Irrigated Forages for Western Nevada-Type Climate

Joint Recommendations by Nevada Cooperative Extension University of Nevada, Reno and the Soil Conservation Service

Authors

E. H. Jensen, Extension Agronomist, University of Nevada, Reno
J. W. Doughty, State Resource Conservationist, Soil Conservation Service, Reno
B. E. Wheeler, Central Area Agronomist, University of Nevada, Reno
C. D. Leedy, Western Area Extension Agronomist, Douglas County Extension

Summary

A series of publications regarding plant materials adapted for various uses and soils in the different climatic regions of Nevada has been developed by Nevada Cooperative Extension, University of Nevada, Reno and the Soil Conservation Service, United States Department of Agriculture. This series includes four publications: Irrigated Forages for Northern Nevada-Type Climate; Irrigated Forages for Western Nevada-Type Climate; Irrigated Forages for Southern Nevada-Type Climate; and, Conservation Plantings for: Rangeland, Windbreaks, Wildlife and Soil Conservation Cover.

The recommendations were developed to serve as a common source of information and recommendations regarding plant materials. Their use is encouraged by agricultural workers in the state to aid individuals/agencies in arriving at proper decisions regarding use of plant materials for agricultural and nonagricultural use such as mining reclamation, highway beautification and recreation.

Acknowledgments

The joint recommendations have been developed with the assistance of many workers. Special recognition is accorded to E. A. Naphan (Retired), Norman R. Ritter (Retired), and Jake C. Garrison (Retired) of the SCS; and to F. F. Peterson (Retired), D. E. Gilbert (Retired), and R. O. Gifford (Deceased) of the University of Nevada, Reno, for their contributions.

Bernard M. Jones
Director
Nevada Cooperative Extension
University of Nevada, Reno

William D. Goddard
State Conservationist
Soil Conservation Service
Reno

The University of Nevada, Reno is an Equal Opportunity/Affirmative Action institution. The university employs only U.S. citizens and those aliens lawfully authorized to work in the United States.
All programs and services of the U.S. Department of Agriculture are offered on a nondiscriminatory basis without regard to race, religion, color, sex, age, national origin, or handicap.

Table of Contents

UNIVERSITY
OF NEVADA
RENO

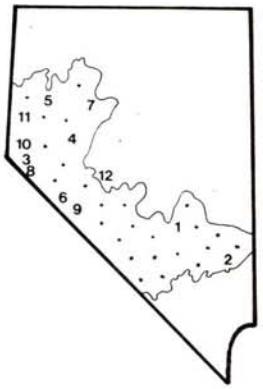
Irrigated Forages for Western Nevada-Type Climate

Introduction

This publication is intended to provide information regarding irrigated forages adapted to Western Nevada. Recommendations have been developed jointly by Nevada Cooperative Extension and Soil Conservation Service. Climatic conditions and availability of plant materials have also been considered. It is recognized, however, that these recommendations may require adjustments on any individual farm or ranch as dictated by particular needs or conditions within a small area.

Resource Areas

The areas in Nevada for which these recommendations are intended is shown in the shaded area of the map. Resource areas 22, 26, 27, and 29 as defined in Agricultural Handbook 296, USDA, SCS, 1981, "Land Resource Regions and Major Land Resource Areas of the United States" are included.



1. Adaven
2. Caliente
3. Carson City
4. Fallon
5. Gerlach
6. Hawthorne
7. Lovelock
8. Minden
9. Mina
10. Reno
11. Sand Pass
12. Smoky Valley

The area consists of portions of the east slope of the Sierra Nevada, and numerous north-south-oriented mountain ranges and intervening valleys or internally-drained basins. The mountains have considerable relief and consist mostly of igneous and metamorphic rock. Fan piedmonts, fan skirts, lake shoreline features and alluvial flats and playas of basin floors are common landforms. The soils of the valleys and basins have formed in alluvial or lacustrine sediments.

Table 1
Climatic data for selected western and central Nevada locations

Location	Elevation (feet)	Annual Precipitation (inches)	Mean Temperature		Mean Freeze-Free Period	
			Annual °F	July °F	32°F days	24°F days
Adaven	6300	13	49	70	122	178
Caliente	4400	9	53	76	150	211
Carson City	4600	11	50	70	123	177
Fallon	4000	5	51	73	132	192
Gerlach	3900	5	51	76	138	201
Hawthorne	4100	4	54	76	165	220
Lovelock	4000	6	52	75	129	178
Minden	4700	9	50	69	104	162
Mina	4600	4	54	78	155	213
Reno	4400	7	49	68	103	171
Sand Pass	3900	7	51	73	138	199
Smoky Valley	5600	6	50	71	109	156

Elevations in the area range from about 3,000 feet in Pahranagat Valley to over 13,000 feet on Boundary Peak in the White Mountains.

The climate of the area is influenced to a large degree by the complex topography. Much of the area is under the influence of the rain shadow, produced by the Sierra Nevada. Consequently, precipitation is generally lower and cloud cover is generally less than the area further west. Precipitation varies from 4 inches in the valleys and on lee slopes to approximately 13 inches at the higher elevations. Much of the precipitation falls as snow with average amounts of snow ranging from 5 inches in the valleys of the western portion to 55 inches at higher elevations. Precipitation during the summer comes primarily from thunderstorms. Cold air drainage into valley floors causes low temperatures in these areas, particularly during the critical spring and fall periods. The number of hot days (temperature over 90 degrees Fahrenheit) varies from 20 on the Sierra Nevada slopes to about 70 degrees Fahrenheit in the east near Caliente. With warm, clear days, low humidity and frequent wind, total annual evaporation is high, varying 65 inches in the northern portions to 85 inches in the central and eastern portions of the area. Selected climatic data are given in Table 1.

The Truckee, Carson, Walker and Humboldt Rivers are important sources of surface water in the area. Water from these streams is used for irrigation in the vicinity of Reno, the Fallon-Fernley areas, and in Carson, Smith, Mason and Lovelock valleys. Several storage reservoirs have been constructed on these streams. In addition to the above streams, numerous small mountain streams are used for irrigation at scattered locations throughout the area. Several large springs supply most of the water for irrigation in Pahranagat Valley. Ground water is available in limited quantities in the valleys throughout the area, and has been developed in Truckee Meadows, Mason Valley, Fish Lake Valley, Pahranagat Valley, Penoyer Valley, Sarcobatus Flat and several other valleys. The quality of most surface water is good. Ground water varies somewhat in quality from valley to valley. It is generally of good to fair quality except for certain locations in some of the larger enclosed sinks and basins.

Major land uses in the area include irrigated farming, grazing, wildlife, woodland, watershed, recreational, defense and some urban, suburban and industrial use.

The following key identifies the major differences in soil properties that affect the varieties of irrigated forages that should be grown in Nevada. To use the key, start at the top and work down stepwise and put your soil in the first group it fits.

Other problems such as climate, slope, fertility, stoniness, and water management will have to be considered separately. Soils should have at least 20 inches of usable depth for best production of improved irrigated forages; soils less than 10 inches deep usually require irrigating too frequently to be suitable for improved irrigated forages. Salt-affected or sodium-affected (alkali) soils should be reclaimed by proper use of drainage, leaching, and soil amendments. Contact your Nevada Cooperative Extension agent for information on taking soil samples for salt and sodium analysis.

A more complete listing of the properties of these soil groups is given in the Appendix along with a detailed list of properties to use in the field for determining soil drainage and water holding capacity.

Key
Soils for Irrigated Forages

Table 2

Irrigated Forage Plant Characteristics

Grass	Recomm. Varieties	Winter hardiness	Seedling vigor	Yield Potential	Longevity	Growth habit	Compata-bility	Palatabil-ity	Recovery Rate	Use	Stubble Height (inches)	Drought tolerance	Wetness and flood tolerance	Salt and alkali tolerance
Tall fescue (1)	Alta Fawn	Excellent	Good	High	Long	Bunch	Poor	Fair	Rapid	Multiple	Three	Fair	Good	Good
Orchardgrass (2)	Potomac Latar	Good	Good	High	Medium	Bunch	Good	Excellent	Rapid	Multiple	Three	Fair	Poor	Poor
Smooth brome-grass	Marchar Lincoln (3)	Excellent	Good	Medium	Medium	Sod	Good	Excellent	Medium	Multiple	Three	Good	Fair	Fair
Turkish (meadow bromegrass)	Regar	Excellent	Good	Medium	Medium	Sod	Good	Excellent	Rapid	Multiple	Three	Fair	Good	Fair
Creeping meadow foxtail (4)	Garrison	Excellent	Good	Medium	Long	Sod	Good	Excellent	Rapid	Multiple	Three	Poor	Excellent	Good
Reed canarygrass (4,5)	Ioreed	Excellent	Poor	High	Long	Sod	Poor	Poor	Rapid	Multiple	Three	Good	Excellent	Poor
Basin wildrye	Magnar	Excellent	Poor/ Fair	High	Long	Bunch	Poor	Poor	Slow	Multiple	Eight	Excellent	Good	Good
Tall wheatgrass (6)	Alkar	Excellent	Excel-lent	High	Medium	Bunch	Poor	Poor	Slow	Multiple	Eight	Excellent	Good	Excellent
Intermediate wheatgrass (7)	Greenar	Excellent	Good	High	Medium	Sod	Good	Good	Medium	Multiple	Four	Excellent	Poor	Fair
Pubescent wheatgrass (7)	Greenleaf Luna Topar	Excellent	Good	Medium	Long	Sod	Good	Good	Medium	Multiple	Three	Excellent	Poor	Fair
Streambank wheatgrass (8)	Sodar	Excellent	Good	Low	Long	Sod	--	Poor	Slow	Erosion Control	--	Excellent	Poor	Good
Timothy (9)	Drummond Climax	Excellent	Good	Medium	Short	Bunch	Good	Good	Slow	Hay	Three	Poor	Good	Poor
Kentucky bluegrass (10)	Park	Excellent	Good	Medium	Long	Sod	Poor	Good	Rapid	Pasture	Three	Poor	Good	Poor

(1) Use in simple mixtures (preferably one grass, one legume).
(2) Potomac is an early maturing variety and Latar is later maturing. Latar is more compatible with alfalfa than Potomac in maturity dates.
(3) Other Southern types also adapted.
(4) Well adapted to wet non-saline areas.
(5) Well adapted to wet non-saline soils. Harvest at or before signs of heading. Plant high germination seed.
(6) Use in saline-sodic soils.
(7) Use where short season water prevails.
(8) Streambanks and critical areas -- not for grazing.
(9) Primarily used as horse feed.
(10) Pasture invader and special use.

Table 2
Irrigated Forage Plant Characteristics (continued)

Grass or legume	Recomm. Varieties	Winter hardiness	Seedling vigor	Yield Potential	Longevity	Growth habit	Compata-bility	Palatabil-ity	Recovery Rate	Use	Stubble Height (inches)	Drought tolerance	Wetness and flood tolerance	Salt and alkali tolerance
Desert wheatgrass (1)	Nordan Hycrest Ephraim	Excellent	Excel-lent	Medium	Long	Bunch	Good	Good	Slow	Multiple	Three	Excellent	Poor	Good
Siberian wheatgrass (1)	P27	Excellent	Excel-lent	Medium	Long	Bunch	Good	Good	Slow	Multiple	Three	Excellent	Poor	Good
Sudangrass (2)	Piper	Poor	Excel-lent	Medium	Annual	Bunch	Poor	Good	Rapid	Pasture, silage or green chop	Four	Fair	Poor	Good
Alfalfa (3)		Excellent	Excel-lent	High	Long	Tap Root	Good	Excellent	Rapid	Multiple	Three	Good	Poor	Good
Red clover	Arlington Kenland	Good	Excel-lent	Medium	Short	Branch Tap root	Good	Good	Slow	Multiple	Three	Poor	Fair	Poor
Alsike clover (4)		Excellent	Excel-lent	Medium	Medium	Branch Tap root	Good	Good	Medium	Multiple	Three	Poor	Good	Poor
Sweetclover (5)		Excellent	Excel-lent	High	Biennial	Tap root	Fair	Poor	Medium	Pasture or green chop	Six	Good	Fair	Excellent
Ladino clover (6)		Good	Good	Medium	Medium	Stolons	Good	Excellent	Rapid	Pasture	Two	Poor	Fair	Poor
Strawberry clover (7,10)	Salina	Good	Good	Low	Medium	Stolons	Good	Good	Medium	Pasture	Two	Poor	Excellent	Good
Broadleaf birdsfoot trefoil (8,10)	Viking Leo	Good	Poor	Medium	Medium	Branch Tap root	Good	Excellent	Medium	Multiple	Three	Fair	Good	Fair
Narrowleaf birdsfoot trefoil (8,10)		Good	Poor	Low	Medium	Branch Tap root	Good	Excellent	Medium	Pasture	Three	Fair	Good	Good
Sanfoin (9)	Remont	Excellent	Excel-lent	Medium	Short	Branch Tap Root	Good	Good	Slow	Multiple	Four	Good	Poor	Good
Cicer milkvetch (9)	Lutana Monarch	Excellent	Poor	Medium	Long	Rhi-zomes	Good	Excellent	Rapid	Pasture	Three	Fair	Good	Good

(1) Use where short season water prevails.
(2) Use during hot season in warm areas. Danger of HCN poisoning.
(3) Many varieties are adapted to the area. See your Cooperative Extension agent or SCS district conservationist for current recommendations and variety characteristics.
(4) Adapted to wet soils.
(5) Bleeding hazard -- Coumarin.
(6) Danger of bloat.
(7) Well adapted to wet and wet saline-sodic soils.
(8) Plant in alternate rows to aid in establishment. Non-bloat.
(9) Non-bloat. Use at high elevations where only one cutting for hay is expected.
(10) Molybdenum accumulator.

Table 3

Mixtures and Seeding Rates for Soil Group A

Soils with no problems other than some slight to moderate wetness

Full Season Water				Short Season Water			
Hay	lb/A	Pasture	lb/A	Hay	lb/A	Pasture	lb/A
Alfalfa (1)	10	Alfalfa (1, 4)	2	Alfalfa (1)	10	Alfalfa (1)	2
or		or		or		with	
Alfalfa	5	Ladino Clover (4)	2	Alfalfa	5	Intermediate	
with		with		with		Wheatgrass	8
Smooth		Orchardgrass (3)	5	Intermediate		or	
Bromegrass (2)	8	or		Wheatgrass	8	Pubescent	
or		Tall Fescue	8	or		Wheatgrass	8
Orchardgrass (3)	5	or		Pubescent			
or		Smooth		Wheatgrass	8		
Tall Fescue	8	Bromegrass (2)	8				
or		or					
Turkish		Turkish					
Bromegrass	8	Bromegrass	8				

lb/A = pounds per acre

(1) See your Cooperative Extension agent or SCS district conservationist for current recommendations and variety characteristics.

(2) Smooth bromegrass is not recommended for Smith Valley or Mason Valley.

(3) Seed Potomac orchardgrass with Ladino clover and seed Latar orchardgrass with alfalfa.

(4) A longer regrowth period is recommended for alfalfa than for Ladino clover.

Table 4

Mixtures and Seeding Rates for Soil Group B

Soils with only some moderate salinity-sodium problems

Full Season Water				Short Season Water			
Hay	lb/A	Pasture	lb/A	Hay	lb/A	Pasture	lb/A
Alfalfa (1)	10	Alfalfa (1)	2	Alfalfa (1)	10	Alfalfa (1)	2
or		with		or		with	
Alfalfa	5	Tall Fescue	8	Alfalfa	5	Intermediate	
with				with		Wheatgrass	8
Tall Fescue	8			Intermediate		or Pubescent	
				Wheatgrass	8	Wheatgrass	8
				or Pubescent		or Siberian	
				Wheatgrass	8	Wheatgrass (2)	6
				or Siberian		or Desert	
				Wheatgrass (2)	6	Wheatgrass (2)	6
				or Desert			
				Wheatgrass (2)	6		

lb/A = pounds per acre

(1) See your Cooperative Extension agent or SCS district conservationist for current recommendations and variety characteristics.

(2) Seed Siberian or desert wheatgrass on severely dry sites.

Table 5

Mixtures and Seeding Rates for Soil Group C

Claypans at less than 20 inch depth that restricts root and water penetration

Full Season Water				Short Season Water			
Hay	lb/A	Pasture	lb/A	Hay	lb/A	Pasture	lb/A
Alfalfa (1, 5)	10	Alfalfa (1, 5)	5	Alfalfa (1, 5)	10	Alfalfa (1, 5)	2
or		or		or		with	
Alfalfa	5	Ladino Clover	2	Alfalfa	5	Intermediate	
or		or		with		Wheatgrass	8
Alsike Clover	5	Narrowleaf		Intermediate		or	
or		Birdsfoot		Wheatgrass	8	Pubescent	
Red Clover	5	Trefoil (2)	3	or		Wheatgrass	8
or		with		Pubescent			
Birdsfoot Trefoil (2)	5	Orchardgrass (4)	5	Wheatgrass	8		
with		or					
Smooth		Smooth					
Bromegrass (3)	8	Bromegrass	8				
or		or					
Turkish Bromegrass	8	Tall Fescue	8				
or		or					
Orchardgrass (4)	5	Turkish					
		Bromegrass	8				

lb/A = pounds per acre

(1) Care must be taken in irrigating to prevent loss of alfalfa stands.
(2) Seed birdsfoot trefoil in alternate rows with grass.
(3) Smooth bromegrass is not recommended for Smith Valley or Mason Valley.
(4) Seed Potomac orchardgrass with clover and seed Latar with alfalfa.
(5) See your Cooperative Extension agent or SCS district conservationist for current recommendations and variety characteristics.

Table 6

Mixtures and Seeding Rates for Soil Group D

Clayeyness throughout the soil profile

Full Season Water				Short Season Water			
Hay	lb/A	Pasture	lb/A	Hay	lb/A	Pasture	lb/A
Alfalfa (1)	10	Alfalfa (1)	2	Alfalfa (1)	10	Alfalfa (1)	2
or		or		or		with	
Alfalfa	5	Ladino Clover	2	Alfalfa	5	Pubescent	
with		or		with		Wheatgrass	8
Tall Fescue	8	Narrowleaf		Pubescent		or	
		Birdsfoot		Wheatgrass	8	Intermediate	
		Trefoil (2)	3	or		Wheatgrass	8
		with		Intermediate			
		Tall Fescue	8	Wheatgrass	8		

lb/A = pounds per acre

(1) Seed birdsfoot trefoil in alternate rows with grass.
(2) See your Cooperative Extension agent or SCS district conservationist for current recommendations and variety characteristics.

Table 7

Mixtures and Seeding Rates for Soil Groups E and F

Droughtiness due to gravel at less than 20 inch depth or sandyness throughout the profile

Full Season Water				Short Season Water			
Hay	lb/A	Pasture	lb/A	Hay	lb/A	Pasture	lb/A
Alfalfa (1)	10	Alfalfa (1) with Intermediate Wheatgrass	2	Alfalfa (1)	10	Alfalfa (1) with Crested Wheatgrass	2
or		or		or		or	
Alfalfa with Intermediate Wheatgrass	5 8	Pubescent Wheatgrass	8	Alfalfa with Crested Wheatgrass	5 6	Siberian Wheatgrass	6
or				or		or	
Pubescent Wheatgrass	8			Siberian Wheatgrass	6	Pubescent Wheatgrass	8
				or			
				Pubescent Wheatgrass	8		

lb/A = pounds per acre

(1) See your Cooperative Extension agent or SCS district conservationist for current recommendations and variety characteristics.

Table 8

Mixtures and Seeding Rates for Soil Group G

Droughtiness due to hardpan or bedrock at less than 20 inch depth

Full Season Water				Short Season Water			
Hay	lb/A	Pasture	lb/A	Hay	lb/A	Pasture	lb/A
Alsike Clover (1)	5	Ladino Clover (1)	2	Alfalfa (3) with Intermediate Wheatgrass	2 8	Alfalfa (3) with Intermediate Wheatgrass	2 8
or		or		or		or	
Red Clover	5	Narrowleaf Birdsfoot Trefoil with Intermediate Wheatgrass	5 8	Pubescent Wheatgrass	8	Pubescent Wheatgrass	8
or		or					
Birdsfoot Trefoil (2) with Intermediate Wheatgrass	5 8	Tall Fescue	8				
or		or					
Tall Fescue	8	Orchardgrass (3)	5				
or		or					
Orchardgrass	5	Pubescent Wheatgrass	8				
or							
Pubescent Wheatgrass	8						

lb/A = pounds per acre

(1) Frequent irrigation is needed under full season water but care must be taken to prevent perched water table.

(2) Seed birdsfoot trefoil in alternate rows with grass.

(3) See your Cooperative Extension agent or SCS district conservationist for current recommendations and variety characteristics.

Table 9

Mixtures and Seeding Rates for Soil Group H

Poorly drained soils but without salinity - sodium hazard

Hay	Full Season Water lb/A	Pasture	lb/A
Creeping Meadow Foxtail	5	Creeping Meadow Foxtail	5
or		or	
Reed Canarygrass	6	Reed Canarygrass	6
or		with	
Timothy	5	Strawberry Clover	3
or		or	
Basin Wildrye	10	Alsike Clover	3
with			
Alsike Clover	3		

lb/A = pounds per acre

Table 10

Mixtures and Seeding Rates for Soil Group I

Poorly drained soils with salinity - sodium hazard

Hay	Full Season Water lb/A	Pasture	lb/A
Tall Wheatgrass	10	Tall Wheatgrass	10
or		or	
Tall Fescue	15	Tall Fescue	15
or		or	
Tall Fescue	8	Tall Wheatgrass	10
or		or	
Tall Wheatgrass	8	Tall Fescue	8
with		with	
Broadleaf Birdsfoot Trefoil (1,2)	5	Strawberry Clover (2)	3
		or	
		Narrowleaf Birdsfoot Trefoil (1,2)	5

lb/A = pounds per acre

(1) Seed birdsfoot trefoil in alternate rows.
(2) Seedlings may winterkill if planted in fall.

Table 11
Mixtures and Seeding Rates for Soil Group J
Excessive wetness (very poorly drained)

Possible species for seeding may include the following, but treatment, species and seeding rates will depend upon on-site investigation.

Hay	Full Season Water lb/A	Pasture	lb/A
Creeping Meadow Foxtail	12	Reed Canarygrass	12
or		or	
Tall Fescue	12	Tall Fescue	12
or		with	
Reed Canarygrass	12	Alsike Clover	3
with		or	
Alsike Clover	3	Red Clover	3
or		or	
Red Clover	3	Strawberry Clover	3
or			
Strawberry Clover	3		

lb/A = pounds per acre

Table 12
Disturbed Soils
Soil stabilization, ditchbank and other non-crop seedings

The following species are recommended for stabilizing or protecting disturbed areas that receive over 8 to 10 inches of rain or will receive some supplemental irrigation water.

For wildlife, follow recommendations for hay or pasture if supplemental irrigation water is available.

Drill Seeding	lb/A	Broadcast seeding	lb/A
Streambank Wheatgrass	6	Streambank Wheatgrass	12
or		or	
Crested Wheatgrass	6	Crested Wheatgrass	12
or		or	
Orchardgrass	6	Orchardgrass	12
or		or	
Sheep Fescue	4	Sheep Fescue	8
with		with	
Sweetclover	3	Sweetclover	2

lb/A = pounds per acre

Appendix 1
A grouping of soils for irrigated forages

Soil Group	Major Soil Limitations (1)	Usable Depth in. (2)	Surface Texture (3)	Subsoil Texture (3)	Drainage Class (4)	Salinity Hazard Ec, mmhos/cm (5)	Sodium Hazard (SAR) (6)	Available Water Holding Capacity in Surface Foot in. (7)
A	Soils with no problems other than some slight to moderate wetness	>20	sl,fsl,vfsl, l,sil,si,cl, scl,sicl	sl,fsl,vfsl, l,sil,si,cl, scl,sicl	well, mod. well, somewhat poorly drained	<4	<10	>1.25
B	Only some moderate salinity-sodium hazard	>20	sl,fsl,vfsl, l,sil,si,cl, scl,sicl	sl,fsl,vfsl, l,sil,si,cl, scl,sicl	well, mod. well, somewhat poorly drained	4-10	10-30	>1.25
C	Claypan at less than 20 inch depth that restricts root and water penetration	<20 to claypan	sl,fsl,vfsl, l,sil,si,cl scl,sicl	sc,sic,c	well, mod. well, somewhat poorly drained	<4	<10	>1.25
D	Clayeyness throughout the soil profile	>20	sc,sic,c	sc,sic,c	mod. well, somewhat poorly drained	<4	<10	>1.5
E	Droughtiness due to gravel at less than 20 inch depth	<20 to gravel	sl,fsl,vfsl, l,sil,si	s,ls,gravel, cobbles	well, mod. well drained	<4	<10	>1
F	Droughtiness due to sandiness throughout the soil profile	>20	s,ls	s,ls	excessively well, mod. well, somewhat poorly drained	<4	<10	<1
G	Droughtiness due to hardpan or bedrock at less than 20 inch depth	<20 to hardpan, bedrock	sl,fsl,vfsl, l,sil,si,cl, scl,sicl	sl,fsl,vfsl, l,sil,si,cl, scl,sicl	well, mod. well drained	<4	<10	>1.25
H	Poorly drained but without salinity-sodium hazard	<20	all textures	all textures	poorly drained	<4	<10	>1
I	Poorly drained with salinity-sodium hazard	<20	all textures	all textures	poorly drained	4-20	10-50	>1
J	Excessive wetness (very poorly drained)	<10	all textures peats	all textures	very poorly drained	<4	<10	--

< = less than > = more than

Appendix 1
A grouping of soils for irrigated forages (continued)

1. Only serious soil problems are considered. Gravel content <35 percent by volume is assumed. Climatic, irrigation, and fertility factors are assumed suitable. The drainage and salinity hazards are for the soil at the present time. In defining these soil groups, some major later crop management requirements have been considered in addition to mere species adaption.

2. Usable depth refers to that depth exploited by large numbers of roots.

3. The surface soil is the 0 to 10 inch depth layer, or the plowed layers. The subsoil is the B horizon of soil survey reports if one is present, or else the 10 to 40 inch depth layer, or from 10 inches depth to bedrock or hardpan in shallow soils.

The following list of abbreviations for soil texture names are given by the generalized groups which are used to report soil texture on the soil test data sheets from the Nevada Soil and Water Testing Laboratory, University of Nevada, Reno:

1. Coarse Textures
   - s = sands
   - ls = loamy sand

2. Moderately Coarse Texture
   - sl = sandy loam
   - fsl = fine sandy loam

3. Medium Textured
   - vfsl = very fine sandy loam
   - l = loam
   - sil = silt loam
   - si = silt

4. Moderately Fine Textured
   - cl = clay loam
   - scl = sandy clay loam
   - sicl = silty clay loam

5. Fine Textured
   - sc = sandy clay
   - sic = silty clay
   - c = clay

4. The properties by which drainage classes can be identified in the field are given in Appendix 2.

5. Salinity hazard is defined in terms of electrical conductivity of a saturated paste extract (mmhos/cm) and for the plow layer. If the subsoil is more salt or sodium affected than the plow layer, it should be considered an additional hazard. Both layers should be tested. The upper salinity limit for some of the soil groups is higher than plants will actually grow at, and reflects the assumption that soil tests will be for conditions before the crop is planted, and that salinity will be reduced by irrigation. Soils with yet higher salinity need to be reclaimed before cropping.

6. Sodium hazard (i.e., alkali-affected) is estimated by the SAR value (Sodium Absorption Ratio) of a saturated paste extract. The SAR value is an estimate, and for all practical purposes is the same as the ESP (Exchangeable Sodium Percentage) value, which is also used as a measure of sodium hazard. A safe SAR upper limit for clayey soils is 10; loamy sands and sandy loams may be used with few problems up to values of about 15. Soils with yet higher SAR values should be reclaimed before or during cropping.

7. Values for estimating available water holding capacity (AWC) from textures and thickness of soil horizons are given in Appendix 3.

Appendix 2
Field evidence for identifying soil drainage classes

Class	Field Criteria
Very poorly drained	Water table remains at the surface or within 20 inches most of the year; the surface horizons are commonly dark colored and peaty or mucky; subsurface horizon colors are neutral greys, olive or bluish grey with or without dull mottling; grazing possible at least seasonally, hay can be harvested in drier years.
Poorly drained	Soil very wet much of time; water table seasonally at or near surface for several weeks; water table between 20 and 40 inches most of the year; surface horizon commonly dark colored; prominent soluble salt accumulation may occur at or near surface; subsurface horizon dull grey or olive, with or without mottling; grazing possible most of time, hay usually can be harvested.
Somewhat poorly drained	Soil seasonally very wet for several weeks because of an impermeable layer, or a water table at 40 to 60 inches; surface horizon commonly thick and dark colored; subsurface horizon dull grey and commonly mottled; prominent soluble salt accumulation may occur in upper 40 inches; drainage necessary for deep rooted crops.
Moderately well drained	Soil seasonally very wet for a week or so because of an impermeable layer or an intermittently high water table which is below 60 inches most of the year; or because of surface flooding from adjacent areas; surface horizon usually thicker and darker than adjacent well drained soils; indistinct mottling usually present in lower subsurface horizon.
Well drained	Soil is not very wet for more than a few days after protracted and heavy storms; no water table within 60 inches at any time; surface and subsurface horizons not greyed or mottled, but yellowish, brownish, or reddish colored.
Excessively drained	Soil moist for only few days after storms; soil porous throughout with no fine textured or impermeable layers; water does not run off surface except under most intense storms; no water table within 60 inches.
Altered drainage	Soils which have been artificially drained but retain the dark colored surface horizons, peaty or mucky surface horizon, or dull or mottled subsurface colors from former drainage status.

Appendix 3

Estimates of available water holding capacity based on soil texture

(After: Tech. Note-Soils-15, 1968, SCS, USDA, Berkeley, California)

Available water is that which plants can extract from the soil, and is roughly equivalent to that which is held between 1/10 and 15 bars suction in laboratory measurements, or between "field capacity" and the "permanent wilting" moisture contents. The 15 bar moisture content is quite closely related to the clayeyness of the soil, whereas the moisture content at field capacity is a more variable property affected by soil structure and very fine sand-silt content in addition to clay content. But since soil texture is so important in determining both, it can be used to estimate available water holding capacity (AWC). Volume content of available water is a more useful measure of AWC than weight percentage since we calculate irrigation water in inches, and since the actual amount of water in a soil for a given weight percentage varies with the available water ratio, that is, the decimal fraction of volume of water per unit volume of soil. This is the same as the decimal ratio of inches of water per inch of soil, or feet of water per foot of soil:

$$\text{Available water holding capacity ratio} = \frac{\text{Volume soil, cubic centimeter}}{\text{Volume water, cubic centimeter}} = \frac{\text{inches water}}{\text{inches soil depth}}$$

In the following table, the available water ratios for different textural groups are given. Total AWC can be calculated by multiplying the depth of a given soil by the water ratio for its particular texture. For soils with different textured layers, the AWC for each layer is calculated from its thickness and water ratio, and the values for the layers totaled.

Available Water Holding Capacity Ratio

Textural Classes	Low	Average	High
Gravelly sand Course sand	0.033	0.048	0.063
Sand Fine sand	0.063	0.073	0.084
Loamy coarse sand Loamy fine sand Sandy loam Fine sandy loam	0.084	0.10	0.13
Very fine sandy loam Loam Silt loam Sandy clay Silty clay Clay	0.13	0.15	0.17
Sandy clay loam Clay loam Silty clay loam	0.17	0.18	0.19

Appendix 4

Common name	Scientific name
Alfalfa	*Medicago sativa* L.
Alsike clover	*Trifolium hybridum* L.
Basin wildrye	*Elymus cinereus* Scribn. and Merr.
Broadleaf birdsfoot trefoil	*Lotus corniculatus* L.
Cicer milkvetch	*Astragalus cicer* L.
Creeping meadow foxtail	*Alopercurus arundinaceus* Poir
Crested wheatgrass	*Agropyron cristatum* (L.) Gaertn.
Desert wheatgrass	*Agropyron desertorum* (Fisch.) J. A. Schultes
Intermediate wheatgrass	*Agropyron intermedium* (Host.) Beauv.
Kentucky bluegrass	*Poa pratensis* L.
Ladino clover	*Trifolium repens latum* L.
Narrowleaf birdsfoot trefoil	*Lotus tenius* Waldst. Kit. Ex Willd.
Orchardgrass	*Dactylis glomerata* L.
Pubescent wheatgrass	*Agropyron intermedium trichophorum* (Link) Halacsy.
Red clover	*Trifolium pratense* L.
Reed canarygrass	*Phalaris arundinacea* L.
Sainfoin	*Onobrychis viciaefolia* Scop.
Sheep fescue	*Festuca ovina* L.
Siberian wheatgrass	*Agropyron sibiricum* (Willd.) Beauv.
Smooth brome	*Bromus inermis* Leyss
Strawberry clover	*Trifolium fragiferum* L.
Streambank wheatgrass	*Agropyron dasystachum riparian* (Scribn.) (J.G. Smith) and Bowden.
Sudangrass	*Sorghum sudanense* (Piper) Stapf
Sweetclover - yellow	*Melilotus officinalis* (L.) Lam.
Tall fescue	*Festuca arundinacea* Schreb.
Tall wheatgrass	*Agropyron elongatum* (Host.) Beauv.
Timothy	*Phleum pratense* L.
Turkish bromegrass (meadowbrome)	*Bromus biebersteinii* Roem. and J. A. Schultes
White Dutch Clover	*Trifolium repens* L.

Suggested seeding rates are given as pure live seed (PLS). Legume seed should be inoculated with the proper inoculant.

Appendix 5
Pure Live Seed Conversion Chart

To use chart:
Locate the percent purity and percent germination of the seed on lines A and B. Lay a straight edge between these two points. The point of the intersection with line C is the conversion factor for that seed.

Example:
Purity 95 - line A
Germination 35 - line B
Conversion Factor 3.00 - line C

It will take 3 pounds of this seed to equal 1 pound of pure live seed. Multiply this factor by the PLS seeding rate to obtain the seeding rate for this lot of seed.