The Origin and Development of World Forage Crops

P. D. WALTON, M.Sc., Ph.D., M.I.Biol., P.Ag.[1]

The establishment of forage plants and grazing animals precedes the advent of man. From remotest antiquity man has depended on forage species to support either the wild game he hunted or his domestic animals. The prairies and plains of North America, the pampas of South America, the velds of Africa and the steppes of Asia are all of great antiquity. They represent areas of climax vegetation determined initially by soil and climate. Such grasslands cover some eighteen million square miles and extend over 24 per cent of the world's vegetative area.

Grasses and herbs appeared on the earth in the Tertiary period and diversified and spread through mid Tertiary and Miocene eras. They presented new environments which had not existed previously, and which were exploited by herbivorous mammals. Global topography made these new regions rich in ecological habitats and in turn evolution filled these niches with an ever expanding and diverse range of grazing herbivores.

For example, in North America the uplift which formed the Rocky Mountains caused changes in climate. Over a large area of the continent dry summers, followed by drier winters, made the region unsuitable for the existing forests. Trees were replaced by grasses. Grasslands were then developed not only in response to climate and soil but in interaction with the animals that grazed them. Herds of buffaloes and horses have cropped, trampled and fertilized the prairies of North America. In parts of the world this evolutionary association between plant and animal has existed for twenty million years. Both types of organism have acted as reciprocal influences on the other. In grasses the caryopsis, palea and lemma have all been modified to facilitate seed distribution by animals. Also grasses are structurally well adapted to withstand grazing. Short basal internodes, rhizome formation, branching by basal tillering and growth from a basal meristem are all adaptations for survival under grazing. Lateral shoots from basal buds replace the main shoot. Also, as leaves are cropped they will be replaced from below, while the sheathing leaves protect apical meristems from trampling and cropping. A firm anchorage is also provided by a fibrous root system in conjunction with underground stems. In most grasses stem internodes elongate only when the inflorescence develops. The period when reproductive structures are vulnerable to the bite of a grazing animal is thus reduced to a minimum. After this manner evolved the 40 grass species used in sown pastures today.

Of the grasses used by man in his pastures none were derived from the American continent. By far the larger number are species indigenous to the forest fringes of Eurasia and Africa. For this too there may well be a reason. The family Bovidae, to which our domestic cattle and sheep belong, originated in Eurasia in Pliocene times and moved into Africa during the late Pliocene period. Few species reached North America and the grasses evolved there were developed in interaction with other types of grazing animals.

After the evolutionary process had produced grasses and grazing animals which might co-exist, man took his place in world history. Essentially the grasses fill man's dietary needs in two ways. First, in the form of cereal crops, grasses provide grains which form the main carbohydrate part of man's food. The advent of many great civilizations is associated with the availability of a productive carbohydrate crop. In the colder northern areas oats and rye predominate, while wheat and barley are the most important crops in the temperate regions. Rice, wheat, maize, sorghum and the millet feed the peoples of the tropical and temperate regions. Of these crops, rice and wheat are by far the most important. Second, the livestock, which provide the proteins and fats in man's diet, are supported

[1] Plant Sciences Department, University of Alberta, Edmonton, Canada. Submitted for publication 12 July 1969.

by forages and grasslands. The advance of knowledge and skill in growing cereal crops and in maintaining grazing animals has been closely linked with the advance and progress of civilization. Nor has this changed today. Progress in our present civilization will depend on man's ability to feed the expanding world population.

The domestication of animals and the growing of cereal crops commenced some 12,000 years ago. In many areas land was cleared for planting and game was hunted by burning the vegetation. There is evidence that this use of fire, combined with that of grazing animals brought about great changes in the world's vegetation. Areas dominated by trees and shrubs became areas of grassland and crops. As man settled in these areas he became more dependent upon grasses for his civilized life.

However, if man was to adopt a settled way of life on the great plains of the temperate regions he had to provide for his animals and himself during the winter season. He preserved both straw from his cereal crops and grass from the fields. Lucerne was the first cultivated forage plant. It was brought to Greece during the Persian invasion in 490 B.C. The Romans utilized it during their conquest of Greece and took it to Rome in 146 B.C. The Romans were the first to leave a written record of a few of the many ways of making hay. While records show that clover was regarded as a valuable forage by the Saxons in 800 A.D., it was not until the 16th Century that man started to sow particular grasses to form meadows for hay making and grazing. Then, in Europe, rye grass (*Lolium perenne* L.) was used.

An even more important step was the appreciation of the value of mixing legumes with grasses to form a pasture. Just when this practice started is not certain but Sir Richard Weston is usually given the credit for introducing red clover into pastures in England in 1613. By 1730 Townshend devised the four course farming system in England which introduced the practice of alternating arable land with a period under grass. The usual ley, as the non-arable part of the system was called, was, at that time, red clover and rye grass. Leys were normally of short duration.

The next major change in pasture production took place in middle of the 19th Century. This was the introduction of the use of fertilizers to improve growth of pastures. In the late 1880's basic slag became available from the steel industries. This phosphatic fertilizer, which was used in European farming in a general way, was also applied to pastures.

The application of artificial fertilizers called for detailed scientific research if they were to be put to the best possible use. The world's first agricultural experiment station was established in England at Rothamsted in 1843. While arable crops were given attention first, Lawes and Gilbert published in 1882, a paper which gave details of the effect of fertilizer on forage production from permanent pastures at Rothamsted. In 1889 experimental work on pastures commenced in Germany and spread to other parts of Europe.

In 1896 another important experiment was started at Cockle Park, the Faculty of Agriculture Research Farm at Durham University, England. This experiment was different from that at Rothamsted in one important respect. The productivity of the plots was measured by the live weight gains of sheep grazed on them and not by the weight of forage produced. The trials showed that basic slag aided the development of wild white clover in pastures, and that pasture improvement was reflected in the live weight gains which animals made. Further research at Cockle Park over the years indicated the most valuable combinations of clovers and grasses for British pastures. Thus phosphatic fertilizers, white clovers and the best grasses came to be regarded as an important part of pasture production.

It was not, however, until after the end of the first World War that it was fully appreciated that pastures and grasslands should be regarded in much the same way as any other crop; that they called for the same attention from research workers and the same care and consideration from farmers. It was in fact food shortages, especially in the form of animal products, following the

war, which drew attention to this need. Investigations had been started in 1914 by Dr. J. B. Orr at the Rowell Research Institute at Aberdeen. He followed the chemical and nutritive changes in pastures through a 12 month cycle and investigated the effect of fertilizer applications and stocking rates. During the 1920's this work was extended to Cambridge, New Zealand, Australia and South Africa.

The most important of these new ventures was the establishment in 1919 of the Welsh Plant Breeding Station at Aberystwyth under the direction of Professor R. G. Stapledon. Over the years this station has provided a range of superior strains of pasture plants as well as developing seed mixtures and advancing our knowledge of pasture management. Finally in 1929 the Commonwealth Agricultural Bureau set up a department which acted in the clearing and exchange of information throughout the Commonwealth. In more recent years the Food and Agriculture Organization of the United Nations has given additional impetus to the dissemination of knowledge about pastures and grasslands.

Thus, pasture research had its beginnings in the cool, humid, temperate regions of Great Britain and north-west Europe. The conditions there prevailed in few other parts of the world. In fact, the drier prairie regions of the world called for a very different approach. The earliest settlers in the northern parts of America found that forage was most urgently required for winter feeding. The harvesting of meadowlands often of poor quality, became important for livestock maintenance where there was a snow cover through the winter. The natural meadow flora was, however, found to be of very poor nutritive value indeed. Grasses and clovers were brought from England. Grasses were first introduced in 1670 and clovers followed a few years later. In these early years Timothy was an important meadow grass.

Even before 1890 it was evident that in Australia periodic droughts, overgrazing and rabbits could together cause serious deterioration in Grasslands. The prairies and the great plains of America were to follow a similar pattern. Here burning and overstocking played a part. The botanical composition of these areas changed. The more palatable and nutritive species were replaced by worthless types. This process culminated, after nearly a century of deterioration, in the droughts of the early 1930's.

It was evident that where climax grasslands were situated in areas of low rainfall which experienced periodic droughts, careful management of the numbers and distribution of stock was essential. Adjustment of the stocking rate must be used to control the botanical composition of the pasture. Thus, grassland ecology and range management have been the fundamental part of grassland research in the United States and Australia during the last 30 years. The problems in the management of pasture in temperate climates received attention in the second decade of this century. It was not until at least 10 years later that the problems of the drier grassland regions was recognized.

In Canada, this new awareness of these research needs resulted in the passing in 1935 of the Prairie Farm Rehabilitation Act. Thus funds became available for forage research in Canada on a much wider scale. Swift Current Experiment Station became a centre of grassland survey and management research. It was studies there that first drew attention to the value of crested wheatgrass in providing a vegetative cover on abandoned or depleted farm lands. In Saskatoon the establishment of the Forage Crops Laboratory in 1932 had an important impact on the breeding of crested wheatgrass, bromegrass, and alfalfa which is still evident today.

In the post war years the emphasis on forage research in Canada again changed. Previously, forage had been important as a means of soil conservation and regeneration. Now production was of major importance. Consideration was given to intensifying grassland management rather than area expansion. Winter hardiness and the production of more leafy swards was given consideration. Plant breeders produced a range of varieties. Rambler, Beaver and Roamer were improved alfalfa strains. While Carlton and Magna, bromegrass; Summit, crested

wheatgrass; Chief and Green leaf, intermediate wheatgrass; Orbit, tall wheatgrass; Sawki, Russian wild ryegrass; Chinook, orchard grass; and Boreal, creeping red fescue; were all important additions to the range of material available. The search for productive forage strains adapted to the arid climates of the prairies of Western Canada still continues. Russian wild ryegrass and crested wheatgrass have been shown to be exceedingly valuable in Alberta and Southern Saskatchewan. In the northern parts of the Prairie Provinces of Canada grass and alfalfa mixtures have given extremely high yields. While wide row spacings, alternate rows of grasses and alfalfa together with high nitrogen applications have all increased productivity.

A consideration of past developments always leads to the contemplation of future prospect. How will forage crops be developed in the future? One thing is certain that in farming today high yields arising from the ability to absorb high inputs profitably are essential. Crops without this potential will not survive. With high quantity forages, however, must go an improvement in quality. In any crop the meaning of the word "Quality" is difficult to define. For forages quality is the ability of plants to produce materials which contain nutrients in proper proportions for a balanced ration. The production of strains of forage which have not only high yields but the type of nutritional balance suitable for different classes of livestock presents an important challenge to plant breeders in the years to come.