The fibrous root systems improve soil tilth and fertility by contributing tons of soil-building material. Legumes contribute abundant and economical sources of nitrogen necessary for plant growth. The uses of grasses and legumes in crop rotations can reduce the incidence of insects and diseases that damage cultivated crops.

Farmers and ranchers in Idaho should select improved forage varieties and mixtures adapted to their soils, their available water supplies and their seasonal needs for hay, pasture and silage. The comparative advantages of forage crops, especially for livestock-oriented farms, should be analyzed by each operator to determine how they may fit into the farming practice. A proper balance of forage crops with other crops allows the operator to utilize his labor, capital and land most profitably. The technology to produce excellent forages in Idaho is available in this bulletin.

Production of certified seeds is an important enterprise in Idaho. Quality seed of most recommended forage crop varieties is readily available throughout the state. Consult your local seed dealer, county agent, SCS district conservationist or the Idaho Crop Improvement Association in Boise for seed sources. Certified seed is recommended. The tag on each sack will show the State Seed Laboratory analysis.

2 Grasses and Legumes For Hay, Pasture and Silage

Many excellent grass and legume varieties are available for the varying soil and climatic conditions in Idaho. They are well adapted for use as pasture, hay and silage. The species and varieties vary in their adaptation to soil, moisture, climate and management needs.

Table 1 lists and describes the most important perennial species for Idaho. In general, legumes are best adapted to medium textured soils where annual precipitation averages 14 inches or more. Grasses have a wider adaptation to soils and precipitation. Some grasses are best adapted to high moisture conditions, others to irrigation and well-drained soils. Many grasses are suited to limited rainfall conditions. In the more arid areas, plant performance is influenced less by total annual precipitation than by when it occurs.

Detailed descriptions of legumes and grasses recommended for Idaho are given in Section 3.

Site Adaptability for Forage Species

Plants vary in their adaptation to soils, moisture and climate. Optimum performance of an individual variety or of a mixture depends on good site adaptation, including adequate moisture throughout its growing period (s).

Soil Characteristics

Major soil characteristics that influence plant adaptation include depth, texture, reaction, drainage, fertility and wetness. Many soil series, as classified by the Standard Soil Survey, are quite similar in their major limitations to plant adaptation and can be grouped to simplify plant selection. Soil group designations as determined by major limitations are as follows: (See Table 2.)

Group A — All climatically adapted plants suited. Moderately coarse to medium-textured soils that are deeper than 40 inches, moderately well to well-drained, that may have slight wetness and slight salinity or alkalinity.

Group B — Choice of plants limited by droughtiness. Coarse to very gravelly medium-textured soils that are excessively drained with less than 5 inches of available water-holding capacity in the root zone, neutral in reaction.

Group C — Choice of plants limited by fine textures. Moderately fine to fine-textured soils over 40 inches deep that are moderately slow to slowly permeable, neutral in reaction.

Group D — Choice of plants limited by very slowly permeable (claypan) subsoils. Moderately coarse to medium-textured soils underlain by a claypan at 10 to 36 inches depth, neutral in reaction.

Group E — Choice of plants limited by wetness. Moderately coarse to fine-textured soils that are imperfectly to very poorly drained, neutral in reaction.

Group F — Choice of plants limited by salinity or alkalinity. Soils are over 20 inches deep and moderately to strongly saline alkali, usually imperfectly to poorly drained.

Group G — Choice of plants limited by depth. Soils are shallow to moderately deep, well-drained, over hardpan, bedrock or other material that prevents root penetration, neutral in reaction, and retain less than 5 inches of available water-holding capacity in the root zone.

Group H — Choice of plants limited by acidity. Soils are medium to extremely acid, more than 20 inches deep.

Moisture Requirements

Plants vary in their moisture requirements. Some plants — Kentucky bluegrass, orchardgrass, tall fescue, clovers and the birdsfoot trefoils are examples — require more than 22 inches of annual precipitation or season-long irrigation for good performance. Others like Siberian, crested and bluebunch wheatgrass will persist and produce economic forage yields in the cooler areas (less than 140 frost-free days, 32° F) with 9 inches average annual precipitation. Plants like Garrison creeping foxtail, Reed canarygrass, and alsike, white Dutch and strawberry clover will tolerate prolonged soil wetness and inundation. Intermediate, pubescent and tall wheatgrass, smooth bromegrass and sainfoin require 12 or more inches of annual rainfall; these plants lack good regrowth potential so are best adapted for use in one-crop hay areas.

Use of Grass-Legume Mixtures

Grass-legume mixtures have proven their value in the control of soil erosion, in improving soil tilth and soil fertility and in reducing water run-off. Vigorous growing grasses also reduce invasion by weeds and the need for herbicides.

Feeding trials have shown that grass-legume mixtures are equally as nutritious and are as productive of livestock products as are legumes seeded alone. Forage yields of grass-legume mixtures under irrigation are generally equal to those of the legume seeded alone and are consistently equal to or higher than the legumes alone under non-irrigated conditions.

Legume-grass mixtures are more suitable for use as silage than either component seeded alone and they can be used for hay and pasture. The mixture has less bloat hazard than straight legume and will produce more and higher quality forage than will straight grass. The grass portion of the mixture will help maintain forage yields as legume production declines from diseases and insects or inclement weather.

Simple mixtures of one grass and one legume produce as much forage as complex mixtures and are grazed more uniformly. They require less seed and they are easier to establish when seeded in alternate rows. Complex pasture mixtures revert to simple mixtures within a few seasons because of selective grazing and differences in the competitive ability of the species and varieties used.

When fields include two or more types of soil or moisture problems, select the grass-legume mixture best adapted to the most limiting condition. A more complex mixture may be desirable if soil and moisture conditions vary widely.

Some suggested grass-legume mixtures for use in Idaho are shown in Table 2. The table also shows the soil group(s) to which the mixture is adapted, the recommended seeding rate for each component and its moisture requirements. Refer to Page 5 for soil group descriptions.

Seeding rates as listed in Table 2 are based on pounds pure live seed (% germination X % purity X 100). The lower seeding rates for legumes are those considered maximum for non-irrigated seedings.

Moisture requirements are divided into three conditions: adequate irrigation water for season-long irrigation, short season water supplies adequate for one crop of hay and non-irrigated. Adaptation of a mixture to the two irrigation levels is denoted by 'X' in Table 2. Minimum average annual precipitation is shown for non-irrigated cropland.

Siberian, crested and bluebunch wheatgrass, not included in Table 2, are normally seeded alone on rangelands too arid for alfalfa and the other legumes. These grasses can be seeded in mixtures with alfalfa for hay and pasture on non-irrigated sites where alfalfa is adapted.

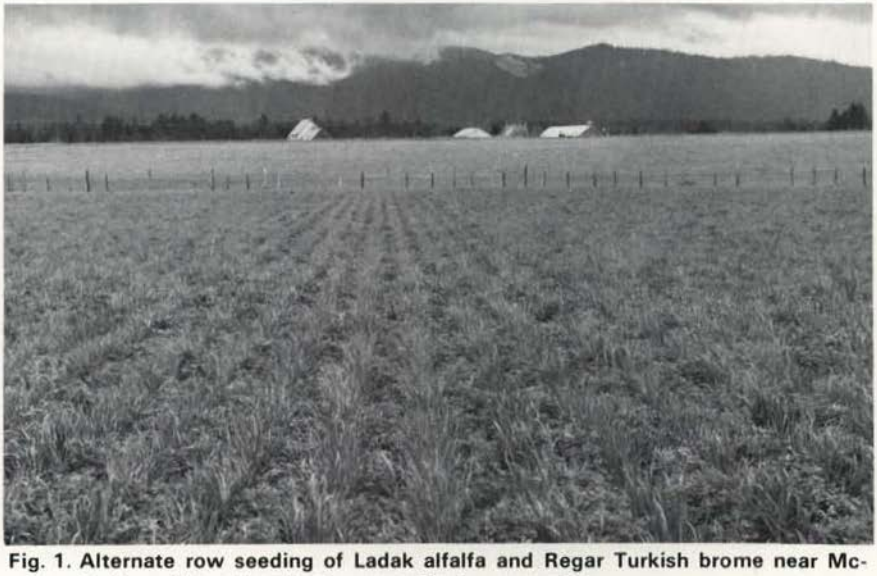

Fig. 1. Alternate row seeding of Ladak alfalfa and Regar Turkish brome near McCall provides a long-lasting stand for hay or pasture.

Table 1. Characteristics and adaptability of some major forage species for Idaho.

Species	Growth habit	Palatability	Optimum moisture requirement*	Site adaptation — characteristics
Legumes				
Alfalfa	Tap to rhizomatous	Moderate	16-25+	Well-drained, mod. deep to deep, fertile soils; mod-salt tolerance; variable moisture requirement.
Alsike clover	Stoloniferous	High	25+	Withstands wet, acid, poorly drained soil; low salt tolerance; high altitude
Ladino or white clover	Stoloniferous	High	18-25+	Well-drained, acid to weak salinity, season-long moisture, rapid regrowth
Milkvetch	Rhizomatous	High	16-25+	Frost tolerant, weakly acid to mod. salinity, shallow soils; slow to establish, no bloat, non-toxic
Red clover	Non-spreading	Medium	20-25+	Fertile, well-drained shallow soils, rapid establishment, low salt tolerance
Sainfoin	Non-spreading	High	14-22+	Medium textured, calcareous, mod. deep to deep, (30"+) well drained soils; needs limited irrigation, no bloat, frost tolerant, slow regrowth (except Remont), not competitive — seed alone or in alternate rows
Strawberry clover	Stoloniferous	High	25+	Tolerates salty, wet, less fertile soil; slow to establish, low growing
Sweet clover	Non-spreading	Low	15-20+	Neutral, saline to alkine, mod. shallow-deep imperfectly drained to non-fertile, frost tolerant, annual or biennial
Trefoil	Non-spreading	High	20-25+	Moist lowland, fertile, med. to fine textured soils, 12" + soil depth, slow to establish, no bloat, not competitive — seed alone or in alternate rows
Grasses				
Bluegrass, Kentucky	Rhizomatous	High	18-25+	Well-drained, fertile soils, cool-season, rapid regrowth, slow growth when hot, low salt tolerance, high N requirement
Bluegrass, Big Sherman	Bunch	High	14-22	Drought tolerant, vernal dominant, soil conserving, med.-to-well drained soils

Brome, Turkish Regar	Semi-bunch	High	16-22	Well-drained, fertile, drought tolerant, persists, rapid recovery, variable productivity, leafy
Brome, smooth	Rhizomatous	High	16-22+	Well-drained, fertile soils, low salt tolerance, tolerates wet soils, slow recovery after grazing or mowing
Crested wheatgrass	Bunch	Medium	10-16	Drought and cold tolerant; good seedling vigor, mod. salt tolerance, spring-fall use
Siberian wheatgrass	Bunch	Medium	8-14	Similar to Crested Wheatgrass but more drought tolerant, leafier, later maturing, much shorter awned and more nutritious
Intermediate wheatgrass	Sod	High	14-22+	Fertile, well-drained soils, slow regrowth, (one crop), mod.-late maturity, high forage yields
Orchardgrass	Bunch	Med. High	20-25+	Well-drained, salt-free, fertile soils; fast recovery, high summer productivity
Creeping foxtail	Rhizomatous	High	18-25+	Seasonally wet soils, peat, low salt tolerance, to med. acid, fertile, season-long growth, self-seeding
Perennial ryegrass	Bunch	High	18-25+	Fertile, well-drained to poorly drained soils, neutral to acid
Pubescent wheatgrass	Rhizomatous	Medium	12-22	Fertile, well-drained, mod. drought tolerance, mod. late maturity, mod.-high forage yields
Reed canary	Rhizomatous	Med. High	25+	Wet-seasonally wet, weakly salty, fertile, med.-deep soils, good regrowth, persistent
Bluebunch wheatgrass	Bunch	Medium	10-16	Drought and cold tolerant; leafy, mod. late maturity, slow establishment, high quality, leafy
Tall fescue	Bunch	Medium	18-22+	Tolerates low-mod. wetness, mod. salinity-weakly acid, low fertility soils; good regrowth, leafy, fibrous when mature, stands abuse
Tall wheatgrass	Bunch	Low	15-22	Good salt tolerance, med. frost tolerance, late maturity, high forage yields

*Species adapted to 22+ moisture requirements also respond well to irrigation.

Table 2. Some recommended grass-legume mixtures for hay, pasture and silage in Idaho.

Mixture	Soil group	Seeding rate (lb/A)	Moisture Requirements		
			Full season irrig. water	Short season irrig. water	Non-irrigated Min. precipitation
Alfalfa and Latar orchardgrass	A, B, C and D (20-36" depth)	4-6 4	X (X-Adapted)	- (- - Non-Adapted)	20"+ (omit soil group B)
Alfalfa and Regar turkish bromegrass	A, B and D (20-36" depth)	4-6 8-10	X	X	16"+ (omit soil group B)
Alfalfa and Manchar smooth bromegrass	A, B, C and D (24-36" depth)	4-6 6-8	-	X	16"+ (omit soil group B)
Alfalfa and Alta tall fescue	A, B, C, D (20-36" depth) and F (mod. salts)	4-6 6	X	-	20"+ (omit soil group B)
Alfalfa and intermediate or pubescent wheatgrass	A, C and D (20-36" depth)	4-6 8	-	X	12"+
Alfalfa and Alkar tall wheatgrass	F (mod. salts)	4-6 8-10	X	X	14"+
Madrid sweet clover and Alkar tall wheatgrass	F	6 8-10	X	X	14"+
Birdsfoot trefoil and orchardgrass	A, C, D, and G	3 4	X	-	20"+
Birdsfoot trefoil and Garrison creeping foxtail or Reed canarygrass	E, H	3 5 5	X	-	22"+
Lutana cicer milkvetch and orchardgrass or Regar turkish bromegrass	A, B, D, and G	10 4 8-10	X	X (omit soil group B)	18"+ (omit soil group B)
Lutana cicer milkvetch and Alta tall fescue	A, B, C, D F (mod.), G	10 6	X	-	18"+ (omit soil group B)
Ladino or White dutch clover and Kentucky bluegrass	C, D, E, and G	4-6 4-6	X	-	24"+

Alsike or Red clover and Garrison creeping foxtail	C, D, G E, H	3-4 5	X	X (only soil group E)	24"+
Eski or Viva sainfoin and intermediate wheatgrass	A, B	30 6	-	X	14"+ (omit soil group B)
Remont sainfoin and Regar turkish bromegrass or orchardgrass	A B	30 8-10 4	X	X (omit orchard grass)	14" 14" 20" (omit soil group B)

NOTES: Double seeding rates if seed is broadcast.

Reduce seeding rate of legume or use alternate-row seeding technique if high grass to legume hay composition is desired.

Seeding rates can be reduced 25-50% if legume and grass is seeded in alternate rows.

Seeding rates are based on 100% live pure seed.

Smooth brome not adapted to areas where the average frost-free period at 32°F is more than 150 days.

Short season irrigation indicates enough water to produce one crop of hay.

Improved Grasses And Legumes for Idaho

Irrigated and Sub-humid Area Grasses

Orchardgrass (Dactylis glomerata)

Orchardgrass is a long-lived bunchgrass characterized by rapid regrowth after clipping or grazing. This characteristic makes it a valuable grass for pasture as well as hay use. Ladino plus orchard is a widely used irrigated pasture mixture. Most varieties mature too early for use with alfalfa in hay and pasture mixtures. However, later maturing varieties have now been developed.

Varieties — Latar is a late maturing variety of orchardgrass developed specifically for use with alfalfa for hay. It is low in lignin and highly nutritious and palatable. It is an excellent variety to use with alfalfa for pastures managed to allow 30 to 42 days regrowth between grazings. Other important varieties are Pennlate, Pomar and Potomac.

Tall Fescue (Festuca arundinacea)

Tall fescue is a long-lived bunchgrass characterized by stiff leaves that become rather unpalatable as the plant matures. It has an extremely wide range of adaptation and is a high yielding grass. Leaves remain green late in the summer and maintain growth on irrigated land during hot weather. It is acceptable to livestock in early stages of growth, but must be properly managed to prevent the development of mature foliage which is rather harsh and unpalatable. It is primarily a pasture grass best suited to beef cattle and horses.

Varieties — Alta tall fescue is the variety that is best adapted to Idaho. Two recent new varieties, Fawn and Kenmont, have been released. They are well adapted to heavy soils, slightly wet soils and slight-moderate saline soils.

Smooth Bromegrass (Bromus inermis)

Smooth bromegrass is a long-lived, sod-forming grass that spreads by rhizomes. It is adapted for use with alfalfa for hay, pasture or silage — especially in areas where climate or moisture limits hay production to one crop. It is easily established. If planted without a legume, it requires high rates of nitrogen fertilization for maximum growth. Smooth bromegrass makes slow recovery after cutting for hay or grazing.

Varieties — Manchar is the most important variety of smooth brome in Idaho. It is high-yielding, leafy, palatable and provides fair regrowth after clipping or grazing. Other available varieties include Saratoga, Landcaster, Lyon, Parkland and Superior.

Regar Turkish Bromegrass (Bromus biebersteinii)

Regar Turkish bromegrass is a very leafy, long-lived semi-bunchgrass that spreads by short rhizomes. It produces a mass of long, basal, lax, pubescent leaves. It is adapted for use in legume-grass mixtures for hay, pasture and silage. Compared to smooth bromegrass, it is adapted to the same sites, establishes as easily, starts spring growth earlier and makes rapid recovery, is more drought tolerant, more palatable and persists well under close grazing. Regar is not well adapted to wet, fine textured, and poorly drained soils.

Varieties — Regar is the only commercial variety.

Tall Meadow Oatgrass (Arrhenatherum elatius)

Tall meadow oatgrass is a productive short-lived perennial. It does well on most soils but prefers them well-drained. It will not stand prolonged flooding and is fairly drought tolerant. It is often used in short-term pastures. Tualatin is a common variety.

Intermediate Wheatgrass (Agropyron intermedium)

Intermediate wheatgrass is a long-lived, sod-forming grass characterized by little regrowth after clipping or grazing at the hay stage. Thus, its use under irrigation is limited specifically to spring-early summer pasture since it does make a large amount of growth early in the season and stays green into July. Its primary adaptation is in areas where one crop of hay per year is produced. In these areas, common throughout Idaho, a Ladak alfalfa-intermediate wheatgrass mixture cut for hay will generally outyield any other mixture. Intermediate wheatgrass usually flowers about 2 weeks later than alfalfa. Intermediate wheatgrass is adapted to dryland areas where the annual precipitation averages 14 inches. It has good seedling vigor.

Varieties — Greenar is the leading variety at the present time. Oahe is an excellent variety under 16 inches or more annual precipitation. Tegmar, a dwarf form, is described below.

Other Important Grass Species

Pubescent Wheatgrass (Agropyron trichophorum)

Pubescent wheatgrass is a long-lived sod-forming grass that is very similar to intermediate wheatgrass in appearance, growth form, area of adaptation and uses. It generally excels intermediate in forage yields in areas where the annual precipitation averages 12 to 14 inches, but intermediate wheatgrass is more productive in higher rainfall areas. Topar and Luna are varieties well adapted to Idaho conditions.

Timothy (Phleum pratense)

Timothy is a bunchgrass which is best adapted to mountain meadows. It is also widely used to reseed burned-over and cut-over timberland because it is so easily established on these sites. It is very palatable but becomes woody if permitted to mature. The late maturing varieties such as Drummond, Climax and Essex are preferred. It is a one-crop grass. Clair is an early variety.

Tall Wheatgrass (Agropyron elongatum)

Tall wheatgrass is a tall, coarse late-maturing bunchgrass. Its outstanding characteristic is its ability to grow on alkaline soils, especially under irrigated or sub-irrigated conditions. It will not persist under close mowing or grazing. Alkar is the recommended variety due to its superior cold tolerance. It has shown excellent performance and production when used as pasture or silage on salty soils. Orbit is another winter-hardy type.

Tegmar Dwarf Intermediate Wheatgrass (Agropyron intermedium)

Tegmar intermediate wheatgrass is a dwarf form of intermediate wheatgrass selected for erosion control and soil stabilization. It is a long-lived, sod-forming, drought tolerant wheatgrass that differs from other intermediate wheatgrass strains by sodding sooner, more rapidly, more densely and by being shorter in height. It has excellent seedling vigor. The foliage is of high quality but total production is less than that of the more robust and taller strains.

Tegmar is adapted in areas where annual precipitation exceeds 12 inches for soil stabilization of waterways, diversions, reservoir berms, highway rights-of-way, ski slopes, camping areas and other similar uses.

Pomar Orchardgrass (Dactylis glomerata)

Pomar orchardgrass has been selected for use as an orchard cover crop. Its short growth, shade tolerance and resistance to insects and diseases make it an ideal plant to use in orchards irrigated with short-riser sprinkler systems. The foliage, when clipped before cureout, decomposes more rapidly than that of other grasses used as orchard cover crops. This characteristic and its short height reduce maintenance costs of seeded orchards.

It is adapted to most soils used for irrigated orchards in southern Idaho. Clean seedbeds are required for good establishment. Pomar is the only commercial strain of dwarf orchardgrass.

Annual Ryegrass (Lolium multiflorum)

Annual ryegrass performs as an annual or winter annual. It does well on most well-drained sites. It has quick recovery after use and is valuable in short-term pastures.

Perennial Ryegrass (Lolium perenne)

It is a short-lived perennial and grows under most soil conditions other than wetness and alkali. It is not drought tolerant. It produces well, has good regrowth and comes early in the spring. It is highly palatable. Manhattan, Norlea and Pennfine are available varieties.

Kentucky Bluegrass (Poa pratensis)

Kentucky bluegrass is a perennial, sod-forming grass. It makes a dense turf because of its sodding characteristic. Although these grasses are especially adapted for beautification and recreational uses, some varieties also provide good forage. They are well adapted to shallow, fertile soils due to their shallow root system. They are persistent

under close grazing and are highly palatable. They are used for erosion control on critical areas. The variety Troy has been recommended as a forage variety. Many turf varieties are adapted for Idaho.

Rangeland Grasses

Desert or Standard Crested Wheatgrass (Agropyron desertorum)

Desert wheatgrass is a long-lived bunchgrass characterized by excellent drought and cold tolerance. It is productive on dry rangeland sites where precipitation averages 8 inches or more. It has good seedling vigor and provides early spring grazing as well as some late fall grazing with fall rains. Crested wheatgrass matures and goes dormant in early summer.

Varieties — Nordan is the recommended variety. It has strong seedling vigor, makes more rapid spring growth, is leafier and more productive.

Siberian Wheatgrass (Agropyron sibericum)

Siberian wheatgrass is a long-lived, drought-tolerant bunchgrass similar to crested wheatgrass in growth form and area of adaptation. It differs from crested wheatgrass in that it is awnless, has finer stems and more leaves, is more nutritious, more drought tolerant, matures later and stays green longer into the season. Siberian is more productive than crested wheatgrass under drier conditions and is preferred by livestock, especially when both grasses have headed. Grazing studies show animals gain more and faster on Siberian forage than on crested forage.

Varieties — P-27 is the only commercial variety of Siberian wheatgrass.

Fig. 2. Siberian wheatgrass provides good grazing under long-season, dryland conditions on the M. Bastian ranch near Arimo.

Streambank Wheatgrass (Agropyron riparium)

Sodar is a native, drought tolerant, sod-forming perennial wheatgrass. Its good seedling vigor, short sod-forming growth form and longevity make it a good erosion control plant. Sodar's principal use is for low maintenance ground cover due to its low yield of top growth. It has fine foliage but is not very palatable to livestock. If planted alone, it does a good job in protecting ditch banks, roadways and fills.

Beardless Wheatgrass (Agropyron inerme)

Beardless wheatgrass is a long-lived native bunchgrass with good drought and frost tolerance. It is more difficult and slower to establish than crested and Siberian wheatgrass. However, once fully established, yields equal or excel those of crested and Siberian. It has the additional advantage that it can be used as early season, mid-season and late fall pasture.

Varieties — Whitmar, a native selection, is the only variety presently available. Compared to crested, it starts spring growth earlier, stays green about 2 weeks longer into the season, is leafier and is more nutritious after cure-out.

Wetland Grasses

Creeping Foxtail (Alopecurus arundinaceus)

Creeping foxtail is a long-lived, sod-forming grass with black seeds. Meadow foxtail is a long-lived bunchgrass with white seeds. Both are well adapted to wet soils and soils subject to flooding. Spring growth starts early in the spring as snow melts and continues throughout the growing season. Recovery after clipping or grazing is rapid. The forage is lush, tender and palatable. Forage quality persists at a higher level throughout the season than does that of most other grasses.

Varieties — Garrison creeping foxtail is recommended for use in southern Idaho, including Adams and Valley Counties.

Reed Canarygrass (Phalaris arundinacea)

Reed canarygrass is a long-lived, sod-forming grass adapted to wet meadow sites for hay and pasture. It starts spring growth early and makes rapid recovery after clipping or grazing. Forage is nutritious and palatable in the vegetative stage but quality drops rapidly after plants head. Annual applications of nitrogen are essential to maintain the high initial yields.

Because Reed canarygrass is a vigorous sodder and spreads easily by seeds, it should not be planted where it can invade irrigation water delivery systems or spread by seed to irrigated rotation cropland. It is best adapted for use as permanent hay and pasture in locations where it cannot spread by seed or rhizomes to other cropland fields.

Varieties — Ioreed canarygrass has outperformed other commercial varieties in southern Idaho. Rise, Frontier, Vantage and Castor are also available.

Fig. 3. Garrison creeping foxtail is persistent, sod-forming, good for hay or pasture. Best adapted to wetlands and mountain meadows, it does well mixed with legume.

Legumes

Alfalfa (Medicago sativa)

Alfalfa is a long-lived perennial legume with good drought tolerance. It is widely adapted and grows well throughout Idaho except on dry range sites, poorly drained areas, shallow soils and some of the cut-over timberland of northern Idaho. It is the highest yielding of the perennial forages and should be grown wherever it is adapted.

Varieties —

(1) Northern Idaho and Non-Irrigated Southern Idaho — Ladak-65, Vernal and some Flemish types look promising under short rotations. Also Alfa, Warrior and Haymor have done well in North Idaho.

(2) Irrigated Southern Idaho — Dawson, Lahontan, Vernal and Warrior are adapted for longer rotations in the Snake River Valley. Saranac, Cardinal and other Flemish varieties have done well in short rotations.

Red Clover (Trifolium pratense)

Red clover is a short-lived perennial legume but is usually managed as a biennial. It is adapted to most soils, including shallow soils or well-drained soils with a medium-high water table. It is used to replace alfalfa on acid soils or the cut-over timber areas or northern Idaho where alfalfa does so poorly. It does well on irrigated soils throughout the state.

Varieties — Kenland, Lakeland and Pennscott are the better adapted medium red clover varieties.

Ladino Clover (Trifolium repens)

Ladino clover is a long-lived, stoloniferous legume used in irrigated pastures. It is a giant form of white clover but does not withstand as

much close grazing or trampling as white clover. It can be crowded out of mixtures with tall growing grasses if they are allowed to mature, since Ladino can tolerate only a minimum amount of shading. It makes rapid regrowth after grazing. Requires light, frequent irrigations every 7 days or oftener. Pilgrim, Merit and Tillman are recognized varieties.

Alsike Clover (Trifolium hybridum)

Alsike clover is a short-lived perennial legume that is usually managed as a biennial. It is well adapted to acid, poorly drained areas and grows well in many of the mountain meadows. It will reseed itself in the moist sites if allowed to go to seed. Its performance and persistence on adapted sites have surpassed other clover varieties. Aurora is a recent release from Canada.

Cicer Milkvetch (Astragalus cicer)

Milkvetch is a bloat-free, non-toxic, winter-hardy, vigorous-sodding, long-lived and persistent herbaceous legume. The succulent stems are semi-prostrate. Plants usually require two or more years to come into full production. Rhizomes generally start forming in the second year and sodding is rapid thereafter. It can become a weed and is not recommended for use on regularly rotated cropland. It is best suited for permanent pasture or hayland and especially where alfalfa consistently freezes back or where it is not well adapted to the soils.

Varieties — Lutana is the recommended variety. It starts spring growth later in the spring than alfalfa, but can be equally or more productive of forage.

Yellow Blossom Sweet Clover (Melilotus officinalis)

Sweet clover is a biennial. It grows well on most soils and sites and is one of the more drought and alkali-tolerant legumes. It reseeds itself readily and is used in many pasture mixtures. Since it can cause bloat and prevent blood clotting, good management is necessary if it is used as pasture. It has value as a green manure and winter cover crop. Madrid, Goldtop and Yukon are yellow varieties. Denta, Polar, Arctic and Huban are white varieties.

Sainfoin (Onobrychis viciaefolia)

Sainfoin is a long-lived, tap-rooted, bloat-free legume that is well adapted for hay on non-irrigated, calcareous soils in areas where annual precipitation exceeds 12 inches. Its adaptation for hay and pasture use looks promising on both irrigated and non-irrigated soils. However, management techniques to maintain high production and persistent stands have not been determined.

Sainfoin establishes easily and rapidly. Spring growth usually excels that of alfalfa — as does fall recovery. Recovery after cutting is slower than that of alfalfa. It is tolerant of insects that damage alfalfa but subject to crown rot. Frost tolerance is excellent. Sainfoin is not adapted to wet soils, to fine textured or shallow soils or to frequent irrigations. It should be inoculated prior to seeding to insure good plant performance.

Sainfoin is highly palatable to livestock, game animals and upland

birds. It is equal to alfalfa in total energy — and feeding trials indicate it ranks with alfalfa as a good producer of meat, milk and other animal products.

Varieties — The Eski and Viva varieties are recommended in Idaho especially for non-irrigated soils. Remont, is recommended for use under irrigation due to its superior regrowth.

Broadleaf Birdsfoot Trefoil (Lotus corniculatus)

Birdsfoot trefoil is a long-lived perennial legume. It does not cause bloat and has good potential use in pastures. It has some potential in the cut-over timberlands and on shallow, wet soils where alfalfa grows poorly. In these areas, it may replace red clover for use in long-term forage stands. It does not have the extreme tolerance of alsike clover on acid, poorly-drained soils. It germinates readily but is not competitive when seeded in the same row with other grasses and legumes. Good establishment requires that it be seeded only in pure stands or in alternate rows with the grass.

Birdsfoot trefoil makes most of its regrowth from buds that form in axils between leaf and stem. Cutting the first 2-3 crops for hay before grazing will help prevent using this palatable plant too closely.

Varieties — Cascade and Granger have provided the highest yields in tests to date. Other broadleaf types are Maitland, Mansfield, Tana and Viking.

Fig. 4. Lutuna cicer milkvetch is a bloat-free legume that is slow to establish but long-lived, vigorous, frost-tolerant and productive on wet soils in combination with many grasses.

Seeding

Selection of Seed

Use certified seed. It assures varietal purity, high quality, high germination and freedom from noxious weed seeds.

Seed only adapted varieties approved by the Experiment Station. There is a distinction between varieties recommended for forage production within the state and varieties recommended for seed production here but used for forage production elsewhere.

Alternate Row Seeding

A single grass-single legume mixture is particularly well adapted to alternate row culture.

There are two methods of making alternate row seedings with a grass drill:

a. Block alternate flutes in the grain box and legume box and then calibrate the drill for proper seeding rate.

b. Partition the grain box between each flute and drill the grass and legume through alternate openings. Proper seeding rates can be obtained by mixing the seed with cleaned rice hulls or split pea hulls. The hulls and seed mixture will flow through the drill at the same volume rate as barley (bushel for bushel).

Alternate row culture increases the chances of successful seedling establishment as a result of decreased competition. This is most important in areas where successful seedling establishment is a difficult problem and for species such as birdsfoot trefoil, cicer milkvetch, sainfoin and creeping foxtail that are poor competitors in the seedling stage.

Alternate row seeding assures establishment of the desired proportions of grass and legume and helps maintain that balance throughout the life of the stand.

Seedbed Preparation

A firm, weed-free seedbed is of primary importance in the successful establishment of small-seeded grasses and legumes. A firm seedbed holds moisture near the surface, helps control depth of seeding and provides ready anchorage for the tiny seedling roots. The soil surrounding the seeds after seeding should be moist to promote rapid germination, emergence and successful establishment of the forage species.

Weeds provide severe competition for forage crops. Prepare a clean, weed-free seedbed. Several pre- and post-emergence herbicides are now available. Caution must be exercised. Follow instructions on the label.

In sandy soil subject to wind erosion, forage seeds may be drilled into clean cereal stubble without seedbed preparation. In salty soils, leaching of salts before seeding will aid establishment.

Method of Seeding

Plant all seedings with a drill. Best results are obtained when drills are equipped with depth regulators. Drills distribute the seed more uniformly and assure proper soil coverage to increase the possibility of successful stand establishment.

Many grass seeds are light and chaffy, may have awns and will not feed through the drill evenly. Seed bridging can be prevented by mixing the grass seed for each acre with enough rice or pea hulls to make one bushel. This mixture will feed through the drill readily, to give uniform distribution of seed. Drills calibrated to seed one bushel of barley per acre will plant the seed-hull mixture at the desired seeding rate.

If the drill does not have press wheels, roll or cultipack the field before seeding. Cultipacking assures close contact between the seed and moist soil particles which results in rapid germination and uniform emergence. Cultipacking after seeding and when soil is wet will result in severe crusting on many soils.

Seeding with a deep furrow drill or in furrow bottoms will aid establishment on soils that crust, on salty soils and where moisture is limiting.

Depth of Seeding

Depth of seeding of most pasture species should not exceed ½ inch on fine-textured soils, 1 inch on loam soils and 1 ½ inch on sandy soils. Small-seeded species should be planted shallower than large-seeded species. When mixtures are sown, the depth of seeding should be regulated to favor the small-seeded species.

Time of Seeding

Spring seeding is generally recommended for all areas of Idaho — with the following exceptions:

In southern Idaho irrigated areas with a long growing season, forage crops may be successfully seeded as late as August 15 to September 1. This allows the seedlings to become well established before fall freeze-up and results in minimum winter-killing as compared to later seeding.

Late fall seeding is recommended where average rainfall is less than 12" annually. The seeding should be made late enough in the fall so that the seeds do not germinate until the following spring.

Inoculation of Legume Seed

All legumes should be inoculated with the proper strain of nitrogen fixing bacteria. There are different strains of rhizobia for alfalfa-sweetclover, cicer milkvetch, true clovers, pea-vetch, cowpea, soy-

bean, lupine, sainfoin and trefoil. The inoculum is best applied immediately before seeding and care should be taken to avoid exposing the bacteria to direct sunlight. If preinoculated seed is used, note expiration date of inoculum.

Companion Crops

Spring seeding without a companion crop will usually result in the most certain and most rapid establishment of forage crops. However, companion crops may provide such advantages as:

a. Reduction of erosion

b. Reduction of weed competition

c. Providing a source of income during the year the forage crop is becoming established. However, companion crops should never be used in areas where a moisture shortage is likely to develop early in the season or on non-irrigated cropland.

The more competitive companion crops result in severely reduced forage yields the next year and moderate reductions in the second forage year. Thus, the detrimental effect of companion crops is not limited to reduced vigor and growth of the forage species during the seedling year.

Peas are the best companion crop, followed in order by barley, oats and spring wheat. Peas mature early and have less competitive effect on the forage seedlings than any of the cereals. When peas are used as the companion crop, normal seeding rates may be used successfully.

When cereal companion crops are used, the seeding rate may be reduced by one-half without reducing grain yield materially. The cereal should be seeded in double-width rows and the forage mixture either seeded in alternate rows or seeded crosswise to the grain rows.

Rate of Seeding

There is no apparent advantage in forage quality or yield after the seedling year when seeding rates are higher than those recommended. Use of excess seed merely provides some insurance for adverse environmental conditions.

The most accurate ways to calibrate a drill are to use rice or pea hulls or count the seeds dropped per linear foot. Run the drill over hard ground or a canvas and count the seeds dropped per linear foot of drill row. Then compare with Table 3 which gives the number of seeds per pound, recommended planting rate per acre and seeds per foot at that planting rate for the common forage species.

If the seed is broadcast, the planting rate should be doubled to compensate for uneven seed distribution and uneven depths of planting.

---

* Seeding rates are based upon live pure seed (L.P.S.) which is the percentage of seed that will germinate. This is calculated by multiplying germination % x purity % x 100. Germination and purity are given on the tag. When this is less than 100, increase seeding rate by this formula:

$$\frac{\text{Rate recommended} \times 100}{\text{L.P.S.}} = \text{adjusted seeding rate.}$$

Table 3. Seeding rate of common forage species and live pure seeds per linear foot of drill row.[a]

Species	Seeds per pound[b]	Six-inch spacing[c] Grass & legume same row		Six-inch spacing[d] Grass & legume alternate row	
	(000)	lbs / acre	seeds / foot	lbs / acre	seeds / foot
Legumes:					
Alfalfa	227	6	15	4	21
Clover, Alsike	680	2	16	1	16
Clover, red	272	4	13	3	19
Clover, Strawberry	288	4	13	3	19
Clover, white & ladino	800	2	20	1	20
Milkvetch, Cicer	134	10	15-16	8	24-25
Sainfoin	18	40	8-9	30	12-13
Sweetclover	258	5	15	3	18
Trefoil, birdsfoot	470	3	17	2	17
Grasses:					
Bluegrass, Kentucky	2,156	4	100	2	100
Bluegrass, Sherman big	920	4	40-42	3	50-63
Bromegrass, Regar	101	8	9-10	6	13-14
Bromegrass, smooth	125	6	9-10	4	11-14
Canarygrass, reed	506	5	30-31	2	23-25
Fescue, tall	234	6	16	4	21
Foxtail, meadow	900	4	42	2	42
Oatgrass, tall	150	8	14-17	6	21-26
Orchardgrass	540	4	24-22	3	36-33
Ryegrass, annual	217	6	15-14	4	20-18
Ryegrass, perennial	247	6	17-19	4	23-25
Timothy	1,300	3	45-42	2	60-57
Wheatgrass, crested	175	6	12	4	16
Wheatgrass, intermediate	100	6	7-6	4	9-8
Wheatgrass, pubescent	91	8	8	6	12
Wheatgrass, Siberian	161	8	15	6	22-23
Wheatgrass, tall	76	10	9	6	11
Wheatgrass, Tegmar intermediate	115	10	13-10	6	16-12
Wheatgrass, Whitmar	135	7	11-10	5	15-14
Wildrye, Russian	170	7	14	5	19

[a] Double the seeding rate for broadcast seeding

[b] Source: Association of Official Seed Analysis, USDA Handbook 339 and Aberdeen PMC

[c] If only one species is planted, double these rates

[d] For 7-inch drill rows, multiply the solid seeding and alternate row values by 1.17.

5 Fertilization

Soil tests are available through the University of Idaho Cooperative Extension Agents' offices. Samples are forwarded to the Soil Testing Laboratory, Moscow, either by the County Agent, the fertilizer dealer or individually by the farmer. Several commercial testing services are also available. Tests every three years are recommended to check the soil needs for fertility improvement. A farmer's own experience and observations are important to help determine the need for additional plant nutrients in a certain field.

The proportion of grass to legume in established stands can be modified by fertilization. The grass portion may be increased by applying a nitrogen fertilizer. The legume portion may be increased by omitting the nitrogen and applying fertilizers that contain sulfur, phosphorus and/or boron. (See Tables 4 and 5).

At high elevation, mountain meadow fertility trials on improved species of grasses have shown that 80 to 100 pounds of nitrogen per acre increased both the yield and protein content of the forage. Invasion of sedges was retarded by nitrogen fertilization — a result of increased grass vigor. Best returns have occurred where water control was practiced. Wild flooding reduces the response from fertilizers.

Phosphorus is of maximum benefit in meadows that have a good legume stand. Phosphorus promotes persistence and productivity of the legumes. Apply 60 pounds of $P_2 O_5$ per acre annually or as required from your soil test.

In general, where there is a limited supply of manure, apply it first to the cash crops. Extra manure should be applied to the pasture and new forage seedings. Manure containing noxious weed seeds should not be used. Manure favors late summer growth if applied in winter or spring. Reduce the amount of nitrogen supplied by commercial fertilizer by 4 to 5 pounds per acre for each ton of manure applied.

South Idaho Conditions

Non-irrigated Grasses and Legume-Grass Mixtures

Nitrogen — Forage stands that have a high percentage of legumes do not usually benefit from nitrogen fertilizers. Where the phosphorus content of the soil is relatively high and with 18+ inches of moisture, both forage yield and protein may be increased — without losing the legume stand — by adding 30-40 pounds of nitrogen. Older stands of grass may be benefitted by adding 30 to 40 pounds of nitrogen; however, avoid annual applications until residual responses are determined.

Phosphorus-Potash — Use a soil test to determine needs.

Irrigated Legumes and Legume-Grass Mixtures

Nitrogen — Forage mixtures with a high percentage of legume need only limited amounts of nitrogen. Mixtures with a high percentage of grass should receive about 100 pounds of nitrogen per acre each

year after they are established. A split application of half in the fall and half in early summer is more beneficial than a single application. An application of 20 to 30 pounds of nitrogen per acre to rotation pastures each time the livestock are moved promotes even growth of forage throughout the summer. Intensive pasture management and high producing pastures may require more than 100 lbs N /acre each year.

Phosphorus — Alfalfa is a heavy feeder of phosphorus. Thus, phosphorus needs should be checked periodically with a soil test. An average annual application would be 60 to 80 pounds of P_2O_5 per acre. Phosphorus used on legumes has a beneficial effect on the row crops that follow. Phosphorus may be applied at any time during the year except when the ground is frozen.

Potash — Use a soil test to determine needs. Current experiments indicate that there is sufficient potash in most Snake River Plains soils for forage crops. Coarse textured soils are the major exceptions.

Sulfur — Alfalfa has responded to sulfur in mountain valley areas. This is related to low sulfur content of irrigation water and heavy winter leaching.

New Forage Seedings

New forage seedings on low-fertility soils or following a grain crop are favored by low rates of nitrogen and phosphorus. About 30 to 60 pounds of nitrogen and 60 pounds of available P_2O_5 (or quantities based on soil test) are adequate. Nitrogen may not be essential to the successful establishment of forage crops seeded on high fertility soils or following heavily fertilized row crops.

Northern Idaho Conditions

Non-Irrigated Legumes and Legume-Grass Mixtures

Boron and sulfur — Boron deficiency symptoms are becoming more prevalent, especially on alfalfa and red clover. Apply 200 pounds of borated gypsum per acre every year or 400 pounds per acre every other year in the fall or early spring. Alfalfa requires more boron than clovers. Where severe deficiency occurs make an initial application of 40 pounds of agricultural borax or equivalent per acre and then use the recommended rate of borated gypsum in following years. Avoid an excess of boron as it is a soil sterilant at high rates.

Table 4 presents various boron carriers, percent boron and the conversion factor for borax equivalent. For example, 22.5 pounds of agricultural borax equivalent could be obtained from 40 pounds of anhydrous rasorite (40 pounds Borax X 0.56).

Nitrogen — When the legume stand is sparse and the grass stand is good, apply 30 to 50 pounds of nitrogen per acre in the early spring. The lower rate should be used on coarse-textured, droughty soils and the higher rate on finer textured soils. Where legumes make up about 60 percent of the stand, limited response to nitrogen can be expected.

Phosphorus — Make a soil test to determine needs. Clay ridges and cut-over forest soils are more deficient in phosphorus than bottom

Table 4. Boron carriers, percent boron and conversion factors for borax equivalent.

Boron carriers	Percent boron	To convert to borax equivalent multiply by
Borated gypsum	1.0-1.5	11.3
Borax, granular	11.3	1.00
Anhydrous rasorite	20.2	0.56
Plant food borates	14.3	0.71
Water soluble compounds:		
Solubor	20.5	0.55
Borospray	18.5	0.61

Table 5. Plant nutrients contained in various fertilizers.

	N	Available P_2O_5	S
	%	%	%
Ammonium nitrate	33.0	—	—
Urea-Nugreen	45.0	—	—
Ammonium sulfate	21.0	—	24.0
Calcium cyanamid	20.0	—	—
Anhydrous ammonia	82.0	—	—
Calcium nitrate	15.5	—	—
Aqua ammonia	20.0	—	—
Single superphosphate		20.0	10.0
Treble superphosphate		45.0	2.0
16-20-0	16.0	20.0	14.0
11-48-0	11.0	48.0	3.0
Gypsum	—	—	18.0

lands. Usually 40 to 80 lbs of P_2O_5 per acre where P is deficient will aid maintenance of legumes in the stand.

Potash — Make a soil test to determine needs. Present experiments have failed to show any economic response from the use of potash on mineral soils. Organic soils have usually given an economic response to potash application.

Irrigated Legumes and Legume-Grass Mixtures

In general, needs for nutrients except nitrogen will be very similar to those required for non-irrigated mixtures. If the grass portion of the mixture is low, apply 60 to 80 pounds of nitrogen per acre. Split

applications, one-half in the fall and the rest about the middle of June, provide increased benefits over a single application. If late growth is desired, as in an irrigated pasture, apply an additional 20 to 30 pounds of nitrogen per acre about August 1.

New Forage Seedings

Apply about 50 pounds of nitrogen and 40 to 80 pounds of P_2O_5 per acre before seeding. Make a soil test to determine exact phosphorus and nitrogen needs.

Under higher rainfall dryland conditions light fall applications of N may be beneficial for stand establishment.

In Bonner and Boundary Counties, legume seedlings respond well to 150 pounds of 16-20-0 per acre or equivalent. When ammonium sulfate is used, the application of borated gypsum may be reduced or deleted depending upon the rate used. Both of these fertilizers supply sulfur and — since borated gypsum also supplies sulfur — the amount of borated gypsum required to provide the needed sulfur is reduced. (See Table 4). Make sure that an adequate supply of boron is present also.

Fig. 5. A grass-legume mixture of intermediate wheatgrass and alfalfa on the Hubbard ranch, Soda Springs.

Irrigation

Over one-half of the irrigated land in Idaho is devoted to forage crop production. Hay and pasture use more water than any other crop — about 30 inches per season. Since irrigation management is quite different for alfalfa and grasses, they will be treated separately.

Crop Needs

Alfalfa

Alfalfa is a deep-rooted plant using moisture from 5 to 6 feet deep or deeper. This large root-zone reservoir allows it to go much longer between irrigations than shallow-rooted grass, although both use about the same amount of water to produce a pound of dry matter. Since it is a constant feeder, moisture is required in varying amounts all year around. This is why a good response is noted from early deep irrigation of alfalfa, especially if it has been allowed to go into the winter dry.

Grass-Legume Mixtures

Grasses such as tall wheatgrass, orchardgrass and tall fescue may be deep rooted, but generally most grass roots are in the surface 2 feet of soil. The root zone of Ladino clover is about 1.5 feet and alfalfa, 5 to 10 feet. Frequent light irrigations that wet the surface 2 feet of soil will be adequate for the shallow-rooted legumes and grasses.

The grass-alfalfa mixture will have to be irrigated more often than alfalfa alone, with light, frequent irrigations for the grass. Irrigate to moisten the full root zone at least twice a season to insure optimum growth of the alfalfa. Late fall irrigations that fill the soil profile are especially beneficial for plant survival and early spring growth.

Grass requires an even supply of moisture for optimum growth. If allowed to get too dry or too wet, production will be reduced.

For average conditions, pastures should be irrigated when soils have dried to about 50 per cent of their available water-holding capacity. Early season moisture is important to early spring growth of both grasses and legumes.

Irrigation Methods

Border, corrugation, controlled flooding and sprinkler irrigation can be used on forage crops. Choose the method best adapted to the slope, soil, water supply and labor supply. An irrigation system should permit good water management. Border irrigation is one of the best methods and should be used wherever water supplies and land conditions permit.

Water Management

The best way to tell when to irrigate is to watch soil moisture. Dig one-third of the way into the root zone. Apply water when moisture levels fall below 50% of the soil's water-holding capacity. Be sure to start early enough to be over the field by the time the last set needs irrigating.

Generally, on a deep silt loam soil a 2-inch application of water on pasture and a 4-inch application of water on alfalfa will wet the effective rooting zone. Use an auger or probe to determine the wetting front. The soil will offer greater resistance to probe penetration just below the wetted zone.

Irrigating the Established Crop

The full soil profile should be moist at the beginning of the growing season. This extends 5 feet down in deep soils or to the restrictive layer in shallow soils.

Forage crops should be irrigated immediately after removal of hay or pasture crop so that rapid regrowth may occur. In many areas, it is a practice to irrigate each alfalfa crop twice — except possibly the first crop.

New Seedings

The root zone of a new seeding is only a few inches deep (4 to 12 inches). Light, frequent irrigations are required to keep the soil-moisture level above 50% and prevent overwatering.

Planting in dry soil usually results in poor seedling emergence. Irrigating before seedlings emerge frequently causes soil crusting. After the plants have emerged, light, frequent irrigations should be applied to promote root development. Withholding water will not force deeper root development.

Irrigation of Mountain Meadows

Water management is the first step toward greater efficiency in the production of forage on mountain meadows. Poor water management can eliminate the benefits of other applied practices, including fertilization and re-seeding. Continuous irrigation with spring runoff waters is especially damaging to the establishment and growth of desirable forage species.

Fig. 6. Well-managed Lahanton alfalfa-Alta fescue pasture on Wesley Kent farm near Middleton provides 7 months grazing on 5-day-per-pasture rotation basis.

7 Pasture Management And Utilization

The goals of pasture management are to (1) produce high yields of palatable and nutritious forage, (2) extend the grazing season from as early in the spring to as late in the fall as feasible, (3) provide a fairly uniform supply of feed throughout the entire grazing season and (4) maintain productive life of stand for 6 or more years.

New Pasture Seedings

Harvest the first crop and preferably the second crop of a newly established pasture as hay or silage. This allows the plants to become well-established before they are subject to trampling and pulling by livestock.

Spring seedings under irrigation may be lightly grazed in late summer or early fall if a dense, vigorous stand is present.

Dry, non-irrigated land pasture seedings should never be grazed the first year or until plants are well-rooted to withstand pulling. This may require two or three years in the drier areas.

Established Pasture Stands

Allow 8 to 14 inches of topgrowth to develop before turning livestock on the pasture in the spring.

Never graze the topgrowth closer than to 4 to 6 inches from the ground since it reduces yield, weakens the plants, increases erosion and allows weed invasion. Irrigated and humid area pastures subject to continuous over-grazing generally end up as a low-producing bluegrass pasture. Allow 30 to 42 days regrowth between grazings for alfalfa-grass, 21 to 28 days for other legumes. Short grazing periods of 3 days or less promote uniform grazing, reduce bloat hazard and can eliminate the need to mow or clip. Allow 6 to 8 inches of fall regrowth before September 10 or at the first killing frost.

Over-mature forage is unpalatable and of low nutritive value. Tall-growing plants may shade out such desirable low-growing plants as Ladino clover.

Clipping — If pastures are properly grazed the forage will not need clipping. Severe or frequent clipping (under 4 inches) will reduce yield and regrowth. Two clippings per year are generally satisfactory. Avoid clipping 4 to 6 weeks before killing frost so that legumes will replenish food reserves in the roots.

Fertilization — The vigor and yield are increased by proper fertilization. See Section 5 on types, rates and frequency of application of fertilizers.

Irrigation — Irrigate pastures when needed and preferably after each grazing period. This will increase yield and provide grazing during late summer when most dryland pastures are dormant. See Section 4.

Close grazing in late fall depletes root reserves and can result in reduced vigor and loss of stand. Leave 6 to 8 inches of fall growth. This may be lightly grazed after the ground freezes but a minimum of 4 to 6 inches of stubble should be left for winter protection.

Grazing Systems for Irrigated or Sub-humid Area Pastures

Continuous grazing — Grazing a pasture continuously results in reduced yields, weed invasion and the eventual loss of the more productive forage plants. Although grasses such as Kentucky bluegrass, tall fescue and white Dutch clover will persist under close frequent grazing, total forage yield will be low.

Rotation grazing — Compared to continuous grazing, rotation grazing increases the productivity of most forage species and thus increases farm income from forage production.

Rotation grazing is a system that provides 4 or more pasture units so that each can be grazed in rotation to provide proper regrowth for maximum forage yields. Grazing periods and regrowth intervals are regulated by the number of pasture units. Pasturing a relatively small area with enough animals to uniformly consume and utilize the forage is the most desirable and efficient system. Thus a large area should be subdivided into relatively small units. For example, 4-pasture system for alfalfa-grass would allow each unit to be grazed 10 days with a 30-day regrowth period between grazings. An 11-pasture system would allow a 3-day grazing period with 30 days of regrowth between grazings. Grazing period and irrigation can be correlated to avoid pasturing the fields when soils are wet or watered.

Advantages of rotation grazing are:

a. Proper rotation grazing promotes vigorous plant regrowth and uniform forage utilization.

b. The forage can be maintained in a relatively young, rapidly growing and nutritious state.

c. High-yielding forage species which are susceptible to overgrazing and trampling damage can be successfully maintained.

Daily ration, ration-a-day, or strip grazing — This method involves the use of an electric fence to confine the livestock to enough pasture for one day's (or less) use. The livestock are moved to a new pasture each day — or more frequently.

Green chop, soiling, zero grazing, or green feeding — This method involves the daily or semi-daily chopping of fresh forages which are hauled and fed to the livestock in a feedlot.

Storage feeding — This method involves the year-around feeding of hay and silage in a dry lot.

Grazing Systems for Arid Land Pastures

Continuous grazing — This system usually results in the rapid depletion of the more desirable plant species, loss in forage yields and uneven or close utilization.

Deferred rotational grazing — This method involves the subdivision of the arid pasture land into 3 or more pasture units. A different unit is grazed each successive spring, allowing the other units to attain full growth. The last unit is usually allowed to set seed. Each unit then receives a complete series of such treatments within 3 or 4 years, depending upon the number of units.

Not more than 50 percent of the season's available vegetative growth should be removed by early spring grazing. Fall grazing often results in more complete utilization. These practices allow the more desirable forage plants to maintain vigor for continued high production and maintenance of stand under low moisture conditions.

A modification of this system is to seed several species in different pastures, using rapidly developing plants for early spring use only and later maturing plants for late spring and summer use.

Temporary or Supplementary Pastures

Supplementary pastures can provide good, succulent pasturage during the hotter portions of the grazing seasons when sufficient permanent pasture is generally not available. Crops that provide good supplementary pasture are the spring and winter cereals, pea-oat mixtures and, in the lower Snake River Valley, sudangrass.

Special pastures

These pastures are seeded to early producing forage species and used as early spring pasture until rotation pastures are available for use. Such pastures are used as holding pastures for calves, bulls, bucks, lambs or other animals on a temporary basis. Plants that will persist under this type of use are tall fescue, Regar Turkish bromegrass, Kentucky bluegrass and \White Dutch clover. They are grazed as indicated above, then used for hay prior to fall use.

Bloat in Ruminants on Pasture

Bloat may occur anytime when legumes other than birdsfoot trefoil, sainfoin and cicer milkvetch are pastured. Bloat is thought to be due to failure of the animal to belch and thus eliminate stable froth formed during the digestion process. This failure may be due to animal factors, plant factors and decomposition products of rumen fermentation.

The bloat hazard may be reduced in several ways:

Reducing Bloat Hazard

a. Seed a grass-legume mixture, but keep the seeding rate of the legume low (1 to 2 pounds per acre of alfalfa). Keep the legume component in the pasture mix under 50 percent. This can be done by reducing the seeding rate of the legume or by use of the alternate row seeding technique.

b. Do not graze the animals during the spring when there is a rapid change from cool to warm growing temperatures. Under

these conditions, legumes often make a sudden flush of growth and outgrow the grass.

c. Keep grasses and legumes in proper balance with an adequate fertilization program. Adequate levels of phosphorus are important. See Sections 2, 4 and 5.

d. Do not turn hungry livestock into a legume pasture. Fill them up with dry roughage and water first. Dry roughage available at all times will help prevent bloat. Dry roughage may be provided by mowing strips through the pasture and allowing the clippings to cure before turning in the livestock.

e. Watch livestock closely, especially the first 2 or 3 days they are on legume pasture.

f. Have salt and water available at all times.

g. Feed a supplementary ration of grain to livestock on legume pasture.

h. Turn livestock into a new pasture during the heat of the day.

i. Allow legumes to reach a more mature stage of growth before pasturing.

j. Remove stock as soon as the grass portion of the mixture has been grazed to a 4-inch stubble.

k. Research has been conducted with various antibiotics — and antifoaming agents such as oils, silicones, detergents, tallow and other surfactants — but none have proven very satisfactory.

Recent research indicates that a surfactant, **Poloxalene,** when free-fed in salt-molasses blocks offers promise of significantly reducing bloat. Amounts of poloxalene received by the animal must be adequate. The surfactant does not seem to affect feed consumption or animal productivity, but is not readily taken by all animals.

Because of the nature and condition of the animals and plants consumed by animals, bloat to some degree may be a problem which will require vigilance and thorough management practices on the part of the livestock operator. A veterinarian should be consulted if you have any problems.

Production Of Quality Hay

High quality hay may be defined as properly managed, weed-free hay cut at the proper time, properly cured and stored so there is a minimal loss of palatability and feeding value from that of the original crop.

Frequently, a high loss of nutrients results from poor harvesting methods. Estimating conservatively, 20 percent of the nutrients in hay are frequently lost. Any method of reducing nutrient losses is important to the hay producer and the livestock feeder.

Physical Characteristics of High Quality Alfalfa Hay

Leafiness — High-quality alfalfa hay contains about 50 percent leaves. These leaves provide 50 to 75 percent of the digestible matter, 70 percent of the protein and 90 percent of the carotene found in alfalfa hay. Any leaf loss reduces the nutritive value of the hay.

State of maturity — Time of cutting or stage of maturity of the plant is the most important factor in maximizing yields of high quality hay. Nutrients, especially protein and phosphorus, are at their highest level at bud-stage of the plant. Nutrient production per acre decreases after this stage of plant growth. Percent protein may drop from 17 percent at bud-stage to 13 percent at full bloom. Phosphorus may drop from .26 to .17 percent.

Natural green color — Bright green hay indicates a high level of carotene or provitamin A. Bright, prolonged sunlight will destroy this valuable provitamin on mowed hay.

Foreign material — Weeds and other foreign material result in decreased palatability and feeding value.

Other characteristics — Texture and aroma are also important in high quality hay.

Quality and Dry Matter Losses in Producing Alfalfa Hay

Hay can be lost in the field simply by failure to harvest. This includes mower skips and clipped hay not picked up by other harvesting machines. There are also many other ways to lose quality and dry matter.

Respiration losses — Harvested plants continue to respire for some time until the individual cells die. Rapid drying is essential if respiration losses are to be kept to a minimum.

Mechanical losses — This refers primarily to the loss by leaf shattering. Overcuring causes excessive brittleness and increased loss of leaves and fine stems. Some farmers bale in the evening or early morning when the dew is present to reduce leaf loss, especially if the hay is slightly overcured.

Leaching losses — Rain leaches out the more water-soluble and highly digestible nutrients. The sun bleaches out the natural green color associated with carotene content.

Fermentation losses — These losses occur through the destructive action of bacteria and fungi in wet, moldy hay. They can be prevented by storing hay at the proper low moisture content.

Producing High Quality Hay

To produce high quality hay, you must follow those practices outlined earlier that promote development of a vigorous, weed-free, high-yielding stand of a forage crop. Then you must harvest at the right time.

Harvesting — Best time for harvesting is at a relatively early stage of maturity. The recommended harvest stages for the common forage crops are given in Table 6. As you harvest, cut only the amount of forage that you can handle with your equipment by the time the hay is cured sufficiently for storage.

Hay crushing, crimping or conditioning — Tests in Idaho have shown that the use of a hay crusher will reduce hay drying time by about 1 full day. This is very important if it means the difference between getting the hay in before a heavy rain. Many types of machines are available to crush the hay. Attachments are available on swathers so that hay may be cut, crushed and windrowed in one operation.

Table 6. Recommended harvest stage of forage crops.

Crop	Recommended Harvest Stage
Alfalfa (all except last crop)	Bud to first bloom or before new tillers start.
Alfalfa (last crop) *	4-5 weeks prior to average date of first killing frost.
Red and Alsike clover	Early bloom to ½ bloom.
Grasses	Between heading and flowering.
Small grains (oats)	Late milk to soft dough stage.
Grass-legume mixtures	When the legume is ready as noted above.
Milkvetch	10% bloom.
Sainfoin	First green pod.
Birdsfoot trefoil	30-40% bloom.
Corn for silage	Hard dough — early dent stage — before killing frost.

* The time lapse between the last hay cutting and the first killing frost must allow enough growth to occur to replenish the root reserves for winter hardiness and early spring growth. The residue after killing frost may be moderately grazed or removed for hay.

Fig. 7. Alfalfa - orchardgrass hayfield on Lee Wright farm near Payette provides high quality hay, green-chop or pasture.

Windrowing — Windrowing reduces leaf loss. The swather is recommended since it will cut and windrow in one operation and will minimize leaf loss. The swather will not pick up dust, rock, metal and other objects — as will the side-delivery rake.

Processing Hay

Hay may be processed by baling, chopping, cubing, pelleting and wafering or it may be stored loose in stack or mow. Baling is the most common method. Hay put in outdoor stacks and in barns may be stored with or without artificial drying. Preservatives such as salt and carbon dioxide generating compounds are sometimes used but they are ineffective and are not recommended. Preservation is not necessary if the proper moisture content is reached.

Moisture content — Best moisture content for hay storage depends on how the forage is treated. The following are guidelines:

Treatment of forage	Maximum percent moisture
Loose hay	20-25
Baling	15-20
Chopping	10-14

Hay of a higher moisture content than indicated should not be stored. In addition to the danger of molding the hay, there is the possibility of spontaneous combustion resulting in a costly fire.

Moisture content may be roughly estimated by these methods:

	Estimated moisture content
a. Freshly cut forage	70-80 percent
b. When material is well wilted	60 percent
c. When stems are tough but leaves are dry and just beginning to shatter	30 percent
d. Twist a few stems until they break. If there is no evidence of moisture and the stems are slightly brittle	25 percent

9 Silage Making

Crops Suitable for Silage

Grass silage — Grass silage includes grasses, the small grains, legumes and grass-legume mixtures. Coarse and weedy crops may be better utilized as silage than as hay. However, the quality of the silage will be no better than the quality of the crop ensilage.

Corn silage — In areas where corn is well adapted and where growing season is at least 130 to 140 days, more nutrients per acre can be produced from corn silage than from any other crop — providing proper varieties and proper cultural practices are utilized and the corn is allowed to mature to the hard-dough stage. Harvest before a serious frost which will destroy leaves and green material.

Pea-oat silage — Pea-oat mixtures also make a high quality silage. Seed the recommended oat variety for your area at 30 to 40 pounds seeding rate with 50 to 60 pounds of field peas an acre. Harvest the mixture for silage when the oats are in the soft dough stage.

Miscellaneous crop silages — Silage may also be made from sorghums, sunflowers, pea vines, beet tops and processing by-products such as beet pulp, fruit culls, potatoes, cannery refuse, etc. Most processing by-products make a high moisture silage and should be chopped into the silo along with 15 to 30 percent dry hay by weight.

Be sure these by-products are free of chemical residue.

Making High Quality Silage

Stage of harvest — Harvest grass silage at the same stage as grass hay (See Table 6). Ensile corn in the early dent, a hard dough stage.

Length of cut — Knives should be set for ⅜" cut. The knives should be sharp to obtain a desirable fine chop that will pack tight.

Moisture content — The optimum moisture content for higher quality silage is 55 to 70 percent.

Fresh-cut grass silage will usually have a moisture content of 75 to 80 percent. Ensiled at this time, grass will produce high-moisture silage which results in offensive odors and excess leakage with loss of soluble nutrients. High moisture silage may be prevented by:

a. Wilting — Wilt the green material in the field until it reaches a moisture content of 65 to 70 percent. The proper moisture level can be estimated by noting when the leaves and stems become limp. The "grab test" may also be used. Squeeze a handful of freshly chopped material and release it. If the material opens up slowly, leaving slight moisture in the hand, then the moisture content is about right. If the material remains in a ball and the hand is moist, then the moisture content is too high. If the material falls apart readily, leaving no moisture in the hand, then the moisture content is too low. Generally, grass silage need not be wilted more than about 2 hours.

b. Using preservatives or conditioners — Preservatives need not be used if the material is ensiled at the proper moisture content. Recommended preservatives reduce the moisture content and add carbohydrates. About 90 percent of the nutrients in the preservatives are retained in the silage, where they stimulate the growth of desirable bacteria. Conditioners are of maximum benefit when high protein, high moisture silage is made. See Table 7 for suggested preservatives and rates.

In making corn silage, wilting or preservatives are not needed since corn is already at about the right moisture content if harvested at the proper stage. Harvest before heavy frost.

Packing the silage — As the silo is filled, pack the silage well, especially near the outside wall since silage has a tendency to pull away from the outside wall as it settles. It is often desirable to pack the top daily for a week after the silo is filled.

Covering the silage — The top of the silage should be covered with a silo cap or large sheet of plastic that is weighted down to exclude water from rain or snow. Keeping out excess water will prevent excessive moisture build-up in the silage and leaching of nutrients. Although a cover may exclude some oxygen, a tight seal achieved by packing the top layers will provide adequate protection against excess spoilage.

Feeding silage

For all practical purposes, 3 tons of silage will replace 1 ton of hay of similar kind and quality. Most dairymen feed free access to both silage and alfalfa hay. Silage should be fed immediately after milking as off-flavored milk often results if silage is fed too soon before milking.

Table 7. Suggested pounds of preservatives per ton of green cut material for ensiling various crops.

Type of silage	Choice of preservative			
	Molasses	Ground grain	Molasses ·· dry beet pulp	Dry ·· hay
Legumes				
fresh, green	80	200	200-300	200-300
wilted ·	60	150	100	—
Grass-legume mixtures				
fresh, green	60	100	100	100
wilted ·	—	—	—	—
Grasses and cereals				
fresh, green	40	100	—	—
wilted ·	—	—	—	—

· See section on "wilting", for definition of wilted — 65 to 70 percent moisture.

·· Use just enough dry material to absorb all the juice from the green silage.

Weed Control

Weed Control in Seedling Forages

The severity of the weed problem in forage crops will be determined by:

- the quantity and kinds of weed seeds present in the soil,
- the rate of forage crop emergence and establishment and
- the inherent competitive ability of the forage crop.

Seed Quality

Use plump, well-matured forage seed. Plump seed produces strong seedlings. Their greater food supply permits them to emerge from greater soil depths. This helps insure a uniform stand in spite of normal variations in planting depth.

Use certified seed. The best quality seed contains a very low percent of weed seed.

Effect of seedbed preparation and time of seeding

See seedbed preparation in Section 4. Prepare seedbed far in advance when possible and give additional shallow cultivations to stimulate germination and destroy sprouting weed seeds located at or near the soil surface.

Weed seeds vary in their season of germination. Most lambs-quarter and pigweed seeds germinate in early spring, for example, and the foxtails and tickle grasses germinate in early summer. An intermediate seeding date gives time for additional spring cultivations and permits the forage crop to become established before the summer annual grassy weeds emerge.

In long-season areas, alfalfa and other legumes will survive weed competition better when seeded in early fall than when seeded in the spring.

Mowing or Clipping

The possible benefits from mowing new forage seedings have been underestimated. One of the major effects from mowing new forage seedings several times is that seed production of annual weeds is greatly reduced. Best results are obtained if clipping can be delayed until 8 to 10 weeks after seeding. Clip to a height of about 3 inches. This will reduce shading and temporarily reduce competition for moisture, thus enabling weak forage seedlings to become better established. Earlier clipping may damage seedlings and may make an additional later clipping necessary to prevent seed production of the annual weeds.

Dinitro herbicides for weed control in grasses (use only the selective dinitros) — Apply 2 weeks after emergence or when grasses are 2 to 4 inches tall. The weeds must be small, having not more than 2 to 3 true leaves. These materials work best during warm weather. At high temperatures, rates should be reduced to prevent injury to the grass. The average application rate of the 13-percent material is 3 quarts per acre in 50 gallons of water.

Applications can be made when the grass is much younger, so these materials frequently are more satisfactory than 2, 4-D for early germinating annual weeds. The dinitros are ineffective on perennial weeds.

Dinitro herbicides for weed control in legumes (use only the selective dinitros) — Apply after legumes have developed true leaves. Most legumes can be treated at 3 quarts in 50 gallons of water per acre without serious injury. (Alfalfa can stand higher rates.) Weeds must be small for effective control. Dinitros work best during warm weather. At high temperatures, rates should be reduced to prevent excessive injury to the forage crop.

Diallate or IPC for wild oat control, 2, 4-DB for some annual broadleaved weed control and EPTC for the control of some types of broadleaved and grass weeds can be used in most legumes. Diallate, IPC and EPTC are generally incorporated into the soil before seeding and 2, 4-DB is applied after the crop has true leaves but while the weeds are still small. Use these materials according to the manufacturer's label on the container.

The selective dinitros and 2, 4-DB are the only chemicals that can be used on grass-legume mixtures.

2, 4-D for weed control in grasses — Grasses should not be treated until 6 weeks after emergence. Spray the amine form at 1 pound acid equivalent per acre.

In the second year, perennial grasses may be treated at 2 pounds acid equivalent per acre if noxious weeds are present. The bromes, fescues and wheatgrasses are tolerant to these treatments; bluegrasses and orchardgrasses are less tolerant.

Other chemicals — New chemicals, new uses for older chemicals and occasionally deletions of old chemicals are constantly appearing. Check with your County Agent relative to these changes.

Weed Control in Established Forages

A well-established, adequately fertilized forage crop is in itself one of the best methods for controlling both annual and perennial weeds.

Occasionally, under dryland or partially irrigated conditions, additional control measures are needed. Many annual weeds may be controlled with applications of dalapon, CIPC, diuron, simazin and other herbicides. These chemicals are applied in the fall, winter and early spring. Contact herbicides such as oils and dinitro compounds may be used to destroy patches of dodder and other annual weeds.

Use according to the manufacturer's recommendations on the label.

Insect Control

Insects with different habits are found in our forage crops. Many are parasites or predators of pests — and their effectiveness may be reduced or lost by thoughtless application of insecticides. Therefore, the following steps are essential for effective insect control:

1. Determine what insect is doing the damage.
2. Apply control measures during that period or stage of the insect's development in which the greatest degree of control can be attained.
3. Use the insecticide or other control measure which will give the best control without damaging the plants, affecting the soil adversely or making the forage unfit for livestock consumption. A control measure which does the least harm to beneficial insects, parasites, predators and pollinators should be used.
4. Thorough coverage is essential for effective control.
5. If in doubt, call county agents for information about when and what controls to use.

Insect Pests

Alfalfa weevil

Appearance — Adult weevils are about 3/16 inch long and have a medium-sized downward projecting beak. Adults have a wide brownish stripe down the back. The small, oval-shaped, pearly yellow eggs darken to a dark olive green color as hatching approaches. The legless larvae, on hatching, are dingy yellow but soon become green with a shiny black head and a prominent white stripe along the middle of the back. When full grown, they are about 3/8 inch long. The pupa is adult-like, immobile and contained within a lace-like cocoon.

Injury — The adults do very little damage except to very young stands which they can seriously injure. The larvae, which feed on the terminals and skeletonize the leaves, do the most damage.

Control — When 50% of the terminals show injury, use one of the several effective insecticide treatments — such as malathion, diazinon, Guthion, Furadan, Supracide or Imidan. **Read the label.** Early

NOTE

Any insecticide used for the control of an insect pest must be registered for that use by the U.S. Government. These registrations can be changed at any time. The grower must restrict his use of pesticides to those allowed by current registrations. If in doubt, contact your County Extension Agent or the University of Idaho Extension Entomologist for up-to-date information about insecticide usage.

cutting can also be effective, but the stubble may have to be sprayed. At present, there is only one small wasp parasite of the weevil in Idaho. By itself, the wasp is not very effective in reducing weevil damage.

Clover root borer

Appearance — The adult is a dull-black or dark-brown, somewhat hairy, cylindrical, hard-bodied beetle about 1/12 to 1/10 inch long. The larvae are small, brown-headed, legless, white grubs about 1/10 inch long. Both may be found in burrows in the roots, but the adult is usually found around the crown of the plant.

Injury — Plants that turn brown, wilt and die may have been killed by the borer boring through the roots and grooving the surface.

Control — Limiting the stand to a duration of two years and frequent irrigations should hold the borer in check.

Clover root curculio

Appearance — The adult somewhat resembles the alfalfa weevil with a shorter, broader snout. It is also shorter, slenderer and copper-gray to shiny brownish-black in color. The larvae are grayish-white, legless, brown-headed grubs which, when mature, are about 1/6 inch long.

Injury — The larvae score and furrow the roots of clover and alfalfa. Sometimes they girdle the root. Injured plants wilt during hot weather and die.

Control — Crop rotations and frequent watering in irrigated areas will prevent the build-up of injurious populations. Controls used for lygus usually hold this pest in check.

Cutworms

Appearance — The adults are dull-colored, heavy-bodied, dusk or night-flying moths. The larvae are caterpillars from 1 to 2 inches long when full grown, nearly naked, usually dull-colored and indistinctly marked with stripes and spots according to species. Cutworms are common pests on all forage plants.

Injury — Injury varies according to species. Cutworms may (1) cut off plants at or just below the soil surface; (2) climb plants to feed on the leaves, buds and fruits; (3) feed on the tops of plants while migrating in large numbers or (4) feed on roots and underground parts of plants while remaining in the soil.

Control — Chemical control is most successful when cutworms are small. Usually, an irrigation will help by forcing them to the soil surface. Dibrom, Dylox, methoxychlor, toxaphene, and Sevin baits are registered for various crops. **Check the label.** Besides chemical control, summer plowing and fallowing until frost are of value against cutworms which lay their eggs on vegetation. Parasitic wasps and flies, ground beetles and birds help control cutworms.

Pea aphid

Appearance — The adult pea aphid is a light to dark green, soft-bodied leggy aphid about 3/16 inch long and 1/16 inch wide. The smaller nymphs resemble the adults.

Injury — Aphids suck sap or plant juice from the plant, causing it to turn yellow and wilt if infestations are large enough. Heavy infestations can also cause top die-back, failure of the first crop, reduced vigor in the second and destruction of part of the alfalfa, clover, vetches and other legume stands.

Control — When plants become unthrifty because of an infestation or when 300 aphids are collected per 180° sweep with a 15 inch insect net, malathion, methyl parathion, diazinon, Trithion, Systox, Di-Syston granules or dimethoate can be used for control. **Read the label.** The aphid has many natural enemies — parasites and predatory insects as well as fungus diseases.

Spotted Alfalfa Aphid

Appearance — This 1/16-inch long aphid is lemon-yellow in color with 6 or more rows of conspicuous grayish spots on the back.

Injury — The aphid injects into the alfalfa plant a toxin that causes leaf yellowing and drop. Besides this, the aphid secretes large amounts of honeydew which serves as a good medium for a black, sooty-mold fungus. Small numbers can kill a plant.

Control — Controls should be applied when the population reaches 20 to 40 aphids per stem. On seedlings, one aphid per stem may require control. For insecticides see pea aphid, but **check the label** to be sure material is registered for use against the spotted alfalfa aphid. Use resistant varieties of alfalfa such as Washoe or Lahontan if these are adapted to your area of the state.

Wireworms

Appearance — Wireworms are hard-bodied, slender, cylindrical, shiny, yellow-to-brown, slow-moving larvae or "worms" found in the soil. They have 3 pairs of legs which cannot be seen from above. The last segment of the body may be pronged or forked. When full grown, they can be ¾ inch long. The adults are the familiar, slender, tan-to-brown-to-black, 1/3 to ½ inch click beetles.

Injury — Wireworms destroy seeds, kill seedlings by feeding on the crown and rootlets and injure tubers, bulbs and roots of all major forage plant species.

Control — There are no controls which can be applied once the crop has been planted. Clean stands of alfalfa (no grass or weeds) should reduce wireworm populations. If surveys indicate you have an infested field, insecticides such as Dyfonate, chlordane, Thimet or parathion can reduce or eliminate damage to your next crop. **Read the label** to determine if and how a material can be used.

Other Insects

Occasionally, black plant bugs, **Labops** spp. and **Irbisia** spp.; sawflies, **Pachynematus** spp. and **Dolerus** spp.; grass thrips, **Anaphothrips obscurus;** aphids (many species); winter grain mite, **Penthaleus** major, and Banks grass mite, **Oligonychus pratensis,** may attack grasses in sufficient numbers to cause damage.

Beneficial Insects

There are many beneficial insects, some of greater value than others. Just a few of the more useful are described here. Many times there are sufficient beneficial insects in a field to hold pest species in check and keep the damage or injury below the economic level. Every effort should be made to determine if such is the case before applying a pesticide since other pests may cause economic damage if all their predators and parasites are eliminated. If an insecticide must be applied, you may have the option of choosing a material which will do little or no harm to the beneficial insects. To do so would be wise; such a choice can help prevent the flare-up of a second pest.

Lady beetles

Everyone is familiar with the black-spotted, bright orange beetles that are about ¼ to 1/3 inch long, but most people are not familiar with their dragon like larvae. A full grown larva will be about 2/5 to 3/5 inches long, elongate in form and usually covered with spines. Many of them are brightly colored with dark spots. There is one tiny black lady beetle about 1/6 the length of its larger relatives. It preys on spider mites. The larger lady beetles prey on aphids, mealybugs, scale insects and spider mites.

Damsel bugs

These bugs are slender, ⅜ to ½ inch insects with piercing-sucking mouthparts. Their tan-to-gray bodies are narrowed at the front and have somewhat enlarged front legs for grasping their prey. The nymphs are very similar except the smaller ones do not have wing pads. Damsel bugs feed on lygus bugs, aphids, leafhoppers, spider mites and small caterpillars.

Green lacewings

Adults have large membranous wings with lacelike veins. Their green bodies are slender and their antennae are long and thin. The larvae look like alligators with long, hollow, sickle-shaped jaws. Adults feed on nectar and honeydew, but the larvae impale aphids, other small insects, eggs and spider mites on their mandibles and suck them dry.

Syrphid flies, flower flies or hover flies

This is the fly that resembles a bee or wasp as it hovers around and alights on flowers. the 1/4 to 3/5-inch long adult feeds on nectar,

pollen and honeydew. The ¼ to ½-inch long spindle-shaped larvae are brown or green, wrinkled maggots. They use their mouth hooks to seize and hold aphids while sucking their body fluids out.

Bigeyed bugs

These 1/8 to 3/16-inch long bugs have large protruding eyes and piercing-sucking mouthparts. They and their nymphs, which look like them, feed on aphids, lygus nymphs, leafhoppers and spider mites.

Others

There are many brown, black, red or metallic blue or green wasps ranging in size from 1/8 to 1½ inches long that parasitize our insect pests. They are usually specific as to the pest they attack. Parasitic flies, pirate bugs, ground beetles and other predaceous and parasitic insects, as well as spiders and predaceous mites, help control our crop pests.

Points in Insect Control

1. Proper control methods and proper timing of applications are essential for good control.
2. Drive less than 3 miles per hour when applying insecticides to insure thoroughness of application.
3. Adjust the ground sprayer to use 30 to 50 gallons of finished spray per acre applied at a pressure of at least 100 pounds per square inch. For air application, use 10 gallons of finished spray per acre.
4. Watch closely and avoid skips in application.
5. Treat the field when the wind is not blowing.
6. Remove or cover all bees or notify the beekeeper.
7. To prevent excessive residues, follow the instructions on the pesticide container label for the specific crop, specific dosage and the specific time of application.

READ THE LABEL

Pesticide Residues — If recommendations for use of chemicals are carefully followed, residues should not exceed the tolerance established for any particular chemical. To avoid excessive residues, follow recommendations carefully with respect to dosage levels, number of applications and minimum interval between application and harvest.

The grower is responsible for residues on his crops as well as for problems caused by drift from his property to other properties or crops.

Diseases of Forages In Idaho

Diseases Affecting Alfalfa

Bacterial Wilt

Distribution — Most of the land farmed prior to WWII.

Cause — A bacterium, **Corynebacterium insidiosum**, which survives in dead alfalfa tissue in the soil.

Symptoms and effects — Infected plants are stunted and exhibit yellowing. Shortened stems result in bunchy growth. The leaves are small and often cupped. When roots of infected plants are cut a yellowish or brownish ring is evident under the bark. Yellowish or brownish streaks may appear in the outer woody tissue under the bark.

Stands 3 or more years old, sometimes younger, wilt and die rapidly during warm weather. Plants infected during midseason usually do not survive the winter.

Control — Tolerant varieties are the best means of control. Ranger, Buffalo, Ladak, Lahontan, Orestan, Vernal, Caliverde and Washoe are tolerant. If susceptible varieties are seeded, rotate to other crops two or more years after the second year of alfalfa production.

Black Stem

Distribution — Statewide.

Cause — Ascochyta imperfecta, a fungus which survives on alfalfa refuse in the soil, and can be seed-borne.

Symptoms and effects — The fungus produces dark brown to black elongated lesions on stems and leaf petioles. Brown spots may appear on the leaves. Young shoots may be girdled.

Plants are affected most in the early spring and late summer during rainy periods. A prolonged wet spring enables the fungus to be perpetuated, causing reduced yield and quality, defoliation and death of stems.

Control — Clip early if the disease appears to be serious. Rotate to non-legume plants. Plant disease-free seed. Seed from regions having dry summers is less likely to be infected.

Downy Mildew

Distribution — Statewide.

Cause — Peronospora trifoliorum, a fungus that survives in infected leaves on the soil surface.

Symptoms and Effects — Diseased parts include leaves and sometimes the stems. New leaflets become pale green to yellowish green and may roll or twist downward. A delicate, violet-gray, downy mold growth often is abundant on the underside of infected leaflets. When the entire stem is affected, all leaves and stem tissue are yellow. The stems are larger in diameter and shorter in length.

The fungus is active between temperatures of 50 degrees and 60 degrees F when the humidity is high. Thus, most damage occurs on the first cutting, but occasionally the second cutting may be affected. Damage consists of defoliation and shortened stems.

Control — Clip early to save as many leaves as possible.

Yellowing, leaf discoloration, dwarfing

Distribution — Statewide.

Cause — Nutritional deficiency, lack of nodulation, soil conditions.

Symptoms and effects —

(a) Nutritional: **Boron** deficiency result in dwarfed plants, short terminal internodes, death of terminal buds and yellow to bronze foliage. **Potash** deficiency causes marginal yellowing and white spotting of leaflets. **Phosphorus** deficiency causes purple discoloration of new growth.

(b) Lack of nodulation: Plants are stunted and generally unthrifty. They gradually recover with age as natural processes take over. Dry soil at planting time, or acid soil will inhibit growth of nodule-forming bacteria. Exposure of inoculated seed to bright sunshine will kill the bacteria.

(c) Soil conditions: A condition in north Idaho often referred to as "sick alfalfa" is common in cutover timber lands. The plants are stunted and generally unthrifty. Yields are poor in spite of good stands. The condition often is alleviated after 2 to 3 years' growth in the field. The cause is unknown.

Yellow alfalfa is common under three conditions: (1) in early spring when the soil is cold and biological activity in the soil is low; (2) in second cuttings when the soil has previously been scraped or disturbed by earth moving equipment; and (3) in second cuttings when the soil has been allowed to dry out excessively during the harvest of the first cutting, then overirrigated after removal of the first cutting.

Control — Add nutrients as needed to alleviate nutritional deficiencies. Exercise care in handling and seeding inoculated seed. Provide ample water as needed. Provide sufficient water just prior to clipping the first cutting to carry over through removal of that cutting.

Diseases Affecting Clover

Powdery Mildew

Distribution — Statewide.

Cause — Erysiphe polygoni, a fungus which overwinters on the plant and on infected clover refuse.

Symptoms and effects — The disease is more spectacular than damaging. Small patches of fine, white to pale grey, cobwebby fungus growth develop on the upper leaf surface. The patches later enlarge and coalesce. Infected leaves appear as if they had been dusted with white flour.

Control — None suggested.

Rust

Distribution — Boundary County.

Cause — Uromyces trifolii, a fungus that survives on living clover leaves or on dead infected leaves.

Symptoms and effects — Reddish-brown rust pustules are visible on the under surface of the leaves. Severely rusted plants may reduce forage and seed yields, but usually the infestation occurs too late in the season to cause measurable losses.

Control — None suggested.

Viruses

Distribution — Statewide.

Cause — Several viruses, most of which are transmitted from plant to plant by aphids. One, aster yellows, is transmitted by a leafhopper.

Symptoms and effects — Symptoms are most conspicuous in the leaves and are quite varied because so many viruses are involved. The symptoms include vein yellowing, yellow patches between the veins and mild to severe mottling of the leaves. Sometimes the leaves are curled, puckered — or ruffled. Aster yellows causes the flowers to turn into leaf-like structures.

Some clover viruses have no apparent effect on the vigor of the plant. Others cause severe stunting. Such infected plants may not survive a severe winter or a prolonged drought. Some, in conjunction with root and crown rotting fungi, cause a general decline of plants which die throughout the summer, soon after clipping.

Control — Grow clovers in short rotations. Rotate a red clover seed crop after one year's seed production.

Diseases Affecting Alfalfa and Clovers

Cold and winter injury

Distribution — Statewide.

Cause — Environmental conditions such as (1) low temperatures, (2) desiccation, (3) smothering by ice, (4) soil heaving due to alternate freezing and thawing.

Symptoms and effects — Small to extensive brown flecks occur in the phloem and xylem (food and water conducting tissues). Small cracks may be present beneath the outer bark. The crown and upper part of the taproot may be partially or totally killed. Affected plants may not survive the winter. Dead plants may be scattered, or plants in areas of varying size may be killed.

Control : Use winter hardy varieties. Irrigate late in the fall. Do not clip or graze late in the fall.

Root and Crown Rots

Distribution — Statewide, but most severe from the Rupert-Burley area to western Idaho.

Cause — Species of **Fusarium, Rhizoctonia, Pythium** and possibly **Phytophthora** which are soil-borne fungi. The disease complex is enhanced in the crowns by wounds created by winter injury, livestock, machinery and desiccation.

Symptoms and effects — Distinct absence of lateral and hair roots. Pale yellow to brown or black streaks occur on and in the roots. When severe, internal dry rot is evident. One-year-old infected alfalfa roots may be rotted off 6 to 8 inches below the soil surface. Infected roots of older plants are branched extensively, resulting in shallow rooted plants. The entire center of the crown may exhibit a dry rot, leaving a whorl of buds at the extremity of the crown.

Infected plants are stunted and require more frequent irrigation due to the shallow rooted condition. The plants may die throughout the growing season. Yield is reduced. Plants are more subject to cold and winter injury.

Control — Plant in a firm seedbed. Apply adequate nutrition, but avoid the application of nitrogen. Minimize competition with nurse crops and maintain uniform soil moisture for good growth. Avoid damage to roots and crowns caused by late fall grazing and spring toothing. Irrigate late in the fall to reduce winter injury.

Sclerotinia Wilt and Crown Rot

Distribution — Western Idaho on alfalfa, north Idaho on clovers.

Cause — **Sclerotinia trifoliorum,** a fungus which survives as specialized black fungus structures (sclerotia) in the soil.

Symptoms and effects —

(a) Alfalfa: Stems and crowns are attacked during wet, cool periods or when dense foliage provides high humidity. Affected tissues develop a soft watery rot with dense, white fungus growth on the rotted tissue. Stems wilt when the stem base or crown is rotted. Part or all the plant may die.

(b) Clovers: Brown spots appear on the leaves in late fall. Diseased leaves fall and are covered with a dense white fungus growth. The disease spreads to the crown. In the spring the infected crowns develop a soft watery rot. The new growth wilts, dies and may be covered with the fungus growth. Hard black bodies (sclerotia) about the size of wheat kernels are produced. Stands can be reduced considerably during the early spring.

Control — Rotate with non-legumes 3 to 4 years. Avoid overfertilization (especially nitrogen). Plow deep to bury the sclerotia.

Stem Nematode

Distribution — Most of the irrigated land farmed prior to WWII from the Rupert-Burley area to western Idaho. Also found in the Riggins area, near Malta and in Franklin County.

Cause — **Ditylenchus dipsaci,** a nematode that survives in alfalfa and clover refuse in and on the soil. The nematode can survive in the soil in the absence of a host for at least 2 years.

Symptoms and effects — Diseased plants are severely stunted. The stems have shortened internodes and the diameters may be 3 to 4 times larger than normal. The disease is most easily observed in the early spring (April 15-May 15) on plants 3 or more years of age. Severely infected plants die during the winter and early spring. With the onset of hot weather, symptoms disappear on surviving plants and the plants may appear normal, but many of these die during the growing season due to crown infection and crown rot due to fungi.

Control —

(a) Alfalfa: Plant resistant varieties or blends containing resistant varieties such as Lahontan or Washoe. Rotate 2 or more years after the second year of production with crops other than alfalfa or clover.

(b) Clover: Rotate after the first year of production with crops other than alfalfa or clover.

Diseases Affecting Grasses

Smuts

Distribution — Statewide.

Cause — Mostly species of **Ustilago, Tilletia** and **Sphacelotheca,** fungi that may be soil-borne or seed contaminants. A few, the stem smuts, may survive on infected refuse.

Symptoms and effects — The plant parts affected depend upon the species of smut. When severe, seed production can be reduced considerably.

(a) Stem smuts: Dark brown to black masses of smut spores (sori) are produced on the stems. Grasses most commonly affected are certain species of **Agropyron** (wheat grasses), **Elymus** (rye grasses) and **Poa** (blue grasses).

(b) Head smuts: Smut sori are produced in the inflorescences. The floral bracts as well as the ovary are involved. Species of **Bromus** (brome grasses) and **Festuca** (fescues) are most commonly affected.

(c) Kernel smuts: Smut sori form in the ovaries and assume the general shape of the seed. Species of **Agropyron, Bromus, Elymus** and **Festuca** are the most common host grasses.

Control — Seed treatment with Thiram may reduce the incidence of some of the head and kernel smuts the first year of production.

Rusts - Stripe, Leaf and Stem

Distribution — Statewide, but the incidence fluctuates yearly.

Cause — The fungi **Puccinia striiformis,** and subspecies of **P. recondita** and **P. graminis,** respectively. Stripe rust survives the winter on leaves of infected living hosts including winter wheat. Leaf rust may survive the winter some years on perennial grasses but usually the alternate host (Meadow Rue) is necessary to perpetuate the fungus. Stem rust requires the alternate host (barberry) for perpetuation.

Symptoms and effects —

(a) Stripe rust: Linear yellow to orange rust pustules develop on the leaf blades and sheaths. When severe, forage yield can be reduced considerably.

(b) Leaf rust: Small, circular, orange-red rust pustules develop on the leaf blades and sheaths. The disease is seldom of economic importance in Idaho.

(c) Stem rust: Brick red pustules develop on all above-ground plant parts. The pustules rupture the epidermis of the plant causing the infected plant parts to present a ragged appearance. Older pustules contain black spores. These are overwintering spores and cause no damage to grass plants. If stems are infected prior to the dough stage of developing seed, the seed will be shriveled and thus of poor quality.

Controls — No control is suggested for the control of stripe or leaf rust. As for stem rust, eradication of nearby barberry plants is the only practical method.

Ergot

Distribution — Statewide.

Cause — Mostly **Claviceps purpurea**, a fungus that survives as a specialized fungus structure (sclerotia).

Symptoms and effects — Hard gray to violet colored fungus bodies (sclerotia) replace some of the kernels. The sclerotia usually are 2 to 3 times the length of a normal kernel. The sclerotial stage is preceded by a "honeydew" stage which consists of a sticky mass on the flower parts.

The sclerotia contain substances toxic to livestock. Feeds containing 1.0 percent sclerotia are hazardous. Prolonged feeding can result in abortion, nervous disorders, blindness and paralysis. It also can cause sloughing of hooves, tails and ears in young animals.

Control — Destroy straw and stubble. If ergot is prevalent in grasses or cereals (wheat, oats, barley, rye) they should be mowed prior to flowering. Destroy infested screenings.

Snow Molds

Distribution — At high elevations where deep snow is common.

Cause — Species of **Typhula** and **Fusarium**, fungi that survive in or on infected plant tissues or in the soil.

Symptoms and effects —

(a) **Typhula** (speckled snow mold): A faint cobwebby growth of fungus, develops on the old leaves from the time the snow melts until 2 to 3 weeks later. As the leaf tissues are killed, the fungus produces small, round, reddish-brown sclerotia. With a continued cool (below 45 degrees F) and wet spring, the new growth may be affected, thus retarding forage production.

(b) **Fusarium** (pink snow mold): Early symptoms are similar to those induced by the former, but the fungus growth is salmon pink. The dying leaf tissues at first assume a pink color which later bleaches to a buff color. This fungus can be more devastating than **Typhula** because root and crown tissues also can be attacked causing delay in growth, stunting of plants and sometimes death.

Control — Do not apply fertilizer late in the fall to promote late growth, as those leaves may be attacked under the snow. Establish plantings as early in the spring as possible. Where feasible include a mixture of grasses and legumes.

Diseases Affecting Alfalfa, Clovers and Grasses

Damping-off and Seedling Blight

Distribution — Statewide.

Cause — Various species of the soil-borne fungi **Rhizoctonia, Pythium,** and **Fusarium.**

Symptoms and effects — Two types of damping-off occur: pre-emergence and post-emergence. In the former, the disease often is referred to as seed decay because poor emergence of plants leads one to believe the seed decayed. This disease type causes a reduced stand.

Post-emergence damping-off occurs as the plants are emerging or soon after emergence. The stems become discolored and the plant dies quickly. A stand can be nearly destroyed within a 2 to 3 day period. Surviving plants may be weakened and yield poorly.

Control — Plant in good seedbed in well drained soil. Avoid over-irrigation when the plants are small.

Leaf spots, blotches and stripes

Distribution — Statewide.

Cause — Species of several fungi and bacteria which survive in living hosts or dead infected refuse.

Symptoms and effects — Symptoms vary considerably because so many pathogens and forage species and varieties are involved. Infected leaves may exhibit spots that are circular, boat shaped, striped, streaked or irregular. The colors of the spots may vary from buff to brown to black or even purplish.

The general effects of the various foliar diseases are reduced leaf area, defoliation of legumes and reduced yield and quality.

Control — Harvest early to save as much of the foliage as possible. Plant a mixture of legumes and grasses where feasible.

Reference Publications

Seeding and Establishment

1. Establishment and Production of Grasses Under Semi-arid Conditions in the Intermountain West, Harold L. Harris, A. E. Slinkard, A. L. Hofenrichter, Bull. 532, July 1972, Idaho Agricultural Exp. Sta.
2. The Establishment and Management of Alfalfa, Dale Smith, Bull. 542 Univ. of Wisconsin, Jan. 1960.
3. Legume Inoculation, USDA, Farmer's Bull. 2003, 1953.

Soils - Fertility

4. Soil Sampling, Frank Parks, Idaho Current Inf. Series, No. 162, May 1971.
5. Phosphate Fertilization Studies in Idaho Using Radioactive Phosphorus, J. V. Jordan and G. O. Baker, Idaho Agricultural Exp. Sta., Research Bull. No. 35, March 1957.
6. Fertilizing Irrigated Pastures, Charles G. Painter, R. S. Samson, A. E. Slinkard, Idaho Agricultural Exp. Sta. Bull. 452, Feb. 1967.
7. Idaho Fertilizer Guide; Irrigated Alfalfa, Wayne Thiessen, Idaho Agricultural Ext. Service FG-14, 1972.
8. Idaho Fertilizer Guide; Field Corn for Silage or Grain, Wayne Thiessen, Idaho Agricultural Ext. Service, FG-7, May 1971.
9. Idaho Fertilizer Guide; Irrigated Pastures, Wayne Thiessen, Idaho Agricultural Ext. Service, FG-5, May 1971.
10. Irrigation and Fertilization of Field Corn Grown for Silage in Southeastern Idaho, Galen McMaster, J. G. Walker, E. Owens, Idaho Agricultural Exp. Sta. Bull. 392, Sept. 1962.
11. Nitrogen — What Farmers Should Know About It, G. O. Baker, C. G. Painter, Idaho Agricultural Ext. Service Bull. 275, June 1961.
12. Phosphorus — What Farmers Should Know About It, C. G. Painter, G. O. Baker, Idaho Agricultural Ext. Service Bull. 276, June 1961.
13. Harvest Timing, Fertilization and Species of Hay for Western Montana, Donald R. Graham and C. W. Roath, Montana Agricultural Exp. Sta. Research Report 22, July 1972.

Management - Utilization

14. Managing Beef Cattle on Improved Irrigated Pastures, Ed Duren, Idaho Current Inf. Series, 198, Feb. 1973.
15. Manage Corn Silage for Maximum Value, Edward A. Fiez and G. Cleveland, Idaho Current Inf. Series, 188, June 1972.
16. Corn Silage for Dairy Cattle, David L. Thacker, Idaho Current Inf. Series, 50, April 1967.
17. The Sagebrush Region in Idaho - A Problem in Range Resource Management, E. W. Tisdale, M. Hironaka, M. A. Fosberg, Idaho Agricultural Exp. Sta. Bull. 512, Dec. 1969.
18. Producing Field Corn in Idaho, Robert Higgins and E. Owens, Idaho Agricultural Ext. Bull. 402, June 1963.
19. Management of Lutana Cicer Milkvetch for Hay, Pasture, Seed and Conservation Uses, James R. Stroh et al, Montana and Wyoming Agricultural Exp. Sta. Joint Research Journal 66, Nov. 1971.
20. A guide to the Management of Idaho's Wet Pastures, USDA-SCS, Boise, Idaho 1971.

21. Alfalfa and Alfalfa-Bromegrass Hays for Growing and Fattening Lambs, T. B. Keith, R. H. Stark, C. W. Hickman, Idaho Agricultural Experiment Station and USDA-SCS Journal of Am. Sci., Volume 9, Number 4, November 1950.

22. Beef Production on Irrigated Pastures, Clair R. Acord, Utah Agricultural Exp. Sta., Utah Science, Volume 30, 1969.

23. Enterprise Cost Alfalfa Hay: Loose, Baled and Chopped, Bill Chiese and George M. Goodwin, Montana Agricultural Ext. Service Bull. 1056, May 1968.

24. Temperature Stress on Growth and Seed Characteristics of Grasses and Legumes, Western Agricultural Exp. Sta. Cooperative Tech. Res. Bull. 97, Colorado, June 1967.

25. Management of Alfalfa for High Quality Hay on Non-Irrigated Lands of Northern Idaho. Chester L. Canode and K. H. Klages, Idaho Agricultural Exp. Sta. Res. Bull. 36, April 1957.

27. Pacific Northwest Range - Its Nature and Use, Idaho, Washington, and Oregon PNW Coop. Ext. Bull. 73, Mar. 1966.

Varieties

28. Sodar Wheatgrass, Donald Douglas and R. D. Ensign, Idaho Agricultural Exp. Sta. Bull. 234, Apr. 1954.

29. Nordan Crested Wheatgrass for Idaho, Ronald B. Foster and H. McKay, Idaho Agricultural Exp. Sta. Bull. 395, June 1962.

30. Regar Bromegrass, Ronald B. Foster, H. McKay and E. Owens, Idaho Agricultural Exp. Sta. Bull. 470, Aug. 1966.

31. Alfalfa Varieties and Areas of Adaptation, Leaflet 507, Crops Research Division, USDA, 1962.

32. Washoe Alfalfa for Southern Idaho, John J. Kolar, Idaho Agricultural Exp. Sta. Bull. 487, May 1967.

33. Grass Varieties in the United States, A. A. Hanson, USDA Handbook 170, Nov. 1972.

34. Grasses and Legumes for Soil Conservation in the Pacific Northwest and Great Basin States, A. L. Hofenrichter, J. L. Schwendiman, H. Harris, R. S. MacLauchlan and H. W. Miller, USDA-SCS Handbook 339, 1968.

35. Tegmar — Dwarf Intermediate Wheatgrass, Harold L. Harris and H. B. Roylance, Idaho Agricultural Exp. Sta. Bull. 504, Mar. 1969.

36. Sainfoin — Forage and Seed Production in Northern Idaho, Glen Murray, Idaho Current Inf. Series 137, Oct. 1970.

37. Sainfoin — Time of Cutting, Wendal Hassel, USDA-SCS Tech. Notes, TN Plant Materials No. 17.

Pest Control - Weeds - Insects - Diseases

38. Wireworm Control — Irrigated Farming, L. E. O'Keeffe, Idaho Current Inf. Series 99, Mar. 1969.

39. Insect Control for Alfalfa Seed Production, Roland W. Portmand and H. Homan, Idaho Current Inf. Series 183, Apr. 1972.

40. Perennial Weed Control, Robert Higgins, Idaho Current Inf. Series 160, May 1971.

41. Idaho Weed Control Handbook, Idaho Agricultural Ext. Service, Apr. 1971.

42. Alfalfa Analyst — On Diseases, Insects and Deficiencies, Idaho, Oregon, Washington PNW Bull. 129, Dec. 1972.