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The Effects of Improvement Practices on Vegetation in Barren Pasture: The Case of Kastamonu

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A B S T R A C T

The research was conducted in the pasture of Alpagut village of Kastamonu center (410 25' 48.52"N, 330 55' 20.54E, altitude 851 m) located in the Western Black Sea Region of Türkiye to determine the changes in pasture vegetation caused by pasture soil improvement and management practices. The study was conducted between 2017 and 2023. According to the pasture soil analysis, fertilization was done with base fertilizer in autumn 2018 and top fertilizer in spring 2019. Shrub clearing and rotational grazing system were applied. Vegetation change in pasture soil was measured by the modified wheeled loop method during the flowering period of the plants in the pre- and post-improvement periods. It was determined that improvement practices increased the proportion of legumes, other families and perennial plants and contributed to the formation of a balanced vegetation. The proportions of declining, spreading, invasive and annual species were 11.50%, 5.10%, 46.75% and 33%, respectively, before pasture topsoil reclamation, while there was a decrease in annual species in the post-reclamation period. There was an increase in declining, reproductive and invasive species. It was found to be 26.66%, 15.39%, 55.86% and 17.00%, respectively. While *Bromus sp., Sanguisorba minor, Fumana arabica, Festuca ovina species* were dominant in the pasture area in the pre-improvement period, *Bothriochloa ischaemum, Teucrium chamaedrys, Festuca ovina* and *Astragalus frickii* species became dominant after the improvement. It was determined that improvement and management practices increased the area covered with vegetation from 74.00% to 98.00%, the proportion of legumes from 1% to 12%, and the pasture condition and health classification from poor-healthy to moderate-healthy category. It is recommended that the grazing plan for pasture sustainability be maintained.

1. Introduction

The meadow and pasture land areas in Türkiye, which were 44.20 million ha in 1940, decreased drastically to 12.30 million ha until 1991, and increased to 14.60 million ha today as a result of the studies started with the Pasture Law (Anonymous, 2022). The total pasture land area of Kastamonu province, where the research was conducted, increased to 28,302 ha. When the districts of Kastamonu are calculated, Devrekani, Centre and Taşköprü districts have the highest pasture land area respectively. The calculated pasture land areas of these areas are 8099 ha, 8876 ha and 2796 ha, respectively (Anonymous, 2023a; Gürel and İnan, 2022b).

Our pasture areas are our natural resources where the production of quality roughage required for animals is the cheapest. Due to irregular and excessive grazing in pasture areas, there is a

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decrease in the proportion covered with plants over time. Erosion and landslides occur on sloping lands as the botanical composition is disrupted, the plant species that animals love to eat are reduced and replaced by invasive species (Tosun, 1996; Gökkuş and Koç, 2001; Sürmen and Kara, 2022). For this reason, pastures should be grazed in accordance with the grazing systems and if necessary, it is necessary to carry out reclamation studies using appropriate reclamation methods (Alay et al., 2016; İspirli et al., 2016).

Pasture vegetations as an organic asset climate, topography, soil and other organisms is under the constant influence of the conditions it affects (Sürmen and Kara, 2018). As it is not possible to apply or develop any improvement method without knowing the vegetation structure of pastures, it is also necessary to examine the vegetation characteristics in detail before starting improvement, to identify pasture sections that differ in terms of yield and quality due to changes in soil and vegetation cover, and to carry out improvement and management practices specific to these areas (Yavuz et. al., 2022; Alay et al., 2016; Özyazıcı and Yıldız, 2017; Yavuz and İspirli., 2021). Fertilization is one of the most applied methods in pasture soil improvement. It is possible to increase the yield of pasture 2-3 times with an appropriate fertilization considering the species composition of vegetation and rainfall (Altın et al., 2007). Nitrogen and phosphorus are the nutrients that are most deficient in the soils of our country and therefore affect the yield the most. The effectiveness of fertilizers varies according to the application time and amount of rainfall fertilizer (Çomaklı et al., 2005).

Nitrogen and phosphorus are the nutrients that are most deficient in Turkish soils and therefore affect the yield the most (Çomaklı et al., 2005). The effectiveness of fertilizers varies according to rainfall, time and amount of fertilizer application. When the effects of fertilization on botanical composition are examined; nitrogen increases the proportion of grasses, while phosphorus and sulfur increase the proportion of legumes (Hatipoğlu et al., 2001). Therefore, botanical composition should be taken into consideration in pasture fertilization. Phosphorus fertilizers not only increase pasture yield in pasture but also increase the efficiency of nitrogen when applied together with nitrogen (Black, 1968). In some studies on nitrogen and phosphorus fertilization in different ecological conditions in Türkiye, Büyükburç (1999) reported the most suitable doses for yield and quality as 5 kg/da N, 5 kg/da P_2O_5, Altın et al. (2010) reported 4 kg/da N, 4 kg/da P_2O_5.

In this study, it was tried to determine the effectiveness of the applied reclamation methods through the changes in the botanical composition and pasture condition class of the pasture caused by reclamation practices such as fertilization, brush clearing and regulation of grazing in accordance with soil analysis.

2. Materials and Methods

2.1 General Soil Characteristics of Pasture

In 2017, soil samples taken from 0-20 cm soil depth according to the sampling method with soil auger tool from pasture soil were analyzed at Kastamonu Special Administration Directorate. Fertilization was done according to soil analysis. The soil is salt-free and poor in organic matter. The soil structure of the pasture area is in the neutral class with a pH value of 7.4. Pasture soil, which has a medium calcareous structure, does not have sufficient values in terms of phosphorus (1.71 kg/da) (Aydeniz and Brohi, 1993) (Table 1.).

Table 1. Some chemical and organic matter contents of soil samples taken from pasture

Province	Village	Pasture Parcel	Pasture Area (da)	Analysis type	Conclusion	Status
The Center	Alpagut	118/149	481,674	Potassium (K_2O) kg/ha	29,76	Middle
				Phosphorus (P_2O_5) kg/ha	1,71	Very little
				Lime (%)	14,75	Medium Calcareous
				Organic Matter (%)	1,93	Less
				Total Salt (%)	0,01	No Salt
				pH	7,4	Neutral
				Pasture parcel	69	Clay loam

2.2. Description of the Research Area and Vegetation Characteristics

The study was carried out in a pasture area of approximately 481 ha located at an altitude of 851 (410 25' 48.52"N, 330 55' 20.54"E) in Alpagut village of Kastamonu province. The study area is sloping and 11 km away from Kastamonu province (Figure 1). The average temperature of Kastamonu province for many years is 10.30 °C and the average annual precipitation is 667 mm (Anonymous, 2023b).

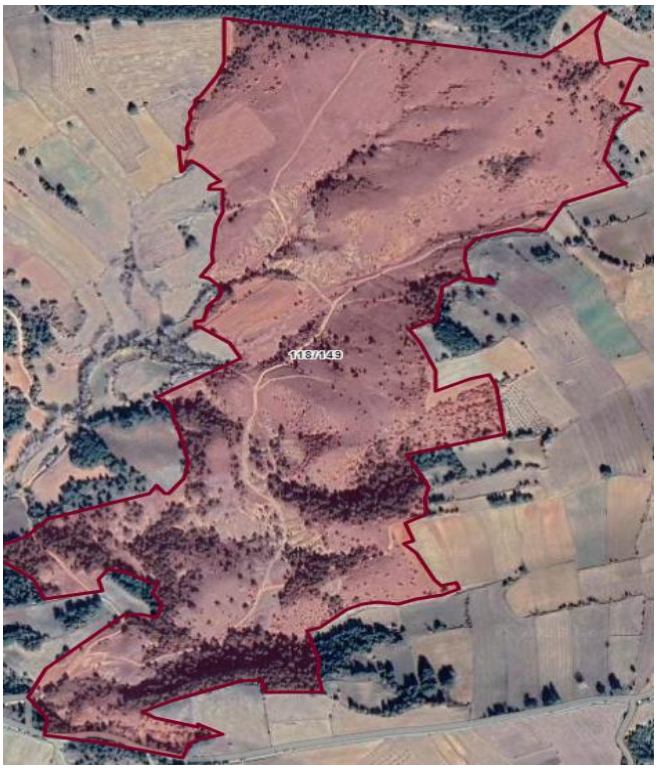

Figure 1. Test Location

The Black Sea Agricultural Research Institute Directorate and Ondokuz Mayıs University, Faculty of Agriculture conducted vegetation surveys of the pasture and determined the botanical composition and pasture condition class one year before starting the rehabilitation in the pasture area. Improvement recommendations were made according to the results of the vegetation report. Vegetation survey was carried out in 2017 by reading plant species during the flowering period based on the east, west, north and south directions of the pasture at a total of 400 points in 4 lines of the pasture (Gürel and İnan 2022a). Vegetation survey was carried out in pastures according to the modified wheeled point method. In the pre-improvement vegetation survey, the area covered with plants was determined as 79%. In the vegetation survey we conducted, 18 different species were identified, 1 from leguminous, 3 from grass and 14 from other families.

2.3. Vegetation Studies

Within the scope of the pasture improvement and management project implemented in Alpagut village, fertilizer doses recommended by Kastamonu Special Administration Directorate were used in fertilization application. In this context, in 2018, 20.20.0 compound fertilizer was applied with 5 kg da^{-1} P_2O_5 and 5 kg da^{-1} N (nitrogen) calculation in autumn with pure matter calculation. In the spring of 2019, Ammonium Sulphate (21%) N fertilization was applied at the rate of 5 kg da^{-1} N (nitrogen).

In the first year of the improvement program, in August 2008, the spreading juniper tree, thorny blackthorn and blackberry bushes, which were not preferred by the animals in the pasture soil area, were removed from the pasture by removing the roots with the excavator machine.

In Alpagut village pasture, a free grazing system was applied for 195 days starting in early April and continuing until October 15 before the pasture improvement project, while a rotational grazing system was applied for 150 days between May 15 and October 15 for the improvement program and after.

3. Results and Discussion

As a result of the vegetation survey of Alpagut village pasture before the improvement program, 18 species were identified and their soil coverage rate was 62.90%. The vegetation measurements of the pastures were carried out using the modified wheeled loop method and were determined at the flowering stage of the dominant plants in the pastures as described by Koç and Çakal (2004). Plant species in the field are divided into 3 classes as decliners, multipliers and invaders. Pasture condition classification was made in the pastures studied by taking into account all of the decliners and 20% of the multipliers among the plants identified. The proportion of vegetation covering the soil was determined by the ratio of the number of points where vegetation was found to the total number of points measured during the vegetation survey (Gökkuş et al., 2000). According to the results of the vegetation surveys conducted after the improvement, the number of species identified was 29, while the soil coverage rate of the species

increased to 73.86%. While *Bromus sp. Sanguisorba minor, Fumana Arabica, Festuca ovina* were the dominant species in the pasture before improvement, *Bothriochloa ischaemum, Teucrium chamaedrys, Festuca ovina* and *Astragalus frickii* were the dominant species in the vegetation after improvement (Table 2, 3 and 4.).

Of the 18 species identified in 2017, 1 legume, 3 grass and 14 other species belonged to other families. Of the 29 species identified in the vegetation survey conducted after 5 years of alternate grazing, 5 were leguminous, 5 were grass and 19 were species belonging to other families (Table 2 and 3).

Table 2. Decreasing and increasing species in pasture composition, SCR (%) and PCR (%)

Pre-improvement Declining Plant Species					**Declining Plant Species after Improvement**				
Species	Family	Life span	SCR(%)[1]	PCR(%)[2]	Species	Family	Life span	SCR(%)	PCR(%)
Chrysopogon gryllus	Rosasea	Perennial	0.85	1.00	*Bothriochloa ischaemum*	Poaceae	Perennial	24.89	25.40
Sanguisorba minor	Poaceae	Perennial	10.20	12.00	*Koeleria cristata*	Poaceae	Perennial	0.88	0.90
					Onobrychis armena	Fabaceae	Perennial	0.88	0.90
Total			**11.05**	**13.00**				**26.66**	**27.20**
Pre-improvement Reproductive Plant Species					**Post-improvement Reproductive Plant Species**				
Species	Family	Life span	SCR(%)	PCR(%)	Species	Family	Life span	SCR(%)	PCR(%)
Festuca ovina	Rosasea	Perennial	3.4	4.00	*Festuca ovina*	Rosasea	Perennial	10.58	10.80
Teucrium polium	Lamiaceae	Perennial	1.7	2.00	*Plantago holosteum*	Plantaginaceae	Perennial	0.98	1.00
					Poa bulbosa	Poaceae	Perennial	0.98	1.00
					Teucrium polium	Lamiaceae	Perennial	2.84	2.90
Total			**5.10**	**6.00**				**15.39**	**15.70**

[1]SCR: Soil Coverage Rate (%), [2]PCR: Plan Covered Rate (%)

Table 3. Invasive species in pasture composition, SCR(%) and PCR(%)

Invasive Plant Species before Improvement					**Invasive Plant Species after Improvement**				
Species	**Family**	**Life span**	**SCR(%)**	**PCR(%)**	**Species**	**Family**	**Life span**	**SCR(%)**	**PCR(%)**
Astragalus bicolor	Fabaceae	Perennial	0.85	1.00	*Anthemis cretica*	Asteraceae	One-year	0.88	0.90
Allium scorodoprasum	Liliaceae	Perennial	0.85	1.00	*Astragalus frickii*	Fabaceae	Perennial	4.70	4.80
Bromus sp.	Poaceae	One-year	28.05	33.00	*Brachypodium distachyon*	Poaceae	One-year	1.96	2.00
Eryngium campestre	Umbelliferae	Perennial	0.85	1.00	*Calamintha grandiflora*	Lamiaceae	Perennial	1.18	1.20
Fumana Arabica	Cistaceae	Perennial	6.80	8.00	*Eryngium campestre*	Umbelliferae	Perennial	2.06	2.10
Globularia orientalis	Globulariaceae	Perennial	0.85	1.00	*Euphrasia pectinata*	Scrophulariaceae	One-year	3.82	3.90
Koeleria cristata	Poaceae	Perennial	0.85	1.00	*Fritillaria acmopetala*	Liliaceae	Perennial	1.96	2.00
Minuartia Circassica	Caryophyllaceae	Perennial	0.85	1.00	*Galium aparine*	Rubiaceae	One-year	1.27	1.30
Muscari sp.	Liliaceae	Perennial	0.85	1.00	*Globularia orientalis*	Globulariaceae	Perennial	2.25	2.30
Noaea mucronata	Chenopodiaceae	Perennial	0.85	1.00	*Helianthemum nummularium*	Cistaceae	Perennial	3.72	3.80
Paronychia chionaea	Illecebraceae	Perennial	0.85	1.00	*Herniaria incana*	Caryophyllaceae	One-year	0.98	1.00
Potentilla crinita	Rosaceae	Perennial	0.85	1.00	*Linum hirsutum*	Linaceae	Perennial	0.98	1.00
Teucrium chamaedrys	Lamiaceae	Perennial	2.55	3.00	*Medicago minima*	Fabaceae	One-year	1.18	1.20
Thymus comptus	Lamiaceae	Perennial	0.85	1.00	*Minuartia anatolica*	Caryophyllaceae	Perennial	2.84	2.90
					Ornithogalum orthophyllum	Liliaceae	Perennial	1.27	1.30
					Poa annua	Poaceae	One-year	1.96	2.00
					Potentilla recta	Rosaceae	Perennial	0.98	1.00
					Taraxacum scaturiginosum	Asteraceae	Perennial	2.06	2.10
					Teucrium chamaedrys	Lamiaceae	Perennial	13.43	13.70
					Tragopogon aureus	Asteraceae	Perennial	1.18	1.20
					Trifolium arvense	Fabaceae	One-year	1.37	1.40
					Trifolium dubium	Fabaceae	One-year	3.82	3.90
Total			**46.75**	**55.00**				**55.86**	**57.10**

The applied pasture improvement program caused significant changes in pasture vegetation and vegetated area. While increasing the vegetated area in the pasture, it also ensured that important declining species became the dominant species in the vegetation (Table 2 and 3.). Foreign plant clearing, control of animal grazing and fertilization were effective in making these species dominant. Unfortunately, pasture vegetation is degraded by grazing in violation of management rules (Holechek et al., 2010). If grazing pressure is controlled, the chance of survival of declining species in vegetation increases. As a matter of fact, according to Uzun and Ocak (2019), declining species had higher proportional values in low-intensity grazing systems than in high-intensity grazing systems. The number of desirable species decreases with heavy grazing in pastures. In grazed areas, the proportion of species belonging to other families was approximately two times higher than in ungrazed areas (Bakoğlu et al., 2009).

According to the results of the vegetation surveys conducted by the Black Sea Agricultural Research Institute Directorate and Ondokuz Mayıs University Faculty of Agriculture in the spring of 2023, it was determined that the proportion of legumes in the botanical composition of the pasture increased from 1% to 12.20%, the proportion of species belonging to other families increased from 27% to 56.50%, and the proportion of grass decreased from 46% to 31.30% (Table 4.). In the improvement study conducted by Yavuz and İspirli (2021) in the grassland, the proportion of legumes and grass increased while the proportion of other families decreased. Generally, fertilizer phosphorus increases the proportion of legumes, but decreases the proportion of grass and other families (Çomaklı et al., 2005). In soils where grasses are dense and legumes are low, the amount of symbiotic nitrogen that plants can utilize is low, and swelling may occur in animals grazing on pasture at high legume and pasture rates below 40% (Vough et al., 1995).

Table 4. Effects of improvement practices and fertilization on families, annual and perennial species distribution, pasture condition and pasture health class

	Pastue Status	Pasture Health Classroom	Legume plants (%)	Grass plants (%)	Other Family (%)	Anunal (%)	Perennial (%)
Before reclamation	Healthy	Weak	1,00	46,00	27,00	33,00	41,00
After Reclamation	Healthy	Middle	12,20	31,30	56,50	17,60	82,40

In general, fertilizer phosphorus increases the proportion of legumes and decreases the proportion of other families (Çomaklı et al., 2005). A one-way increase in vegetation cover in favor of grass or legumes is not desirable in pasture management. In soils where grasses are dense and legumes are low, the amount of symbiotic nitrogen that plants can utilize is low, and swelling may occur in grazing animals at high legume and grass rates below 40% (Vough et al., 1995).

The decrease in the proportion of grass was due to the increase in the proportion of area covered by vegetation. As a matter of fact, fertilization and vegetation clearing, clearing form and controlled grazing have a positive effect on the botanical composition of the pasture (Altın et al., 2010 Aydın and Uzun, 2000). Pasture fertilization is an effective improvement method and is effective on the change in botanical composition (Aygün et al., 2017). In order to obtain quality forage from pastures, they should be fertilized sufficiently and should be supported by fertilization under suitable ecological conditions (Aydın and Uzun, 2000). There may be a significant change in the botanical composition of the pasture depending on the type and dose of fertilizer applied (Algan and Aydın, 2017; Gürel and İnan, 2022a: Gürel and İnan, 2022 b.).

While the pre-improvement pasture condition was determined as poor and the pasture health class was determined as healthy, as a result of the activities carried out within the scope of the improvement program, the pasture condition and health class were determined as medium and healthy.

4. Conclusion

As a result, pasture improvement and fertilization significantly increased pasture yields and significantly affected botanical compositions in Alpagut pasture area. İmprovement practices positively affected the botanical composition of the pasture and resulted in a more balanced vegetation. The significant increase in the proportion of perennial declining species and perennial

increasing species led to an improvement in pasture condition and health class.

With both the applied improvement methods and the determined grazing season, the pasture condition health classification increased from poor-healthy to medium-healthy. The main reason for this development is the positive changes in botanical composition caused by improvement practices and fertilization.

In order to maintain sustainability in pasture land, it should be taken into consideration that firstly, grazing should be planned correctly, and then some maintenance and improvement processes, especially fertilization and weed control, should be carried out on time.

Conflict of Interest

The author declares that there is no conflict of interest.

Author Contribution

As the author, he/she declares that he/she has made his/her own contribution to the article.

Ethics Committee Decision

This article does not require Ethics Committee Decision.

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