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Forage Species Diversity and Perception of Farmers on Rangeland Resources in Tikur Incinni District, Oromia, Ethiopia

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ABSTRACT

Rangelands in Ethiopian highlands are among the most threatened ecosystems as a result of unregulated expansion of crop cultivation and overgrazing. This study was conducted with the objective of assessing forage species diversity and determining their conservation status in the study area. Vegetation data was collected from a total of 60 sample plots of 400 m^2 and 300 subplots of 1 m^2 for herbaceous species. Sample plots were laid along six transect lines at a regular interval using systematic sampling techniques. To document indigenous knowledge, semi-structured questionnaire was used and 60 farmers were interviewed. Descriptive statistics was used for data analysis. A total of 58 species belonging to 53 genera and 22 families were collected and identified. Poaceae and Asteraceae were the most important families having diverse genera and species. Higher species diversity was documented in privately owned rangeland than in the communal rangeland indicating the negative impacts of overgrazing and unregulated expansion of crop farmland into rangelands. Farmers identified human population growth and cropland expansion into rangelands as major factors for rangeland degradation and loss of forage species. Sustainable management of rangeland resources using area enclosure as one management tool for ecosystem restoration and biodiversity conservation was recommended.

Key words: *Botanical composition; Communal rangelands; Fallow; Indigenous knowledge; Rangeland; Degradation; Threats*

Introduction

Challenges associated with conversion of tropical forest ecosystems into pasture or crop fields such as biodiversity loss, soil degradation, and loss of ecosystem services have been identified and reported by many researchers [1]. However, practical problems related to conversion of highland rangelands into crop fields in many developing countries such as Ethiopia are not sufficiently addressed. Rangelands are important ecosystems for a variety of services including biodiversity conservation and source of forage species. Plant species composition, vegetation cover (basal cover), forage production (productivity), land condition (soil erosion and compaction) and management at a particular location(s) aimed at sustained livestock production have been used as indicators for the health of rangeland condition [2]. Optimum range condition will differ according to the manner in which the rangeland is used (e.g., Cattle, Sheep, Wildlife).

Rangeland ecosystems are ecologically and economically important for livestock production, erosion control, carbon storage, source of medicines, tourism, recreation, source of high-quality water, clean air, wildlife habitat and biodiversity conservation [3,4]. Rangeland biodiversity provides and maintains ecosystem services essential to

agriculture and positively contributes to ecosystem functions such as productivity and nutrient cycling. Review of studies show that biodiversity conservation and sustainable use are important for the production of food and other agricultural goods that are essential for humanity, including food security, nutrition and livelihoods improvements. Biodiversity loss diminishes several ecosystem services by altering ecosystem functioning and stability [5]. Such changes will result in reduced capacity of ecosystems to provide society with the goods and services needed to prosper [6].

Sustainable Rangel and Production is Based on Grass Management, Animal Management, and Livestock Marketing

Livestock in Sub-Saharan Africa are dependent primarily on native grasslands and crop residues [7]. Natural pasture comprises the largest feed resource in Ethiopia, but an estimate of its contribution varies [8]. It was estimated that 80- 85% of the livestock feed comes from natural pasture. Grazing is the predominant form of ruminant feeding in most part of the crop-livestock farming areas in Ethiopia [9]. However, Darkoh et al. [10] reported that, crop residues contribute half (40 to 50%) of the livestock feed. Despite their environmental and socioeconomic importance, rangelands have been under threat in many African countries due to expansion of unregulated crop cultivation, overgrazing, unregulated increased arbitrary settlements blocking traditional herd mobility, and bush encroachment. Rangeland biodiversity is important for environmental, economic and other ecosystems services and therefore, generating local level data was found important and timely.

Plant species diversity refers to the number of species and their relative abundance in a defined area. Diversity measurements incorporate both species richness (S), (the number of plant species in a community) and species evenness (J), (an estimate of species distribution within a community) [11]. A community is perfectly "even" if all the species in the community have an equal number of individuals and are all the same in size. Various indices combine these two factors to measure diversity in plant communities. Commonly used diversity indices include the Shannon-Wiener index (H') and Simpson's diversity index.

Spatial scale strongly influences biodiversity the relationship between biodiversity and ecosystem functioning is likely to be scale dependent. At the smallest scale (<1 cm^2), species diversity is low because of the physical limitation of the space occupied by a single individual. As the scale or area measured increases, species richness increases, but at a declining rate. Although this positive relationship results partly from the greater variability encountered with larger sampling areas, it also occurs within uniform environments. Because species richness (and biodiversity) is related to the size of area measured, all studies on plant species diversity must report the scale at which observations are made. Thus, measuring and evaluating species diversity on grazing lands is more than simply counting or listing the number of species encountered. Evaluating species richness without taking into account evenness and spatial scale effects could underestimate the importance of diversity in shaping the function of rangeland ecosystems.

Studies have shown that, overgrazing has been among major factors causing change in botanical composition and biodiversity loss in many rangeland ecosystems. However, there were limited studies in Tikur Incinni District on the botanical composition of forage species and comparative studies between open and relatively enclosed rangelands. Therefore, this study aimed at undertaking this comparative study of forage species and also documenting data on their richness and conservation status.

Materials and Methods

Location of the Study Area

The study was conducted in Tikur Inchini district which is located in west Shoa, Oromia regional state about 162 km from Addis Ababa and 50 km from zonal town Ambo (Figure 1). Total area of the district is 38688.11 ha of this, about 18824 ha (48.66%) is cultivated land, 3207.62 ha (8.29 %) is forest, 12056.07 ha (31.16%) is grazing land and 2952 ha (7.63%) is inaccessible land. This study was conducted in two Kebeles (smallest administrative units) of the district, namely Homi Hene which is located at 10 km from Incinni town Nanno Jedue which was adjacent to Homi Hene and around 15 km from Inchini town. These kebeles were identified based on reconnaissance survey that was conducted with knowledgeable local people, experts from the district, development agents and researcher. According to the local people, Homi Hene and Nanno Jedue were formerly known for their large sized communal rangeland, large livestock population but recently encroachment of unregulated crop farm to the rangeland, land redistribution for landless youth, increase in stocking rate were identified as major factors affecting forage species diversity and sustainability of natural rangeland. The experts and local people mentioned that the similar problems were found in all Kebeles of the district. Therefore, the two Kebeles were selected as representative sites.

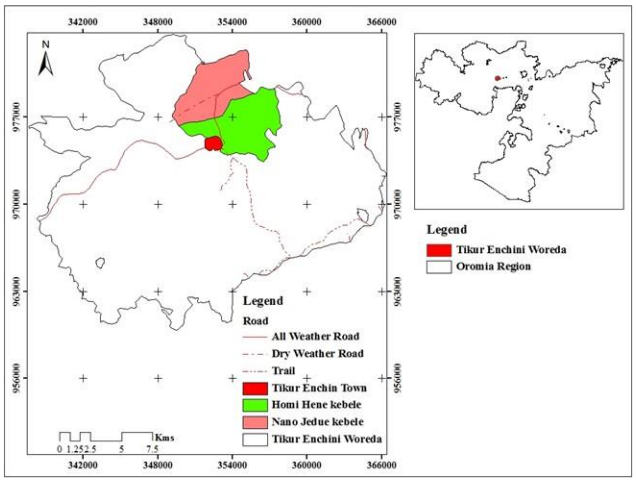

Figure 1: Map of the study area in Tikur Incinni District, Oromia, Ethiopia.

Climate and soil type

The study area belongs to the moist sub humid moisture region with an average annual rainfall between 1000-1400 mm. Rainfall in the study area is bimodal, with the long rains between June and October and short rains between March and April. An average monthly temperature varies between 14.4oC-16.2oC with average minimum and maximum temperatures of 8.8oC and 21.6oC, respectively. Altitude of the district ranges from 2200 to 3023 m above sea level. Clay (Black), clay loam (red) and sandy loam (light black) were reported to be dominant soil types in the study area.

Vegetation

Tikur Inchini is dominated by Enset based agriculture and livestock production. Many of the areas under grazing are communal lands while some pasture lands are managed by the individual owners. Cattle, Sheep and horses are the dominant domestic animals. Natural pasture (range land) is the main source of feed while crop residues and Enset leaves are also used during dry season.

Population

Human population of Tikur Inchinni District was estimated to be 73,696 with 36,589 male and 37,107 females. Livestock population was 87,345 cattle, 4,517 goats, 47,680 sheep, 851 mules, 4,356 donkeys and 37,150 horses.

Data collection

Vegetation sampling for diversity assessment was conducted in the late wet season (in October 2014) at a time when most plants (grasses) are in full flowering stage which is important for their identification. The study sites were stratified into privately owned fallow grazing land and communal rangeland based on the management practices for the grazing lands. Transect method was employed to take sample plots from the two land use types (privately owned fallow grazing land and communal rangeland). Data was collected from sampling plots of 20 m × 20 m (400 m^2) along the line transects. In the communal rangeland, the first plot was laid at the beginning of the line transect while the consecutive plots were systematically located at an interval of 200 m across a linear transects. The distance between parallel line transects was 500 m. A total of six line transects (three from Homi Hene and Nanno Jedue each) were used to collect vegetation sample. Data was collected from 60 plots, 30 from communal rangeland and 30 from privately owned fallow grazing land. Five 1 m × 1 m subplots (four at each corner and one at the center) were established within the major plot to measure herbaceous forage species composition, richness, and diversity. Plant specimen were identified in the National Herbarium of Addis Ababa University, Ethiopia using the published volumes of Flora of Ethiopia and Eritrea. Voucher specimens were deposited in National Herbarium of Ethiopia, Addis Ababa University. Herbaceous species richness was determined as total number of species count per unit area (Table 1).

Results and Discussion

Table 1: Species, Genera and Family Diversity of Plants in Tikur Incinni District, Oromia, Ethiopia.

Family	Genera	Species
Amaranthaceae	1	1
Apiaceae	2	2
Asteraceae	9	9
Campanulaceae	1	1
Caryophyllaceae	3	3
Commolinaceae	1	1
Convolvulaceae	1	1
Crassulaceae	1	1
Cypperaceae	2	2
Euphorbiaceae	2	2
Fabaceae	3	5
Lamiaceae	5	5
Linaceae	1	1
Malvaceae	1	1
Orobanchaceae	1	1
Planaginaceae	1	1
Poaceae	13	15
Polygonaceae	1	2
Ranunculaceae	1	1
Rosaceae	1	1
Tiliaceae	1	1
Violaceae	1	1
22	53	58

Comparative study of species in the communal grazing land and privately owned fallow land showed that private fallow land had more number of species, higher evenness and more diversity than the communal grazing land showing the negative impacts of overgrazing on plant species diversity. Similar results were reported from Jabi Tehnan, north western and Hawassa Zuria, southern parts of Ethiopia. This study showed that the Shannon diversity index for the communal grazing land was less than that of the private fallow land which is in agreement with many previous research reports but the difference was relatively small (2.22 in open grazing lands and 2.83 in private fallow land). According to the study reported from north western part of Ethiopia by Asmare and Gure the Shannon diversity index was much lower for open grazing sites than the enclosed adjacent site (e.g., 1.05 for open grazing and 2.94 for enclosure).

Conclusion

Although rangeland in Tikur Inicinni District was decreasing overtime and overgrazed, still there were rich diversity of forage species in the District calling for conservation and sustainable utilization of local biodiversity. The study showed that there was higher species diversity in privately owned rangeland than in the communal rangeland indicating the negative impacts of overgrazing and unregulated expansion of crop farmland into rangelands. Communal rangeland was more exposed to degradation and soil erosion compared to the status of private fallow rangeland. There was no land use plan and strategy for communal rangeland and this gap could be among major factors contributing to continued rangeland degradation and conversion into crop field. Overgrazing was identified as major factor responsible for declining soil fertility and rangeland productivity of rangelands in the District. Human population growth and cropland expansion into rangelands were identified as major factors for rangeland degradation and loss of forage species. Land use planning and focused interventions to manage forage species and other multipurpose species was identified as critical issue that need immediate action. Conservations of rangeland resources through proper grazing management including rotational grazing need to be given priority to avoid overgrazing and conserve of locally threatened species.

Putting in place a coordination mechanism for concerned institutions for coordinated intervention was noted to be critical. Furthermore, conservation of those forage species using both in-situ and ex-situ methods should be given attention. The use of area enclosure and fallow systems need to be promoted as these approaches are cheap and have contributed to local biodiversity conservation and sustainable use.

This study showed that rangeland degradation has been contributing to local loss of species diversity eventually leading to less forage production and animal productivity. Farmers also confirmed that unsustainable land management has been affecting their livelihoods. Although Ethiopia has put in place National Biodiversity Strategy and Action Plan and many biodiversity related strategies and laws, their implementation was minimal calling for focus on law enforcement for sustainable development.

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