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Role and management of permanent grasslands

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Abstract. Permanent grasslands are open areas covering nearly one fourth of the total land area in the world. Temperate grasslands such as prairies, pampas, steppes or paramos have hot and dry summers, and rainy cool winters. Grasslands are vitally important for livestock as a feed source, environmental protection, conservation of genetic resources, preservation of natural resources, sustainable agriculture, wildlife habitat, tourism and leisure. As a science and technique, the grassland management provides the maximum production with the conservation of vegetation, soil and the other natural resources. The effective management of grasslands depends on a number of different factors such as the characteristics of grassland, plant species, livestock type and environmental sources. Use of proper grazing system is the most important practice in management. The main principles of grazing management are grazing capacity in relation to the number and kind of animals, grazing period and grazing distribution. Grassland management also involves weed control, fertilization, burning, and seeding with natural grasses or other plants.

Keywords. Pasture – Meadow – Livestock – Grazing.

Rôle et gestion des pâturages permanents

Résumé. *Les pâturages permanents sont des espaces ouverts qui représentent presque le quart de la surface totale des terres du monde. Les pâturages tempérés tels que prairies, pampas, steppes ou "paramos" ont des étés chauds et secs, et des hivers froids et pluvieux. Les pâturages sont d'une importance vitale pour le bétail comme source d'aliment, protection environnementale, conservation des ressources génétiques, préservation des ressources naturelles, agriculture durable, habitat pour la vie sauvage, tourisme et loisirs. Du point de vue scientifique et technique, la gestion des pâturages permet un maximum de production tout en conservant la végétation, le sol et les autres ressources naturelles. La gestion efficace des pâturages dépend de plusieurs facteurs différents tels que caractéristiques des pâturages, espèces végétales, type de bétail et sources environnementales. L'utilisation d'un système approprié de pâturage est la pratique la plus importante en matière de gestion. Les principes essentiels de la gestion de la paissance sont la capacité de paissance liée au nombre et au type d'animaux, et la période et distribution de la paissance. La gestion des pâturages implique également le contrôle des mauvaises herbes, la fertilisation, le brûlage, et l'ensemencement avec des graminées naturelles ou d'autres plantes.*

Mots-clés. *Pâturage – Prairie – Bétail – Paissance.*

I – Introduction

Grasslands are wide and open areas where grasses and other herbaceous plants are dominant. They exist on every continent except Antarctica. The major units in vegetation are grasses with few or no trees. Grassland was defined by UNESCO as “land cover with herbaceous plants with less than 10 percent tree or shrub cover (White, 1983; cited in Anonymous, 2011a). In the same source, wooded grassland is explained as “the vegetation with grasses and grass-like plants with 10-40 percent tree or shrub cover”.

Worldwide agricultural area is 13 billion hectares. Grasslands as permanent meadows and pastures cover nearly 25.8 % of the land area with 3.355 million ha (FAO, 2011). The area covers 68.6% of total agricultural land. In contrast, permanent meadow and pastures (14.6 million ha) cover nearly 19 % of the total land area and 37.4 % of total utilized agricultural land in Turkey (TurkStat, 2012).

The grasslands are grouped into two categories, tropical and temperate grasslands. Tropical grasslands called as savannas being hot all year with wet seasons are located between the Tropic of Cancer and the Tropic of Capricorn. Temperate grasslands having hot summers and cold winters are in the north of the Tropic of Cancer in Northern Hemisphere, and in the south of the Tropic of Capricorn in Southern Hemisphere.

There are different names for temperate grasslands scattered around the world such as prairies, pampas, campos, paramos, steppes and veldts (Anonymous, 2011b). Prairie refers to the grasslands located interior parts of North America. Pampas are the lowlands in Argentina, South America. Campos meaning field in Spanish lies in Uruguay and Brazil with few trees or shrubs. Paramo is high, tropical, mountainous vegetation above the continuous timberline located in "the northern Andes of South America and adjacent southern Central America. Veldt refers to the wide open rural spaces in South Africa covered in grass or low scrub. Steppes occurring in Europe and Asia have semi-arid and continental climate. A great amount of these grasslands have been transformed to fields for agriculture.

In 1998, Allaby stated that grassland occurs where there is sufficient moisture for grass growth, but where environmental conditions prevent tree growth. Its occurrence, therefore, correlates with a rainfall intensity between that of desert and forest (Anonymous, 2011a). Anderson (2012) reported that there is not a single climate for all grasslands, and they occur in the areas of the earth that receive as little as 200 mm of precipitation annually to areas that have 1300 mm annually while mean temperatures vary from 0 to 30^{o}C.

Permanent grasslands are located between upper parts of the cultivated fields and lower zones of the forests (Altın *et al*, 2005). Upland grasslands, Subalpine and Alpine pastures, having a shorter vegetation period occur above the forests. In many areas, grasslands separate forests from deserts. Tropical savannah occurs in Africa, Australia, South America and Indonesia with a yearly rainfall of 50-130 cm. Some temperate grasslands have less rainfall, 25-90 cm, than tropical ones (Anonymous, 2011b).

The Mediterranean basin covering some parts of three continents lies west to east from Portugal to the shores of Lebanon, north to south from Italy to Morocco. The region has Mediterranean climate meaning rainy, mild or cool winters with hot and dry summers. The Mediterranean topography consists of high mountains, long beaches, intensive scrubs, grasslands as semi arid steppes or coastal wetlands (Sundseth, 2000). Knight (1983) described the region as an extensively modified environment, coastal land is modifying by cool or warm sea currents, some areas by the mountainous systems, others having continental climates due to distance from the oceans.

II – Role of permanent grasslands

The importance and roles of the permanent grasslands were grouped in 5 categories: feed source for livestock, conservation of genetic resources, sustainable agriculture, preservation of natural resources, and wildlife habitat.

1. Feed source for livestock

Grasses are the main component of grasslands. There are also sedges, rushes with some trees and shrubs that vary in number dependent upon the ecological conditions. Pasture and meadows are essential feed source for livestock, and provide forage for a certain period of the year.

The cost of grassland management is lower than that of growing crops which requires several operations every year such as tillage, sowing, harvesting, etc. Grasslands provide more benefits to the farmers in terms of income from the unit area than the cultivation of field crops, especially on marginal lands. They can occur on these marginal areas that are unsuitable for proper

cultivation of crops in consideration with soil, slope or topography. In comparison with fodder crop production, grasslands have more nutritious and palatable plants and are more resistant or tolerant to the stress conditions such as drought or flooding than crops. Besides grazing animals are healthy and strong in addition to being resistant to diseases.

On the other hand, it is necessary to produce hay or silage to feed the animals during the winter. Farmers need available fields or they must use some parts of grasslands to grow forage crops. In fact, as Carlier *et al* (2009) emphasized, grasslands have been converted into cropland which caused reduction of grassland area and overgrazing the remaining parts in Western Europe. Similar event occurred in Turkey resulting in a serious decrease of permanent pasture and meadows from approximately 37 million hectares in 1950's to 14 million hectares in 2000's. Grassland area declined from 48.7% to 19% of total land area (Öğüt and Eryılmaz, 1991).

2. Conservation of genetic resources

Genetic resources are vitally important for the agricultural production. Breeders need a wide range of germplasm existing in the nature to improve crops. Hawkes (1981) said that such a large germplasm including cultivars, breeding lines and also wild species is necessary. As the world's population increases, the food requirement largely depends on the conservation and utilization of plant genetic resources.

Grassland plants have evolved under the influence of periodic droughts, frequent burning, and grazing animals and adapted to all of them (Anderson, 2012). This evolution together with so many different ecological conditions created a great biodiversity. Alrababah *et al* (2007) stated that biodiversity has become a very important issue recently in arid and semi arid ecosystems and grasslands, and conservation of these systems is more important in terms of species richness. Grasslands having many different plant and animal species as well as other organisms are important reserves for genetic resources and biodiversity.

The Mediterranean region is the centre of origin and diversity of many crops, especially cereals and legume species such as wheat, barley, oats, chickpeas, lentils etc. with a large number of endemics (Robertson and Bounejmate, 1999). The region also has a lot of wild species related to those crops.

Reid and Bennett (1999) defined genetic erosion as the loss of genetic material (genes, genotypes) and also the habitat of a specific taxa. The main causes of genetic erosion are changes of production systems, replacement of old local varieties with high yielding varieties, excessive use of chemicals, urban expansion and industrial development. Carlier *et al* (2009) emphasized the disappearance of many species through the conversion of native grasslands into monocultures of forage crops causing deterioration of biodiversity. They also cited that grasslands for summer grazing and maize silage for winter feeding are the only processes in modern dairy farms in EU.

Overgrazing is another reason for the loss of genetic resources, which makes the proper management and conservation of permanent grasslands more important.

3. Sustainable agriculture

Grasslands are an important factor for sustainable agriculture. Well managed grasslands and rangelands can promote sustainable agriculture (Anonymous, 2011a). Potter and Paulette (2004) pointed out some criteria for the conservation and sustainable management of forests, which can be applied to the grasslands: conservation of biological diversity, maintenance of productive capacity, health and vitality of the ecosystems, conservation and maintenance of soil and water resources, maintenance of contribution to global carbon cycles, maintenance and enhancement of long term multiple socio economic benefits to meet the needs of societies.

They defined ecological sustainability as the maintenance and restoration of the composition, structure, and processes of ecosystems over time and space. Grassland vegetation also has a vital role for erosion control in consideration with sustainability.

4. Preservation of natural resources

Grasslands are a mixture of different grass species, legumes and herbs, and act as carbon sinks, erosion preventives, birds sanctuary areas, habitats for small animals, and nitrogen fixation sources. They are able to sequester about double the quantity of carbon in comparison to arable land. Prevention of erosion and the immobilization of leaching minerals are interesting additional effects in the frame of a sustainable agriculture and development of the countryside areas (Carlier *et al*, 2009).

Pasture and meadows preserve natural resources and the environment, maintain high micro and macro flora activity in the soil, and increase soil porosity. Grasslands provide carbon and water storage, recreation and watershed protection. Most grasslands are important catchment areas for the water resources. Grazing mismanagement damages the grassland and also causes serious damage to agricultural land and siltation of irrigation systems and reservoirs because of increased erosion and run-off. Minahi *et al* (1993) state that they are almost as important as forests in the recycling of greenhouse gasses and that soil organic matter under grassland is of the same magnitude as in tree biomass (Anonymous, 2011a).

Sperling (2011) indicates that healthy rangelands capture, store, and safely release water from rainfall and snowmelt. Industrial development, tourism and leisure facilities such as swimming pools and water parks cause excess consumption of water. From this point of view, grasslands have become more important.

Grasslands are important for tourism and leisure in some areas, some may have sites of religious significance (Anonymous, 2011a). They are not only furnishing a habitat for wildlife, both flora and fauna, but also contributing to the attractiveness of the landscape. Pasture and meadows are generally colourful and aesthetic appearance. They have an aesthetic role and recreational function as providing public access that other agricultural areas usually do not allow (Carlier *et al*, 2009).

5. Wildlife habitat

Sperling (2011) classified the biotic components of grasslands as producers (plants), consumers (animals) and decomposers (microorganisms and insects), and indicated that grasslands throughout the world are essential to the survival of plants, animals, and bird species. Grasslands provide important breeding grounds for many bird species. Grasslands support a variety of wildlife species. In fact, some kinds of birds cannot live in any other ecosystem (Anonymous, 2012a). Grasslands are also primary food resources for wild herbivores.

Farrel (2006) listed grasslands and wildlife relationships. According to the writer, grasslands provide habitat for many animals, provide food for wildlife at different times of the year, form a cover for small animals, especially the birds, hiding from predators, protect them from bad weather, and make up a nesting habitat for them

III – Grassland management

There are a lot of factors causing the degradation of grasslands (Carlier *et* al, 2009; Anonymous, 2011a); converting the grasslands into cropland, grazing heavily by livestock, fire whether spontaneous or arson, subdivision with or without fencing, and provision of water points to extend the grazing area or season.

Grassland management deals with the conservation and utilization of pastures and meadows. A good management produces grass for the livestock, maintains wildlife habitats, conserves the soil and other natural sources, and preserves the landscape.

Grassland management's goal is to maximize the production and utilization of grasslands as much as possible without any damages to the environmental sources such as soil and water, and living organisms. Gençkan (1985) defines the grassland management as "a science of utilization of grasslands to get maximum animal production together with the conservation of vegetation, soil and the other natural resources".

Grassland ecosystem consists of plants, animals and the environmental conditions with the interactions among them. The production capacity of grasslands depends on these factors. (Anonymous, 2011c). For a better understanding and efficient management of the grasslands, it is important to have sufficient knowledge on these components and the interactions between them. The first step for good management is to define objectives in consideration with all components concerned and then to make decisions about how to manage the grassland. Proper grassland management not only increases the amount and quality of feed, but also improves growth rate of the livestock.

Grazing is the most important issue in the management. The main factors that provide maximum utilization of the grasslands are grazing capacity, grazing period, uniform distribution and, kind and class of animals. Grassland management also involves some cultural techniques such as weed control, fertilization, seeding with natural species, and preventing the growth of shrubs.

1. Grazing capacity

Grazing capacity is the maximum number of animals on a given management unit without any damages to vegetation and other environmental resources such as soil and water for a period of time. Stocking rate refers the number of animals concerned. If stocking rate is above the capacity, it means overgrazing which causes deterioration of the grasslands. This happens in vast majority of pasture and meadows in some countries including Turkey.

Animal unit, size of the grassland and available forage yield are used to calculate grazing capacity. Animal unit (AU) is one mature bovine weighing 500 kilograms with a dry matter intake of 12.5 kilograms per day. If the vegetation is uniform, overall size of pasture can be used for calculations. When the pasture has different types of vegetation, size of each is determined separately. Available forage yield is half of the actual yield of the grassland.

Grazing capacity (GC) is equal to:

GC = [Size (ha) x Available yield (kg ha^{-1})] / [Dry matter intake per AU (kg day^{-1}) x Grazing period (day)]

Grazing period is about 150 days in East Anatolia and 200 days in coastal areas. The area per Animal Unit equals to:

Area (ha) / AU = [Dry matter intake per AU (kg day^{-1}) x Grazing period (day)] / [Available yield (kg ha^{-1})]

The area per animal unit was 4.45 hectares in Turkey in 1940's. It was much higher than the present day's value of 0.85 hectares (Yavuz, 2011).

Grazing pressure is the relationship between the number of animal units and forage dry matter production per a management unit at a certain point in time. Overgrazing is concerned if the animals consume more than 60% of total forage produced by the management unit in a grazing season. The desirable plants disappear or lose their vigour by grazing too many animals or heavily grazing by a few animals (Heady and Child, 1994). Less valuable forage species replace those desirable plants. If overgrazing continues for a long time, it results in serious deterioration of the grassland.

For the improvement of grasslands and implementation of other management practises, grazing pressure should be moderate, with the consumption of 40-60 % of total forage production. In that case there is no change in botanical composition. This utilization reflects maximum use of grassland with the maintenance of productivity. Light grazing expresses a consumption of less than 40 percent.

2. Grazing period

Grazing period is the time span during which grazing occurs. Throughout the Mediterranean region the grazing season is the whole year (Heady and Child, 1994). In permanent pasture and meadows grazing initiates at a certain level of the growth when the plants mature for proper grazing. Plant height is one of the control factors. Generally accepted plant height for initiation is between10 to 30 cm. If the grassland consists of tall plants higher than 120 cm, grazing may start when the plants reach 30 cm height. Pastures with short species are grazed when the plants reach the minimum height of 10 cm. Grazing should be stopped at least 3-4 weeks before winter cold weather. The period depends on the ecological conditions, for example in Mediterranean climate the length of grazing period is six months from spring to autumn, while it is about five months in eastern part of Turkey.

The governors in each county in Turkey announce the beginning and ending dates of grazing. The basic problem for grasslands is that the farmers adhere those dates. Grazing starts as soon as snow cover disappears in Central and East Anatolia, and lasts when the winter temperatures begin.

3. Animal distribution

One of the grassland management practices is to distribute the animals uniformly throughout the pasture for maximum use without damages to soil and vegetation. Livestock feeding, handling, and watering facilities should be designated and installed in a manner to improve and/or maintain animal distribution. These facilities should also be designated and installed to minimize stress, the spread of disease, parasites, contact with harmful organisms and toxic plants (NCRS, 2006).

When left to natural habitats, cattle graze readily accessible areas first and forage may be underutilized on less accessible range. Unless these habits can be overcome, preferred areas may be overused while other areas are passed up (Anonymous, 2011c). Topography also influences the use of forage plants, the steepness and length of slope are important for the distribution of cattle. They generally prefer the least slope gradient or flat lands where heavy grazing occurs. Animals tend to graze near the streams where plants are green and more palatable for a longer period than those on the other places, especially on slopes.

Heady and Child (1994) listed some management practices to spread animals in accordance with the herbage resources such as development of water, fencing, roads and trails, herding, salting. Water sources provide a better distribution of the animals and utilization of the land. Availability of water on non grazed and/or lightly grazed areas also determines the grazing season and the number of livestock.

Well established fences are useful tools to control cattle and make them graze in a particular part of the pasture for an appropriate time. Fences divide the grasslands into different parts to let different classes graze separately. They also provide animals certain areas and keep them away from the others. Roads and trails simplify the use of pastures.

Herding is also a useful tool to increase efficiency in use of the grasslands. Cattle can be removed from preferred areas to less utilized areas. Animal movement may be adjusted by proper use of salting. Placement of salt in such locations that animals are encouraged to be away from sensitive areas.

Water, salt or other tools such as construction of the material for shade and fertilization make the animals move to preferred areas and stay out of overgrazed or heavily trampled parts.

4. Animal type

The effective management of grassland involves different livestock grazing the same grassland in a complementary manner. All animal species prefer certain types of vegetation. Dairy cows need young and nutritious plants for milk production; in contrast beef cattle prefer more mature and less palatable plants.

Sheep graze with their narrow muzzles and select individual leaves and other parts of the plant of a wide range of plant species(Frame, 1992). Sheep graze the grassland efficiently if the grass is short, they cannot use properly if the stand has grasses taller than 5-10 cm (Anonymous, 2011d). Cattle tear off the plants with their tongues and prefer tall grasses.

When compared with the grazing of either cattle or sheep separately, mixed grazing with cattle and sheep can improve pasture utilisation and maintain sward quality, increase growth rates in livestock, and reduce internal parasite burdens (Anonymous, 2012b). Different kind of animals can also be used for weed control, for example ragwort may be reduced by sheep, thistles and rushes may be grazed by goats (Frame, 1992).

5. Grazing systems

Proper grazing management maintains wildlife habitats, conserves the soil, and preserves the natural beauty of grassland landscape. A well planned grazing system provides forage as much of the year as possible to minimize supplemental feed cost without resources degradation. (NCRS, 2006; Anonymous, 2011d).

For the implementation of a grazing management plan, the factors to be considered are types of animals, dominant plant species, availability and distribution of water, and topography. There are three main grazing systems, continuous, seasonal and rotational grazing (Frame, 1992; Heady and Child, 1994; Anonymous, 2011b,c; HRWC, 2012).

A. Continuous grazing

Continuous grazing refers the utilization of a management unit for the whole year. The cost of this system is less than the other in consideration with labour, fencing, watering, etc. Continuous grazing is widely used and provides forage during the grazing period, but it is very difficult to achieve optimum grazing pressure. It often causes overgrazing or non grazing on some parts of the pastures unless carefully managed.

B. Seasonal grazing

Animals graze on some pastures for only part of the year. The land is not grazed for a certain period to allow the plants to rest and grow. For example many grasslands in British Columbia are grazed by cattle in spring or fall months. Lands in higher elevation ranges are used for late spring and summer grazing.

C. Rotational grazing

The pasture is divided into several parts and each part is grazed in sequence throughout the grazing period. Animals are regularly moved to fresh sections and previously grazed one is left for regeneration. Types of rotational grazing include daily strip grazing in pastures, short rotations with two or three pastures, and complementary rotations with different species. The advantages of this system are to improve livestock distribution, allow resting periods for preferred areas, and utilize forage efficiently on ungrazed areas. Rotational grazing limits soil compaction, encourages root growth, and reduces fertilizer leaching. The system also provides

a continuous ground cover throughout the year reducing erosion, improves nutrient intake by evenly distribution of manure, and extends grazing season. Rotational grazing has different types of applications.

Rest rotation grazing: The grassland is divided into four or more pastures. One of them is rested throughout the year, and the others are rotationally grazed. This system is useful for the pastures having sensitive plant species which need a long period of recovery.

Deferred rotational grazing: Deferred rotational grazing consists of two or more pastures, one of which is not grazed until seed production. After grazing whole season one of the others is left for resting. The system allows the plants to reach maximum growth level and produce seed. This grazing system needs long periods of rest and grazing.

6. Fodder crop production

Production of pastures is as important as the production of crops to increase farm income and security, to improve efficiency of fertilizers, and to provide sustainable agriculture without tillage (Anonymous, 2011a). In order to use the grassland efficiently, it is necessary to produce hay or silage to feed the animals in the winter. The farmers need available fields to do it, or they must use some parts of the grassland.

Supplemental feed and/or mineral requirements should be balanced with the forage consumption to meet the desired nutritional level for the kind and class of grazing livestock (NCRS, 2006). Annual forage crops and crop aftermath extend rest periods and grazing season, and provide feed during periods of slow forage growth.

7. Other management practices

Grassland management also involves some other practices such as burning, fertilization, weed control, seeding with natural plants, and clearing or discouraging the growth of invasive shrubs and brushes.

Grasses being dominant in many grasslands are able to withstand grazing and fire. When burned grasses can grow again because the growing point of most plants is at the base, close to the ground (Anonymous 2011c). If the area is not grazed or mowed, grass stands may need periodic renovation to remove excess litter which may reduce the quality of wildlife habitat (NCRS, 2001).

Controlled fire can stimulate grass and wild flowers to reproduce, allow germination of seed bearing annuals, increase plant species diversity, control unwanted woody vegetation, open up the stand for movement of small animals and birds, reduce competition from weeds, discourage the development of shrubs and trees, recycle the nutrients tied up in old plants, improve poor quality forage, increase plant growth, and reduce the risk of large wildfires (NCRS, 2001; Anonymous, 2012a).

Fertilizer application increase forage production. Species composition can be readily manipulated by specific fertilizer treatments (Fenner and Palmer, 1998). The efficient use of on-farm manures and slurry maximize output from grassland system and minimize the environmental impact (Anonymous 2012b).

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