

Grasses
And
How To Grow Them

Thomas Shaw

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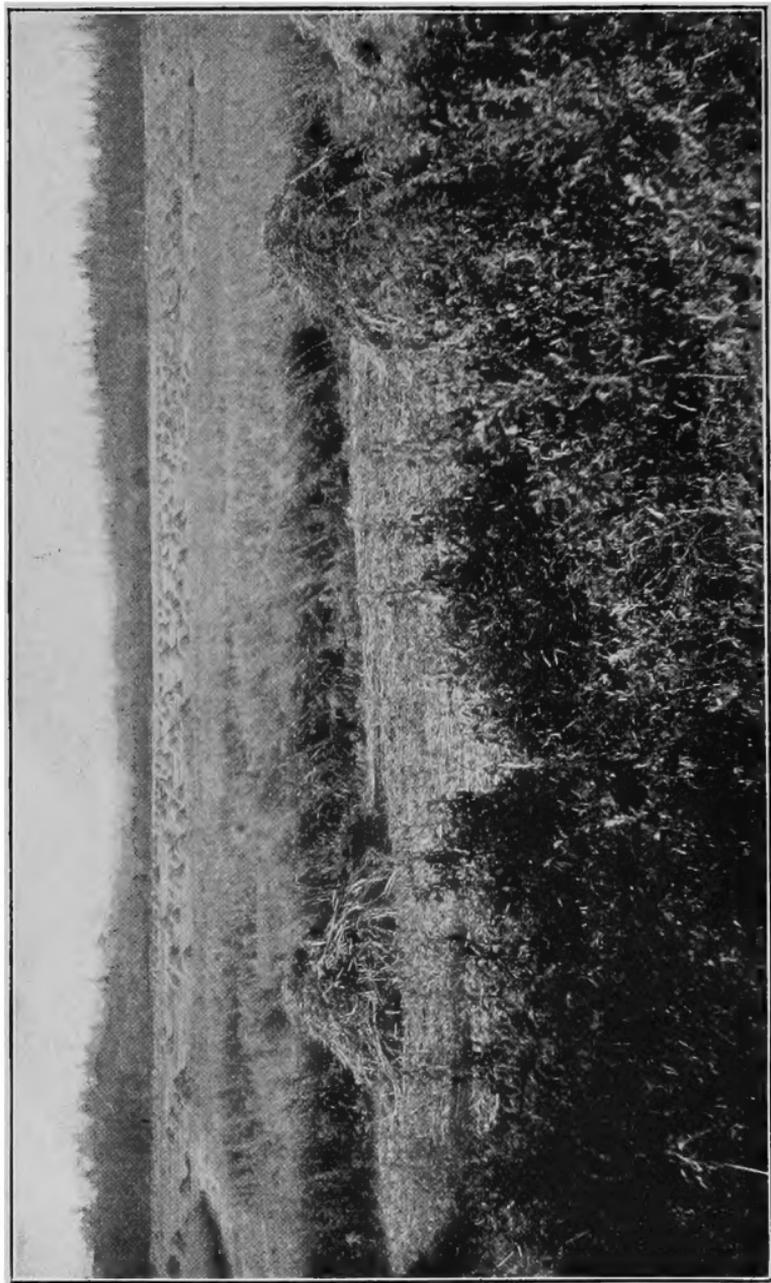


FIG. 1. FRONTISPIECE.
Making Hay on the Tide Lands near Fairhaven, Puget Sound, Wash.

GRASSES
AND
HOW TO GROW THEM
IN
NORTH AMERICA

By THOMAS SHAW

PROFESSOR OF ANIMAL HUSBANDRY AT THE
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AUTHOR OF

"FORAGE CROPS OTHER THAN GRASSES"

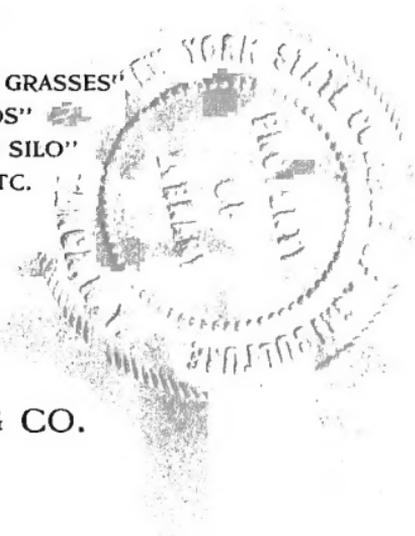
"THE STUDY OF BREEDS"

"SOILING CROPS AND THE SILO"

"ANIMAL BREEDING" ETC.

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In preparing this work, the author desires to acknowledge the assistance derived from "Grasses of North America," by W. J. Beal, "Forage Crops and Grasses," by Charles L. Flint, "Grasses and Clovers," by Henry A. Dreer, "Farmers' Book of Grasses," by D. L. Phares, and bulletins issued by several of the experiment stations in the United States and Canada, also by the United States Department of Agriculture.

For the sketches, the author is indebted to Prof. A. M. Soule, Director Experiment Station, Knoxville, Tenn., William T. Shaw, Corvallis, Oregon, and the Bureau of Plant Industry of the United States Department of Agriculture.

To all persons in the United States who are interested in the growing of grasses or in grazing, this work is most respectfully dedicated by the Author.

University of Minnesota, 1903.

THE AUTHOR'S PREFACE.

As is generally known a number of books have been written on grasses in our own country and also in lands beyond the sea. These furnish much valuable information with reference to grasses, but in all or nearly all of them, the tendency is to treat of grasses from the standpoint of the botanist rather than from that of the agriculturist. As far as the author has been able to ascertain, no book has yet been written which takes the economic grasses of this country in an orderly and comprehensive succession, and points out to the farmer how to grow them. Much valuable information is given in the agricultural press but it is more or less fragmentary in character and in the nature of things is soon lost to the view. Certain bulletins published by the Agricultural Experiment Stations treat of grasses, but excellent as many of these are for the purpose for which they were written, much of the information which they give is only applicable to limited areas.

It will be the aim in this book to discuss all the grasses at present found in the United States and Canada possessed of any considerable economic value, when viewed from the standpoint of the needs of the stockman and the farmer. The discussion will include the characteristics of each kind of grass, its adaptation to climate and soil, place in the rotation, preparing the

land for the seed and sowing the same, pasturing and harvesting for hay and for seed and renewing the grasses where this may be practicable. It will also discuss the questions of temporary, permanent and range pastures respectively and that of meadows and making hay. Although the clovers are largely grown for practically the same economic uses as grasses, the discussion of the former will be reserved for a separate volume.

In writing the book, the aim has been to prepare a volume that would discriminate between the important and the unimportant in economic grasses, and to present information in an orderly and consecutive way with reference to the former only, that would in some measure at least meet the needs of the farmer and the student of agriculture.

University Experiment Station, St. Anthony Park, Minn., 1903.

TABLE OF CONTENTS.

	Page
	CHAPTER I.
INTRODUCTORY	1
	CHAPTER II.
GENERAL PRINCIPLES FOR GROWING GRASSES.....	8
	CHAPTER III.
TIMOTHY	49
	CHAPTER IV.
KENTUCKY BLUE GRASS	79
	CHAPTER V.
BERMUDA	111
	CHAPTER VI.
ORCHARD GRASS	131
	CHAPTER VII.
RED TOP	147
	CHAPTER VIII.
RUSSIAN BROME	166
	CHAPTER IX.
MEADOW FESCUE	190
	CHAPTER X.
TALL OAT GRASS	206
	CHAPTER XI.
MEADOW FOXTAIL	222
	CHAPTER XII.
GRASSES USEFUL BUT DIFFICULT OF ERADICATION.....	232
	CHAPTER XIII.
RYE GRASSES	265
	CHAPTER XIV.
MISCELLANEOUS GRASSES	289
	CHAPTER XV.
TEMPORARY PASTURES	335
	CHAPTER XVI.
PERMANENT PASTURES	365
	CHAPTER XVII.
MEADOWS AND MAKING HAY.....	403
	CHAPTER XVIII.
PASTURES ON THE RANGE.....	436

LIST OF ILLUSTRATIONS.

Figure.	Page.
1. Making Hay on the Tide Lands, near Fairhaven, Puget Sound, Wash.	Frontispiece
2. Timothy	51
3. Kentucky Blue	81
4. Bermuda	114
5. Bermuda Turf	125
6. Orchard	133
7. Red Top	149
8. Russian Brome	167
9. Meadow Fescue	191
10. Tall Oat	207
11. Meadow Foxtail	223
12. Quack	233
13. Johnson	248
14. Western Rye	265
15. Perennial Rye	274
16. Texas Blue	291
17. Rescue	310
18. Sheep's Fescue	315
19. Velvet	322
20. Permanent Meadow on Tennessee Experiment Farm...	409

INDEX.

	Page
Australian Saltbush, discussion of,.....	326-330
described	326
distribution	327
soils	328
place in the rotation.....	328
preparing the soil.....	328
sowing	329
pasturing	329
harvesting for hay	330
securing seed	330
renewing	330
Bermuda, discussion of,.....	111-130
described	111-115
distribution	116, 117
soils	117
place in the rotation.....	118
preparing the soil.....	119
sowing or planting	120-122
pasturing	123
harvesting for hay	124
securing seed	127
renewing	128
eradicating	129
Blue Joint, discussion of,.....	331, 332
Blue Grama, discussion of,.....	333, 334
Carpet, discussion of,.....	318-321
described	318
distribution	319
soils	320
place in the rotation.....	320
preparing the soil	320
sowing or planting	320
pasturing	321
harvesting for hay	321
securing seed	321
renewing	321
Crab, discussion of,.....	260-264
described	260

	Page
distribution	261
soils	261
place in the rotation	261
preparing the soil	261
sowing	261
pasturing	261
harvesting for hay	262
securing seed	263
methods of eradicating.....	263
Fowl Meadow, discussion of,.....	305-309
described	305
distribution	305
soils	306
place in the rotation	306
preparing the soil	307
sowing	307
pasturing	307
harvesting for hay	308
securing seed	308
renewing	309
General Principles for Growing Grasses, discussion of,....	8-48
described	8, 9
adaptation in grasses	10
place in the rotation	11, 12
preparing the soil	13-17
seasons for sowing.....	17-19
methods of sowing	19-23
depth to bury seed.....	23-26
methods of covering.....	26-28
amounts of seed to sow.....	28-30
sowing with or without a nurse crop.....	30-35
sowing grasses alone or in combination.....	35-37
grazing of meadows	37-39
grazing of pastures.....	39-41
renovating meadows	41-43
renovating pastures	43-46
grasses as soil improvers.....	46-48
Italian Rye, discussion of,.....	281-288
described	281, 282
distribution	283
soils	284
preparing the soil	285
sowing	285
pasturing	286
harvesting for hay.....	286
securing seed	287
renewing	287

	Page.
Johnson, discussion of,	248-260
described	248-250
distribution	250
soils	251
place in the rotation	252
sowing or planting	253
pasturing	254
harvesting for hay	255
securing seed	256
renewing	257
eradicating	257, 258
value of	259
Kentucky Blue, discussion of,.....	79-110
described	79-83
distribution	83-85
soils	86-88
place in the rotation.....	89
preparing the soil	90, 91
sowing	92-96
pasturing	97-99
harvesting for hay	100, 101
securing seed	101, 103
renewing	104-108
blue grass in lawns	109, 110
Meadow Fescue, discussion of,.....	190-205
described	190-194
distribution	194-197
soils	197
place in the rotation	198
preparing the soil	199
sowing	199-202
pasturing	202
harvesting for hay	203
securing seed	204
renewing	204
Meadow Foxtail, discussion of,	222-231
described	222
distribution	225, 226
soils	227
place in the rotation	227
preparing the soil.....	228
sowing	228, 229
pasturing	230
harvesting for hay.....	230
securing seed	231
renewing	231
Meadows and Making Hay, discussion of,.....	403-435
described	403, 404

	Page.
Hay crops for states and provinces.....	404
Northeastern States	405-407
Southeastern States	407-409
Canadian Northwest	409
Upper Mississippi Basin.....	410-412
Irrigated Western Valleys.....	412
West of the Cascades.....	413-417
Miscellaneous discussions upon.....	417-435
preparing the soil	417, 418
sowing	419
harvesting	420-422
curing hay	422-428
storing hay	428-431
grazing	431-433
fertilizing and renewing.....	433-435
Orchard, discussion of.....	131-146
described	131, 132
distribution	135, 136
soils	136
place in the rotation.....	137
preparing the soil	138
sowing	139-141
pasturing	141, 142
harvesting for hay.....	143
securing seed	144, 145
renewing	146
Perennial Rye, discussion of.....	273-281
described	273-276
distribution	276, 277
soils	278
place in the rotation.....	278
preparing the soil.....	278
sowing	279
pasturing	280
harvesting for hay.....	280
securing seed	280
renewing	281
Permanent Pastures, discussion of.....	365-402
described	365, 366
Different classes of.....	366-369
indigenous	367
introduced	367
indigenous and introduced.....	368
duration of	368
Adaptation to various soils.....	369-373
upland	369
slough lands	370
sandy lands	371

	Page.
dry areas	371
wet soils	372
growing in shade	372
growing in marshes	373
States and Provinces.....	373-384
Northeastern States	373-376
Southeastern States.....	376-378
Canadian Northwest	378
Upper Mississippi Basin	379-381
Semi-arid Belt	381
Irrigated Western Valleys.....	383
Miscellaneous discussions upon.....	384-402
sowing	385-389
grazing	389-392
fertilizing and renewing	392-395
transforming brush lands	395-398
transforming native prairie	398
shifting lands	399-401
renewing	401, 402
Quack, discussion of.....	232-248
described	232-236
distribution	237
soils	238
place in rotation.....	238
preparing the soil	239
sowing	239-240
pasturing	241
harvesting for hay	241
securing seed	242
renewing	242
eradicating	245-247
observations	247
Range Pastures, discussion of.....	436-457
range states	436
range country described.....	436-438
soils	441
climate	441, 442
grazing	443
carrying capacity	444
range country in Canada.....	444
Grasses falling	445-448
extent of	446
causes of	446-448
Renewing grasses	449, 450
practicability of	449
impracticability of	449
necessary modifications	450
West of Cascades	383

	Page
Difficulties of renewing.....	450-454
fencing	451
sowing seed	452
substitution	452-454
Future of	454-457
protection of	455
rearing stock	455
disposing of stock	455
fattening stock	456
Red Top, discussion of,.....	147-165
described	147-151
distribution	151-153
soils	153
place in the rotation	154
preparing the soil	155
sowing	155-159
pasturing	159, 160
harvesting for hay	161
securing seed	162, 163
renewing	164
binding soils	165
Rescue, discussion of,	309-313
described	309
distribution	310
soils	310
place in the rotation	310
preparing the soil	311
sowing	311
pasturing	311
harvesting for hay	312
securing seed	312
renewing	312
Rough Stalked Meadow, discussion of,.....	301-304
described	301
distribution	302
soils	302
place in the rotation.....	303
preparing the soil.....	303
sowing	303
pasturing	304
harvesting for hay	304
securing seed	304
renewing	304
Russian Brome, discussion of,.....	166-189
described	166-170
distribution	170-173
soils	173
place in the rotation	174-176

	Page
preparing the soil	177, 178
sowing	179-182
pasturing	183
harvesting for hay	184
securing seed	185-187
renewing	188
destroying	189
Sheep's Fescue, discussion of,	313-318
described	313
distribution	314
place in the rotation	314
preparing the soil	314
sowing	317
pasturing	317
harvesting for hay	317
securing seed	317
renewing	318
lawns	318
Tall Oat, discussion of,	206-221
described	206-210
distribution	210-212
soils	212
place in the rotation	213
preparing the soil	214
sowing	215-217
pasturing	217
harvesting for hay	218
securing seed	219
renewing	220
Texas Blue, discussion of,	297-301
described	297, 298
distribution	298
soils	299
preparing the soil	299
sowing or planting	299
pasturing	300
harvesting for hay	301
securing seed	301
renewing	301
Temporary pastures, discussion of,	335-364
described	335, 336
Adaptation to various conditions	337-342
upland pastures	337
slough lands	338
sandy lands	339
dry areas	339
wet soils	340
growing in shade	341

	Page
States and Provinces.....	342-353
Northeastern States	342-344
Southeastern States	344-346
Canadian Northwest	346
Upper Mississippi Basin.....	347
Semi-arid Belt	348
Irrigated Western Valleys.....	349, 350
West of the Cascades.....	351
Pastures other than grasses and clover.....	352
Miscellaneous discussions upon.....	353-364
sowing	353-355
grazing	356, 357
fertilizing and renewing.....	358-360
influence on succeeding crops.....	361-364
Timothy, discussion of,.....	49-78
described	49-53
distribution	54
soils	55, 56
place in the rotation.....	57
preparing the soil.....	58, 59
sowing	60-69
pasturing	70, 71
harvesting for hay.....	72-74
securing seed	75-77
renewing	77, 78
Velvet, discussion of,.....	322-326
described	322
distribution	323
place in the rotation.....	324
preparing the soil.....	324
sowing	324
pasturing	325
harvesting for hay.....	325
securing seed	326
renewing	326
Western Rye, discussion of,.....	265-273
described	265-267
distribution	267, 268
soils	269
preparing the soil.....	269
sowing	270
pasturing	271
harvesting for hay.....	272
securing seed	272
renewing	272
Wire, discussion of,.....	289-297
described	289-293
distribution	293

	Page
soils	293
place in the rotation.....	293
preparing the soil.....	294
sowing	295
pasturing	295
harvesting	295
securing seed	296
renewing	296

CHAPTER I.

INTRODUCTORY

The grass crop of the United States is unquestionably its most valuable crop and so it will continue through all time. True, it is assigned the second place in the United States Census Returns of Agricultural Statistics for 1899. Corn is given the first rank but these reports do not take into account the value of the pasture produced by grasses, nor do they include the ameliorating and renovating influence which these exert upon the soil, and, consequently, upon the production of other crops. The influence referred to relates to the maintenance of the supply of humus in the soil and the effect which the presence of the same exerts upon aeration, friability, moisture and available fertility. It is at least an open question if the influence, which the grass thus exerts on subsequent production in other crops, is not as valuable in the aggregate in short rotations as the grass crop itself. It is an open question, therefore, as to whether grass in its death does not give to the agriculturist a return equal to that given during its life.

So necessary is the grass crop to the maintenance of an equilibrium in cultivated soils, that, in its prolonged absence, it is not possible to maintain the same in cultivated soils. Commercial fertilizers may be made to maintain an equilibrium in fertility, but they do not

materially influence the mechanical condition of the soil, which exerts an influence on production, not second in importance to fertility. To maintain such a condition, grasses must be grown in the ordinary processes of tillage. They are the balm which soothes the wound given to Mother Earth by the ploughshare and other implements used in tillage.

The question of grass production, therefore, is of supreme importance to the farmer and because it is, any practical information bearing upon the growth of grasses should merit his attention.

Grasses But Little Known.—Notwithstanding the great value of grasses to the farmer, it would probably be correct to say, that he knows less about them and the best modes of growing them than about any other crop or class of crops as are commonly grown on the farm; nor is he altogether to blame for such lack of knowledge. The farmers of this continent have not had access to any book which deals with the question of growing grasses, as applicable to all parts of the United States and Canada. They have had access to only such avenues of information bearing upon this question, as have come from their own personal experience, that of their neighbors, or from the desultory and inadequate discussion of these questions in the agricultural press.

It is not surprising, therefore, that the average tiller of the soils knows about only a few grasses; those that are cultivated in his locality. Including clovers, these are probably less in number than half a dozen. In regard to some of these, though they have grown upon

his land during all the years that he has tilled the same, he has never learned the extent of the service, they may be made to render him by stimulating them to higher production. Such, for instance is blue grass (*Poa pratensis*) abused by overgrazing and neglected by being allowed to grow unfertilized; like Topsy in the marvellous story, they just grow because they are allowed to grow. The knowledge of these truths has moved the author to write this book and if it brings any added light to those who desire the same, one purpose for which it has been written will have been well served.

Students of the agricultural colleges, as well as farmers, labor at a disadvantage with reference to the question of grasses. They pursue their studies in the absence of a text book which tells how to grow them. When this is said, it must not be interpreted in the slightest degree as reflecting on the excellent books that have been written in America on the grass question; these were written for a different purpose. A second purpose in writing this book, therefore, is to put, in the hands of the agricultural student, a book that will render some assistance to him in the study of this involved and difficult problem.

Grasses Worthy of Cultivation.—The dearth of information with reference to growing the more valuable grasses, that are being cultivated, or that are susceptible to profitable cultivation, is all the more surprising when these are considered. In this book the aim has been to discuss all the varieties that are considered really worthy of cultivation on lands that are tilled in the United States and those not yet cultivated but which

give promise of sufficient value when cultivated; the former of these number only 24 and the latter 3. This fact seems incredible when it is called to mind that the number of the species of grasses in the world runs into the thousands and that in some of the individual states it runs into the hundreds. It is well, probably, that the number of the useful grasses is not greater in the meantime, since the list would seem to include enough to meet the present needs of the agriculturist. The smaller the number of grasses that suffice to meet those needs, the easier it is to acquire a knowledge of the best methods of growing them. This does not imply, however, that the necessities of the agriculturist will not, in the future, call for an enlarged list of varieties. When that time comes, the wisdom of the agricultural scientists will be found equal to the occasion, either in evolving new varieties or in improving older ones. In the meantime, the fact cannot be gainsaid, that, to the practical agriculturist, knowledge pertaining to the valuable grasses of sufficient value to justify growing them under cultivation, is of far greater account than knowledge pertaining to grasses, the low value of which, will not warrant such cultivation; hence, the restriction of the present discussion to the former.

Grasses of Highest Value.—The very limited number of grasses, that are of highest economic value under cultivation, is even more surprising than the number which may be profitably cultivated. But three varieties of the entire number are worthy of a place in the front rank. These are timothy (*Phleum pratense*), king of the hay grasses on the American conti-

ment; Kentucky blue grass (*Poa pratensis*), king among the pasture grasses of the northern states and Canada, and Bermuda grass (*Cynodon dactylon*), king among the pasture grasses of the south. But six varieties would seem worthy of a place in second rank. These are orchard grass (*Dactylus glomerata*), redtop (*Agrostis vulgaris*), Russian brome (*Bromus inermis*), meadow fescue (*Festuca pratensis*), tall oat grass (*Arrhenatherum arvenaceum*), and meadow foxtail (*Alopecurus pratensis*). The claim of meadow foxtail to a place among these six may be disputed but leaving it out it would seem correct to say that the present needs of the agriculturist in the lines of hay and pasture could be pretty well met by these eight grasses. The other grasses discussed are all possessed of considerable value, but in the meantime would not seem worthy of being placed higher than in the third rank in the little array of grasses that merit the attention of the tillers of the soil under American conditions:

Plan of the Discussion.—The subject opens with the discussion in Chapter II of the General Principles which govern the Growing of Grasses. This was deemed necessary because of the desire to give prominence to the question of growth, rather than to that which related to structure and classification of the grasses. In the judgment of the author, this chapter is the key to the discussion and therefore should be given more careful thought by the reader than any other chapter in the book.

Chapters III to XI inclusive treat of the nine grasses that would seem to be possessed of highest economic

value among the grasses at present cultivated in the United States. They may be considered, therefore, as the major grasses. It is the aim in the discussion to take these in the order of relative importance; whether they have been so placed, may justly be regarded as open to dispute because of the difficulties to be encountered in making such a comparison. Though correctly placed at the present time, the order of relative importance may change, as public attention becomes more and more centered upon their relative adaptation and properties in the future. It may be questioned as to whether meadow foxtail is deserving of the attention given to it and yet it has not only been extensively cultivated in north-western Europe but is there highly prized. There would seem to be no good reasons why it should not render similar service in certain areas of this country, when more attention comes to be given to the growth of permanent pastures, for which it is more especially adapted.

Chapters XII to XIV discuss what may be considered the minor grasses worthy of cultivation. Some of these are of much economic importance, as, for instance, western rye grass (*Agropyrum tenerum*), but distribution of all, or nearly all, of them is more sectional than is that of the major grasses. Chapter XII discusses grasses highly useful in producing food for animals but which are so difficult of eradication that it would seem unwise ever to sow them on lands that are again to be cultivated. It was thought best, however, to include them since because of the extreme difficulty in eradicating them, it is all the more important that

their habits of growth should be well understood. Chapter XIII considers Rye Grasses and probably includes all of this family, at present, worthy of cultivation under American conditions. In Chapter XIV various grasses are considered of still less economic importance to the whole country. It may even be questioned as to whether some of these are worthy of cultivation, as for instance, velvet grass (*Holcus lanatus*) but it will be found that each of them has a useful mission in some locality and under some conditions.

Chapter XV discusses Temporary Pastures; Chapter XVI, Permanent Pastures; Chapter XVII, Meadows and Making Hay, and Chapter XVIII, Pastures on the Range. The discussion of each of these phases of the grass question is of necessity brief, too brief probably to be sufficiently comprehensive and succinct, but the course adopted seemed necessary to avoid unduly swelling the contents of the volume.

CHAPTER II.

GENERAL PRINCIPLES WHICH APPLY TO THE GROWING OF GRASSES.

In discussing the question of grasses and how to grow them it is quite impossible to lay down any hard and fast rules which will be applicable in all instances and without variation, owing to the differences in method called for by a difference in the conditions which relate to growth. This difference may arise from variations in soils, in climates, in the rotations practiced, and also from various other causes, including the various uses for which they are grown. To illustrate:—while it may be advantageous to bury grass seeds to a considerable depth in certain soils, it may be equally advantageous to sow them on the surface in other soils. While the best results may be obtained from sowing some grasses in the spring in certain climates, to secure equal results in certain other climates, it would be necessary to sow them in the fall. Again, while in some instances a stand of certain grasses can only be obtained after a crop which puts humus in the soil, under other conditions an equally good stand may be obtained by sowing them, almost anywhere in the rotation, and while it may be eminently proper to sow certain grasses with but scant thickness, to grow seed crops it may be equally proper to sow them quite thickly when the object is

to provide pasture for sheep. Differences of treatment equally striking also arise in the laying down of permanent pastures and in the management of the same. In some localities the best permanent pastures consist of a single grass. In others, the pastures are improved as the number of the properly selected grasses grown in them is increased.

The fact remains, nevertheless, that there are certain principles which will be found so frequently applicable when applied to the growth of grasses as to render very substantial aid to those concerned in growing them when intelligently applied. Because of this the attempt to formulate these, or at least the chief of them, and to emphasize certain facts of general application, is not only justifiable but it is in a sense a necessity. It is thus very evident that those who grow grasses intelligently must always stand upon the watch tower of careful consideration while thus engaged.

The more important of the principles which relate to the growing of grasses are found in such phases of the question as the following:—viz., Adaption; place for them in the rotation; preparing the soil to receive them; seasons for sowing; methods of sowing; depth to bury the seed; methods of covering; amounts of seed to sow; sowing with or without a nurse crop; sowing alone or in combinations; for hay or for pasture; the grazing of meadows; the grazing of pastures; renovating meadows; renovating pastures, and the discussion of the question of grasses as soil improvers. These will now be discussed in the order named. But before doing so it may be well to emphasize the fact, that these prin-

ciples are general rather than specific in their application. They do not apply equally to the growth of all the different varieties, nor do they apply equally to the growing of the same variety in all sections of the country.

Adaptation in Grasses.—In growing grasses it would not be easily possible to give too much consideration to the question of adaptation. It is not wise to attempt to grow grasses for practical uses in localities not reasonably well adapted to their growth, howsoever valuable they be in themselves or as a food for live stock. At the present time, however, the adaptation of several varieties of even the more valuable of the grasses is not fully known in this country. The place for experiment, therefore, with a view to throw further light on these is a very wide one, nor should conclusions be reached too quickly in regard to such adaptation in any state or province. Adaptation may be sectional because of soil peculiarities and for other reasons. In Southwestern Minnesota, for instance, the adaptation for blue grass is only quite ordinary, whereas in several counties in the northeastern part of the same state it is extraordinary.

When determining which grasses shall be grown in any locality, the aim should be to give the preference to those useful varieties which have the highest general adaptation for that particular locality. For instance, Russian brome grass (*Bromus inermis*) has high adaptation for the conditions that generally prevail over the northwestern states and also the northwestern provinces of Canada, while its general adaption to the southern

states is much lower. Consequently, this grass should be given a much more prominent place in the states and provinces first named. Because of this difference in adaptation it may be eminently proper in certain instances to give the right of way in production to certain grasses that are intrinsically much inferior to others, could they be grown. In this fact the justification is found for growing under some conditions such varieties as couch grass (*Agropyrum repens*), Johnson grass (*Sorghum halapense*) and Bermuda grass (*Cynodon dactylon*), all of which are weed-pests of the most perplexing type, when allowed to grow under other conditions. It is not wise to attempt to grow grasses to any considerable extent in any locality for which their adaptation is lower than what may be considered as normal for them. Nor should valuable time and labor be thrown away in the attempt to grow a large variety of grasses in permanent pastures where the conditions only favor the growth of a few varieties.

Place in the Rotation.—The aim should be to sow grasses on clean ground. They should, therefore, as a rule, be sown after a cleaning crop, that is to say, after such crops as are cultivated while they are growing or after a summer-fallow. These crops include corn, sorghum, the non-saccharine sorghums, potatoes, field roots, rape, tobacco and cotton. When thus sown for hay, a crop is secured that is usually entirely free, or, in the main, free from extraneous products which would lessen the value for feeding at home and to a still greater degree for exposing for sale on the market. When thus sown for pasture, the pastures will be clean or meas-

urably so. When these are weedy when first laid down, the tendency is that they shall become more so as they become older, much depending of course upon the kind or kinds of the weeds that infest them, and when weeds increase in them they cannot be got rid of without great labor. The tendency with biennial and perennial weeds is to increase, especially the latter. But there are some kinds of weeds more commonly of the annual class, and which are eaten by live stock, that decrease in pastures. Such are wild oats. And some kinds of grasses crowd out not a few of the forms of weed life. Such are Kentucky blue grass (*Poa pratensis*) and Russian brome (*Bromus inermis*). Because of this power, there may be instances in which these grasses can be sown on weedy ground.

When grasses thus follow cultivated crops, if sown on ground that has been prepared to receive the seed by stirring the surface and pulverizing without having ploughed it, the further advantage follows: viz., that the land will be firm and consequently would lose less by surface evaporation than if it had been prepared in the ordinary way. This, in dry areas, is a matter of much importance. When such lands are not ploughed after the removal of the crop, the further advantage follows, that the weed seeds in the lower sections of the cultivated soil are brought to the surface. In many instances these will perish before the grass crop will be broken up again.

Some grasses may follow immediately on the removal of forests, as soon as the brush and valueless parts of the trees have been burned. Kentucky blue grass

(*Poa pratensis*) is pre-eminently adapted to such a use, as it will soon subdue the growth of extraneous and comparatively useless products that once spring up as it were spontaneously on such lands. Other grasses may be sown in certain areas of the unbroken prairie for the purpose of crowding out and supplanting the original grasses which grew upon them. Such is Russian brome (*Bromus inermis*), but this grass will not crowd out and supplant all kinds of prairie grass or even the same kind in all places.

It is proper to follow grasses with such crops as luxuriate in soils plentifully supplied with humus. Such are corn, potatoes, flax and rape. Where the sod is old, that is where grass has grown for several successive years, and is then broken up, it may be advantageous to grow on it some such crop as peas or vetches to aid in subduing the sod, that is, in hastening its decay. Oats are also capable of growing in good form after nearly all kinds of grass, as they are a strong feeding plant. It is common and usually preferable to defer the sowing of the other small grains, as wheat and barley, until the following year.

Preparing the Soil.—When preparing the soil for any kind of grass the aim should be to secure a moist, firm and finely pulverized seed bed. These requisites would seem to be more important relatively than depth of tillage, since many kinds of grass when once started, have much power to send their roots and rootlets down into the soil below the line to which cultivation is ordinarily carried.

Moisture in the soil is of course necessary to secure

germination and unchecked growth after the plants have started. It is secured under dry conditions by ploughing the soil or disking it some time previous to the sowing of the seed and then by harrowing it at intervals to form and preserve what may be termed a dust mulch to prevent the escape of subterranean moisture through capillary action. This power to retain moisture also increases with the increase in the proportion of humus, that is of decaying or decayed vegetable matter in the soil. The abundant presence of this element is not so necessary to the successful growth of grasses as to that of the small grains, since one object in growing grasses in the rotation is to increase the humus in the soil. Nevertheless, up to a certain limit, the presence of humus is quite helpful to the growth of these also.

Firmness in the soil is secured by having a considerable interval between the ploughing of the soil or the first disking of the same, and the sowing of the seed. It is further aided by harrowing, rolling and rainfall. It is beneficial, since it tends to exclude an excess of air in the soil near the surface, and since it also conduces to resistance to the influences that tend to promote the escape of moisture by surface evaporation. It also renders soils which are liable to heave less susceptible to the action of frost. This condition, therefore, is of much consequence with such soils when grass seeds are sown upon them in the autumn. With light spongy soils, a firm condition is even more important in the spring, and especially under conditions when moisture may be more or less lacking. An excess of firmness in certain heavy soils may be induced by excessive rain-

fall, hence, in certain areas, to avoid such a possibility the ground should not be prepared long before the grasses are sown. As a rule, in dry climates that degree of firmness in the soil that will best promote the growth of grasses will increase up to a certain limit with the increase in the interval between the breaking up of the soil with the plough or disk, and the sowing of the seed. Conversely, when rainfall is abundant, excessive firmness will be hindered by the shortening of such a period. The character of the soil of course has an important bearing on the length of the preparatory period, when growing such grasses, that will put the soil in the best condition to receive them.

Under ordinary conditions, it would not be easy to over-estimate the value of fine pulverization in the seed bed on which grasses are to be sown. Its value arises from excluding an excess of air from the soil near the surface when the plants begin to grow, in reducing evaporation, in securing a more abundant germination in the seeds sown, and in furnishing a feeding ground which the tender rootlets can easily penetrate as they push out. This condition is likely to be promoted by the influences that tend to produce moistness and firmness in the soil. The influence of frost on fall ploughed lands is specially helpful in securing a fine pulverization. Some lands have it naturally in a far greater degree than others, hence, in those which have, the effort to secure such pulverization is not much necessary on the part of the husbandman. On all soils stiff in texture, the fineness of the seed-bed will be proportionate to the labor put upon it when preparing them

as by using on them the harrow and the roller. The roller will be found specially helpful when laying down soils to grass. Before they are sown, it very greatly aids in securing a fine pulverization. After they are sown it firms the surface soil, pressing it around the seeds and thereby hastening germination. But when grass seeds are sown in the autumn on heavy soils and in rainy climates, it would be easily possible to have the pulverization so fine, that impaction of the soil to an injurious extent would follow. Grasses like other plants grow luxuriantly in proportion as the elements of plant food are readily available and abundant in the soil, hence, it is quite possible to so reduce the available fertility in a soil through excessive cropping, that on these a stand of grass cannot be secured unless they are first enriched. No fertilizer that can be applied under these conditions will equal farmyard manure, since it yields up the elements of plant food in it but gradually, hence, the nitrogen in the same is not leached out of the soil so readily as when applied in the form of commercial fertilizers. It also improves the mechanical condition of the land. In dry climates, when buried in the soil, it should, when fresh, be applied to the crop preceding grass, but its presence in the soil in a form so bulky should liberate moisture unduly, through the resistance which it offers to the influences that promote impaction, but, when reduced, it may be applied though in but moderate quantities, just before the preparation of the land for the crop, or while it is being so prepared. Farmyard manure has in it of course all the essential elements required to promote growth in grasses.

If nitrogen is needed in the form of commercial fertilizers, it is better to apply it on the surface after sowing the seed, and after the plants have begun to grow rather than before. If applied sooner there is the hazard that it would be washed down into the soil and subsoil before the grass roots could take it up, and this hazard is proportionate to the amount of the rainfall at such a time. It may be applied as nitrate of soda or sulphate of ammonia or in various other forms. When phosphoric acid is wanted, it may be furnished in the form of mineral phosphate, ground bone or basic slag, and applied while preparing the soil, more especially when about to harrow it not long prior to the sowing of the seed. Potash may be applied in the sulphate or muriate form, as Kainit, or as wood ashes, and like phosphoric acid, it may be profitably incorporated in the soil near its surface.

Seasons for Sowing.—Nature teaches some lessons with reference to the seasons at which seeds may be sown that may be studied with profit. She usually scatters the seeds of grasses in the autumn. Sometimes sprouting follows at once, and when it does the young plants become strong before the arrival of winter. But the seeds thus sown do not always sprout in the autumn, owing to want of moisture. They are, however, in that condition which promotes sprouting in the early spring, as soon as plant growth begins, because of the abundance of the moisture that is pretty certain to be present at that season. It follows, therefore, that the best time to sow the hardy varieties of grasses is in the autumn. But, when thus sown, sufficient time should

be given to the young plants to become firmly rooted before the arrival of winter. When they cannot be sown thus early, it is usually better to defer sowing until just before the ground freezes in the late autumn, in localities where the winters are stern. Where they are open, there may be hazard in sowing thus late, as, during mild spells, the seeds may sprout and perish later, through heaving of the soil, or from other causes. But some varieties of grasses are so tender as to render advisable the sowing of these only in the spring.

Notwithstanding that a good catch of the hardy variety of grasses is more assured when they are sown in the early autumn, it may not always be desirable to sow them then, for various reasons. The nurse crops with which they are commonly sown may not be needed, the weather may be uncompromisingly dry, and the opportunity may not be present for putting the ground in that condition which is necessary to render growth reasonably assured. When these grasses cannot be sown in the autumn, the aim should be to sow them in the early spring, as early as the conditions will admit of sowing them. The varieties are but few indeed that are so tender that they will take injury from the severity of the spring weather. When sown early, they become firmly rooted before the dry weather of summer follows, and so can better withstand it. Hence it is that grasses are frequently sown with advantage on the lingering snows of winter or on the early snows of spring. When sown on the undeparted snows of winter, there is some hazard that a portion of the seed, at least, may be carried away by the rapid melting of the

snows, as, when warm rains hasten the departure of these. At other times they are profitably sown quite as early or nearly so, on ground in a honeycombed condition. But where the conditions are such that nature is not likely to provide a sufficient covering for the seeds after they have been sown, the sowing should be deferred until the ground can be covered with the harrow.

The late sowing of grasses in the spring may succeed in climates which have considerable rainfall in the summer, but it will not be successful in those opposite in character. The most hazardous seasons in which grasses can be sown are the late spring and the early summer.

Methods of Sowing.—Grasses are usually sown by hand, by machines run by hand, or by the seed drill. Which of these methods of sowing will be preferable will depend upon circumstances. Hand sowing can be done under some conditions in which neither the machines run by hand nor those run by horses can be used, and because of this, the necessity for more or less of hand sowing will never cease to exist.

Sowing by hand is usually a necessity when the seed is sown while the snow is yet on the ground, or the ground is in such a condition that hand machines may not be used on it. It may also be practiced when sowing cannot be done by the machines referred to from want of adaptation in these for sowing certain of the larger kinds of seeds. The sowing of grasses by hand is the most difficult kind of hand sowing. To do it well usually requires not a little practice, backed up by dexterity in acquiring a proper grip of the seed between the thumb and two adjacent fingers and an easy and correct swing

of the hand. Because of the lightness of the seeds it is not easy to secure evenness of cast in the same. The difficulty in this respect may arise from the improper character of the swing of the hand or from the influence of the wind on the seed while falling or from both causes. Because of the influence of wind a calm time should be preferred for the sowing of grass seeds by hand and the lighter the seeds the calmer should be the time chosen. But it is possible to sow some of the heavier of the grass seeds by hand, while more or less wind is blowing, if the sower takes advantage of the direction of the wind to assist in carrying the seed.

More commonly the hand sower uses but one hand when sowing grass seeds. When one cast has been sown across a field he turns around, and on the return trip makes the seed overlap more or less the cast sown on the forward trip. Those who can sow with both hands make the two casts at one trip, and consequently sow twice the area in a given time. When both hands are used in sowing, the seed is carried in a sheet, or sack, or box, in front of the sower and suspended from the shoulders. Such a sowing sheet or sack is easily improvised.

When the ground has been ploughed in ridges of more or less width, hand sowing is facilitated, as the sower has the furrows to guide him in walking straight. When these are but twelve feet distant, one ridge can be sown during each forward or return trip by the person who sows with both hands. In other words double hand sowing will cover a strip of about twelve feet at one time. Where no ridges are made the sower will probably find it necessary to set up stakes to guide him as

to the direction to take, but following the marks made by the grain drill may sometimes be found a sufficient guide.

The hand machine most in favor is usually spoken of as the "wheelbarrow seed sower," from the fact that the distributor of the seed is wheeled over the ground on a light hand barrow. The distributor usually sows about 12 feet in width each time it passes along or across the field, but some are made to sow a wider area. This form of hand machine may be used when considerable wind is blowing, as, when the seed falls from the same, it has not far to fall, until it reaches the ground. It sows seed evenly, may be used at any time during the day, and can be managed by a person not skilled in hand sowing, but it cannot be used with advantage when the soil is in that condition that would cause it to cling to the wheel or to the feet of the sower in any considerable quantities. Other kinds of hand sowers have been used, but none of these answer the purpose better or even as well as the hand sower referred to. However, hand machines which are strapped to the shoulder and are operated by a crank, find favor with not a few, and they are certainly very suitable for scattering seed over lands encumbered by "brush," that is by a growth of young trees and bushes.

When grass seeds are sown with the grain drill they are more commonly sown by means of what is termed a "grass seed sower attachment," which is used in conjunction with the drill while the latter sows grain, and it is placed so as to drop the seeds in front of the grain tubes or behind them, as desired. The grass seeds thus

sown fall upon the surface of the soil. When they fall before the grain tubes they are partially covered. When they fall behind them they have no covering except such as may be given subsequently. Some "broadcast seeders," that is, seeders which sow grain by scattering it broadcast are also furnished with grass seed attachments. Grass seeds are sometimes mixed with grain and sown with the same, but this method of sowing in many instances buries the seed too deeply.

The sowing of grass seeds with the grain drill or with the grass seed attachment to the same, results in a considerable saving of labor. But even this method of sowing them cannot be said to be perfected. When the seed is sown along with the grain, in addition to being buried too deeply in nearly all soils, it is deposited in the line of the grain row, hence the young plants are crowded and shaded more than if they could be deposited between the grain rows. And when the seed falls on the surface, additional covering is necessary. If, therefore, a seed drill were invented that would deposit grass seeds between the grain rows and while the grain was being sown, and that would cover the seed at any desired depth, in the judgment of the author a great advance would be made in the method of sowing grass seeds. More perfect machinery is also wanted for the even distribution of some of the lighter seeds, as for instance the seed of meadow foxtail (*Alopecurus pratensis*). Such seeds do not feed into the distributors of the grass seeds now in use with that regularity that could be desired. But one make at least of the hand sower which

is wheeled over the ground is being so improved that it will sow almost all kinds of grass seed.

Depth to Bury the Seed.—The depth at which grass seeds should be buried will be influenced by the size of the seed, the character of the soil, the nature of the climate, the season of the year at which the seed is sown and the relative inherent vigor of the seed. As a rule the relation between the size of the seed and the depth at which to bury it is both close and intimate. The larger the seed, the more deeply does it require to be buried, and the smaller it is the more shallow the covering that best meets the conditions of growth. But the inherent vigor of the seed has also a qualifying influence. The more vigorous the seed the better it can withstand burial too deep, or too shallow to furnish the best conditions for growth.

No one of these influences, probably, is so great as that of soil conditions. As a rule, the lighter the soil, in the sense of its being sandy, the more spongy it is in the sense of the particles lying lightly upon each other, and the less capable it is of resisting the influences of surface evaporation, the more deeply should the seed be buried and vice versa. It would probably be correct to say that for all the cultivated grasses some covering would be preferable to none at all. In some instances the roller following the sowing of the seed, prior to the falling of rain, will provide a sufficient covering, and there are instances in which rain alone will provide a covering. Particularly is this true of seeds that are sown on clay soils in the autumn where heavy rains in that season and in the winter following tend

to pack ill-drained soils. Usually a light harrow with many teeth and which may be adjusted at any angle desired may be made to furnish a sufficient covering. But there are soils in which it may be advantageous sometimes to bury even small grass seeds, as timothy and alsike clover, to the depth of two inches or even to a greater depth.

The more moist the climate, the more shallow relatively may grass seeds be covered. The reasons for this will be at once apparent. The more frequent the rains, the more copious the dews, the more humid the air, the more moderate the temperatures, the nearer to the surface can the young plants secure the requisite moisture, because of the extent to which under the conditions just stated the influences which produce it fall upon and penetrate the soil, and because of the slow yielding up of moisture to the influences which produce surface evaporation. Hence it is that grass seeds and indeed all seeds cannot be best planted at the same depth in all localities in which the climatic conditions differ, even though the other conditions should be the same.

From what has been said with reference to the influence of soil and climate on the depth to which seed should be planted, it will be apparent, that when grass seeds are sown at those seasons when moisture is abundant they will need less of a covering than when sown at other seasons. Thus it is that the seeds of many grasses will grow with reasonable certainty in certain areas, when sown in the spring on late snows and on ground honeycombed with the frost, without any other covering than nature can give them. When sown on

late snows the seeds are carried down with the melting of the snows, and are lodged in the small crevices in the soil, or are brought so closely in contact with the soil that when moist weather follows they germinate successfully. Such germination is all the more successful when the seeds are sown on ground on which a nurse crop is growing, since the shade it furnishes at the season of germination is helpful to the growth of the young grass plants.

When grass seeds are sown quite early in the spring, they usually require less covering than when sown later. The roots find moisture near the surface more readily at that season, and the young plants are less liable to be injured by the drought of summer. The later they are sown, therefore, in the spring, the more deeply relatively should the covering be. Unless when sown quite early in the spring the aim should be to use a harrow in covering the seed, and the necessity for careful harrowing increases with the advance of the season. When grass seeds are sown in the autumn an intermediate covering is usually preferable, as, if covered shallow the seed may not find sufficient moisture, and if covered deeply the growth may prove insufficient to fortify the plants to meet, in the best manner, the adverse conditions of winter weather. But there may be good reasons in some instances for covering grass seeds slightly or deeply when sown in the fall.

The inherent vigor of the plants has much to do with the depth to which the seed ought to be buried in order to secure the most successful germination. Some grass seeds have much power to grow without any covering at

all save what nature can bring to them. Such, for instance, is blue grass (*Poa pratensis*). Because of this power it will sometimes take possession of soils without being sown at all save by the hand of nature. Particularly is this true of lands that have produced forest, in areas which abounded at one time in the eastern and middle states, and also in the provinces of Canada east from Manitoba. On these areas this grass usually takes complete possession of the soil, to the exclusion of nearly all the other forms of vegetable life, and without any aid from man except in removing the shade of trees with the axe, and also that of large and coarse forms of vegetation, as bushes for instance, by allowing animals to graze upon them. Timothy will grow on such lands and in some instances without being covered artificially, but it will usually grow more successfully when provided with a slight covering. Blue grass evidently has greater inherent power to grow than timothy, a fact that is evidenced in the ability of blue grass in certain soils to crowd out timothy in pastures, to the extent of taking complete possession of the soil. The possession of inherent power to grow in a marked degree in unfavorable conditions enables many forms of weed life to get a hold on the soil without any covering being furnished to the seeds other than nature gives them.

Methods of Covering.—When grass seeds are sown while the snows yet linger on the ground honeycombed with the frost, no covering can be given to them other than that which nature furnishes, nor, as previously intimated, is it required. Nor is any other covering need-

ed in many instances when these are sown in the autumn, with or without a nurse crop, in a climate that is humid, and especially when rains are frequent, providing the seed is sown as soon as the ground has been made ready to receive it and before rain has fallen on the same. The first rain that falls would seem to provide a sufficient covering for the seed. But there are instances when a light harrow should be run over the ground. In the renovation of pastures, seeds which fall to the ground subsequent to maturity are able to grow without any covering.

When the seed is sown in the spring on a winter crop after the ground has become settled a heavy harrow will usually cover the seed better than a light one, and sometimes it may be even necessary to weight the harrow. When it is sown in the spring with or without a nurse crop, when the seed falls on the surface, in nearly all instances it is advantageous to cover with the roller or the harrow. On heavy soils well supplied with rain in the spring, covering by rolling will usually suffice. But in loam soils when the rain is not abundant, and more especially when the summers are hot and dry, the seed should be covered with the harrow. On firm soils the smoothing harrow will probably do the work better than a heavy harrow, as it will bury the seeds less deeply. But on soils the opposite a heavy harrow is to be preferred because of the greater depth to which it buries the seeds.

When the seed is deposited along with grain sown with the drill, or with the broadcast seeder, it may not be necessary to harrow the ground further, but if sub-

sequent harrowing will prove helpful to the growth of the grain, which it does in some instances, it will also prove helpful to the growth of the grasses sown along with it.

A brush is sometimes used to cover grass seeds and with good results as when but a shallow covering is needed, but frequently it is not easy to get a small bushy tree that will cover a wide strip at one stroke, and that will leave the land smooth and even. This method of covering grass seed is now seldom or never resorted to when a good and suitable harrow can be secured.

Amounts of Seed to Sow.—It is not possible to state the amount of seed of any kind of grass that would prove satisfactory in all areas, since the amount that is most suitable for one locality or for a certain kind of soil would be too little for another locality or for a different kind of soil, and would probably be an excessive amount under yet other conditions of climate and soil. While 9 pounds of timothy may be mentioned as a suitable quantity to sow under average conditions, under other conditions 6 pounds will suffice, and yet again it may be advantageous to sow 12 pounds.

The following rules may be submitted as a general guide in determining the amounts of seed to sow: 1. The more stern and rigorous the climatic conditions, the larger the amounts of seed that should be sown to allow for the loss of some of the weaker plants. 2. The more suitable the natural soil conditions for any kind of grass, and the more perfect the preparation of the soil to receive the seed, the less the quantity that is required, for the reason first, that these conditions insure growth

from a higher per centage of the seeds than if the conditions were the opposite, and second, that the plants require more room for development because of the greater size to which they grow. 3. The finer the character of the fodder wanted from grasses fed in the green or in the cured form, the larger the amounts of seed that are required. 4. When sowing varieties which have the power to multiply plants as they grow by means of creeping rootstocks moderate amounts of seed are to be preferred to large amounts, unless when these are sown in short rotations, lest they should soon become too thick and matted to produce returns that would prove entirely satisfactory. 5. When grasses are sown alone more seed is required of the variety sown than if the same variety were sown in combination with other grasses, and the larger the number of grasses in the combination the less the relative proportion of each that should be sown. 6. When laying down land in permanent pasture larger amounts should be sown of those varieties which are known to have the highest adaptation and value for the conditions under which they are sown and vice versa. 7. The quantity of seed required usually increases with the size of the seed of any variety and the opposite of this is also true. 8. In semi-arid climates sparse or only moderately thick seeding is preferable to thick seeding, as the degree of the moisture obtainable is then more perfectly adjusted to the needs of the individual plants. Notwithstanding that it is not possible to state the amount of seed of any given variety of seed that will answer equally well for all areas, something will be said about the amounts

that will be at least approximately suitable under varying conditions when treating of the respective grasses which will be later discussed with some degree of minuteness.

Sowing With or Without a Nurse Crop.—It is more common to sow grass seeds with than without a nurse crop. A nurse crop is one which is supposed to benefit the crop sown along with it for a time, by the shade which it affords, and in some instances by the shelter which it furnishes from the sweeping winds of winter, as, when grasses are grown along with some kind of winter crop. The practice rests on premises that are correct. Notwithstanding, some writers favor sowing the seeds alone and there may be instances in which it would be commendable to sow them thus. But as a rule the practice of sowing grasses with a nurse crop is likely to continue in favor with a great majority of those who till the soil.

The benefits arising from sowing grasses with a nurse crop include the following: 1. When thus sown shade is furnished for the young plants while they are yet tender until they become firmly rooted in the soil. 2. The shade thus furnished is adverse to the crusting of the soil, a condition which when present is full of hazard to young grass plants, especially when they are exposed at such times to hot suns. 3. Usually the nurse crop can be grown as well with the grasses present as when these are absent, but to this there may be some exceptions. For instance, when timothy is sown at the same time as winter wheat, it sometimes grows so vigorously that the yield of the wheat is somewhat re-

duced. But when this happens, compensation is obtained in part at least, by the added value given to the straw. The leading objections to sowing thus are: 1. That sometimes the grass or grasses are weakened and partially destroyed by excessive shade in the nurse crop. 2. That in other instances the vitality of the grasses is so weakened through the consumption of moisture by the nurse crop, especially during the ripening period, that when the nurse crop is removed when ripe, the hot sunshine prevailing at the time will in some areas and in some seasons kill a portion of the plants. Sometimes the destruction is total. 3. When the nurse crop lodges some considerable time before it is ready to be harvested, the grasses sown with it are pretty certain to be smothered by the nurse crop. Such lodging may be prevented by pasturing the grain crop for a time in the early stages of the growth of the same.

The benefits from sowing without a nurse crop include the following: 1. In some instances a more vigorous stand may be secured, since the plants have the full benefit of unimpeded sunlight and of all the moisture in the soil. Especially is this true when the plants are sown on clean soil and start well when they begin to grow. 2. When hay of a certain kind is wanted it may be obtained one year sooner, in some instances, when sown without a nurse crop, as for instance, when timothy is sown alone in the autumn, or when certain of the rye grasses are sown in the spring. 3. A stand of grasses may sometimes be secured when thus sown under conditions of weather that would prove fatal to grasses sown with a nurse crop, more especially when

there is but little moisture in the soil. The objections to sowing thus are: 1. In a majority of instances only a partial crop of grass is obtained the first season, hence, the value that would have accrued from a nurse crop had it been grown is reduced in proportion as the grass crop is short in its yield. When it is necessary to take one season to secure a stand of grass without getting a return from it, the question arises as to whether food for stock should not be grown in some other way. 2. In many instances, weeds grow, which if not checked would shade the grass quite as much as the grain, and would also mature seeds the plants from which the following year would greatly reduce and injure the hay crop. This can be prevented of course by mowing them off and allowing them to lie on the ground to form a mulch when not too dense, but this of course entails considerable labor. 3. It sometimes happens that the young plants, when sown thus, are killed out partially or wholly in spots by the hot sunshine on an encrusted soil. It is evident, therefore, that the practice of sowing grasses with a nurse crop is likely to prevail generally in the future as in the past.

The nurse crops that may be used are various. They include all or nearly all the small cereal grains; in some instances rape and in others grains grown in mixtures for soiling food. Winter rye is one of the most favorable crops with which to sow grasses, since these may in many instances be sown in the fall or early spring as may be necessary. It does not stool as much as some grains, hence it injures the young grass less by excessive shade, and it is harvested early, thus giving the grass

plants the benefit of more sunshine and moisture than would be possible when sown with a crop of grain in the spring. Spring rye also answers the purpose well, but the grass seeds can only be sown upon it in the spring, and usually not so early as on winter rye. Winter wheat makes nearly as good a nurse crop as winter rye, but it stools more and is not harvested quite so early. Other winter crops, as for instance winter barley or winter oats make good nurse crops where these can be grown, as in the southern states. But the fact is to be remembered that when sowing grasses with winter crops adverse influences which injure the nurse crop, as cold winds or heaving through freezing and thawing alternately will also in a measure injure the crops sown with these, though probably to a less extent. Barley stands relatively high as a nurse crop for grasses. It does not shade them for so long a period as some other nurse crops, nor is the shade so dense, since the growth of barley is not so tall as that of other cereals; more sunlight is admitted during the maturing period of the barley. Oats are probably less favorable to the growth of young grasses than any of the other small grains except peas. They stool more than other grains, and are of more leafy growth, hence they provide a denser shade, and in maturing they draw heavily on the moisture of the soil. But oats may in many instances be profitably used as a nurse crop by sowing a less quantity of the seed than is usual and then cutting the oats for hay as soon as they are fully in head. When they are thus harvested, the drain of soil moisture so rapid during the maturing period is prevented. To preclude such a drain, when it can be

done without loss, is usually greatly advantageous to grasses sown with a nurse crop, since the weather is usually both hot and dry as the harvest season approaches. The chief objection to flax as a nurse crop is the late season at which it is sown, but some authorities cherish the opinion that there is something in the flax itself that is not favorable to the growth of grasses after the crop has been removed. Nevertheless, the sowing of grasses with flax is frequently attended with a fair measure of success. Experience in growing grasses with a rape crop is limited, but in some instances it has succeeded. The same is true of sowing them with mixed crops grown for grain or for soiling. The one objection to growing them thus is found in the greater relative thickness to which such crops are usually sown. But in the case of soiling crops, the removal of these before maturity is so far favorable to the growth of the young plants. Peas and vetches, when sown to produce grain are usually hurtful to grasses sown with them, since they nearly always lodge some considerable time before they mature. But in some instances grasses and also clovers are sown along with grain or forage plants sown alone or in combinations to provide grazing for horses, cattle, sheep or swine. When such grazing is grown it is more commonly on the humus soils of the prairies and in areas in which the rainfall is less than normal. Grasses and also clovers are sown on these in the usual way when the forage crop is sown. As soon as the grain has become well started the animals are turned in to graze upon it. In some instances a better and surer stand may be obtained than from sowing the

grass seeds in the ordinary way. For the further discussion of this question see page 180 in the book "Forage Crops Other than Grasses," written by the author.

Sowing Grasses Alone or in Combinations.—Whether any kind of grass should be sown alone or along with other grasses depends upon the object, or objects, for which it is grown; and also on the degree of its adaptation to the locality.

When any variety is grown for seed it is usually sown alone, but in some few instances certain varieties may be sown in combination even when seed is sought. Timothy is frequently sown with medium red clover. The year after sowing the seed the crop is cut once, and in some instances twice, for hay. During several subsequent and successive seasons it may be practicable to harvest the timothy for seed. But to growing grasses together for seed there is the strong objection, first, that they produce seed less perfectly when grown thus, because of the thick growth produced by mixtures; second, that in many instances they do not ripen their seeds at the same time; and third, that it would prove a difficult, if not, indeed, an impossible, task to separate many kinds of seeds when thus harvested together, they are so nearly alike in size.

When grown for hay it is common to sow grasses in mixtures and these mixtures frequently contain also the seeds of certain of the clovers. These mixtures usually yield more and produce hay of finer growth than when sown alone. But when sowing two or more varieties together it is usually better to select those which mature about the same time, that they may be har-

vested when each variety has reached that stage of growth when it is best fitted for making good hay. Some of the less important of these combinations will be referred to later, when discussing certain of the more important of the grasses.

When pastures are wanted the grasses sown to produce them are generally sown in combination. To make permanent pastures they are nearly always sown thus. Sometimes it may be advisable to sow but one variety to produce pasture either temporary or permanent in character because of the peculiar adaptation of the same to the climatic and also to the soil conditions. Kentucky blue grass (*Poa pratensis*), timothy (*Phleum pratense*), Russian brome grass (*Bromus inermis*) and Johnson grass (*Sorghum halapense*) are frequently sown thus. But in a great majority of instances it is advisable to sow grasses in combinations to make permanent pastures and the larger the number of the grasses that can be successfully grown in these the more valuable are they. When sown thus they not only produce more pasture than one variety would, but they produce it more continuously through the season and for a longer period. This arises first, from the denser character of the growth; second, from the different parts of the season when each variety is at its best, and third, from the greater durability of some varieties as compared with others. When determining the grasses which should be sown in combination, the aim should be to sow only such varieties as will produce relatively well under the conditions present and that are not short lived. While it may be proper in some instances to sow many varie-

ties, in other instances and indeed generally but a limited number of varieties should be chosen, and yet again but one variety. It would seem to be correct to say that when determining which grasses should be sown in combination pastures, adaptation should be the first consideration, intrinsic value for the end sought the second, and permanence in growth the third. Notwithstanding there may be instances in which it is wise to sow freely in the mixture some short lived variety to provide abundant grazing while the slower growing varieties are becoming established.

The Grazing of Meadows.—The way in which meadows are grazed has a far more important influence on their productiveness than is generally supposed. The practice of grazing them closely in the autumn is quite common and this is frequently done the autumn immediately following the sowing of the seeds.

When thus grazed the vitality of the plants is lessened. The protection which the autumn growth furnishes being thus removed, the roots of the plants are more exposed to the severity of the winter weather than they would otherwise be, and, in consequence, they grow less vigorously than they otherwise would the following season. Severe grazing of newly sown meadows in the autumn sometimes leads to their destruction before one crop of hay has been grown. Of course, all grass plants are not equally injured by such grazing, but there is probably no variety the yield of which will not be lessened the following season when thus closely grazed unless the season and other conditions are unusually favorable.

When meadows are not thus closely grazed in the autumn the grass starts much more quickly in the spring than it would under conditions the opposite. The young shoots are protected from the cold winds and the early frosts which retard growth at that season. They are thus protected by the aftermath of the previous season, which acts also as a mulch and thus retards surface evaporation in a marked degree. The increase in the yields from the protection furnished by aftermath is in some instances as much as 50 per cent.

But it does not follow that meadows should never be grazed after harvest. In some seasons the growth of the aftermath will be so vigorous that during the following winter the grass in at least portions of the meadow would be smothered, and in other portions growth would be retarded by the excessive amount of the mulch produced, and the hazard is greater with free-growing plants, as clover, and in countries subject to heavy falls of snow. Moderate pasturing, therefore, is frequently helpful, but the aim should be to graze meadows early rather than late in the autumn. Nor should they be grazed when the ground is so wet that it will poach through the sinking of the feet of the animals which graze upon it. Grazing meadows thus on clay soils especially would be highly injurious to them. It should also be remembered that the more closely animals graze the more will the meadows be injured by such grazing. Because of this, grazing with cattle is less injurious than grazing with sheep. The grazing of meadows, therefore, after harvest is usually injurious in proportion as it is late and close, as the plants grazed are lacking in in-

herent vigor and in ability to grow quickly, as the soils are wet and heavy of texture, and as the winter weather is severe and the summer weather dry.

The Grazing of Pastures.—Much of what has been said in the preceding section on the grazing of meadows will also apply to the grazing of pastures. But the productiveness of the latter is likely to be injured more by excessive grazing than that of the former. Grazing is excessive when it lessens the possible production of the pasture, but it may not be easy to determine in many instances when that point is reached beyond which further grazing would be excessive, since what would be in excess in a season characterized by drought would not be so in one characterized by an abundant rainfall.

Close grazing injures pastures by weakening their capacity to grow, by increasing their exposure to injury through surface evaporation, by removing what would prove a protection to them in winter, and in some instances by preventing the plants from re-seeding.

That plants breathe through the medium of the leaves is well known. It follows, therefore, that the strength of the plant, when amply supplied with food and moisture will be proportionate to the extent of the surface through which it breathes. This explains in part at least why a larger amount of food will be furnished by grass plants from a given area under normal conditions when mowed than when grazed. But this result will probably be modified when moisture is insufficient. Consequently, the closer the grazing the less ordinarily will be the production of the pastures.

When grasses are kept constantly bare, surface evaporation is more rapid than it would otherwise be, and because of this the grasses will suffer sooner from a deficiency of moisture. The earlier in the season, therefore, that close grazing begins, and the more persistently that it is followed, for one season and for successive seasons the more is productive power in the pastures weakened. In climates in which the supply of moisture is ample the mistake of too close grazing is not nearly so serious as in those opposite in character, but in any climate it lessens productiveness.

When the grasses enter the winter eaten down to the ground, or nearly so, they not only suffer more from exposure than they would were they protected by a self provided covering, but as in the case of meadows, they spring up more quickly and more vigorously in the spring. The difference in both respects is marked. As a result, earlier grazing is possible, and the animals thus grazed are not so liable to injury from a too lax condition of the bowels, as if turned out onto grazing in the spring consisting only of fresh grass; the old grass which is eaten along with the new militates against such a condition.

The hindrance to the re-seeding of grass plants in pastures of but short duration is not serious, since they are sown to be broken up again. Nor is it so greatly important in permanent pastures laid down by man, since the hand that sowed the seed which made these can add more seed from time to time as occasion may require. But with permanent pastures made by nature, as on ranges, this question becomes one of great significance.

Range pastures cannot be kept from deteriorating where re-seeding through the processes of nature is hindered by close grazing.

Pastures are grazed under improper conditions if grazed when too wet or when too much frozen. When the soil is too wet the ground poaches, and in some instances becomes impacted. Both conditions are adverse to growth. The injury from such pasturing on very stiff soils may extend over years. The reasons for the injury to pastures from close grazing when the ground is hard frozen are not so apparent, but the fact of such injury cannot be doubted, nor should the fact be overlooked that all the influences unfavorable to production in pastures just so far encourage the growth of weeds in these.

Renovating Meadows.—Since meadows are in a great majority of instances of but limited duration, the attempt is seldom made to renovate them. More commonly when the production on these falls below the line of profits, they are overturned with the plough. But in some instances the stand of grass secured at the first is only partial, and for various reasons it may be desirable to improve it. In other instances the stand may be good but the production is low from want of plant food in the soil. In these it may be desirable to stimulate growth, and in yet other instances, owing to the difficulty of getting a stand, the aim is to prolong the period of productiveness through what is termed self-seeding; that is, renewal from seed which falls from the plants in the meadow.

When the stand of grasses is but partial, as when, for

instance, it grows in the lower lands and fails on the higher ground through drought or poverty of soil, a full stand may sometimes be obtained by simply adding more seed, and providing the same with a covering. If the stand on the spots that need renewal is partial; that is to say, if there are plants there but growing too thinly, the seed should be sown on the surface and covered with the harrow, but the ground should not be harrowed to the extent of destroying many of the plants that are already established. If the areas that require re-seeding are devoid or nearly so of plants it may be helpful, in some instances, to disk the ground before adding more seed. The seed thus added should be sown in the fall as soon as fall rains come. If a top dressing of fine farmyard manure is added before or after harrowing in the seed, but not in such quantities as to hinder growth by smothering, the young grasses will grow more vigorously and will go through the winter in much better form. In the absence of farmyard manure certain commercial fertilizers may be used with profit. Timothy meadows especially may be thus renewed with much advantage.

When the growth of the plants is to be stimulated fertilizers must be applied. For this purpose no better fertilizer can be used than farmyard manure, could it be obtained in sufficient quantities, as it acts as a mulch in addition to the fertility which it supplies. It may be used in the fresh form, especially when evenly and not too thickly distributed, as with the aid of the manure spreader or in the reduced form. When applied it ought to be in the autumn rather than the spring on

lands that are not hilly. If applied in the spring in the fresh form it is not easy to avoid raking up more or less of the manure in the hay at harvest time. Artificial fertilizers may of course be used in lieu of farmyard manure. The kinds that ought to be used and the quantities to use will be determined largely by the needs of the soil and of the plants. Fertilizers rich in nitrogen are especially helpful in growing grasses. Potash is equally helpful in growing clovers, but in a majority of instances complete fertilizers are the most satisfactory. It is usual to apply these fertilizers just after growth has begun or after each cutting.

The renewal of meadows through self-seeding is more applicable to those in which medium red clover (*Trifolium pratense*) is one of the factors, than to those composed entirely of grasses, since the former produces seed in the autumn after one crop of hay has been harvested. On certain light soils and in certain areas more or less deficient in rainfall, meadows have thus been maintained for many years. But to maintain them thus it was found necessary to graze them but little, or not at all, according as moisture was present or absent. Meadows composed entirely of grasses could not be renewed thus, since after being mown they do not usually produce seed again the same season. But it would be possible to renew them thus by grazing for one season, but not so closely as to preclude a part of the plants from maturing and shedding seeds.

Renovating Pastures.—Pastures may be renovated and improved by adding seed directly or through the medium of self-seeding, by dressing them with fertilizers

and in some instances by re-ploughing them. The various phases of this wide question, however, will only be touched upon here. The precise methods of securing such renovation are more fully discussed in Chapters XV and XVI.

In certain areas when moisture is more or less deficient as in the semi-arid belt, and in lands immediately adjacent thereto, the grasses become thinner and in spots fail altogether when they are grazed closely for a term of years. The same is also true of pastures in certain soils of the south much deficient in plant food. As these fail the soil remains uncovered, or is more or less possessed by noxious weeds. In tillable areas the remedy is adding more seed in the late fall on the disked or unbroken surface, or in the early spring, with or without disking or harrowing according to circumstances. When this is done it has not usually been found necessary to cease pasturing unless for a short time after sowing the seed. Where tillage cannot be given as on the range the remedy lies in so restricting the grazing that the grasses may mature seeds to a greater or less extent and so re-seed the land. On the open range, that is, on that part of the range country known as public domain, such restriction has not heretofore been found practicable. But on those portions of the range under private ownership this can be done when the range is fenced, either by grazing so moderately that more or less seed from the grass plants will mature every year or by pasturing only in alternate years.

Top dressing with fertilizers may be made to greatly increase the productiveness of pastures in areas sub-

ject to cultivation. On the range such fertilization would not be practicable because of the cost. Of these fertilizers none are so effective probably as farmyard manure, since as when applied to meadows it acts as a fertilizer and also as a mulch, and the more quickly it can be applied after it is made, the greater is the benefit that follows from applying it. While it may be applied at nearly any season, the greatest benefit, probably, will accrue from applying it in the late autumn or early winter because of the protection which it affords and because of the stimulus given to the growth of grasses covered by it as soon as growth begins in the spring. So great is the stimulus given to such dressings by the growth of grasses that they crowd out many kinds of weed life that may be present. The deeply rooted objections in the popular mind to such applications, because of the weed seeds which they bring to the pastures, would seem to be cherished to an extent far beyond the danger incurred. Such dressings are peculiarly adapted to pastures which form a part of the regular rotation, since the stimulus thus given to the growth of the grass plants adds to the humus of the soil when the pastures are overturned with the plough.

Artificial fertilizers are more commonly used in top dressing pastures in the complete form, but frequently the fertilizer is applied only in the form of nitrogen. Sometimes phosphates only are used and sometimes wood ashes. The needs of the soil should chiefly determine the kinds of fertilizer to be used and the quantity of the same.

Only with certain kinds of grasses can pastures be

renovated by breaking them up occasionally with the plough and then in due time following with the harrow. Included in the number are quack grass (*Agropyrum repens*), Russian brome (*Bromus inermis*), Johnson grass (*Sorghum halapense*) and Bermuda grass (*Cynodon dactylon*). It will be observed that these all have the power to multiply by pushing root-stalks through the soil, but all grasses which have such power may not be renewed thus. Because of this quality these grasses are much liable to become sod bound; that is to say, so thick that free growth is hindered. By breaking them up occasionally, as referred to above, they start off with renewed vigor. The frequency with which they should be thus ploughed, the season for doing the work and the method of doing it will be influenced by such conditions as climate and soil. Since experience in renovating pastures thus is limited; the precise methods to be followed are as yet but imperfectly understood.

Grasses as Soil Improvers.—Grasses, unlike clovers and other legumes do not bring fertility to land. On the other hand, they remove it in the hay, which they furnish as in the case of non-leguminous cereals, unless fed upon the farm which produced them and the manure thus made is returned to the land. Even when pastured there is a loss of fertility unless the animals grazed upon the pasture remain upon them by night as well as by day. But since inert fertility is being gradually liberated in all soils, and since grasses not only gather more or less of this in the processes of growth, but actually hasten such liberation while they are growing, the soil upon which they grow grad-

ually becomes richer in available fertility, except in so far as the product of such growth is removed from the land. This explains why the producing power of grass-producing lands grazed by sheep is increased. It also explains at least in part why poor soils become more productive when they have become covered with a growth of grass.

Grasses, however, improve the mechanical condition of the soil. They put humus into it not only in the decay of their rootlets, but also in the decay of the sod which they have formed when it is buried with the plough. The vegetable matter thus furnished yields up plant food in a readily available form, binds light soils so that they lift less with the winds, and renders stiff soils more friable and consequently easier of access to the roots of plants. And they greatly increase the power of all soils to retain moisture in the cultivable area for the benefit of succeeding crops.

The extent of the benefit thus conferred will increase with the increase of the supply of vegetable matter thus furnished and with the slowness of the decay in the same. When grasses have been grown upon a piece of land for a time the maximum production of humus is practically reached. If, therefore, when this limit has been reached, the pasture is broken up, and the same land is again laid down to pasture it is very evident that much more humus will be put into the soil thus rotating grasses than by growing them for long periods. In tillable areas, therefore, it is greatly important that grasses shall be rotated with other crops. In climates lacking in humidity and warmth and also in moisture,

the decay of vegetable matter is relatively slow, hence, the benefit from the decay of such matter is much more lasting in these climates than in those opposite in character. Consequently it is greatly important that grass crops shall form a factor in rotation, even though they should not bring fertility directly to the soil.

CHAPTER III.

TIMOTHY.

Timothy (*Phleum pratense*), has also been known by the name Herd's grass and in some instances by that of Meadow Cat's Tail. It is said to have been found growing wild in a swamp in Piscataqua, N. H., prior to the middle of the eighteenth century by one Timothy Herd; hence the origin of the name Timothy and possibly also Herd's grass, although some authorities lean to the view that the latter name was given because of its use in providing grazing for the herd. It was known chiefly by the name Herd's grass for several decades in New England; others claim that it was named Timothy from Timothy Hanson of Maryland, who, it is said, and with much probability, introduced it from England about the year 1720. Other authorities state that in that year Timothy Hanson took the seed from New York to the Carolinas and thence to England, but there can be no doubt that it is also indigenous to England. Yet again it has been claimed that the seed was taken from Virginia to England by one Peter Wynch in 1760 or 1761. It is quite possible, therefore, and highly probable, that the seed was derived from the two sources; that is, from England and America.

The plants tiller considerably, and when not crowded will each produce several stems. The stems grow up-

rightly and usually attain the height of about two feet, but in some instances they grow to a height of four to five feet. They are surmounted by a handsome circular spike or head, which is also elongated, and is usually about three to four inches long, but sometimes they are produced as long as 12 inches. When in full bloom a field of timothy is an attractive sight, especially in the early morning while the dew lingers. The whole field, at such times, presents the appearance of a sea of filaments standing out from the heads and sustaining delicate and, in a sense, almost colorless flowers. The leaf growth cannot be said to be large in proportion to the stems, but it is fine and makes good grazing in the early season. When the plants grow closely, the growth of stem is fine, which of course increases the palatability of the hay. The root growth is fibrous and bulbous. The fibrous character is greater relatively in good and moist soils and the bulbous in poor soils. In any event the bulbs are small and the plants feed chiefly not very far from the surface.

Timothy is perennial and under the most favorable conditions will grow at least a score of good crops in succession, but under conditions that are not really favorable, it is short lived. Ordinarily it will grow several good crops in succession before it is necessary to break up the sod. It grows rather slowly compared with some of the other food grasses, and ordinarily it makes but little growth the same season subsequently to its being mown for hay.

There are several varieties of timothy, but these are known only to botanists. At least the seed has not come



FIG. 2.

TIMOTHY (*Phleum pratense.*)

Oregon Experiment Station.

into the market under names that would indicate specific varieties. And yet it is claimed by botanists that some of the varieties are so distinct and so specifically superior to the variety commonly sown as to deserve sufficient attention to grow them with a view of placing them on the market on the ground of superior merit.

Timothy is grown rather for hay than for pasture, and yet in certain areas of the prairie it is much relied upon for pasture at the present time. Close grazing may weaken the plants under certain conditions, but ordinarily it does not readily succumb because of such treatment. Of all the grasses now grown for hay on the North American continent, timothy is unquestionably the most generally useful and it is by far the most extensively grown. This arises in part from the wide range in its adaptation, but more from its many good qualities. These include the ease with which it may be grown, cured and transported, the high palatability and nutrition which it possesses, and the attractive appearance and readily marketable character of the hay. The hay, though fed to horses, cattle and sheep, has been found specially adapted to the needs of horses, and most of all adapted to the needs of horses when at work. This arises in part from the suitability of the food constituents which it contains, and in part from its meekness to the digestion of horses at work. It may be more suitably fed to cattle and sheep when grown along with some variety of clover, since, when thus fed, the fodder is in better balance. When fed to sheep it should be of fine growth and cut early.

Distribution.—As has already been intimated, tim-

othy is thought to be indigenous to both Europe and America. It is now also grown over considerable areas in Western Asia and Northern Africa, and without question a wide area of distribution awaits it south of the equator.

Timothy calls for a climate, temperate rather than torrid or frigid, and moist rather than dry. But few climates, if any, are too humid for the successful growth of timothy, the other conditions being right. But the climate is too dry even in some parts of the United States and Canada. Especially is this true of the mountain valleys eastward from the range of mountains nearest to the Pacific and of the range country for several hundred miles east from the Rockies. But in these areas good crops can be grown under irrigation and also without irrigation on many of the bench lands which appertain to the mountains. That it is able to endure much cold is evident from the fact that the winters of Manitoba and Assiniboia do not destroy it. It cannot so well endure hot summer temperatures, and this, in part, accounts for the comparatively little success that attends its growth in several of the southern states.

In the United States, timothy may be grown under certain conditions in some portion or portions of every state in the Union. If, however, a line were run across the continent from Washington to San Francisco, north of that line would lie those states in which timothy may be said to be a staple crop. In these states the highest adaptability to its growth is found in those of them adjacent to the Canadian boundary. Nowhere on the continent probably does timothy grow so well as on the

tide lands of the Atlantic and the Pacific northward from the fortieth parallel. It also grows with great luxuriance in the river bottoms of Washington and British Columbia in Canada and adjacent to the sea. In the southern states, much of the soil is too low in humus for the successful growth of timothy until the lack mentioned is supplied, notwithstanding the humid character of the climate. But in certain areas, especially on the plateaus of the mountains, good crops of timothy are grown. The states which are lowest in adaptation for the growth of timothy are those which lie to the southwest.

Timothy grows more or less vigorously on suitable soils in all the provinces of Canada, and with much vigor in Ontario and Quebec. The tide lands of the maritime provinces are capable of producing good crops of timothy indefinitely. It does not grow well on the western prairies as in other areas of the Dominion of Canada. Especially is this true where the rainfall is light, as for instance toward the Rocky Mountains when approached from the east.

Soils.—Timothy will grow, but, of course, not equally well, on a wide range of soils. There is probably no soil in the cultivable area of America in which it will absolutely fail to grow to some extent, when the climatic conditions are suitable. Nevertheless, to grow it at its best, the soil should be rich and moist, and at least fairly well supplied with humus. Consequently, timothy usually grows luxuriantly on reclaimed swamp lands and on the alluvial soils of river bottoms. To these may be added certain of the volcanic ash soils of the

west. It generally grows in good form on the humus soils of the prairie, on upland loams and even on stiff clays. But to grow the crop at its best in reclaimed swamps it is necessary that the soil shall be muck rather than peat. In the latter, if unreduced, it will not make much growth, even though sufficient moisture should be present. In river bottoms it is necessary that the soils, if sandy, shall contain at least a fair proportion of loam. In the volcanic ash soils of the western mountain states, it would seem to be specially necessary that ample moisture shall be present. In the humus soils of the prairie sufficient clay is requisite to keep them from lifting with the wind. Upland loams require at least a fair amount of fertility, and stiff clays enough of humus to prevent them from impacting and baking in a degree seriously harmful to growth. The valley lands of the east and the west, all across the northern half of the continent, have specially high adaptation for timothy, but nowhere probably higher than on river bottoms and reclaimed lands beside the Pacific and the Atlantic. On the foothills of the Alleghanies and of the Rockies it grows well, a fact in a considerable degree accounted for by the seepage from the mountains, which keeps the ground moist. The return from certain of the humus soils of the prairie is frequently disappointing, but this arises probably more from a lack of moisture than a lack of plant food in the soil. It would probably be correct to say that the black soils of the prairie, so light that the winds will sometimes carry them, are not really good timothy soils.

Dry, sandy soils and soils low in fertility are ill

adapted to the growth of timothy. This is true of the last named class of soils, regardless of their composition or mechanical condition. Good crops of timothy cannot be grown on a hungry soil, any more than good crops of wheat. Sandy soils low in humus are usually of this character, and are, moreover, leechy; hence, on these the crop is usually characterized by lack of vigor in its growth. The naturally hungry character of many of the upland soils of the south is largely responsible for the lack of adaptation in these to the growth of timothy.

Place in the Rotation.—Timothy should be sown on clean soil. It should, therefore, follow such crops as have been given clean cultivation during the period of growth. These will include corn, sorghum, the non-saccharine sorghums, all kinds of field roots, potatoes, in some instances rape; also cow peas and soy beans. It may also be sown with much advantage on lands that have been properly summer fallowed. It is, of course, frequently sown on land that is not clean, and it may grow with some vigor under such conditions, but the hay produced will not be of prime quality because of the weeds that are mixed with it.

Timothy may be followed by almost any kind of a crop, since, when sown alone it does not form a stiff sod; hence, the crops which immediately follow timothy are usually able to gather sufficient food from the soil. But the aim should be to follow timothy with some small cereal grain crop which has much power to gather food in the soil, since, under some conditions, overturned sod does not decay quickly enough to enable certain crops to gather food therefrom with sufficient quickness

to produce results such as may be desired. The oat crop is a favorite one to sow immediately after timothy. The same is true of flax, in areas where that crop is successfully grown. When the sod can be ploughed immediately or soon after the timothy has been harvested for hay, or even earlier when it is being used as pasture, winter wheat or some other winter cereal may be sown upon it with much advantage. Peas or vetches will grow luxuriantly after this crop, and they aid in reducing the sod where this may be necessary to bring the land in proper condition for sustaining successfully some cereal that has less power to gather its food. Overturned timothy sod is also advantageous to the growth of such crops as corn, potatoes, the sorghums and rape. All of these feed ravenously on the decaying vegetable matter in the sod. But, since these are all grown as cleaning crops, the growing of such cereals as oats, barley and Canada field peas, the peas to be followed by wheat, are more commonly made to follow crops of timothy.

Preparing the Soil.—In ordinary practice, when timothy is sown with a nurse crop, that degree of pulverization which prepares the soil sufficiently for sowing the nurse crop is considered sufficient for the timothy also. But this does not always hold true. Clay soils are frequently covered with small clods on the surface, the pulverization under these being so fine that the small grains sown on them will start with sufficient vigor, while the timothy seed, being planted nearer the surface, will not germinate well unless the weather should prove more than ordinarily moist. In nearly all instances, therefore, it will prove advantageous to work the ground

sufficiently to secure a fine condition of tilth on the surface. The more nearly the condition of the pulverization secured resembles that of a garden prepared for the seed the better. To secure this may involve the persistent use of the harrow and roller, but labor thus expended will ordinarily be well repaid in the better stand of timothy that will follow. But to this rule there may be some exceptions. For instance, when timothy is sown in the autumn on stiff clays, and in areas subject to beating autumn or winter rains, when the pulverization is fine beyond a certain degree, the soil "runs together;" that is, the fine particles in it adhere so closely that in some instances it becomes encrusted—a condition adverse to every form of plant growth. When timothy is sown alone, as it sometimes is in the early autumn, the ground may in many instances be prepared by simply using the disk, the harrow and the roller. Such preparation will usually suffice when the surface of the soil is at least reasonably free from weeds. Such a condition is frequently met with on soils from which a heavy crop of peas or vetches have been harvested or from which a cultivated crop as potatoes, have been removed. But if the soil sustains weed growth in any marked degree then it ought to be ploughed if possible a considerable time before the seed is sown, and pulverized by suitable cultivation. On soils that are liable to lift with the wind, it would probably be better to sow the seed amid the grain stubbles in the early autumn and cover with the harrow. The stubbles will so far hinder the winds from lifting the soil, and will also furnish protection to the young plants in the winter season.

The more that soils are enriched for timothy, the better will be the growth that will follow. It is more common, however, to stimulate growth by dressing the plants with a fertilizer than to apply fertilizers to the soil previous to sowing the seed. Farmyard manure is an excellent fertilizer, but when applied on soils intended for timothy, if in the fresh form, the results are likely to prove more satisfactory on the whole if it is used when preparing the crop that precedes timothy, since the unused increment still left in the soil is then easily accessible to the young timothy plants. But reduced farmyard manures may be applied with advantage when preparing the soil for the nurse crop with which the timothy is to be sown; coarse manures may also be thus applied, where the conditions favor rapid decomposition in the soil and especially when the period of soil preparation covers a considerable length of time.

Sowing.—The time at which timothy may and ought to be sown will vary much with variations in climatic conditions. It would probably be correct to say that in all places in which it can be grown with a fair measure of success, the two best seasons for sowing it are the early spring and the early autumn. When sown in the early spring a stand is more assured than when sown later, and the same is true of early fall sowing. In all the states northward and in all the provinces of Canada, in which winter rye and winter wheat can be sown with success, timothy may sometimes be sown while the snow still lingers. When thus sown, as the snow melts, it comes in contact with the soil while the latter is yet moist, and much of the seed is covered in the little openings on the

surface by soil particles shifting position. If sown while the "old snow" is yet several inches deep, the danger exists that much of the seed may be carried away by the waters formed in the rapid melting of the snows through a sudden drop in the temperature, and this condition may be further aggravated by heavy rains.

Timothy may also be sown in the spring on ground in a honeycombed condition, induced by alternate thawing and freezing in the early spring, while there is yet much moisture in the soil. When the seed is sown on soils in the condition stated, the work can best be done in the early morning when the air is still and while the ground is yet frozen. By the time the ground has settled down to a normal condition much of the seed is covered, and a stand is reasonably assured. On some soils, however, timothy seed cannot be sown thus since they do not honeycomb. Where they do, a stand is more certain than it would be if the sowing were deferred until the ground was dry enough to render it necessary to cover the seed with the harrow.

On soils which carry crops of winter wheat or winter rye, also winter barley or winter oats, and which do not honeycomb, the sowing of the seed in spring should be deferred until it can be covered with the harrow. If sown on such soils without any covering and dry weather should follow, the seed or, at least, much of it, would not grow, and a stand would not be secured. But in a wet season it would likely be different.

When the seed is sown with any kind of spring crop, it should be put in when practicable at the same time as the nurse crop or as soon as possible thereafter. The

earlier that such crops can be sown the more assured the stand of the clover in a normal season, since more time is then given to the plants to become well rooted before the arrival of dry and hot weather, when the summer is moist, timothy would succeed when sown late, but since such seasons cannot be foretold, late sowing is always attended with more or less hazard to the timothy.

When timothy is sown alone, it may be best sown in the late summer or in the early autumn. When sown thus in the spring a stand may also be secured, but seed sown thus in the spring seldom produces a full crop of hay the same season, while the reverse is true of seed sown in the fall. When sown with any of the winter crops named above, the aim should be to sow the timothy seed along with the nurse crop, or as soon as possible thereafter. Early sowing in the autumn enables the plants to become so strong that they can well resist the adverse influences of winter weather. Early sowing in the spring enables the plants to become rooted and strong before the coming of the hot and usually dry weather of summer. When the seed is sown late in the fall the vitality of the young plants may become weakened if not destroyed by cold winds and low temperatures which prevail in certain areas. On soils that heave with the frost, the stronger the plants the better can they resist the influences which produce such heaving. Timothy when sown in the autumn would seem to be able to withstand adverse influences at least as well as winter wheat, winter oats or winter barley. Some farmers in the northern states claim good results from sowing timothy in August on overturned stubble land, and

along with fall turnips. They claim that the turnips protected the crop in winter and fed it the next summer.

Whether timothy should be sown alone or with a nurse crop must be determined by the object sought from sowing it. Where a full crop of timothy is desired the first season after sowing, it ought to be sown alone in the early autumn as intimated above. Sowing it thus in the early spring would almost certainly insure a stand and would also provide more or less pasture the same season, but it would not seem to be good practice in farming to sow timothy alone in the spring, unless where a full crop could be looked for the same season.

All things considered, a good stand of timothy is more certain when sown along with a winter rather than a spring nurse crop, and it will also furnish more pasture after the crop has been removed. The dry weather of summer more frequently kills the timothy if spring sown than does the harsh winter weather that, which was properly sown in the autumn. Of the winter crops, rye and barley are probably the best; and after these wheat and oats in the order named (see page 32). If these crops are pastured rather than harvested, the return in pasture the same season from the timothy will be increased. When sown in the spring, the following nurse crops are good in the order named, viz., spring rye or speltz, barley, spring wheat and oats. Timothy may also be sown with grain grown for pasture. Such grain may be grown alone or in combination with other grains, and the timothy also may be sown singly or in combination with other grasses and clovers. (See page 35.)

Timothy may be sown by hand with the aid of some hand sowing machine, the grain drill, and sometimes the broadcast seeder. When sown while the snow still lingers in the spring, hand sowing is a necessity. It may also be resorted to under all other conditions except when the seed is to be mixed with that of the nurse crop amid which it is to grow. But there are some objections to hand sowing. First, it involves more labor than sowing by some of the other methods named. Especially is this true when the comparison lies between hand sowing and sowing with a grain drill; second, the seed can only be sown when the air is reasonably calm and still, otherwise it will fall irregularly. The fact remains, nevertheless, that one skilled in hand sowing can sow timothy when quite a breeze is blowing by shaping his course accordingly, and by adjusting the swing of the hand or hands to meet the exigencies of the occasion; and third, the number of persons relatively who can sow such seed with regularity and evenness is not large and it is probably decreasing. In former years when seeds were all sown by hand, a considerable number of farmers could sow admirably with both hands, but now, and especially in the west, such seed sowers are not numerous.

If sown with hand machines, the kind must be determined by the sower and the conditions under which the seed is sown. But the "wheel barrow seed sower" is most in favor for such work. Unless when the wind is blowing quite strong it will sow the seed evenly, and at least as quickly as it can be scattered by a person using both hands. Like hand sowing it does not bury the seed.

Timothy seed is frequently sown with the grain drill.

In some instances the seed is mixed with the grain previously, in others at the time of sowing. Some farmers who till soft and open prairie soils claim that this method has proved satisfactory with them. But, on heavy soils it would not prove satisfactory, since it would bury it far too deeply. There is the further objection that it does not feed out evenly along with the grain. Because of the smallness of the seeds, it feeds out more quickly than the grain, but this can be partially obviated by occasionally stirring the seeds more or less by hand in the grain box while it is being sown. But grain drills are now being introduced which convey the seed into the drill tubes with sufficient regularity. There is also the further objection that the seed being placed in the line of the row with the grain, the plants as they grow are crowded and shaded overmuch by the grain. Grain drills with a grass seed attachment (see page 21), deposit the grain very evenly. Under some conditions it is better to have the seed fall before the drill tubes, but under other conditions it should fall behind them. When it falls before the grain tubes, further covering is frequently unnecessary, but not in all instances. When it falls behind these, covering with the harrow is usually advantageous but not in all instances. Some growers cover with the weeder.

Timothy seed may also be sown with the broadest grain seeder. It may be thus sown by mixing the seed with the grain. But some broadcast seeders have attachments for sowing grass seeds, and, when they have, the seed should be scattered with these. Whether it should fall before the seeder or after it, will depend upon such

conditions as relate to soil and moisture. Except on certain prairie soils, scattering the seed before the seeder would usually bury it too deeply.

The depth to which timothy seed should be buried will depend on such conditions as relate to climate, season and soil. The more moist the climate, the less the necessity for putting the seed down deeply into the soil and vice versa. The dryer the summer climate, the greater the necessity for putting the seeds down if sown in the spring, and the colder the climate, the greater the necessity for putting them down in the autumn. The later in the spring that the seed is sown, the deeper should it be buried, and the same is true of autumn seeding on soils that lift. The heavier and firmer the soil as a rule, the less deeply does the soil require to be covered, and vice versa. Under some conditions the seed does not need to be covered in any other way save as nature covers it. Under other conditions it may be advantageous to cover it as deeply as two inches if not indeed, even more deeply. In a majority of instances an ideal depth would be about half an inch.

When sown on the snow or on land in the honey-combed condition, of course the seed cannot be covered by any artificial process. When sown with a grain drill or broadcast seeder and along with the grain, it must also be buried as deeply as the grain. When sown on winter crops in the spring after the soil has become firm, the seed ought to be covered with the harrow or weeder. The stiffer the soil, the heavier the harrow that ought to be used, and the more erect should the teeth be when in use, and vice versa. Stirring the surface

soil thus to cover the timothy seed, will also be helpful to the grain crop. When the seed falls before the grain tubes of the drill, it frequently requires no other covering, but sometimes a stroke of the harrow will be found helpful. When the seed falls behind the drill tubes, in moist climates no covering is necessary other than that given by the rains, but, on such soils, if sowing the timothy is deferred until after rain falls, in nearly all instances it would be advantageous to harrow. On prairie soils and especially where the conditions are dry, when the seed is sown thus, in nearly all instances the harrow ought to be used.

The roller will sometimes furnish a sufficient covering. This frequently proves true of soils in moist climates, especially those of a heavy texture. But in soils that will lift with the wind, the harrow should immediately follow the roller, and in the autumn when covering the seed, the roller should seldom or never be used without the harrow following it.

Timothy may be sown in various combinations. The most suitable of these is clover in one of its varieties. It has peculiar adaptation for such a combination, for the reason, first, that it has power to fight the battle for existence and to hold its own place when sown along with clover. Second, a greater return of the combined crop is usually obtained than would be of either plant grown singly. Third, the quality of the hay is improved for general feeding because of its increased fineness and wider adaptation to the needs of the various classes of live stock. Fourth, the timothy luxuriates on the food furnished by the dead clover roots. And

fifth, as timothy is usually longer lived than clover, it is then possible to secure a longer succession of hay or pasture crops than if timothy were sown alone.

Timothy has been more commonly grown in combination with red clover than with any other variety, and chiefly for the reason, probably, that red clover is grown to a far greater extent than the other varieties. If grown along with red clover, the conditions being equally favorable to the growth of both, the first year of cutting, the hay will be chiefly clover, the latter being the more vigorous growing plant early in the season. The second year timothy will predominate as the clover is generally short lived, and the third year the crop will be all or nearly all timothy. But the combination of timothy and mammoth clover or of timothy and alsike clover, is superior to that of timothy and medium red clover, and principally for the reason that it matures about the same time as these, whereas it matures about three weeks later than medium clover. It has higher adaptation for being grown with alsike clover than with the mammoth, since both alsike clover and timothy grow at their best in soils rich in humus and moist in character. For certain uses, redtop added improves the crop, especially in its yield. Timothy also matures about the same time as meadow fescue, hence the two may be sown in conjunction for hay where the conditions are favorable, but this does not seem to have been done to any great extent in America. On some irrigated lands in the west, timothy and alfalfa have been grown together with some success.

For permanent pastures timothy has an abiding place

because of its power to endure. The prominence given to it in these should depend upon its relative adaptation as compared with other grasses. It can usually be given a place in these north of the fortieth parallel of north latitude and in instances not a few considerably south of that line. In the upper Mississippi Basin and indeed in all the northern states and provinces of Canada, it should be an important factor in permanent pastures mixed in character.

The amounts of timothy seed to sow will of course be much influenced by varying conditions. When sown alone for hay or pasture it is seldom necessary to sow more than 12 pounds of seed per acre, and on some soils 8 pounds will be found ample. In some instances as in the semi-arid belt east of the Rocky mountains, better results may frequently be looked for from sowing 6 pounds because of the scarcity of moisture. Eight to ten pounds may be set down as average amounts.

When sown with medium red, mammoth or alsike clover 6 pounds may be considered an average amount to sow, but this may be increased to, say 8 pounds, or reduced to 4 pounds according to the object sought. Similarly the amount of clover seed in the combination for a hay crop will vary, but the amounts respectively of common red and mammoth may be set down as 6 to 8 pounds per acre and of alsike at 4 to 5 pounds. When sown with red top only 6 pounds of timothy and probably the same amount of red top will suffice. And when sown with alsike clover and red top in combination 4 pounds of timothy would seem to be enough, adding 3 or 4 pounds of red top and 3 pounds of alsike

clover. A mixture of timothy and alsike clover only is usually preferred as hay for the market to a mixture consisting of timothy, alsike clover and red top.

When the crop is sown to produce seed, a less quantity will suffice than when it is sown for hay. When the crop grows quite thickly, the size of the heads is reduced; when it is sown to produce a fine quality of hay, of course thick seeding must be resorted to. Timothy is seldom sown alone for permanent pasture, but if it should be thus sown heavy seeding ought to be given. When used as a factor in permanent pastures from 3 to 4 pounds per acre ought to suffice.

Pasturing.—In some sections of the prairie, as where for instance the conditions have proved too cold, and it may be too dry also for clover, and where blue grass or Russian brome has not yet been introduced, timothy is about the only cultivated grass used in providing pasture, and yet it is not pre-eminently a pasture plant. This has doubtless arisen from necessity rather than from choice in areas not very long settled and in which the question of pastures from cultivated grasses has not yet been given much attention. The bulk of the growth for the season is made before the arrival of mid-summer and if not eaten down until well advanced in growth, the plants are not highly relished by live stock. Particularly is this true of it after the heads have appeared. Although it stands pasturing well when the conditions for growth are generally favorable, on certain of the soils of the prairie close pasturing will cause it to fail within a very limited number of years. For this, doubtless, lack of moisture is in part responsible,

but on certain soils of the south it will soon fail under close grazing even when moisture is sufficiently prevalent. Ordinarily the results will prove much more satisfactory when timothy forms but one factor of the pasture, although in providing pasture for horses it has found some favor in certain localities though sown alone. For pasture as also for hay it is more commonly sown with medium red clover than with any other variety of clover or grass, since, when thus grown, while the clover lives the grazing can be continued through nearly all the year. But when it is desired to obtain pasture speedily through the aid of timothy, it may be done in certain areas by sowing the seed in the autumn along with winter rye. The rye is then pastured in the spring, and when the rye pasture has failed the timothy continues to provide pasture more or less through the summer.

In pasturing timothy the grazing should begin reasonably early in the spring, but very close pasturing at that season will materially lessen the yield if a dry season should follow. On the other hand if the pasture is under stocked it will be eaten closely in certain portions and in other portions will form heads. When this occurs the field mower should be run over the pasture before the seed matures.

Usually close grazing in the autumn will materially lessen production the following season, whether the plants are devoted to furnishing pasture or hay. Because of this many growers of timothy hay for market do not graze the meadows in the autumn. The mulch provided by the aftermath furnishes excellent

winter protection in bleak locations and is particularly favorable to early and vigorous growth the following season. But there are localities as in certain of the river bottoms west of the Cascade mountains, in which timothy meadows are grazed much of the winter and yet produce large crops of hay.

The growth of timothy pastures will be greatly stimulated by top dressings of farmyard manure. These are best applied in the autumn, but may also be applied in the winter when the ground is frozen unless on hilly land. Since timothy is non-leguminous it is wholly dependent on the soil for its nitrogen. Consequently fertilizers rich in nitrogen whether applied as farmyard manure or as commercial fertilizers will greatly stimulate the growth. But in actual practice, nitrogen in the latter form is usually applied to timothy meadows rather than to pastures of the same.

Harvesting for Hay.—The stage of maturity at which timothy ought to be harvested for hay will depend to some extent on what it is intended for. For cattle and sheep it is frequently cut when coming into bloom. Particularly is this true when it grows amid a good crop of medium red clover. In order to secure the highest feeding value in the clover it is necessary to cut the timothy while yet somewhat immature to furnish the best results in feeding. But even when grown alone for the uses named, it should be cut while not yet in full bloom. It will then be less woody and more palatable than if cut later, although there may be some loss in weight. If cut when in full bloom, the hay is somewhat more dusty than it would otherwise be,

hence, so far it is objectionable for being fed to horses. When the crop is to be harvested to provide hay for horses, or that is to be put upon the market the aim should be to cut it at the stage spoken of as the "second bloom," which really means when it is about to go out of bloom. This may be known by observing when but a small part of the tops of the heads only continue to produce blossoms. The bloom comes out a little late on that part of the head and is likewise a little later in departing. When cut at this stage all the weight possible is secured in the crop, also all the nutriment possible, and it is still relished by horses.

In a great majority of instances but one crop is obtained per year, but under the influence of liberal and timely applications of commercial fertilizers, nitrogenous in character, it is sometimes possible to get two cuttings a year, but the second will consist chiefly of rowen, that is of grass that has not yet reached the heading out stage. From two such cuttings of timothy and red top grown together, from 5 to 8 tons per acre have been cut from year to year for several years past, by Mr. Geo. N. Clark of Higganum, Conn. At least 4 tons may be secured from one cutting of timothy alone in a single season. Two tons per acre are considered a really good crop. But the average crop is about $1\frac{1}{4}$ to $1\frac{1}{2}$ tons. One ton per acre is considered a light crop.

In some locations, as on the river bottoms and reclaimed tide lands of Western Washington, as many as twenty crops of good yielding timothy have been grown in succession without apparent diminution in the yield. On certain prairie soils where moisture is lacking the

yield the second year of cutting is frequently much diminished. Under ordinary farm conditions where timothy is grown as a staple crop it is usually cut for but two successive seasons, but in some favored situations several successive crops are grown. When timothy only occupies the land the first cutting commonly gives the best yield, but when properly dressed with fertilizers the yield ought not to diminish for several years.

The mower is almost the only implement used for cutting timothy, but on new land where stumps abound it may be necessary to cut it with the scythe. The fact should not be lost sight of that under some conditions as those of great drought the stand of the timothy may be injured by too close cutting with the mower. When the weather is settled and bright, the crop may usually be cut one day and stored away some time during the following day. When stored thus quickly the tedder usually follows the mower, but with an interval of several hours between. The crop is then drawn into winrows with the horse-rake and is loaded from these with the hay loader or otherwise. In the advanced stages of maturity, it may be possible under the most favorable conditions to cut timothy in the morning and store it away the same evening. But in such instances a free use of the tedder must be made. In showery or damp weather and especially when the crop is cut early, it should be raked as soon as the work can be done successfully, and then put up into cocks until cured. When thus put up, rain will not penetrate these or injure the hay nearly so readily as though it were clover. When clover and timothy are much mixed and especially when

clover is abundantly present the safer plan is to cure the hay in cocks. But a mixture of timothy is favorable rather than otherwise to the curing of clover since it cures more readily.

Securing Seed.—When the timothy crop is intended for seed, it may be necessary to spend some time in removing weeds from the same either by hand pulling or by using the spud, or what is usually better by using both. This of course should be done before any of the seeds mature.

Among the noxious weeds that sometimes infest timothy meadows are: Pigeon weed (*Lithospermum arvense*), sometimes called red root; Wild flax (*Camelina Sativa*), sometimes called false flax; the Canada thistle (*Cirsium arvense*), blue weed (*Echium vulgare*), French weed (*Thalaspia arvense*) and Hungarian mustard (*Sisymbrium sinapistrum*); also couch or quack grass (*Agropyrum repens*). All these mature their seeds before timothy is harvested for seed.

Timothy is ready for being harvested for seed when the seeds turn brown and as soon as ready it should be promptly harvested and put in shock. If not harvested with reasonable promptness and if left standing long in the shock when harvested there is likely to be considerable loss from the shedding of the seed. The binder can best be used in cutting the seed crop. The next best implement would probably be the self rake reaper. When thus cut, however, the labor in handling would be greater. The crop may be threshed at once or it may be stored for threshing as desired. It is threshed with the ordinary threshing machine, but the

wind must be shut off sufficiently to do the work properly. The hay or straw, as it is sometimes called when threshed, has some feeding value, but it is very woody and is not much relished by live stock. The stripper has occasionally been used in gathering the seed but when thus gathered the straw is virtually of no use for grazing stock.

The seed should be carefully fanned before putting it on the market. The aim should be to so clean it that it will take the market as No. 1 and so bring the highest price. This it will not do unless carefully cleaned, and with a fanning mill well furnished with sieves, no matter how good the quality of the seed may be, it will be found difficult to remove some kinds of weed seeds that may be present. It may also prove difficult if not impossible even to remove all the clover seeds that may be present should this be desired. Especially is this true of alsike clover, the seeds of which are so nearly of the same size as those of timothy. But some of the seeds of medium red and mammoth clover may be so small that they even cannot be all removed. When timothy is wanted for seed, therefore, it is not wise to grow clover or the clovers along with it. But for home sowing the presence of clover seed in many instances would not be objectionable.

As many as 7 or 8 bushels of seed have been threshed from an acre of timothy, but from 3 to 4 bushels would be a good crop, 4 bushels being above the average. In some instances not more than 2 bushels are realized per acre. Several crops of seed may be taken in successive years from such soils, but the tendency of such crop-

ping even in these is to decrease the yields, since producing seed tells adversely on the vitality of the plants. Growing timothy seed is hard on land.

Through the medium of timothy seed, many foul weeds have been introduced, hence the importance of getting good pure seed. At every seed warehouse, various grades may be purchased, but good pure seed only should be bought by the farmer; notwithstanding that it will be higher priced than the other grades. It could not be otherwise. But in a majority of instances, where timothy can be grown successfully, the farmer can and ought to grow his own seed. When doing so he simply requires to select a part of a field, usually not more than two or three acres, in which the timothy plants are vigorous and free from weeds. This when ripe can be harvested and threshed as described above and at the same time as the grain is threshed. If perfectly free from noxious weeds, winnowing such seed further would not even seem much of a necessity. In this way seed could be saved from year to year that would be always fresh and pure.

Renewing.—The attempt is seldom made to renew timothy meadows which at one time possessed a good stand of plants, except by top dressing them with fertilizers. But there are instances in which when the seed is sown, only a partial stand is secured. Some parts of the area sown, as the lower land for instance, may have a good stand, and the higher land an imperfect stand or even no stand at all, and yet it may be desirable to grow timothy on such areas. This may in some instances be accomplished by sowing seed where

more plants are wanted in the early autumn, and covering with the harrow, even at the risk of sacrificing some of the plants already growing. In others the seed is sown in the early spring without harrowing and in yet others it is sown later in the spring and harrowed. Whether the attempt to thus complete the stand of the plants all over the field will be preferable to ploughing the land again and re-seeding it, will depend chiefly upon the proportion of the entire area on which a sufficient stand has been secured.

In pastures, timothy as other grasses is sometimes renewed by adding more seed. This may be done in the same way as meadows are renewed, as described in the preceding paragraph, but in some instances the ground is disked before adding the seed. In yet others winter or spring rye is added on the disked parts to provide pasture speedily. And yet again timothy is sown but not with much frequency and chiefly with the seed of other pasture plants on pastures that have been disked for the purpose of improving them.

CHAPTER IV.

KENTUCKY BLUE GRASS.

Blue grass is of several varieties. But two of these, however, are of very much importance in furnishing pasture or hay. These are the varieties known as (*Poa pratensis*) and (*Poa compressa*). The former is more commonly known as Kentucky blue grass, but it is also called June grass, from the fact, doubtless, that more commonly it matures its seeds in June. It has also been called Spear grass, and Smooth Stalked Meadow grass. The latter is usually spoken of as Flat-Stemmed Blue grass but is also sometimes called Wire grass and Flat Stalked Meadow grass. A third variety commonly spoken of as Texas Blue grass (*Poa arachnifera*), has been found of considerable value in certain of the southern states, but the discussion of this variety will be deferred and taken up in Chapter XIV.

Poa pratensis varies in height from a few inches to 18 or 20 inches, but on average soils the height is about 15 inches, although under the most favorable conditions it grows much higher.

The stem is erect, smooth and round, and the panicle is also erect and spreading. The leaves are relatively small and numerous. The whole plant is of a light green color, but the spikelets frequently assume a brownish purple tint, somewhat resembling the tint of red

top. The root-stocks are creeping, and when well set they fill the sod with a close dense turf on a favorable soil, but it possesses the soil somewhat slowly, hence, two or three years must usually transpire before it thus possesses the soil. *Poa compressa* grows to the height of about 1 foot, but, through liberal fertilizing may be grown to the height of 2 or even 3 feet. The stems are upright and flattened and are nearly solid. The panicle is short and compact, but expands at the flowering season. The leaves are short and fairly numerous. The whole plant is of a dark bluish green color, and the stems retain their color after the seeds have matured. The root-stocks are creeping but under American conditions do not fill the soil so completely as those of the other variety.

Poa pratensis begins to grow reasonably early in the spring and is at its best for pasture in the month of May or June. It pushes up its seed-heads rapidly and evenly and quickly matures its seed. The heads and stems soon assume a yellow tint, and growth even of the leaves practically ceases, if the weather is dry, until the early fall rains come. The leaves then push out again with much vigor and continue to grow until frost comes, and where the climate is not severe they keep green all winter. *Poa compressa* does not start quite as early as *Poa pratensis* in the spring. It grows more slowly and comes into flower several weeks later. It usually matures seed in July. While it retains its greenness for a long period, it does not grow so freely in the autumn as *Poa pratensis*. Nevertheless under favorable conditions it also furnishes good winter pasture.



FIG. 3.

KENTUCKY BLUE GRASS (*Poa pratensis.*)

Oregon Experiment Station.

Both varieties are very palatable. All kinds of stock are exceedingly fond of both; both are exceedingly nutritious; while both are hardy, *Poa compressa* is probably the hardier in so far at least as it has greater power to grow on poor, stiff, arid, dry soils. *Poa pratensis* is the better pasture grass, but *Poa compressa* is much the superior for hay. The former is highly prized and is freely sown, whereas the latter has not been taken at its true worth, and has usually grown as it were spontaneously. Consequently its distribution does not nearly equal that of the other variety. Taking it all in all, Kentucky blue grass is probably the most valuable pasture grass in America, but some authorities claim first place in this respect for orchard grass. Unquestionably, however, blue grass is more generally grown in the United States than orchard grass, and the preference thus shown for blue grass is not accidental since blue grass is more palatable and nutritious and has a wider distribution.

Distribution.—Blue grass (*Poa pratensis*) and also (*Poa compressa*) are indigenous to Europe, and it is thought also to certain parts of the United States. It is thought to be native to the Wabash valley having been found growing there in 1811 by the troops of William Henry Harrison on their march to Tippecanoe. It grows in considerable areas of Asia also and in certain parts of New Zealand and Australia. It is becoming in a sense cosmopolitan in the temperate zone. But nowhere does it grow better than in certain parts of the United States and Canada. In these it is more highly prized than in Great Britain, since in that country its

aggressive character enables it to crowd other valuable grasses out of the permanence which ought to be retained in the same.

These two varieties of blue grass grow best in temperate climates. They can stand much cold in winter and also heat in summer without succumbing to either, but they do not grow well in a dry climate or under conditions too dry for the successful growth of the common cereals. It is found at its best where the rains are moderate and frequent throughout much of the year.

It is doubtless correct to say that blue grass is grown more or less in every state and territory in the Union. It would be equally correct to say that from the Mississippi to the Atlantic it occupies more territory than any other grass, and that in the greater portion of the territory thus occupied it has been found more useful in providing grazing than any other grass. The same statement will apply with almost equal force to the country westward from the Mississippi for a considerable distance, or until the areas are reached in which the rainfall is light. From the line which forms the eastward border of the area named until the Rocky mountains are reached, and in the plains between the mountains, as for instance, the bench lands in the Big Bend country in Washington, the conditions are too dry for the successful growth of blue grass. But in the bench lands of the foot hills it is being found that blue grass will yet fulfill a not unimportant mission. This grass grows at its best in the United States in the limestone soils of Kentucky and in the states lying

northward from these until the lakes are reached. These are the soils that grow hardwood timber, as for instance hard maple, elm, basswood, ash, birch and burr oak. The very highest adaptation for it, therefore, is found in what were the hardwood timber areas of Kentucky, Missouri, Iowa, Indiana, Illinois, Ohio, New York, Michigan, Wisconsin and Minnesota. It also prevails in the New England and eastern states. While in them the climate is very suitable for growing it, the prevailing soils are such as only to produce a moderate growth. In the southern states and especially on the uplands and mountains blue grass grows freely. But, because of certain soil peculiarities in some of these, it has been stated that it is not so nutritious as on the limestone soils of the central states. On soils in the south that are sandy, the lack of fertility and the summer heat are adverse to high production in blue grass as pasture or as hay. On the moist Pacific slope in Washington and Oregon this grass grows with much satisfaction where it has been introduced.

In Canada, blue grass grows in good form in all the timber country from Winnipeg to the Atlantic. Naturally infertile soils are against the most abundant production in much of the soil in the maritime provinces, but in Ontario blue grass grows with as much luxuriance as in Kentucky, with the difference, however, that the season for its growth is shorter than in Kentucky. In the prairie soils between Winnipeg and the mountains, blue grass can be grown, but less satisfactorily as Winnipeg is receded from until the Rocky mountains are reached. In this area Russian brome (*Bromus in-*

ermis) will be superior. West of the mountains is a country high in adaptation to the growing of blue grass. But in no part of Canada does blue grass grow better than in Ontario. In some parts of that province its growth is not excelled on any portion of the American continent.

Soil.—Blue grass is adapted to many kinds of soil. In fact there is scarcely any variety of the same in which it will not grow to some extent unless it be soil charged with alkali in a considerable degree, or sandy soil low in fertility and deficient in moisture. The wide range in adaptation to soil conditions which this grass possesses, along with the even wider range which it has of accommodating itself to climatic conditions chiefly account for the fact, that on the North American continent it is now or is eventually going to be practically cosmopolitan in one of its varieties.

The highest conditions for the growth of blue grass are found in clay loam soils and more particularly in those underlaid with clay sufficiently retentive to retain moisture at least in fair degree, and yet sufficiently open to prevent water from lying unduly on the surface. In other words the highest conditions for growing blue grass are found in soils well adapted to the growth of what are termed hard woods of varied character. This explains, in part at least, why blue grass so quickly takes possession of forest lands when cleared and kept clear of timber.

Next in adaptation, probably, come rather stiff clays, the producing powers of which have not been impaired by working when unduly wet or by pasturing when in

a similar condition. After these may be placed loam soils, giving the precedence of course to clay loams, rather than to sandy loams. The humus soils of the western prairies, originally devoid of timber, cannot be said to be possessed of the highest adaptation for blue grass. On the other hand the adaptation of these is not low. It is true, nevertheless, that ordinarily blue grass does not make in these that thick, close, dense growth that it makes in clay loam soils, nor will it withstand vicissitude so well. This explains, in part at least, the greater difficulty in maintaining excellent blue grass lawns in cities built on purely prairie humus soils. On the soils of the far west volcanic in their origin, blue grass will grow well where moisture is sufficiently present, but in much of the area covered by these soils, water is wanting in that degree which hinders seriously the growth of the grass.

The degree of the adaptation on muck lands for growing blue grass depends much on the nature of the muck and on what lies beneath it. If the muck is considerably mixed with soil washed down from higher land, and if at the same time it is underlaid with clay, other conditions being correct, blue grass will grow admirably. On the other hand, if the muck is chiefly or entirely composed of vegetable matter so little reduced that many of the characteristics of peat appertain to it, its adaptation to the growth of blue grass will be considerably lessened. If it is underlaid with quick sand, the degree of the adaptation will be still further lessened.

In peat soils the adaptation for blue grass is lower

than in muck soils but much depends on the character of the peat. If much reduced and the supply of moisture is ample, such a soil may maintain a good growth of blue grass, but, if the peat is but little reduced and if the moisture is deficient, as it sometimes is in swamps too deeply drained, the grass may not be able to maintain a stand upon it.

From what has been said about muck and peat soils, it is very evident that the adaptation of these to the growth of blue grass will vary exceedingly. In some instances, more particularly when they are mixed with deposits brought in from higher ground, and moreover when the water-table lies at a correct distance from the surface, such soils produce pasture with much abundance and continuity. Under other conditions the returns are meagre, and under yet other conditions this grass may refuse to grow at all on peaty soils. When soil saturation is unduly abundant and prolonged, coarser grasses will be sustained, as for instance wire grass. Nevertheless it is true that blue grass will live under a thin covering of water at certain seasons for several weeks.

Whether blue grass will grow at all on sandy soils with but little earth in them will depend almost entirely on the degree of moisture present in them during the growing season. On the other hand, there are certain moist sandy loam soils which are highly adapted to its growth. All degrees of adaptation are found between these extremes in sandy soils, according as they are influenced by components other than sand, by moisture and by temperature. But, as a rule, the adaptation of

really sandy soils to the growth of blue grass is low rather than high. *Poa compressa* would seem to be the hardier grass of the two since it will grow reasonably well on dry, sandy, thin soils and gravelly knolls providing the rainfall is sufficient. Nevertheless, moist gravelly clays are much better suited to its growth.

Place in the Rotation.—Blue grass in the strict sense of the term, is not a rotation crop, since its highest use is the production of pasture, and because it takes more than one year to establish a good blue grass pasture. A place is seldom given to it, therefore, in short rotations, but of course as with alfalfa, it has a place in long rotations. In other words there are certain crops which it may be made to follow or precede with more of fitness than if made to follow or precede other crops. Owing, however, to its aggressive character it may be made to follow almost any crop.

As with all other grasses it will become established more quickly and will grow more vigorously when sown on clean rather than on foul land. The aim should be, therefore, to sow it after some cleaning crop as corn, sorghum, the non-saccharine sorghums, potatoes, beans, cow peas and soy beans when these crops have been given clean cultivation. But there may be conditions in which it may be proper to sow blue grass on soil that is foul with certain forms of weed life, and also worn, as for instance, when the pasture is wanted at the earliest moment practicable, and no other soil properly prepared is at hand on which to sow it. Observe, however, that it is only in exigencies that this course is to be commended. When once it has obtained a foothold

on such soils, it will soon prove more than a match for nearly all forms of weed life.

Preparing the Soil.—The preparation that is best suited to the sowing of blue grass will vary with the soil, the climatic conditions, and the season for sowing. Sandy soils and also humus and muck soils are usually possessed of a pulverization sufficiently fine to secure good germination in the seed. The labor in preparing these is one of smoothing and levelling rather than one of pulverizing after they have been ploughed or disked. In some instances impaction, through the use of the roller, will be helpful. Loam soils may call for more of pulverization, but usually the labor in preparing these is not great. Clay soils are the most difficult by far to prepare, owing to the labor called for in pulverizing them. In many instances they are cloddy, hence much harrowing and rolling alternately are usually necessary to secure a tilth sufficiently fine. This work may in some instances be greatly facilitated by not failing to take advantage of propitious seasons for securing the requisite fineness of pulverization, as for instance, after the falling of gently saturating rains, but not too soon after these fall. Where rainfall is abundant and well distributed, a fine pulverization is not so necessary as under conditions the opposite.

On lands newly cleared of timber, no further preparation is necessary or even possible usually, than clearing off the encumbering logs and brush. And even such clearing may not always be absolutely necessary, as among logs and brush not dense or tall, it may be quite possible to start blue grass growing. On stubble

lands where blue grass is sown in the autumn, it may in some instances be advisable to plough the land, as when it is very foul with weeds. In other instances, disking may suffice, as when the surface is clean but unduly firm. And in yet other instances no preparation may be necessary, as when the surface is clean, soft and moist.

When the seed is sown on clay soils in the autumn, a pulverization of soil less fine will answer than if sown on the same in the spring, especially when these are exposed to alternations of freezing and thawing during the winter, and to the sweep of cold winds. But when sown on these in the spring also, pulverization too fine would be possible, especially in climates where occasionally downpours of rain occur, as these would encrust clay surfaces when fine beyond a certain degree.

When the seed is sown in the spring, fine pulverization is more necessary than in the autumn, and for reasons that will be apparent from what has been said above. But, happily the degree of the pulverization that is best suited to the nurse crop will also be best suited to the blue grass sown with it. That it is so is fortunate, since, unless when sown for permanent pasture, it is more common to sow blue grass with a nurse crop, the reasons for which are given later. (See page 94.)

It is not usual to fertilize land on which blue grass is to be sown with a view specially to promote the growth of the blue grass. Since it is able to get and to maintain a hold on nearly all kinds of soil without such aid, fertilizers are usually reserved for crops which have

less power to gather plant food in the soil. Fertilizers that are suitable for timothy will also be suitable for blue grass. (See page 72.) The method of fertilizing the pastures by top dressing them, would seem to be preferred to that which fertilizes the land on which the seed is to be sown, as the young plants grow too slowly to make the best use possible of the fertility thus applied. But lands that are well filled with vegetable matter are much more favorable to the growth of the young plants than land in which the same is deficient.

Sowing.—In northern areas it is more common to sow blue grass in the spring than in the autumn, and probably for the reason chiefly, that it is more convenient to sow it then, especially when sown as it usually is in the north, along with other grass mixtures. But it may in some instances be sown with much advantage in these areas in the fall. In fact it is possible to sow it successfully under some conditions during almost any part of the season of growth. When sown in the spring, the earlier that it is sown the more successfully it is likely to grow. When sown in the autumn, the sooner that it is put into the ground after moisture comes, the more certain is the stand likely to be. In the states of the middle south as for instance, Kentucky, where probably this grass grows at its best, it is commonly sown in the autumn, especially when sown by itself to provide permanent pasture.

Nature teaches an important lesson with reference to the sowing of this grass. Where not grazed too closely it sows a crop of seed every year. The seed matures

upon the stalk and then falls down or is wafted by the winds to adjacent areas. Under normal conditions the seed thus wafted would seem to have much power to grow. Of this fact evidence is furnished in the almost absolute certainty with which blue grass ultimately takes possession of waste land in a locality into which it has once been introduced and in which any of the seed is allowed to mature.

The seed thus scattered must, in great part at least, grow without a covering, hence the plan of growing blue grass seed as soon as practicable after it is gathered, even though it should be sown in the chaff, would seem to be a commendable one. In southern latitudes, therefore, it would seem to be the better plan to sow blue grass seed in the late summer and early autumn, since in these it is nearly always practicable to sow it at that season. The power which this grass has to grow without a covering, especially when it is fresh and sown in the chaff, explains why a stand can usually be obtained with much certainty by cutting the grass like hay as soon as the seed matures and scattering it over the ground where a stand is desired. The hay thus scattered affords protection for the young plants that grow from the seeds when they come in contact with the earth. Blue grass has thus been introduced on to sod-bound native prairie where close pasturing has followed this method of scattering the hay. It may be scattered thus from the stack in winter if desired.

Blue grass is nearly always sown by hand, partly for the reason that but few if any machines yet introduced sow it satisfactorily, and also because the danger

would be present that in some soils at least, drill machines would cover the seed too deeply. When sown in mixtures, it is common to mix the blue grass seeds along with the seeds of other grasses before these are sown. It is usually covered with a light harrow, since, as previously intimated, a deep covering for this grass is not necessary, although the proper depth at which to cover it will vary with conditions. On soils which incline to cloddiness, the roller will in many instances provide a sufficient covering, but on such soils it ought not to be covered thus, unless the harrow is made to follow the roller.

In very many instances, blue grass is sown with a nurse crop. The exceptions include lands more or less deforested, rugged lands difficult of tillage and by-places generally. Even when sown to provide permanent pasture, it is frequently sown thus, but to this there are some exceptions also, especially in areas the most favorable to its growth. In northern areas, winter rye is probably the best nurse crop with which to sow it, and chiefly for the reason that it may be sown on the rye in the early autumn which is really the best season for sowing it, all things considered, only a moderate seeding of the rye should be used. If the rye is grazed off in the spring, the blue grass will develop more quickly and strongly than if the rye is harvested. In areas with winters sufficiently mild, blue grass may also be sown with winter barley and winter oats, also winter wheat. When sown in the spring with a nurse crop that is to mature, spring rye or barley is the most favorable to the growth of the grass. But if sown with a

thin seeding of oats cut early for hay, the results will probably be quite as good.

Blue grass should not be sown in short rotations, since it is slow in becoming well established. In rotations of some considerable duration, it is frequently sown in combination with medium red, mammoth or alsike clover, or with all three combined, with white clover and timothy added. The clovers and timothy are intended to furnish grazing until the blue grass becomes well established. Blue grass, orchard grass and white clover make an excellent combination for such rotations where the conditions favor the growth of all three. On low-lying soils such as are found in sloughs, blue grass, red top, timothy and alsike clover make a good combination for hay or for pasture. In latitudes in which the winters are stern, blue grass, Russian brome grass and white clover grown together, promise much for such rotations, but experience in growing them thus is not of sufficient duration to determine fully the value of such a pasture crop. It is not yet known whether blue grass or Russian brome if sown together would obtain the mastery or if both would continue to grow indefinitely. On lands once covered with forest, it is probable that blue grass would crowd the Russian brome, but that on real prairie soils the reverse would prove true. When sown, in mixtures intended for permanent pastures, the relative prominence given to the blue grass should increase with its relative adaptation to the locality, and, even when blue grass is intended to be virtually the sole grass in the pasture, white clover ought to be sown along with it. The clover probably aids the growth

of the blue grass rather than hinders it, since it brings nitrogen to the soil. It also grows most vigorously after the blue grass has begun its summer rest, hence the season of pasturage is prolonged. The two will also grow thus together for an indefinite period.

The amounts of seed to sow will vary with soil and climatic conditions and with the combinations in which the seed is sown. When sown alone on good soils and without a nurse crop it is seldom necessary to sow more than 20 to 28 pounds of good clean seed per acre, but if sown in the chaff not less probably than 3 or 4 bushels per acre would be required. When sown with Russian brome grass and white clover without a nurse crop 6 pounds of the brome grass and 1 pound of the clover, and 10 pounds of the blue grass per acre will usually make a sufficient seeding. But to increase the grazing the first year, it will doubtless be found profitable to add 3 to 4 pounds of timothy per acre. When sown on low lands with timothy, red top and alsike clover, 4, 4 and 3 pounds each per acre of these respective forage plants, with 7 pounds of blue grass ought to suffice. When the mixture consists of blue grass, timothy and medium red or mammoth clover, 7 pounds of the blue grass, 6 of timothy and 3 to 4 pounds of medium red clover per acre ought to suffice. When sown in combination with many varieties of grass and clover, as in making permanent pastures mixed in character, usually not more than 5 pounds of blue grass per acre will be required. Where white clover is not already established in any locality, that is, where it has not been grown long enough to lodge many of its seeds in the

soil, it will always or nearly always be in order to add a little white clover to any of the mixtures referred to. In some instances it may not be necessary to sow blue grass in these, since, in certain soils on which it has been grown for some time, these would seem to be so filled with the seed that blue grass within two, three or four years, will have possessed the soil to the extent of crowding the other grasses to their injury.

When purchasing blue grass seed, much attention should be given to the character of the same in regard to cleanliness, more particularly in regard to freeness from chaff. The standard weight of blue grass is 14 pounds to the measured bushel, and yet as handled by seedsmen the weight varies from 8 to 30 pounds per bushel. This point should not be overlooked when determining the amount to sow.

Pasturing.—Under certain conditions blue grass will readily establish itself, though live stock should have constant access to the fields where it has been sown. There are other conditions where such treading would injure both the soil and also the grass. But, generally speaking, grazing closely while the plants are young does not injure blue grass as it would other grasses. In fact such close grazing may be advantageous to it by removing shade, as when the seed is sown on the unbroken prairie. Until blue grass becomes well established on clay soils, it should not be grazed when these are unduly wet, or the soil will poach and will also become impacted to the injury of the grazing. However, when blue grass has covered the soil with a thick sod it may be

grazed even on stiff clays with but little injury to the land at nearly all seasons of the year.

Blue grass may usually be grazed closely all the while without destroying the stand of the same. But when grazed thus a maximum of pasture under the conditions existing cannot be secured, and the drier the climate the less, relatively, will the grazing be that is produced. When kept eaten down closely, the capacity of the plants to grow is lessened, through a less vigorous vitality than they would otherwise have, and through the increased exposure of the soil to the evaporating influences of the sun. Such exposure in winter is also adverse to the most vigorous growth and this influence is intensified with increase in the severity of the cold when the ground is uncovered. Grazing in winter under such conditions is also to some extent harmful, but blue grass pasture seldom succumbs entirely because of close grazing, on account of adverse climatic conditions, where it has once become established.

To obtain the largest possible amount of pasture from blue grass it should not be grazed closely at any season. So great ordinarily is the increase in the yield of the pasture, when thus managed, that in some instances it is not grazed at all in the spring. When thus left ungrazed at that season, the grass reaches a maximum of growth usually in May or June, according to the latitude, and matures more or less seed. The seed stems dry so as to be of little service for food, but the mass of fine leaves near the ground usually retain their greenness during the summer and renewed growth follows the falling of autumnal rains. Such pastures furnish

excellent summer and autumn grazing, especially for horses and cattle. They usually lay on flesh quickly while being thus grazed. In climates sufficiently mild, these pastures also furnish good winter grazing for these classes of animals. For sheep and swine they are not so palatable, because of the presence of weedy seed stems, nevertheless sheep are likely to do well on such pastures more especially in the winter. They and also horses will even paw off the light snows and maintain themselves in good form from such grazing where the climatic conditions are not too severe.

When blue grass pastures are grazed off closely in the spring and early summer, and the stock is then removed during the greater part of the season, the grass will usually make a good growth. Where the winters are mild, such grazing will be found particularly adapted to the grazing of sheep. But when covered with white frost, animals turned upon them early in the day should first have access to some kind of fodder, lest disorders in the digestion should be produced. Where the winters are stern, these pastures should furnish excellent grazing in the early spring. They begin to grow considerably earlier than when they have not been thus protected, and the growth is more vigorous. The fresh blades growing up in the grass add to its palatability, and the blades and stems that have cured on the ground counteract the tendency in the new growth at such a season to produce in animals a too lax condition in the digestion. Moreover these pastures furnish abundant grazing at that early season when it cannot so well be obtained from any other source. Blue grass when re-

tained for pasturing for prolonged periods crowds out nearly all kinds of weeds. Among the exceptions are ironweed (*Vernonia noveboracensis*), blueweed (*Echium vulgare*), the oxeye daisy (*Chrysanthemum leucanthemum*) and in some instances the Canada thistle (*Cirsium arvense*). When these are present in any considerable numbers it may be advantageous to clip them annually with the scythe or with the field mower to prevent them from maturing seed, as live stock are not likely to graze them off.

Harvesting for Hay.—Blue grass being rather a pasture than a hay plant, is not usually made into hay, unless in the absence of better hay products. It is not sufficiently bulky, hence the yield per acre is not large, and unless cut with much promptness as soon as it reaches the proper stage, it becomes woody. To secure a large amount of blue grass hay would necessitate mowing over a relatively large area in proportion to the bulk. But this does not mean that blue grass does not produce a large amount relatively of pasture per acre, since, in growing pasture, it virtually produces two growths in the year, that is, in the spring and in the autumn. Nor do the above remarks apply equally to the variety *Poa compressa*, which, in suitable soils, will yield at least a ton per acre of good hay. The crop is not bulky, but it weighs very heavily in proportion to its bulk and the hay is much relished, especially by horses. Moreover it has the peculiar property of gumming the knives of the mower while it is being cut.

Blue grass is ready for being cut when in early bloom. It is not difficult to cure, hence, in good weather it may

be cured in the winrow after having lain in the swath for a period more or less prolonged. Running the tedder along the winrow will facilitate the curing process, but usually the crop is not bulky enough to call for the use of the tedder, before it is raked in winrows. Of course it may be cured in the cock when desired, and when thus put up, the cocks are not readily penetrated by rain. This accounts for the fact that hay cut in fence corners and by-places, which is frequently chiefly blue grass, has long furnished a favorite material for topping stacks of grain, clover and in fact nearly all kinds of farm crops.

On certain soils, blue grass comes into meadows without being sown, and so as to furnish a large part of the hay crop. In these instances it is usually ready for cutting earlier than other grasses. The best time to harvest the crop under such conditions should be determined by the extent to which the other hay plants are present, and by their proportionate value for hay. The aim should be to cut the crop at that stage which will give the largest amount of good food, though some of the plants should be over mature and some of them under mature.

Securing Seed.—While it would seem to be true that blue grass is capable of maturing seed in any climate in which the plants will live, it is also true that the practice of harvesting it for seed is confined to but limited areas. At the present time the larger portion of the seed sold in the market as Kentucky blue grass comes from certain counties of Kentucky, Iowa and Missouri. Of course, some other states furnish more or less. The

reason why the states named furnish so much seed is owing probably to the relative abundance of the seed production in these, but is also owing in part, doubtless, to the fact that in other areas, prolific also in the production of seed, the farmers have not yet come to realize the profit that may accrue from harvesting blue grass seed. Special care is also necessary in handling and storing the seed, as shown later, and this may also act as a deterring influence. But, whatever the reasons that deter farmers from harvesting the seed for market, with the aid of a stripper operated by hand or by horse power, they may without difficulty collect seed for sowing on their own farms and of the finest quality, which may be sown in the chaff.

The seed, as just intimated, is harvested with a stripper, of which there are two leading kinds, viz., the rotary and the comb. The former is simply a box on wheels with a revolving cylinder in front with numerous wire nails in it. This revolves rapidly and throws the seed into the box. The latter is a platform hung on wheels and has in front a heavy steel comb. It is important that the pastures be kept free from weeds, as any leaves of these which grow in the grass will be thrown into the box along with the seed. Portions of the heads are also thus mixed with the seed. The revolving stripper, which is usually about as wide as the field mower, can harvest more acres in a day than the field mower, since it may be driven faster. The seed is ready for being harvested as soon as the heads turn brown. The harvesting season usually lasts from say 10 to 14 days, but this is influenced by locality and is some-

times of even less duration. The yield of course varies greatly; the approximate average may be put at 7 to 8 bushels per acre, but in some instances as many as 25 bushels have been harvested.

Great care must be used in curing blue grass seed or it will lose its germinating power. It heats very readily, so much so, that what is gathered should be emptied from the sacks at the end of each half day's work. It should be spread on a tarpaulin or on clean ground to dry in the sun, or on a drying floor with the opportunity for more or less draught to pass over it. On the floor it would not be well to spread seed more deeply than two inches at the first. The depth may be gradually increased, but at no time probably should it be more than say 15 to 20 inches. So quickly does the newly stripped seed heat when not thinly spread, that it has been known to entirely lose its germinating power within 24 hours of the time at which it was harvested. While newly harvested seed may possess 95 per cent in germinating power, seed put upon the market is considered good when the germinating power is 50 per cent. After the seed has been dried sufficiently it is usually shipped to certain centers where it is cleaned with machinery especially adapted to the work.

This grass will furnish seed in suitable localities for successive years. Nor does the reaping of seed hinder grazing the land subsequently the same season. It is claimed that after the seed is harvested, more grazing will be obtained from such a pasture than from one that has been grazed closely from spring until fall. The claim is probably correct, since the harvesting only re-

moves the seed, and as has been shown previously, close grazing all the time tends to lessen production.

Renewing.—The renewing of blue grass pastures, important as it is, calls for further experimenting before all is known that ought to be known with reference to it, but some things regarding this question have been settled with at least a measure of definiteness. Among these are the following:

1. That in many localities blue grass pastures at length become "sodbound," that is, the plants become so numerous and the roots so matted, that the free growth of the grass is so hindered that the maximum of production is reduced in proportion as this condition exists, and it becomes further aggravated in dry weather.
2. That this sodbound condition may be so dealt with as to greatly improve the yield of the pasture crops. This has been attempted in various ways, but chiefly through the aid of the disk harrow, and also the common harrow, has it been successfully accomplished. The following has probably been the most successful of all the ways that have been tried of renovating blue grass pastures which have been sodbound: The disk harrow is run over the sod at that season when the frost is only out sufficiently to allow the disks to cut down to the depth of two or three inches, and yet the frost below precludes the sinking of the feet of the horses to any considerable depth. The disk is then run straight crosswise or at an angle over the land previously disked. The disks are set so as to leave the cuts of sod somewhat on edge. The harrow then follows at once or a little later. If other seed is to be sown, as white clover, or orchard

grass or both, or indeed any kind of clover, it should usually be sown before the harrow. The necessity for using a roller will depend upon conditions. And there may be some soils, as for instance, very stiff clays, where such treatment would injure the land through poaching, unless alternate freezing and thawing followed quite soon. This method of renewal has succeeded well on prairie soils. But the attempts to improve blue grass pastures by simply running the harrow over them have not proved markedly successful. 3. That when the stand of the seed on blue grass pastures is thin or spotted, it may be renewed in some instances by simply adding more seed. In other instances by pasturing so lightly that some seed will mature and fall, and through its subsequent distribution by the winds will strengthen the pasture. And in yet other instances by disking those portions of the pasture with but little grass on them and sowing and adding more seed along with rye or some other grain. When more seed is scattered over the pastures, the early autumn will probably prove the best season for sowing it, using, if possible, fresh seed, and harrowing or not harrowing, according to conditions. The next most favorable season for doing this is the early spring. Winter rye will usually be found the most suitable grain to sow on the disked portions of pastures, as, if sown in the early fall, it will furnish grazing both fall and spring, while the grass sown along with it is becoming rooted. And 4. Blue grass pastures may be greatly strengthened by spreading over them farmyard manure, fresh or at any stage in its decay. The manure may be applied at any season of the year. But

the best results probably are secured by spreading it in the fall and also in the early winter. It then acts as a protecting mulch, and since the soluble portions work down into the surface of the soil and are taken up by the grass roots, the result is a free and abundant growth of grass. Nor does the manure when thus applied affect injuriously the palatability of the grass. This it does to some extent, if applied after the grass has made much growth in the spring.

Commercial fertilizers are seldom applied to blue grass pastures and chiefly for the reason that they cannot be spared for such a use. In other words, it is considered more necessary to use them for other crops. But should the circumstances justify the application, the growth of the grass may be much stimulated by their use. The needs of the soil should determine the fertilizer to be used. Usually nitrogen may be applied with advantage in the spring after growth has begun. One or two dressings may be given as necessary, with an interval of several weeks between them. On nearly all soils blue grass will be benefited by dressing it with phosphates fall and spring, and the same is true of dressings of potash. The increased growth from dressing with wood ashes is also marked.

Blue grass will, on certain soils, come into the meadows and pastures to the extent of finally crowding out the grasses composing them, without having been sown in the same, unless by the hand of nature. This it will do under all or nearly all conditions quite favorable to its growth. For instance, where timothy and clover are sown and cut for two or three successive seasons for

meadow, this grass is pretty certain to appear more or less the second year, and if grazing follows in subsequent years it will not be very long till the pasture is one of blue grass. This would seem to indicate that many of the seeds of this grass are lying in such soils in a dormant state, and ready to grow when the conditions favor such growth.

It is possible also to so transform the grasses of the prairie without ploughing them that they will ultimately become essentially blue grass pastures. This may be done by scattering seed over them, not necessarily in large quantities at one time, in the autumn or early spring. The best time probably for sowing such seed is just after it has been gathered. Especially is this true of areas in which the summer climate is dry, as for instance, the bench lands of Rocky mountain areas. The seed thus used may be sown quite as well in the chaff as in the cleaned form. In due time some of the plants will grow. If only a part of them are allowed to mature their seeds, as when the grazing is not too close, these fall down and are scattered more or less and produce fresh plants. The transforming process is hastened by the increase of plants through the root-stalks pushed out from the growing plants. It may be still further hastened by adding more seed the second autumn or the third. The advantage from sowing the seed in small quantities at one time and repeating the sowing another season lies in the fact that the risk of losing all or nearly all the seed is lessened, should it all be sown at one time, and a very dry season follow. When the seed is sown thus it would not seem necessary to

scatter more than three or four pounds per acre at one time. The period required to transform pasture thus will of course vary greatly, but the transforming work is usually done in a few years. There are, however, localities which include wide areas, as on certain of the ranges, especially those of the south and west, where such transformation cannot be made, owing to the aridity of the conditions.

When blue grass is newly introduced into any locality it may be established readily in by-places with but little expense, if the seed grown even on limited areas is saved by means of a hand stripper and scattered over these as soon as it has been secured. Seed thus sown has strong germinating power.

On certain soils that are springy in character, blue grass will come in and take possession, when the forest is cut away. These soils are usually composed of muck and more commonly they are located at the base of a hill, or lie between land that on either side is more or less elevated. Seepage waters come into these depressions, of course, from subterranean sources, and rising from below saturate them to excess at certain seasons of the year. At other seasons they can be grazed. Partly through the action of frost and partly because of treading by animals grazing on them, these lands assume the form of innumerable hillocks resembling ant hills. These lands usually furnish a large amount of grazing. If, however, the seepage waters coming down from the higher land were sufficiently intercepted by a drain or drains skirting the same at the base, and running parallel to them, the capacity of such grazing lands

would be much increased. The surface would also gradually assume a level form.

Blue Grass in Lawns.—Wherever Kentucky blue grass can be grown successfully it is a favorite grass for lawns. The dense, fine, almost velvety sward it makes pre-eminently fits it for such a use. Its crowding habit of growth enables it to keep at bay almost all forms of weed life when it has once become set; that is to say, well established. Cessation of growth and turning brown for a time in summer when unirrigated, are the weakest points in this grass as a lawn grass.

In making lawns on the farm the ground should be first cleaned on the surface, as by summer fallowing for the whole or even for a part of the season. It should then be well-levelled. The seed ought then to be sown, preferably in the early autumn and covered with a rake or a light harrow. It may be sown unmixed or mixed with white clover, and with or without a nurse crop of grain sown thinly, according as conditions may call for the same. The nurse crop and weeds if present should be cut back occasionally the first season. If the farm house lawn can be cut with the field mower much labor is saved in keeping it in order.

In making blue grass lawns in cities substantially the same process may be followed, with the difference that these being small it may be necessary to do much of the labor by hand, and the seed may be sown any time between spring and early fall when the ground can be watered. It is important with all lawns that the earth shall all have evenly settled before the seed is sown, and it should be thickly sown to promote quick setting.

When a blue grass lawn is well established under suitable conditions and with ordinary care, it is there to remain. If a more vigorous growth is wanted it may be secured by top dressing with farmyard manure or with compost well decomposed and preferably applied in the autumn. In some instances the dressing should be raked off in the spring. Wood ashes and commercial fertilizers may also be applied, but these do not afford winter protection as does the manure or the compost. If commercial fertilizers are applied, those nitrogenous in character are to be preferred.

CHAPTER V.

BERMUDA GRASS.

Bermuda grass (*Cynodon dactylon*) is also known by the names Dog's Tooth grass, Scutch grass, Wire grass, Reed's grass, Bahama grass, and Indian Couch grass. In Australia it is called Couch grass and in India Darva grass. The name Dog's Tooth grass is a literal rendering of *Cynodon*, the first word of the botanical designation. The name Bermuda grass has doubtless been applied to it from the abundant growth which it makes in the Bermuda islands, although it did not originate in these. Dr. Phares says it is the same as Creeping Dog's Tooth grass in England, Chiendent in France, and Doob or Durva in the East Indies. Some writers claim that it is the Sacred Durva grass of the Hindoos, celebrated in the sacred vedas as the shield of India, in the absence of which the cattle would perish, but the evidence in support of this view is not regarded as entirely satisfactory.

Bermuda grass is a creeping perennial, the creeping stems of which produce nodes or joints at short intervals. Each node is capable of producing a new plant, though completely separated from all the others. These stems have been known to extend 12 to 15 feet in a single season under the most favorable conditions for growth. When the joints come in contact with the earth, they send down fibrous roots into the soil as do the run-

ners of white clover. It also produces underground stems near the surface to the depth of 4 to 5 inches and extending outward several feet. From the overground creeping stems are numerous ascending or upright leafy branches from 4 to 10 inches in height. Other grasses of like appearance have only a single leaf to each joint, while this grass has two, three, and even four leaves to the joint. From 3 to 5 digitate spikes are borne on each stem at the top when it blooms. These are widely spreading, often purplish in color and 1 to 2 inches long. The leaves are flat, also spread widely and gradually taper to a slender acute tip. The roots, other than the underground root-stalks, are fibrous and feed deeply, but the usual depth for ploughing is deeper than the root-stalks are wont to go.

This grass, much written and spoken against, and much feared by many planters because of the difficulty of eradicating it in cultivated land, is steadily growing in favor in the south, and justly so, owing chiefly to its great value as a pasture grass under southern conditions. Lands well laid down to Bermuda grass are in many instances considered the most valuable property of the southern farmer. It is strictly a summer grass, as it grows best when the heat is greatest, the other conditions being right. It starts late in the spring, grows slowly at first and turns brown with the earliest frosts of autumn, but it grows right on through the whole of the summer. While it grows best in good soils, no grass in the south will furnish so much valuable pasture when grown on poor sandy, gullied or worn soils. It has much power to withstand heat and drought. Though ap-



FIG. 4.

BERMUDA GRASS (*Cynodon dactylon*).

Tennessee Experiment Station.

parently dead from drought it will quickly revive when moisture comes. It will also withstand inundations better probably than any other valuable grass grown in the south. But it does not succeed well in the shade, hence it is not well adapted for being grown in groves and while it is becoming "set" it must be protected against brome grass and briers. It will not grow in cold or even cool weather, nor can it live in a soil deeply penetrated by frost. Under favorable conditions it covers the soil so densely as to exercise a salutary and considerable influence on the retention of moisture, and it is also favorable to the action of earthworms, so helpful to soil improvement.

This grass is beyond question the most valuable pasture grass in the south. It will furnish grazing on soils too poor to grow cultivated crops, will furnish more and better grazing than any other southern grass and will also stand closer grazing and more tramping under all conditions than any other. All kinds of live stock kept upon the southern farm are fond of it, at all stages of development until smitten by frost. It also makes excellent and valuable hay, more palatable and nutritious than that made from blue grass.

Bermuda grass also renders excellent service in preventing erosion in soils and in binding the same. It will hold together the most arid and loose sands when once set in them. It has no superior in forming a sod on ditch banks and ravines. It is specially helpful in filling up gullies little by little, since it grows up through the deposit of soil which it arrests from water passing through it. It aids in holding up steep banks

and in preventing land slides, and nothing can surpass it for sodding the levees of alluvial lands. It is also used as a lawn grass in the south where blue grass will not so well serve the purpose. The chief objection to it is the brown shade which characterizes it during the season of frost.

One of the chief objections to Bermuda grass is the difficulty found in eradicating it on good soils. Many growers of this grass, however, affirm that they do not desire to completely eradicate it where it is grown in rotation with other crops, since the residue of the grass plants remaining in the soil after other crops have been grown in the rotation, makes the re-establishment of this grass much easier than it would otherwise be.

Distribution.—It is thought that Bermuda grass is a native of tropical Asia. It is now grown in many tropical countries. It has been grown to a considerable extent in various areas of southern Asia widely distant from one another. Howsoever introduced, it has been grown in the southern states for fully three quarters of a century. Its growth there is said to have been first noted by General Bethune, who gave considerable attention to its distribution in the south.

In the United States it is grown chiefly south of the 37th parallel, that is, south of a line running along or near the northern limit of the states of North Carolina, Tennessee, Arkansas, Oklahoma, Mexico and Arizona, including the southern portion of California. It would seem to be grown in every state south of this line and eastward from Texas. In these states it is probably destined to become the best pasture grass grown, and in

them it is also likely to be much grown for hay. Its growth has been much retarded in the cotton growing states by the trouble found in completely exterminating it in soils much used for growing cotton and corn, but now that the fact is becoming recognized that the lands well set to Bermuda grass are yielding higher revenues than the former, its growth is rapidly extending. It is certainly destined to become the leading pasture grass in all the states south of the parallel named, in areas susceptible of cultivation.

Bermuda grass has also been grown with much success in Virginia where the farmers are laying down to this grass considerable areas that were formerly devoted to wheat culture. In Southern Kentucky, Missouri and Kansas, it has been introduced to some extent, but only with variable success because of the cold in winter. Even in some parts of Tennessee and Oklahoma, winter weather injures it. It will succeed well in Southern California, and reasonably well in much of that state, but it is not a success in Oregon. North of the states named this grass would not seem to have any economic mission because of low temperatures. It will live much further north, but does not make sufficient growth to enable it to compete with grasses better adapted to northern conditions.

Bermuda grass has no economic mission whatever for Canada. It is doubtful if it would endure the cold winters in any province of Canada except possibly in British Columbia and close beside the Pacific.

Soils.—Bermuda grass will grow and thrive in almost any kind of soil, but of course not equally well. It

thrives best on rich soils, alluvial in character, such as is found in river bottoms and in drained depressions into which deposit has been washed from the higher lands. It is much better adapted to sandy lands than to stiff clays, but in the latter it will grow when once it gets a start. It may be made to cover any of the soils so depleted in fertility that their cultivation has been abandoned, providing other forms of growth, as broom sedge and bushes are not allowed to crowd and overshadow the grass while it is becoming set. It may be made to bind shifting sands so light that they will blow, though of course from the shifting character of these it is not easy to get the plants started. It will also tolerate considerable alkali in the soil, insomuch that on soils too alkaline to grow other grasses, it will yield some profit grown as pasture and on subsoils laid bare through the removal of the top soils in filling gullies, it will grow, providing they are given a light dressing of farmyard manure. The service that it may be made to render in turning those gullied soils and worn lands into profitable grazing and in preventing them from washing in the future, is, in the aggregate, beyond all computation.

Place in the Rotation.—Strictly speaking, Bermuda grass is not a rotation plant. Because of the difficulty found in eradicating this grass and because of its continuity in growth, its highest use is found in permanent pastures. But it can be and is used in rotations. For instance, it may be followed by corn, cotton or wheat or other grains, growing these in some sort of alternation for a limited number of years. Those who grow it thus and who wish to lay down these lands to Ber-

muda grass again, are careful not to carry the exterminating process too far before this is attempted. The roots remaining in the soil will again produce Bermuda pastures if properly protected. There is the objection to this plan, however, that it does not admit of what may be termed clean cultivation.

Because of the increased crops that have been obtained after breaking up lands on which Bermuda has grown for several years, some have concluded that it is a soil enricher. This, however, is not correct in the sense intended. If pastured or mown for successive years, the land meanwhile receiving no dressing of fertilizer, in any form, as with timothy in the north, the fertility content would be lessened in its entirety. The better crops which follow this grass are due, therefore, to the much humus put into the soil by the grass, in other words, to the mechanical and chemical influence which it exerts on the soil in its decay, and to the fertility which is thus made more readily available.

Preparing the Soil.—When land is to be laid down to Bermuda grass, the cleaner and richer it is, and the better its mechanical condition, the sooner will a stand of the grass be secured, and the greater will be the returns from it. When planting it on cultivated land, therefore, any attention that is judiciously given to the cleaning of the land will be time well spent. The conditions for planting after a well cared for corn, cotton or tobacco crop, are very suitable.

For spring planting the preparation that is given to making the land ready for a corn crop is deemed suitable.

ble also for planting Bermuda grass, but such preparation should be made early in the season.

When the crop is planted on rough land possessed with sassafras and broom sage, the only preparation given is to remove these for a time by cutting and this may be absolutely necessary even when judicious grazing is possible. The same is also true of stony and rough land. Poor land that has been gullied is prepared by ploughing, which should be deep rather than shallow, by filling the gullies with the scraper and applying a thin coating of farmyard manure when the top soil has been removed before planting the grass.

Sowing or Planting.—As the seed of Bermuda grass is low in germinating power and as the price is high, running all the way from, say 50 cents to \$1.00 per pound, it is not much sown in the United States. It is not only low in germinating power, but the young plants from the seed grow so slowly that they are much liable to injury from the crowding of weeds, unless well cared for. The plan, therefore, of planting portions of the roots has come to be generally adopted.

Nevertheless it may be advisable to sow seed on a limited area, in order to get a stand of plants to be used as cuttings in laying down pastures. It should be sowed only on clean and good land and while the same is moist. It is recommended to sow the seed broadcast and to cover it with a rake. A pound of seed should sow one-fifth to one-third of an acre. Weeds must be kept away from the young plants until they attain some considerable size. The method of sowing the seed in drills

would doubtless be preferable. It would call for less seed and would make it practicable to keep the land clear with considerably less labor. Lawns may be thus seeded where Bermuda cuttings or sods cannot be obtained.

The following are chief among the methods commonly adopted in planting the grass:

1. Portions of sod are obtained and are cut into pieces about 2 inches square with a sharp spade or corn knife. Shallow furrows are made both ways in well prepared land and the pieces of sod carried in baskets or otherwise are placed in the intersections of these. The top side of the sod is kept upward. Sometimes the earth is adjusted to the pieces with a hoe or they are covered lightly with the plough, the land then being smoothed with the harrow.

2. In the fall while breaking the land with a turning plough, drop small pieces of sod in every third furrow behind the plough 1 to 2 feet distant, the next furrow slice being made to cover these. Then sow rye on the land and in the spring graze down by cattle to aid in removing the shade from the crop and to firm the land. Horses and sheep should not be thus grazed while the grass is setting, as they bite off many of the creeping stems and thus interfere with the spread of the grass.

3. In light furrows made between the rows of corn when ready to be laid by, drop small pieces of the sod 1 to 2 feet apart and cover with a small harrow or plank leveller, such as may be run between the rows of corn.

4. The plants are dug up and shaken free from earth

and run through a cutting box, the aim being not to make the lengths short, and these are scattered over well prepared land and covered with the harrow, followed or preceded by the roller as may be advisable under the circumstances. It has been recommended to sow it thus with oats, but there is the objection that the shade from the oats will hinder growth. If the oats are cut for hay, however, the injury thus resulting may not be any more than from weeds growing amid the plants.

5. In unprepared land on which broom sage and saffras may be growing, pieces of sod drawn in a wagon may be planted in openings in the ground made with a hoe, the earth being adjusted with the foot. These openings may run from 3 to 6 feet apart each way. The closer they are the more quickly will the grass possess the land. Attention must be given at the same time to removing the shade of broom sage or saffras if growing there, by grazing or cutting down according to the season of the year. This method is adapted to the planting of large areas of run down land when it is desired to change them into Bermuda pastures at a minimum expenditure of labor.

6. Small areas are sometimes planted by barefoot boys who drop the pieces of sod into the soil when soft and push them down into the same with the foot.

Spring planting should begin as soon as the danger from frost is over and may continue on into the summer, but early planting is much to be preferred. When planting in the autumn it is necessary to cover more deeply than when planting in the spring. Planting when moisture is absent should be avoided, and fresh plants or cuttings only should be used. In some in-

stances cultivation is given to the land for a time between the rows of Bermuda sets with a view to clean the same. In other instances pasturing with cattle has the same object in view, and in yet other instances the crab grass which grows on the land is cut for hay.

A real difficulty is frequently experienced in trying to get Bermuda grass to grow on shifting sands, from the very fact that they do shift. About all that can be done probably to prevent this, is to plant the grass at those seasons when growth is possible and when high winds are less likely to prevail.

Pasturing.—Bermuda grass is unquestionably the best pasture grass in the south, viewed from the standpoint of palatability, productiveness and endurance. There are reasons for believing that in its proper sphere it will produce more grazing and more meat than blue grass under the most favored conditions. When well set on good land, it has maintained a mature cattle beast to each acre and produced more than 200 pounds of beef during six months of grazing. Sheep can graze upon it from 7 to 9 months in the year according to the locality. One explanation of its ability to produce these results is found in its power to grow right through the summer months. The first frosts, however, injure it for grazing, since they turn the leaves brown, and severe frosts northward from the Gulf of Mexico take the succulence out of the stems and leaves. Further south the stems remain green all winter and so may be made to furnish grazing, but the propriety of grazing closely at that season is somewhat doubtful, lest the roots should become too much exposed to the frost. The

aim should be rather to grow Texas blue grass or some other grass to provide winter grazing.

With many other grasses close grazing should be avoided, but Bermuda should be grazed somewhat closely during the season of growth, except when it is becoming established, at which time close grazing would hinder the runners more or less from pushing out and forming new plants. It should be thus grazed for the reason, first, that it is then more palatable; second, to prevent the stems from becoming hard and wiry and so indigestible that their nutritive value is much impaired; and third, to keep down briars and weeds that might otherwise injure it by their shade. With this object in view, it has been recommended to graze sheep on it early in the season. When grazed close, no other grass is able to dislodge Bermuda grass unless it be carpet grass (*Paspalum platycaule*) found in Louisiana and other parts. When the grazing does not keep the grass down, the plan of mowing it when necessary in conjunction with the pasturing has frequently been advantageously adopted. The wiry condition of the stems when too long ungrazed has, it is claimed, in some instances, led to loss in the animals grazed upon them.

In seasons of much drought the plants will, on some soils, appear to die, but when rain comes they will revive again with surprising quickness. Overflow during the growing season rather encourages the growth of this grass, but for a time it usually injures grazing by the sediment deposited on it.

Harvesting for Hay.—Bermuda grass should be cut for hay when the greatest number of stems are in bloom.

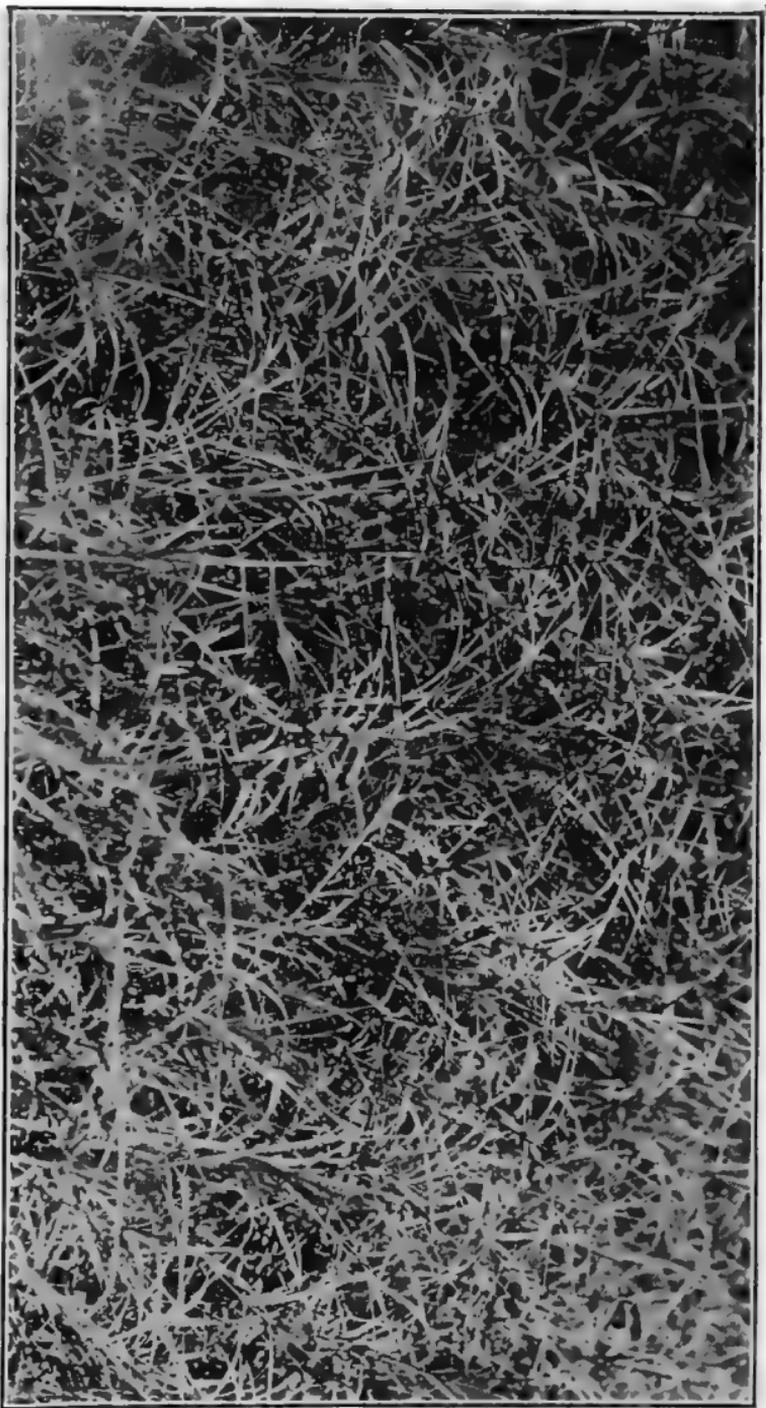


FIG. 5.

BERMUDA GRASS TURF.

Tennessee Experiment Station.

Soon after they have reached that stage the upper portion dies and the leaves below fall off. The tedder should follow when necessary as soon as the crop is wilted, to secure evenness in the curing of a grass so fine, and as soon as ready, frequently the same day that it is mowed, it should be put up into cocks and remain in these until cured. In handling the hay, a fork with many tines should be used, because of the fineness of the hay.

The number of cuttings in the season will depend upon the soil and weather. These run all the way from 1 to 5 and the yields also vary accordingly. They run all the way from half a ton to 2 tons per cutting. The hay per season ordinarily runs from 1 to 5 tons. By using nitrate of soda 10 tons have been reaped and in one instance recorded as many as 13 tons per acre were reaped in one year. The more frequent the cuttings, the cleaner is the hay likely to be.

Securing Seed.—Bermuda grass produces little or no seeds in the southern states, hence nothing can be said in the meantime about growing it for seed in the same. The seed in the market is grown in a still warmer climate than that of the southern states. Since the grass will soon be grown in so many centers that it will not be difficult to obtain portions of the sod for planting, the question of seed production would not seem to be one of great importance in the United States. In view of the fact that a stand of the grass can be more quickly obtained from root cuttings than from seed, and of the further fact that on some soils some difficulty attends its eradication, it would seem to be on the whole

fortunate for southern agriculture that the plants do not bear seed freely.

Renewing.—Bermuda grass, like quack grass, becomes sod bound after a few seasons of pasturing or mowing, hence where practicable it is recommended to break it up by ploughing and smoothing the ground quite soon thereafter with the harrow; ploughing it thus loosens and aerates the soil, breaks up the matted roots and brings new life to the plants. The frequency with which this ought to be done, the best season for doing it, and the exact mode of doing the work will depend upon conditions such as relate to climate, soil and the denseness of the sod. Usually it is recommended thus to break up the sod with the plough every 4 or 5 years. Northward the work should not be undertaken just on the approach of winter, lest too many of the plants should perish. Far south it might be desirable to have many of them perish to thin them. The depth of the ploughing should be gauged by the character of the soil, but it ought always to be as deep as experience has demonstrated that it can be done with safety to the plants. The more dense the sod, the less the danger of destroying too many of the plants by deep ploughing and harsh treatment.

But even under conditions where Bermuda grass cannot be thus dealt with, it will continue to produce well for many years, as has been demonstrated on free grazing lands in proximity to the cities.

The renewal of this grass is sometimes effected by ploughing the land in September or October and sowing it with red clover, winter oats or the sand vetch

(*Vicia villosa*). These are grazed when ready, but in some instances the clover is cut for hay, the Bermuda grass furnishing grazing later in the season.

The grass may also be renewed in a sense by either of the following methods: 1. Apply such commercial fertilizers as the circumstances may call for. 2. Fatten cattle on the pastures, and feed to these more or less of such food as corn, cotton seed meal or oilcake while being thus grazed. 3. Fatten sheep or lambs on the same, fed liberally with grain or oilcake or with both.

Eradicating.—At one time this grass was the dread of the planters or of many of them because of the persistence with which it grows on good soils subjected to cultivation. At the present time some persons who grow it in the rotation do not try to completely eradicate it. They believe that the extra cultivation required to keep it in check in cultivated crops is more than compensated by its influence in binding soils and in other respects benefiting them. When Bermuda is wanted again, enough plants remain in the soil to quickly form a sod. The fact remains, however, that clean cultivation is preferable to that which is partially clean, hence it is well to be able to eradicate the grass should this be desired. When such eradication is attempted, climate, soil and season materially influence the methods to be adopted, and also the results. It is much more easily eradicated when the winters are cold, in soils that are low in fertility and in summers that are dry.

The following methods of eradicating this grass will prove more or less successful: 1. Plough on the near approach of winter and expose the roots. Then grow

two crops of corn or one of corn and one of cotton, to which thorough cultivation is given. 2. Sow oats and sand vetches together, or clover, in the autumn, and cut the same for hay. Follow with cow peas for hay and then grow two cultivated crops successively on the land. 3. Plough shallow in June, turning the furrows edge-wise rather than over. Later with a rotary or some other harrow, free the roots as far as practicable from the earth. Sow cow peas. Follow with oats and vetches, cow peas again, and then corn or cotton. 4. In small areas swine will virtually dig out this grass.

Some persons claim that because of the difficulty found in eradicating this grass, it should never be sown on land that is to be again cultivated. The author does not sympathize with that view, as, unlike Johnson grass, it can be eradicated without great cost. But the indolent farmer should never allow it to come into his cultivated ground.

CHAPTER VI.

ORCHARD GRASS.

Orchard grass (*Dactylus glomerata*) is also known by the name of Cocksfoot, a name frequently applied to it in England from the fanciful resemblance of the clusters of the panicle to the foot of a cockerel. The stem is strong and inclines somewhat to coarseness, unless when the plants grow thickly. It usually grows from 2 to 2½ feet high, but under favorable conditions may reach from 4 to 5 feet in height. The leaves are large, long and numerous. The panicle is open and spreading and from 2 to 6 inches in length. The leaves are a dark green in color, but the panicle is frequently tinged with violet spikelets. The roots are fibrous, the fibres going down deeply into the soil, which gives it considerable power to withstand drought. On good soil and suitable, the plants have the appearance of much strength and vigor.

Orchard grass is an annual. It is ready for pasturing earlier in the spring probably than any other grass of much economic importance in the United States, except Russian brome grass. It comes into flower in May or June according to the locality, and then quickly reaches the mature stage. It continues to grow with more or less vigor during much of the summer, and again makes an abundant growth in the autumn as soon

as the autumn rains fall. The rapidity of the growth during spring and fall is very marked on favorable soils, hence the abundance of the production furnished by this grass. It is reasonably hardy, but will not withstand exposure to extreme conditions as well as blue grass or Russian brome grass.

Orchard grass has the habit of growing in bunches or tussocks unless thickly sown, hence the aim should be to sow it so thickly as to prevent this when it is grown for pasture, otherwise it ought to be grazed so closely that these tussocks will not overshadow other grasses that may be growing between them to the extent of destroying these grasses. It has also much power to grow in the shade, as in orchards or parks. In New England especially, the practice has been quite common to sow it in orchards, hence, probably, the name orchard grass.

It is an excellent pasture grass when properly managed, but is not so nutritious or palatable as blue grass, although it furnishes more grazing during the season and also ranks high for its nutritive qualities. For permanent pastures it is possessed of a high value. Owing to its peculiar habit of growing in tussocks and also because of the coarseness of the leaves, it is not well adapted to the making of lawns.

It makes good hay when cut and cured at the right time, but it has never become so generally popular for such a use as timothy, either on the farm or in the market. This is owing, doubtless, to the quickness with which the stems become woody if not cut at the right time, to its being more difficult to cure, to the less degree of its palatability and to its greater bulkiness.



FIG. 6.

ORCHARD GRASS (*Dactylis glomerata*).

Oregon Experiment Station.

Orchard grass is very enduring under favorable conditions. Meadows composed of this grass have been mown for a dozen years and more. Instances are on record wherein pastures of orchard grass have endured for 40 years. But ordinarily it does not maintain its hold upon the ground unimpaired for periods so long.

Distribution.—Orchard grass is indigenous to Europe, and is probably grown in every country of the same. It is also grown in Northern Africa, certain parts of Asia and in many parts of North America. It is said that it was introduced into England from Virginia in 1764. In Britain it soon became greatly popular especially for pasture purposes.

Orchard grass is best adapted to a temperate climate in which the extremes of cold are not excessive. It cannot be grown as far north as blue grass or Russian brome grass, but is successfully grown further south than either of these grasses. Nor can it so well withstand the sweep of cold winds in unsheltered places, especially on western prairies. Like nearly all the cultivated grasses it grows more successfully under moist than under dry conditions, and yet it has considerable power to grow under conditions somewhat dry when once established. In Central and Western Kansas, for instance, it will stand more drought than blue grass.

In the United States orchard grass grows with no little satisfaction on suitable soils in nearly all the country east of the dry belt, that is to say, east of a line running from north to south, say 300 to 400 miles west of the Mississippi river. The exceptions are the wind swept areas of northwestern prairies, the light

sandy soils of the Lake Superior region and the soils of the southern states that have been much worn. It should prove satisfactory in such areas of the lower Mississippi basin as contain alluvial soils and more particularly those that are considerably impregnated with clay. The highest centres of adaptation are probably found in the states of Indiana, Pennsylvania, Kentucky and Tennessee. In New York and the New England states it has long stood high in favor with the farmers, also in certain parts of Ohio, Virginia, Kansas and some other states. It grows well on the moist foothills of the western mountain states and even in some of the higher valleys, and without irrigation. Prof. H. T. French has spoken well of its merits as a pasture grass in certain parts of Idaho. West of the Cascade mountains, except on gravelly soils, it grows with much luxuriance north of San Francisco. The western ranges are probably the lowest in adaptation for orchard grass of all the areas in the United States.

In Canada, the highest adaptation for orchard grass is found in the deep loam soils of Western Ontario, but even in these it is not likely to supersede blue grass for pasture or timothy for hay. In Quebec and in all the maritime provinces of Canada it grows satisfactorily, the soils being right, and along the Pacific it is quite at home as far north as Alaska. But it is not likely that it will ever prove a decided success on the prairies between the Rocky mountains and Lake Superior.

Soils.—Orchard grass grows best in deep, rich, moist clay loam soils, possessed of a sufficiency of lime, but it will also do well on sandy loam soils which rest on

clay somewhat dense in texture. Even on clays somewhat stiff it will give reasonably good returns as hay or as pasture. In fact this grass will do well on almost any kind of soil that is rich, well drained and porous. On the average prairie soils of the Mississippi basin it grows freely, but in the northern portions of the same which are much exposed to the sweep of winds in winter, it does not endure well. Other soils of the prairie are so rich as to produce a coarseness of leaf and stem that are not desirable, but this may be counteracted to some extent by thick sowing. While orchard grass has high adaptation for moist soils, it will fail under conditions of excessive wetness or dryness in the land, hence it is ill-adapted to undrained sloughs or to sandy soils deficient in moisture. In the gray soils of the Rocky mountain valleys it grows luxuriantly under irrigation. Where the other conditions are suitable and the soil is low in fertility, this grass will readily respond to the free application of fertilizers.

Place in the Rotation.—Since orchard grass, like blue grass, is relatively better adapted for pasture than for hay, it is scarcely possible to assign it a place in a fixed rotation. When grown for hay or for the seed, the length of the rotation will depend upon the continuance of the profitable productiveness of the grass. This varies much in different localities, but, usually, the tendency in the grass to improve for several years after it has been sown, has led to the practice of maintaining orchard grass meadows and pastures for several successive years. When grown with red clover for hay, the rotation will be shortened or lengthened accordingly

as the sod is broken when the red clover ceases to produce abundantly, or at a later period. When grown for pasture and more especially in permanent pastures, the duration of the rotation will of course be largely dependent upon the duration of the pasturing period.

It is evident, therefore, that orchard grass is not well adapted to short or to regularly fixed rotations. When sown, however, as in the case of timothy, it may best follow cultivated crops which have been sown to clean the land or after summer fallow when summer fallowing is practiced. As with timothy also, it may be best followed by corn or by some small cereal, as oats or flax which grow best on soils supplied with vegetable matter in an early stage of decay. Potatoes also will grow well after this grass.

Preparing the Soil.—When orchard grass is sown along with such cereals as rye, wheat, oats and barley, the preparation of the soil best suited to the growth of these crops will also be the preparation suitable for orchard grass. It is considered preferable to plough the land in the autumn in localities where such a method of handling the land is generally advantageous. As with other grass seeds a fine tilth is usually preferred, but under some conditions, when sown in the fall, it would be possible to make the seed bed too fine for the best results to follow. For autumn sowing, simply disk-ing the land on some soils will suffice. On other soils it would be necessary to stir it more deeply by using the plough, and there may be instances in which the sub-soiler may be advantageously used with the plough. Notwithstanding, on other occasions, the grass will grow if

sown after harvest on stubble land and without being covered with the harrow. When sown in groves or in woodland the stand is much more certain if the leaves have been previously raked off or burned where they may have been lodged. In such situations a stand has been secured even when the young plants have been pastured off from the first.

Sowing.—Orchard grass is more commonly sown in the early spring, but it may also be sown at various seasons. As with clover and timothy it is sometimes sown on the late spring snows, or on ground honey-combed with frost. But sowing is probably more frequently deferred until the ground is dry enough to admit of covering the seed with the harrow. In moist situations it may be sown almost any time during the spring when it occupies the land alone. It has also been sown in the late summer or the early autumn. But it should not be sown late in the autumn lest the young plants should perish through the rigors of the winter following.

Whether the seed should be sown alone or with a nurse crop, depends in part on conditions as to moisture or the opposite, and the quickness with which a strong stand is required. Under conditions of ample moisture, it is more common to sow with a nurse crop, but quite frequently the other method of sowing is also adopted. When it is, it is necessary to keep the weeds well clipped back lest they should smother the young plants. Rye, barley and wheat in both the winter and spring varieties are the favorite nurse crops, but it is not infrequently sown also with oats seeded both autumn and

spring. When sown with autumn grains it can usually be sown earlier in the spring and on a firmer seedbed than when sown with the same grains of the spring varieties, hence the young plants can better withstand drought, and the shade of the nurse crop is removed earlier. When sown with oats the oats should be thinly sown and also cut early.

The seed is more commonly sown by hand than by any other method, but it is not improbable that in some soils the plan of mixing and sowing it along with the grain when the latter is drilled in would prove satisfactory. Much care should be taken to sow the seed evenly to avoid any vacancies that will encourage the forming of tussocks.

When the grass is sown alone, many urge sowing not less than two bushels of seed per acre, that is about 28 pounds. But the amount sown varies from 2 bushels down to 1 bushel. When sown alone to provide hay, not less, probably, than 2 bushels per acre ought to be sown to insure a fine growth of stalks and leaves, but, when sown to grow seed, the quantity may in some instances be profitably reduced to 1 bushel, lest the size of the seed heads should be too much reduced by overcrowding. When sown along with red clover to provide meadow, a method of sowing which is extensively practiced and which meets with much favor, some authorities advocate adding as much as 12 pounds of red clover seed per acre to the 2 bushels of orchard grass seed. Others again claim good results from sowing 1 bushel of orchard grass and 8 pounds of red clover. A few pounds of tall oat grass or of perennial rye grass are

sometimes added per acre especially when growing meadow. When this is done the amount of orchard grass seed is correspondingly reduced. In the south orchard grass and red top are frequently sown together for pasture. When thus sown, 14 pounds of orchard grass and 7 pounds of red top would probably suffice. In some instances timothy is added, but rather with the object of covering the ground more perfectly and thus increasing the pasture than of making hay. When sown in permanent pastures the amount of seed to sow will depend upon the character of the pasture but will vary all the way from a few pounds up to a bushel according to the conditions.

Much care should be exercised in purchasing orchard grass seed lest it be adulterated with the seeds of one or the other of the rye grasses. The author has been told by a very competent seedsman who has been long prominent in the seed business, that not less than four-fifths of the orchard grass seed of commerce is much adulterated with the seeds of the afore-mentioned grasses. These are cheaper and their detection is not easy because of their similarity.

Pasturing.—Since orchard grass comes up early in the spring, the pasturing may begin correspondingly early. Since also the leaves become a little coarse and less tender with advancing age, and since it soon reaches that stage where seed stems are thrown up, it is well to pasture this grass with reasonable promptness and closeness in the early part of the season. When the season advances and becomes more dry as it advances, as is very frequently the case, the growth is less vigorous, but

as soon as the fall rains come growth begins again and is strong and free in proportion as moisture and plant food are present in the soil. The growth of orchard grass is more prolonged and continuous than that of blue grass, and it provides more pasture, but the pasture is not equal to blue grass in palatability or in nutritive qualities.

Where the spring grazing is not reasonably close, the seed stems formed will not be eaten readily by live stock. If left standing they will of course produce seed, which tends to lessen production in the pasture. This may be avoided as in the case of timothy by running the field mower over the field, the cutter bar being raised high. Weeds that may be growing in the pasture will thus also fall before the mower.

From Central Indiana southward, orchard grass is frequently grazed during much of the winter. This may be done in a judicious manner without injury to the grass when once it has become well established. It may even be pastured with some freedom by horses and sheep, when covered to a considerable depth with snow. But care must be taken not to pasture it when the ground is so soft that the feet of the animals which feed upon it will sink into the same, and the more the clay increment in the soil, the greater will be the injury that will follow such pasturing. North of the latitude named this grass is also sometimes pastured in winter, but where the cold is severe, much grazing injures the plants more or less by removing needed protection. The palatable and nutritive qualities of the grass are also injured by temperatures low beyond a certain degree.

Pasturing orchard grass the season that it is sown should be avoided unless the plants are vigorous and the growth luxuriant. But where both the conditions named are present, pasturing may follow without hazard in the autumn and in mild climates also in the winter.

Harvesting for Hay.—Since orchard grass quickly matures after the heads appear, it should be cut for hay with promptness as soon as it comes into flower, or, what some consider better, as soon as the flowers have fallen in part or in whole. If not cut until a later stage, the stems quickly become woody and the hay loses much in palatability. For this reason and for the further reason that orchard grass matures for hay in a busy season, no more of it should be kept for hay than the grower can harvest at the proper time. When cut it should be cured in the winrow or cock rather than in the swath. Complete curing by the last named method would also result in a loss in palatability. When cured in the cock the natural greenness of the hay is best maintained, but the labor in curing is greater than when cured in the winrow. In curing heavy stands of this grass the tedder may of course be made to render good service. Since orchard grass takes much more injury from rain than timothy, every necessary attention should be given that will hasten the curing of the hay. Such attention is all the more needful because it is generally ready to be harvested late in May or early in June, when showers are usually not infrequent.

After the first cutting the grass springs up again with much vigor when the conditions for growth are favorable. When it has grown again for several weeks it

may be cut a second time for hay or pastured as may be desired. If the weather has been so dry that many of the heads did not appear with the first cutting, they will appear during this second period of growth, hence the crop of the second cutting will be much akin in character to that of the first cutting. Otherwise it will consist of "rowen," that is of leaves which have grown up after the first cutting. The leaves sometimes make an inch of growth in a day. A third cutting is occasionally obtained under conditions that are quite favorable, and in the case of irrigated land rich in character, a fourth cutting. The character of the hay of the different cuttings subsequent to the first will be much alike, since under normal conditions the plants head out but once a year. It may also be added that on unirrigated land the rule is to cut but once a year and then to pasture subsequently.

The yield in hay of course varies. From the first cutting it may be put at about $1\frac{1}{4}$ to $1\frac{1}{2}$ tons per acre. From three cuttings as much as 4 tons per acre have been obtained in one season. On certain soils especially those of the eastern and southern states, the growth will be greatly stimulated by the application of suitable commercial fertilizers (see p. 16) just after each cutting of the crop. On irrigated soils the fertilizers ought to be applied as soon as the irrigating waters have disappeared.

Securing Seed.—When orchard grass is ripe, the heads assume a light yellow tint, and the stems turn yellow for some distance below the head. When ripe, the harvesting should be done with much promptness, other-

wise the seeds will shatter much during the process of harvesting.

Two methods of harvesting have met with more or less general favor. By the first, the binder is set high, at least a foot from the ground, and is run over the crop. The object sought is to secure the stems and heads which are bound in sheaves in order that the parts beneath the cut portion may be mowed and made into hay, for which it is fairly well adapted, because of the abundance of the leaves. By the second method the binder is also used. The sheaves are carried by the bundle carrier, that a number may be dropped off in one place. These are set up in round shocks, and the top of the shock is bound with a band drawn from one of the sheaves. If the weather is good, threshing from the shock is labor-saving, and is attended with but little loss of seed, but the crop may of course be housed or stacked and threshed later. When drawing the sheaves, the wagon rack should be covered with a canvas to prevent losing the seed that drops from the head, with the same object in view the aim should be to lift each round shock entire by using a suitable fork. It would also seem to be labor saving to harvest the seed with a stripper suitably made.

The seed may be threshed with a common thresher, but special sieves are used. In winnowing the seed special screens are also necessary, and care must be taken in handling the same to avoid heating until it is dry.

The yield per acre varies from 5 to 20 bushels. The average yield is probably about 8 or 10 bushels. While the weight of the seed varies somewhat, the average weight may be put at say 14 pounds to the measured

bushel. The yield of the seed frequently increases from year to year for several years, and the stand also thickens from the shattering out of the seed. Much of the home grown seed is now produced in Kentucky, Indiana and Idaho.

Renewing.—Since orchard grass is one of the most abiding of grasses on soils which are adapted to it, on these it is not difficult to renew it. When not pastured too closely, some of the seed will mature. When this falls, young plants spring up and renew the pasture. But where this cannot be done, the pasture may be thickened especially on favorable soils, by sowing seed in the early fall or spring and covering the same with the harrow. Under conditions of abundant moisture harrowing may not be necessary. The amount of seed to sow will of course vary with the needs of the pasture. If the weather following such attempts at renewal should prove unfavorable, it may be necessary to sow again when the opportune season arrives. When the ground is kept well covered with plants, the herbage will be finer and consequently better than when the plants are fewer and the yield in pasture is also greater. On soils which are liable to heave, the roller can occasionally be used with much advantage, as may be necessary, and this is true also of orchard grass kept for meadow or for hay. This must be done in the spring when the ground is not too moist to poach, nor too dry to prevent the proper firming of the plants.

CHAPTER VII.

RED TOP.

The name Red Top is applied in a somewhat loose sense to many species of grass growing in the North temperate zone, all or nearly all of which are characterized by panicles or heads more or less tinged with reddish brown or purple, as they approach the ripening period. These belong to the genus *Agrostis*, of which it is said there are about one hundred species. Of these the two so-called varieties *Agrostis vulgaris* and *Agrostis Alba*, are by far the most useful. These are not recognized as being botanically distinct. When grown on dry soils the stems are short and the panicles have a lighter shade, hence probably the distinction *Alba*.

Red Top in the United States is known by many names, nearly all of which are more or less sectional. These include Herd's grass, Bent grass, Creeping Bent, Rhode Island Bent, English Bent, White Bent, Fine Bent, Burden's or Borden's grass, Dew grass, Summer Dew grass, Fiorin, Finetop and Tall Red Top. Creeping Bent (*Agrostis stolonifera*) and Rhode Island Bent (*Agrostis canina*), are considered by some authorities as only modifications of the form *Agrostis vulgaris* growing under different soil conditions. Others look upon them as varieties or sub-varieties. It may truthfully be said of the entire genus *Agrostis*, that it passes

into forms which have been given specific names; of these names the term Herd's grass has by far the widest application. It is the common designation for red top in Pennsylvania, and in all or nearly all of the southern states. The name Herd's grass is thought to have been given because of its very general adaptation to the needs of the herd. In all or nearly all the northern states, it is known only or chiefly by the name of red top. In England the term Bent is applied to all, or at least to several, of the forms of this grass.

Red Top is a perennial grass which grows from a few inches to five feet in height under varying conditions of soil and climate. But the average height is probably 18 to 20 inches. In the southern states, it grows taller than in those north. The stems are erect, slender, smooth and round. The linear leaves are probably not so numerous as in timothy. The panicle is oblong and spreading, and though it varies considerably in color under different conditions of growth, the panicle is generally characterized by a purple tint which seems to deepen with increasing luxuriance in the growth of the grass. The roots are more or less creeping and gather food near the surface, rather than from the subsoil. The form known as Creeping Bent has long, prostrate and creeping stems, which take root at every joint. This habit of growth gives it much power to grow on moist soils, or even on somewhat dry sandy soils where other good grasses grow shyly, and eventually to cover them with a stiff sod. The form known as Rhode Island Bent, sometimes called Brown Bent and Dog's



FIG. 7.

RED TOP (*Agrostis vulgaris*).

Tennessee Experiment Station.

Bent, has fine root leaves and is able to form a close turf on soils low in fertility. This grass in one or the other of its forms would seem to have greater power to grow on a variety of soils than any other cultivated grass. Notwithstanding, it grows better on moist than on dry soils, hence the frequency with which it is found in sloughs, in ditches and in by-places generally. Before the introduction of timothy, it was a chief reliance for hay. Since that time, it is grown more for pasture, alone or in mixtures where meadows are more or less permanent. It starts later in the spring than blue grass, grows more slowly and is later coming into flower.

It is now more highly esteemed as a pasture grass than a hay plant, because of its power to endure, and because of the degree of its permanency, but in many areas it is still considered an important hay plant. Although quite suitable as pasture or hay for horses, cattle and sheep, when the growth of the pasture is well advanced, it is not so highly relished by the stock. Though some claim it equal to and even superior to timothy for hay, the claim will scarcely hold good when viewed from the standpoint of palatability or suitability for marketing. But in nutrition, it is placed next to blue grass.

It is chiefly valuable as a fertilizer because of the humus which it puts into the soil when plowed under. Because of its permanency it may be made helpful in keeping weeds at bay. It may also be made helpful under some conditions in binding soils that are gullied and in helping to fill up the same. (See p. 120.)

Distribution.—Red Top is indigenous to Europe and

also to America. In the cultivated form it was doubtless introduced at first from England. It was called English grass by certain of the early writers. But this grass is doubtless indigenous to certain low lands in all or nearly all the Northern States from New England westward to Dakota, more especially Michigan, Wisconsin and Minnesota, and in some states south from there. This fact has been disputed by some botanists, but it cannot be successfully gainsaid. In Britain this grass does not hold so high a place relatively among the economic grasses as in America, and in the Northern States it has never held so high a place relatively as in those further South. This is probably owing to the freer growth of certain other useful grasses in the North, as timothy and blue grass. Red Top is very hardy. In no part of the United States will it succumb to the cold. It is also able to endure in Canada as far north as cultivation has been carried. It would also seem able to endure more heat than timothy or blue grass. It does best under moist conditions and yet it has very considerable power to endure drought.

It would probably be correct to say, that no grass in America is possessed of so wide a distribution. It will grow in one or the other of its forms in some portion or portions of almost every state and territory in the Union. In the South especially, it has a more general distribution than any other grass. The moist climate of that region is favorable to its growth. It grows best there in the river bottoms but will also grow high up on the sides of the mountains. Notwithstanding the favorable climatic and soil conditions, in considerable

areas of the south and more especially in Kentucky and Tennessee, it would doubtless be correct to say, that even larger crops can be grown alone or in conjunction with other grasses, in certain of the Northern and Middle states. These include Indiana, Illinois, Iowa, Minnesota, Wisconsin and Michigan; especially in the slough lands of those states does it grow with much luxuriance. In the New England States, considerable prominence relatively is given to red top in the valley lands. In New Jersey it is a favorite grass. In the southwestern states, it does not flourish without irrigation, nor has it been found to render much service in any of the semi-arid country east of the Rocky mountains. In the irrigated western mountain valleys, hay fodder crops that are considered superior are given attention to the practical exclusion of red top.

In no part of Canada has much attention been given to the cultivation of red top. Notwithstanding, in the low lands of Ontario and Quebec, it grows freely and on the tide lands of the maritime provinces and British Columbia even larger crops may be grown. In many parts of Manitoba and the N. W. territories of Canada fairly good crops can be grown. It will also grow, but more shyly, on the uplands of the maritime provinces, because of the want of nutriment in the soil.

Soils.—No useful grass in America will grow on a greater variety of soils and yet some soils have far higher adaptation for red top than others. Highest in adaptation probably, are the tide lands which border on the Atlantic and the Pacific. Next in adaptation come the slough lands composed largely of humus, or

river bottoms, made up of alluvial soils considerably tempered with clay. After these would probably come the humus soils of the prairie, and the loam soils of the same. Then would come clays and after these, sandy loams. It will do well in the sandy soils of river bottoms when enough moisture is present. While it will grow well on certain of the sandstone soils of the south, so deficient in lime as not to maintain blue grass in good form, it will grow much better on the deep calcareous soils of the same. It is one of the best grasses to grow on thin soils, and it will even grow, though in a dwarfed form, on poor gravelly soils. No other useful grass would seem so well adapted for being grown in wet situations, even in places so moist, as to be saturated with water for a considerable portion of the late autumn and the early spring. It will even stand shallow submergence for several days, when the weather is cool; and for a longer period than almost any other useful grass, when it is warm. But it does not stand drought as well as Russian brome grass or some of the wheat grasses.

Place in the Rotation.—Red Top usually requires several years to become “set,” that is, to form a sod as dense as it can become under the attendant conditions of growth, consequently it is not a good rotation plant; and yet it would not be correct to say that there is no place for it in rotations. But that place is more on uplands than in reclaimed marshes, since in the soils of the latter it is more abiding than on uplands. Speaking in a general way, on these and in fact on all soils, it is helpful in bringing humus to them, and, because of

this, the mechanical and chemical effects of red top sod, especially on worn soils, is very helpful.

The crops which may best be made to follow red top are those which feed ravenously on humus soils, such for instance as corn, the non-saccharine sorghums, potatoes and rape. But certain of the small cereal grains may also be thus grown with profit. Legumes should only be sown thus when the sod may be so stiff as to call for reduction before growing on the land such crops as wheat, oats and barley.

Preparing the Soil.—The preparation of the soil for red top is much the same as that which fits it for receiving orchard grass. (See p. 138.) But clean cultivation preceding red top is even more important than the same preceding orchard grass, since it takes longer to become established. When it is to be sown alone, as for the production of seed, it is specially important that it should be sown on clean land, that is on land on which a cultivated crop has been grown under clean conditions. In fact such conditions are the most favorable to its growth in all soils. But on the galled soils of the south it is sometimes sown and top dressed with or without manure, according to the degree of the depletion, in order to cover them with a grass sward, which in turn, will form in them the basis of successful crop production.

Sowing.—Both north and south the seed is sown in the autumn and in the spring. In the south autumn sowing is growing in favor, since a better stand of the plants is then more uniformly obtained. When a hay crop is wanted the first summer after sowing the seed, or

even when grazing is wanted thus soon it ought to be sown in the autumn and on clean land. This method will also succeed in the north under conditions favorable to autumn growth, but, since it is seldom sown in the north except in conjunction with other grasses, it is more common to sow it in the spring. When sown in the spring, early sowing is preferable, especially on uplands. On marshy lands, considerably saturated with water, and on which it is desired to add red top to the grasses that may be already growing there, it is well to sow when the frost begins to leave the surface of the bare ground.

The seed is usually sown by hand. Under some conditions it may be sown mixed with the grain, but, on many soils, this method of sowing would bury the seed too deeply. By mixing the seed with certain substances, as for instance earth, salt, or wheat bran, it could be sown with the grain drill, but it is usually sown in the chaff. In order to secure a more even distribution of the seed, some growers scatter half the seed to be sown by going first in one direction and then sowing the balance by going again over the land crosswise.

When wanted for meadow, the seed is frequently sown alone without a nurse crop, and, as previously intimated in the autumn. When sown in the chaff, it is almost invariably sown in the autumn, and in no other way can a stand be so certainly secured. The seed is then fresh, its germinating power is at the best, and the chaff scale aids in keeping the seed in that damp condition which is favorable to quick and sure germination. But it may also be sown in the autumn, along with a

nurse crop, as for instance, winter rye, winter wheat or winter barley, and in conjunction with timothy. When sown in the autumn, a stand is on the whole more assured than when sown in the spring. In the spring, red top may be sown with any of the small cereal grains, but when thus sown the aim should be not to shade the ground too densely by using a more or less reduced quantity of the seed of the nurse crop. When sown on galled or impoverished lands, in order to cover them with a sod, it is also usually sown alone.

When sown in combination with other grasses red top and timothy make a favorite mixture on soils neither high nor very low. On low soils no combination of grasses for hay is more popular than red top, timothy and alsike clover. These are adapted to the same soils and mature about the same time. When sown for pasture, this grass may be sown alone, but better in combination with other grasses and with certain of the clovers, according to the nature of the conditions of climate and soil.

The extent of the covering required depends largely on soil conditions; sometimes in both fall and spring sowing, no covering is required. In other instances, the roller will furnish a sufficient covering; usually, however, a light harrow furnishes the best covering for the seed.

The amount of seed to sow will vary with the object sought in sowing, as in providing hay or pasture, with the cleanness of the seed and with the nature of the combination with which the seed is sown. When sown alone with a view to make pasture quickly, more seed

would be required than if sown to provide hay or to furnish seed. From half a bushel to a bushel of clean seed is the amount sown by many growers, but some sow considerably more, even as much as two bushels. The normal standard bushel weighs 14 pounds, but as the seed comes into the market, the measured bushel varies from an amount considerably below the standard to as high as 44 pounds. It is very evident, therefore, that the amount of seed to be sown will vary greatly with the character of the seed used, a fact that should not be overlooked when purchasing seed or when sowing the same. When sown in mixtures for hay or for pasture, the amounts of seed to use will lessen with the number of the varieties sown and with the amounts of seed used in these. When clean seed is used, 6 pounds of red top and 6 pounds of timothy would suffice per acre. If red clover is added, 4 pounds of red top, 4 of timothy and 6 pounds of common red or mammoth clover would suffice. When sown with alsike clover and timothy, 3 pounds of the alsike, 4 pounds of timothy and 4 pounds of red top should be enough.

When sown in mixtures for pasture, orchard grass and red top go well together on southern uplands. Fourteen pounds of the former and 7 of the latter should make a sufficient seeding. In the north on land somewhat low, 4 to 5 pounds of clean blue grass seed per acre may be profitably added to the mixture of alsike clover, timothy and red top given above for hay, even though the pasturing should not begin until two or three crops of hay have been harvested. But red top may usually be added with profit to any combination of grasses used

north or south in making permanent pastures. Usually from 3 to 5 pounds of good clean red top seed should be enough to sow per acre in such combinations. It should be remembered, however, that the amounts of seed named are only approximate estimates, and that it may be necessary to vary them to suit varying conditions.

In the south red top is sometimes used in making lawns. For such a use it has a higher adaptation than blue grass. When so used, much of what was said as to methods to be followed when sowing blue grass on lawns will also apply to red top.

Pasturing.—Although seldom sown alone in the northern states or in Canada to provide pasture, it is a chief reliance for such a use in many parts of the southern states. It is highly valued there as a pasture grass because it is nutritious and fairly well relished by stock; because it will provide much grazing in the year, even in addition to a crop of hay; because it furnishes good winter as well as summer grazing; because it forms a good sod that stands grazing well; and because it is, for the conditions named, one of the most enduring grasses.

As already intimated, it ranks nearly as high as Kentucky blue grass in its nutritive properties and, until well advanced in growth, it has a fair amount of succulence. But when it approaches the ripening stage, stock do not eat it. Nevertheless, when properly grazed, it will furnish good pasture for all kinds of stock, even for dairy cows whose needs call for succulent food much of the year.

Although it is a little slow in starting in the spring and after it has been cut for hay, because of continuity in the growth, the amount of grazing furnished is relatively large. Some farmers in the states which circle around Kentucky, claim that they get from 5 to 7 months' pasture from it in addition to a crop of hay. It is probable, however, that when thus grazed, the production of both hay and pasture is less than it would be if not grazed so much. Unless on soils low and quite rich, the best crops of hay will be obtained from lands not grazed closely in the autumn.

In warm spells in winter, it may be grazed in the south, at least in many instances, without injury to the grasses after it has formed a good sod. When not closely grazed in summer, the dead grass of that season falls down and provides a mulch for the young grass, amid which young blades grow up, even in the winter. In the spring, such pastures are especially prized for areas that are producing lambs. These pastures are so highly useful to southern farmers, that they study to provide them for their live stock. Although red top eventually forms a stiff sod, considerable time is necessary before this can be secured. Consequently heavy grazing the first season after sowing in the spring or even in the autumn should be avoided. The variety *Agrostis stolonifera* forms so stiff a sod even on lands considerably saturated with water, that they will not poach when grazed by live stock. But even on sterile soils, ordinary red top will eventually furnish a dense sod.

All authorities are agreed as to the enduring character of this grass. To southern farmers this is a matter

of much moment, since with them blue grass and timothy are not so valuable relatively, nor are they so enduring as in the north. In southern pastures, red top will endure where eventually both timothy and blue grass will fail. Because of this property, red top should be given much prominence in the permanent pastures of the south.

Harvesting for Hay.—Before the general introduction of timothy, red top was a principal reliance for hay. In the southern states, it is still one of the principal hay crops, or at least one of the chief factors in the same. In the North, it is seldom sown for hay except in mixtures. While some farmers claim that it is superior to timothy for hay, timothy is usually, and doubtless with good reason, considered superior as a hay plant. It weighs more heavily in proportion to the bulk, and in the North especially, larger average crops can be obtained. But red top has the advantage of having smaller and softer stems.

It is ready for being cut when in fullest bloom, or at a period somewhat later, especially when it is to be fed to horses. If allowed to stand too long, the palatability will be lessened. It is cut, of course, with the field mower. It is more easily cured than many kinds of grass. If mown in the afternoon and teded the next morning once or twice, it may then be raked and put into cocks. After standing a day or two it is ready for being stored. In good weather the curing process may be completed in the winrow, which has the advantage of making it possible to lift it with the hay tedder. When cut toward the period of full maturity, it is pos-

sible by using the tedder freely to cut in the morning after the dew has lifted and to store the same evening.

The average yields of red top lie between one and two tons per acre. On ordinary soils the yield would not usually be much more than one ton, and on rich low land it would seldom be less than 2 tons. Under the most favorable conditions, as much as 4 tons per acre have been harvested. In mixtures, as when grown with timothy and alsike clover, the average crop would probably exceed two tons per acre.

Securing Seed.—Illinois and New Jersey would seem to be the centers of seed production at the present time. The crop is ready for being harvested in about 20 days from the time when it is in full flower, but this will vary with the weather. It should not be left unharvested for a very long period after the grain is fully grown within the chaff.

At least three methods of harvesting the seed have been adopted. By the first of these it is cut with the self-rake reaper, and laid off in loose sheaves. By the second it is cut with the binder and the sheaves are stood up in long shocks. By the third the seed is secured by the aid of the stripper. The first method can be best practiced only when the weather is good. It facilitates rapid curing. The second method is safer when the weather is broken, and it facilitates the easy handling of the crop. The stripper may be used in the same way as in harvesting the seed of blue grass. The last named method is by far the most expeditious of the three, but it leaves the straw in the field where it grew. This, however, is not a total loss, as when it falls down in the au-

tumn it will serve as a mulch to protect and encourage the growth of winter and early spring grazing.

When the crop is cut with the binder, which is the method usually adopted, it may be threshed at once. As it will keep well in the mow or the properly made stack, threshing may be deferred when desired until the busy season for work is over. In threshing with the ordinary threshing machine, the wind must be partly shut off, as the seed and chaff are light. Special screens must also be used in threshing. When the seed is being stripped care must be taken as with blue grass to store it in a way that will prevent heating and the loss in germinating power that would follow. (See pp. 102 and 103.)

Ordinary winnowing mills well equipped with sieves and properly run may be used in separating the chaff from the seed, but to do this work in the very best form and with dispatch, special sieves are desirable. For home use, and especially when the seed has been stripped, no better plan can be adopted than to sow the seed in the chaff. As red top seeds freely, the seed may be cheaply secured by the farmer in this way and consequently liberal quantities of the seed may be sown.

The states that are said to furnish red top seed in the largest quantities at the present time are those of Illinois, Indiana, Kentucky and Tennessee. Since however this grass is indigenous to the low lands of Michigan, Wisconsin and Minnesota, it would seem probable that in time much seed would also be grown in these and in some other states. The production of seed may be set down at 8 to 20 bushels per acre.

Renewing.—Since red top is one of the hardiest of grasses, and since, under fair treatment, the sod tends to improve, renewal, in the sense of obtaining a stand and maintaining it, is only necessary when the catch is imperfect, or when it is desired to stimulate the grass by the application of fertilizers.

Where the stand of the young plants is not sufficiently numerous, it may usually be improved by simply adding more seed. This may be done in the early autumn, in advance of or simultaneously with the coming of the first rains, in the late autumn, too late to admit of the seed sprouting before the arrival of spring, or in the early spring. Whether harrowing is necessary must be determined by the circumstances. If the seed is sown in the early autumn and especially if fresh seed is sown in the chaff, it is usually not greatly important that the harrow shall be used. The thickening of the stand of seed may also be hastened by allowing the plants present to ripen their seeds and then let the winds strew them over the ground. This method will be found quite effective especially on moist soils. In this way hillsides given to washing with the rains may be clothed after scattering plants have obtained a foothold on the same.

For renewing in the sense of stimulating growth, no fertilizer is equal to farmyard manure applied as a top dressing, since it acts quickly, its action is prolonged, and in addition, for a considerable period it provides a mulch for the grass which is helpful to it both summer and winter. But commercial fertilizers will also render good service. (See p. 17.)

In some soils with high adaptation to the growth of

this grass it will come into land on which it has been previously grown without being sown, where cultivating to produce crops may have ceased, and will in time form pastures as blue grass does. It will also come into pastures in which it has not been sown and add to their productiveness. And yet its eradication to the extent of not being harmful to grain crops is easy. The aggressive power which thus inheres in red top is not equal to that of blue grass.

Binding Soils.—In the southern states especially, red top has been found useful in binding soils that wash, in making the further gullying of the land to cease, and in filling up gullies that have been made. It is claimed that for such a use no grass will equal it in the South except Bermuda grass. Into the sides of these it sends its long rhizomes which produce fresh plants. In time they cover the bottom of the gully. The plants growing there will catch and hold soil that is being carried down by the water. The process is repeated from year to year until, in time, much of the depression is filled.

CHAPTER VIII.

RUSSIAN BROME GRASS.

Russian Brome grass (*Bromus inermis*) is also known in America by the names Austrian Brome, Hungarian Brome and Awnless Brome, but more commonly it is designated simply Brome grass, or Bromus. The name Austrian Brome grass was given to this grass in the earlier references made to it in the reports of the experimental farms of Canada, where it was first tested and from which it was first distributed to any considerable extent in America. It was so given doubtless because of the extent to which it has been grown in Austria during recent years, and because of the high adaptation which it has for the light soils of that country. Similarly, doubtless, the origin of the name Hungarian Brome grass is to be accounted for. The term Awnless Brome grass is owing to the absence of awns on the panicles. But the name Russian Brome grass would seem to be more appropriate because of the longer period during which it has been grown in Russia.

Russian brome grass grows to the average height of about 24 inches, but under some conditions it will reach the height of fully 5 feet, and under others it will not come into head at all. The leaves are medium large and the leaf growth is very abundant for a considerable distance from the ground. The leaves furnish a dense



FIG. 8.

RUSSIAN BROME GRASS (*Bromus inermis*).

Tennessee Experiment Station.

mass of foliage which completely hides the earth. The roots push through the ground like those of quack grass (*Agropyrum repens*), hence, they soon fill the soil. Because of this quality, Russian brome, though it should grow but thinly at the first, will soon so possess the soil with its roots, that a thick and dense sward will be produced. The stems are surmounted by a panicle open and spreading and that is usually 4 to 6 inches long, but in some instances is considerably longer.

This grass can endure any amount of cold. It would also seem able to stand almost any amount of heat such as is experienced in the temperate zone. It is probably unequalled by any of the cultivated grasses in its ability to grow in light soils and to withstand drought unless it be Western Rye grass (*Agropyrum tenerum*). It comes up in the spring earlier than any of the valuable grasses. It grows through much of the summer when a reasonable amount of moisture is present, and it continues to grow until frost somewhat severe causes a cessation in the same. It comes into head in the month of June, in northerly areas, and earlier in those that are southerly. In from three to five weeks after it comes into head, the seeds are mature. Recent experience in growing it at the Indian Head Experiment Farm, Assa., Canada, would seem to indicate that it will grow well in shade.

Russian brome grass is essentially a pasture grass, but it also makes good hay. All kinds of stock are fond of it, and no other grass, unless it be orchard grass, will furnish grazing for so large a portion of the year. Its producing and feeding value for hay is about equal to

that of timothy, but the latter is more marketable because of its greater weight in proportion to the bulk, and it is also preferred in the meantime for feeding horses. The greatest weakness of Russian brome grass probably, is the tendency which it has to thicken to such an extent that growth is checked in consequence.

Distribution.—Russian brome grass is indigenous to Asia and Europe, ranging from the Atlantic to Siberia. In Europe it has been cultivated for more than a century and for a long time to a greater extent in Russia than in other divisions of that continent. During the last half of the nineteenth century, it was introduced into Hungary and by a long series of experiments its superior adaptation for light lands in that country was demonstrated, as also its ability to withstand well, long periods of drought. In both Europe and Asia it was first grown northward rather than southward, and on soils light rather than heavy. Since it has been introduced into North America it has shown at least equal adaptation for like conditions. There is probably no grass among the hundreds that have been tried on this continent which may be grown successfully over a wider area and under a greater variety of conditions.

Russian brome grass was first introduced into the United States in 1882 by the experiment station of California. It was first introduced into Canada by Dr. William Saunders, director of Experiment Farms in that country, in 1886. In experiments conducted with it at stations in the various provinces, it was found pre-eminently adapted to the conditions of the northwestern provinces of that country. The general distribution of

seed began there as early as 1890, and was continued for a number of years, with the result that it is now quite generally grown over the Canadian Northwest.

While the first introduction of Russian brome grass into America is to be credited to California, the fact remains, nevertheless, that the first general seed distribution of the grass over large areas is to be credited to Canada. It was in that country that it was first extensively tried. There also the seed was first grown for the seed trade in America, and it was from that country the seed merchants of the United States first obtained supplies of American grown seed. Moreover, the attention of the American public was largely drawn to its merits through the many references made to it in Canadian publications. Of all the foreign grasses introduced into America during recent decades, this grass promises to be the most generally useful. Until within the past few years nearly all the seed sown has been imported from Europe and Asia. But now much seed is being grown not only in the Canadian Northwest but also in certain of the northwestern states of the Union.

This grass will grow better where moisture is abundant and the temperature moderate than under conditions the opposite; but it has at the same time, unusual power to successfully withstand cold and drought. When once established, temperatures, howsoever low, do not seem to destroy it. Reference has already been made to its great drought resisting qualities, but its value as a drought resisting grass lies more in its ability to live under dry conditions than to grow under the same. It keeps alive under conditions that would de-

stroy many other grasses and it will then grow vigorously when moisture is brought to it. It can be made to render excellent service in states where the rainfall is not more than 12 to 15 inches.

There is no state in the Union in which brome grass will not grow more or less vigorously, but as with timothy, it has highest adaptation for the states which lie north of the line that marks the northern boundary of Tennessee. Owing to its recent introduction it can scarcely be said that its distribution in the United States has been fully determined, but the reports that come from the experiment stations north of this limit named, nearly all speak more highly of the results obtained from growing it than do the stations located in states south of the said line. As in the case of timothy, the best crops of this grass can be grown in those states that border on the Canadian boundary line, but the centers of distribution in this country are more likely to extend westward from the Mississippi until the Cascade mountains are reached, and southward from the said boundary through two or three tiers of states. In other words it will be found in the northerly areas of the semi-arid belt, and in areas that border upon the same to the east and the west. Its highest utility will probably be found in North and South Dakota. But it is likely to render much service also to Western Minnesota, Kansas, Nebraska, Wyoming, Montana, Colorado, Idaho, Washington and Oregon, and it may be other states south from these. The centers of distribution are likely to culminate in these states, not because Russian brome grass will grow better in them than in states further to the

east, but because it will grow better in them than other useful grasses.

This grass will grow at least fairly well in all the provinces of Canada, but the center of distribution is likely to be found in the prairie provinces, since in these other grasses do not grow so satisfactorily. The best crops of this grass, grown on the continent, will probably be grown in Manitoba, Assiniboia, Saskatchewan and Alberta. Much of the upland soil in the Canadian maritime provinces bordering on the Atlantic, like the soil of New England, is too low in fertility to grow this grass in best form without first being enriched.

Soils.—But few kinds of grass will grow so well on so great a variety of soils. The popular idea in America, at least, is, as previously intimated, that it has special adaptation, for sandy soils, deficient in moisture. This view is only partially correct. While it has relatively high adaptation for these, the richer and the more moist the soil, the better will this grass grow in it. The best crops of Russian brome grass, therefore, in tillable areas, will be obtained from rich alluvial deposits, or from valley lands with a deep moist soil and abounding in humus. Next in order in adaptation may be placed clay loam soils, open in texture and rich in the elements of plant food. After these the ordinary soils of the prairie so largely made up of vegetable matter; then clays; after clays sandy loams and gravelly loams; and last of all sandy and gravelly soils deficient in loam and also in moisture. In the states which include the range country, this grass will of course grow at its best in the valleys where it can be irrigated, but in many of

these it will grow better than almost any other kind of grass that has been tried without irrigation. In slough lands it grows luxuriantly when these are drained, and will live and flourish though covered with shallow waters even for weeks in succession while the weather is cool, and yet on dry sandy soils, when once established, it has great power to maintain its hold. The luxuriance with which it grows is greatly influenced by moisture. Because of this, the returns in pasture or in hay will greatly fluctuate where the weather conditions are fitful, hence, in certain areas of the range, while in some seasons it may not be profitable to mow it, in other seasons it may give a bountiful return.

Place in the Rotation.—Russian brome grass is of so recent introduction into this country, that its place in the rotation has not yet been very clearly defined in the practice of those who have grown it. As it has been grown more under conditions where the rainfall is light, the inclination has been not to break up the sod where it has once been established for a number of years. Notably has this been true of the semi-arid country in the west, where it has been grown thus far chiefly for hay. In such areas it is quite frequently sown on the newly broken prairie prepared as for wheat. But in time it will probably be found that it will be good practice to follow it with some variety of corn adapted to the soil and weather conditions where this crop can be successfully grown, following the corn with one or more grain crops and again sowing with brome grass. The number of the crops that should be taken before the brome grass is again broken up cannot be stated definite-

ly until experience has thrown more light upon this question, but it will probably be found that it would not be advisable to take more than two crops of hay and one or two of pasture, before breaking up the sod. In any event, the sod should not be allowed to become so filled with the roots of the grass before this is done as to preclude the possibility of making a good seed bed for corn or other crops on the overturned sod without too great an expenditure of labor.

In areas where crops of grain are regularly grown, and more especially in those in which a regular rotation is attempted, brome grass may come anywhere in the rotation, but as with other grasses, a stand is more assured on land that is clean. But, if not smothered by weeds when the plants are young, this grass has more power to crowd them out later than most other grasses. When once established, if not broken up for a number of years, in certain of the prairie soils the roots will fill these so completely that when the ground is ploughed the furrow slice is a mass of roots so bound together that pulverization cannot be secured without great labor. Because of this, in such areas, the sod should be ploughed before it became so filled with the interlacing roots. The number of years required to induce such a condition will vary with soils and with the precipitation. Usually the grass may be cut two seasons and pastured one before the sod becomes so stiff as to become thus difficult of pulverization. But when it does occur, it is probable that rape, or flax, or buckwheat sown on it would aid in more quickly reducing the sod.

In all arable areas deficient in rainfall, where this

grass flourishes, it may be turned to excellent account in supplying the land with humus. In areas where the soils are so light that they lift with the wind, it may be made to render valuable service by counteracting this evil through the binding influence of the roots. Its value for both uses is assuredly very great. Where Russian brome grass is grown in such areas, it should therefore be followed by such crops as corn or the small cereal grains. If the roots are so many that a good seed bed for small grain cannot be made without too much labor, corn should be the first crop grown, since more time would be available in preparing the seed bed, and the cultivation following would accelerate decay in the sod, which would then be in good condition to receive some small cereal grain crop the following year. In areas where corn does not grow well or is not needed, winter rye will reduce a stiff sod more quickly and effectively than the other small cereals. The beneficial effects of the decaying sod mechanically and also on the retention of moisture would thus be felt for a number of years, how many, would depend on the degree of the precipitation. It would, at least, be felt long enough to influence favorably the growth of two or three crops following.

In the southern states, when Russian brome grass can as a rule be sown with much greater advantage in the autumn than in the spring, it may be made to follow any crop of the season that has been removed sufficiently early to admit of properly preparing the ground. It may therefore follow with much propriety any kind of winter cereal as wheat, rye, oats or barley, grown alone

or in combinations for the grain or for pasture; it may in turn be followed by any crop which is greatly benefited by an abundance of humus in the soil. The roots of the grass are less likely to possess the soil so completely in the South, because of the less fertility which in many places, southern soils possess. Decay in the overturned sod is much quicker, hence the roots are not so likely to possess the soil to the extent of frustrating the effort to grow a crop successfully upon them the same season that they are broken.

Preparing the Soil.—The most important requisite in preparing the ground for Russian brome grass would seem to be cleanliness. As the young plants grow slowly the first season, if not sown on land that is reasonably clean, the danger is imminent that weeds will overshadow the young plants to their injury, if not to their destruction. It may, therefore, be sown with advantage after a crop that has been cultivated, as corn, for instance, or on ground that has been summer fallowed during a part of the season or the whole of the same. In northerly latitudes and on prairie soils, the plan has proved satisfactory which ploughs the land the previous autumn and then uses upon it occasionally the harrow or cultivator or both, until the seed is sown. In this way the ground may be cleaned sufficiently to admit of sowing the grass in June, but it is more common on land prepared thus to sow the seed from August onward according to the climatic conditions.

When this grass is sown along with a crop of grain, the preparation of the soil that is best suited to the needs of the grain will also be that best suited to the needs of

the grass. This means that as a rule the pulverization should be fine; but in certain soils and under certain climatic conditions, it is not desirable to have the ground pulverized very finely when the seed is sown in the fall. This is true of clays north or south. On soils that drift it is better to sow on a rough surface if the seed is to be covered with the harrow to bury it more deeply and also to have it rough to prevent blowing. When the seed is sown just before the advent of winter, which, in northerly latitudes would seem to be a good season for sowing, under certain conditions it has been recommended to sow on land ploughed but harrowed only slightly or not at all. When thus sown the ground may be smoothed with the harrow, when the plants have become so firmly rooted that the harrow will not pull them out.

When sowing Russian brome grass on the open range, for the purpose of supplanting the grasses which may grow there, the land is first disked in some instances, especially when the sod is at all dense. In other instances, where the native grass plants do not completely cover the ground, the seed is sown without any preparation having been given to the land. It is not certain, however, that the best method or methods of thus superseding the grasses of the prairie have yet been ascertained.

Deep ploughing has been recommended in certain areas, when preparing the land; but ordinarily this would not seem to be necessary, unless where such tillage was practiced to insure soil moisture. The roots of Russian brome grass have much power to push through the soil

and also down into it, hence, on the average prairie soil, such deep tillage would not seem to be specially necessary, if necessary at all, in preparing the land for this grass.

Sowing.—Under some conditions Russian brome grass may be sown during any month of the season of growth. Under average conditions, however, the favorite season for sowing is the early spring, especially when sown with a nurse crop. But, in the northwestern provinces of Canada, it is frequently sown in June. It is also frequently sown in August or September, on land that has been summer fallowed. There is usually enough rainfall in these months, especially in June, to sprout the seed. It also grows on clean land and makes a crop the following season. In the southern states, when sown in the autumn, a good stand is more assured than when sown in the spring, but to this there may be some exceptions. When sown thus, the plants grow during much of the winter; whereas, if sown in the spring, hot and dry weather following might prove fatal to the seed. In areas with low winter temperature, and a small amount of precipitation, many growers prefer sowing the seed in the autumn. It is then ready to grow in the early spring, and thus get the full benefit of all the moisture that comes at that season; when sown in the late autumn a full crop cannot be made the following season; when sown alone in the upper Mississippi basin, early in June, would be a good time to sow the seed on suitably prepared land, as by that time many of the weed seeds in the surface soil would have germinated and been destroyed. But when thus sown it would be necessary in

some instances to run the mower over the ground once or oftener the same season to keep weeds from maturing seed.

The seed has more commonly been sown by hand than by any other method. It does not feed well into the ordinary drill tubes alone or mixed with grain unless perfectly clean, owing to the chaffy character of the seed. But it would seem probable that the seed could be sown with the drill by mixing it with some heavy substance as earth. It would also seem probable that some form of hand machine would be introduced in the near future that would do this work satisfactorily. Sowing the seed by hand is slow and tedious. Owing to the lightness of the seed, only a narrow cast is made and it can only be sown in a still time. There is the further objection that the seed will fall unevenly, unless when sown by a skilled sower.

Opinions differ widely as to whether Russian brome grass ought to be sown alone or with a nurse crop. This question is much affected by locality and the season at which a crop is sown. Where the rainfall is sufficient, and when the seed is sown in the early spring, ordinarily it ought to be sown with a nurse crop, as if sown alone, weeds will probably shade the grass as much or more than a nurse crop would, unless cut back with the mower. In the North, winter rye, winter wheat, where it can be grown, or any of the small spring cereals, as wheat, oats, barley or even flax, are suitable nurse crops. The least suitable is oats, because of the leafy character of the growth, and yet oats make a very suitable nurse crop if sown quite thinly and cut for hay while

yet immature. In the southern states, any of the winter cereals will answer as well as nurse crops. When the rainfall is short and when the seed is sown later than the early spring, it is more commonly grown alone so that the young plants may have the full benefit of all the moisture in the soil. The plants are delicate when young, in the sense that they grow slowly, and that then they are easily destroyed by dense shade. This fact should never be lost sight of when sowing Russian brome grass, and the amount of seed sown in providing the nurse crop should be regulated accordingly. The harrow is generally used in covering the seed. A moderate covering is preferred in moist climates, but in dry areas and light soils the covering should be deeper, especially when the seed is sown in the spring.

The amount of seed that ought to be sown will vary with the object sought from sowing it, and also with soil conditions. When wanted for pasture, as quickly as the same can be provided in good form, more seed is required than when hay is sought; and on soils low in fertility more seed ought to be sown than when the conditions are the opposite. Some authorities recommend sowing as much as 30 pounds of seed per acre, a seeding that would certainly be excessive. A sufficient stand has been obtained from sowing as small a quantity as 3 pounds per acre, but not until the second year after sowing the seed. As the tendency is ever present with Russian brome grass to thicken from season to season, if the plants grow too thickly at the first, the yield of seed is lessened even the first season, and subsequently the yield in hay and pasture will be less also than if the

plants were more numerous. When seed is wanted the season after sowing, 1 to 12 pounds per acre should suffice on average soils. To produce hay the year after sowing the seed, from 12 to 15 pounds should be enough, and for pasture 15 to 18 pounds. When sown in combination with other grasses, the quantity may be made to vary from 2 to 3 pounds, upwards, according to the object sought.

But little is yet known, based on American experience, as to the value of Russian brome grass for growing in mixtures to make permanent pasture. Since it is aggressive, it may be expected ultimately to crowd out nearly all other kinds of grasses. Kentucky blue grass is probably the only highly valuable pasture grass that would not ultimately be entirely dispossessed by it, and in northerly areas where the conditions are highly favorable to the growth of the Russian brome, even blue grass may not be able to withstand its encroachments. In Hungary it is sometimes grown along with alfalfa and some Montana experience has also proved reasonably successful in growing it thus. In Manitoba, however, it has been grown successfully with timothy in such rotations sowing about 6 pounds of each per acre.

Because of the slow growth of Russian brome grass when it is young, when it has been sown with a nurse crop, the stand secured may appear feeble in the autumn after the grain has been harvested. The heavier that the growth of the grain has been and the drier the autumn, the more feeble will the grass appear. Because of this, the temptation sometimes arises to break up the field, under the impression that the stand of

grass is not worth saving. This should not be done hastily or without the most careful examination, as, if the plants are present in reasonable numbers, even though small, the return the next year may prove quite satisfactory.

Pasturing.—The value of Russian brome grass for pasture will depend in a great measure, on the favorable or unfavorable character of the conditions for growing the grass. On northwestern prairies, it will furnish much more grazing relatively than the native grasses of the prairie, and probably more than any of the other cultivated varieties. In southern areas it would seem to be less valuable relatively, but in these its relative adaptation for pasture has not been generally proved. It is probable, however, that in these it will lose its succulence in prolonged periods of dry and hot weather, as it does on certain of the western ranges until awakened by the autumn rains.

This grass will stand close grazing better than many other grasses, because of its inherent vigor, and the character of the root growth, but, as with these, it will yield much more pasture when it is not closely grazed. In some instances, especially on sandy land, it has been known to receive serious injury through excessive pasturing, and more especially when grazed thus the same year that the seed was sown. Ordinarily, however, it has much power to stand close grazing without succumbing. The aftermath in meadows is also much more abundant than from many other grasses, hence it is common to graze it down, but, when thus grazed, the effect will doubtless be to lessen the return from the hay

crop the following season. While it will stand severe tramping better than many other kinds of grass it should not be forgotten that American experience with reference to this is as yet but little in-evidence. Its greater value for pasture compared with range grasses, arises not only from the earlier period when it is ready for being grazed, the larger return which it produces and the excellence of the grazing which it furnishes in the autumn, but also from its high palatability. As a pasture it has probably no superior in its own special domain.

Harvesting for Hay.—When Russian brome grass is to be made into hay, it may be cut from the stage at which it is fully out in head until the blossoms disappear, according to the use that is to be made of it. As in the case of timothy, it is cut at a somewhat more mature stage for horses than for cattle or sheep. If cut too soon, the hay will be lacking in body and weight. If cut too late it will be woody. But in instances in which the seed stalks are not plentiful (see p. 185) the injury to the hay from deferred cutting is much less than when the opposite is true. A favorite time for cutting is when the plants are first coming into bloom. Much of what has been said as to the mode of cutting and curing timothy (see page 72) will apply also to the cutting and curing of Russian brome grass. The hay, when properly cured, is eaten with a relish and its feeding value is much akin to the feeding value of timothy. The large amount of leaf growth in it adds much to its palatability. The hay is usually free from weeds, espe-

cially after the first cutting, as there is a tendency in this grass to crowd out weeds when once it is established.

The yields of hay vary exceedingly with variations in soils and in seasons. Ordinarily the best yields are obtained from the first cutting, but sometimes the second cutting, that is, the cutting obtained the third summer after the sowing of the seed is more productive because of the thickening of the grass with age. Usually only one cutting is made in a season, but the aftermath is generally abundant. After the second cutting, the yields of hay usually decrease from the over-thickening of the grass. The average crop may be put at about $1\frac{1}{2}$ tons per acre, but under favorable conditions it is fully 2 tons. Four to 5 tons have been cut from an acre and again the yield has been as low as $\frac{1}{2}$ ton.

Securing Seed.—Russian brome grass is ready for being harvested about three weeks subsequently to the stage of full bloom, but this will vary somewhat with the weather. The crop is sufficiently mature when the seed kernel is full of meat, but the meat in the same is still soft and pliable like rubber. The heads have then assumed that purple glue tinge which indicates ripeness. It should be cut with much promptness when mature, as the seed when over-ripe shatters easily.

Different modes of harvesting the seed have been recommended. Some advocate cutting the seed crop with the binder. It is set so high as to cut and bind into sheaves the seed stems that rise above the leaves, but without cutting the leaves which mass so thickly for some distance above the ground. The sheaves when cut are removed and put up in shocks until dry, but they

may of course be shocked up in the same field. The residue of the grass uncut is then mowed with the mower and made into hay. This method may be the best to follow when the seed stems rise up thinly, which is apt to be the case after the crop has been cut for two or three successive seasons.

A second method cuts the crop and cures it as though it were being cured for hay. When thus managed, the cutting and handling of the crop when being cured should not be done in the driest and hottest part of the day, to avoid undue shelling. This method should only be resorted to, at least in climates where the harvest weather is usually good, when the facilities for harvesting by one or the other of the methods given are not present.

A third method uses a stripper. This method is probably a good one, but it has not as yet been much practiced. It should certainly prove an expeditious way of getting the seed, as it would preclude the necessity of threshing the crop, and there would seem to be no serious objections to it. It is probable, however, that as with blue grass seed, much care would have to be exercised in drying the seed, lest its germinating power should be injured through overmuch heating. After the seed had been thus removed, the crop would still furnish fairly good hay because of the abundance of the foliage below the seed heads.

A fourth method cuts the crop with the binder. The sheaves are not tightly bound. They are cured in shocks, preferably in those that are long rather than round. When dry the crop is threshed at once or is

stored away in mows or stacks for being threshed later. This method has been found to work well, especially with crops in which the seed stems are numerous.

Russian brome grass may be threshed with the ordinary threshing machine, but when threshing it, the wind has to be nearly or entirely shut off. It is cleaned with the ordinary fanning mill, but when cleaning it thus, due attention must be given to the amount of wind used and to the adjustment of the sieves.

The yields of the seed vary exceedingly. Usually the best yields are obtained from the first cutting, if the plants are sufficiently numerous. If not, the best yields will probably be obtained from the second cutting, other things being equal. Later, the yields will almost certainly decrease because of the thickening or matting of the grass. The best yields of seed up to the present have been secured in the prairie provinces of the Canadian Northwest, in North Dakota, in the more northerly of the Rocky mountain valleys, and from the bench lands of the range states south from the Canadian border. As many as 600 pounds of seed have been secured from an acre in the areas specified, but 300 to 400 pounds would probably be an average from crops of the first cutting.

The seed of this crop as of all other crops not long introduced is high, but it may be obtained by those who can afford to wait, without much outlay. If 15 to 20 pounds of seed are secured and sown on properly prepared land, the individual could expect the next year to secure, say, 400 pounds of seed from the acre. This would sow nearly 27 acres using 15 pounds to the acre. The seed crop thus grown could, if necessary, be threshed

with a flail, and in many instances at least, the seed thus threshed could be sown in the chaff with positive advantage, the same season in which it grew. In fact, under certain conditions, it could be sown at once.

Renewing.—If the stand of Russian brome grass is unduly thin at the first, it may be improved by adding more seed in the autumn and covering or not covering with the harrow according as sound judgment may dictate. Under some conditions it may be preferable to add the seed in the spring. But even though the stand should be thin, if it is fairly regular it will thicken up sufficiently. But its behavior in this respect is much influenced by soil and climate. Where moisture is deficient, it does not thicken to nearly the same extent as under conditions the opposite.

This grass may be renewed in very many instances by simply ploughing it and then smoothing the surface with the harrow. The results will be greatly influenced, however, by the way in which the work is done. In ploughing, the aim should be to cut narrow rather than broad furrows and to lay them over at a sharp angle rather than flat, and to plough but moderately deep as ploughing is done in the locality. The preferable time for such ploughing is when the ground is moist. When thus treated the grass will start off with renewed vigor. How frequently this mode of renewal may be practiced and how long it may be expected to prove effective, cannot be stated on evidence based on American experience, but there would seem to be no good reasons for concluding that it would not succeed indefinitely or at least for a long time. This mode of renewal would seem to

be well worthy of attention on the part of farmers and ranchmen in areas wherein agriculture is more or less dependent on the successful growth of this grass. The interval between the sowing of the seed and the first renewal by this process and between subsequent renewals should be determined by the necessity for the same, as evidenced by undue matting of the grass accompanied by a deficiency in growth.

Destroying Russian Brome Grass.—In some localities some difficulty has been found in getting rid of this grass when meadows or pastures are broken; especially is this true of rich and moist soils. Where this danger exists, either of the two following methods will prove effective:—First, backset the sod as in breaking up the prairie, that is, plough it shallow in June and deeper later; or, second, plough reasonably deep and with care, and follow with a well cultivated crop of corn. But it would seem to be correct to say that no one who desires to sow this excellent grass should be deterred from sowing it from fear that it would make trouble by persistently remaining in the soil.

CHAPTER IX.

MEADOW FESCUE.

The term meadow fescue includes any one of the numerous species of grasses of the genus *Festuca*. The varieties of this genus are numerous. The most valuable of these are *Festuca pratensis* and *Festuca ovina*, the former being equally valuable for grazing and fodder, and the latter for grazing only. Meadow Fescue (*Festuca pratensis*) sometimes confusingly referred to as *Festuca elatior* and vice versa is also called Tall Fescue, Tall Meadow Fescue, English Blue grass, Randall grass and Evergreen grass. *Festuca pratensis* and *Festuca elatior* are really two varieties of Fescue. Some consider the latter as the species and the former as the variety, but *Festuca pratensis* would seem to be more serviceable to American conditions than the other. The terms Tall Fescue and Tall Meadow Fescue, are, or ought to be, restricted to the variety *Festuca elatior*. In Virginia meadow fescue is commonly spoken of as Randall grass. In Mississippi, North Carolina and some other states it is called Evergreen grass from the green color which it maintains even amid the snows of winter.

Meadow fescue is a perennial which is somewhat slow in coming to maturity. It is by far the most important and valuable of the many grasses of the fescue family.



FIG. 9.

MEADOW FESCUE (*Festuca pratensis*).

Tennessee Experiment Station.

Especially in Europe has it been assigned a prominent place in producing live stock, where the fescues are more numerous and important than in America. The variety *pratensis* grows usually to the height of about 2 feet. The stems are round and smooth. The panicle is erect and nodding, and somewhat resembles that of chess (*Bromus sacalinus*). The leaves are fairly numerous and large. The roots are fibrous and go down deeply into the soil, in some instances, it is said, as deeply as those of clover. Compared with this variety *Festuca elatior* is considerably larger, taller and coarser, sometimes reaching the height of 4 and even 5 feet. The leaves are much longer and broader, some of them attaining the length of 2 feet. The head is more open and less erect, but is more numerously flowered. The roots are stronger and more woody, and the plants grow more in tufts like those of orchard grass. But since the distribution of these varieties is about the same and since the conditions of growth are very similar, what follows with reference to distribution and growth may be considered as applying equally to both.

Meadow fescue grows slowly and takes two or three years to attain to a maximum of production. It does not grow so early or so quickly in the spring as some other grasses, but it continues to grow far on into the autumn and in climates sufficiently mild even into the winter. It comes into bloom a little earlier than timothy. Like orchard grass it has considerable adaptation for growing in shady places. All authorities who have written upon it are agreed that it is an excellent pasture grass, because of its ability to grow during much

of the year, because of its ability to withstand conditions, wet and dry, warm and cold, because of the considerable degree of palatability which it possesses and because its nutritive properties rank at least fairly high. Because of its permanency in conjunction with the good qualities named, it should be given a foremost place among grasses sown for permanent pasture. It ranks high, also, as a hay plant. Amid suitable conditions it furnishes a large amount of good hay that is much relished by live stock, but when grown for hay it is more commonly as a factor in the crop than as the sole crop, owing to the considerable period which it requires to attain to a maximum of development, it is better adapted to meadows of a considerable degree of permanency than to those of short duration. The variety *elatior* is less well adapted for producing hay because of the coarse character of the stems and leaves and of the tendency which it has to tussock, but it is thought that it produces more pasture than the other variety.

Meadow fescue is relished by all kinds of domestic animals and is very suitable for them. In America, however, it is not grown very often alone except for seed, hence its productive value for pasture or hay has not been so fully determined as that of some other grasses. From Kentucky and Virginia southward, its relative value for winter grazing is even greater than for summer grazing owing to the fresh and succulent character of the pasture which it furnishes at that season.

Distribution.—Meadow fescue is indigenous to Europe and western Asia. It is much grown in Great

Britain, Lapland, Norway and Sweden, and more or less of it is grown in all the intervening countries until the Mediterranean is reached. It is a favorite meadow and pasture grass in the countries specifically designated and it is grown to a much greater extent relatively in these than in North America. Although introduced into America, it is thoroughly at home on this continent, and may be grown with more or less success in some part or parts of every state in the Union and of every province in Canada.

That meadow fescue is well adapted to endure low temperatures is well attested by the fact that it grows so well in Lapland and Norway. That it is well able to endure warm climates is witnessed by its behavior in the south, for which its adaptation is considered higher than for the north. But it should be noticed that its highest value in the south is found in cool rather than in hot weather. It grows better of course in moist than in dry climates and yet it is able to endure much drought because of the deep feeding of the roots.

The ability which this grass has to grow and to maintain its greenness when the cold is not too extreme, is one of its most valuable features. Because of this it is especially valuable as a pasture plant for autumn and winter grazing in all the southern states where it has been grown. Its value for such a use has been much praised in Virginia, the Carolinas, Kentucky, Tennessee, Mississippi and Kansas. At the agricultural experiment station at Kansas it has been tested for more than twenty years and as a result has been assigned a foremost place with orchard grass in adapta-

tion for Kansas conditions. Its behavior in furnishing hay and pasture has also been favorably reported from New York, Pennsylvania, Delaware, New Jersey and in several of the New England states. It has been recommended by high authority as being suitable for Indiana, and there would seem to be no good reasons why it should not be equally suitable for the conditions of the neighboring states. In the states bordering on the Mississippi, except in Kentucky and Tennessee, it has not been much tested, but it should grow fairly well in all of these. In the semi-arid states it should stand dry weather better than some other grasses, yet it is at least doubtful if it has any important mission for these in the purely range country, but where winter wheat will grow nicely in these as it does over large areas so will meadow fescue. In the more northerly of them the conditions would be against winter grazing in the lines on which it is conducted in the Atlantic and Gulf states. Meadow fescue will doubtless grow well in the irrigated valleys, but it is not specially needed in these, since they grow alfalfa and clover so well. No place probably in the United States or indeed in North America has higher adaptation for meadow fescue than the strip of coast land along the Pacific from California to Alaska.

Meadow fescue proved to be one of the most satisfactory grasses grown as permanent pasture at the Ontario Agricultural College experiment station at Guelph. It was not only one of the most abiding but also one of the most productive of these, and yet as a pasture or a meadow grass it is not much grown on Ontario farms or

indeed on farms in any part of Canada. It is not well known in the various provinces of that country, although it is pretty certain that it could be grown with profit in tillable areas from Lake Huron to the Atlantic. In the northwestern provinces of Canada, Russian brome grass and western rye grass (*Agropyrum tenerum*) are likely to remain higher in favor than meadow fescue. Four reasons may be given why this useful grass is not more generally sown—first, the seed is relatively high; second, it is frequently adulterated with one of the rye grasses, which it very much resembles; third, its merits are not universally known; and, fourth, it takes so long to reach a maximum of production that it is not well suited for being grown in meadows of short duration.

Soils.—Meadow fescue will grow, but of course not equally well, in a great variety of soils. Although when once established it has much power to maintain its hold on soils lacking in moisture during at least a portion of the year, it will grow much better relatively where considerable moisture is present, even where the land is annually covered by the overflow of rivers. It is best adapted to good, strong, moist loams well stocked with the elements of production, and underlaid with a subsoil which the roots can easily penetrate to a considerable depth. The best returns have been obtained from this plant when grown on such soils in states which have a considerable rainfall. On the deposit soils of river bottoms it has also proved highly satisfactory where the sand element in these has not been too pronounced. In alluvial bottom lands it grows luxuriantly

at present. On sandy loams it grows with no little vigor, the growth being modified, of course, by the character of these, and the same is true of the humus soils of the prairie except where these are too lacking in density and moisture. Although sandy, gravelly and rocky soils are not high in adaptation for meadow fescue, it will maintain its hold on these and produce much grazing where the moisture is ample as witnessed in the good grazing furnished by it on the mountain lands of Tennessee. Although this grass grows much better on slough or marsh lands that are drained, it will succeed in these even when the degree of saturation during a portion of the year is considerable.

Meadow fescue is ill adapted to lands that are low in fertility. If these are at the same time leechy, the adaptation even in moist climates is lessened and in dry climates it renders growth almost prohibitory. Nor will it grow well on good strong soils laden with plant food when the rainfall is low beyond a certain degree, as witnessed in the semi-arid belt; yet it will endure more drought than timothy, as observed in the relatively better returns obtained from it in Eastern Kansas, Idaho and Eastern Washington.

Place in the Rotation.—Meadow fescue is not well adapted to short rotations, since as intimated previously, it takes from 2 to 4 years to reach that point when a maximum of production will be realized. When sown in meadows it is sown only in those that are to be mown for several years in succession before breaking them up; and when sown in permanent pastures it ceases altogether in the true sense of the term to be a rotation

plant. In this respect it will occupy about the same place as Kentucky blue grass, and much that was said about the place which the latter occupies as a rotation plant may apply equally to meadow fescue (see page 89). Like all grass plants, it is best sown on clean land, whatever the process may have been that was adopted in cleaning the same, and is followed by crops that feed eagerly on the gathered supplies of available plant food furnished by the grass roots in their decay. These include the small cereal grains, corn, the non-saccharine sorghums and rape.

Preparing the Soil.—The preparation of the soil for meadow fescue is not different from the preparation of the same for several other grasses that are being discussed. Usually it requires a seed bed, moist and finely pulverized, but there may be instances, as on the light soils of the prairie so light that they lift with the wind, when a rough surface would be preferable to a smooth one. There may be other instances as when the seed is sown in the autumn when a surface to some extent cloddy would be preferable to the same too finely pulverized; yet again there are instances as when sown in the spring on loam soils in which pulverization cannot be too fine for best results. Unless where the soil runs together in the sense of impacting or washes away, autumn ploughing aids much in securing a fine seed bed in the spring.

Sowing.—The time or times at which meadow fescue may be best sown will depend much upon the locality. It is hardy, hence at the North the seasons for sowing it are about the same as for sowing timothy, that is, during

August or September, and in the spring from the time the ground is uncovered until the small cereal grains have been sown. In the South it is usually sown August 1st to November 1st. As with timothy in the North, when sown in the autumn it should be sown early enough to secure a good growth in the plants before entering the winter. In the North it is more commonly sown in the early spring and on ground where it can be covered with the harrow. In the South it is oftener sown in the fall.

Like the seeds of nearly all grasses except timothy, it is usually sown by hand, but it is practicable under certain conditions to sow it with the grain drill and with the hand seed sower run like a wheelbarrow when sown alone. It may be sown before the grain drill on properly prepared land or after it, and in either case the harrow should follow to cover the seed unless in climates that are quite moist. When sown before the drill a more complete covering is secured.

Because of the slow growth made by the young plants, it is important that the seed shall be sown with a nurse crop, otherwise weeds will have to be mown twice or oftener, in the season. Any of the small cereals may be used as the nurse crop. Winter rye and winter wheat are the most suitable, all things considered, since in these it may be sown autumn or spring. In the South winter barley is a good nurse crop and winter oats may also be used.

Notwithstanding the value of this grass for meadow and for pasture, it cannot be said that it is widely sown for either purpose. The relative slowness with which it

establishes itself probably explains why it is not more sown for hay. The great extent to which the seed is adulterated by those of the more short lived rye grasses probably furnishes one explanation why it is not more sown for pasture. For either purpose it is almost invariably sown with other grasses. For meadow the best single grass with which to grow it is timothy in the North, since the two ripen nearly at the same time. If clover is added, alsike is preferable to other varieties, since it ripens later than the medium red and does not smother the crop with which it grows to the same extent as rank mammoth clover does. These three should furnish excellent crops of hay on suitable land, although the author cannot cite any instances in which they have been grown thus. Russian brome grass, orchard grass and tall oat grass would not be so suitable to grow along with it for meadow; nor would medium red clover, since all three mature considerably earlier.

The important mission of this grass in America is in growing pasture in combination with other grasses and more especially in those pastures that are abiding. In these it has much power to take care of itself, though crowded when once it is established. It will be found more valuable relatively in pastures in the southern, central and far western states than in those north, since for these it seems to have higher adaptation than in those North, especially in areas with Kansas and Idaho as centres. Along with tall oat grass and orchard grass it furnishes good pasture not temporary in character and the same is true of it in certain areas of the South where it fits in particularly well with orchard grass in providing such pastures,

since both have considerable permanency. The meadow fescue readily fills the space between the tussocks of the orchard grass.

When sown alone 2 bushels of seed or 28 pounds is about the right quantity to sow per acre on average soils. Some recommend a larger amount. When sown with timothy for hay 14 pounds of the former and 6 pounds of the latter would suffice; when sown with alsike clover and timothy 7, 2 and 4 pounds respectively should make a suitable mixture; when sown for permanent pasture the amount of seed will of course vary. If meadow fescue and orchard grass are sown together to provide such pasture about a bushel of the seed of each should be used. If tall oat grass is added, 8 or 9 pounds of each of the three should be enough. If sown in mixtures with a larger number of grasses it would not seem necessary to sow more than 5 or 6 pounds of this grass per acre, because of its abiding character in permanent pastures.

Pasturing.—Meadow fescue stands grazing well when it is once set. It does not furnish grazing so early as some of the other good grasses, but it grows better than blue grass in the summer and as previously intimated, it has much power to grow in cold weather and also to retain its genuineness. It grows more or less in Maryland, Virginia, Tennessee and some other states through much of the winter; hence, it furnishes good winter grazing for horses, cattle and sheep, but more especially for horses and sheep, since these can graze upon it though covered with snow, both pawing down to it through the snow. It is claimed that it will grow thus on moun-

tain lands in the South higher than those on which blue grass is found.

For temporary pastures meadow fescue should not be looked upon as a reliance, since these would be broken up before the grass had reached the limit of capacity to produce. But few grasses, however, if indeed any, excel meadow fescue for permanent pasture, where the conditions are at all favorable to its growth. Its duration under some conditions is very great. One instance is on record in Tennessee in which this grass has furnished good grazing for 50 years. Whether it would endure thus long in northern areas does not appear to have been well established. It is probable, however, that it will survive longer in southern latitudes than in those north where the winters are stern.

Harvesting for Hay.—Meadow fescue comes into flower a few days earlier than timothy. It should be cut ordinarily about the blossoming stage, but not quite so early for horses as for cattle and sheep. The method of cutting and curing is about the same as that adopted in cutting and curing timothy, that is, it is cut with the mower and is cured in the winrow. (See p. 74.) It makes a good quality of hay. The yield of hay ordinarily runs from 1 to 2 tons per acre, but in some areas it produces much larger yields. As high as 4 tons have been cut per acre. Since it is seldom grown alone for hay, its value for market purposes does not appear to be well established in this country, but, since it weighs reasonably well, it should prove at least a fair merchantable hay. When the seed can be obtained plentifully at lower rates and in purer form, and when the value of

this grass for permanent meadows becomes better known more of it will be sown.

Securing Seed.—Meadow fescue produces seed abundantly. The chief centres of seed production at the present time in the United States are Northeastern Kansas and Idaho. It is also grown in certain areas in Missouri and Nebraska, but not so extensively as in the areas named. One seed firm at Lawrence, Kansas, handled 50 car loads of home grown seed in 1902. The yields in the localities named average about 200 pounds per acre, but in some instances they run from 300 to 400 pounds. The first two or three seed crops are the most productive, but where the weeds and other grasses are kept out seed crops that should be remunerative may be taken for a longer period. The quality of the seed grown in these centres is most excellent. It is fortunate that the seed supply from the centres named is increasing. It will, in time, doubtless render it unnecessary to import seed, much of which in the past has been so largely adulterated with the seed of perennial rye grass, sometimes to the extent of 75 per cent. The prejudice thus begotten against sowing this grass in certain quarters is unfortunate as it has reacted against its distribution.

Meadow fescue ripens quickly after it comes into flower. It should therefore be harvested with promptness. There is no better way of harvesting the seed crop than by cutting it with the binder and threshing it with the ordinary grain thresher. It is not difficult to clean the seed with a good fanning mill.

Renewing.—Information with reference to renewing

this grass based on American experience is very meagre. In meadows it is of less importance than in permanent pastures because of the comparative infrequency of the former. In permanent pastures in which it is desired to give this grass considerable prominence if the grazing is not close the heads which escape the grazing will produce seed, which, when it falls down, will in due season germinate under many conditions and will in this way increase the grass in the pasture.

CHAPTER X.

TALL OAT GRASS.

The term oat grass means any cultivated species of *Avena*. Tall oat grass (*Arrhenatherum avenaceum*) is the most valuable variety of the oat grass family. It is also known by the names Tall Meadow Oat grass, False Oat grass, Evergreen grass, Grass of the Andes and French Rye grass. It is the *Avena Elatior* of Linnaeus. It inclines to what may be termed the tussock habit of growth. Under some conditions it reaches the height of 7 feet and under others does not exceed 2 feet. Under average conditions the height to which the plants usually attain is about 3 feet. The foliage is abundant but is somewhat coarse. The stems are also more or less coarse, which detracts from its value for hay. The panicle is long, narrow and nodding, and leans slightly to one side. It considerably resembles that of the common oat, but is more slender in every way. The roots are long and fibrous, going down deeply into the soil, but in some instances, as when the soil is not suited to the needs of the plants, they become bulbous.

Tall oat grass is a perennial in its habit of growth and somewhat long lived. The seed is large and has strong germinating power. The plants grow rapidly in the early spring. They furnish much pasture in the northern states in May, and in the southern states as early



FIG. 10.

TALL OAT GRASS (*Arrhenatherum avenaceum*).

Tennessee Experiment Station. •

as April or even earlier. It is ready for being cut for hay at least as early as orchard grass, that is to say in June in the northern states and considerably earlier in the southern states. After being cut for hay it springs up vigorously and makes an abundant aftermath. It seeds freely, but ripens the seeds unevenly, and sheds them very quickly when ripe. In the North even it will make two crops of hay under quite favorable conditions and in the South three are frequently obtained. In the North from two to three cuttings of greed food may readily be obtained from this grass in one season and in the South even a larger number are sometimes made.

When sown in the spring it may frequently be cut for hay the same season. In the autumn it again grows freely and in the South it keeps green all winter and furnishes, according to some authorities, more pasture at that season than any other grass. Since the roots go down deeply into the soil it stands drought well, and is possessed of considerable power to gather plant food, even in poor soils. Moreover it is easier to secure a stand of tall oat grass than of almost any other variety of cultivated grass.

The testimony regarding the palatability of the hay and pasture furnished by tall oat grass is by no means uniform. Some claim that both pasture and hay are much relished by farm animals. Others claim that they do not take to it readily. Amid this conflict of statement it would probably be correct to say that the palatability of the pasture or hay does not rank high, owing in part to the coarseness of both leaves and stems,

but more to a somewhat bitter taste which characterizes it. In nutritive properties it ranks at least medium.

The contrast is somewhat striking between American and English testimony with reference to this grass. The former speaks encouragingly as to its value as a cultivated grass. The latter is pretty generally of such a character as to discourage its growth, and this in spite of the fact that it is extensively grown in France and other countries in western Europe. Sir J. B. Laws, after discussing it, evidently in an impartial manner, concludes that its value is questionable. English opinion with regard to it would seem to be influenced by the large number of the other cultivated grasses which can be grown there, some of which are in several respects superior to tall oat grass for English conditions. Furthermore, tall oat grass prefers a climate not too moist.

Distribution.—Tall oat grass is common in Europe and also in western Asia. It is probably indigenous to both of these continents. It was introduced into this country from Europe and probably many years ago. It has long been grown in Virginia and in certain portions of New England it was cultivated to some extent as early as the first quarter of the last century when it was valued somewhat highly, more especially because of the early and rapid growth which it makes in the spring.

It is a hardy grass and can endure much heat and cold. Its adaptation for southern conditions would seem to be much higher than for those in the North, but this probably arises more from congeniality in the soil conditions than from those of climate. It will grow well in a climate that is moist, as is evidenced by its be-

havior in France, but it grows at its best under conditions of both climate and soil that are not over moist. An over moist climate is also much adverse to the proper preservation of the hay made from this grass.

Tall oat grass though not much grown in the northern states, is susceptible of a wide distribution throughout the republic. Many good words have been spoken in its favor in the South and West. In some of the southern states it is placed at the head of the list of the cultivated grasses. As previously intimated it has been grown successfully for many years in Virginia. In Georgia it has been given first place among the valuable grasses. In Nebraska, though not very extensively grown, it is in good repute and in Idaho it is grown considerably both on the upland and along with alfalfa on irrigated land. Coming northward it has done well on certain of the sandy soils of Michigan and in some areas of Pennsylvania. It is not probable that this grass will be grown to a very great extent east of the Rocky mountains and north of the fortieth parallel, because of the success with which other grasses may be grown in nearly all of the area named that are considered superior. Nevertheless, in the light soils found in certain areas of Michigan, Wisconsin and other states, this grass should be further tested. For such soils it has this advantage over Russian brome grass, that it germinates more quickly and will produce much more abundantly the season that it is sown. In the semi-arid belt it will grow better than almost any other variety, unless it be the Russian brome, but in much of this area the conditions are too dry even for tall oat grass. In nearly all the

southern states it grows more readily probably than any cultivated grass that does not make trouble by persistently remaining in the soil. The food produced by it in the South is usually much more than from an equal area in the North. In the southwestern states it can be grown in but few localities without irrigation because of drought. But it would seem to have considerable adaptation for the dry portions of certain of the northern mountain states, as Washington, Idaho and Oregon. But even in these it is not likely to be so much grown as meadow fescue, because of some superior qualities possessed by the latter.

In Canada there would seem to be no very large place for tall oat grass. In the provinces from Lake Huron eastward, other grasses with superior qualities grow so well that the necessity for it is not felt, although it could be grown successfully in parts of all of these provinces. In the provinces west from Lake Superior it would seem that it has not been much tested, but it is not likely that in these it will supplant Russian brome grass, the qualities of which are in some respects superior. More especially is this true of the latter with respect to palatability, permanency, and the extent to which it fills the soil with vegetable matter.

Soils.—Tall oat grass, though more indifferent to soils than some other grasses, will nevertheless grow much better on some soils than others. The soils best adapted to growing it are those that are somewhat dry, porous and sandy or gravelly in texture. As the roots feed deeply, it is important that the subsoil shall be porous. Whatsoever the character of the surface

soil, therefore, this grass ought not to be sown where a hard pan subsoil comes up near the surface of the ground. The favorite soils for tall oat grass are those that are sandy in texture and yet possessed of enough of loam to furnish food for free growth in the plants, and that are moreover underlaid with a porous subsoil, preferably clay. It will grow well in the alluvial soils of river bottoms when sandy in character and not surcharged with moisture. But it will also grow reasonably well on light sandy soils though underlaid with sand or gravel, unless where the conditions are extremely dry. It will even grow reasonably well on gravelly soils under similar conditions. Its adaptation for the soils of the Rocky mountain areas is relatively high as it is also for much of the light soil found in the South. On the vegetable soils of much of the prairie it also behaves well, as shown by experience in growing it in Iowa and Kansas, more especially when these are not so light as to lift with the wind. Stiff clays are not well adapted to the production of this grass, and on slough soils several of the cultivated grasses will grow much better. Where these are undrained it would not be wise to try to grow it on them. Nor does it grow well on soils otherwise favorable to its development when unduly saturated with water during any considerable portion of the year.

Place in the Rotation.—Since tall oat grass makes a strong growth the first season that it is sown, and since it has also considerable power to maintain its hold upon the soil, it is adapted to both short and long rotations. It may be sown to provide hay or pasture for

but one or two seasons or it may be sown alone or along with other grasses to provide pasture that is to endure for a number of years. As with all other grasses it is best sown on a clean soil, consequently in the rotation it should naturally follow crops that have been cultivated and kept clean during the season of growth. But since it has much power to grow while the plants are yet young, it can fight its own battle better than some other grasses, should it be necessary to sow it on soil not well cleaned. Especially would this be true if the weeds in these soils were annuals, as, subsequently to the cutting of the first crop the oat grass could be so dealt with as to prevent these from re-seeding.

Tall oat grass could be followed by almost any crop that would grow in the locality, but it would be preferable to follow it with a crop that requires much vegetable matter in the soil in an easily accessible form to grow it at its best, as corn, the non-saccharine sorghums, potatoes and certain kinds of garden produce; also the small cereals non-leguminous in character. In Britain one form of oat grass known as the *bulbosum*, is difficult to get out of the soil when the sod is broken, but no difficulty of this nature occurs with tall oat grass.

Preparing the Soil.—The preparation of the soil for tall oat grass is essentially the same as for other grasses that have been discussed. North or south, east or west, the aim should be to have a clean seed bed. North or south, simply cultivating or disking and then harrowing the land after a crop that has been cultivated will be a sufficient preparation for receiving the seed, whether sown fall or spring. When the oat grass is sown at either

of the seasons just named it will usually be found preferable to defer sowing until time has been given for the sprouting of many of the weed seeds in the surface soil. But sowing should not be too long deferred in either case, lest dry weather should destroy the young plants in the first instance, and harsh weather should do the same in the second. When sown with a nurse crop the preparation of soil that is most suitable for the nurse crop will also be most suitable for the tall oat grass. This will mean that on nearly all soils the finer the pulverization for spring sowing the better, but that for autumn sowing it is not always advantageous to have a very fine seed bed. Since tall oat grass is a large seed and has strong germinating power, it will make a stand under conditions that would be fatal to some grass plants that are more delicate when young, but with this as with all other plants, the labor expended in preparing a suitable seed bed will be wisely expended.

Sowing.—Tall oat grass may be sown north, south, east or west, in the autumn or the spring. On suitable soils it will probably endure the cold of winter as well as timothy, when sown in the fall, but when thus sown it should be in the early autumn, that the plants may be strong before the arrival of winter. Dr. D. L. Phares claims that below parallel 30 it may be sown with safety from November 1st onward to the middle of December. In the South especially, it is usually considered preferable to sow after the fall rains begin, more particularly September or October. When sown thus early, full crops may be reaped the following year. But

it may also be sown in March and April and furnish a good cutting of fodder the same season. In the North the seed will usually be sown the same time as winter wheat or rye; it will usually be sown with one or the other of these crops, if sown in the autumn. In the spring the seed may be sown at the same time as the small cereal grains as a matter of convenience, since it will more commonly be sown with these, but it may also be sown later if desired.

Tall oat grass may be sown as already virtually intimated with any of the small cereal grains. But in seasons of good growth the oat grass sometimes grows so strong as to hinder the yields of the grain. Especially is this result likely to follow when it is sown with winter wheat. The value of the wheat straw in such instances is greatly enhanced, but it may be at too much of a sacrifice to the grain. The feeding value of the straw of winter rye would thus also be considerably enhanced, but it may be at too great a sacrifice of the rye. The feeding value of the winter rye straw would be considerably increased without so much injury to the grain yield as in the case of wheat. When sown with winter barley or winter oats, a good fodder crop of the two should be produced the following spring. It may also be grown in some localities with either of the rye grasses.

This grass is usually sown by hand, more especially when sown in the chaff; since the seed is large it is not difficult to sow it thus. It should be covered with the harrow when thus sown, but it does not require to be so deeply covered as grain. Where the seed is clean it

may be sown along with grain, but to this method of sowing there is the objection that frequently it buries the seed too deeply.

For producing hay, tall oat grass may be sown with orchard grass and medium red clover, as they are ready for cutting about the same time. It is also sometimes sown with alfalfa, but when thus sown it is rather to lessen the tendency in the alfalfa pasture to produce bloat than to increase the yield of the pasture. It may of course be sown alone to provide pasture, but is usually sown in conjunction with other grasses. It is more frequently sown for pastures in permanent mixtures than in any other way. When sown alone, not less than two bushels of clean seed, 24 pounds, ought to be used, but when grown for seed a somewhat less quantity will suffice. In the chaff the quantity ought to be considerably increased. When sown with orchard grass one-half the quantity should suffice; when sown with red clover one-third of the amount; when sown for permanent pasture usually 3 to 5 pounds will suffice but the amount of seed required will of course vary with the object sought.

Pasturing.—There is considerable conflict in opinion with reference to the value of this grass for pasture. English testimony on this point is in the main unfavorable while American testimony is in the main favorable. The latter testimony in some instances speaks enthusiastically, probably too much so with reference to its value for pasture. The strong points in its favor are, its early, quick and continuous growth. A chief weakness consists in the bitter taste which characterizes it

and which does to some extent lessen its palatability. If sown in the early spring it will produce pasture the same season. The aftermath, after cutting it for hay or seed is also abundant. Its highest value for pasture, however, is found in the South, in some parts of which it may be grazed all the winter. Some consider it the best pasture grass for winter which grows in the South. In the North this grass is not likely to be grown to any considerable extent to provide pasture unless in permanent pastures, since other pasture grasses grow there which are considered superior. Even in permanent pastures it is not so enduring as some other grasses. But in the central states and in some parts of the west where it is grown in conjunction with orchard grass and some other grasses its value for pasture is relatively higher.

Harvesting for Hay.—Tall oat grass is ready for being harvested for hay very early in the season. Even in Ontario, Canada, it should be cut for hay sometime between the middle and end of June. It should be cut promptly when the blossoms begin to come out freely, as it rushes rapidly to maturity and soon loses much in palatability and in relative digestibility. It is of course cut with the mower, and may be handled and cured much the same as timothy (see page 72). But in curing it, every reasonable effort should be made to protect it from rain or heavy dews, as it very easily takes injury from either of the sources named. It is not difficult to cure after it has been cut for seed. A reasonably good crop of hay can be obtained from it, even as far south as the Ohio river, while, south of that line, it is not un-

common to cut two crops of hay in one season. The yield of hay may be set down as running from 1 to 3 tons per acre as the soils vary on which it is grown and also as the season admits of cutting one or two crops.

Testimony regarding its value for hay is conflicting. Some growers think well of it. They claim that it is more soft and palatable than timothy, for instance. The first claim is correct, but because of this it would be less valuable for market uses. The second does not generally hold good, and because of the great promptness necessary in cutting and curing it the difficulty of curing any considerable area of it in best form is greatly enhanced.

Securing Seed.—Tall oat grass seeds freely. The seeds begin to ripen in from six to twelve days from the time of blossoming. The length of the interval is much influenced by the weather, but it is always short. The seeds on the top of the heads begin to ripen first and as soon as these show indications of falling off the cutting should not be delayed for a single day or a considerable proportion of the seed may be lost. The delay of only a few days in harvesting has resulted in the entire loss of the seed crop.

From what has been said it will be apparent that not only promptness but much care must be exercised in harvesting the crop, otherwise much of the seed will be lost. One of the best methods of cutting is to set the binder high so as to cut off the stems above the mass of the lower leaves, and to shock the sheaves thus made in long rather than in round shocks, until dry. These may then be drawn on racks covered with some kind of

cloth or canvas to catch the seed that shells. The seed may be threshed with a common threshing machine, but certain special attachments to the same facilitate the work and prevent the loss of seed. The seed being relatively large is more easily separated from the chaff by winnowing than the seed of certain other grasses. When the seed crop is harvested the residue of the crop left uncut may then be cut and made into hay. The seed crop may also be harvested by setting the binder so low as to cut the entire crop. But to harvest it thus would considerably prolong the period necessary to cure it sufficiently for threshing, which would probably result in the loss of much seed, and the labor of threshing would also be considerably increased. The seed weighs 12 pounds to the bushel. The yield runs from 10 to 20 bushels per acre. Certain of the lands in the Palouse country in Washington now furnish seed of an excellent quality.

Renewing.—American experience in the renewal of this grass either in pastures or for meadows is not plentiful. The very meagre records, however, which bear upon this question show that it responds readily to top dressings with farmyard manure. Reasoning from general principles, it would seem to be easy of renewal on congenial soils, since it readily produces seed. The seed sheds easily and the germinating power of the seed is good. Where the stand for meadow or pasture has become too thin, therefore, it would seem reasonable to suppose that, adding more seed, fall or spring, but more particularly in the early fall, and covering the same by plentiful harrowing would produce renewal in the crop. In some situations also where the soil and cli-

matic conditions are both highly favorable, renewal may possibly be brought about by grazing in a way that will admit of the falling of seed on the ground where it has matured. In permanent pastures mixed in character, and in which some of the other grasses are more aggressive, it would not be easily possible to renew tall oat grass.

CHAPTER XI.

MEADOW FOXTAIL.

Meadow Foxtail (*Alopecurus pratensis*) is a grass plant that has attained much popularity in England and also in some other parts of the continent of Europe. In appearance it bears no little resemblance to timothy, but the leaves are shorter and the heads also are shorter, broader, softer and more velvety. The whole plant is more smooth and soft than timothy. Moreover it is ready for being grazed much earlier than timothy. It also comes into flower several weeks earlier than that plant.

This perennial grass in its habit of growth is considerably like timothy. The plants grow singly and distinct and when not too crowded each throws up several spikes, but when overcrowded many of the plants will not come into head at all. While the height attained varies much, the average height may be put at from 18 to 24 inches, but in rich situations the stems may attain the height of 3 feet. The leaves are quite numerous and the spikes are from 2 to 4 inches long and about one-fourth of an inch in diameter. The root is short and creeping, but it has considerable power to retain its hold upon the soil. It grows very quickly, especially early in the season, and is one of the first grasses to furnish pasture. At the Ontario Agricultural College



FIG. 11.

MEADOW FOXTAIL (*Alopecurus pratensis*).

U. S. Department of Agriculture,
Washington, D. C.

experiment station the heads appeared in some seasons before the end of May, or earlier than those of blue grass. In Tennessee they sometimes appear early in April. In favorable situations it grows up quickly again after being grazed and also after being sown for hay, but in somewhat dry conditions as in some parts of the Mississippi basin it behaves differently.

Meadow foxtail is much relished by all kinds of stock, whether grazed or fed as hay. It is not only palatable, but its abundant leaf growth and softness make it grateful to animals which feed upon it. But it is slow to become established, hence it is not well adapted for short rotations. It will rather be grown in pastures and meadows more or less permanent in character. Where the conditions are just right for its growth, it is peculiarly well adapted for permanent pasture.

Distribution.—Meadow foxtail is a native of Europe. It has higher adaptation, however, for those parts of that continent in which the climate resembles that of England. Authorities agree as to its high value for permanent grazing in Britain, where it forms one of the principal grasses in such pastures. It has long been in favor in that country. In 1824 Sinclair states that it constituted part of the produce of all the richest pastures that had come under his notice in Lincolnshire, Devonshire and in the vale of Aylesbury. It also grows in western Asia and northern Africa. It is not indigenous to America, nor can it be said that it has obtained a very extensive foothold in any part of the same.

While this plant is fairly hardy it is not well adapted to extreme conditions of heat or cold, drought or exces-

sive wet. It grows best in a climate moist and cool, moister than much of the climate of the Mississippi basin and cooler than that of the southern and southwestern states, unless in such portions of the same as are elevated. It is also a grass that succeeds well under irrigation, hence there may yet be a place for it in the mountains of the West, although from the nature of the production there that place is likely to be limited.

This grass has been grown more or less in the New England states and those adjacent and its adaptation for these has been commended. Notwithstanding it has been but little grown in a large way. The inference would seem just, therefore, that it is not more extensively grown for the reason that some other grasses, notably blue grass, has been found better adapted to the conditions in these states. The assumption will also probably be found correct that in the elevated areas of the Allegheny mountain region southward from New England it may be made to render good service in permanent pastures. West of the Cascade mountains it should also grow well in Washington and Oregon. In other parts of the United States the conditions would seem to be of a character not highly favorable to the growth of this grass.

In Canada it is not likely to come into much prominence. It will grow reasonably well in Ontario and the provinces eastward, but not sufficiently well, apparently, to make it prominent among economic pasture grasses. At the Ontario experiment station at Guelph it proved considerably less satisfactory in permanent pasture than meadow fescue and tall oat grass. It is not likely to

have any important mission in Manitoba and the country westward to the Rocky mountains, but it may yet render substantial service in certain parts of British Columbia.

Soils.—All authorities agree in representing that meadow foxtail will thrive best on a rich, moist, deep, strong soil, with an underlying subsoil porous and yet moist. It will probably grow best on rich, calcareous loams and rich sands when thus underlaid. Richness and moistness are important essentials in the soils in which it grows, and linked with these there should be more or less of friability. In Britain it has given good results on land more or less springy at certain seasons. It has high adaptation for rich porous soils that can be subjected to irrigation. It has been claimed that it will grow on any soil except the driest sands and gravels, but the claim does not hold good except where moisture is abundant as in the climate of Great Britain. In the Mississippi basin its growth is not altogether satisfactory on the loose soils of the prairie, though these should abound in the elements most essential to plant growth. On sands and gravels in the dry portions of the West it would probably not succeed at all, until the irrigated mountain valleys are reached. Even in Britain it does not well maintain itself on soils dry beyond a certain degree.

Place in the Rotation.—Since meadow foxtail is slow in becoming established, and since it has the power to maintain itself for many years without failing, it is not essentially a rotation plant. It cannot be used at all in short rotations. Its special mission is to furnish per-

manent pasture and in a less degree permanent meadow. When these meadows and pastures are broken, however, it should be followed as in the case of other grasses by crops that luxuriate in decaying vegetable matter such as the small cereal grains, corn and potatoes. It is especially important that this grass shall be sown on a surface made clean by the processes of cultivation, because of the long time that it takes to become established. Otherwise weeds will crowd and smother the plants.

Preparing the Soil.—In preparing the soil for meadow foxtail, fineness, firmness, moistness, richness, and cleanness should be sought, especially the conditions last named. The plants being delicate at the first grow slowly, hence, unless the conditions are quite favorable when this grass is sown alone it is much liable to be smothered with weeds; when the soil is not naturally rich it should be fertilized with reasonably well decomposed farmyard manure or by applying artificial fertilizers particularly such as are reasonably rich in nitrogen. When sown with other grasses to provide permanent pasture the preparation that will be suitable in making a seed bed for such pastures will also be suitable for meadow foxtail. (See p. 385.)

Sowing.—The seed of meadow foxtail may be sown in the autumn or in the spring in climates not so stern as to preclude autumn sowing. In the New England and middle states it is better to sow in the spring and early in order to take advantage of all the moisture of the season. In the southern states and beyond the Cascade mountains it may be sown in the autumn, preferably as soon as the autumn rains come.

The seed is very light, weighing only five pounds to the bushel when sown in the chaff in which form it is usually sown, consequently it can only be sown by hand. When sown in permanent mixtures the seed is of course mingled with the seeds of at least such of the other grasses in the mixture as call for hand sowing.

When sown alone for meadow or for seed, it is probably better to sow it with than without a nurse crop, but the latter must not be of a character to form a dense shade. This can be regulated when sowing with any of the small cereal grains by sowing them more or less thinly according to the kind of the grain. If the seed is sown without a nurse crop much attention should be given to keeping weeds so cut back that they will not crowd the grass nor mature seeds.

When sown alone authorities claim that not less than 3 bushels per acre should be used when sown in the chaff. If the seed was of the best this would seem to be an excessive quantity, as according to Flint, an ounce contains 76,000 seeds, but for various reasons it is not easy to secure good, reliable, pure and fresh seed, hence under ordinary conditions it may be well to sow the quantity named. As with timothy the plants do not thicken when once set, hence, liberal sowing at the first is a necessity. When sown to provide permanent pasture the amount of seed to use will vary with the prominence to be given to this grass in the pasture. As the plants are feeble when young and therefore much liable to be overshadowed by those that are more vigorous a liberal use of seed would be advisable in permanent pastures. It should not be necessary, however, to sow more

than 5 pounds of seed per acre in any instance, and seldom necessary to sow so much. From 2 to 3 pounds of good seed should furnish many plants in the mixture. For various reasons it is not easy to secure really good seed. This no doubt accounts in part at least for the unsatisfactory results that have frequently followed the sowing of this grass under American conditions. The high price of the seed has also been against its extensive use.

Pasturing.—The high value of meadow foxtail in producing pasture under conditions favorable to its growth cannot be questioned. Its earliness, permanency, persistency in growth and high palatability recommend it for such a use. Moreover it withstands cropping well. It is these qualities which have made it a favorite pasture grass in the permanent pastures of Britain and more especially in the sheep grazing districts. While it may be cropped down quite early in the season at which time it grows with much vigor, it does not grow so well later, hence it is much better to sow it with other grasses when sowing it for pasture. Since it luxuriates on rich soil it is peculiarly responsive to dressings of fertilizer in various forms.

Harvesting for Hay.—Although frequently grown for hay in Europe, it is questionable if this grass will ever become highly popular as a hay plant under American conditions, since where the conditions are most favorable to its growth in this country they are also quite favorable for the growth of timothy, which is king among the hay plants in America. It is very light, compared with timothy and is lacking in what may be

termed "body," that is substance, firmness and weight. The slowness with which it matures also so far unfits it for a hay crop.

It should be cut for hay when in bloom as then it is claimed the plants are possessed of a maximum amount of nutrition. When in full bloom a field of meadow foxtail is handsome to look upon. It is claimed that the hay has a higher nutrition than timothy. It may be cut and harvested in the same way as timothy. (See p. 72.)

Securing Seed.—The author has not been able to obtain any information with reference to harvesting the seed crop under American conditions. The seed used in this country would seem to be all or nearly all imported. Much of it is also adulterated with velvet grass (*Holcus lanatus*) or with rye grass. The seed crop ripens unevenly. Some of the heads are approaching ripeness while other heads are still in flower. The seed crop is also said to be peculiarly liable to injury from insects and also blight. Moreover it is not easy to thresh and prepare for market. These difficulties in the way of procuring seed explain in part at least why the seed is high.

Renewing.—When this grass is sown for meadow and the stand is imperfect it would probably be better to refit the land and sow again than to add seed, without thus preparing the soil, as the young plants are unable to flourish in soil where the conditions are not highly favorable. The same reasoning will apply in the main to the renewal of the pastures.

CHAPTER XII.

GRASSES USEFUL BUT DIFFICULT OF ERADICATION.

In this chapter three grasses will be discussed which are now almost universally looked upon as weeds. These are Quack grass (*Agropyrum repens*), Johnson grass (*Sorghum halapense*) and Crab grass (*Panicum Sanguinale*). All three are possessed of much economic value and yet they are so difficult of eradication that they have become in a sense the dread of the farmers in localities into which they have been introduced. In the judgment of the author, they should never be sown on land that is to be tilled again. However, there are localities where they have become so entrenched that it may be the part of wisdom so to manage them that the highest return possible will be secured, rather than going to the expense of eradicating them. In other instances and generally they should be given no rest by those who cultivate the soil until eradication is complete. In the hope that some light may be thrown upon the difficult and perplexing problem of dealing with these in a manner at once intelligent and effective, these grasses will be considered separately and with some minuteness.

QUACK GRASS.

Quack grass (*Triticum* or *agropyrum repens*) is probably more frequently designated Couch grass by those

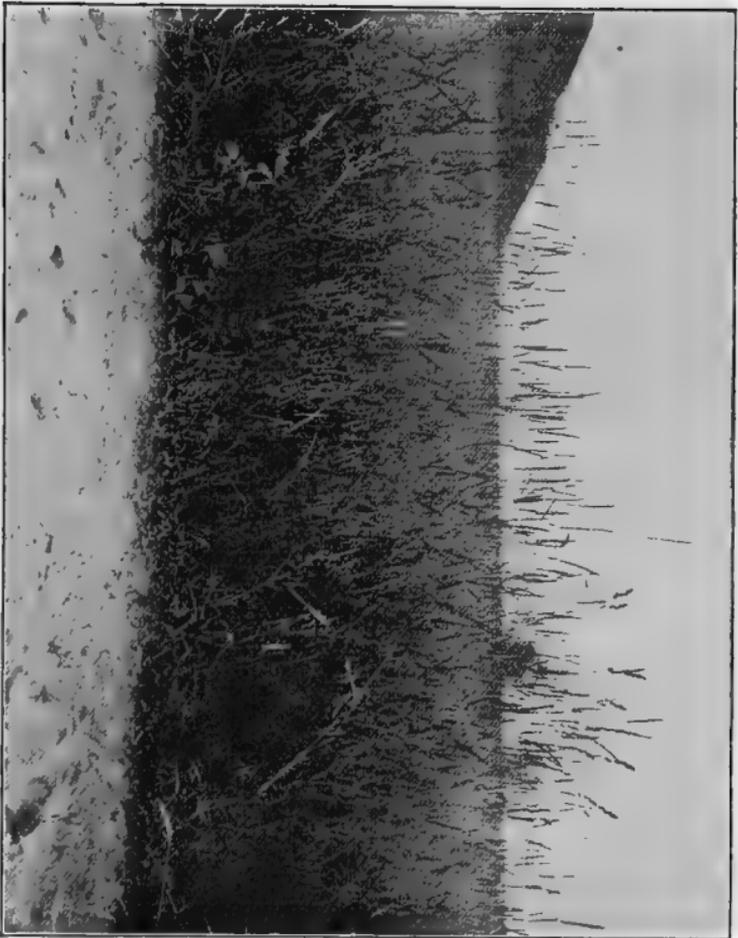


FIG. 12.

QUACK GRASS (*Agropyrum repens*).

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Washington, D. C.

who have written with reference to it, but the tendency now is to call it Quack grass. It is also known by the names Twitch, Quitch, Squitch, Witch, Scutch, Quake, Dog, Durfee, Chandler, Fin's, Rye or Creeping Wheat grass. Dogs occasionally eat of the leaves, since with them it acts medicinally as an emetic, hence the name Dog grass. The terms Rye and Wheat grass have doubtless arisen from the resemblance of the plants to those of rye and wheat. It varies much and is closely allied to varieties that are not so persistent in the habit of retaining a hold upon the soil.

This perennial grass thickens very quickly in the soil where it once gains a foothold, and to the extent of becoming so matted or sodbound that the yield of pasture or hay is seriously lessened when the grass is undisturbed by cultivation. This result arises from the peculiar character of the root growth. The strong, stiff creeping root-stocks or rhizomes branch out in every direction and so completely fill the soil that other grasses or weeds cannot grow in the same. The roots are numerously jointed and at each joint is a bud capable of producing a fresh plant. The plants also grow from seed. The stems grow from 1 to 3 feet in height, the average being $1\frac{1}{2}$ to 2 feet. The heads or spikes are rather slender and usually straight, bearing considerable resemblance to those of wheat. The leaves are of a dark green shade. They bear considerable resemblance to those of timothy near the ground, but they are larger and stronger and of a darker green.

The good qualities of quack grass may be summed up as follows: 1. It will grow more or less well in almost

any kind of soil. 2. It is easily introduced and when once established will endure indefinitely, since it can withstand excessive cold or heat, drought or wet to a remarkable degree. 3. It pushes up quickly in the spring, grows abundantly until matured, makes much aftermath when mown and grows up freely in the late autumn. 4. It is much relished as pasture by all kinds of live stock, especially if grazed before the plants become woody, and produces as much good hay as timothy, when cut in season, and more nutritious in character. 5. It crowds out nearly all kinds of weeds where it grows. 6. It may be made to render much service in binding soils along gullies and embankments. And 7. Though it may tend to lessen the fertility of soils when pastured for successive years, yet when buried in the soil it exerts, in many instances, a favorable influence on the same mechanically.

Notwithstanding these good qualities, the author desires to say with all possible earnestness, that this grass should not be sown on arable farms or at least on such portions of them as are to be tilled, for the reason that it hinders cultivation; lowers the yields in the crops, and requires great labor to eradicate it when this may be desired. Where it may be legitimately grown is discussed later. (See p. 238.) It also adds greatly to the labor of tillage by the toughness of the sod which it forms. This makes the land difficult to plough. Because of the extent to which the roots fill the soil, it is even more difficult to provide a loose seed bed than to plough the land; because of the extent to which the roots fill the soil, it is even more difficult to provide a loose

seed bed than to plough the land, and because of the vigor with which it grows among grain crops, it more or less reduces the yields. The methods of destroying it are discussed below. (See page 245.)

Distribution.—Quack grass is native to Europe. In Great Britain and other countries, it has long been proscribed by the farmers because of the great labor which it has caused; because of its persistent presence in cultivated fields. When it was introduced into this country is not known. There is, however, a species of grass much like it which is native to certain parts of the far western plains and which is there regarded as a good pasture grass.

Quack grass flourishes best in a climate that is temperate and moist and yet it will grow, but of course with much less vigor, in a climate both warm and dry. But it will grow better in temperatures that are moderately cool than in those which are hot.

It will grow in almost any part of the United States which it is possible to cover with a mantle of vegetation. It would seem, however, to grow more vigorously in the northern and central states than in those southward. It has spread to a greater extent probably in the prairie states in the upper Mississippi basin than elsewhere, but for many years it has also given trouble to the farmers of New England.

In Canada this grass will also grow with great vigor in all areas where the soils, when tilled, will grow cereal grains. But nowhere in that country does it grow with more vigor than in the provinces of Ontario and Que-

bec, since in these both the soil and climatic conditions are exceedingly favorable to its growth.

Soils.—As implied in what has already been stated, quack grass will grow in almost any kind of a soil. But it also has its favorite soils. It grows probably in greatest luxuriance in clay loam soils, moist and friable, but it also grows with much vigor on the black loam soils of the prairie so largely made up of decayed vegetation. It grows with much persistency even in stiff clays. In rich lands it luxuriates and also in the alluvial soils of river bottoms. In sands and gravels low in fertility it can fight the battle of existence, but from these it is much more easily dislodged than from soils rich and friable.

Place in the Rotation.—No place can or should be assigned to such a plant in any regular rotation because of the trouble which it gives in being removed from the soil. It would not be wise even to sow it in pastures mixed in character which are intended to be permanent as it would certainly crowd out all or nearly all the other sorts because of its aggressive character. But the author is by no means convinced that it should never be sown. It may be wise, in some instances, to sow it on infertile sands too poor to sustain other grasses in good form. There may also be a place for it on certain lands in the semi-arid region east of the Rocky mountains, especially in such of them as can be broken by the plough. It would seem reasonable to suppose that this grass would furnish much more food from a given area when managed as described below (see p.

242), than is now obtained from the grasses which at present occupy the soil.

Preparing the Soil.—As applicable to cultivated farms, it is not necessary to discuss this question; as on the cultivated portions of these the seed of quack grass should not be sown. But if it should be desired to sow the same on parts of the semi-arid range country when it is not expected that the soil shall ever be regularly tilled there can be no question but that a stand of the grass would be more quickly obtained on ploughed land than on the unbroken sod. Whether on such sod the seed would grow the author has not been able to ascertain, but the chances are that some of the plants would obtain a hold if the seed were sown in the fall; when thus started, even though the plants were thin and scattered, the habit of growth in the grass would justify the conclusion that they would spread to the extent of occupying all the land. It is also questionable, if under these conditions, the plants would ever become so thick and matted in their growth as in climates with sufficient rainfall.

This grass may also be sown on sands too low in fertility for regular cropping and on gravelly, stony and rocky places which never can be tilled.

Sowing.—This grass will doubtless grow sown fall or spring, but it is difficult to obtain seed. Because of the weedlike character of the grass, many seedsmen do not keep it in stock, as it should not be sown on lands that grow other crops. When the seed is sown, therefore, of necessity it will be without a nurse crop. After a seed bed has been prepared, where this is practicable,

the seed can best be sown by hand and covered with the harrow. Hand sowing is also of course necessary when tillage is impracticable. Thin sowing would seem preferable, as, although the grass produced the first year or two should be less than maximum yields, these would be more in the years that immediately follow than if the grass had been sown thickly at the first, as the pasture would not so soon become sod bound to the extent of necessitating renewal (see p. 242). It would not be necessary to sow more than 12 pounds per acre. The seed weighs 20 to 24 pounds per bushel.

Where it is impossible to obtain seed at a reasonable price, it may be possible to obtain the roots of this grass without other cost than that of taking them out of the ground. This could best be done by the aid of a plough, which would turn a clean cut and narrow furrow and only deeply enough cut to make the roots easy of access. They could then be shaken free from the adherent earth with a fork. In a larger way the roots could be drawn to the surface by a spring tooth harrow and collected with a horse rake. If the roots thus secured could then be run through a cutting box so as to cut them in lengths not too short, material would thus be furnished for scattering thinly over prepared land and then covering the same with the harrow. The outcome would be quick setting of the plants. They should not be allowed to remain long out of the ground unless kept in a damp condition. This method would seem specially well adapted to securing a stand of the plants on infertile sandy soils.

Pasturing.—As quack grass grows up with much vigor in the early spring and as it becomes somewhat woody after the seed stems begin to push up, it ought to be kept grazed with reasonable closeness. If the seed stems are not kept from forming, much of the grass will be left uneaten unless the stock that graze upon it are compelled to eat it in order to satisfy their needs. The capacity of this grass to furnish grazing does not seem to have been tested in an experimental way, but there is no doubt that it is relatively high. Close grazing in the autumn would also seem justifiable because of the extreme hardihood of the grass. The nutrition in the pasture is higher than that of timothy. If grazed when succulent it has been pronounced excellent for milk production. The pastures may be greatly improved on some soils by harrowing early with a heavy harrow, while the ground is soft. In other instances it would be necessary to use a disk harrow. Nitrogenous fertilizers judiciously applied will also greatly stimulate the growth of the pastures.

Harvesting for Hay.—Authorities are agreed as to the good quality of the hay made by quack grass, providing it is cut not later than the blossoming stage. It is thought to be as valuable as timothy for feeding on the farm, but it is not so marketable as the latter. It would seem correct to say that it should not be sown for the express purpose of providing hay, but may of course be legitimately used for hay where it has already possessed the soil. When so used it ought to be cut before any of the seeds mature, otherwise these may be the means of starting the grass in fields where it is not

wanted. The cutting and curing of the hay may be managed in the same way as the cutting and curing of timothy. (See p. 72.) From 1 to 4 tons are produced per acre. The average is probably about $1\frac{1}{2}$ tons.

Securing Seed.—This grass is seldom, if ever, grown for seed in the United States, hence the author is unable to state the best method of securing seed based on American experience. According to Beale, it does not readily produce seed until the plants become dwarfed and crowded because of a matted condition of growth or through more or less of impoverishment of the land. It is also quite probable that the tendency in the plants to produce seed is less on the humus soils of the prairie than on soils essentially clay in texture. It is also certain that more or less of the seed matures in the grain crop amid which this grass grows, and in this way aids in the distribution of the same. The capacity of this grass to produce seed under prairie conditions, would seem to have been under-estimated, otherwise there would be no adequate explanation of the abundant presence of this grass in the soils of the upper Mississippi basin. If seed crops should be wanted, they can probably be obtained by cutting crops which mature seed with the binder and threshing them as orchard grass is threshed. (See p. 145.)

Renewing.—When quack grass becomes sod-bound to the extent of lessening the grazing furnished by it, it may be renewed by ploughing and then harrowing the land ploughed. The depth to which the land should be ploughed, the best season for doing the work and the frequency with which this should be done depend upon

conditions which relate chiefly to soil and climate; consequently, uniformity in the exact methods followed in renewing the grass would not be wise. Ordinarily the land should not be ploughed more deeply than the mass of the roots go. The work may be best done in the early fall or early spring and at intervals of say 2 to 4 years. If ploughed quite late in the fall, the upturned roots would be injured by the frost in cold climates and ploughed late in the spring, much of the usual season for growth would be lost. The work should be done with a strong team because of the toughness of the sod. It should also be done with a plough that will turn a smooth furrow that a reasonably smooth surface may be made with the harrow. Such renewal is very helpful in increasing growth in the pasture. By such a method of renewal, accompanied by an occasional dressing with fertilizers, this grass could doubtless be grown for many years.

Eradicating.—Quack grass seeds are frequently introduced along with those of seed grain, amid which they have grown, more especially along with wheat and oats. It may also be introduced in stable manure purchased in cities, towns and villages. A few plants are thus lodged in the fields in one or more centres. In these there may be but a single plant at the first. Through the aggressive character of the root growth, the plants in each center soon grow into a small patch and then into a large one. While the fields are being cultivated, the roots are being carried to other parts of the field by implements used in tillage. These form new centres from which growth radiates, insomuch that

in time if the spread of the plants is not checked the field is completely possessed by the grass.

In combating this grass, the following are among the most effective of the measures that may be adopted:

1. Plough after the crops have been harvested. Work the roots to the surface by using some form of spring tooth or other harrow. Then rake with the horse rake and burn when dry. Follow with one or two crops of corn planted in hills and to which the most thorough cultivation is given.

2. Sow rye in the autumn. Let the rye mature the following season or graze it which is preferable and follow with a smothering crop as sorghum or corn sown thickly. If necessary grow corn on the same land the next year, managed as outlined above.

3. Manure the land heavily with reasonably well composted manure. Give to it careful and thorough preparation. Grow on it corn or sorghum, preferably the latter, sown thickly with the drill and as grain is sown and then follow with corn grown as described above.

4. Plough the land carefully after the grass has made a good start in the spring. When ploughing it turn narrow rather than wide furrows. Then use the disk until a good seed bed is formed and then sow barley thickly, using $2\frac{1}{2}$ to 3 bushels of seed per acre. Plough again as soon as the barley crop is removed.

5. Summer fallow the land, ploughing the same or stirring the surface after it has been ploughed with sufficient frequency to prevent the plant from breathing through the leaves for a single season.

6. Divide the infested area into two or three fields. Grow on these for forage such crops as winter rye, barley and oats sown together, rape or kale and corn or sorghum; not fewer than two of these crops are to be grown in succession each season. These are to be grazed off by sheep, alternating the grazing in the different fields, and the process is to be continued as long as may be necessary.

7. Small patches may be virtually destroyed by enclosing swine on them and leaving them until they have consumed the roots, of which they are fond.

Methods 1, 2 and 3 can best be pursued in areas where corn is a leading crop, but, where it is not, field roots may be substituted for corn. Method 4 can be best adopted in prairie areas north of parallel 45 where barley can be successfully grown where sown thus late.

Observations.—1. Quack grass has been destroyed in some soils by one ploughing if done just at the setting in of a prolonged summer drought. The furrows should be narrow and left on edge as much as possible and not disturbed subsequently with the harrow or other implement until the grass dies through want of moisture.

2. In seasons of much rainfall it is virtually impossible to destroy quack grass without excessive labor, as at such times stirring the soil usually encourages the growth of the grass.

3. Whatever method of eradication may be adopted, it is usually necessary to dig out stray plants with a pronged fork in order to complete the work. With this object in view, such a fork should be carried in some

way when practicable by work hands engaged in the various processes of cultivation.

JOHNSON GRASS.

Johnson grass (*Sorghum halapense* or *Andropogon halapensis*) is a large, strong, coarse grass of the sorghum type that has been grown for many years in many parts of the South. It is also known by the names Means grass, Cuba grass, Guinea grass, Alabama Guinea grass, Syrian grass, Egyptian grass, St. Mary's grass, Green Valley grass, Arabian Millet and Egyptian Millet. It was introduced into South Carolina in 1835 by Governor Means of that state, who obtained the seed from Turkey, hence the name Means grass. Some years later William Johnson of Marion Junction, Alabama, who obtained the seed from Governor Means, gave much attention to placing its good qualities before the farmers of the South, hence in time it came to be known generally as Johnson grass. It has frequently but erroneously been called Guinea grass, since these grasses have but little in common, except that both under favorable conditions produce a large amount of hay, and both are easily injured by close pasturing. Unlike Johnson grass, Guinea grass has no creeping root-stocks and will not produce seed in the United States. It is also more delicate in winter.

This grass is perennial and it closely resembles young cane until the plants are a foot high. The stems are usually from 3 to 6 feet or more in height, but they have been known to grow to the height of 10 to 12 feet. They are amply supplied with leaves, large, long and



FIG. 13.

JOHNSON GRASS (*Sorghum halapense*).

Tennessee Experiment Station.

broad. The head is open and branching, from 6 to 12 inches long, and somewhat resembles that of barnyard grass. The root-stocks are creeping and so numerous and large that they almost completely fill the soil to a considerable depth. Full sized roots are sometimes found 2 feet below the surface. Some of them are half an inch in diameter and they are supplied with latent buds about an inch apart, hence the smallest portion if left in the soil is sure to grow.

Johnson grass does not start in the spring until the weather is warm, and ceases to grow in the autumn as soon as it gets cool. In the summer it grows very rapidly under favorable conditions, and will furnish two to five cuttings of hay in one season. While the weather remains warm it may be cut as soiling food once a month. While stock are fond of it as hay or pasture when grazed sufficiently early, it does not endure close grazing well, but is essentially a hay and soiling plant. It is also a hot weather plant which can endure much drought, but which succumbs to excessive wetness. It is commonly obtained from seed, but may also be grown by planting the roots. The seed bears some resemblance to flax seed.

The strong points of this grass may be summed up as follows: 1. It may be grown indefinitely as permanent meadow. 2. On good soil it yields enormous crops of hay annually in the aggregate, which may be grown at a profit. 3. It not only makes good hay but is a grand soiling plant, owing to the number of the cuttings which it will furnish. 4. It is relished by live stock as pasture, soiling food or hay. 5. A winter crop of some other

fodder may be reaped on the same land early in the season with more or less frequency and two cuttings of Johnson grass at a later period. 6. Swine can obtain much food from its roots.

The weak points of Johnson grass are: 1. It will not grow satisfactorily in a cold climate. 2. Although stock are fond of it as pasture, close and continued grazing soon lessens its productiveness, but does not entirely remove it. 3. Where it has been grown it is likely to continue to grow more or less among crops sown subsequently and to their serious injury. 4. Under favorable conditions for growth it is almost impossible to eradicate it.

Distribution.—Johnson grass is native of western Asia. It also thrives well in northern Africa and southern Europe. It was introduced into the United States as already stated in 1835.

This grass is adapted only to climates that are reasonably warm. It will not grow at all satisfactorily under conditions where the frost penetrates the ground to any considerable extent, as down to the bottom of the frost line, it is claimed, the roots will perish. In latitudes where the roots are thus injured but not destroyed to their full depth, the growth that follows from below the frost line is late and unsatisfactory. Even in the southern states the growth in the spring is relatively late and slow, and with the first frost of autumn it ceases to grow. The hope, therefore, which some ranchmen have cherished, viz., that it will succeed in the cold areas of the semi-arid belt is never likely to be realized. It will stand dry weather well when once established,

but will yield much better crops where the rainfall is normal.

The most favorable conditions for growing Johnson grass in the United States are found in North and South Carolina, Georgia, Florida, Alabama, Tennessee, Mississippi, Louisiana, Arkansas, Oklahoma and Texas. In Virginia, Kentucky, Tennessee, Missouri and Kansas it has been grown with some success as far north as the latitude of St. Louis or about 38 degrees north. But there would seem to be no good reasons for growing it in these states since they produce other forage crops both numerous and abundantly. Above the fortieth parallel the attempt should not be made to grow it for economic uses. On the southwestern ranges the conditions are too dry for growing it with much success, nor is it a good pasture grass, viewed from the standpoint of maintenance, under close grazing. Doubtless it will grow well in the milder of the mountain valleys in the West and beyond the Cascades, but it would certainly be a mistake to grow it in these, because of the abundance of superior forage which may be grown in them from plants that are easy of eradication.

In Canada there is no place for this grass. The climatic conditions are too cold. Any attempt to introduce its growth into any of the provinces of Canada for economic uses would be unwise.

Soils.—Johnson grass will grow on a variety of soils, but it will succeed best on loams rich and deep, since its roots gather food from all parts of the soil down to a considerable distance. It would probably be correct to say that it will grow in good form on ground that

will produce good crops of corn, and that where it is grown the other conditions being right, the yield will be proportionate to the richness of the soil. Excellent crops may usually be grown on rich alluvial soils and calcareous loams if well drained. It is important that all lands on which it grows shall be free from superfluous water, as soils that contain an excess of water are much adverse to the growth of Johnson grass. While it will grow on sandy and light soils, even on sandy dunes and barren fields, the yields are small and unsatisfactory.

Place in the Rotation.—It can scarcely be said of Johnson grass that it is a rotation plant, since, usually when grown for hay, it is grown indefinitely from year to year. Because of the persistence with which it grows up in other crops that follow it, and from year to year, it ought not to be grown in the alternations of any regular rotation. Wherever it is grown, the aim should be to grow only Johnson grass and to so stimulate its growth by fertilizers that a maximum of production will result. But there is a sort of alternation in which it is frequently grown, that is to say, a crop of grain such as winter oats harvested early in the season, and two successive crops of hay taken the same season from the Johnson grass, these growing up from the roots of the grass that are in the soil. This is made possible and also practicable by the slow growth of the Johnson grass in cool weather, and by the favorable influence which, under certain conditions, breaking up the root system has upon the growth of the plants. Clover has also been sown on the scarified or disked surface of a

field. The first cutting would be taken for hay, after which the Johnson grass would take possession, the decaying clover roots meanwhile feeding the grass.

Preparing the Soil.—When the seed of Johnson grass is sown to obtain a stand of the plants, it should be on clean soil, or the weeds will greatly hinder the growth of the grass for a time. It grows rather slowly and delicately at the first, notwithstanding the rapidity with which it grows later. Similar preparation should also be given to the soil when it is planted from cuttings, not because it will be unable to make a stand under those conditions, but because it will require a considerably longer time to do so. Some growers have even gone the length of summer fallowing the land for one season before sowing this grass, but clean cultivation given to some crop requiring the same ought to answer the purpose sought just as well.

Sowing or Planting.—Johnson grass may be propagated from seed or by means of cuttings from the rootstocks. The former is the simpler method and the less expensive when good seed can be obtained, but in some instances the seed produced is not very satisfactory. Many of the seeds are defective and many will not germinate, but this does not hold true of all seed.

It would be easily possible to sow the seed too early in the spring as the young plants are tender. Spring sowing may extend from April to July, April being a favorite month. Autumn sowing may extend from August to October according to the locality, September being a favorite month. The seeds are slow of germination, especially in cool weather. But little return will

be obtained from spring sown seed the same season, but seed sown in the autumn should produce two cuttings of hay the following year. The seed may be sown by hand and covered with the harrow or it may be put in with the drill. It should not be buried deeply. It is not customary to sow the seed in combination with other grasses, but it may be sown with a nurse crop. It is usually recommended to sow one bushel of seed per acre. Some again consider a peck to half a bushel sufficient. But the amount of seed that may properly be used is much influenced by the condition of the land. Heavy seeding is recommended in the spring that the grass may hold its own against weeds. When the land has been well prepared much less seed will suffice than when the opposite is true. When the land is weedy the seed is sometimes sown in rows far enough apart to admit of horse cultivation, with a view to encourage growth in the plants.

When propagated from cuttings, roots are obtained and planted in shallow furrows made with the plough. They are covered with the harrow. The roots may be made with the spade or corn knife, but most rapidly if shaken free from dirt by running them through a cutting box. Another method is to plant the roots between the hills of corn, or in furrows made between the corn rows when the corn crop is being made ready to lay by for the season. In yet other instances the plants are put in one way between the hills of corn, the cultivator being used but one way in cultivating the corn, and so as not to disturb the Johnson grass.

Pasturing.—While this grass is much relished by

stock before the heading out stage, and while it is also valuable for milk production, it does not stand well continued pasturing and yet long pasturing does not completely destroy it. It only reduces the return in pasture. The plants thicken up again in time when the pasturing ceases. When the pasturing is thus reduced, the land is frequently ploughed and sown with winter oats. One effect of the ploughing is to aid in renewing the grass. It is of but little use for pasture after the seed forms; it becomes so woody.

Swine are fond of the roots. They search for them as diligently, it has been claimed, as for sweet potatoes or artichokes. An occasional ploughing will greatly aid the swine in searching for the roots.

Harvesting for Hay.—Johnson grass is ready for being harvested for hay when it comes into bloom. It ought not to be allowed to pass this stage before being cut, as later it turns woody very quickly. In such a condition live stock do not eat it readily. Some advocate cutting it as soon as the heads appear and before it comes into blossom.

The plan is considered a good one which cuts it in the forenoon, following in due time with the tedder and raking and putting into cocks the same afternoon or evening. It is drawn when ready and stacked or housed, and is fed or baled from the stacks as circumstances warrant. When curing, it is the aim to preserve the greenness to the greatest extent possible.

In the Gulf States from 3 to 5 cuttings may be obtained from it each season. The first of these is ready about the middle of May. Each of the subsequent cut-

tings is ready at intervals of 4 to 6 weeks from the time of the cutting immediately preceding. The yield from each cutting is from 1 to 3 tons according to the richness of the land. Further north from 2 to 3 cuttings only can be obtained, because of the shorter season for growth. As many as 15 tons have been grown per year, but under conditions that were most favorable to its growth, and when the same has been further stimulated by suitable fertilizers. The average yields, however, will probably not exceed 4 to 5 tons per acre per season.

Fertilizers may be applied early in the season or between the cuttings as prudence may dictate. The kind of fertilizer will of course depend on the land, but nitrogenous fertilizers are usually most helpful to the growth of this grass. One hundred pounds of gypsum per acre and a similar amount of complete fertilizer applied before or after the first cutting have given good results. Of course where this grass is to be cut from year to year indefinitely, the question of proper fertilization becomes one of the very first in importance.

In some sections of the South, more especially in the Gulf States, some growers have large areas laid down to this grass. They bale the hay. For this hay there is a good demand in the South, and large profits are made in some instances from growing it. Notwithstanding the coarseness of the hay, it is quite palatable, having in it a considerable quantity of saccharine content.

Securing Seed.—This grass seeds freely, but under some conditions and in some seasons, the seed does not fill out well. A good crop of seed would be about 9 bushels per acre. The first cutting of the grass for the

season is preferred for seed, but it may be obtained from the second. It may be cut for seed with the binder and harvested with the ordinary grain separator. The binder may with advantage be set to cut the crop high, to avoid unnecessary work in threshing. The seed, when properly winnowed, should weigh 25 pounds per measured bushel. Owing to the strong feeling that exists against this grass, because of the difficulty in destroying it, the demand for the seed has been very greatly curtailed, and this has had the effect of discouraging the growth of seed.

Renewing.—As with all plants that increase by means of root-stocks, pushing out horizontally into the soil, the tendency is constantly present in this grass to such increase in the number of the plants as to cause them to mat to the extent of decreasing growth. When this occurs, ploughing the land and smoothing the surface will renew growth in the same. And since growth in Johnson grass entirely ceases during the season of frost the plan has been adopted in some instances of ploughing the land in the fall and sowing on it a crop of winter turf oats as previously intimated. But the grass should be well set before this is attempted. The method which grows clover early in the season for promoting the growth of the grass has already been referred to.

Eradicating.—Testimony is almost unanimous in the opinion that Johnson grass cannot be entirely eradicated where it has once obtained a foothold. That is not the opinion of the author, who cherishes the view that if the plants are not allowed to grow above ground for a single season, they will die. To prevent them from

breathing thus would doubtless involve great labor, but it should prove effective. It has been claimed that pasturing will eradicate it, but the claim is not well supported by facts. Close and constant pasturing will greatly decrease it, but some of the plants remain ready to increase and take possession should the land be again cultivated. It is also claimed that swine will eradicate it if allowed to dig up its roots for the purpose of feeding on them. To accomplish this, however, may require several seasons, and though successful is only applicable to limited areas.

But it is easily possible to adopt measures that will prevent it from gaining a foothold on a farm on which it has not yet appeared, and from spreading on one where it may be growing.

The chief agencies in spreading it are the following:

1. Carrying portions of the root to new centers of distribution by means of the plow, harrow, cultivator or other implements of tillage.
2. Sowing the seeds along with those of grain amid which Johnson grass may have matured.
3. Seeds scattering from plants that may have grown up and matured in a crop of grain or in corn or cotton after these have been laid by.
4. In the droppings of cattle that may have eaten the seed. The last named is one of the most common mediums by which the seed is carried.

The preventive measures are:

1. Exercise such care in tilling land where the grass already exists in certain places as will prevent carrying the roots to new centres.
2. Exercise even greater care in the purchase of seed grain or in cleaning the same.
3. Prevent seed from

maturing in fields where other crops are grown. 4. Do not allow stock to feed on hay or pasture which contains mature seeds.

Value of Johnson Grass.—Because of the many conflicting views that exist in the South with reference to this question, it is not easy to determine as to the place for this grass. That quite a number in several states have found its cultivation largely profitable is certainly true. That it has proven more valuable than the cotton crop in many instances is equally clear. There is also ample evidence to show that under some conditions, when cotton follows this grass, its presence has not very seriously interfered with the cultivation of the cotton. And that it has considerable value as a hay and soiling plant cannot be questioned. Many have grown it for both uses with much profit and for many successive years. Nevertheless the difficulty of removing this grass from the soil is so great that numbers who have sown it are willing to give a handsome reward to have it eradicated from their farms. Its presence on certain lands has certainly tended to lessen their value. This in itself should furnish a strong argument against extending its growth. There is not the same necessity for growing it now in the South as formerly, since other hay and pasture plants are now better known, which may be grown without experiencing serious difficulty in removing them from the land. While, in some instances, it may be well to make the best of the presence of this plant where it has possessed the land, it should certainly be the aim to prevent its further distribution

and to eradicate it completely where it is present only in patches, small or large.

CRAB GRASS.

Crab Grass (*Panicum sanguinale*) is one of a somewhat numerous family of plants. It is doubtless so named from the fancied resemblance which its spikelets bear to the claw of a crab.

The stems grow from 1 to 3 feet high. They have been known to reach the height of 7 feet, but the average height in good soil is a little more than 2 feet. They are much branched and are somewhat decumbent at the base. Under favorable conditions roots are formed at the lower nodes. From three to six flower spikelets from 3 to 6 inches long proceed from the top of the stem. These produce seeds freely. The roots are fibrous.

Crab grass is an annual which grows best in summer and in the hottest weather. It springs up in stubble fields where grain has been grown, and in a few weeks, if encouraged by frequent showers, will produce one or even two crops of hay. It will also grow up quickly in corn that is laid by, so as to cover the ground deeply with a coating of herbage. It is very troublesome in cultivated crops and in gardens, more especially when these grow in fertile soils, but in grass crops that are at all permanent in character it soon gives way to other grasses. It furnishes excellent hay and grazing, being at once palatable and nutritious. This singular plant has the characteristic of being one of the best hay plants of the South and at the same time one of the most troublesome weeds.

Distribution.—Crab grass is said to be native to the South and also introduced from the old world. It certainly finds a very congenial home in the South. It grows in all the states thereof from Virginia to Texas. North of the Ohio river it is but little known. Above that line it is not grown to provide hay or grazing.

Soils.—Crab grass grows most luxuriantly in good soils. The richer the soil the more luxuriantly will it grow, but it will grow reasonably well in any soil that will produce crops of grain, corn, tobacco or cotton.

Place in the Rotation.—This grass being at the same time a weed is not grown in any regular rotation. When used for hay and pasture, such utilization is simply making the best of an intruder, which grows as it were spontaneously in the cultivated fields. It may also be utilized in putting humus in the soil by ploughing it under in the autumn. This of course ought to be done before it matures seed.

Preparing the Soil.—Since the seed of this grass is seldom or never sown, of course no preparation of the soil is necessary. Nevertheless when it is desired to get grazing from it as early as possible, land in which the seeds are present, if ploughed in May, harrowed and rolled, will soon be covered with a luxuriant growth. Two mowings may be obtained from land treated thus.

Sowing.—Since the crop grows spontaneously it is seldom or never sown. In fact it would not seem wise to sow a plant which is troublesome to destroy. The aim should rather be to get rid of it. The seeds will live long in the soil—how long is not known.

Pasturing.—This grass furnishes excellent grazing

from June or July onward until autumn. In a few weeks after a grain crop is cut, it furnishes fine pasture, coming in at a season when in its absence it would frequently be necessary to resort to soiling crops. But it will not provide grazing in winter.

In the "Farmers Book of Grasses," Dr. D. L. Phares, the author, gives an interesting experience in growing this grass for hay in alternation with Burr clover (*Medicago maculata*), grown to provide winter and spring grazing. The clover was sown on prepared land in the autumn and grazed from December to April. The clover then matured enough of seed to provide another crop before the plants died in May. They had no sooner disappeared than the crab grass sprang up thickly and was mowed in July or August and again in October. The yield of the crab grass was $2\frac{1}{2}$ to 3 tons per acre from the two cuttings. The second cutting was much lighter than the first, but of finer quality. The clover would then spring up again and furnish grazing for the winter to be followed in turn by the crab grass. This was continued for several years without diminution in the yields of the clover or the crab grass. The clover was apparently able to keep the soil supplied with a sufficiency of nitrogen.

Harvesting for Hay.—Crab grass hay is harvested like other hay. It should be cut when the flowers are formed. It cures readily and quickly in good weather, but takes great injury from rain or even from heavy dews. In showery weather the cocks should if possible be protected by caps, and when stacked they should be topped out with other grass that turns the rain bet-

ter than crab grass. The yields of hay reaped in stubble fields run from 1 to 2 tons per acre on average land. The hay contains but little fiber and stands well in nutritive qualities and is much relished by stock. It has been claimed by good authorities that more hay is made from this grass in the South than from any other grass. Since it is so frequently used for this purpose, and since it costs only the harvesting of the crop, it has been called "the poor man's hay." In some instances after corn has been harvested it is cut for hay, but usually it would be a better plan to graze the grass under such conditions than mow it. When crab grass grows up strongly amid cow peas intended for hay, the grass will facilitate the curing of the hay when the crop is cut.

Securing Seed.—As the seed of crab grass is seldom, if ever sown, it is very seldom if ever saved for sowing. If wanted, however, it could easily be obtained by cutting with the binder and threshing the crop.

Methods of Eradicating.—It has been claimed that hay made from this grass has been more valuable acre for acre than the revenue obtained from cotton or corn. Nevertheless because of the trouble which it gives in cultivated crops, it would seem to be wise to discourage its growth.

To eradicate it is no easy task since it seeds so quickly and profusely, and the seeds retain germinating power for so long a period in the soil. The season for attacking it is that time of the year when it matures seed, and the aim should be to adopt those methods of eradication that will most quickly cause the seeds to germinate with a view to destroying them. The fol-

lowing methods are submitted among others that might be given: 1. Sow forage crops and graze them off as described in method 6 given for eradicating quack grass (see p. 247). Proceed thus for a term sufficiently long to effect the end sought. 2. Sow cow peas or some crop that requires cultivation from year to year and in alternation with grain crops for a period sufficiently long. No crab grass seeds should be allowed to mature in the cultivated crop.

CHAPTER XIII.

THE RYE GRASSES.

Of the rye grasses but three would seem deserving of the attention of those who till the lands of the United States and Canada. They are considered in the present chapter; these are Western Rye grass (*Agropyrum tenerum*), Perennial Rye grass (*Lolium perenne*), and Italian Rye grass (*Lolium Italicum*.)

Western Rye grass, native to the prairies of the American and Canadian Northwest, is possessed of considerable merit and is likely to be extensively cultivated in northern areas. Perennial and Italian Rye grasses have long been high in favor with the agriculturists of Europe. They have not been assigned an equally important place under American conditions but have sufficient adaptation to certain of these conditions to merit attention.

WESTERN RYE GRASS.

Western Rye grass (*Agropyrum tenerum*) is sometimes called Slender Wheat grass. The term Rye grass has doubtless been applied to it from the somewhat close resemblance which it bears to that plant. Although of the same family as quack grass, it does not send out underground stems like the latter. The name Slender Wheat grass has doubtless been applied to it because of

the resemblance which the long, slender and smooth heads bear to those of wheat. It is the only grass among the hundreds growing wild on the prairies of the West or Northwest which, up to the present time, has been found of sufficient value to give it a place among the cultivated grasses.

Western Rye grass is a perennial. Properly speaking, it is a bunch grass. It is the famous bunch grass of the bunch grass ranges of the Canadian Northwest. When growing on the ranges the height at maturity is from 12 to 18 inches, but under cultivation it grows to the average height of about 3 feet; in some instances, it attains to the height of 4 feet. When the plants do not grow too closely, they produce many leaves around the crown but these are not so numerous, nor do they grow as high as those of Russian brome grass. Several stems rise from one plant. These grow erectly and produce a head with an average height of about 6 inches but sometimes they are considerably longer. The roots are fibrous and abundant; the long tendrils from the same push away far downward into the soil. It is the root system of growth, doubtless, that gives the plant the marked ability which it possesses of withstanding drought.

Western Rye grass is one of the hardiest of grasses; none of the cultivated grasses excels it for growing under dry conditions. Under very dry conditions it will give better yields than Russian brome. It does not begin to grow so early in the spring as some other grasses, nor does it grow with much vigor in the autumn. It comes into flower from July first and onward and is a



FIG. 14.

WESTERN RYE GRASS (*Agropyrum tenerum*).

U. S. Department of Agriculture,
Washington, D. C.

great producer of seed. It will thrive under a great variety of conditions and will produce relatively large quantities of hay. Moreover, like timothy, the hay is easily handled; the seed is easily sown and the crops of hay and seed are easily managed.

While it is a good pasture grass, the season of abundant growth is not of very long duration. If pastured before the heading out stage, it is much relished by stock but not so much at a later stage of growth. The hay is eaten readily by stock, if cut early, but is not highly relished, if harvested later; and it produces but little aftermath.

Compared with Russian brome grass, its great rival in the entire American Northwest, the Russian brome starts earlier in the spring, produces a more abundant leaf growth through the season and especially in the autumn and furnishes hay that is better relished. But the Western Rye produces somewhat heavier yields of hay under like conditions; especially under dry conditions, it grows somewhat better on soils more or less impregnated with alkali; furnishes seed that is more easily secured and gives no trouble as the Russian sometimes does by remaining in the land. Both are strongly drought resistant, but in this respect the rye grass probably excels; both will grow well in moist conditions but in this respect the Russian brome excels; both are good soil binders but here again the Russian brome is somewhat ahead.

Distribution.—Western rye grass is indigenous to America. Although it has doubtless grown wild on the Western prairies during forgotten centuries, it was

not until 1883 that attempts were made to improve it by cultivation. In that year, Mr. Kenneth McIvor of Virden, Manitoba, Canada, gathered some of the seed with a view to test its qualities under cultivation. It was Mr. McIvor who first drew the attention of the public to its merits. In this way the Canadian and American departments of agriculture became interested in the distribution of the seed for experimental purposes in various provinces and states.

This grass will grow under a great variety of climatic conditions but is relatively better adapted to cool than to hot temperatures. Although it will grow more readily and vigorously in moist climates, it has peculiar adaptation for growing on the dry prairies of the West. No amount of cold seems to injure the plants.

Western Rye grass grows on the western prairies from California and New Mexico on the south to British Columbia and Athabasca on the north. It has also been found as far east as New Hampshire. On the plains of the western and more especially the northwestern prairies, it has rendered the best service in providing grazing for the live stock of the ranchman. Its most congenial home in a state of nature is the foothills and the bench lands of the Rocky mountains. In the western states it has rendered excellent service on the ranges from Nebraska northward. East of the Mississippi river other grasses, already introduced, so completely meet the requirement of farmers, that it is not probably western rye grass will be much grown in these.

In Canada although it will grow well under cultivation from sea to sea, it will be most helpful in the

provinces west from Lake Superior and especially in localities more or less deficient in rainfall. East from Lake Superior, timothy will meet the needs of the farmer better than western rye grass.

Soils.—There are but few grasses, if indeed any, which adapt themselves so well to a wide range of soils and soil conditions. As with other grasses, the better the soil the better the crop yields will be, but it will also give fair returns from sands and humus soils, so light as to lift with the winds. It has peculiar adaptation for being sown on prairie soils, and its great value on these consists in the comparatively good yields that may be obtained from it, under conditions too dry for the most successful growth of grasses that are more palatable. It will grow on heavy soils, as well as on those that are light, and will even give good returns on soils so impregnated with alkali that they will not grow a good crop of grain. When grown for a term of years on these, grain crops may then be grown successfully, but much alkali will, of course, prevent the successful growth of either.

Preparing the Soil.—In preparing the soil for this grass, it is better usually to plough in the autumn, and then to harrow at intervals in the spring, until the grass is sown about the end of May. By that time many of the weed seeds near the surface have been sprouted. When sown with a nurse crop which is to be harvested, it must, of course, be sown early. On soils that drift, the plan has succeeded well, which ploughs the land, not too early, so as to escape as far as practicable the usual season of soil drifting; to plough somewhat

deeply and then to sow along with some grain, any time between June and the early autumn when the ground is moist. Preparing the land and sowing the seed of this grass must be considered with special reference to the needs of areas, frequently short in rainfall, since it is in these that western rye grass will render the most important service.

Sowing.—Under the conditions where the necessity exists for sowing western rye grass, it can be sown with the best assurance of success somewhat late in May or in June, and on soil prepared by ploughing in the fall and giving successive harrowings in the spring. When thus sown, it is considered preferable to sow without a nurse crop; and then to mow once or twice to prevent weeds from seeding, leaving the plants cut to mulch the soil. The seed should be sown when the land has been moistened by rain. In some instances, pasturing has not been found hurtful. In many places, however, especially where the annual rainfall is reasonably ample, it has succeeded quite well when sown in the spring on fall ploughed land and with a lightly seeded nurse crop as 2 to 4 pecks of oats. In a normal season, the oats may be cut when ripe, but in a dry year they should be cut somewhat high for hay, as soon as fully out in head. When sown early on soils that blow, the grain should be allowed to reach the height of 2 or 3 inches before sowing the rye grass seed; but when sown on such soils after June first, it will answer to sow at the same time as the nurse crop. It may be sown by hand or with a hand seeder specially made to sow such grass seeds, which is wheeled over the ground when in use and covered

with the harrow; it may be sown with some makes of grain drill as, for instance, the "Superior" with a "vertical feeder." To feed out well, the seed must be well cleaned. It should be put in from 1 to 3 inches deep, according to the soil and season; when sown on soils that will drift after the grain is up, it is better to sow across the grain rows than in the same direction.

More commonly this grass is sown alone, and when sown for seed, it must be sown thus. For hay, it may sometimes be preferable to sow it with Russian brome grass as the latter aids in making a thicker stand by growing between the bunches of the rye grass, while the former aids in the quick curing of the hay. For pasture, western rye grass may be sown alone but better probably with Russian brome grass and in some areas with the said grass and timothy.

When sown alone, about 15 pounds of seed per acre is the correct quantity to sow; when sown with Russian brome grass $7\frac{1}{2}$ pounds of each may be sown for hay, using a little more seed for pasture; when timothy is added, the proportions would be about 6 pounds each of Russian brome and western rye and 4 pounds of timothy.

Pasturing.—Western rye grass furnishes pasture abundant and nutritious in the spring and summer months, but loses its succulence in the autumn, having a tendency, like various other range grasses, to cure in the soil. It is more nutritious than Russian brome grass or timothy, either as pasture or hay. Some growers pasture their meadows for a time in the spring but under some conditions this would be hazardous.

Harvesting for Hay.—Western rye grass should be harvested with much promptness or it will lose rapidly in palatability. When allowed to get ripe or nearly so, before it is cut, it will not be eaten readily by farm animals. It should be cut as soon as fully out in head which will be early in July. When grown along with Russian brome, the latter will be further advanced but it will not seriously injure it for hay.

It is harvested for hay with the mower and is handled in the same way as timothy; it is easily handled, being straight like timothy. The yield under ordinary conditions will run from 1 to 2 tons per acre, but under superior conditions of cultivation has yielded as high as 3 to 4 tons per acre.

Securing Seed.—Western rye grass seeds freely. Good average crops will produce 300 to 400 pounds of seed per acre and the seed weighs 20 pounds per bushel. But seed very clean and good weighs 25 pounds. The crop should be harvested with the binder and when the seeds are fully ripe. This may be known by the change in the color. It should then be harvested promptly or there will be loss of seed from shelling. It is threshed with the grain thresher and winnowed with the fanning mill, much the same as timothy. (See p. 75.) The seed is nearly as easily cleaned as that of an ordinary oat crop.

Renewing.—It is not usual to try to renew western rye grass, when it begins to fail, but rather to break it up by ploughing and sow again, if necessary. It will furnish remunerative crops of hay or seed for three or four seasons. The ground then becomes so settled and dry

that it does not yield so well, but it will maintain its hold on many soils for, at least, half a score of years. Like all cultivated grasses on the prairie, it is quite responsive to top dressings of farmyard manure. There is probably no better way in which such manure can be applied where this grass is grown.

PERENNIAL RYE GRASSES.

Perennial Rye grass (*Lolium Perenne*) is also called English Rye grass, Rye grass, Ray grass and Darnel. In some localities it is chiefly known by the name English Rye grass, and this name has doubtless come to be applied to it because of the extent to which it has been cultivated in England. In that country there are several varieties and sub-varieties named chiefly after seedsmen or seed-firms.

This grass is perennial and stoloniferous in its habit of growth, but like timothy, under ordinary conditions it is not a long lived perennial, seldom enduring for a longer period than seven years and usually for a period considerably shorter. The stems are numerous and slender and grow from 1 to 3 feet high, the average being less than 2 feet rather than more. Each stem has 4 to 6 joints, which sometimes assume a brownish tint. The leaves are numerous and succulent and of a darker green than those of Italian rye grass. The heads are slender and from 3 to 10 inches long though commonly not more than 6 inches. In general appearance perennial rye grass has some resemblance to quack grass (*Triticum repens*). The roots do not feed deeply. Stems push out laterally and from these the joints of the upright stems ascend.

Although perennial rye grass has long stood in the front rank among cultivated grasses in Britain, it may not become greatly popular in this country, for the reason, probably, that in the sections best adapted to its growth, timothy has stood higher in favor. While it is of a vigorous habit of growth, starts early in the season and produces reasonably good grazing and hay, it has some weaknesses. Being a shallow feeding plant, it is easily injured by drought; being a gross feeding plant it is exhaustive on the soil. It is too short lived to answer well for permanent meadows or pastures and cannot stand temperatures that are quite low in winter, nor great heat in summer. Moreover it is relatively low in nutrition and in a dry season produces but little aftermath after it is mown.

But under favorable conditions, that is on somewhat heavy soils, it is a great producer, more especially of hay, and it produces seed abundantly.

Live stock are fond of it both as hay and pasture, but its relatively low nutrition is against it for both uses. It is not well able long to withstand the crowding of certain other grasses; hence, under United States conditions it is usually better to sow it alone or along with other grasses or clovers intended for meadows of limited duration. It has also been recommended for lawns but for this purpose it is usually too short lived.

Distribution.—Perennial rye grass is native to Europe and probably parts of Asia and Africa. In the mild and temperate climates of England, France and other countries of Europe, it has long been cultivated, in England for more than two hundred years and in France for



FIG. 15.

PERENNIAL RYE GRASS (*Lolium perenne*).

Oregon Experiment Station.

a longer period. In Britain it is said to have been popularly grown at least one hundred years before the growing timothy and orchard grass became general. In some parts of the United States, particularly in the East and South, it has been grown to some extent for nearly a century, but at no time does it appear to have become greatly popular, under United States conditions, for the reason probably that timothy and orchard grass, the two great rivals of perennial rye grass in its own special domain, are considered superior. This grass grows at its best in climates that are temperate and moist. It is not well able to withstand extremes of heat or cold or drought, consequently its growth in the United States is likely to be confined to areas somewhat limited in comparison to the whole area.

Since this grass is best suited to a climate temperate and moist, it grows fairly well in much of New England, in the North Atlantic States, south of New England and in the states which border on Lakes Erie and Ontario. But the most popular conditions for its growth are probably found in Washington and Oregon, west of the Cascade mountains. In the upper Mississippi basin it does not very well withstand the extremes of heat and cold. At the Minnesota Experiment Station, St. Anthony Park, the author was able to secure a good growth of this grass in summer, but it died in winter. In the southern states, the summer heat is too great for this grass, and in the semi-arid belt and southwestern states, it is quite unsuited to the average conditions pertaining to plant growth.

In Canada, perennial rye grass is never likely to be

given an important place except in Southern Ontario and western British Columbia the winter climate is too cold for growing it in the very best form, and in these orchard grass and especially timothy are considered superior.

Soils.—The best soils for perennial rye grass are those that are moist, that contain a considerable content of clay, and at the same time are rich in nutriment. Light sands, low in fertility, are ill adapted to its growth. Nor is it well able to fight its battle on the stiffest clay. In Europe the many variations which characterize this grass have given it varied adaptation to soil conditions which are not easily specified. But few grasses respond more readily to applications of manure, solid or liquid, or to suitable dressings with commercial fertilizers.

Place in the Rotation.—Where the conditions are favorable for the growth of this grass, its place in the rotation would be much the same as for timothy. (See p. 57.) Briefly stated it would be in a rotation extending from 3 to 7 years. It would come in properly after a cleaning crop, and would precede a crop which feeds well on decaying vegetable matter in the soil.

Preparing the Soil.—The preparation of the soil suitable for perennial rye grass is about the same as what is suitable for timothy. (See p. 58.) Stated briefly the seed bed should be clean, finely pulverized near the surface, firm and moist, and may be made fall or spring. But since the seed is relatively high in germinating power, a stand may be more easily secured though

the preparation has been defective than with some other grasses.

Sowing.—Perennial rye grass may be sown in the autumn or in the spring. Early sowing is to be preferred both seasons when practicable, that the plants may enter the winter in a strong condition in the one case, and that they may better withstand dry weather in summer in the other. August and September would be favorable months for autumn sowing. In the spring it is usually considered preferable to defer sowing until the seed may be sown by hand and then covered with the harrow.

The seed may be sown alone or in certain combinations. When wanted for soiling food, it is usually sown alone; when wanted for hay it may be sown with advantage with red clover, as both mature early; when wanted for pasture it may be sown alone, but better with grasses not too aggressive in character. In the North, perennial rye grass, medium red clover and timothy would make a suitable combination on average soils, and in the South perennial rye grass, orchard grass and tall oat grass. As with all varieties of grass, it is commonly sown by hand, and covered with harrow or roller or by using both.

When sown alone not less than 1 bushel of seed is required nor more than 2 bushels. When sown with red clover 12 pounds of the rye grass and 10 pounds of the clover should ordinarily suffice. When timothy is added to the mixture the amounts of rye grass and clover respectively should be reduced. With orchard grass and tall oat grass in the South 12 pounds of the rye

grass should ordinarily suffice, but there may be good reasons for varying the same considerably.

Pasturing.—Perennial rye grass furnishes much pasture early in the season but not in the latter part of the same. Although it is relished by live stock before the time of coming out in head it is not so relished after that stage is reached, consequently when it is pastured it should be kept grazed down with at least reasonable closeness. Nor does it stand grazing as well as some other grasses. Consequently it is more frequently grown for hay or for soiling than for pasture. But on heavy soils it is much better for grazing than on those opposite in character.

Harvesting for Hay.—Perennial rye grass should be cut for hay when in blossom and in the early stage of bloom. Beyond this stage it becomes woody quickly. The method of cutting and curing are usually the same as for timothy. (See p. 72.) When grown alone this grass is probably better adapted to soiling than to any other use, since it is ready early in the season and when cut about the stage of coming into head or sooner quickly grows up again.

Securing Seed.—This grass is a heavy producer of seed. On rich soils it is claimed that it has produced as much as 40 bushels of seed per acre. This amount, however, is far beyond the average. There is perhaps no better way of harvesting this crop for seed than by cutting it with the binder, and curing in the long rather than in the round shock, and threshing with the grain separator. But there would seem to be no good reasons why the seed should not be gathered with the stripper.

This, of course, would leave the haulm upon the ground, but in any event it is not of very much value for food. Because of the abundance of the seed production, the seed does not command so high a price as that of many of the other grasses. The temptation, therefore, is ever present with seedsmen who are so minded, to mix the seed with that of other grasses which are higher. With some of these the fraud is not easily detected by the unskilled. Seed crops tend much to exhaust the fertility of the land which, of course, is so far an objection to growing them.

Renewing.—Since rye grass is grown in short rather than in long rotations it is not usually necessary to try and renew it, when the stand secured is only partial. It is usually considered more profitable to prepare land and sow again.

ITALIAN RYE GRASS.

Italian Rye grass (*Lolium Italicum*) is so named doubtless from the fact that it has long been grown in Northern Italy, from which it has been distributed into various countries. It is also sometimes called Ray grass. It does not seem to have been introduced into Western Europe until a period considerably later than the introduction of perennial rye grass.

Italian rye grass grows to the height of 2 to 3 feet. The leaves are abundant. The heads are slender, from 6 to 12 inches long and sometimes nodding. The fibrous roots have much power to gather food from the land on which it grows. The leaves are of a dark green and have a peculiar "glint" which makes a field of this grass look very beautiful when swayed by the wind.

This grass may be distinguished from other rye grasses by having short, armed or bearded spikelets, and by the quicker, larger and more vigorous character of the growth. It also differs from perennial rye grass in having broader leaves, in the better feeding quality of the grass and in its being less permanent.

Italian rye grass is biennial or perennial, frequently lasting two to three years. Under some conditions, however, it is an annual. The difference in duration arises doubtless from a difference in conditions of climate and soil and from a difference in the treatment of the plants. In climates with stern winters it is an annual. It would seem to stand foremost in rapidity of growth throughout the entire season of vegetation. As many as eight or ten cuttings have been made in a single season under forced conditions of growth. It has been known to produce soiling food in five to six weeks from the date of sowing and every few weeks subsequently, until the arrival of winter. But to grow thus rapidly the conditions for growth must be very favorable. It will endure any amount of forcing by way of irrigation and fertilization, the returns being usually proportionate to the attention thus bestowed upon it. It forms a dense turf while it lasts, but it is of course short lived. It is one of the earliest grasses in spring and one of the last to cease growing in the autumn. Some writers claim that it will endure both heat and drought well. Others say that it does not well endure drought and this view would seem to be correct. It cannot live through the cold winters of the northern states unless under very exceptional conditions.

It is quite palatable, even more so, it is thought, than perennial rye grass. It is valuable both as pasture and hay, but is not adapted to either permanent pastures or meadows. Its highest use is in furnishing soiling food for dairy cows and other stock. Under some conditions a sufficient area of this grass would furnish soiling food during all the season of growth. In this respect it is probably only rivalled by alfalfa. In nutrition, Italian rye grass does not stand so high as some other grasses.

Distribution.—Italian rye grass is native to Europe. In Lombardy it is thought its cultivation first began many years ago, and more especially in the irrigated districts of that country. It has been cultivated in France for at least a hundred years, and in England and Scotland for more than half a century. For several decades it has been tried in some parts of the United States. Notwithstanding, its cultivation has not become very general in any section of the country.

It has been claimed that it is equally well suited to all the climates of Europe. This claim is somewhat extravagant, as it will not endure extreme cold. It succeeds best in moist equable temperatures, hence the best results should be obtained from growing it, the soil conditions being correct, in the Central North Atlantic states and in those of the Pacific coast northward.

In the United States good crops of Italian rye grass may be grown on suitable soils in nearly every state in the Union, but in the southwestern states and in the Rocky Mountain states far northward, it would be nec-

essary to irrigate to grow it successfully, unless on the higher bench lands adjacent to the mountains. In the northern states from Montana eastward, it must, as a rule, be grown for what it will produce in one season, as in these it will succumb to the cold in winter. In the southern states it will endure longer. But it should render the best service North or South when grown for what it will produce in one season, as it so frequently succumbs to the cold of winter. It should render best service North or South where it can be grown under irrigation and to provide soiling food.

This grass could doubtless be grown in Ontario and Quebec, but could not be expected to endure the cold of winter in these Provinces of Canada. It is not likely to prove a marked success in the maritime provinces of that country, or on the western prairies, but it ought to succeed at least reasonably well in British Columbia.

Soils.—Italian rye grass will grow well on a variety of soils. Being a gross feeding plant and a rapid grower, it does best on lands rich in the ingredients that promote growth and in a mechanical condition favorable to the same. It will grow well, therefore, on moist alluvial and calcareous loams or marls, on moist rich loamy sands, on clays of medium tenacity, or on slough lands that have been drained and that are not too peaty in character. It will not grow so well on tenacious clays, nor will it give very good results on dry soils or worn lands of any kind, or on wet soils, notwithstanding that it is so well fitted for being grown under irrigation. It would not be easy to make land too rich for growing this grass at its best.

Preparing the Soil.—The preparation of the soil for this grass is much the same as for orchard grass (see p. 138.) It is particularly essential that the seed bed shall be moist or the rapid growth expected from the grass will not be forthcoming. In order to accomplish this considerable labor may sometimes be necessary when preparing the seed bed for being sown in a dry autumn.

Sowing.—In the Northern States and in Canada, the seed of Italian rye grass must be sown in the spring, otherwise the young plants will in many instances perish in the winter. In order to make the most of the one season's growth, it should of course be sown in the early spring; in the Southern States, after the autumn rains begin to fall, from August onward. It is then ready for cutting or pasturing early the following spring. October is a favorite month in which to sow. It is commonly sown by hand and is seldom sown in mixtures.

There would not seem to be any advantage from sowing it in mixtures of any of the winter cereals. The sand vetch would answer better, as the food would then be in better balance, and still better probably to sow with crimson clover, as the two plants would be ready for the first cutting about the same time. It is not advisable to sow the seed along with other grass seeds to make permanent pasture as it is short lived, and, in dying, would for the time being make vacancies in the pasture. But there may be conditions when it would be advisable to sow it for temporary pasture with a view to tide over, for the time being, a shortage in pasture.

The seed weighs 18 to 22 pounds to the bushel. The

amount to sow should be varied with the soil and the use that is to be made of the food. Thick sowing is necessary on very rich soils where growth fine in character is wanted. The amounts of seed mentioned as the proper amounts to sow, run all the way from 20 to 50 pounds per acre, but, in the judgment of the author, from 20 to 30 pounds should be sufficient. When sown with crimson clover, 10 pounds each of the rye grass and clover under average conditions would be proper amounts to sow.

Pasturing.—Although as previously intimated, Italian rye grass is not valuable as permanent pasture, it furnishes excellent temporary grazing. When devoted to such use, however, it should be kept well grazed to prevent the plants from reaching the earing stage, as like other grass pastures they will then produce more and better grazing. In the far South it will produce winter grazing at a time when both Johnson grass and Bermuda grass are dormant. The color of the butter made from the milk of cows grazed on it has been praised. Because of its great power to take up fertilizers quickly, its growth may be stimulated by applying certain of these, as may be desired, either when grazing this grass or growing it for hay.

Harvesting for Hay.—Owing to the rapidity with which Italian rye grass grows, it may be made to produce two or more cuttings a year of hay and several cuttings of soiling food. When irrigated, the water should be applied at once after each cutting. It is then also that liquid manures and other forcing fertilizers ought to be applied. This is frequently done in Great

Britain and also in some countries on the continent. It should be cut for hay when coming nicely into bloom and for soiling food after it has made sufficient growth to make it worth while cutting it. In Louisiana it has been cut for hay as early as April. And in some parts of the South it has been cut for soiling food in December, from seed sown earlier in the autumn. Under favorable conditions several tons of cured hay are harvested per acre. The mode of harvesting for hay is about the same as would be suitable for timothy (see p. 72).

Securing Seed.—This grass, like perennial rye grass, seeds freely. A seed crop and one hay crop at least should be obtained the same season, and also a seed crop and more than one soiling crop. Whether seed should be taken from the first or second cutting should depend on conditions such as relate to climate and growth. The aim should be to have the seed crop mature when the weather is usually favorable for harvesting the same. It should also be taken from that cutting for the season in which is found fullness of growth without excessive rankness. The seed may be harvested with the binder, dried sufficiently in long shocks and threshed with an ordinary grain thresher. The yield of seed from an ordinary crop should be not less than 20 bushels per acre. The seed is grown to some extent in the counties of Polk, Benton and Del Norte, California.

Renewing.—It would seem possible to renew this grass by scattering seed over the sod every year or every second year, at a suitable season and harrowing it care-

fully. But it is questionable if, as a rule, such renewal would be profitable, as after a time, the fertility of the soil would be much depleted unless heavily fertilized, and its mechanical condition would become such as to prove less favorable to abundant production than if the seed were sown on newly ploughed ground and in proper rotation. Sowing afresh, therefore, on properly prepared land is preferable to renewing.

CHAPTER XIV.

MISCELLANEOUS GRASSES.

In this chapter will be discussed several grasses, each of which is possessed of more or less value under cultivation. Wire grass (*Carex vulpinoidea*) is placed at the head of the list, because of its great value, but recently discovered by the manufacturer. Then follows Texas blue grass which promises much to the farmers of the South in furnishing winter grazing. After these come certain grasses which have been found of more or less value to agriculturists in various parts of the country, but which are not so generally grown, as nearly all those previously discussed. These are Rough Stalked Meadow grass, Fowl Meadow grass, Rescue grass, Sheep's Fescue, Carpet grass, Velvet grass and Australian Saltbush. Lastly, the discussion of those grasses is taken up which give promise of considerable value under cultivation and yet the degree of that value has not been demonstrated through cultivating them. But two are included in the list, viz., Blue Joint (*Calamagrostis canadensis*) and Blue Grama (*Bouteloua oligostachya*).

WIRE GRASS.

Wire grass (*Carex vulpinoidea*) is a grass, the growth of which is confined to marshes. It is not to be confounded with various other grasses, which grow

on dry soils and which are frequently designated wire grass, as for instance Kentucky blue grass (*Poa pratensis*). Wire grass is so named, doubtless, from the tough character of the stems, so tough that they resist distension in a marked degree without breaking.

This grass is a perennial, which grows to the height of about two feet generally. Usually much of the growth is made while the soil, which produces it, is yet covered with water for a short distance above the surface. The water gradually subsides as the season advances and has entirely disappeared from the surface by the time that the grass is ready for being harvested. The stems are relatively numerous. The panicles produce seed if the spring should happen to be so dry as to stunt the grass in its growth; but in ordinary seasons and under conditions which favor vigorous growth, it is said that it does not produce seed. It has a creeping root-stock and the roots form so strong a turf that heavy loads can be driven across wire grass meadows, which rest upon a cushion of miry peat oftentimes several feet deep.

This grass does not begin to grow until the frost leaves the ground for some distance below the surface; but it grows rapidly in the late spring and early summer; and is ready for being harvested in July. It retains its greenness for several weeks; hence, the season of harvesting is frequently prolonged. It is practically useless as food for live stock, owing to the woody character of the stems. It has been used to some extent by upholsterers, but now it is chiefly used in the manufacture of binder twine, furniture, mats, rugs and

articles of clothing, all of which are enduring. The articles made from it are not only useful, but they are unique and attractive; even ladies' hats are now being manufactured from this material.

Distribution.—Wire grass is native to America. While more or less of it is found in various states and provinces, the chief centres of production at the present time are the numerous and large marshes of Northern Minnesota, Northern Wisconsin and Manitoba in Canada. The area of this grass is decreasing in some quarters with the gradual recession of the waters of the marshes. In others it is increasing as in the gradual lowering of the waters of lakes with sedgy shores.

Soils.—This grass grows only in peat soils, or, more properly in marshes or bogs, in which the peat is decayed more or less but only on and near the surface. It is essential to the life of this grass that a certain degree of watery saturation shall be preserved during much of the year; and yet the water should not rise much above the surface of the ground, for any considerable length of time or the grass would perish. On the other hand where too little water is present and for too short a portion of the year, wire grass will give way to other forms of grass, possessed of higher food value.

Place in the Rotation.—Of course, wire grass is not a rotation plant, in the ordinary sense in which the term is used, and yet there is a sort of rotation in which nature has placed it. In the gradual evolution of the lower forms of plant life, it has a place between the mosses and bushes, which cover muskegs and marshes;

and the rushes and sedges which grow around the edges of certain lakes on the one hand, and the redtop and blue joint grasses on the other.

Preparing the Soil.—While nature sows wire grass, the sowing can only prove effective where the conditions are favorable to the sowing of the grass. Where the watery saturation is excessive, as in muskegs or in certain shallow lakes, the waters must be lowered by nature or by man. In settled states, recession in the waters advances with the advance of cultivation into lands not previously tilled, hence, the growths mentioned, as preceding wire grass are gradually being supplanted by the same. Particularly is this true of peat bottomed lakes. When the recession advances beyond a certain degree, the wire grass fails to be supplanted in turn by blue joint or redtop. These changes made by nature are slow. In many instances, it is possible to hasten them, as when the outlets of these watery situations are of such a character that the waters may be in part drawn off. When thus lowered sufficiently, fire may be made to run over the surface of the muskeg in the spring, while the frost is still near the surface to kill the tea bushes and burn the moss. If this were done in the dry autumn, the fire would burn down into the peat. With the bushes dead and the moss burned, nature does the rest. Where she gets seed enough to sow whole marshes so as to transform them into meadows in two or three seasons is in a sense one of the mysterious things. Equally mysterious is the source of the seed supply, which, under certain conditions, will transform a wire grass meadow, in a few seasons, into

one of blue joint or redtop. Something approximating to the above, is the preparation of soil, required for the introduction of wire grass. Where the grass has not been cut the previous year, it is necessary to burn it off with fire. This is best done in the spring while the frost is yet up to the surface of the ground. Dead grass amid the green crop would render the latter unfit for manufacturing purposes.

Sowing.—From what has been said, it will be apparent that, up to the present, nature has been found sufficient to the task of sowing the seed; the attempt by man to sow it has never probably been made; yet man has a duty to perform, where these meadows are to be made permanent. Attention must needs be given to the water supply and to the removal of the same. This cannot always be done, but in many instances, it can. Many of those wire grass meadows are found in lowlands, where shallow lakes abound. This makes it possible to lower the water so as to drain the meadow in getting it ready for harvesting; such draining is further facilitated by the presence of certain open ditches cut through the meadows where needed. It is also possible by damming up the outlet to flood the land sufficiently at certain seasons of the year, since in some of those meadows the fall is not more than one foot per mile.

Pasturing.—Wire grass does not furnish good pasture. Live stock will not eat it, if they can get other grass, owing to its toughness and probably to its want of palatability.

Harvesting.—The harvesting of wire grass begins

early in July or as soon as the grass is fully headed out and it may be continued until the autumn, when necessary, but the late cut grass is not nearly so valuable as that cut early. The cutting is done by self-rake reapers which leaves the grass in sheaves, where it dries on the ground. Men follow the reapers and straighten the sheaves for the "gleaners." When the grass is dry enough, the gleaners follow; lift the sheaves from the ground and bind them. They are then drawn on wagons to hay sheds and are finally baled for shipment to the factory. The horses which do the work on the meadows are shod with bog shoes, and the wagons have wide tires. Late in the season, the grass is cut and bound with binders.

Securing Seed.—No attempts have probably been made to secure the seed of wire grass and it is questionable, if it will be necessary to give attention to the matter for many years, if indeed ever. The grass seems to require dwarfing or stunting in order to make it produce seed. The seed is triangular in outline, and ripens in July. It could most conveniently be gathered probably by the stripper but may be also harvested and threshed like the seed of other grain.

Renewing.—The only sense in which it would seem possible to renew this grass, where it begins to fail would seem to be by regulating the water supply. As it is necessary to keep the grass practically free from other grasses, where redtop and blue joint come in around the edges of the meadow, the only practical way to remove them would be to submerge them until they would vanish. There are also certain grasses of the

sedgy order which grow amid the wire grass in the depressions. How to get rid of these is not easily apparent without lowering the water unduly for other portions of the meadow; nor has it been determined how long a wire grass meadow can be maintained and whether the same can be mowed every year without interruption. It is probable, however, that with the proper regulation of the water supply, those meadows may be rendered permanent for many years.

It is fortunate that valuable uses have been found to which this grass has been put. The discovery is making highly productive thousands and tens of thousands of acres of peat lands that must otherwise have remained unproductive for many years.

TEXAS BLUE GRASS.

Texas blue grass (*Poa arichnifera*) might well be named the blue grass of the South, as it promises to do for much of the Southern country what blue grass has done for the North. As it becomes known it is more prized in the South, where, along with Bermuda grass, it furnishes grazing practically all the year.

This grass has considerable resemblance to Kentucky blue grass, not only in appearance, but also in its habit of growth. It is taller, however, the stems of the latter growing to the height of 1 to 3 feet. The leaves are long and slender. The panicles are 4 to 6 inches long and densely flowered. The roots are creeping.

Texas blue grass is a hardy perennial and one that has a vigorous habit of growth.

It grows quite vigorously during much of the winter in nearly all parts of the South. It has been stated that it has been known to grow 10 inches in as many days in Texas at that season. It blooms in April or May according to the latitude. Even as far north as Tennessee, it will keep green and furnish grazing through all or nearly all the winter. It soon forms a dense turf which stands grazing well. Although the plants produce seed readily, the seed is woolly in character, hence it is not easily handled or sown. It is more easily propagated by means of root cuttings.

It is much relished by all kinds of stock and stands grazing well, hence it is well adapted for permanent pasture. It will make food for hay, if cut in season, but its highest use is to provide winter pastures. After being cut for hay or grazed in spring, it pushes up readily when the fall rains come after the rest of summer.

It is the complement of blue grass in the South, a plant with nearly all the good qualities of the former and adapted to southern conditions.

Contrasted with Kentucky blue grass, the Texas blue is taller and of stronger but coarser growth. The rhizomes are also larger and stronger. It stands more drought and heat than blue grass, and is even better fitted for winter grazing, but it will not stand low temperatures as well as the other.

Distribution.—Texas blue grass is a southern grass. It is native to Texas and probably some other parts of the South. It is said that it was first brought into cultivation by Geo. H. Hogan of Texas. It has been



FIG. 16.
TEXAS BLUE GRASS (*Poa arichnifera*)
U. S. Department of Agriculture,
Washington, D. C.

tried in all the states of the South and Southwest, and for all or nearly all of these it has much promise. It has been found hardy as far north as Ames, Iowa. In Kansas, it has given no little satisfaction

It has not been fully determined as to how far north it may be grown with profit, but it would seem safe to say, that it would not be necessary to grow it where full crops of Kentucky blue grass can be grown, since the latter will doubtless be more valuable in its own proper field.

Soils.—Texas blue grass will grow on any good soil. It does best on alluvial soils, but all soils that will grow corn and cotton will grow this grass. It will also grow on worn lands, but it requires a longer time to establish it on these.

Preparing the Soil.—The preparation of the soil is virtually the same as for Bermuda grass (see p. 119), especially when the root cuttings are planted. This means that it is possible to establish it on worn land, that is now growing such products as sage brush and sassafras.

Sowing or Planting.—Texas blue grass is frequently sown, but owing to the woolly character of the seed it is not easily sown. It may be sown in the spring or the early autumn, preferably the latter, and with or without a nurse crop, but preferably with one, if the nurse crop is not too thickly sown. The woolliness of the seed makes it difficult to sow even by hand. It may be, however, that the improved seeder which is driven like a wheelbarrow will sow it all right and

with ease to the sower. About 10 pounds of seed per acre ought to suffice.

This grass can be established at least as quickly and even more surely by planting the divided roots. The preparation of the land and the planting of the roots may be done in much the same way as Bermuda grass is planted (see p. 120), but the root cuttings of the Texas blue grass should be planted closer because of the less power which it has to multiply rapidly. Two feet by one has been mentioned as a suitable distance, for planting the root cuttings. Whether it will answer best to sow it alone or in mixtures does not appear to have been fully determined. Some have thought that by growing it along with Bermuda grass the two would furnish grazing all the year, but experiments with that aim in view have thus far not been markedly successful.

Pasturing.—This grass would seem to be especially well adapted to the growing of pasture in the South. In these, it will grow more rapidly than Kentucky blue grass and will produce much more grazing. It has been claimed, that in this respect, it is not surpassed by any other grass, in the South. It grows early, and although it does not grow quickly in dry summer weather, it comes on at once after the autumn rains begin to fall, and grows through much or all of the winter, according to the locality, thus furnishing winter forage freely. It keeps green through nearly all the year, even as far north as Tennessee. It forms a thick turf and stands grazing well. It is particularly

well adapted for permanent pastures in its own particular domain.

Harvesting for Hay.—This grass, being a much stronger grower than Kentucky blue grass, furnishes more hay. It should be cut like other grasses when in bloom. It may be harvested the same as timothy.

Securing Seed.—This grass, like the Kentucky, seeds freely and may be harvested with the binder.

Renewing.—Although information is not plentiful with reference to this question, it would seem to be quite practicable to renew this grass by disking it once or twice or oftener when it becomes sodbound and applying fertilizer. Breaking up the roots with the plow as in renewing Bermuda grass would be too severe treatment for Texas blue grass unless done with care and skill.

ROUGH STALKED MEADOW GRASS.

Rough Stalked meadow grass (*Poa trivialis*) is also known by the names Rough meadow grass, Roughish meadow grass, Green grass, Common meadow grass and Orchiston grass. The designation Rough Stalked is given to it because of the roughness of the stems below the panicle. The name Orchiston grass has been given to it because of its abundance in the grass lands of Orchiston near Salisbury, England.

This grass is closely related to Kentucky blue grass, but it is taller and more slender and has a rougher stem. The root is also fibrous, whereas that of June grass is creeping. It is a perennial and grows to the height of 1 to 3 feet. The stems are decumbent at

the base. The leaves are numerous, flat, and from 3 to 6 inches long. The panicle is open and resembles a narrow pyramid in form. It is quite open and from 3 to 8 inches long.

It is best adapted to moist conditions. It grows well amid the shade and protection furnished by other grasses, produces a sweet and fairly nutritious hay, and is greatly relished both as hay or as pasture by horses, cattle or sheep. In Britain, it is much preferred to June grass, although it is considerably later in its habit of growth. It multiplies only by means of the seed, hence in a few years it dies out, even in permanent pastures.

Distribution.—This grass is found in Europe, North Africa and Siberia. It has been introduced into America. It is said that it has been longer cultivated than any other *poa* and the statement is probably true. It is still in high favor in England and also on the Continent.

Rough stalked meadow grass prefers a moist and temperate climate. It has not been very extensively grown in this country, but where tried under suitable conditions has proved itself to be a useful grass. On low lands, it should do well from Lake Superior to the Gulf of Mexico. The little attention that has been given to its introduction in the United States is owing in part at least to the difficulty of obtaining good seed and to the high price of the same.

Soils.—Rough stalked meadow grass, like redtop, is adapted to soils low and moist. This does not mean that it will not give returns on productive upland or prai-

rie soils, but that the best returns will be obtained from moist humus soils of the slough order from which the surface water has been sufficiently removed. It should not be sown on clayey, gravelly or sandy knolls.

Place in the Rotation.—Rough stalked meadow grass, like redtop, is not adapted to short rotations. Much of what has been said of the place for redtop in the rotation will also apply to this grass.

Preparing the Soil.—The preparation of the soil for rough stalked meadow grass is about the same as for redtop. (See p. 155.)

Sowing.—The best time to sow rough stalked meadow grass in the North is the early spring, and in the South, the early autumn, providing enough of moisture is in the soil. It may be sown by hand or with the improved seed sower that is wheeled over the ground. The seed is not easily sown by hand, owing to its woolly character. It proves more satisfactory when grown in mixtures. It may be profitably sown with orchard grass, redtop, fowl meadow grass and timothy, when providing pasture. In providing hay, orchard grass should be omitted as it ripens considerably earlier than the other grasses named. The most suitable of these for sowing in conjunction with rough stalked meadow grass are redtop and fowl meadow grass. If sown along with Kentucky blue grass, the latter will in time crowd it out. The yields of hay will be much increased by sowing rough stalked meadow grass along with other varieties that are grown under like conditions. This grass has also been recommended for sowing in certain low lying woodland pastures.

The seed weighs 14 pounds to the bushel. When sown alone one bushel ought to suffice; when sown with other grass, the amount of seed required will be influenced by the number of the grasses sown, and by the use that is to be made of them, also by adaptation in soils. In mixtures it will seldom be necessary to sow more than 7 pounds per acre and frequently much less than this amount will suffice.

Pasturing.—While this grass stands pasturing reasonably well for a season, close grazing will injure it in time, especially in warm situations. The aftermath is said to be more nutritious than the hay.

Harvesting for Hay.—The hay is cut and harvested in about the same way as timothy. (See p. 72.) The yields are heavy on good soils, and it has been said are always greatest in mixtures. It has been claimed that in England it will yield more than rye grass, but this statement will probably apply only to certain localities. Testimony is agreed as to the high quality of the hay.

Securing Seed.—As the seed of rough tailed meadow grass is very largely if not entirely imported, American methods of saving it cannot be given. It would seem reasonable, however, to suppose that it could be saved by much the same plan as Kentucky blue grass. (See p. 101.)

Renewing.—When this grass fails, it will probably be found better to re-sow than to try renewal by adding seed from time to time, but to this there may be some exceptions.

FOWL MEADOW GRASS.

Fowl meadow grass (*Poa serotina*) belongs to the same genus as Kentucky blue grass. It is also called False redtop, Duck grass and Swamp wire grass. Because it sends forth flower stems from the lower joints after the main panicle has bloomed the term *serotina*, ever-flowering, has been applied to it. It is said to have been introduced into a low meadow near Dedham, Massachusetts, by wild ducks and other water fowl, hence the name Fowl Meadow grass.

The stems of this grass are somewhat weak, hence they are considerably given to lodge. They grow from 2 to 3 feet high. The leaves are narrow, smooth and plentiful. The head is from 6 to 14 inches long and is erect and spreading, when in bloom but more or less contracted and drooping, when ripe. The roots are slightly creeping. Fowl meadow grass is perennial. It is nutritious, makes excellent hay and also yields abundantly on suitable soils. The hay is highly palatable to stock, but owing to its softness is not considered quite equal to timothy for horses, nor does it furnish quite so marketable a hay as timothy. It is somewhat late coming into flower and does not grow much aftermath. Its highest use is for being grown along with certain other grasses on low lands for making hay.

Distribution.—Fowl meadow grass is native to Europe and also to many parts of America. It has been grown under cultivation in New England for more than one hundred and fifty years. Jared Elliott wrote commendingly about it in 1749, when contrasting its merits with those of timothy. It forms a considera-

ble proportion of the hay crop in New England, but does not appear to be cultivated to any very great extent in other states although indigenous to several of these. In the southern states, it grows well on suitable soils, but has not been very extensively tried on these. On low lands in the central states, more attention should be given to growing this grass in mixtures than has heretofore been accorded to it. In Ontario also and other parts of Eastern Canada, the grass grows in good form. Its cultivation in Europe does not appear to have been greatly successful.

Soil.—Soils well supplied with humus are best adapted to the growth of this grass. It will even succeed in slough lands, over-moist for some other grasses. It succeeds admirably on bottom and intervale lands that are occasionally overflowed, and yet it does not stand submergence for any considerable period, especially when the weather is warm. But it will succeed in sands too wet for the ordinary processes of comfortable tillage. It will also grow well on uplands which consist of moist warm soil. It should not be sown on dry soils, on stiff hard clays, or on sandy or gravelly soils.

Place in the Rotation.—This grass is not really a rotation grass, but like redtop it may be made such under certain conditions. (See p. 154.) Its highest adaptation is found in meadows of some permanency. When grown in bottom lands that are readily tillable, it may come after any crop to which clean tillage has been given, as corn or potatoes, and may be followed by any crop or succession of crops adapted to such

lands and especially to such as flourish best on plentiful supplies of humus. A hay meadow of this grass will last for many years, if properly managed.

Preparing the Soil.—The preparation of the soil for fowl meadow grass is much the same as for redtop. (See p. 155.) It may also be introduced into lowlands congenial to its growth by sowing the seed without ploughing the land, but such introduction will of necessity not be rapid.

Sowing.—This grass may be best sown in the early spring in the northern states and Canada, but in the southern states it would doubtless be better sown in the autumn. It may be sown alone, or what is better in the mixtures that have adaptation for lowlands, as, for instance, along with timothy or redtop when sown for hay and along with one or both of these when sown for pasture with blue grass added. Alsike clover may also be added for both uses, but alsike and fowl meadow grass would not go well together for making hay, except with some stiffer grass as timothy to support them. The seed is usually sown by hand and covered with a light harrow. It weighs 12 to 14 pounds per bushel, but when very well cleaned weighs 19 or 20 pounds. When sown alone not less than 2 bushels of seed should be used. When sown along with other grasses the amount will of course vary with the kind and proportions of the other grasses sown.

Pasturing.—From spring until the early autumn fowl meadow grass furnishes good grazing, but after a hay crop the aftermath is not abundant. As a pas-

ture grass it serves a better purpose in mixtures than alone.

Harvesting for Hay.—In the northern states fowl meadow grass blossoms in July and August. It is best cut when in flower. But if not harvested at that time, the stems fall down and especially from the lower joints other flower stems are sent up. Because of this habit of growth the grass suffers little through deferred cutting. In fact it has been claimed that the highest production in weight and nutrition is obtained for the hay that is cut late. It may be cut any time from July to October and is harvested in the same way as timothy, but will probably require more time on an average to cure because of its softness. Jared Elliott claimed that it would make better hay for shipping than timothy but the testimony of the intervening years has demonstrated that the opposite is true.

Securing Seed.—It is not so easy to secure the seed of this grass as of some others, owing to the lodging habit which characterizes it. To cut it with the binder set high would seem to be one of the best ways of cutting the grass for seed, but the author cannot cite any instance based on actual experience in which the work has been done in this way. The part left uncut could then be pastured or even cut for hay. Much care is required in threshing and cleaning the seed. Average yields may be set down at 6 to 7 bushels per acre. As it is not easy to distinguish the seed from that of some other varieties of grass, it is much adulterated. That is one reason why it, and several other more or less useful grasses, are not sown to a greater extent than they are.

Nevertheless, when the cultivation of a grass popular a century and a half ago does not extend greatly, the conclusion would seem to be correct, that the grasses more generally cultivated stand higher in the popular estimate.

Renewing.—A grass that produces seed during so large a portion of the season has no little power to re-seed the soil on which it grows if not grazed too closely. When thus treated it should endure for a long time.

RESCUE GRASS.

Rescue grass (*Bromus unioloides*) is also known by the names of Schraeder grass, Australian grass and Arctic grass. It is closely allied to Chess or Cheat (*Bromus secalinus*). A grass which grows vigorously even under hard conditions and which produces good hay and pasture, but which when once introduced is likely to appear in future grain crops grown on the same land. But the hazard is not so great that rescue grass will remain in the land where it was grown. This grass grows erectly and from 1 to 3 feet high. It produces an abundance of leaves. The panicles are large, much branched, loose and nodding. They present a beautiful appearance as they sway to and fro in the wind. The plants tiller much under favorable conditions of growth. The roots are fibrous. The whole plant bears considerable resemblance to *Bromus secalinus*, but it is probably more leafy, and hence so far a better pasture grass. The seeds resemble those of the former so closely that they are frequently sold under the name of rescue grass.

Rescue grass is an annual, but if eaten closely it will live for a longer period than one year, in some instances for 2 or 3 years. It is essentially a winter grass and should usually be sown for the purpose of providing winter pasture. Although it does not grow rapidly at first, it does later, hence, in the far South, it may be made to furnish grazing in January and February, and later may produce a crop of hay. It matures in March and April in Texas. It furnishes good grazing and good hay, but if allowed to go to seed the seeds will germinate later and appear in the next crop.

Distribution.—Rescue grass is said to be a native of South America. It has been grown to some extent in all the states of the South, but has been grown to a greater extent in Louisiana, Mississippi, Alabama and Georgia than in the other states. It will endure the cold of winter in latitudes considerably higher, but there would seem to be no good reasons for growing the plant where it will not provide grazing in winter.

Soil.—This grass will grow best of course in rich strong soils, but it will grow, though more feebly, in poor and thin soils. If grown on the latter, it should be stimulated by liberal fertilizing.

Place in the Rotation.—Rescue grass being essentially an annual and a winter grass may come anywhere in the rotation, whether it be a long or a short one. When winter grazing is much desired, it may be grown from year to year, alternating with cow peas. The latter fertilizes the soil for the rescue grass and, if ploughed under, will furnish a supply of humus.



FIG. 17.

RESCUE GRASS (*Bromus unioloides*).

Tennessee Experiment Station.

Preparing the Soil.—As the seed of rescue grass should be sown in the autumn, the ground may be prepared any time previously during the summer. After winter crops, ploughing and subsequently pulverizing will make a timely and suitable seed bed. But if any considerable amount of the seed is allowed to drop in the pastures, and if some such crop as cow peas is made to follow the seed which has fallen, it will germinate in the autumn and produce grazing or hay and, in some instances, both if desired.

Sowing.—Rescue grass is best sown in the autumn. Ordinarily it is not sown until the fall rains come, as it does not germinate earlier, hence it is commonly sown in September or October. But in some seasons it starts earlier. In other seasons it will not start until December or January. Moisture and reasonably cool weather are two of the essentials necessary to the successful growth of rescue grass.

It is commonly sown alone, but may be sown along with crimson clover and certain other plants. When sown alone about 30 pounds of seed will suffice per acre. If sown with other plants the amount of seed should be correspondingly reduced.

Pasturing.—While this crop furnishes excellent winter grazing, it would not be correct to claim that it will furnish more grazing in the aggregate than winter oats, but it has been claimed that it has greater power to furnish grazing in cool weather, as for instance, in January and February, when such grazing is most needed. It is then especially serviceable in providing food for brood mares with autumn foals, milch cows, ewes with

young lambs; calves and brood sows. In some loose soils, the stock grazing upon it will to some extent pull it out of the soil.

It is possible to grow rescue grass for pasture for successive years on the same land and with undiminished yields, by simply allowing some of the seed to drop in the pasture, and then ploughing and enriching the land in early summer by applying manure or artificial fertilizer, or by growing cow peas as already intimated. This plan may be commendable when winter grazing is wanted, located quite near to the buildings.

Harvesting for Hay.—As already intimated, rescue grass may be grazed in the winter and then allowed to grow hay or mature seed later. The hay crop in Texas and Louisiana from this grass is ready for being harvested in March or April. It is cut and cured like orchard grass. (See page 143.) The hay is not difficult to cure. The proper season for cutting is that of early bloom. While this grass makes good hay, it is in no way superior to that made from winter oats, and some are of the opinion that the average yields are not equal to those obtained from oats. Good yields of hay may be set down at 2 tons per acre, but on good bottom lands the yield will be considerably larger.

Securing Seed.—It is not difficult to secure seed from this grass. When ripe it may be cut with the binder and threshed and cleaned like wheat. The yield may be set down as varying from 20 to 35 bushels per acre. The seed weighs 14 pounds per bushel.

Renewing.—From what has been said above it will be apparent that the renewal of this grass may be

brought about by simply allowing the seed to drop in the pastures. There is the objection to this, however, that the seed may remain ungerminated in the soil and grow in succeeding crops. Because of this, some writers advise against the sowing of rescue grass for any purpose and the advice should certainly be heeded by the careless farmer. Those who cultivate carefully, however, should have but little to fear from the introduction of this grass upon their farms.

SHEEP'S FESCUE.

Sheep's Fescue (*Festuca ovina*) is a low growing grass which has the habit of bunching in dense tufts. The leaves are short, very fine, slender, and almost bristle-like in their erection, and not infrequently are characterized by a grayish color, tinged with red. The stems are slender, not particularly numerous, and grow from 6 to 12 inches high, but usually do not attain a height of more than 8 inches. The heads are short and slender, somewhat one-sided, and they spread more or less when in flower. The roots are fibrous. The extent to which sheep have been grazed on it has doubtless given to it the name Sheep's Fescue.

There are several varieties of this plant which bear no little resemblance to one another. One of the best of these is Hard Fescue (*Festuca durinacula*). The latter is taller than Sheep's Fescue, less densely tufted and equally if not even more hardy.

Sheep's Fescue is a perennial. It has much permanency, more particularly in lands where the growth is not overshadowed by larger plants. It is very hardy.

Though too small to grow as hay, it has been found quite useful under some conditions in providing pasture for sheep and cattle, both of which are very fond of it. It is also highly nutritious. In America, it has not been much introduced into cultivation; but it may be advisable to sow it under some conditions.

Distribution.—This grass is probably native to Europe, Asia and North America. It has rendered much service in providing grazing on the arid plains of Asia. It will grow in many sections of the United States and Canada, and, where the conditions are hard, may frequently be made to render considerable service in furnishing pasture. It has special adaptation to Rocky mountain areas. Being extremely hardy, it is on the whole better adapted to northern than to southern conditions. Its chief value lies in furnishing pasture on dry soils where better grasses refuse to grow. It has much power to grow on dry, sandy or gravelly soils, on clay hills and on rocky mountain slopes with but a thin covering of earth.

Place in the Rotation.—Sheep's Fescue is not a rotation crop, since it is not commonly sown on prepared land; but of course it may be grown in rotations in pastures of more or less permanency.

Preparing the Soil.—This grass is indigenous to many sections. In these the question of soil preparation and of sowing is not greatly important. In such areas, the grass usually grows, as it were, spontaneously, and if not kept grazed too closely will scatter the seeds so as to thicken the grazing. Scattering seed on unbroken land, which is not covered with a close



FIG. 18.

SHEEP'S FESCUE (*Festuca ovina*).

Tennessee Experiment Station.

grass turf, will usually result in establishing the grass in the same.

Sowing.—The seed may be sown in the spring or in the autumn. When sown on unbroken lands, it is usually sown alone. But it is also sown sometimes with mixtures intended for permanent pastures, and in making lawns. If sown alone to make a lawn, seed would be required at the rate of 2 bushels per acre. To form a dense pasture quickly of Sheep's Fescue alone, would call for about the same amount of seed. When sown in permanent mixtures, it is not usual to sow large quantities of seed, usually not more than 3 or 4 pounds per acre; but there may be instances in which it would be advisable to sow much larger quantities of seed.

Pasturing.—This grass well withstands close and prolonged pasturing. It has much power to retain its hold upon the soil, and when grown amid other pasture grasses helps to form a dense turf. In the Highlands of Scotland, this grass has helped to furnish grazing for sheep for centuries.

Harvesting for Hay.—Sheep's Fescue is seldom or never harvested for hay under American conditions. The yields in the form of hay are usually so much less than those of some other hay grass grown in the locality, that hay is seldom sought from the latter. But of course it can be cut for hay. When so cut it must be handled with many tined forks, because of the shortness and fineness of the product.

Securing Seed.—The supply of seed is all or nearly all imported. The grass seeds freely in proportion to

the number of the seed heads. And seed could of course be grown under American conditions, but whether its growth would be highly profitable at the present time is questionable, owing to the limited demand for the seed. In the latitude of New England, the seed matures in July. There is probably no way of harvesting it, that will prove so satisfactory as gathering the seed with the stripper. It weighs 12 to 14 pounds per bushel. The yields are not very large as the seed heads are not very numerous relatively.

Renewing.—To renew this grass means the application of more seed. This may be done in pastures by simply allowing some of the seed to ripen and become strewn with the wind, or by adding some more seed at the proper season or seasons. In the absence of positive experience, it will probably be found that sowing soon after the seed matures in the summer or in the quite early spring, will secure the end sought.

For Lawns.—Sheep's Fescue has been much used for lawns under certain conditions. When thickly set it makes an attractive lawn, and has the merit of growing slowly, thus lessening the number of the cuttings required, but a lawn made of this grass is not darkly green as other grass lawns. This, however, has the charm of novelty in addition to the dense character of the sward.

CARPET GRASS.

Carpet grass (*Paspalum platycaule*) is sometimes called Louisiana grass. It is so named doubtless for the reason that it is native to Louisiana, and has been grown there with considerable success. The specific

name means flat stem, so given because of the flatness of the stems and leaves. It is also called Blanket grass, for the reason probably that it forms a close dense covering which spreads over the earth like a blanket. The softness and denseness of the covering is like that furnished by a carpet, hence the name commonly applied to it.

This grass is extensively creeping in its habit of growth. It is a perennial. The stems near the ground are broad and thin. The leaves are not only broad, but short and bluntlike. The stems lie almost on the ground and frequently root at the nodes. From these they send up many leafy or flower bearing branches from 5 to 25 inches high, but more commonly not more than 12 inches. These are naked and at the apex nearly always divide into 2 or 3 small spikes or flower bearing branches from 1 to 2 inches long. The creeping stems spread rapidly and soon form a dense sod, which crowds out other plants. It is evergreen at the far South. It can well withstand protracted drought. It forms a very dense sod and has been found helpful in binding soils that wash.

It is much relished by live stock and makes good hay, but, owing to its strongly creeping habit of growth has to be cut low. It is not so nutritious as Bermuda grass.

Distribution.—Carpet grass is now grown more or less in all the southern states, but it grows at its best in those which border on the Gulf. It will also grow in the southwestern states in the presence of enough of rainfall. It will also grow as far north as the north-

ern boundary of Tennessee, but will succumb to severe winters in portions of the state. There is no useful place for it further north than the state named.

Soils.—This grass will grow in almost any kind of soil, but, like every other variety, it grows best in good soils. However, its ability to grow in soils so light that they wash and to bind them speaks well for its growing powers.

Place in the Rotation.—Since carpet grass is perennial in its habit of growth, it is not really a rotation plant when grown for permanent pasture, but of course it may be made such by breaking up the sod. Since, however, it takes some time to form a sod, it is not considered good practice to make the rotations short. It is adapted to the same rotation as Bermuda grass. (See p. 118.) But, unlike Bermuda grass, it is easily removed from the soil. Since it is easily injured by the shade of stronger plants, it can be best started in clean soil. It is not adapted to woodlands.

Preparing the Soil.—Much that has been said about preparing the soil for Bermuda grass will also apply to carpet grass. (See p. 119.) But on many of the soils of the South it is able to establish itself without covering.

Sowing or Planting.—This grass is propagated by means of the seed and also by means of root cuttings. much of what has been said about the propagation of Bermuda grass will also apply to carpet grass. (See p. 120.) When the seed is good, it is not necessary to sow it thickly because of the ability of the grass to spread and thicken in the soil. But it would be easily

possible to carry the idea of thin seeding too far. It should not be planted in conjunction with Bermuda grass, as it has a tendency to crowd out the former, which is the more valuable.

Pasturing.—Although carpet grass furnishes good grazing it ought to be grazed rather closely, in order to get the most that can be gained from it. This is necessary because of the creeping habit of the growth. It grows earlier in the season than Bermuda and also later, consequently it is better adapted for winter grazing.

Harvesting for Hay.—For the same reason that it is necessary to graze carpet grass closely, it is also necessary to mow closely for hay. The hay is not equal to that obtained from Bermuda grass as it is more composed of stems. Though not a handsome lawn grass, it is sometimes grown in lawns. But, when closely shorn in these, it forms a very perfect-like sod which is attractive.

Securing Seed.—This grass seeds freely. In this one explanation is found of the frequency with which it comes amid other crops and in by-places. The seed is not yet handled by seed houses. It is doubtless correct to say, that when sown, only a few pounds of seed are required per acre.

Renewing.—If some seeds are allowed to mature and fall to the ground, it is not difficult to cause the grass to thicken where the plants are few and straggling. The habit of rooting at the joints also facilitates renewal, where, from the overshadowing of large plants, growth had been injured.

VELVET GRASS.

Velvet grass (*Holcus lanatus*) is also known by the names, Meadow Soft grass, White Timothy, Salem grass, Velvet Lawn grass, Velvet Mesquit grass, Soft grass, Yorkshire grass and Yorkshire Fog. The three names mentioned last have been applied to it in England. It is also known by various names on the Continent. The name Velvet grass has doubtless been given to it because of the resemblance which it bears to the softest velvet, in appearance and touch.

This grass grows from 1 to 2 feet high, but in some parts of the South where it has improved by acclimation, it grows from 2 to 4 feet high. The stems are round and grow erectly. The leaves are plentiful. The panicle is 2 to several inches long and is variously tinted, but more commonly the tint is a whitish green, pinkish or purple. The roots are fibrous. This beautiful grass is so striking in its appearance and is so different from other grasses, that it is sure to be noticed and admired wherever seen.

Velvet grass is perennial in the North, but not strictly so in the South. Notwithstanding its beauty, it ranks low in economical value. It grows so readily on some soils when introduced as to almost assume the character of a weed. Live stock are not fond of it either as pasture or as hay, since it is spongy, insipid and deficient in saline properties. But its nutritive value is said to exceed that of timothy or orchard grass. Yet since it will grow on soils too poor to grow many other grasses, it has a useful mission in some sections of the country. It is not to be confounded with Creep-

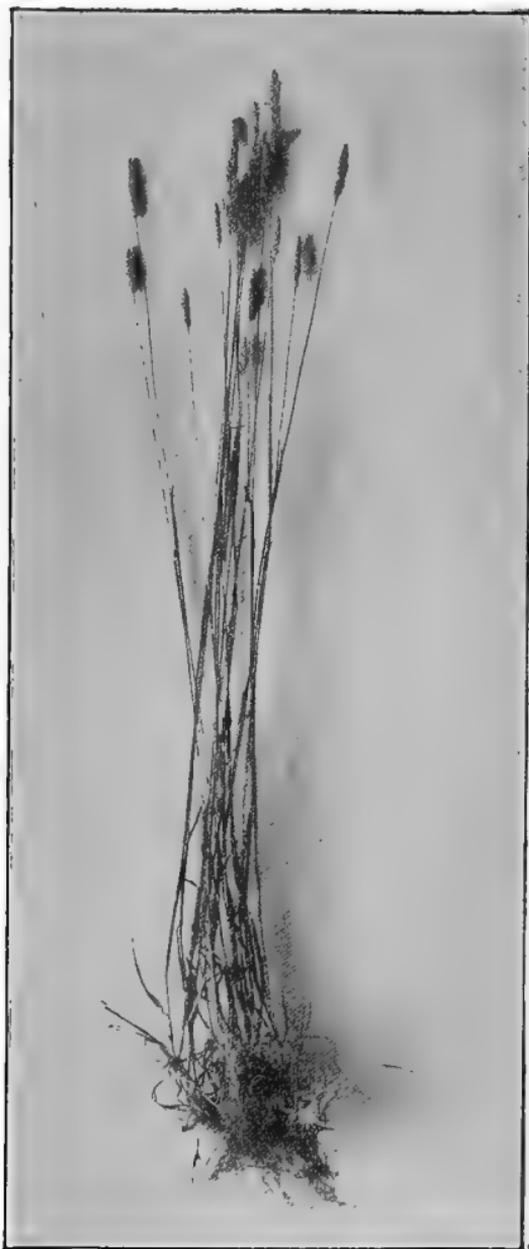


FIG. 19.

VELVET GRASS (*Holcus lanatus*).

Oregon Experiment Station.

ing Soft grass (*Holcus mollis*), which is regarded as a troublesome weed. The latter has a creeping root and an open and spreading panicle.

Distribution.—Velvet grass is native to Europe. In the moist climate of Great Britain, it grows so vigorously as almost to assume the character of a weed. It was introduced many years ago into several of the states, more especially those south and west. It is a fairly hardy grass but is best adapted to climates moist and free from great extremes, especially of cold and drought.

In this country it has been grown much more in the southern and western states than in those northward. In these it has not only been tolerated, but its growth has been encouraged in instances not a few. It will grow well in New England also, and in all or nearly all the states where the rainfall is normal. But the attempt should not be made to grow it, where other grasses can be grown successfully, that are relished by live stock, and that are at the same time sufficiently productive. In limited areas in nearly all the southern states, it has been cultivated to some extent, and in some instances with advantage. In eastern Oregon, along the coast of which, it has been cultivated, it has become so aggressive in meadows as to be troublesome. In the dry areas of the semi-arid country, it is not likely to prove helpful. It will grow in Canada, in Ontario and eastward, also along the Pacific, but is not needed in these areas, where better yields can be obtained from grasses that are superior.

Velvet grass will grow in almost any kind of land,

however poor, but it grows best on moist peaty land. It will grow on light thin lands, on dry sandy and gravelly soils, or on retentive clay hills, when insufficient moisture is present. When properly sown on these, it will not only produce crops, but when ploughed under, it prepares the land for growing other and better crops.

Place in the Rotation.—From what has been said, it will be evident that velvet grass is not properly speaking a rotation grass. When grown it should rather be to produce pasture or hay on poor soils. When ploughed up, however, it should of course be followed by such crops as experience has shown can be grown with profit under the conditions.

Preparing the Soil.—It is not necessary to take so much pains in preparing the land for this crop as for many grasses that are grown, but, when sown, the aim should be to so prepare the land when practicable, that a good stand would likely be secured. Under some conditions, however, velvet grass will ultimately possess land if the seed is simply scattered over the same in the late summer or early autumn.

Sowing.—The time for sowing velvet grass varies with the locality. In the North, all things considered the early spring would be the best season, but, doubtless, sowing late would sometimes answer. In the South the seed may be sowed also in the early spring, but it is better to sow it in the autumn from August onward, according to the nature of the weather. In the extreme South, when sown in August, the crop may be cut for soiling food in January and February,

and later if desired for seed. It is usually sown alone, as when sown with better grasses it is likely to crowd them, and it is also less relished by the stock as pasture or hay. The seed being very light is sown by hand and because of its lightness must be sown with care. It may also be propagated by dividing the roots and planting them, but this process is unnecessarily slow and tedious. In the South it may be successfully sown under some conditions at the last cultivation given to corn, the sorghums or root crops. From 10 to 14 pounds of seed are usually sown per acre.

Pasturing.—While this grass is not considered a good pasture grass, because of its low palatability, there are localities in which it will not only be eaten by live stock, but in which its presence is much preferable to no grass. In the presence of better grasses the stock will pass it by ungrazed. This allows the seed to ripen and scatter before the winds which it does readily because of its lightness. It is thus increased in pastures. Under these conditions, the aim is to get rid of it rather than to allow it to increase.

Harvesting for Hay.—Like nearly all kinds of grass, velvet grass should be cut at the blossoming stage. Under average conditions it comes into flower in June, but in some locations in May. Its presence in good hay is not desirable, for the same reason that it is not desirable in pastures, but under some conditions it can be grown where hay cannot be made from grasses of superior quality. In these it is much better than no hay. Fertilizing mixed pastures or meadows in which this grass is growing, tends to increase its growth, the

opposite of what usually follows such applications on inferior grasses where these may happen to be growing.

Securing Seed.—Velvet grass seeds freely and is therefore quite productive of seed. Several bushels are obtained from an acre. The seed is light, weighing not more than 6 to 7 pounds per bushel, under the methods of cleaning that have prevailed. The demand for the seed is not brisk, consequently not much attention is given to the production of the same. The crop may be harvested much in the same way as meadow fescue. (See p. 204.)

Renewing.—Velvet grass will renew itself, if some of the plants are allowed to go to seed in the pastures. This would mean of course, that grazing should not be close when such a result is desired. Velvet grass pastures may be thus maintained for many years.

AUSTRALIAN SALTBUSH.

The Saltbush is essentially a product of the semi-arid country, although it will grow even more readily under favorable conditions. It is of several species. The variety which seems to meet with most favor in this country is that known as the Australian (*Atriplex Semmibaccata*). It is so named, doubtless, from the fact that it was introduced from Australia.

In its essential characteristics and habits of growth it is more like a bush or shrub than like a grass. The plants are spreading and drooping rather than erect. Stems rise up numerously from the crown of the plants. They are slender and covered with many branchlets, and these in turn are thickly covered with long rather

than broad leaves. After growing upward for a short distance, the branches reach outward and many of them droop. In this way branches from a single bush have been known to extend a distance of 8 feet in every direction from the crown of the plant, but usually they are much less in size, especially when they are crowded. The stems become quite woody for some distance from the base as the plants grow older, hence the outer portions are much more suitable for food. The roots go down deeply into the soil and subsoil. In hard pan soils they are not much branched, but under conditions the opposite the branches are numerous and spread out in every direction.

Australian Saltbush is perennial. It furnishes pasture and also hay for horses, cattle, sheep and goats, where other plants that furnish these in more desirable forms will not grow. The best service which it thus renders is in soils so impregnated with alkali that they will sustain but few forms of vegetable life.

Distribution.—Plants of the Saltbush species are native to both the old and new worlds. The Australian Saltbush is doubtless native to Australia and was introduced into California in 1888.

It is adapted to warm climates. How far north it may be grown has not been determined, but unless beside the Pacific, it is questionable if it will endure the winters further north than Spokane in Washington. It will of course thrive much better under favorable conditions as to moisture than under those the opposite. Nevertheless, its growth has been satisfactory where the rainfall has not exceeded 5 inches.

This plant may be expected to render the best of service in the warmer and drier portions of the semi-arid belt, including the states of California, Nevada, Utah, Wyoming, Colorado, New Mexico and Arizona. It may be said with safety that it has no mission for Canada nor is it likely to be grown in any part of the United States where range grasses will grow reasonably well.

Soils.—Australian Saltbush will grow best on good soils, but it will also grow on soils that are shallow and underlaid with hardpan, when it has once been established. It is likely to take its place side by side with the sage bushes that grow on the sandy stretches of the semi-arid west, and to reclaim to productiveness wide stretches which the alkali present in the soil has heretofore kept destitute of vegetation. It must not be understood, however, that this plant will grow in all alkali soils.

Place in the Rotation.—Australian Saltbush is of course not a rotation plant. When once established the aim is to keep it growing. It is probable, however, that where it has been grown for some time on alkali soils, it will so improve them that they will thenceforth sustain one or more of the grasses proper.

Preparing the Soil.—The best methods of growing Australian Saltbush under American conditions have not been fully worked out. Since, however, moisture is necessary to induce germination, and since precipitation is light, where this plant grows the plan which works the ground on the surface during the summer, something after the manner of caring for a bare fallow

to prepare it for autumn seeding, would probably be the best.

Sowing.—Some authorities have recommended germinating the plants in the greenhouse and then planting them out. But this plan will not answer for large areas, owing to the cost. The seed should be scattered on land prepared as described, in the autumn, at which season some precipitation may be looked for, and to cover it with the harrow. But, on some alkali soils, better results will be obtained from sowing the seed on certain alkali lands on undisturbed surfaces, and pressing the same into the surface soil by running over it a heavy roller. Under yet other conditions, as when the plants are liable to be disturbed by weeds, it has been recommended to sow the plants in rows several feet apart and to give them some cultivation for a time. It is not usually necessary to seed heavily, since, when the plants have once become established, they will scatter seeds and will thus form additional plants if allowed to do so.

Pasturing.—Grazing with horses, cattle, sheep or goats may take place at any season that the animals will eat the plants. There is no dispute as to the plants being nutritious since they are relatively rich in protein, but much difference of opinion is expressed as to the palatability in the same. It is pretty certain that domestic animals, unless it be goats, will prefer grass when they can get it, but that in the absence of grass they will feed upon the Saltbush pastures with readiness. The best service probably which these plants will render is in producing winter grazing.

Harvesting for Hay.—In a dry climate there should be no real difficulty in making Australian Saltbush into hay in much the same way as other hay is harvested. It makes a coarse woody hay, but in situations where better hay cannot be obtained, it is vastly better than none, since range animals will feed upon it with more or less of relish in the winter season. However, it is better adapted relatively to furnish winter grazing in mild climates than to furnish winter hay.

Securing Seed.—But little is known as to the best methods of securing the seed of this plant under American conditions. This phase of its cultivation has not been well worked out. Fortunately it seeds freely. The plan of cutting it with a self-rake reaper and threshing with a separator would seem to be quite feasible. The author has not been able to get any information as to the yields of the seed or to the mode of preparing the same for market.

Renewing.—Australian Saltbush has not been grown long enough in this country to admit of gleaning much information on this question. But the fact that it is able to increase by self-sowing is significant. This should make it possible to control the renewal of pastures by simply allowing the plants occasionally to produce more or less seed.

PROMISING GRASSES NOT YET TESTED.

When the ranges of the west and northwest came to be opened up, the expectation was cherished, that among the many grasses growing on them, some would be found that would so respond to cultivation, as to prove more valuable for some conditions, than many of the

older cultivated grasses. This expectation has been realized only in a slight degree. The only range grasses that are coming into general cultivation to any considerable extent at the present time are western rye grass (*Agropyrum tenerum*), in the North and Texas blue grass in the South. Notwithstanding the value of these grasses, they cannot be placed in the very front rank.

Among those not yet tested under cultivation, or only partially tested, are but two varieties, which are possessed of any considerable promise when cultivated. These are Blue Joint (*Calamagrostis canadensis*) and Blue Grama (*Bouteloua oligostachya*). It is of course possible that other range grasses may yet be brought to the front, but the hope of this does not seem bright at the present time.

Blue Joint (*Calamagrostis canadensis*).—This grass is perennial. It grows to the height of 3 to 6 feet and is surmounted by a panicle, rather narrow and purplish in color. It bears considerable resemblance to that of redtop, but it grows much higher and larger. The leaves are large and very abundant. The roots are creeping and the root system is very heavy.

Unlike other grasses, known as blue joint, on the range it grows only in moist situations and produces much more abundantly than these.

Blue Joint grows with great rapidity in May and June, and is a great yielder, giving generally from 2 to 4 tons per acre of excellent hay, that is much relished by live stock.

It is distributed over nearly all the northern states,

but, uncultivated, its growth is confined to marshy ground and to lands situated along creeks and rivers, that are sluggish in their flow. It is found in the Mississippi basin as far south as northern Missouri, but is most abundant in the marshes of Michigan, Wisconsin, Minnesota and Manitoba in Canada.

Blue Joint prefers marshy lands, too wet for reedtop and too dry for wire grass. It thrives best on decomposed or partly decomposed peat, but has also responded encouragingly when tested at the experiment station at Ames, Iowa.

In a natural state, its place in the rotation has been given. Under cultivation, it would probably answer best as permanent meadow; nor can anything be said, at present, based on experience as to the best methods of preparing the land and sowing the seed.

The plants seed with considerable freedom and mature their seeds in July. It should be cut for hay not later than the early flowering stage, or it will lose much in the palatability, but in this respect it does not lose to the extent of many other grasses. The hay is eaten with much relish by all classes of farm stock and is said to be of average nutrition. While in a state of nature, though eaten readily by stock at the proper season for grazing, which is late in May or early in June, the ground is usually too soft for such grazing. It is probable that the seed could be best secured by setting the binder as high as possible and binding into sheaves.

This grass should certainly be carefully tested in an experimental way on low lands, to which cultiva-

tion may be given and which are underlaid with peat. It is possible, that under conditions more dry than those where it now grows at its best, it would not endure long. Notwithstanding it is certainly worthy of further investigation.

Blue Grama (Bouteloua oligostachya).—This grass belongs to a somewhat numerous family, which have special adaptation for warm, dry range conditions. It has also been called Mesquit of Mezquite. It is the most promising of all the grama grasses, although the variety Tall Grama (*Bouteloua racemosa*) has been well spoken of. Blue grama grows to the height of 6 to 18 inches, but seldom exceeds the height of 12 inches, under range conditions; under cultivation it grows higher. The leaves are numerous, narrow and firm. The spike is 1 to 5 inches long. It has strong rhizomes and forms a dense turf.

It is a hardy grass and specially drought resistant. It is much relished by live stock as pasture or as hay. It seeds freely and has the property of growing when rain falls and then seeding and curing as the weather becomes dry.

This grass extends from the Mississippi to the Pacific and from British Columbia to Mexico. In Montana it is called Buffalo grass and frequents the bench lands at elevations from 3000 to 5000 feet above sea-level. It grows at its best between latitudes 36 deg. and 42 deg. north.

It has great power to grow under dry conditions, but will also grow better where moisture is more abundant. Its highest utility will likely consist in re-cloth-

ing ranges, where other grasses have failed, through overstocking, hence it is not likely to be a rotation grass. When cultivated, it will grow and thrive under conditions more dry than would be suitable for other cultivated grasses.

Blue grama is a nutritious and palatable grass and stands grazing better than almost any other range grass. This is owing, in part at least, to the dense turf which it forms, notwithstanding that it is a bunch grass. The hay is considered about the best produced on southwestern ranges and, in some areas, is about the only hay obtainable. The seed can be obtained, under cultivation, like that of other grasses, by stripping or reaping and threshing, but information with reference to growing it is very meagre.

Blue grama is certainly deserving of careful experiment, more especially in the range states. At the Oregon Railroad and Navigation Company's station at Walla Walla, Washington, in 1899, it gave the most satisfactory results in growing hay and seed, among the many varieties tested at that station.

CHAPTER XV.

TEMPORARY PASTURES.

Pastures are of two kinds, temporary and permanent. The former, sometimes called rotation pastures, are grown to provide grazing for but a limited number of years; in some instances, for only one season and seldom for more than three seasons. The second are grown to furnish grazing for an indefinite number of years, usually for a long period and in some instances, as in the case of range lands and lands that are untillable, for all time. The term rotation pastures is applied to the former because they form a part of a regular or irregular rotation grown in conjunction with grain and other crops.

Temporary pastures are usually, but not always, grown in some sort of alternation with crops grown to provide hay or soiling food, but usually the former. In nearly all instances, when hay is taken from these crops, it is taken from the first crop. Sometimes the crop is made into hay for two successive seasons and then pastured for one or more years. In some instances but one crop of hay is taken and one of pasture; in others several crops of both are taken. More commonly, however, hay is grown for two successive seasons and the crop is then pastured for one or more seasons. The hay crops are taken first because larger

yields are obtained then than could be obtained later, and because weed growth is thus better kept in check than it would be if the first crop were grazed.

When growing these pastures, a due regard must be had to the quick setting of the grasses and varieties must be chosen that reach a maximum of production quickly, as for instance timothy. Grasses that do not reach the zenith of productiveness for several years, as for instance blue grass, should not be sown in these pastures. In very many cases, clover, in one or more of its varieties, is made to form a part of these pastures. In growing them no combination is more frequently used than timothy and clover. Careful attention should also be given to the choice of varieties that mature at nearly the same seasons of the year. The necessity for this arises from the advantage to the hay crop when all the grasses composing it can be harvested at the proper season. In laying down permanent pastures, the opposite course should be adopted in order to furnish continuous growth throughout the season.

When pastures are wanted for but one season, they are usually furnished by growing clover of one or more varieties, millet in one of its varieties, sorghum, one of the non-saccharine sorghums, vetches, rape, kale and the small cereal grains sown alone or in conjunction. The growing of these for pastures is discussed in "Forage Crops Other Than Grasses" by the author. Readers who desire information with reference to the growing of these pastures are referred to the said volume.

GRASSES ADAPTED TO VARIOUS CONDITIONS.

Since grasses differ much in the degree of their adaptation to various conditions, a brief discussion with reference to such adaptation will follow. The question will be discussed from the standpoint of conditions such as apply to soil, climate and ability to grow under shade.

For Upland Pastures.—In the northern states and Canada, cultivated grasses, best adapted to ordinary upland soils in producing temporary pastures, are timothy, orchard grass, Russian brome, redtop, and western rye grass. Meadow Fescue and tall oat grass are not included, since several years are required to grow them at their best. Timothy, though not of highest value in producing pasture through the season, is, nevertheless, extensively sown for such a use, since it will grow over a wide area, sets quickly and has special adaptation for being sown with the red clovers on upland soils. When Russian brome is wanted for temporary pastures, it should be sown thickly so as to get a full stand the year after sowing. The method most commonly adopted in obtaining temporary grazing in the North is by sowing timothy and red clover, as a full stand of these may be obtained the year after sowing them. Blue grass and white clover come into these pastures in many sections without being sown. In much of northwestern Canada, this combination is not successful since clover, heretofore, has failed to grow satisfactorily. When these pastures are to be maintained for four to six years, more attention should be given to adding the seed of orchard grass and redtop than has been given to the sowing of these in the

past. The grasses of lesser value for the conditions named are Italian rye, tall oat and perennial rye grasses.

In the southern states those grasses best adapted to such conditions are tall oat, orchard, redtop and in some parts timothy and rescue grass. Those of less value for pasture include Italian rye, perennial rye, velvet grass and in some parts carpet grass. Bermuda and Texas blue grasses are both adapted to permanent grazing.

For Slough Lands.—In the northern states and Canada, the cultivated grasses, best adapted to slough lands and such as are low-lying but drained, are timothy, redtop and Russian brome. Any one of these alone or in combination may be made to furnish good grazing in such situations better than they will furnish on ordinary upland. The grazing may be further improved by sowing alsike and white clover with these pastures. The mixture, most frequently sown on such lands, is a combination of timothy, redtop and alsike clover. The cultivated grasses less frequently sown on such lands include fowl meadow, rough stalked meadow and Italian rye grasses.

In the southern states, redtop is the best pasture grass for such situations. Timothy and also Italian rye grass will answer in some localities. In the South, however, it is relatively more important that temporary grass pastures shall be supplemented by pastures furnished by sowing certain grasses alone or in mixtures. Further reference will be made to the sowing of these in the present chapter.

For Sandy Lands.—The range of adaptation in cultivated grasses for sandy or gravelly lands is not wide and it narrows as the conditions become drier. For temporary grazing on such lands, winter rye, not a grass in the ordinary use of the word, will furnish more pasture than anything else. Of the true and valuable cultivated grasses, Russian brome stands first in adaptation for such situations, but even this grass will not provide abundant grazing on such lands. Where moisture is ample, the production on these lands may be greatly stimulated by fertilizing them and then sowing red clover along with the grass. This is one of the situations in which sowing quack grass seed may in some instances be admissible in the North, and velvet grass in the South, where Russian brome grass does not succeed so well. In these southern pastures, Japan and Buffalo clovers will prove helpful in supplementing the grazing.

It may also be found, especially in the dry uplands of the West and Southwest, that it may be advisable to introduce tall grama (*Bouteloua racemosa*) and blue grama (*Bouteloua obligostachya*), but more experience in growing these is wanted before pronouncing definitely with reference to this question.

For Dry Areas.—For dry areas such as those of the semi-arid belt east of the Rocky mountains and in certain of the plains within the mountains, it is at least questionable if any of the cultivated grasses will be found any improvement over those which nature has placed there. Nor has the fact been fully demonstrated, that any of these can be established over wide

areas of the range in the absence of cultivation. It may yet prove, however, that Russian brome and blue grama may be found able to supplant the grasses growing in certain areas of the prairie where the former have in part succumbed to close pasturing. This question is further discussed in Chapter XVIII. (See p. 452.)

For Wet Soils.—Soils, that are saturated with water during any considerable portion of the year, are ill adapted to the growth of grasses that are valuable, when viewed from the standpoint of food producing properties. Those that are covered with water annually for any considerable time have still lower adaptation for such production. The deeper the water that covers, and the longer the period of such covering, the less valuable is the grass production that follows. If better grasses are to be grown, the lowering of the water should first engage the attention of the grower. Where this cannot be done, the work of improvement is well nigh hopeless. Grasses and sedges that grow under these conditions are usually coarse, low in nutritive qualities and still lower relatively in palatability. Some grasses, however, grow in such situations that may possess considerable feeding value. Such is what is popularly termed blue joint (*Calamagrostis canadensis*) which grows in certain of the swamps of Minnesota, saturated in winter and ordinarily dry in summer. Others are valuable for manufacturing. Such is wire grass (*Carex vulpenoidea*) which grows in peat swamps and others again are valuable only for litter.

It is interesting to note the improvement that takes

place in the grasses that grow on soils that were marshy as drainage progresses. The impassable muskeg, for instance, in the northern states will sustain only the Labrador Tea shrub. Lower the waters of the muskeg, and wire grass dies to make way for some better grass—how much better will be determined by the character of the underlying peat. The evolution that may be accomplished by the drainage of some marshes is very great. But this does not apply to all marshes, as in some the peat is of such a character that it cannot be speedily made to sustain a vigorous vegetation for a prolonged period, after the removal of the water.

Some grasses will grow well in lands so low as to be saturated for several days and even weeks, when the weather is cool, providing the water does not rise above the surface or does not cover it more than two or three inches. The four valuable grasses best adapted to such situations are Russian brome, redtop, fowl meadow, timothy; alsike clover is also possessed of such adaptation. During warm weather, such saturation is usually injurious.

For Growing in Shade.—Grasses differ much in their adaptation for growing in shade. As the country grows older, it is legitimate to expect that park-like pastures for live stock will more and more abound. If this expectation is realized, the question of adaptation in grasses to such conditions will become increasingly important. Orchard grass, heretofore, has stood highest in the popular estimate for being grown under such conditions; meadow fescue can also endure con-

siderable shade. It may yet be found, however, that Russian brome will rival even orchard grass in its ability to grow beneath the boughs of trees. At the Indian Head experimental farm, Assiniboia, Canada, this grass is virtually covering the ground amid the windbreaks on the farm. Kentucky blue grass has considerable power to grow in such situations. In growing any grass beneath the shade of trees, the fact, that the feeding value of the same is lessened in proportion as the density of the shade increases, should not be overlooked.

GRASSES FOR THE STATES AND PROVINCES.

The attempt will be made to name the grasses that are suitable for furnishing temporary meadows and pastures, adapted to the various states of the Union and the different provinces of Canada. To facilitate this work these will be divided into several groups. In making these divisions the plan will be to include the states and provinces in the same group in which the production is similar or approximately so.

For the Northeastern States.—The northeastern states are intended to include in this discussion all those states that lie north of the Ohio and Potomac rivers and east of Lake Michigan and Illinois.

The grasses which have suitable adaptation for these are those which have suitable adaptation also for the provinces of Canada east from Lake Huron to the Atlantic. The grasses which will best furnish temporary pastures in these include timothy, orchard grass and redtop, valuable, all things considered, in the order named. Notwithstanding that the value of orchard grass for grazing may be intrinsically superior, timothy

fits so well with medium red, mammoth and alsike clovers for growing hay that it is almost invariably sown with one of these and mowed for one or two years; then pastured for about the same length of time before the sod is broken.

For the relative amounts of seed to sow when timothy is sown with medium red clover, with mammoth clover, or with alsike clover, see p. 69. If sown with two of these, the quantity is reduced. As previously intimated, timothy and medium red clover are more commonly sown on uplands; timothy and alsike are sown on lowlands. Orchard grass is more commonly sown in conjunction with medium red clover. For the proper amounts of seed to sow, see p. 140; for the amount to sow alone, see p. 140. Redtop, as previously intimated, has highest adaptation for low lying lands not only because it grows better in these, but because these are usually grazed for a longer period than uplands before being broken, which better suits the considerable time required by this grass to become established. But upland soils also may be so congenial to the growth of this grass, that it may prove profitable also to sow it in these, when the pastures are not of short duration. When medium red or mammoth clovers are sown on upland soils along with timothy, orchard grass and redtop to provide hay and pasture about 6 pounds of either of the clovers per acre and 3 pounds of each of the other grasses should be sufficient. Redtop is usually sown on lowlands with timothy and alsike clover. For the amounts of seed to sow, see p. 158.

In the area named, Kentucky blue grass and white clover are much prone to come into the pastures even though temporary in character, hence, it is not necessary to sow them.

The grasses with less adaptation for such pastures in these states include Russian brome, tall oat, rough stalked meadow and fowl meadow grasses. Russian brome will grow well over all this area as pasture or as hay, but it is slow in becoming established. It is less easy of establishment than some of the others named, and it is less necessary to grow it than under other climatic conditions. A few pounds of tall oat grass seed sown along with clover and timothy or clover and orchard grass may prove helpful. Two pounds of alsike clover seed may also render good service when sown with one or more of these grasses and clovers, in certain upland soils.

In all the area now being considered, these grasses may be sown alone or with a nurse crop, but preferably with the latter, as then a crop is secured while the pastures are becoming established.

For the Southeastern States.—This group of states comprises those which lie between the Ohio and Potomac Rivers and the Gulf of Mexico, also the states of Arkansas, Louisiana and that portion of Texas which is adjacent to the Gulf of Mexico.

The grasses in it, best adapted to the production of temporary pastures and meadows include orchard, tall oat, redtop and timothy, valuable probably in the order named, when considered in their adaptation to the whole region. These grasses are sown singly or in

combination, with or without a nurse crop. The best season for sowing is the autumn, after the fall rains come and early enough for the grass to get a firm hold upon the soil, before the advent of winter. In certain parts of this area, especially those that lie to the northward, red and alsike clovers may supplement these grasses, but toward the Gulf the conditions are not highly favorable to the growth of these. When these grasses are sown alone 28 pounds of orchard grass should suffice per acre; 24 pounds of tall oat grass; 28 pounds of redtop and 12 pounds of timothy. For temporary pastures, orchard grass should probably be given the first place and for temporary meadows tall oat grass; but for those more permanent in character, redtop would probably be more valuable; in portions of Virginia, Kentucky and Tennessee, timothy should be given first place. In combination, orchard and tall oat grasses grow well together, using 14 pounds of seed of the former per acre and 12 pounds of the latter. White clover or Japan clover (*Lespedeza striata*) usually comes into these pastures when not broken for two or three years. If red clover is sown with orchard and redtop grasses, not more than 4 to 6 pounds of the seed will be required and some reduction may be made in the amounts of the seed sown of these respective grasses.

Southward tall oat grass and rescue grass will give the best probable results among grasses and Japan clover among clovers. Rescue grass is an annual and when sowing it for pasture or to provide hay use 30 pounds of seed. When Japan clover is sown alone

use 12 pounds of seed per acre. When sown together use half the amount of the seed of each and sow the former in the autumn and the latter in the spring. Orchard grass may also have a place. In all these states, however, unless it be those lying northward, the plan of growing temporary pasture and fodder from certain annuals sown in the autumn is to be commended, since these furnish excellent winter and spring grazing. (See p. 356.) The best common grazing is obtained from Bermuda grass.

Next in adaptation to the grasses named would be Italian and perennial rye grasses; these have scarcely received that attention in the South which their merits claim.

For the Canadian Northwest.—This division includes all the provinces of Canada between Lake Superior and the Rocky mountains. The conditions are much the same also in the Red River valley in Minnesota and North Dakota.

The three best grasses for pasture and meadow in all this region are Russian brome, timothy and western rye grass probably in the order named. The first named is decidedly in the lead as a pasture grass. All in all, it is also important as a producer of hay for feeding on the farm, but timothy must be assigned first place in growing hay for market. These grasses may be sown alone or in combination. When Russian brome is sown alone to provide pasture or hay quickly, sow 18 pounds of seed per acre; of timothy, 12 pounds; of western rye, 18 pounds. When Russian brome and timothy are sown together apply 9 and 6 pounds of

these respectively; this combination meets with considerable favor. When Russian brome and western rye are sown together use 9 and 9 pounds respectively. This combination is specially adapted to areas where the conditions are dry. When Russian brome, timothy and western rye are sown together, about 6 pounds of the seed of each would be ample to sow. Whether clover in any of its varieties can be sown to advantage in this area, or in any part or parts of it, to supplement the grasses named, has yet to be demonstrated.

For the Upper Mississippi Basin.—This group of states includes Wisconsin, Illinois, Minnesota, Iowa, Missouri and eastern Kansas, Nebraska and a limited portion of eastern North and South Dakota.

In the northern portion of this area, the leading grasses for temporary grazing and also for hay are timothy, redtop, Russian brome, medium red and alsike clover. On the uplands, timothy and red clover are more commonly sown, as in the states comprised in the northeastern group. On the lowlands, timothy, redtop and alsike clover are the grasses most frequently sown. In portions of Minnesota and Wisconsin, including much of eastern Minnesota and wide areas in Wisconsin, once covered with hardwood forest, the adaptation of the soil for the various kinds of clover and for blue grass is remarkably high. Hence, in these areas blue grass and white clover come into the pastures, when of any considerable duration, without being sown. The same is true of blue grass in much of the lowland soil. The adaptation of meadow fescue and meadow foxtail have not been well tested in these

areas, but Russian brome has been sufficiently tested to demonstrate that it stands high in adaptation both for hay and pasture. What has been said of those portions of Minnesota and Wisconsin, will also apply, in the main, to Iowa and Illinois except that adaptation for growing clover in these, though high, is not so high as the portions of Minnesota and Wisconsin that were specified. Orchard grass and tall oat grass have but medium adaptation. In southwestern and western Minnesota and in the Dakotas, timothy and clover pastures are of short duration, although the production of both are improving and Russian brome is growing in favor. In Missouri, timothy and clover do well in providing hay and grazing, but in the parts of Kansas and Nebraska included, while clovers flourish, timothy does not quite equal orchard grass in furnishing pasture; the same is true of Russian brome. Alfalfa is coming to be the leading plant in providing hay and swine pasture in eastern Kansas and Nebraska; its cultivation for these is rapidly extending in the other portions of the area now being considered.

For the Semi-Arid Belt.—In this group of states are included all those that lie east of the Cascade and Coast mountains, exclusive of the irrigated valleys and west of the states included in the upper Mississippi and southeastern groups.

In the greater portion of this area, the pasture and hay grasses are such as nature provides; the former on the uplands and the latter in the depressions. These vary with the locality and the degree of the humidity. They include a great variety of grasses, nearly all of

which are possessed of high nutrition, but the major portion are of a somewhat dwarfed habit of growth and they grow more sparsely as moisture decreases. Acre for acre, as compared with sown pastures, these pastures are relatively low in producing power; whether in this respect they can be improved by other grasses is problematical. This question is further discussed in Chapter XVIII.

On many of the uplands, however, at the base of the mountains, usually spoken of as the "foothills," pasture and hay from such plants as alfalfa, timothy and other grasses can be grown, but the range of such production has not yet been ascertained. The chief supplies of fodder, required to supplement grazing in the winter in these areas, will come from the irrigated valleys found with more or less frequency in much of the range country. However, on the uplands of Washington, Idaho and Oregon, taking Moscow as a centre, pasture or meadow may be obtained from orchard grass, Russian brome, tall oat grass or meadow fescue.

The Irrigated Valleys.—The reference here is not only to the valleys now irrigated in the region that is being considered but to those also that are susceptible of irrigation, and that will unquestionably be irrigated in the future that is not far distant. These include all the irrigable valleys in the entire Rocky mountain districts of the United States and Canada.

These valleys are capable of producing for pasture or for hay all or nearly all the valuable grasses and clovers that can be grown on the continent; nor is the

character of the adaptation greatly different until the streams leave the mountain districts, since the climate within reasonable proximity to the coast is mild and even in character. When, however, the river valleys leave the mountains, more especially those that flow inland rather than seaward, the mean temperature differs considerably with latitude. The grasses and clovers that may be grown there along the entire coast under irrigation are nearly the same. In the valleys that extend eastward from the mountains, such grasses as are adapted only to mild climates could not be grown successfully in the northern valleys; nor is this to be regretted since these are not so valuable intrinsically as those that are more rugged and enduring.

All grasses and clovers are not equally well adapted to irrigation. Those that have such adaptation in a marked degree are happily sufficiently numerous to meet all the needs of those who till the soil. Prominent among the grasses that have high adaptation for irrigation are timothy, redtop, Russian brome, orchard grass, meadow fescue, perennial and Italian rye grasses; among the clovers are alfalfa, medium red, mammoth, alsike and the white. In productive power and duration of life, alfalfa is king among the clovers and in productive power king also over the grasses. With such a wide range of valuable grasses to choose from, those who till these valleys can not only secure hay of any combination desired, but they can also secure enormous yields of the same. Heretofore, but little attempt has been made to grow these plants in combination. In growing for hay, the aim should be to

combine those which mature at nearly the same period; alsike clover and timothy furnish one of the best of these combinations, more especially when the quality of the hay is considered. In growing temporary pastures, there is probably no better combination than medium red clover and orchard grass. In growing permanent pastures, all the grasses and clovers enumerated above could be used if desired or any combination of these that might be preferred.

With so much range land as is usually found bordering on these valleys and extending back from them, the land of the valleys is not likely to be devoted to the extensive growing of pastures for some time to come. But their capacity to grow these, notwithstanding, is very great; it would be interesting to know the limit of such possible productivity. In 1900, at the Agricultural Experiment Station Farm at Bozeman, Montana, cattle were grazed on 5.04 acres of irrigated land for an average of 109 2-3 days; the increase in weight made was 4560 pounds. This valued at 4 cents per pound gave a net profit from the pasture of \$36.19 per acre. In growing such pastures, the element of danger from bloat caused by eating green clover will be largely eliminated by growing grasses in combination with it.

West of the Cascades.—This region includes the relatively narrow strip of land between the Rocky mountains and the Pacific and extending from California to Alaska.

All the grasses that have been discussed in this work can be grown in some part of this area. The temperature is mild and even, during much of the year and

the climate is also moist. During nine or ten months of the year, the gentle rains are frequent. This, of course, is greatly favorable to the production of good pastures.

It is simply a matter of choice as to which grasses shall be grown for temporary hay and pasture production. In growing hay those plants should be chosen for being grown singly or in combinations which take the market most readily. At present timothy, with a moderate quantity of alsike clover in it, makes an excellent market hay. For temporary pastures, medium red clover, orchard and Italian rye grasses should answer well; sowing per acre, 6 pounds of clover, 7 pounds of orchard grass and 7 pounds of rye grass.

Pastures Other than Grasses and Clover.—In all or nearly all sections of the United States and Canada, the necessity exists for growing more or less pasture for the various classes of live stock, kept upon the farm in addition to such as are obtained from clovers and the grasses proper. This necessity arises from the frequency with which the grass and clover seeds sown fail to make a stand or with which they may fail, or partially fail, through adverse winter weather. It is present in proportion as these hazards are frequent and severe; as the locality is favorable or otherwise to the production of grass pastures. These include the small cereal grains, leguminous or non-leguminous, the saccharine and non-saccharine sorghums, the various millets, cow peas and soy beans, rape and kale and for swine such roots as artichokes and peanuts. The most valuable of these pastures for cattle are the small cereal

grains, the sorghums, rape and kale, cow peas and soy beans and the millets, probably in the order named. The most valuable for sheep are rape and kale, the small cereal grains, the sorghums, the millets, cow peas and soy beans, probably in the order named. The most valuable for swine are the small grains, cow peas and soy beans, artichokes and peanuts and the sorghums, in the order named. The most valuable by far of the small cereals in providing grazing is winter rye; the most valuable of the pure pasture plants is rape and the most valuable of the sorghums are the saccharine.

This whole question, however, is discussed at length by the author in the book, "Forage Crops Other than Grasses," published in 1900. Readers who desire further information on this aspect of the grazing question are referred to the said book.

MISCELLANEOUS DISCUSSIONS UPON TEMPORARY PASTURES.

A discussion is now submitted with reference to the management of temporary pastures; also with reference to the influence which these exert upon the soil and, through it upon the production of other crops.

Sowing Temporary Pastures.—This question has been touched upon in Chapter II. (see page 36). In sowing temporary pastures, preparation of the land, its condition as to cleanliness and fertilization, the season for sowing and adaptation of the grasses to the needs of the land, the climate and the live stock which will graze upon them are chiefly to be considered. The following rules may be submitted with reference to the

preparation of the land: 1. On average soils aim to have the seed bed fine and smooth at the time of sowing the seed. 2. Seek fine pulverization in lands not naturally friable when preparing the seed bed in spring, but be content with pulverization less fine when preparing the same for autumn sowing in climates of much rainfall in winter. 3. On soils so light as to lift with the winds, sow on an uneven surface and aim to leave the surface rough. 4. Aim so to prepare the land that it will have sufficient moisture near enough the surface to germinate readily the seed when it is sown.

Since nearly all grasses start more feebly and grow more slowly at the first than the small cereal grains, it is more important relatively that they shall be sown on clean land, however it may be cleaned. Since temporary pastures tend to put humus in the soil and also available fertility, it is not as necessary that the soil shall be well supplied with humus and fertility as when sowing many other crops; the growth of the grass, nevertheless, will usually be proportionate to the amount of both in the soil. It is not usual to apply fresh farmyard manure in large quantities the same season that lands are laid down to grass, since the growth of weeds would thereby be encouraged to the detriment of the young grass plants. If, however, these have been applied to some cultivated crop grown, the previous season, the influence is beneficent to the growth of these. The weed seeds in this manure have been destroyed and the residue of fertility from the manure is readily available. On some poor sandy soils,

however, it may be necessary first to bury a green crop, as of rye, to put humus in the soil before the grains are sown; or it may be necessary to apply some artificial fertility on the same.

As a rule, the best results will be obtained from sowing the hardy grasses in the autumn, north or south. In the North it is important that these shall be sown early in the autumn; clovers at the North can be sown in the spring or summer only; in the South they may frequently be sown with advantage in the autumn, as soon as the fall rains come. Plants, other than grasses, sown to provide grazing but for one season should more commonly be sown as early as possible in spring, but to this there are some exceptions. Winter rye is sown in the autumn both north and south; in the South all the small cereal crops grown for such grazing are better sown in the early autumn. Usually in climates with sufficient rainfall, grasses and clovers are preferably sown with nurse crops, whether sown autumn or spring in the North; in the South these are frequently sown in autumn without nurse crops, since when thus sown they are soon ready for grazing.

The question of adaptation of the grasses to the needs of the land involves the study of the habits of growth in each variety of plant grown and of adaptation of soils to the growth in the same. The more rugged grasses only should be grown under hard conditions of soil and climate. Under favorable conditions of both, varieties less rugged but probably intrinsically more valuable, may be grown. Unless for purposes of experiment, grasses of proved adaptation to the

climatic conditions only should be grown. The grasses proper are considered better adapted relatively than the clovers to furnish grazing for horses. Both are very suitable for cattle and sheep, and, when grown in combination, the danger from bloat is practically eliminated. The latter are more suitable for swine. Plants grown only for pasture, as rape, are most suitable for sheep. Those which furnish the most succulence are best adapted for milk production, while not too much succulence gives better results in growing meat.

Grazing Temporary Pastures.—When grass pastures are sown in the autumn they may be grazed the following season, and in some instances southward the same autumn. When sown in the spring, and especially when sown with nurse crops, they should not be grazed the same season. To this also there may be some exceptions, as when, for instance, the growth may be so strong as to endanger the grasses through smothering under snowfall. When the cereal grains are sown for pasture, they should be pastured from the time they will furnish plentiful grazing. Grasses and clovers sown along with them, especially on porous soils, as the black loams of the prairie, will be benefited by such grazing through the firming of the soil, and the more lacking the supply of moisture, the greater will be the benefit. On some soils and in some sections autumn sown cereals may be grazed during the winter with benefit to the crop. Winter wheat, for instance, is thus frequently grazed in Kansas; winter rye may be thus grazed even further north. On rich prairie soils wheat

and oats are made to yield more in moist seasons when grazed by sheep for a time in the spring. This benefit comes largely through increased stooling in the plants.

The following rules apply to the grazing of grass pastures: 1. Never graze these if it is possible to arrange otherwise when the pastures are so wet that the land will poach or become impacted as a result. 2. Close grazing lessens production in the pastures, but in dry seasons the reduction resulting will be much more than in wet seasons. 3. The palatability of all kinds of plants is lessened for grazing if allowed to form the seed head, and to prevent this it may be necessary sometimes to use the mower. 4. Close grazing in the late autumn weakens the vitality of the plants; one result of which is they will not start so quickly or so vigorously in the spring.

The observations now submitted apply rather to pastures produced by the small cereal grains: 1. The further from the earing stage they are kept the more pasture they will furnish and the longer the period during which it will grow. 2. While being grazed, grass pasture should be accessible on which the animals can be pastured in time of wet, when grazing would be hurtful to grain pastures. 3. Because of the succulence of grain pastures and to avoid unnecessary tramping, the animals grazed on grain pastures should be grazed on grass pastures at night and also during a portion of each day.

In pasturing some animals grown for pasture, hazard of loss is incurred. It arises from the following sources: 1. When rape and succulent clovers are

being grazed loss from bloating is sometimes incurred. 2. When cattle are being grazed on sorghum and Kaffir corn, particularly of the second growth, animals sometimes die suddenly while grazing on the same. 3. When cattle graze on cornstalks in the late autumn and winter, they frequently die in considerable numbers. To meet the first danger the animals should be gradually accustomed to the pasture. They should not be turned on the same when hungry, and but cautiously when the plants are wet. As the cause of hazard from the second source is not certainly known, it cannot be fully met, but it has been noticed that the danger is greatest when the growth of the plants has become stunted from drought. The cause of the hazard from the third source is likewise not known, but the incurred loss can certainly be avoided by harvesting the corn at the proper season as it should be harvested, and then feeding it to the live stock. The question of grazing is discussed at some length in the book, "Forage Crops Other than Grasses," referred to above.

Fertilizing and Renewing.—It is not usual to apply commercial fertilizers to stimulate the growth of pastures of short duration. These are more commonly applied when preparing the land, when sowing the seed or while the grasses sown are to be used in producing hay and before they are to be used as pastures. But where it is desired so to use them there can be no objection to such action, providing they are used with discretion and judgment. When used, the kinds to apply, the respective amounts, and the methods of applying them will be the same as those submitted for

fertilizing permanent pastures. (See page 392.)

When temporary pastures are to be fertilized, farmyard manure, reduced or unreduced, will usually give better results than anything else that can be applied. It is pre-eminently adapted to such a use, as it stimulates growth in the grass during all the season of growth by the nutriment which it furnishes; in winter it protects the roots from the adverse influences of cold winds and frost; in summer it acts as a mulch, thus protecting the plants more or less from the influences of drought. By increasing root development in the soil, it adds much to the available plant food for the crops that follow. The fertilizer may be applied by spreading it over the pasture evenly at any season of the year that may be convenient, but to apply it during the first months of grazing will to some extent cover a part of the new growth made, so that it cannot be eaten by the stock. Late autumn and early winter are the most suitable seasons for such applications, because of the lessened pressure of farm work; because of the protection which it gives to the grasses and because of great stimulus which it gives to the growth of these as soon as the growth begins in the spring through the nutriment carried down to the grass by the spring rains. When the snowfall is not too heavy, it may be applied with much advantage during all the season when the ground is frozen.

The chief objections to applying farmyard manure thus have been urged: First, when applied fresh, many weed seeds which will grow later are carried in it; second, much of it is lost through the wasting of early

rains; and, third, the pasture resulting will be distasteful to stock. The answers to these objections are: First, it is only where careless farming prevails that noxious weed seeds abound; second, the loss of fertilization through washing is not great except on side hills being less than the loss which occurs by handling manure in any other way; third, while the grazing for a week or two may be distasteful to live stock, this distastefulness soon leaves it entirely, so that the forage will be all eaten by the stock. To destroy weed seeds on well managed farms by fermenting the manure would be a very expensive process, because of the great loss of nitrogen in the manure during the fermenting. It is probably the most expensive process that can be adopted in fighting weeds. The practice which draws manure from the stables and applies it on the land is an excellent one.

When the beneficent results from applying farmyard manure are considered, it is somewhat surprising that more attention is not given to the manufacture of the same, in areas where the necessity for purchasing commercial fertilizers exists. It would seem quite possible for the farmer to purchase live stock, if necessary, and to purchase food, especially grain food, on which to feed them, without loss, thus getting the fertilizer as a reward for the labor. That would be a much cheaper method of obtaining fertilizer than buying it in hard cash.

The renewing of temporary pastures is not nearly so important as the renewing of permanent pastures, because of the temporary character of the former. The

renewing of permanent pastures is discussed in Chapter XVI. (see page 392). The methods of renewing these will also apply, in great part, at least, to the renewal of temporary pastures.

Influence on Succeeding Crops.—Although the true grass crops are not nitrogen gatherers in the sense in which clover and other legumes are, yet it is important that they shall be grown in rotation, in all or nearly all instances, when tilling arable soils. Growing them thus in the rotation is less necessary when clovers form a part of the regular rotation, but even when clovers are grown, it will usually be found advantageous to grow grasses also. Among the benefits which result from growing grasses in the rotation are the following: 1. They supply the land with humus. 2. They furnish plant food in a more readily available form. 3. They tend to check the growth and increase of weeds.

It is not easy to over-estimate the value of a supply of humus in the soil. It would probably be correct to say that it is well nigh impossible to grow good crops without keeping the land sufficiently supplied with humus, or in other words, vegetable matter. Such matter in the soil promotes aeration in stiff soils and renders them more friable, increases the power of all soils to hold moisture, aids in the chemical transformation of inorganic substances in the soil and renders substantial service in preventing soils from being washed away by an excess of water or from being lifted by the winds. Some soils, more especially those composed of fine clay particles or fine deposit when long cultivated without any replenishment of humus, become so im-

pacted that the air does not readily penetrate them sufficiently, to the great detriment of the crops which grow upon them. Grass roots growing in the same render them more friable by separating the particles, and, consequently, more easily tilled. The labor of pulverizing these soils is lessened in proportion as these are present. The aid thus rendered to aeration will be readily apparent, since the humus substances that have been distributed between the earth particles are easily penetrated by the air. The extent to which such vegetable substances increase the power of soils to hold moisture is very great. They act like a sponge in the soil, arresting moisture going downward or upward and holding it for the growing crops. The service thus rendered in leechy soils is even more valuable than in those that are retentive; hence, interjecting these crops frequently into the rotation is one of the surest safeguards against drought. The way in which they transform inert plant life in the soil in their decay into active or valuable plant food cannot be discussed here. The fact only can be stated, and it is one of much significance to the farmer. The influence of certain grass plants in preventing washing and gullyng is further discussed in Chapter XVI. (see page 399). The extent to which the lifting of light soils by wind is lessened is largely dependent on the kind or kinds of grasses grown and the frequency with which they are grown. Those grasses with a strong and matted root system, as quack grass, best serve this end. The influence of some of these grasses in thus preventing soils

from lifting after they have been ploughed up is, in some instances, felt for at least three years.

While the grasses proper do not, like clovers, add in the same way to plant food in the soil, they do add materially to the supply of available plant food. During the processes of growth they search out and take up plant food from the soil and subsoil, a part of which is retained in the roots broken up and in the stubbles that are buried. These, in their decay, furnish such food for the crops that follow them in a form that is easily accessible. The grass crops, in a sense, act the part of scavengers in the soil for the crops that come after them. Sir J. B. Lawes has estimated that when grass lands are broken 5 to 10 tons of dry matter, roots, leaves and stubbles are deposited in one acre by the grass crop.

Grass crops check the growth of weeds in the soil in various ways. In some instances they crowd them out, as in the case of blue grass; in some, as when mowed and properly pastured, they prevent them from seeding; and in others, as when they are broken for a few years, they cause the seeds of many weeds to perish that are lying in the soils. Pastures and meadows of any lengthened duration render most effective service in this way, as is evidenced by their comparative cleanliness when first broken up.

So beneficent are the influences from introducing grass crops frequently into the rotation, that it is probably correct to say that the instances are few in which successful crop husbandry can be long conducted in their absence. Due attention to this question would

go far toward revolutionizing farming in wide areas of the United States and Canada. Particularly would this be true of much of the South, of the corn belt in the Mississippi basin and of nearly all of the wheat belt in the American and Canadian Northwest.

CHAPTER XVI.

PERMANENT PASTURES.

Permanent pastures, as the name would indicate, are those which are grown continuously on the same land for a successive number of years of considerable duration, or for all time. Sometimes they are practically composed of but a single grass; in other instances and more frequently, they are composed of a variety of grasses which have much power to remain in the land. The dominant idea, underlying their growth, is to crowd into the pasture, as many of the enduring grasses that furnish valuable grazing, as can be grown successfully together for a term of years, and which at the same time, make the bulk of their growth at different periods of the growing season. But since some of these are slow in attaining a maximum of growth, taking as much as three or four years, in some instances, to accomplish this, seed of short-lived varieties is frequently sown also to aid in providing a full supply of grazing, while the slow maturing varieties are attaining a maximum of development. When the pasture is once secured, it is, or ought to be, the aim to maintain it in undiminishing productiveness by keeping it free from weeds and by stimulating growth with fertilizers.

Permanent pastures composed of mixed grasses have not been extensively grown on this continent. It is,

therefore, scarcely possible to speak of them from the standpoint of successful experience. The attention of agriculturists has not been centered on them for the reason among others, that land has been abundant and because of this, the necessity has not been greatly felt for growing pastures on the intensive plan.

That permanent pastures, in one form or another, may be grown and should be grown in all parts of the continent is certainly true. That they may be grown, in some localities with more of relative advantage than in others, is also true. That they can be grown on this continent, as successfully as the permanent pastures of Great Britain and Holland, is not true, except of those sections of the country which have a similar climate. It can only be true of such areas as have a climate that is moist, and in which rain falls in ample supply during the greater portion of the growing season, and where the growing season covers a large portion of the year. The advice to use formulas for laying down these pastures, similar to those used in laying down the same in Great Britain, where the conditions are not the same, has not been good; it has given rise to more or less of prejudice against the idea of permanent pastures, mixed in character.

DIFFERENT CLASSES OF PERMANENT PASTURES.

Permanent pastures in America may be divided into three classes. These are pastures composed of grasses indigenous in character; pastures composed of one or more grasses that have been introduced; and pas-

tures composed of grasses, indigenous and introduced. Which of these should be grown must be determined by the individual needs of each farm and the conditions relating to growth which appertain to the same.

Indigenous Permanent Pastures.—These are pastures made up of a single grass or of a variety of grasses, that are native to the locality. In some instances, they are substantially composed of a single grass; as for instance blue grass; in other instances, many grasses grow in them; such are the pastures of the open range. These pastures are established by the hand of nature, and usually in areas where cultivation is not practicable. Under such conditions, it is questionable whether the attempt should be made to change the character of these pastures by scattering the seed of other grasses. Of course, it is different where cultivation is carried on. But such pastures may be maintained in undiminished productiveness, by the way in which they are grazed, and by supplementing careful grazing by such measures, as the removal of encroaching shade when necessary and fertilizing when practicable.

Introduced Permanent Pastures.—These may be composed of a single grass, as in the case of Russian brome or of a very limited number, as in the case of Kentucky blue and white clover, introduced into areas from which the forest has been cleared away. They may also be composed of a number of grasses suited to growth in the district in which they are grown. The number of varieties that may thus be grown will vary with the conditions. Usually, however, it is difficult, under any conditions, to maintain

undiminished growth in each of a number of grasses, comprising more than half a dozen varieties for a long term of years.

Indigenous and Introduced Permanent Pastures.—These are composed of grasses, native to the country or introduced, and in various combinations. Such, for instance, is a permanent pasture, composed of Kentucky blue grass, indigenous to Kentucky and certain of the adjoining states, with orchard grass and white clover added to the same; redtop, indigenous to the low-lying lands of Minnesota, with timothy and alsike clover added; and western rye grass, indigenous to the American and Canadian Northwest, with Russian brome added. In growing permanent pastures, it should be the aim to utilize valuable indigenous varieties to the greatest extent practicable, since there can be no doubt about the permanence of these.

Duration of Permanent Pastures.—Although the name would imply, that these pastures shall be grown indefinitely, the idea must not be pressed too far. Some of them are, of necessity, permanent as, when growing on the uncultivable range, or in arable areas, where cultivation is not practicable, because of stones or rocks in the land, or because of the hilly or broken character of the land. Some of them are, practically, permanent from choice, as when grown on land, pre-eminently adapted to growing these. Such are some of the pastures of England, more than a hundred years laid down. Again, permanent pastures are of limited duration. They are sown on ordinary lands and are composed of a limited number of grasses, which in time so decrease

in yield as to render it desirable to supplant them with others, for which the ground has been so prepared, that they are likely to produce more abundantly than the former, if left unbroken. Under arable conditions, this form of permanent grazing is likely to be much more extensively adopted than any other. The permanency of such pastures will be largely determined by the degree of production.

GRASSES ADAPTED TO VARIOUS SOILS.

In laying down permanent pastures, due regard must be had not only to climatic conditions but also to those of soil. The mistake of trying to grow a grass on soil uncongenial to it, is equally great with that of trying to grow any kind of grain, under similar conditions. It can only result in failure. Adaptation to soil conditions with these grasses, grown in combination will now be considered.

For Upland Pastures.—On ordinary soils, combinations of grasses that will give the best results will vary considerably with latitude and longitude. The best single pasture for such a use in the northeastern states and the eastern provinces of Canada, is Kentucky blue grass; in the southeastern and southern states, Bermuda grass; in the region which has eastern Kansas for its center, probably orchard grass; in the American and Canadian Northwest, Russian brome grass northward and tall oat grass southward; and west of the Cascades, small white clover or even the medium red which has much permanency. In the locality first designated the best mixture on such uplands would include

Kentucky blue grass, timothy, orchard grass, redtop, meadow fescue, and tall oat grass, useful probably in the order named. Whether Russian brome grass would serve a good purpose in such pastures has not yet been determined in practice. There are some grounds to fear that it might be aggressive overmuch. The clovers would include small white and, in some instances, the medium red and alfalfa. In that designated secondly, the principal grasses would include orchard grass, tall oat grass, redtop and, in some instances, timothy or blue grass. The clovers would include the small white, Japan, buffalo and alfalfa, according to the locality. In that named thirdly, orchard grass, tall oat grass and meadow fescue, with white clover and alfalfa would probably make the most suitable mixture. In that named fourthly, would be Russian brome, western rye and timothy and, in some instances, redtop. In that named fifthly, would be Russian brome, tall oat and meadow fescue. And in that named lastly, may be included almost every valuable grass and clover grown in the United States.

For Slough Lands.—The best single grass for making a permanent pasture in low lying lands in the North, is probably Russian brome, with redtop as a close second. In the South, redtop is deserving of first place. The grasses that will figure most prominently in mixtures in these places, include Russian brome, redtop, fowl meadow, timothy, Kentucky blue and probably perennial rye and meadow foxtail. These are named in the order of all round relative value, but the comparative scarcity of the seed of fowl meadow grass

may keep it from being given a prominent place in such mixtures. In the South, the best yielding grasses in such a mixture will include redtop and white clover and probably perennial rye but in many parts of the South, nearly all the grasses named may be used in the mixture. West of the Cascades all may be included.

For Sandy Lands.—To obtain permanent grasses, that are suitable for sandy lands, furnishes a problem that is not easily solved. The three best grasses for the purpose are Russian brome, Western rye and Bermuda grasses; the clovers will include the Japan and buffalo. For the South, there is no other clover that will prove satisfactory on light sandy land, but in wet seasons the small white may grow well; alfalfa may also be sometimes used. For the North and West, the best of the three grasses named, viewed from the standpoint of utility and permanence, is Russian brome. The distribution of Western rye has not been so well worked out as that of Russian brome, hence its value for southern conditions is not yet well understood. For such soils in the South, Bermuda grass is without a peer. Its adaptation for these is pre-eminent.

For Dry Areas.—The problem of furnishing suitable permanent grasses for dry areas is even more difficult than that of furnishing the same for sandy soils where the conditions may not be so dry. Of the really valuable grasses grown under cultivation, Russian brome is probably the best for the North and West and Bermuda for the South. On dry hard clay soils, Canadian blue grass grows with much tenacity. Southward,

velvet grass grows under dry conditions and the same is true of Texas blue grass. Tall oat grass has also served a good purpose in permanent pastures in dry areas in the mountain bench lands. For arid plains, the Australian saltbush has served a good purpose and it may be that blue grama will be helpful on dry range lands. The best clovers for dry areas are the Japan and the buffalo, but under some conditions, alfalfa could be grown in the mixture.

For Wet Soils.—For soils that are so wet that they cannot be tilled at certain portions of the year, Russian brome, redtop and fowl meadow are probably the three best grasses and next to these Kentucky blue. There is perhaps no good pasture grass, that will stand conditions of prolonging wetness in the soil better than Russian brome; redtop and fowl meadow are also good but, of course, neither will endure wet beyond a certain degree. In hot weather, watery saturation is more hurtful than in cool weather. On lands that are springy in character, blue grass makes good pasture, even when the soil is thrown up in hummocks. For providing permanent pastures under irrigation, Russian brome, Kentucky blue, red top, timothy, alsike clover and alfalfa have high adaptation.

For Growing in Shade.—Orchard grass has long been assigned the premier place for being grown in the shade among the cultivated grasses of America. Russian brome, however, has considerable adaptation for such situations; whether this adaptation will equal that of orchard grass has not been determined in America. Tall oat grass will also grow fairly well in such situa-

tions and the same is true of Kentucky blue. In the North, a combination of orchard grass, Russian brome and Kentucky blue would answer well in groves and parks; and for the South, a combination of orchard, tall oat and probably perennial rye.

For Growing in Marshes.—In marshes where water stands much of the year, it is doubtful if any pasture grasses can be introduced that will give a better return than those which nature may have planted there. Wire grass (*Carex vulpinoidea*) is by far the most valuable grass for such situations and it is not a pasture grass. (See p. 295.) Blue joint (*Calamagrostis canadensis*) will grow in situations that would be too wet for red-top and makes good hay but the results from grazing it on lands so wet as those congenial to its growth, would probably prove hurtful to the future growth of the grass.

GRASSES FOR THE STATES AND PROVINCES.

The grasses best suited for permanent pastures, grown alone or in various combinations, as adapted to groups of states within the union or to groups of provinces in Canada will now be considered. The grouping of these will be the same as in Chapter XV. which discusses Temporary Pastures.

For the Northeastern States.—For the states and provinces of this group see p. 342. The best permanent pasture in all these states, spontaneous in character, is Kentucky blue grass and small white clover. These grasses, especially where they have been once grown, will soon take possession of grounds that have

been cultivated, to the exclusion of all or nearly all other grasses and clovers, though they should not be sown again. This follows on the condition that young trees are not allowed to crowd them or overshadow them by their shade; such a result will not follow, where live stock graze through the season. These two grasses would then take possession of the soil in two or three years to the exclusion of the growth of trees; they will likewise take possession of land from which timber has been removed, when thus given a chance to grow. But the transformation in both instances will be more rapid, if seed is scattered in the early autumn or early spring, even though it should not be harrowed. For this purpose, it should seldom be necessary to sow more than 7 pounds of Kentucky blue grass and 3 pounds of white clover per acre. The pastures, on broken and rugged land in the states and provinces of this group, will usually be composed of these two grasses. For average soils in this group, if a limited number of grasses is chosen with a view to provide mixed pastures for a more or less definite term of years, the following would probably serve the purpose best:

	Lbs. Per Acre.
Timothy	4
Orchard	4
Redtop	3
Russian brome	4
Medium red	3
Mammoth	2
	<hr/>
Total	20

If Russian brome is omitted, as its behavior in mixed pastures under American cultivation is not yet well un-

derstood, add one pound each, in lieu thereof, to the timothy and red top and two pounds to the orchard grass. The red clovers are sown in these as in all the mixtures in which they are included to aid in furnishing pasture the year following that in which the grasses are sown, with the expectation that they will soon entirely disappear. On certain soils, where alfalfa grows readily it may be sown in lieu of mammoth clover, using the same amount of seed per acre. Where the lands are naturally dry, it may be well to substitute meadow fescue for redtop, using the amount of seed named as suitable for redtop. Kentucky blue grass and white clover would be likely to come into the mixed pastures, at all permanent in character, in two or three years, in all or nearly all the states and provinces in the group now being considered. Before many years, they would probably be the leading factors in the same, hence it is not usually necessary to sow them. The same is also true of them in some of the other groups of states. Where it is not, however, it may be advisable in some instances to add a few pounds of blue grass seed and a little white clover seed to the formulas given.

For low lying lands, naturally moist, but on which water does not lie to any appreciable extent, the following grasses would answer for mixed pastures of considerable duration, but not laid down for an indefinite period:

	Lbs. per Acre.
Timothy	6
Redtop	6
Russian brome	5
Alsike clover	3
	<hr style="width: 10%; margin: 0 auto;"/>
Total	20

When mixed pastures are to be laid down for a long term of years, in these states and provinces, good, well-prepared and naturally moist land should be chosen. The following varieties may be used in the mixture and all of them, it is thought, with some profit:

	Lbs. per Acre.
Timothy	3
Orchard	3
Redtop	3
Meadow fescue	3
Tall oat	2
Meadow foxtail	2
Fowl meadow	2
Medium red clover.....	2
Mammoth clover	2
Alsike clover	2
	<hr/>
Total	24

Those who do not care to hazard meadow foxtail and fowl meadow, because of the difficulty of getting good seed, could probably with certainty of success, sow 4 pounds per acre of Russian brome instead. This grass was not included in the formula for the reason, only that experience in growing it in such mixtures in America, is as yet practically wanting.

On sandy lands in these states and provinces nothing better probably can be sown for permanent pastures than Russian brome, using 15 pounds of seed per acre, and for stiff hard clays nothing would seem to serve the purpose better than Canadian blue grass (*Poa compressa*), sowing 12 pounds of seed per acre along with 3 or 4 pounds of medium red clover.

For the Southeastern States.—For the states includ-

ed in this group, see p. 344. The best permanent pasture produced by a single grass in this group of states will not be the same in all of these. In the uplands of the Alleghanies, it will be Kentucky blue grass or meadow fescue. In West Virginia, a large part of Kentucky and a part of Tennessee, it will be Kentucky blue grass. In all or nearly all, the territory not in areas designated, it will be Bermuda grass. But in Eastern Texas and also some other localities, it may be Texas blue grass. The behavior of Texas blue grass and Bermuda grass, growing together, has not apparently been sufficiently tested to justify drawing conclusions, as to the outcome; if these two would grow together, they would furnish permanent pasture, winter and summer.

For permanent pastures of limited duration on average soils in these states, the following grasses will answer for much of the area, but not equally well for all of it:

	Lbs. per Acre.
Orchard grass	5
Redtop	5
Meadow fescue	5
Tall oat grass.....	5
White clover	2
Japan clover	2
	—
Total	24

Under some conditions, it may not be necessary to sow the clovers named, as the seed may be in the soil already; but in such instances it would seem advisable to sow at least 6 pounds of each of the grasses named; 2 pounds per acre of sheep's fescue may also improve

the grazing. This mixture will not likely provide sufficient pasture on poor soil to justify sowing it on the same. Bermuda grass will serve the purpose better.

On bottom lands and alluvial soils, such as are found in river basins, the same formula will answer but it may prove helpful to add to it 2 pounds each per acre of perennial rye grass and meadow foxtail.

For the Canadian Northwest.—For the provinces included in this group, see p. 346. The best single permanent pasture grass for this entire area is Russian brome. How long it may be grown on the same land without decrease in the yield, has not yet been proved but when renewed by suitable harrowing and ploughing every few years (see p. 188) it would last for many years.

The best mixture of grasses for permanent pastures at the present time is the following:

	Lbs. per Acre.
Russian brome	6
Western rye	6
Timothy	6
	<hr style="width: 10%; margin-left: auto; margin-right: 0;"/>
Total	18

In dry areas, it would probably be preferable to sow only Russian brome as timothy will not do well in these; where Russian brome is sown alone, it may be renewed, as indicated above so as to make it permanent. In some of the moister sections of the group of provinces, it may be helpful to add a few pounds of redtop to the above formula and in others a few pounds of Kentucky blue grass; but it would not avail to sow either, where the rainfall is light nor is it wise

under such conditions to sow large quantities of seed, as the moisture is not enough to sustain a dense sward. In the irrigated districts toward the mountains, Russian brome grass, alone or with alsike and white clover, would make excellent permanent pasture.

For the Upper Mississippi Basin.—For the states in this group, see p. 347. In eastern Minnesota, all of Wisconsin, much of Illinois, Missouri, and Iowa, the best permanent pasture grass is Kentucky blue; in eastern North and South Dakota and in a part of Nebraska, Russian brome, and in Kansas and part of Missouri, orchard grass and in some localities Russian brome. In northeastern Minnesota and also in northern Wisconsin, Kentucky blue grass and white clover make excellent permanent pasture and in the same medium red clover will endure for a term of years.

In the blue grass region of the area named north of parallel 40 degrees, the following combination of grasses may be expected to give good results:

	Lbs. per Acre.
Timothy	4
Redtop	6
Russian brome	4
Orchard grass	2
Meadow fescue	2
Tall oat grass.....	2
Medium red clover.....	2
Mammoth clover	2
	—
Total	24

South of parallel 40 and also in the blue grass region, the above formula should be changed to that given below:

	Lbs. per Acre.
Timothy	3
Redtop	3
Meadow fescue	4
Orchard grass	6
Russian brome	4
Tall oat grass.....	2
Medium red clover.....	3
	<hr/>
Total	25

Where blue grass is not already plentiful in the soil, it would be advisable to add 5 pounds of good pure seed per acre to each of the above formulas. In some instances, it may also be advisable to add one pound of small white clover per acre.

For low humus soils north of parallel 40, the following mixture should prove satisfactory:

	Lbs. per Acre.
Timothy	6
Redtop	6
Russian brome	6
Orchard grass	2
Meadow fescue	2
Alsike clover	3
	<hr/>
Total	25

For the same class of soils south of parallel 40, the following formula is submitted:

	Lbs. per Acre.
Timothy	3
Redtop	6
Orchard grass	6
Meadow fescue	3
Russian brome	4
Tall oat grass.....	2
Alsike clover	2
	<hr/>
Total	26

For average soils in eastern Kansas and the territory adjacent, the following formula is submitted as being at least approximately suitable:

	Lbs. per Acre.
Redtop	4
Orchard grass	6
Meadow fescue	4
Russian brome	3
Tall oat grass.....	3
Medium red	2
Alfalfa	3
	<hr/>
Total	25

For the eastern Dakotas, the mixture for permanent pastures would be the same as for the Canadian Northwest. (See p. 378.)

For the Semi-Arid Belt.—For the states included in this group, see p. 348. In that portion of these states which cannot successfully be cultivated, it is problematical if the range grasses, which now occupy the soil, can be supplemented by others that will serve the purpose better. But in such portions as may be cultivated, not including the foot-hills, the following mixture should furnish such pastures from the northern border of Oklahoma to the Canadian boundary and east of the Rocky mountains:

	Lbs. per Acre.
Russian brome	10
Western rye	10
	<hr/>
Total	20

On the bench lands of the foot-hills, the mixture would include the grasses now submitted:

	Lbs. per Acre.
Timothy	4
Russian brome	6
Western rye	4
Alfalfa	4
	<hr/>
Total	18

In the winter wheat growing area west of the Cascades, which has Moscow, Idaho, for its center, the following, it is thought, are the best grasses to grow together:

	Lbs. per Acre.
Russian brome	7
Meadow fescue	5
Tall oat	5
Alfalfa	3
	<hr/>
Total	20

It is questionable if these grasses will stand grazing indefinitely without renewal where the precipitation is so light as in the area now being considered.

For the Irrigated Western Valleys.—In the absence of experience, it would not be possible to state which grass or combination of grasses would prove most satisfactory in providing permanent grazing on the irrigated lands of mountain states. The most productive single plant is alfalfa, but it can be grazed safely by horses, mules and swine, when grown alone. A limited amount, however, can be grown with other grasses, without incurring much hazard to cattle and sheep, also while being grazed. The various clovers assume more of permanency in their habit of growth in such situations; hence it would be possible to grow grazing for a number of years from medium red clover but the same

objection, though in a less degree, would apply to the grazing of these alone, that applies to the grazing of alfalfa. No single grass probably would furnish as much grazing especially in the more northerly of these valleys, as Russian brome grown under irrigation, but timothy and indeed all the leading grasses should succeed well.

The following mixture should give good results:

	Lbs. per Acre.
Timothy	6
Russian brome	5
Meadow fescue	5
Tall oat	3
Alsike clover	3
Alfalfa	2
	—
Total	24

A good permanent pasture could also be grown from the following simple formula:

	Lbs. per Acre.
Timothy	12
Alsike clover	3
Alfalfa	3
Small white	2
	—
Total	20

For Areas West of Cascades.—For the area comprised in this region, see p. 351. Several grasses, possessed of much permanence, may be grown alone for grazing on these Pacific slopes and in the tide lands beside the sea. These include timothy, orchard grass and alsike clover; timothy and alsike clover may be grown almost indefinitely on river bottoms and tide lands, but medium red clover would distribute the grazing more

evenly. The formula for sowing would be at least approximately:

	Lbs. per Acre.
Timothy	10
Medium red	5
Alsike	3
	<hr/>
Total	18

To provide grazing of the most permanent character the following mixture is submitted:

	Lbs. per Acre.
Timothy	6
Orchard	3
Meadow fescue	3
Tall oat	2
Meadow foxtail	2
Sheep's fescue	2
Medium red	3
Alsike	3
	<hr/>
Total	24

Small white clover may be expected to come into any permanent pasture in this region, though not sown, and in some sections also Kentucky blue grass.

MISCELLANEOUS DISCUSSIONS ON PERMANENT PASTURES.

Because of the permanency of the pastures, that are now being considered, it is highly important that when these are laid down, the work shall be done in a way, that will most effectively secure the object sought. Questions which appertain to the laying down of these pastures and to their proper maintenance will now be discussed.

Sowing Permanent Pastures.—Much that has been said in Chapter XV., with reference to the sowing of temporary pastures, will also apply to the growing of permanent pastures. See p. 353. Since the latter, however, are to continue for years it is of far more importance relatively, that a good stand of the plants shall be secured. To insure the same, every care should be taken in the preparation of the land, in the sowing of the seed and in the care of the pastures, until well established.

Grasses for permanent pastures should be sown on land that is at least reasonably clean, in a good condition of tilth and well supplied with plant food. To secure the requisite cleanness, they should either come after the bare fallow or after a cultivated crop to which clean cultivation has been given. When sown in the autumn, they should, as a rule, be sown on summer fallowed land. When the work of preparation has been well done, the land will, unless in exceptional instances, be in an excellent condition of preparation for receiving the seed. If a crop of clover is ploughed under in the spring and the land subsequently summer fallowed by working it only on the top, the grass plants sown subsequently in the autumn should start with much vigor.

When sown in the spring, it may also in some instances be wise to summer fallow the land the previous season, and to bury at least one crop, as for instance peas, to supply the land with the necessary humus and plant food. In other instances, it will answer to sow the seed after one crop of corn well cared

for has been grown on the land or, what would probably be better, after two crops have been grown in succession on the same. If these pastures are not laid down on clean land, their subsequent value will be greatly lessened and the labor of caring for them will be greatly increased. There may also be instances when these grasses may be made to follow a crop of Canada field peas or of cow peas, the latter having been cultivated while growing. One objection to sowing the crop on corn land is found in the corn roots which interfere somewhat with the proper covering of the seed.

It is a great mistake to sow grasses for permanent pastures on land low in fertility. They will not start vigorously on such land and no subsequent fertilizing will secure as good growth in the plants as if they had been given a good start at the first. If farm yard manure is used as a fertilizer, it should be applied a year in advance, unless it is known to possess but few weed seeds. Fertility, applied by ploughing in a nitrogen gathering crop is usually very effective in promoting growth in the young grasses, since these in addition to supplying plant food act favorably on the mechanical and chemical condition of the land, but where it is necessary commercial fertilizers may be applied. Those of course should be used such as the weeds of the land require in each particular locality and they ought to be incorporated with the soil near the surface a short time before the seed is sown or applied when it is sown or subsequently. As a rule, the phosphoric acid and potash are applied previous to or at the time of sowing the seed, and the nitrogen a little later; but they

should be used in quantities sufficient to secure good growth in the young grass plants.

The soil should be well and deeply stirred. In some instances, subsoiling will be helpful and in others it is not necessary. It should be the aim to have some time elapse between the last ploughing given to the land and the sowing of the seed and to stir frequently in the interval with harrow or cultivator to secure a clean seed bed. After Canada field peas, cow peas or corn, potatoes or other root crops it is usually preferable to use such implements in preparing the land as stir the soil on and below the surface but which do not overturn it; it is greatly important to have the seed bed, fine, firm and moist when the seed is sown.

Usually, autumn sowing will be preferable; this is true of the South and, in many instances, of the North, though not of all. In the South, they should be sown as soon as the rains of fall come; in the North, if sown in the autumn, it should, if possible, be not later than August that the plants may have time to make a good growth before winter. Advantage should be taken of the moisture brought to the soil by rain, when sowing the seed. When sown in the spring, in the North, the work should be done as early as the ground is suitable for being worked. In the semi-arid country, the seed should be sown in the early spring or preferably in the late autumn.

The seed may be sown by hand, after all the kinds selected have first been mixed; but when this is sown the work should be done by an expert as it is very necessary that the seed should be evenly distributed.

When sown by hand, the plan of sowing half the seed when first going over the land and then crossing it when sowing the other half is quite certain to secure a more even distribution of seeds that differ in weight than by sowing them all at one cast. When sown with a hand seeder, now in use, which is wheeled over the ground, a more even distribution of the seed will be secured. It may be necessary, in some instances, to sow the coarser seeds together and then to go over the land a second time sowing those that are finer. This may be necessary because the small and large seeds are not likely to feed out evenly, when sown all at once; the opportunity is thus also furnished for running the harrow over the land after the first distribution of seed has been made in order to cover the seeds more deeply. In all or nearly all instances, some covering with the harrow is necessary; whether the roller should follow will depend upon soil and climatic conditions. There may be instances in which the seeds may be sown with the grain drill as when only one or two varieties are sown which require a fairly deep covering.

Usually these grasses are not sown with a nurse crop. Whether a crop shall be obtained from the ground, the season that grasses are sown, is not greatly important relatively; the great matter is to secure a good, vigorous and uniform stand of the grasses. When not sown with a nurse crop, the mower should be run over the ground as often as necessary to prevent the weeds and stronger plants from producing undue shade. Close attention should be given to the matter and it should be done frequently enough to make it unrec-

ecessary to remove any of the weeds or grass so cut from the land. If a nurse crop is sown and in some instances, it may be an advantage to have it very thinly sown and always cut for hay. Such a crop may be helpful in preserving lands from drifting or in protecting the fall sown grasses in the winter.

Grazing Permanent Pastures.—Uniformity in the method of grazing permanent pastures and in the management of the same cannot be practiced. Where the conditions are not the same, the general treatment of pastures will not be the same. Wherever they are, the aim should be to keep them clean and productive and so to manage them that the survival of all the plants sown shall be encouraged.

Usually, it is not considered good practice to graze permanent pastures the same year that they are sown but to this there may be some exceptions, as on soils lacking in firmness and where the rainfall is not plentiful. Close grazing, especially the first season, has the effect of hindering development in root growth the vigor of which is encouraged by growth in the top. The plan of mowing and leaving what is cut to mulch the soil is much better. When the seed is sown in the spring, the pasture should be ready for grazing the next season, but when it is sown in the fall it should furnish moderate grazing the following year; care should be taken not to graze it off too early in the spring. The second year these pastures should not be cut for hay as the development of the crop would tend to smother the weaker grasses.

The closeness of the grazing, that may be allowed

without injuring the grass, is much influenced by soil and climate. The more moist the climate and the more temperate, the closer may be the grazing. Close grazing where the summer heat is prolonged hinders growth through the escape of moisture; and in the autumn in stern climates, it weakens the vitality of the plants by exposing them too much in the winter. On the other hand, insufficient grazing would result in portions of the pasture remaining uneaten, until the grasses had produced stems and formed heads, after which they are not relished. When this does happen, the mower should be used as soon as the heads appear and, where these portions of the pasture are at all considerable, should be made into hay. Where the patches are small, if they can be cut from time to time the stock will likely consume much of it in the wilted form. In dry areas where the soils are loose, close grazing should be avoided and at no time should permanent pastures be grazed when so wet that the danger of poaching is present. The close grazing of Bermuda grass tends to keep out weeds which might overshadow the grass and is, so far, to be commended but not before the pasture has become well established.

On the whole the practice of grazing different classes of animals simultaneously on the same pastures, is to be commended, viewed from the standpoint of the influence which it exerts on the pastures. The tastes of these are different; hence, the pastures are likely to be more uniformly eaten. Where for good reasons which may exist, it is not prudent to graze them thus,

the plan of grazing them in succession will also tend to secure more of uniformity in the grazing.

While the practice of mulching permanent pastures with dressings of farm yard manure is not a good one, unless the manure is so fermented that the weed seeds in it are, in the main, destroyed, that of feeding soiling food on these pastures is beneficial where the work is judiciously done. The food thus fed should be strewn on fresh ground every time that it is fed until the pasture is gone over with a view to secure an even distribution in the droppings of the animals.

Every care should be exercised to keep weeds out of permanent pastures. This is best prevented by properly cleaning the soil before laying them down. Some forms of noxious weed life will gradually disappear as the grass plants take possession of the soil. This is true of nearly all kinds of annuals and of many biennials. It is different with many perennials especially those which multiply chiefly from underground stems; among the most persistent growers in these pastures are the oxeye daisy (*Leucanthemum vulgare*), the Canadian thistle (*Cirsium arvense*) and ironweed (*Vernonia noveboracensis*). On stiff clays Canada thistles will ultimately disappear where the grazing is close and continued for successive years, but on the other soils they will rather increase; oxeye daisies are also likely to increase. The same is true of ironweed and some other weeds unless cut by the mower, at least once a year, and grazed closely with sheep early in the season. If annuals and biennials are not allowed to blossom in such pastures, they will soon disappear. When peren-

nials are not too plentiful, they may be removed by cutting them with the spud when practicable below the surface of the ground, with sufficient frequency, to accomplish the end sought in a single season. Where they are too numerous to be thus dealt with, there is no other way but to tolerate their presence until the pasture is broken; but where a proper use is made of the mower, the scythe and the spud, noxious weeds will be, at least, reduced in permanent pastures, if not entirely removed. Those who may desire to get more information with reference to destroying weeds are referred to the book, "Weeds and How to Eradicate Them," written by the author in 1893.

Fertilizing and Renewing.—The necessity for having the soil in a good condition as to fertility when permanent pastures are laid down has been dwelt upon (see page 392). When the land has been thus enriched, usually no further fertilization is necessary for a few years—how many can only be determined by the needs of the land. But it is evident that no soil can furnish grazing indefinitely, especially for cattle without more or less of depletion in fertility because of the flesh, bone and milk product sold. The necessity for fertilizing the pastures, therefore, will always exist, and the production from the same will be measurably proportionate to the extent of the enrichment. Inattention to this essential in the management of permanent pastures furnishes one reason why they are not more in favor with the American farmer.

Usually commercial fertilizers are preferred for such manuring but farm yard manure, if it could be ob-

tained practically free from weed seeds would be greatly serviceable for such dressings. Muck from swamps and peat from bogs, when the latter is sufficiently decayed are also helpful on certain soils; the same is true of the material from compost heaps, of marls, lime and gypsum. When applying these dressings, the cost of the labor and the distance to which they need to be drawn must be carefully considered. Light dressings and frequent are to be preferred to heavy and infrequent dressings, as in the former instances there is less loss through fertility being carried away by excess of water.

After the pastures are laid down, commercial fertilizers can of course be only applied on the surface. By whatever name these may be known in the market the important food elements in them for the grasses are not more than three, viz., nitrogen, phosphoric acid and potash. The first is more commonly applied in the form of nitrate of soda, sulphate of ammonia or flesh meal from slaughter houses and it is helpful in promoting growth in grasses and clovers. The second is used in such forms as ground bone, ground rock containing phosphates and basic slag and is especially helpful to the grasses. The third is used in such forms as muriate and sulphate of potash, kainit and wood ashes, and, although quite helpful to both grasses and clovers, it tends more to stimulate growth in the latter.

Whether one or two or all three of these shall be applied as top dressings; the quantities of each that shall be used and the frequency of the dressings must be determined by the needs of the soil. In some in-

stances, only one is needed; in others, two; in yet others, all three. Dressings that are suitable for Connecticut soils may not be suitable for those of Carolina; and dressings that may be suitable for soil in one field may not be suitable for soil which is different in an adjoining field or in the same field. The farmer, therefore, who does not know the precise needs of his land should experiment upon small areas, until he ascertains which fertilizers and how much it will pay him to apply.

Usually not more than 100 to 200 pounds of nitrogen fertilizer is used per acre during one year. Two separate dressings of 50 to 100 pounds each are preferred to one dressing of 100 to 200 pounds; the first being given soon after growth begins and the second, during some moist season in the summer. When applied in a very dry time the food in the fertilizer does not reach the plants until rain comes and when applied at a time of too much moisture, or when growth is stagnant, the plant food may too soon leech out of the soil. Finely ground bone or phosphatic rock is a favorite dressing for grass pastures in the unreduced or reduced form. In the latter form, they act more quickly but for a period less prolonged. The dressings are usually applied in the early spring. They seldom exceed 200 pounds per acre and frequently not more than half that quantity is used. Potash is also applied in the spring and in some instances the harrow follows the application, as in the case of phosphoric acid. Wood ashes are commonly applied at the rate of about 50 bushels per acre in the unleeched form

and 200 bushels when leached. Nitrogen is sometimes applied every year, since its effects are not abiding, but phosphoric acid and potash, being of slower action are not usually applied every year. Attention is called to the importance of noting carefully the percentage of plant food, as given by reliable analysis in the various fertilizers purchased; this, of course, has an important bearing on their value.

Transforming Brush Lands.—On many parts of the continent are what are termed “brush lands.” These are covered more or less with bushes such as witch hazel and willow to the extent of preventing the growth of grasses. These areas are more frequent on the borders of prairie land and on some kinds of prairie. In other instances, the forest has been cut away and a dense growth of underwood in the brush stage, or a little larger than brush, is taking possession of the land. In yet other instances, fire has but recently passed through the forest, killing the standing timber and consuming much of the debris which covers the earth; and a thicket of young trees is again covering the ground. The largest areas of these lands are found in the northern states, and the question of transforming them into pastures, without clearing the land entirely by hand labor, is one of considerable importance. The method of doing this work would be, in outline, as follows:

Introduce goats to browse upon the brush; the Angora variety or their grades are to be preferred because of the relative value of the mohair. The goats will do their work more quickly and more effectively, if con-

fined by suitable fencing to a limited area, as much as they will clean up in one or two successive years. If some of the young trees are so large that the goats cannot reach the browse, it may be necessary to fell them with the axe, leaving the trimming to the goats.

At the end of the first year, in the late fall or early spring, grass seeds should be scattered over the land; these, of course, cannot be harrowed. Nevertheless, they will usually germinate on such land, except where the moisture is too much lacking which is sometimes the case amid the eastern ranges of the Rocky mountains.

From what has been said with reference to grasses adapted to various parts of the continent (see pp. 373-384), the varieties best suited to the several localities may be ascertained. To simplify the matter, it would be correct to say, that where it is desired to remove the trees and bushes entirely, the following formulas would answer for nearly all areas in the North and South respectively:

For the North—	Lbs. per Acre.
Timothy	5
Kentucky blue	5
Medium red clover.....	3
Alsike clover	1
Small white clover.....	1
Total	15
For the South—	
Meadow fescue	3
Tall oat	2
Perennial rye	3
Orchard	3
Japan clover	3
Small white	1
Total	15

In the South, the autumn months would be more suitable for sowing the seed. In the North, the hazard of losing the seed, through dry weather, would be lessened by sowing half the quantity one season, and the other half the following season; but such hazard to seed sown on new land is not very great.

At the end of the first season or the second, according to the extent to which the brush has been destroyed, sheep should be introduced and the goats moved on to fresh feeding grounds, as browse, with some grass, is the natural food of the goats, and grass is the natural food of the sheep. The latter will also prevent the bushes and young trees from regaining a foothold on such pastures and will so crop down weeds that the grasses sown will before very long make clean and excellent pasture.

When grasses are sown thus on areas of "slashed over" forest lands, which have been run over by fire, or amid the standing and fallen dead timber of the fire swept forests yet uncut, the germination is so sure and the growth so rapid that these may be readily transformed into pastures, by simply sowing the seed and introducing live stock to graze upon the land. In clearing timber lands, if they are thus laid down to grass, they at once become productive and will continue so until broken with the plough, and without the necessity of applying fertilizers for several years at least. Meantime the stumps, if of the hardwood, will in time decay and leave the land ready for the plough without entailing any considerable labor in their removal. This

method of clearing land is one of the simplest and least expensive that can be adopted.

When it is desired to transform forests into pastures of the park or grove order, the method of so changing them will, to some extent, depend upon the growth of trees present. When all the trees are large, change can be made, with less hazard to the trees that are left, by gradually cutting down and removing such as are not to remain, and by scattering the seeds of such grasses as will grow in shade in the openings. (See p. 372.) Meantime grazing should begin to keep down weeds and second growth of trees. Fire should not be introduced to consume the debris, unless carefully guarded from injuring the trees that are to remain. When the forest is of trees of relatively small growth and thick with brush, goats may be introduced to kill the brush as described above (see p. 395) before grass seeds are sown. But they may also bark some trees, which it may be desirable to retain. If fire is allowed to run over the ground in the early spring, to consume the fallen leaves before the grasses are sown, the stand of these will be made much more certain.

Transforming Native Prairie Pastures.—In certain areas, it may be desirable to transform native prairie pastures into those composed of grasses, that will provide more pasture than is furnished by the former, and without breaking the land with the plough or other implement of tillage. There are localities where such transformation can be more surely made when implements for stirring the ground are not used than where

they are. In these, the soils are light and the normal precipitation is also light. Such areas are sometimes found along the eastern border of the semi-arid belt and probably also in other localities.

Such transformation may be made by sowing the seed of the grasses desired in the early spring. Close pasturing should follow. Where this cannot be done the mower should be used once or twice to remove shade; where neither is done the seed sown will almost certainly be thrown away.

The best grasses to sow in areas where they will grow are blue grass and small white clover; timothy and the red clovers may sometimes be sown on upland prairie, alsike clover being added in low lands. There is much less hazard in sowing a few pounds of seed per acre, two or even three years in succession, than in sowing all the seed in one year.

Permanent Grasses for Shifting Lands.—Some soils are of such a character, that when cultivated for any considerable time, more or less of the soil is carried down to lower levels and, in some instances, much of it is carried quite away, in solution in the water, that runs over the surface of the land. Gullies are formed with more or less frequency and of ever increasing size. These seriously interfere with the tilling of the land and with crop production; they are at all times most unsightly. The best of the soil is thus carried down to the lower lands or washed away entirely. To so great an extent has this eroding process been allowed, especially in some parts of the South, that the further cultivation of the soil has been abandoned.

Prominent among the influences that favor such erosions are: 1. Unevenness in the surface of the land. The steeper the descent, the more easily does the soil moved downward. 2. The sandy character of the soil. The finer the sand, the more easily does it move. 3. The frequency and violence of the precipitation. Areas, where violent thunder storms occur or occasional cloud-bursts, are much liable to suffer from erosion. 4. Lack of porosity in the subsoil which prevents the quick descent of water in the soil, and the nearer the hard subsoil comes to the surface, the greater is the loss of surface soil. 5. Lack of vegetable matter in the soil. The less of this in the soil, the less the water which it absorbs and the less is the obstruction to the removal of soil particles.

Important among the counteracting and preventive influences are the following: 1. Ploughing deeply so that the absorptive power of the ground will be increased. 2. Making parallel surface drains at such distances as may be deemed proper along the sides of hills to arrest and carry descending water along rather than down the hill. 3. Constructing underdrains down the depressions laid not far from the surface and of considerable capacity to aid in carrying away the water. 4. Laying such lands down to permanent pasture and maintaining them as such. 5. Planting them with forest trees. Where such lands are not to be planted to forest, the aim should be to keep them in permanent pasture.

The best grasses for such pasture in the Northwest is Russian brome; in the North, a mixture of Kentucky

blue and white clover; and in the South, Bermuda. Before these are sown on gullied lands, the aim should be to fill them by the aid of the plough and scraper; then to fertilize them before sowing the seed. Some nurse crop, as rye, may be helpful in holding the soil until the grasses get started. On steep side hills, it may prove advantageous to strew litter or straw thinly over the newly sown land.

Gullies may frequently be prevented from washing deeper by perseveringly throwing in them rubbish, such as brush and cornstalks, for a time, to arrest the silt and then by sowing in them, and along the sides such soil-binding grasses as Russian brome in the North, and Bermuda in the South. The tendency in these will be to further arrest silt and to grow up through it, thus raising the land in the ditch gradually to a higher level.

Renewing.—When permanent pastures form a good even sod, made up of a number of grasses, it is questionable if it should be disturbed with the plough or disk, especially in moist climates. Renewal, in such instances, should rather be attempted through fertilization. It may be advantageous sometimes to stir the surface of blue grass pastures with the disk and to add some seed of one, two or three varieties of clover. The best time probably for doing this work, especially on prairie soils, is the early spring, just when the frost has come out far enough to admit of cutting down to the required depth with the disks. When disked one way, it may be profitable, in many instances, to disk both ways, driving at an angle the second time. A few

pounds of clover seeds should then be scattered over the land, and of one or more grasses, if desired. The ground is then smoothed down with the harrow. On some soils, it may be helpful to partly smooth the ground, before sowing the seed. The grazing may go on without interruption.

Reference has been made to the renewing of Russian brome (see p. 188), of Quack grass (see p. 242) and of Johnson grass (see p. 257), by using the plough and harrow. Bermuda grass may also be renewed (see p. 128). Some advocate renewal by simply using the ordinary harrow. To use it thus is of questionable advantage, the impression made on old sod is so slight.

In some instances on light soils or on good soils underlaid with gravel, the grasses fail in certain parts from drought or from excessive pasturing. The remedy is to disk the ground where the pastures have failed, and to sow seed again along with rye or other grain. Here also, the pasturing may go on as usual, if the seed has been plentifully sown.

CHAPTER XVII.

MEADOWS AND MAKING HAY.

The hay crop in the United States for 1899, as reported by the United States Census, taken in 1900, was as follows:

Tame and Cultivated grasses.....	30,605,316	tons
Wild, Salt, Prairie grasses.....	13,904,206	“
Alfalfa	6,222,568	“
Millet and Hungarian grasses.....	4,223,500	“
Clover	4,133,409	“
Grains cut green for hay.....	3,262,957	“

The above enumeration does not include what is designated as forage crops sown for forage and corn stalks, and is submitted to indicate the relative economic importance of the different classes of plants, as grouped for the production of hay, at the time when the census was taken. From this table, the great relative importance of the tame and cultivated grasses, as factors in producing hay, will be at once apparent; and it may be expected to increase relatively rather than decrease, since the source of supply for wild hay will gradually decrease until it will ultimately almost disappear. The grains cut green for hay and the millets which are annuals, also furnish a relatively large amount of the hay used, the sum total being 7,396,366 tons. In 1899, each of the following states produced more hay from grains cut green than they produced of

cultivated hay, viz., Arizona, Arkansas, California, Indian Territory, Louisiana, Mississippi, New Mexico, Oklahoma and South Dakota, hence the relative importance of knowing how to grow these in the best form and in the best combinations.

Since in Chapter XV. the grasses and other plants grown for pasture and temporary meadow are discussed together, in the present chapter only the grasses will be discussed in their relation to providing hay from permanent meadows and other plants from which hay is made in relation to hay producing only. Notwithstanding the importance of the latter as a source of supply to the farmers of the South and West, they will be discussed briefly, as the author purposes to treat of these more fully in a subsequent work dealing with cereals.

In the following discussion, it may happen in some instances, larger quantities of seed may be named, as suitable for sowing in permanent meadows, than have previously been named for temporary meadows; since it is more important in the latter to secure a good stand of the seeds. It is also important, when laying down such meadows that, when grasses are sown in combinations, a careful regard must be had to sowing those together which mature about the same time.

HAY CROPS FOR STATES AND PROVINCES.

In order the more intelligently to discuss this question, the states and the provinces will be divided into groups. The divisions will be the same as those adopt-

ed in Chapters XV. and XVI., when discussing Pastures, Temporary and Permanent.

For the Northeastern States.—For the states included in this group, see p. 342, and for grasses for temporary meadows, see p. 343. The best plant for upland soils and also for river bottoms, where it will grow in this group of states and provinces, is alfalfa. On the upland, it will succeed best on good soils, well enriched and underlaid with clay, not too dense to be penetrated by the roots. The seed should be sown in the spring about the end of the grain growing season, by hand or with such machines as will do the work properly. It is preferably sown alone but may be sown with various nurse crops and at the rate of 15 to 20 pounds of seed per acre. This subject is further discussed in "Clovers and How to Grow Them" by the author. The best permanent hay grass for soils inclining to light, is Russian brome, sown at the rate of 20 pounds per acre (see p. 181). The best grasses for permanent meadows on productive upland soils are timothy and redtop, sown at the rate of 6 pounds of the former and 6 or 7 of the latter. The best average permanent meadow grasses, sown in combination for low lands are timothy, redtop and alsike clover, sown at the rate of 4, 4 and 3 pounds, respectively, per acre. On some low lands, fowl meadow makes excellent permanent meadow, and possibly also meadow foxtail.

Annuals grown for hay in this group are crimson clover, the various kinds of millet, oats, peas and vetches; crimson clover and the millets are usually sown alone; oats are also frequently sown thus, but often also

in conjunction with the Canada field pea or vetches or both combined.

Crimson clover is sown on prepared land in August and September, using 15 pounds of seed per acre. It is only adapted to the more southerly of the states of this group. It is usually ready for harvesting in May. For further facts, the reader is referred to the book, "Clovers and How to Grow Them," by the author.

Of the four classes of millets, viz., Foxtail, Barnyard, Broomcorn and Pearl, the first named is the best for hay production in this group; the varieties known respectively as Hungarian and German are especially suitable. These are sown preferably on clean land in the late spring, subsequent to the corn planting season and on through June. They require from 60 to 75 days to reach the proper stage for cutting. From 2 to 4 pecks of seed per acre are sown, according to the firmness of the hay wanted. It is sown by hand or with the grain drill, and when sown by hand it is covered with the aid of the harrow and roller. When sown with the drill, the seed should be buried from 1 to 2 inches only, the soil being right as to moisture. The sowing of millets is further discussed in "Soiling Crops and the Silo," by the author.

The oats are sown alone to a very considerable extent, to provide hay, more especially for dairy cows. They are sown in the ordinary way, in the spring as soon as the land is ready, whether sown alone or with peas or vetches or both. From $2\frac{1}{2}$ to 3 bushels of seed should be sown per acre, using at least 25 per cent more seed than to grow a crop of grain, in order

to insure greater fineness in the hay. When sown with peas or vetches, about $1\frac{1}{4}$ bushels of each per acre will suffice, when sown with both peas and vetches, 5 pecks of oats, 3 of peas and 3 of vetches will probably suffice. The aim should be to sow as much of peas or vetches in the mixture as are likely to be sustained by the oats, as these furnish not only the more valuable hay plants, but also the more palatable. This can only be determined by experience in growing them.

For the Southeastern States.—For the states included in this group, see p. 344, and for grasses for temporary meadows, see p. 344. The best permanent meadow plant, on average soils, in this group is Bermuda grass and on low lands, Johnson grass. The former of these is discussed in Chapter V and the latter in Chapter XII, p. 248. The most valuable grasses for permanent meadows, sown in combination, on the better class of upland soils, are orchard, redtop, tall oat and meadow fescue. Of these, orchard and tall oat go best together, since they mature about the same time; likewise redtop and meadow fescue; of the two first, 28 and 12 pounds respectively should be sown per acre, and of the two last, 10 and 18 pounds respectively. The permanency of these has its limits as in time they will fail. In certain areas, more especially on bottom lands sufficiently drained, and also on certain upland soils on an open clay foundation, alfalfa makes good permanent meadow. As stated above, from 15 to 20 pounds of seed are sown per acre, but in these states the crop is preferably sown in the fall. This, at least, will hold good in many localities.

Among the best annuals grown for hay are crimson clover, usually grown alone, winter oats, winter barley or winter rye, grown alone or in combination with the sand vetch, cow pea and soy bean; on the best class of soils, millets of the Foxtail and Barnyard varieties. These grain crops are more important relatively in furnishing hay to southern farmers, than grain crops are to farmers in the North, owing to the greater abundance of other hay crops in the North. Crimson clover is grown as described above (see p. 406), but may be sown later and cut earlier; of the small winter cereals mentioned, oats is by far the most valuable for hay. Rye is more hardy and yields well but is lacking in palatability. It may be wise, however, in some instances, to sow it with the sand vetch in order to sustain the latter. These small cereal grains should be sown in the autumn, as soon as the fall rains come, using not less than 2 bushels of seed to the acre, when sown alone, and in many instances they will also furnish grazing for the winter and later will grow up into hay; when winter oats are sown with the sand vetch, use 1 bushel of the seed of each per acre and, in some cases, less of the seed of the vetches; when winter rye is used instead of oats, sow $\frac{1}{2}$ bushel of rye and $1\frac{1}{2}$ bushels of the vetch; enough rye only is wanted to sustain the vetch. Cow peas are sown subsequently to the corn planting season and are usually sown with the grain drill. When sown for hay all the tubes or every other tube is open, or only as many open as will suffice to make room for properly cultivating the crop. The amount of seed varies from 2 bushels per acre to 2 pecks, according to the soil, the



FIG. 30.

Permanent Meadow on Tennessee Experiment Farm.

Tennessee Experiment Station.

variety and the object sought. The variety sown would also be adapted to the needs of the locality. When the crop is not cultivated, the harrow should be used on it with more or less freedom, in the early stages of growth. What has been said about the sowing of cow peas will equally apply to soy beans, grown for hay. Millets can only be sown upon the better class of soils. Their relative importance in furnishing hay in this group is not so high as in some other groups, owing in a large measure to soil conditions. Sorghum is best sown just at the close of the corn planting season on well prepared and fertilized land. From 1 to 2 bushels of seed are drilled in with the grain drill in order to make the growth fine. The crop may be cut twice for hay. The chief objection to it is that it is difficult to cure for hay, nor is it relished so much by stock, as when grown as fodder and fed when more mature. In several of the southern states, however, it is much grown for hay; considerable crab grass is also grown for hay (see p. 262).

For the Canadian Northwest.—For the states and provinces included in this group, see p. 346, and for grasses for temporary meadows, see p. 346. The best grass for permanent meadows in this area generally is Russian brome. Next to it, especially in dry areas, is western rye, and, in areas more moist, timothy. These are best sown for permanent meadow in the late summer and on summer-fallowed land but may also be sown in the spring or in the quite late autumn on clean land. When sown early in the spring, it may be with a nurse crop, thinly sown and cut for hay at the heading out

stage. When Russian brome and timothy are sown, use 10 and 6 pounds of seed respectively; when Russian brome and rye grass are sown, use 9 and 10 pounds respectively. For methods of sowing, see p. 179.

The best grain crops for hay alone or oats and Canada field peas, and probably oats and vetches, especially northward as indicated by the abundance of wild peas growing in northern Alberta and Saskatchewan. Oats and peas may be sown with the drill in the mixed form, using about $\frac{1}{2}$ bushel of oats to about 2 bushels of peas and about $\frac{1}{2}$ bushel of oats to $1\frac{1}{2}$ bushels of vetches per acre. The proportion may need to be varied somewhat in different areas to meet requirements. They should be sown on fall ploughed land and early in the spring; millet also does well in much of this area.

For the Upper Mississippi Basin.—For the area included in this group, see p. 347, and for temporary hay meadows, grown in them, see p. 347. The best single plants for permanent hay meadows in Wisconsin, Illinois, Iowa and Minnesota are Russian brome, on dry soils, and timothy and redtop, for moist lands. In laying these down, sow of Russian brome 15 pounds per acre; of timothy, 12 pounds and of redtop 12 pounds; alfalfa will also grow in many parts of these states, and when it does will make excellent permanent meadow. But by far the best combination for permanent meadows is timothy, redtop and alsike clover, sown on moist soils, at the rate of 4, 4 and 3 pounds respectively per acre. In Missouri, the best permanent meadow grasses are much the same as in these states,

except that Russian brome has a much less important place. In western Minnesota and eastern North and South Dakota, Russian brome is the best permanent meadow grass and timothy is probably next to it; alfalfa is also likely to have its place in these. In eastern Kansas and Nebraska alfalfa is far the best permanent meadow plant; and next to it are meadow fescue, Russian brome, tall oat grass and orchard grass. The latter two may be sown together for permanent meadow, since they mature about the same time, using 12 pounds of seed of the former and 28 pounds of the latter per acre, but the meadow from these will not be very enduring. Meadow fescue, sown at the rate of 18 pounds per acre, or Russian brome sown at the rate of 15 pounds per acre, will be more abiding, but the former will not produce very large yields of hay.

The annual hay plants for this group of states northward, include oats, peas and millets, more particularly of the small varieties. The prairie soils of nearly all the area in this group has high adaptation for millet. Southward in the same, cow peas and soy beans are coming to be grown. For growing oats and peas, see p. 407; millet, p. 336; soy beans and cow peas, p. 407.

For the Semi-Arid Belt.—For the area included in this belt, see p. 348, and for the temporary meadows in the same, see p. 348. The best permanent hay plant for the dry land on which crops can be grown is Russian brome with western rye grass a close second, sowing 15 pounds of the seed of each, when sown alone, and about half the amount of each when sown together. On some of the bench lands northward, timothy is the best

hay plant at the present time; on others of these, alfalfa; of the former, sow 10 pounds of seed and of the latter 15 pounds. On the unirrigated wheat growing lands of Washington, Idaho and Oregon, a combination of Russian brome, orchard and tall oat grasses, using 5, 9 and 4 pounds of seed respectively, will probably make the best combination for permanent meadow; alfalfa will also grow well on much of this land.

In these areas and in others similar in some other states, especially California, a very large amount of hay is furnished by the small cereal grains. For this purpose, much wheat is grown, but oats and barley are also extensively used and in some localities, winter rye and speltz. These may of course be grown alone or in combination. When grown for hay, about 25 per cent should be added to the amount of seed usually sown for grain. The sand vetch, though not much grown as yet in this area, will grow well in much of it and would make a splendid addition to the hay crop, sown at the rate of 1 bushel per acre, along with about the same portion of grain. The dry climate and freedom from rust in the grain makes the hay from the same more palatable than it is in parts of the United States and Canada where there is more moisture.

For Irrigated Western Valleys.—For the states included in this group, see p. 349, and for the plants grown for temporary meadows, p. 350. In these valleys, many kinds of grasses may be grown for permanent meadow. Of these, alfalfa is unquestionably the most important. For all or nearly all these lands, from near Alaska to Lower California, it has wonderful adap-

tation that is, in a sense, remarkable; from two to five crops a year, according to latitude and altitude, are regularly grown. Although the crop is commonly sown alone, there may be combined with it various other grasses. Those which grow quickly and which, like the alfalfa, will furnish more than one cutting, should be chosen. Italian rye grass would be one of the best but that it is short lived; perennial rye lives longer but does not grow so fast; orchard and tall oat grasses may also be thus grown. Twenty pounds of alfalfa seed is ample when sown alone, but when one of the other grasses is added a few pounds of the seed of each will suffice, more or less being used, according to the object sought; the amount of alfalfa seed should be correspondingly reduced.

After alfalfa, the best permanent meadow, for these valleys for the present time, is timothy; if hay is wanted for the market, more especially when it has to be transported in the baled form, sow about 12 pounds of seed to the acre. When the hay is wanted for home or local feeding, sow 10 pounds of timothy and 3 pounds of alsike clover, or 6 pounds of red clover in lieu of the alsike, or 3 pounds of the former and 2 pounds of the latter. Such mixtures prove very satisfactory and last for many years, especially the mixture of timothy and alsike clover. The yield may be further increased on many soils by sowing timothy, redtop and alsike in combination, using 6, 4 and 3 pounds of the seed respectively per acre. Various other grasses may be grown, but none probably will prove so satisfactory as those that have been named.

Various grain crops also may be grown for hay alone or in combination. The necessity for growing these thus does not exist where grasses can be grown so abundantly and of such high excellence.

West of the Cascades.—For the area included in this division, see p. 351, and for the grasses for temporary meadow, see p. 352. The list for permanent meadow is a long one. It includes timothy, red top, orchard grass, meadow fescue, perennial rye grass, Russian brome, alsike and red clover, grown singly or in various combinations. The clovers here assume more or less of a perennial habit of growth. The amounts of seed to sow, when these are sown alone, would be about the same as mentioned for such sowing, when discussing each variety, but minimum rather than maximum quantities, would suffice, owing to the moist character of the climate, so favorable to the growth of grasses. One of the simplest and best combinations is timothy and alsike clover, especially when the hay is to be marketed; to produce such hay from 10 to 12 pounds of timothy may be sown on bottom and tide lands, and 2 pounds of alsike clover; where the yield is for home consumption, redtop should be added; the proportions of seed then required would be about 4 pounds each of timothy and redtop, and 8 pounds of alsike.

For the higher land, timothy and medium red clover would make meadow that would last for several years, if desired, sowing 8 pounds of the former and 6 pounds of the latter. The production would probably be strengthened by substituting 3 pounds each of medium red and mammoth clover for 6 pounds of medium red. On the

light and poorer soils, Russian brome, tall oat and perennial rye grasses could be sown at the rate of 7, 5 and 7 pounds of the seed of each respectively. Various kinds of grain mixtures may be grown for hay. Of these oats, vetches and peas are the best; the oats may, of course, be grown alone, sowing not less than $2\frac{1}{2}$ bushels of seed to the acre. More valuable hay, however, is produced when peas or vetches or both are grown along with the oats. In the mixture, $1\frac{1}{2}$ bushels of peas or the same of vetches would be the proper amounts to sow, at least approximately. When both are sown, one-half of the amount of each would suffice; the variety of vetch sown is the common kind (*Vicia sativa*).

The common vetch is sometimes sown alone for hay, but the better plan is to sow enough grain with it to sustain the plants. In this part of the United States, it is considered a very excellent hay plant. When cut at a stage a little short of ripening, it makes particularly excellent food for sheep. It has high adaptation for all cultivable portions of this region.

MISCELLANEOUS DISCUSSIONS.

The discussions that now follow relate to preparing the soil for meadows; sowing the seed; harvesting, curing and storing the hay; grazing the meadows and fertilizing and renewing them.

Preparing the Soil.—While as previously intimated, careful preparation of the soil is advantageous in growing all kinds of grasses, it may be added, that it is especially so, when preparing the same for permanent meadows, because they are permanent. It would not be pos-

sible, within the limits of this work, to discuss in detail the preparation that would best suit all soils and climates in the various states. A clean seed bed, suitable to the needs of the climate, and well supplied with easily accessible fertility is all important.

Very large yields of grass, composed mainly of timothy, redbtop and red clover have been obtained by Mr. Geo. M. Clark of Higganum, Conn. He gives very fine and thorough pulverization to the land in summer previous to sowing the seed with a view to securing a clean and moist seed bed; sows large amounts of seed and applies suitable fertilizers liberally at the time of sowing the seed and subsequently. By his method two cuttings per annum have been harvested with a total yield of over 5 to more than 8 tons of hay. In preparing the land, the cutaway and spike harrows are chiefly used with a view to chopping and finely pulverizing the land.

While this method has proved eminently satisfactory for that part of Connecticut, to uphold the plan, as some writers do, as being that which should be generally followed in laying down permanent meadows would certainly be misleading. To engraft it on the practice of the farmers in certain parts of Kentucky, for instance, where excellent crops of these grasses can be secured for several years, would be encouraging prodigality in labor and waste in applied fertility; results can be obtained in certain parts of Kentucky, by sowing the grasses on clover sod, ploughed and prepared, with only a fractional part of the labor involved in the other case. To spend a similar amount of labor on land to be laid

down on the western prairies, which lifts with the wind would simply be encouraging the wind to blow it away; and to expend so much labor on a seed bed in the rainy South without subsoiling would not be wise. While the aim should be, in preparing such lands, to have them clean, finely pulverized, moist and rich, these results should be sought by that system which will involve a minimum expenditure of labor; pulverization to the extent of hazarding or inviting subsequent impaction should be avoided; waste in the methods of applying fertility should be avoided. Those methods of preparation will be best which will best meet the needs of the locality whatever these may be.

Sowing.—What has been said in Chapter XVI, as to the time for sowing permanent pastures, will apply about equally to permanent meadows. (See p. 385.) Over much of the country, especially south and west, early autumn sowing will prove most satisfactory.

In laying down permanent pastures, the question of securing the proceeds of a nurse crop at the same time is one of but small importance relatively. The all important matter is to secure a good stand of the grasses because of the permanency of the meadow. As in laying down permanent pastures, nurse crops, when used, should in many instances be cut early to mulch the land, or later and while immature, for hay.

While the quantities of seed named in each case is in the main correct, it is only intended to be approximately so, which may be said of the quantities of seed specified throughout the book. Some successful growers sow much larger quantities of seed than those named;

especially, when laying down permanent meadows, and under their conditions, it is the proper thing to do. They are favored with a moist climate and are careful to maintain an equilibrium in fertility, and, consequently, the soil sustains both denseness in growth and vigor in the same; hence, the yields are relatively high and the quality of the hay is fine; the yields would be quite as large probably, though considerably less seed were sown, but the quality of the hay would not be so fine. But to sow quantities so large without maintaining a high state of fertility, would mean reduced yields, as the food supply in the soil would be inadequate to meet the needs of so many plants. To sow very large quantities of seed on lands, where the normal supply of moisture is low, would mean more or less of failure, since so many plants would be unable to get enough moisture to produce strong growth. To overstock meadow lands thus is akin in principle to overstocking pastures with animals brought to graze upon them.

Harvesting.—The grasses proper are, in nearly all instances, cut with the field mower, when harvested for hay. The same is true of clovers, sorghums, millets and all varieties of cow peas and soy beans. It is necessary to cut them thus to facilitate curing. When seed is wanted, except in the cases of sorghums, cow peas and soy beans, the binder is used. The sorghums, when sown broadcast, are sometimes cut with the mower for autumn feeding, and sometimes with the binder; when grown in drills to which cultivation has been given, they are now more commonly harvested with the corn harvester. The best machine probably for harvesting cow

peas for any use, is the pea harvester; seed crops of soy beans may be cut with the binder.

Nearly all the small cereal grains are harvested with the binder, when cut for hay, whether grown alone or in mixtures; when thus cut, they are more easily handled and with less labor, while being cured, stored and fed. But when harvesting them, the sheaves should be made small and tied rather loosely to facilitate drying. If bound tightly, more or less mould is likely to appear in the sheaves underneath the band that ties them. However, when those cereals grow in mixtures and are much lodged and tangled, it will usually be preferable to cut them with the field mower. When vetches are grown alone for hay, they can be best harvested with the pea harvester but may be cut with the mower.

The proper stage at which to cut nearly all grass-plants is when in bloom, a little prior to that stage for cattle, especially milch cows and sheep, and for horses, a little later than the full bloom stage. Grasses which quickly lose in palatability when nearing maturity should be cut when rather less advanced than others, such are orchard grass and western rye; others again do lose much when cut later than the blossoming stage, such is Russian brome. The clovers should be cut when in full bloom, except alfalfa, which is best cut when coming into bloom. The best time to cut the sorghums, grown thickly for hay, is when seed is in the dough stage; when two cuttings are wanted in the season, it must be cut earlier; the difficulty in curing it increases with earliness in the stage of cutting. The millets are ready for cutting, when all the heads have

appeared and when those first out are beginning to assume a yellowish tint.

Cow peas are cut for hay, when pods that first appeared, are maturing. Soy beans are ready, when the pods are reasonably well filled but not ripe, though for some uses they are cut earlier.

Oats are ready for being cut for hay, when the straw for a few inches below the head and for the same above the ground, has assumed a yellow tint, the other portion of the stalk being yet green; or, when the grain is fully formed and in the milk stage, but not yet advanced in the dough stage. Wheat should be cut at a stage of development a little earlier, lest the straw becomes too woody. Barley is cut a little short of the milk stage or the beards will stiffen too much. Rye, to prevent undue woodiness and want of palatability, is better cut when coming into head. Vetches are ready to make into hay when nearly all the flowers have been succeeded by pods, but while the crop is not yet ripe.

Where large areas are to be harvested, it may not be possible to cut the entire crop at the most suitable stage for harvesting. Something will probably be sacrificed from cutting a part of the crop too early or too late; of the two evils, the former is usually the lesser, hence the wisdom in such instances of beginning to harvest early. Such action is further supported by the general principle, that it is advantageous to be forehanded with work.

Curing Hay.—When curing hay of any kind, the aim should be to expose it no more than is absolutely necessary to the sun, as palatability decreases with in-

crease in bleaching; to protect it, as much as possible, from rain and dews, which take from it aroma and certain other properties, in proportion, as these are present; and to cure it to the greatest extent practicable through the agency of air and wind, as such curing favors the retention of the natural color. Hay that is over sun-cured, not only loses in palatability and in many instances many of the leaves, but it loses unduly in weight. Hay, exposed to excessive rains, especially when from leguminous plants, soon becomes practically valueless for food. On the other hand, hay properly cured chiefly through the agency of air and wind preserves the green color, the aroma, the palatability, the weight and the nutrition to the greatest extent to which it is possible to secure these.

From what has been said, it will be apparent that to secure these results in the most perfect form, hay must be cured to the greatest extent possible, in cocks rather than while spread over the ground exposed to sunshine; or in winrows where much more of the surface is exposed than in cocks. There is also the additional hazard, that if rain falls while the hay is in winrows, the loss from such exposure is usually much greater than when it is in cocks; the relative loss from clovers and other legumes being thus exposed is greater than the loss from the grasses proper. The more nearly cured the hay is, when exposed to rain or dew, the greater the relative injury that comes to it from such exposure. When mixed grains are rained on, while they lie upon the ground, where the mower left them, the further injury follows that they are more or less covered with

particles of soil. The same is true of such crops as cow peas or soy beans. The wisdom, therefore, of getting mown hay into well put up cocks, as soon as possible after it has been mown, is clearly apparent.

Notwithstanding that the very best hay is thus made, much good hay is made by curing it in the winrow or in bunches, made from the winrow by the aid of the horserake. In fact more hay is cured by this process, than by the other and in many instances the practice is not only justifiable but commendable; it is not only labor saving but enables the haymaker to do the work so much more quickly that the hazards from losses of exposure to rain and from the overmaturing of a portion of the crop are lessened; the cost of harvesting is very materially reduced. The time and labor called for in putting hay into cocks are no more than would be required to put it on wagons ready for removal; when placed in cocks, the hay cannot be put upon wagons by the hay loader, as it can when made in winrows. The loss of quality in the hay, therefore, by this mode of curing may be more than made up in the benefits accruing as stated above.

It is relatively more important that clovers and other leguminous hay plants be cured in cocks than that the grasses proper be cured thus; since when cured otherwise, they lose more leaves, part with more of their aroma, take much more injury from rain and dew; when thus cured, the danger from over fermentation in the mow is also lessened. The practice, therefore, which aims to cure these in the cock is to be commended, unless in time of settled harvest weather or in rainless

harvest climates. When harvesting clovers and other legumes, the method of procedure would, in outline, be as follows: Cut with the mower as soon as the dew has lifted. When the crop has wilted somewhat, run the tedder over the mown hay and probably a second time, with an interval of a few hours between. The mower leaves the crop lying closely on the ground, as the horses and mower pass over all the cut portion. The tedder tosses it into the air and in such a way that when it falls down "topsy turvy," it lies more loosely over the ground, so that the air, stirring and passing through it, greatly facilitates quick curing. It is then raked with the horserake, as soon as the rake will draw it easily and cleanly into winrows; when the rake will not do this satisfactorily, it is too green to be raked. It should be put into cocks as soon as raked; these should be small or large according to the degree of curing in the hay. The higher and narrower they are, compatible with firmness, the more symmetrical they are; and the more carefully they are combed down around the sides, the more quickly they will cure and the better they will turn rain. One well used to such work will put the hay into such cocks quickly; while the unskilled and careless may spend their time to little purpose by doing the work slowly and in a slovenly manner.

The length of time between the cutting of legumes and getting them put into cocks varies with the weather and the maturity in the hay. Frequently these may be made the same day the crop is cut; at other times, not until the second day; and in very bad weather, not until

the third day. The length of time that the hay should remain in the cocks will depend chiefly on the weather, but usually it remains thus for two or three days. While in the cocks, it "sweats" more or less which means that it ferments slightly and, as a result, is less liable to ferment excessively in the mow. No time should be lost in storing hay as soon as it is ready.

This may be determined by taking a wisp of hay from within the heap and twisting it in the hands. If no moisture exudes, the hay is ready to store. Another method of judging is by the comparative weight of the hay in being handled, which can be easily judged by a skilled hand. Before drawing the hay for storage, it is usual to spread out the cocks, more or less, for exposure to the sunlight for a few hours, before drawing them and more especially the parts of the same nearest to the ground. This should not be done much in advance of the storing, in showery weather.

Cow peas and soy beans are frequently left longer on the ground, before putting them up in cocks, especially the former, since they cure but slowly. The cocks are made small and narrow in proportion to the height to facilitate drying out. They too are frequently turned over, more or less, before they are drawn, to secure in them quicker and more thorough drying. In some instances, they are stacked soon after being cut. The procedure is, in substance, as follows: Poles are planted in the ground to the height of about 9 feet and one foot into the ground. One pair of strips of wood is fastened to the stack pole at right angles to each other and one foot from the ground. These are laden with

pea hay. A second pair is in due time placed 3 feet from the ground and similarly laden. A third pair is placed 6 feet from the ground, and likewise laden to the top of the pole. These little stacks, not more than 6 feet across, are covered with crab grass. This is only one of many devices, used in the curing of cow peas.

Caps may advantageously be used in curing clover hay, in showery weather, when the quantities to be cured are not large. They may be made of strong cotton cloth, also of other material, about $4\frac{1}{2}$ feet square, with pegs attached to the corners or some kind of weight, as a small stone sewed in each corner. When in use, they are spread over the cocks, and the pegs are fastened into the hay at the sides of the cocks or into the ground. One work-hand should apply them as fast as two put up the hay. When not in use, they should be carefully laid away and, if made of good material, should last for as many as a score of years. In time of heavy rainfall, however, they fail to preserve the bottom of the cock, from serious injury, from the absorption of moisture from beneath.

The plan of storing clover and cow pea hay, as soon as a little wilted, has been tried and, in many instances, with success. The crop is cut and wilted a little and is then drawn and tramped down firmly into mows. Care is taken not to store any of it when wet with dew or rain. The principle involved is much the same as in making ensilage. The requisite conditions, however, must all be carefully observed or serious loss may follow; hence, the unskilled, in this method of curing hay, should thoroughly post themselves regarding all the details requi-

site to success before they attempt to cure it thus. In dry weather, the advantage from curing by this method is to be questioned.

The grasses cure much more quickly than the clovers. The practice is common, therefore, of drawing them together with the hay rake, after the tedder has gone over them, and drawing the hay from the winrows. It is lifted or may be lifted from these with the hay loader. To facilitate such lifting, the winrows should be small. The duration of the exposure will depend upon the kind of grass, its maturity and the weather. In good weather, it can usually be cut one day and stored the next. In showery weather, what is cut should be put up in cocks, as these will shed rain better than those composed of clover. Millet and mixed grains are sometimes cured in winrows and sometimes in cocks; which method should be followed will depend upon conditions. These crops take more injury from rain than many of the grasses but less injury than clovers; hence, in showery weather, they should be cured in the cock.

Storing Hay.—Hay is stored in the mows of barns or in the lofts of stables, in hay sheds or in stacks. The aim should be, on the part of those who feed the hay on the farm, to store it under cover to the greatest extent practicable, in order to avoid the expense of handling a second time before it is fed and the loss from the shedding of leaves and heads, which, in nearly all instances, accompanies the second handling of hay. In handling cow pea, soy bean and clover hay, this loss is very much greater than in handling hay from grasses. Furthermore, the aim should be to store it in such proximity

to the place of feeding, that it will be conveyed to the animals which feed upon it with the least possible amount of labor.

When stored in large quantities in barns, stables or indeed anywhere, it is lifted from the load and dumped in the mow, hay shed or stack, as the case may be, by means of horse-forks or, what is usually better, slings where they can be used. With the latter, the entire load may be taken up and put in place by means of two or three separate draughts. When taken up with the horse-fork, more or less hay falls back again with each draught and has to be relifted. When lifted by either method, careful attention should be given to the even and systematic distribution of the hay in the mow, that it may pack evenly and be taken out again in the regular way. To accomplish this calls for great diligence and fidelity on the part of those who work in the warm mows, when hay is being stored rapidly.

Hay sheds are usually oblong in shape and may be of any size desired. They are usually made by setting upright posts in the ground and putting plates on them and on these rafters sustaining a ridge roof. Suspended from the ridge a track may be constructed, if desired, to carry a fork or sling in storing the hay. These are usually open on every side. Where hay has to be handled a second time, these sheds may be made to render excellent service, since they may be erected in the midst of a permanent meadow and thus furnish safe protection for the hay which is stored with the least possible loss of time in conveying it to the place of storage.

When stacking hay, poles should first be laid under-

neath and only sufficiently near to sustain other poles laid across them; upon this, a covering of old straw should be laid. When the stack rests on the ground, the hay at the bottom of the stack will be injured from one to two feet from the ground, according to the location and climate, by imbibing moisture from the earth.

When building stacks, whether of the long or round form, it is greatly important that the centre shall be kept considerably higher from the ground upward than the sides, otherwise water will seep in from the sides and penetrate downward. It is also greatly important that the stack shall be kept evenly tramped, that the settling may be even. Where the settling of the stack is even everywhere and a little sloping downward all the way from the centre to the outer edges, it would not be easy for any considerable quantity of water to penetrate a stack even though topped out only reasonably well.

Marsh grass where it can be obtained furnishes the best grass covering for stacks. It is most suitably put on in the green form and combed down all around with a rake to straighten the stems downward. Blue grass, such as obtained in fence corners, is also good, since it is not easily penetrated by rain. Small weights should be suspended to wires or ropes, running over the ridge or crown of the stack to hold the covering in place. Sometimes stacks are covered with cloth such as is used in making tents or of any material that will turn rain and that is not too costly.

When clover, cow peas or vetches are stacked in a climate of much rainfall, unless the tops of the stacks

are carefully protected, there will be much loss. The aim should be, therefore, to put these crops under cover, when possible, and to protect the stacks carefully where this cannot be done.

What has been said about storing the grasses proper will apply about equally to mixed grains, cut with the mowers, and to millets except that these are more easily injured by rain. But rain does not harm them as much as clovers. Sorghum hay is more difficult to keep and where it is grown, which is usually in rather dry climates, is frequently stored in quite small stacks from which it is fed.

In large ranches, especially in the West, native hay from the sloughs and alfalfa from irrigated lands are frequently drawn from the winrows on wide sweeps, with one horse attached to each end. These load by simply driving the horses for a short distance, one on each side of the winrow. The load thus gathered is drawn over the ground and deposited on the stacker, which carries it up to the stack. Hay is rapidly stored in this way, but such methods would be ill adapted to stacking in wet climates, as they would result in the spoiling of much of the hay.

It is the practice with some to sow about a peck of coarse common salt over each load of hay. They contend that it tends to preserve hay, stored a little green, and it does in some degree. They also claim that it adds to the palatability of the hay and in some small degree it does. Nevertheless, when the hay is properly cured and stored, it is doubtful if the advantage will cover the outlay for the application of salt.

Grazing Permanent Meadows.—As the primary object in growing and maintaining permanent meadows is to secure hay, rather than pasture, whatever will maintain them in a condition to produce hay is of paramount importance. Pasture should be sought from them only, therefore, to remove a superabundance of covering, such as would hinder their productiveness and, in some instances, their existence unless they are grazed. This will mean, therefore, (1) that the grazing of hay plants should not be done at any season of the year, if such grazing would endanger the life, vitality or productiveness of the plants; (2) that, if admissible, at certain times, it should never be done at such times as it may work harm; (3) that it should not be done when mowing will answer the purpose as well or better.

Some meadow plants should seldom or never be grazed while being grown for meadow. Timothy is one of these, alfalfa is another, and Johnson grass, a third. This does not mean that these plants should not be pastured at all, but the aim should be to avoid pasturing them to the greatest extent practicable. Timothy will sometimes endure winter pasturing very well and remain productive, as in bottom lands or on tide lands in the Puget Sound region. In the other instances, it will produce fair crops from year to year, if never grazed, while if grazed closely in the autumn, the yields will be reduced fully 50 per cent; the same is true of alfalfa; it is also true of Johnson grass, that it may seldom be pastured closely with injury. It is almost certain that where alfalfa and timothy will endure pasturing in the autumn and winter, the returns would be greater if

these crops were not so pastured. While it may be admissible to pasture meadows in the autumn, where climates are mild, where the aftermath is so strong that it threatens to, at least, partially smother the plants and the weather is so moist that it could not be cured, it is never admissible to graze aftermath so closely that it will not protect sufficiently the roots of the plants in winter. It may be admissible to graze the same kinds of meadow much more closely in the autumn and winter in mild climates, than in those that are cold. In fact, it may be death to some meadow plants to graze them in winter at all in cold climates; such is alfalfa. Again where snowfall is abundant, and almost certain, grazing rank meadow plants in the late autumn may prove helpful, whereas similar grazing of the same kind of plants, when they are almost certain to be exposed, would be about sure death to them.

Should aftermath or rowen be abundant, the mower will remove it more evenly than grazing and it may be cut high purposely, the better to afford winter protection. In such instances, mowing would be preferable to grazing.

Ordinarily the aim should be to have permanent meadows go into the winter season, with enough of a covering to protect them sufficiently against adverse winter weather, such as may be expected in the locality. Some plants under certain conditions will not provide more aftermath, from year to year, than is necessary to form such a covering. When they do not, they should never be pastured, while in permanent meadow. But the richness of the ground, and the character of the

manuring, and the influence which these exercise on production will make pasturing meadows admissible under some conditions, where under other conditions, it would not be at all admissible.

Fertilizing and Renewing.—The question of fertilizing permanent meadows has, in most instances, a close relation to their productiveness. Some of these, as alfalfa meadows for instance, will, in certain locations, produce well for many years without any applied fertilizers. The plants are, in a sense, the scavengers of the fertility they require from the soil and air. When these fail, they usually fail because other grasses or weeds come in and crowd the plants. Again, other plants that cannot obtain nitrogen from the air will grow for many years and produce abundantly without applied fertilizers; such are certain grasses grown on tide lands. Yet again, the same plants, grown under other conditions, would not produce hay crops vigorously for two years in succession without being dressed with fertilizer.

If farmyard manure is applied, it should be in a well reduced form and is preferably applied in the autumn and should be evenly spread. Fresh manure would be objectionable because of the weed seeds in it and because of the extent to which the unreduced portions would rake up in the hay.

Commercial fertilizers are peculiarly suitable for applying on permanent meadows from year to year. On these, there is a place in one locality or another for the application of nearly every kind of useful commercial fertilizer brought into the market. But which should

be applied alone or in combinations, the amount to apply and the quantities in which they should be applied, can only be determined by the attendant conditions in each instance. In a work such as this generalizing on such a subject is all that would be prudent or even possible to do.

The needs of permanent meadows seldom call for the application of other kinds of plant food than nitrogen, phosphoric acid and potash; some need only one of these, some want two and some want all three. As to the chief of the forms in which they usually come into the market, see p. 393. It is seldom that more than 800 pounds of commercial fertilizer are applied on permanent meadow lands in one year, and more frequently less than one-half or one-third the amount is applied. In the East and South, it is, of course, much more essential to apply these than in the West and North. For many situations, equal parts by weight of nitrate of soda, finely ground bone, phosphatic rock and muriate of potash, serve a good end; more frequently in purely grass meadows, a large portion of nitrogen or phosphate is wanted, in some instances, more of one of these than of the other two combined. The phosphate and potash are probably best applied in the autumn and a part of the nitrogen in the spring and the remainder soon after the hay is cut. The object of the second dressing is to stimulate the grass to produce another cutting. In order to make large dressings of fertilizer profitable, it is necessary to have a good thick stand of the grasses, otherwise much of the strength of the fertilizer may go toward sustaining weeds.

Permanent meadows seldom require renewing, when properly fertilized. Alfalfa, however, sometimes becomes weedy; when it does, disking in early fall or in spring, according to locality, sowing more seed, and then harrowing are very frequently followed by renewal. In some instances, as on sandy or gravelly soils, the grasses may fail in certain parts. When they do, disk them in those parts, sow more seed at the best season of the year for sowing it, and dress with fine manure. Treat similarly spots that may have winter killed because of ice. Yet again, when ploughing and harrowing may be necessary, as in the cases of Russian brome and Bermuda grass, renew these in that way as often as necessary.

CHAPTER XVIII.

PASTURES ON THE RANGE.

The pastures of the western ranges are of immense extent, as are also those of western Canada. Roughly speaking, it would be correct to say that they embrace considerably more than one-third of the entire surface of the United States and even a larger proportion of the northwestern provinces of Canada.

The Range States.—The distinctive range states include Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada and Idaho. The range country also includes western North and South Dakota and the western portions of Nebraska, Kansas, Oklahoma and Texas; also the eastern portions of California, Oregon and Washington. The range pastures cover from about one-third to two-thirds of the states named, as being partly range, the other portions being arable.

The Range Country Described.—This region is covered with immense areas of mountains, table land and plain, with a considerable area classed as valley land beside the streams. The plains, which lie in great part eastward from the mountains are destitute of trees, except beside the streams which flow through them and which are fed by the melting snows upon the mountains. They are usually, but not always sufficiently even in surface, to admit of cultivating the soil and

growing crops upon it. Over the greater portion of this area, these cannot be grown because of the limited precipitation, which characterizes all this region. It varies from 12 to 15 inches per annum downward to almost nothing. This entire area is covered with short grasses, which make their growth soon after the precipitation for the season comes, and then cure where they grow, in which condition they furnish excellent winter grazing, when present in sufficient quantity.

Between the most easterly and westerly ranges of the Rocky mountains are vast stretches of mountains, table lands or bench lands as they are more frequently called, and plains. These also are covered, more or less, with grasses, being dense or thin according to the measure of the precipitation and the extent to which sand, stationary or shifting is present; to proximity to seepage waters from the mountains and to the heat of the summer climate. Northward in this area, the precipitation is usually more than southward, and the summer heat is less intense; consequently, the grazing is usually more abundant. Grass production decreases with the abundance of sand or gravel, and where the sands shift, it is virtually absent.

But where seepage waters abound and come near the surface, grass production is abundant. The sides of the mountains furnish much grazing until trees clothe them, a condition which increasingly prevails with increasing altitudes, until the upward limit of tree growth is reached, beyond which are realms of rock and snow. The production of this region is not unlike that of the plains east of the mountains, but

especially southward, it is less abundant, a large portion of the country being destitute of vegetation or producing only cactus plants and sage brush, neither of which are valuable as food.

Soils of the Range Country.—The soil in the larger portion of the range country is abundantly supplied with plant food. Much of it is possessed of amazing productive power could it only be supplied with moisture. The secret of this fertility lies chiefly in its origin. Much of it has been made by volcanic action. But it has also been made more fertile, through the accumulation of vegetable matter, which decayed upon its surface through long ages, of which it lost but little from precipitation, washing over its surface or reaching down into the subsoil. To the summit of the mountains, nearly all the soil is fertile; even the shifting of sands can be made to produce liberally, if kept wet by fertilizing waters. Northward, sand is not nearly so much in evidence as southward. In some parts, are considerable areas, so strongly impregnated with alkali that nothing will grow on them, especially is this true of the regions where salt lakes abound.

Climate of the Range Country.—The climate in much of the range country is dry; more dry usually east of the eastern range of the Rocky mountains, than elevated portions. The snow-fall is usually light also, north; and more dry in the lower valleys, than on the elevated portions. The snow fall is usually light also, but much of the range country is exposed to occasional winter blizzards, in some instances of great severity,

and which bring much suffering to the herds and flocks, which frequently ends in great financial losses. In some instances, these blizzards come quite late in spring, as late as May in Montana. At such times, sheep and lambs sometimes perish in large numbers. The temperature of the range country is considerably milder in winter, than corresponding latitudes eastward, owing doubtless to the influence of the Pacific. With sufficiently plentiful surplus of grass, horses and cattle could winter safely on the pastures in all the range country, were it not for two influences, which, when they act in conjunction, make the wintering of stock, more or less hazardous. These are snow-fall, partially melted with "chinook winds," and then suddenly coated with a crust of ice, caused by rapidly falling and low temperatures. These "chinooks" are warm winds, which blow at irregular and not infrequent intervals. Were it not for these, no live stock could graze north in winter. The pastures are thus rendered inaccessible, insomuch that if low temperatures prevail for any considerable period of time, the animals cannot graze and so literally starve. When the weather immediately following is of unusual severity, as sometimes happens, particularly in ranges northward, they perish in great numbers. Driven before the winds, they seek the shelter of willows and other bushes by the streams and die slowly from cold and hunger. The sufferings of live stock, thus exposed and left to die a lingering and cruel death, forms one of the darkest chapters in the industrial history of this country. These cold winters only come occa-

sionally but they come with sufficient frequency to manifest the wisdom of furnishing food supplies to meet such exigencies.

Grazing on the Open Range.—Until within a comparatively recent period, the range country was almost entirely public domain. Even now the same may be said of by far the greater portion of it. Every citizen, therefore, had an equal right to graze live stock on the range; when it was comparatively unoccupied, the business proved highly remunerative. This led to so great an increase in the number of those who engaged in ranching, that in time the ranges became overstocked with results as stated later. (See p. 445.) A common practice at the first was to purchase chiefly young store stock and animals for breeding; to brand them; and to turn them out at large on the ranges. Horses and cattle were managed thus but, of course, sheep had to be accompanied by a herder. The many losses, attendant upon this method of ranching, from various causes, have led to a modification of the system of ranching, somewhat as follows: Individuals took up claims in some favored spot, where water and shelter were obtainable, and where wild hay could be obtained on the low lands, or tame hay, grown usually through the aid of irrigation. Steadings were built and live stock were introduced, usually in a small way at first, and these were bred from, and the animals sold when ready, or shipped to the eastern markets. The stock were grazed in summer upon the adjoining ranges, sometimes owned privately but more frequently public domain. Seldom were they allowed to stray

away far enough to become lost, and in winter when necessary, they were fed hay, provided for them in summer. This method of ranching is rapidly superseding the open range system, and in time will probably supersede it entirely.

Carrying Capacity of Western Ranges.—When the ranges were first grazed by domestic animals, their carrying capacity was considerably more than at the present time. The grazing was much more abundant then than now on the greater portion of the range. The grasses or many of them were famed, and justly so, for their nutrition. But they were short and thin in proportion as moisture was wanting. In places only where moisture was plentiful was there a stiff turf formed. Upon much of the range, the grass plants grew independently, as it were, without any crowding and the relative number of the plants decreased with increasing hardness of conditions, until in some localities but few plants appeared among the sage bushes, and finally that stage was reached in places, where the country was desert. At no time probably could one cattle beast be sustained for a year on less than 10 acres on an average, from produce grown upon the untilled range. At the present time, the carrying power of the range is much less than it was years ago. But the change in ranching referred to, is likely to modify this process and in the end greatly increase the carrying power of the range.

The Range Country in Canada.—It would not be correct to say of any province in Canada that it is entirely a range country, as in all the provinces where

ranges exist, a considerable proportion of the land will grow crops under suitable cultivation. The range country occupies parts of Assiniboia, Alberta, Saskatchewan, Athabasca, and British Columbia. The relative area is probably greater in Assiniboia and Alberta than in any of the other provinces of Canada. The ranges are on the whole more productive than the average of the American ranges, and since the summer climate is cooler they are covered with a more abundant turf. Moreover, they are less injured through overgrazing as they are newer. The ranchmen, profiting by American experience, came early to an understanding as to which parts should be grazed by sheep and which by cattle and this also has had the effect of protecting the ranges, as well as preventing feuds between sheep and cattle owners and their herdsmen. As on the ranges in American states northward, some food is usually needed in winter; strange to say the mean winter temperatures on the Canadian ranges of Assiniboia and Alberta, especially the latter, are not so low as those of Montana and Dakota, although further north. The explanation is found in the greater extent to which "chinooks" prevail in winter. Some authorities claim that these have access to the interior through the lower elevation of the mountains east of Port Simpson.

GRASSES FAILING ON THE WESTERN RANGES.

On many portions of the range, the grasses have failed to such an extent that, as previously intimated, their sustaining capacity has been much reduced. The

extent of such reduction, the causes that have led to it, and the necessity, because of this, for a change in the old-time system of grazing, will now be discussed.

The Extent to which Grasses Have Failed.—While the carrying capacity of the range has been much reduced in the aggregate, this reduction, by no means, applies equally to all parts of the range. On such portions of it as are possessed of a clay loam soil, and over which the grasses have formed a reasonably stiff turf, the sustaining power of the pastures is not much reduced. Much of the range country in the northern states and also in Canada is of this class. On those areas, however, covered with soils, volcanic in origin and which are easily disturbed by the treading of live stock, the grasses have, in many places, grown thin gradually, until they have almost or entirely disappeared. Wide areas exist, which at one time produced reasonably good pastures, that are now absolutely bare. These areas are chiefly found in portions of the central and southern range states. In other localities, plants of little or no economic value have taken possession of the grazing lands in a greater or lesser degree.

There has also been a shrinkage in the producing of what has been termed hay meadow lands, from which winter food supplies have been gathered. Through such shrinkage, the carrying power of the range has been reduced in the aggregate, according to some estimates looked upon as conservative to the extent of 20 to 30 per cent.

Causes of Failure in Range Grasses.—Chief among the causes that have led to reduction in the producing

power of the ranges are the following: 1. Injury from close grazing. 2. Injury from the treading of animals while grazing. 3. Injury from too constant grazing.

On many parts of the range, the conditions are such that under the most favored treatment, the grasses have to struggle for existence, when cropped closely because of that inseparable relation which exists between top and root development. The shade which the grasses provide for themselves, when undisturbed is removed, and the hot sun so saps away the moisture that more or less of the plants succumb.

Far greater, however, is the injury from treading, especially is this true of soils, which readily disintegrate. The treading of animals upon them turns them, more or less, into dust and the plants perish. These results follow more readily and certainly from the grazing of sheep, than from the grazing of cattle, and they are intensified with increase in the range flocks. They not only feed closely together, but they are constantly on the move. When they huddle together in the heat of the day, in order to get the head lowered into the shade, furnished by the bodies of their fellows, they still keep up the movement of the feet. In those light and dry soils, the grasses are thus trodden out of existence. Through such grazing wide stretches of range lands, where growth at the best was almost perilous, have been turned for the time being into deserts. The sheep has been characterized as the animal with the golden hoof and justly so, because of the beneficial influence which it has ordinarily on pastures, in clean-

ing, enriching and improving them generally, but this is not true of sheep in certain of the range pastures. The golden hoof in these is turned into an instrument of destruction. To these results, however, there are exceptions for, on some portions of the range, judicious pasturing with sheep is beneficial in degree, rather than harmful. Such are the portions of the range that have a close turf.

But the injury from too constant and unintermittent grazing has been greater than from too close grazing. Although many of the range grasses are perennial, they are propagated by means of seed only. The very dry portions of the range are ill-adapted to the sustenance of plants that increase chiefly by means of creeping root-stocks. With these the number of the plants is too great for each one to get enough of the scant supply of moisture to sustain them. The fact is significant that in the greater portion of the range country, the grasses have fibrous, rather than creeping roots. They multiply by means of seed. The further fact is significant that these are free producers of seed, thus accentuating the fact that the necessity for re-seeding the ranges is ever recurring, where the productive power of the grasses is to be maintained. The grama grasses especially, which are among the best of the range grasses, are free producers of seed. When the grazing is constant and close, seed production is hindered in proportion as these influences are present. Such grazing has done more harm to the range pastures than probably all other influences combined. The question nat-

urally arises in this connection, can the grasses of the range be renewed?

RENEWING THE GRASSES OF THE RANGES.

It is very evident from what has been said, first, that the sustaining power of range pastures has decreased, and second, that unless the protection is provided in some form this power must further decrease. It may be well, therefore, to consider: (1) Is renewal of range pastures practicable? (2) Is it practicable, without modification in the systems of grazing? (3) Which are the modifications that will make it practicable?

Is Renewal Practicable?—Unquestionably the renewal of range pastures is practicable, however difficult the work may prove. Nature without man's aid, clothed these areas with food plants, each locality with those best adapted to it. What nature has done, it can do again without man's aid, but unaided by man, the work of re-clothing with vegetation, in part or in whole, will be slow. With man's aid, as when he scatters seed upon it, renovation will be much more rapid. In the judgment of the author, it is both possible and practicable to restore the productive power of the ranges, although such restoration, in many instances, will not be easy and, in nearly all, will be slow.

Renewal Not Practicable without Modifications.—That the renewal of the ranges is not practicable under the old system of open range grazing, will be at once apparent to those who understand the range country. It will not be practicable for the reasons, first, that while the range remains public domain and its priv-

ileges are common property, it is almost certain that it will be overstocked; second, that while it is public domain and thus overstocked, the grasses cannot reseed the land sufficiently to maintain themselves without diminution; and third, that while it remains public property, the incentive to protect the range grasses is not practicable. Without modifications in the system of ranching, therefore, the thing that hath been is that which shall be. The sustaining power of the ranges must grow less and less.

Modifications That Are Necessary.—If the range pastures are to be protected and renewed, it is very evident from what has been said that this can be done only under private ownership. Such ownership would not only interest the individual, in protecting the grasses, but also in improving them. Two methods at least can be given attention, both of which should materially farther the end sought. The first is the fencing of the ranges and thus protecting them, and the second is supplementing the seed produced, when the grazing is alternated, by adding more seed or by sowing seed in some instances even where the ranges are not fenced. That the renewal of the ranges is attended with no little difficulty will now be shown.

DIFFICULTIES IN THE WAY OF RENEWING THE RANGES.

The chief difficulties in the way of renewing the ranges arise from the vastness of the area occupied, from the relatively low production of range pastures, and from the scant supplies of moisture. These ob-

stacles will materially influence all attempts at renewal, whether these are made through fencing in the ranges, through adding seed of suitable grasses, or whether renewal is attempted by substituting other grasses for those now on the range.

Renewal through Fencing.—In the judgment of the author, renewal through fencing and alternating the grazing is by far the most practical method of the three. The ranges are protected, not only by a fence running around each ranch, but when the ranches are subdivided so that one year some of the pastures may be allowed to re-seed the ground, the stock in the meantime, grazing in other enclosures, the seed that falls from the former should prove effective in sufficiently thickening the grasses. The next year, the stock can be grazed on these, while in the other pastures seeds are maturing. How frequently it would be necessary to have them thus re-seed the land, has not been demonstrated, but there is no doubt that the necessity for such protection, and re-seeding would decrease with the increase in supplies of moisture and vice versa. In some places, it would probably be necessary to thus rest the grasses every second year and yet again every third year would suffice.

Such fencing, however, is relatively costly. Materials for fencing are not plentiful and transportation of materials long distances is expensive. These things, taken in connection with the relatively low sustaining power of the range, will be found a considerable item in the expenses of the ranchman and, so far, a reducing factor in his profits. The further difficulty will

also have to be met of finding ample supplies of water for the live stock in each area so enclosed. The method of re-seeding, through limited stocking of the enclosed range, would also prove effective and it may be the cheaper of the two in the end. By low stocking is meant keeping down the number of animals kept within the enclosure, so that a portion of the plants would produce seed from time to time.

Renewal through Sowing Seed.—The obstacles in the way of sowing seed by hand are serious. First, about the only range grass producing seed that is cultivated is western rye (*Agropyrum tenerum*). The cultivation of this grass is as yet very limited, hence the amount of seed put upon the market is small. The amount of seed that will yet be grown for many years to come will be an almost inappreciable factor in re-seeding the range. It would be possible for the ranchman to grow his own seed, especially if he could command irrigating waters, but difficulties would attend harvesting the seed under range conditions, except in a wholesale way. Renewal by this method must be very slow for years to come.

Renewal by Substitution.—Even greater difficulties attend the renewal of the ranges by substituting other grasses for those now on the range. This has been advocated, not only where the grasses have failed, but where they have not, and with a view of increasing the productive power of the range. First, no variety, the adaptability of which to range conditions has been proved, is as yet cultivated except in a more or less limited way. It will, therefore, be impossible to obtain

much seed for several years. If the seeds of these grasses are to become so plentiful, as to exercise an appreciable influence on range improvement, they must be grown under conditions such as will produce large quantities of seed. If such renewal should effect improvement for many years the progress must needs be very slow. Second, the number of grasses which promise any improvement, through substitution is very limited. Only three of these at the present time would seem possessed of such promise. These are western rye, blue grama and Russian brome. While in some instances, all three may be an improvement upon range grasses; in others, this is, by no means, an assured fact. To illustrate: It is by no means certain, that western rye grass will prove more suitable for the central range states, than the species of buffalo grass (*Buchloe dactyloides*) which has grown on them to so great an extent in the past, nor is it an assured fact, that Russian brome would be an improvement over the grasses now on northern ranges, though it should be grown on these. The former would doubtless make a better turf on the central ranges and the latter on those of the North, but in either case would the moisture be enough to sustain the grass growing on such a turf to make it more productive than grasses which occupy the soil? Would the Russian brome furnish the winter grazing desired, in as good form as the bunch grasses, which now grow and cure upon those ranges? A negative answer to each question must be looked for. Again would Russian brome not grow so thickly under some conditions, that it in turn would require renewal

through ploughing occasionally? This would not be practicable under range conditions except in a limited way because of the great extent of the ranges. Third, is it possible to supplant other grasses by these without ploughing the land? When a turf now covers the ranges, this is doubtful. If the land has to be ploughed to make such substitution possible, the element of impracticability comes again to the front.

Substitution through sowing the seed of blue grama grass is more hopeful, especially in the central and southwestern range states, where the turf is not usually dense. This grass would seem to have special power to establish itself under such conditions, even when the precipitation is light. But the impossibility of getting supplies of seed in a large way, at the present time, is an insurmountable obstacle in the way of such substitution; sometime in the future, however, this may be different. All the evidence points to the conclusion, under existing conditions, that the best way of improving range grasses, at present, is by some system of alternation in grazing, which makes possible the re-seeding of the land by grasses now growing upon the same. The production of lands, that can be tilled, can almost invariably be improved by substitution, but it is not so of much of the land that cannot be tilled.

THE FUTURE OF THE WESTERN RANGES.

The changes that are being brought about by the irrigation of irrigable lands will exercise an important influence upon the productive power of the ranges. The vast quantities of food thus grown, along with the pri-

vate ownership of the lands, will make it possible to greatly increase the productiveness of the range country. 1. It will make the protection of the ranges easier. 2. It will enable the ranchman to rear much of the stock which he grazes. 3. It will enable him to dispose of it at an earlier age. 4. It will enable him to fatten a considerable proportion of it at home.

Making Easier the Protection of the Ranges.—Irrigation will make such protection possible, by increasing the food supplies. In winter especially, animals will be fed instead of grazed. This will spare the grasses for summer grazing and it will also make it easier to re-seed them by allowing seed to ripen in the pastures. The immense quantities of alfalfa and other food that can be grown on irrigated land will make this easily practicable.

Rearing Stock on the Ranges.—Until recently, ranchmen favored purchasing young animals to grow upon the range. This, at least, was true of cattle. They did so because of the difficulty in getting food supplies to feed young stock, also their dams, on the range in winter. The produce of the natural meadows gradually grew less with retrogression in pasture production, owing to cutting too frequently, in conjunction with over grazing. Experience had demonstrated that, if calves were to be reared on the range, feeding them the first winter was an imperative necessity. This is now easily practicable in all irrigated centres.

Disposing of Stock at a Young Age.—The winter supplies thus grown, will enable the ranchman to dispose of animals at an age younger than would be prac-

licable in the absence of these. Cattle sold at three years, in the absence of such supplies, may be sold at two years, when they are present. A whole year of what is usually termed the food of maintenance may thus be saved, in the rearing of each cattle beast, grown on the ranges. This arises from continuity in growth, made possible in winter, as well as in summer. Young cattle, grazing on the open range, will do little more than maintain themselves during the winter months; when fed upon alfalfa, they make substantial gains. It will be possible, therefore, to save, in the aggregate, the food of maintenance for one year of every cattle beast, grown on the range. In other words, it will make it possible to use such quantities of food, in the aggregate, at one time used as food of maintenance, in growing meat, thus making the ranges just that much more productive.

Fattening Stock on the Ranges.—Formerly stock could not be fattened on the ranges in the very best form, since grass was the only food grown. Now in addition to the fodder, grown under irrigation in the valleys much grain is also being grown. This makes it possible to finish live stock in the range country, before shipment and the proportion that will be thus finished will increase with the increase of such production thus adding to the profits of the ranchman. But it is not probable that the time will ever come, when all the stock, grown on the range, will or can be finished there. The disproportion between the unirrigable and irrigable lands is too great to admit of such a result, hence it will always be possible for the

range to supply, more or less of feeding stock to farmers further east. Viewed, therefore, from the standpoint of actual production in the range, grasses in their aggregate form; that of the great possible increase in production in the range country, and the relation, which range grasses must bear to this increase; and from that of the almost insuperable difficulties in the way of substituting other grasses, for those now growing on the range, the proper preservation of these, as previously intimated, is certainly a matter of national importance.

