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Ecological Characteristic of Grazing Vegetation and Capacity Food for the Large Cattle in Central Highland, Vietnam

Vu Anh Tai[1,*], Tran Thi Thuy Van[1], Bui Quang Tuan[2], Le Duc Hoang[1]

[1]*Institute of Geography, VAST, 18 Hoang Quoc Viet, Cau Giay, Hanoi, Vietnam*

[2]*Vietnam National University of Agriculture, Trau Quy, Gia Lam, Hanoi, Vietnam*

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Abstract: The Highland Central of Vietnam has a high potential for livestock development with a vast grazing areas include scrubs, grassland and some forest types. Currently, the livestock of the Central Highland has been facing with water shortage when dry season has prolonged from 4 to 6 months that make most of the plant communities stop growing. In order to develop livestock in the Central Highland, the ecological characteristics of the natural vegetation were gathered, including structure, seasonal rhythm and succession trend of each plant communities related to grazing. In this paper, the ecological characteristics of 11 natural ecological habitats and one artificial habitat were described. In addition, natural grazing vegetation includes five forests, three scrubs and three grasslands belonging to three bio-climate types (tropical monsoon moisture, tropical monsoon dry and sub-tropical monsoon moisture) and three ecological canopy types (evergreen, semi-deciduous and deciduous) were analyzed. The seasonal rhythm of each ecosystem affected the food resources for the cattle. In which, the main food was found in dry grasslands and scrubs in the rainy season while those habitats have not supported food considerable in the dry season. Thus, the cattle would get food from the moisture habitats in this period. The largest changes of food source ratios between rainy and dry seasons were found in Dak Lak and Gia Lai provinces, where the dry habitats are common. On contrary, the changing ratios at Kon Tum and Lam Dong provinces have been not much. Hence, these two provinces would support stably food for the large cattle during the year. However, when the density of the cattle head is too high, the natural food sources cannot adapt for the cattle requirement especially in the dry season. Thus, people must use the other sources such as planting, industrial food for cattle feeding. The density of the cattle also affected the ecological succession trend of each habitat. In normally, the forest would be changed to the scrubs and the scrubs would be changed to the grassland, and vice versa. In the first trend, it is positive but the second trend is negative. Because of high density of cattle, the negative ecological succession within

* Corresponding author.
E-mail address: tai.botany@gmail.com

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the natural vegetation related to the grazing in the Central Highland has been found at the western area of Dak Lak and Gia Lai provinces, and most areas of Kon Tum and Dak Nong provinces except the habitat along the boundary of the special used forest (national park, nature reserves). The positive succession would be found at all of the special used forest areas, Lam Dong province, Southeastern area of Dak Lak province, Central areas of Gia Lai province.

Keywords: Central Highland, grazing, ecological succession, seasonal rhythm, large cattle.

1. Introduction

Vegetation at the Central Highland (CH) of Vietnam with a high potential of grasses for large cattle feeding has been caring for recent decades. Besides the forests, both of the grassland and the scrubs would be used for grazing, making the high potential for large cattle development, contributing to the like hood improvement of many local minority ethnic groups there. Each household can feed some cows or water buffalos based on the capacity of the local grazing lands, both breeding purpose and fattened purpose gives them a considerable benefit. Recently years, according to the national Statistical Data, the livestock of the Central Highland has been raising up, in 2005 total heads of the cattle were 616,900 cows and 71,900 water buffalos [1] but in 2018, the number had been raised up to 754,700 cows and 86,600 water buffalos [2]. The study on vegetation in the purpose of livestock development at the CH has been conducted within distribution, forage species of grasslands and cultivated species mostly [3-7]. There is no study for the entire grazing region of the CH while the land use has been changed so much for recent years, not much primary grassland in the past has been still exited and nowadays the people could not use primary grassland for grazing because it mostly located at some very hard reachable areas. Because of a large flock, the people must use more vegetation types to support for their cattle's food, including directly grazing and cut food from nature (secondary forest, scrubs, grassland, and plantation) and artificial vegetation. Currently, the CH has been facing of grazing, the impact of the cattle, special in the 4-6 months dry season, when the plants mostly delayed growing because of water insufficient and even most of the plants have been died or continuously survival at the other potential types such as seeds or cryophytes. Totally, the typical climate characteristic of the CH is long and hot dry season in 4-6 months, but in the particular, different area has different climate scheme, including seasonal rhythm and the hardness gradient of the dry season. Therefore, it is necessary to conduct research on the vegetation that covered for all environmental habitats of the cattle in the HC, focusing the potential of food for cattle that each habitat can support in the dry season. Therefore, the ecological characteristics of grazing habitats including distribution and area, species scheme, forage species are described.

2. Methods, Materials and objectives

The materials and objectives of this research are grazing habitats including natural habitats (forest, scrubs, grassland) and artificial habitats (plantation forest) in the Central Highland of Vietnam and its ecological characteristics that related to grazing (abundance species, forage species, feeding productive, vegetation rhythm and seasonal mobilization).

The methods used in the conduction of this research includes field surveys (botanical survey to know the contribution [8], structure of each habitat [9]; general survey the situation of cattle [7]) - the field survey has been conducted in both of 2 seasons (rainy and dry season) in a two-year period (2017-2019, total of 12 transects, 87 sized 1x1m plots include 37 plots in forest habitat, 19 plots in scrubs habitat, 19 plots in grassland habitat and 12 plots in plantation forest habitat); participatory rural appraisal (use questionnaires to interview 998 local people and authorities the information related to grazing, include size of

cattle heard, distance of grazing area from residential area, seasonal rhythm of vegetation, time of water/food insufficient); We also used GIS technology to update the vegetation map, creating a map [10] of potential area for grazing of the CH and then using MapInfo software to to calculate the area of each habitat for each province. In the field surveys, together with the determination of vegetation structure (layers / abundance species) and forage species along the transects, we also cut the grasses on the plot to calculate feeding productive for each habitat in each season [7]. Besides that, we also reviewed and cited some documents and materials related to the grazing, livestock development, vegetation structure and vegetation succession of the locality includes An Khe [11], Ban Me Thuot [12], Yok Don National Park [13] and Kon Ka Kinh National Park [14,15], scrubs as upland rice field in the CH [16], deciduous forests [17] or natural forage species found in the study area as M'Drak [7] and the bioclimatic scheme of study area [18], water resources of study area [19]. The grazing vegetation classification in this paper based on Tropical Ecological Systems in Vietnam [8].

3. Results and discussion

3.1. Schemes of grazing vegetation in the Central Highland

Grazing vegetation in the CH was determined and classed into 3 bio-climate types as tropical monsoon moisture, tropical monsoon dry and sub-tropical monsoon moisture, 4 main terrestrial ecosystems as forest, scrubs, grassland and artificial, those are also divided into 3 seasonal status of vegetation canopy as evergreen, semi-deciduous and deciduous (Table 1), totally there are 12 grazing habitats in the entire HC. The results show that the total area of grazing vegetation in the CH is 1,856,275 ha, the largest area available for grazing in the CH is tropical evergreen monsoon moisture secondary forests and then it is tropical open deciduous broadleaved monsoon dry secondary forest; the available area for grazing at sub-tropical vegetation is limited (mostly in Dak Lak and Lam Dong provinces); Gia Lai province has the largest area of grazable while Dak Nong province is smallest. Dak Lak province has all the grazing types of vegetation. No dry habitat related to grazing was found in Lam Dong province.

3.2. General structure of grazing habitats in the Central Highland

Tropical monsoon dry habitats: there main grazing habitats in the CH, includes 6 habitats (4 forests, 1 scrubs and 1 grassland):

Tropical open deciduous broadleaved monsoon dry forest: this habitat locates mostly at the western of the HC, in administrative districts as Buon Don, Ea Soup, Ea Hleo (Dak Lak) and Dak Mil, Cu Jut (Dak Nong). The vegetation is under tropical monsoon climate, season rain is summer, and moisture is summer only. Forest was formed by high trees mostly growing on rhodic ferralsols, the soil layer is thin. The canopy is formed by trees in 2 layers (canopy layer and under canopy layer), covers about 40-60% and all trees there are deciduous in the dry season. Because of the open canopy, the understorey is very dominant and richness in the rain season including many herb species even some of them are still evergreen in the dry season and providing some food for the cattle.

Tropical open semi-deciduous broadleaved monsoon dry forest: this habitat is also typical for the western area of the HC, mostly locates in the mountain slopes or riverbanks, streambanks at Buon Don, Ea Soup, Ea Hleo (Dak Lak) and Dak Mil, Cu Jut (Dak Nong). The vegetation is under tropical monsoon climate, season rain in summer, and moisture is summer only. Forest was formed by high trees mostly growing on rhodic ferralsols, the soil layer is relatively thick. The canopy is formed by 3 layers of trees and among them, Lagerstroemia spp. is typical of the emergent layers, forest canopy cover for 40-60% area of the ground surface, most trees are deciduous in the dry season, the evergreen trees

are found in the under-canopy layer only. Because of the unclosed canopy, the understorey is very abundant and diverse in the rain season, supporting a lot for the cattle's food grazed there.

Tropical open deciduous broadleaved monsoon dry secondary forest: this had been formed after selected logging of the primary forests mentioned above or resulted in ecological vegetation succession from the tropical deciduous broadleaved monsoon dry scrubs in well management condition (mostly in the special used forests such as national parks or nature reserves). The forest has only one tree layer and canopy covers for 30-40% of the ground surface, completely deciduous in the dry season. The vegetation is under tropical monsoon climate, season rain is summer, moisture is summer only. Forest was formed by high trees mostly growing on rendzinas soils or clay soils, the soil layer is thin.

Table 1. The area of grazing vegetation of the CH

Unit: hectare

Vegetation	HC	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Tropical evergreen monsoon moisture secondary forest	755,758	259,255	149,626	80,384	70,778	195,715
Tropical evergreen monsoon moisture scrubs	70,734	33,854	21,295	6,924	5,673	2,988
Tropical evergreen monsoon moisture grasslands	136,286	54,966	29,453	23,461	18,642	9,764
Tropical open semi-deciduous broadleaved monsoon dry forest	25,901	-	-	858	25,043	-
Tropical open deciduous broadleaved monsoon dry forest	48,837	-	3,093	35,503	10,240	-
Tropical open deciduous broadleaved monsoon dry secondary forest	331,330	227	154,728	167,447	8,928	-
Tropical deciduous monsoon dry scrubs	35,003	127	15,849	18,260	767	-
Tropical deciduous monsoon dry grasslands	38,912	345	15,177	20,937	2,454	-
Sub-tropical evergreen monsoon moisture secondary forest	40,378	948	-	577	214	38,639
Sub- tropical evergreen monsoon moisture scrubs	2,289	-	215	273	-	1,800
Sub- tropical evergreen monsoon moisture grasslands	11,464	-	-	8,456	-	3,008
Plantation forest	359,383	96,896	91,790	52,238	40,501	77,958
Total	1,856,275	446,617	481,226	415,318	183,241	329,872

Tropical deciduous monsoon dry grasslands: This habitat also locates at the same condition to the tropical deciduous broadleaved monsoon dry scrubs mentioned above but the impacted level is more serious, mostly formed after burning of the scrubs or abandoned shifting cultivation areas and in addition, in some areas, because the soil is completely degraded (after stepping by cattle in grazing or natural degeneration themselves because of its mechanical component together with submergence during the rainy season and prolonged drought period in the dry season), it is also formed a scrubs but there is a difference in ecological nature (secondary at grazed area and primary in gray and degraded soil). However, even in the differencing of ecological nature, the special schemes of the grass are generally similar. This is also the main grazing area in the rain season. In the dry season, the food amount is serious reduced, only *Oxytenanthera nigrociliata* was useful for the cattle while the other species were dry, death and the cattle cannot eat.

The forage species found in the dry tropical monsoon habitats (semi deciduous or deciduous; forest, scrubs and grassland) include: *Vietnamosasa pusilla, Eulalia velutina, Eulalia phaeothrix, Cyrtococcum patens, Dactyloctenium aegyptiacum, Digitaria abludens, Dactylocterium eagyptiacum, Digitaria longiflora, Eriachne pallescens, Panicum repens, Paspalum scrobiculatum, Setaria viridis, S. pallide-fusca, S. splendida, Pseudosorghum zollingeri, Rhynchelytrum repens, Panicum sarmentosum, Rottboellia cochinchinensis, Ischaemum indicum, Eleusine indica, Hymenachne acutigluma, Ischaemum rugosum, Pennisetum polystachyon, Heteropogon contortus, Cymbopogon caesius, Panicum maximum, Paspalidium punctatum, Eragrostis pilosa, Imperata cylindrica, Eremochloa ciliaris, Arundinella nepalensis, Cyperus amabilis, Panicum walense, Kerriochloa siamensis, Lindernia crustacea, Fimbristylis falcata, Eragrostis unioloides, Digitaria violascen, D. igitaria setigera* and *Brachiaria eruciformis*,… In those ecosystems, the domesticated elephants also look for food from the species as *Pseudoxytenanthera nigro-ciliata, Cratoxylum formosum, Shorea obtusa, Dipterocarpus tuberculatus, Terminalia* spp., *Xylia xylocarpa, Spondias* sp., *Barringtonia* spp., *Canarium* spp., *Mangifera* spp., *Garcinia* spp., *Crescentia cujete, Garcinia harmandii, Antidesma ghaesembilla, Lablab purpureus, Ficus* spp.,...

Tropical moisture habitats: it is also importance-grazing habitats in the CH, includes 3 ones as 1 forests, 1 scrubs and 1 grassland:

Tropical evergreen monsoon moisture secondary forest: this locates at elevation lower 800m a.s.l., mostly in the production forest of the local people, protection and special used forest managed by the local authorities. The vegetation is under tropical monsoon climate, main season rain in summer, and moisture is around the year. Forest was formed by high trees mostly growing on gray oxisols, the soil layer is relatively thick. The forest canopy is incomplete (canopy cover ranges between 10 and 40%), and there is a lot of light penetration to the lower forest layers, encouraging the growth of understorey vegetation. Grazing is happened within the area of production forest or in the buffer area of protection forest because the core area of protection forest or entire special used forest is well protected and grazing banned. Free grazing is applied at this area, special at Dak To, Tu Mo Rong, Ngoc Hoi districts of Kon Tum province. The cattle can get food during the year.

Tropical evergreen monsoon moisture scrubs: this is secondary vegetation, formed on abandoned shifting cultivation areas, the soil layer is very thin and sometimes mixed with gravels. It locates in a small area mosaic inside the tropical moisture forest as above mention. Besides the grazing, this area also impacted by firewood collection, burning for cultivation by the local people. The habitat locates at elevation lower 800m a.s.l. and grazing on this habitat is happening at most localities of the HC. The vegetation is under tropical monsoon climate, main season rain is summer, and moisture is around the year. The vegetation was formed by

shrubs and small trees mostly growing on gray oxisols, soil layer is relatively thin. The scrubs provides food for cattle during the year.

Tropical evergreen monsoon moisture grasslands: All tropical grasslands were secondary vegetation that was formed on abandoned shifting cultivation land in the past. However, the species scheme is depended on the soil quality, the time of cultivation, the time for regeneration and the level impact from grazing. The vegetation is under tropical monsoon climate, main season rain is summer, and moisture is around the year. The vegetation was formed by shrubs and small trees mostly growing on gray oxisols, soil layer is very thin. The high grassland was formed mostly in the slopes where the cattle have been not usually grazed. Not much grass species in this vegetation was used directly or indirectly (local people can cut it and feed at home). The medium grassland was often formed at cultivation lands after using herbicides. After harvesting the main product (industrial perennial crop plants: cassava, pineapple, passion fruit, piper, coffee,...) the grasses have good condition to grow, most of them would be used for feeding and in the household scale, the local people can utilize those areas for grazing, special in the dry season when the other vegetation is exhausted of food for the cattle (dry grassland and shrubs) or it is too far for grazing (sub-tropical grasslands and shrubs). But recent years, most of those areas were impacted by herbicides, when the local people no need to graze on the land after harvesting, they use herbicides to kill the natural grasses. After some time using herbicides, not many grass species can grow on those lands and the cattle also cannot use most of the other grasses growing on those lands as their food. The short grassland was formed mostly in the large flatten areas, often grazed so the common grasses are often under 15cm of height. Some small shrubs also found there. The forage species there are common also but grazing makes the soil to be more exhausted and limiting the grass growing. The common grazed short grasslands mostly are closed to the wet rice field or on the abandoned shifting cultivation land of the other annual crop plants.

The forage species found in the moisture tropical habitats (forest, scrubs, grassland) include: Impelata cylindrica, Cymbopogom cfertifloms, Digitaria longiflora, Chrysopogon aciculatus, Cymbopogon caesius, Arundinella nepalensis, Setaria viridis, Panicum maximum, Setaria splendida, Brachiaria eruciformis, Cyrtococcum patens, Ischaemum indicum, I. rugosum, Dactyloctenium aegyptiacum, Kerriochloa siamensis, Panicum repens, Paspalum paspalodes, P. commersonii, P. conjugatum, Paspalidium punctatum, Pennisetum polystachyon, Rottboellia cochinchinensis, Digitaria violascen, D. setigera, Echinochloa procera, E. crus-galli, Eulalia velutina, Eragrostis pilosa, E. unioloides, Eremochloa ciliaris, Hymenachne acutigluma,… this is a similar finding in the plantation forest.

Sub-tropical moisture habitats: not often used for grazing habitats in the CH but also includes 3 ones as 1 forests, 1 scrubs and 1 grassland:

Sub-tropical evergreen monsoon moisture secondary forest*:* this forest locates at the elevation of 900-1000m a.s.l., most of them are in special-use forest or protection forest and the grazing has happened at the boundary of the forest only and the area for grazing is limited, only in Gia Lai province (K'Bang district) and Kom Tum province (Kon Ray and Kon Plong districts). In Dak Lak, because the exit of national parks and nature reserve areas, free grazing is stopped within this habitat. In Lam Dong province, free grazing is also not happened in this vegetation. This habitat is not located in Dak Nong province. The vegetation is under montane monsoon climate, main season rain is summer, and moisture is around the year. Forest was formed by high trees mostly growing on gray humus oxisol, the soil layer is relatively thick. Most forage species are similar to but not as abundant as the ones from the tropical evergreen monsoon moisture secondary forest. The cattle can get food during the year.

Sub- tropical evergreen monsoon moisture scrubs: this locates at the elevation in 900-1000m a.s.l., narrow small areas mosaic within subtropical nature forest, scattered at the northern and west-northern area of Kom Tum province, East-southern area of Dak Lak province, east-northern area of Gia Lai province and some northern district of Lam Dong province. Because locates at high elevation, in the tropical zone, the sub-tropical vegetation has been not seriously impacted by the dry season, the species scheme is diversity, there are a lot of species of evergreen plant, so that, in the dry season, the habitat continuously provides a certain amount of food for the cattle, it is very important when the lower habitat has been limited food at late months in the dry season. The vegetation is under montane monsoon climate, main season rain is summer, and moisture is around the year. The scrubs were formed by shrubs with several trees mostly growing on gray oxisols, soil layer is relatively thin. The free grazing during the year has happened at Kom Tum province only.

Sub- tropical evergreen monsoon moisture grasslands: This vegetation locates at the elevation about 900-1000m a.s.l., mostly are interrupted and narrow areas, mosaic inside the natural forests, scrubs in the northern and west northern of Kon Tum province, Southeastern of Dak Lak province, northeastern of Gia Lai province and northern districts of Lam Dong province. The vegetation is under montane monsoon climate, main season rain is summer, and moisture is around the year. The vegetation was formed by grasses mostly growing on gray oxisols, soil layer is very thin. This includes both types of eco-genesis as the secondary or primary ecosystem. The grassland formed on the abandoned shifting cultivation land is secondary and the grassland locates on stead slopes or peaks with very thin soil layer, rocky area ground is the primary ecosystem. Those primary grasslands cannot ecological success to scrubs or bare land and in fact, this vegetation has been not used for livestock because of stead slope topography (very difficult for approach and grazing) and also not much forage species found there. The common grasslands used in livestock here are secondary vegetation that regenerated from the abandoned shifting cultivation land in the past. In the dry season, the shorted grassland was formed on the just abadonated lands, most of the herb species there are dicot plants that the cattle cannot eat.

The forage species found in the sub-tropical grazing habitats (forest, scrubs, grassland) include *Ischaemum indicum, Impelata cylindliaca, Cymbopogom* spp., *Panicum* spp., *Paspalum* spp., *Setaria* spp., *Arundinella nepalensis, Brachiaria eruciformis, Cyrtococcum patens, Dactyloctenium aegyptiacum, Kerriochloa siamensis, Paspalidium punctatum, Pennisetum polystachyon, Rottboellia cochinchinensis, Digitaria* spp., *Echinochloa procera, Eulalia velutina, Eragrostis* spp.,…

Artificial grazing habitat: this include only one habitat as platation forest.

The plantation forest in the CH related to livestock including production forest and productive forest and the common planting tree species are Acacia spp., Eucalyptus spp., Hopea odorata and Pinus spp. together with rubber, cashew and durian. The plantation forest is typical at all localities of the HC. Because of forest canopy cover, the mass of forage species is not much in the rainy season as the other ones but in the dry season, the grasses under forest canopy would still support the cattle. This is very important for a lot of local households who are applying grazing or semi grazing models (grazing in the daytime on the ground of plantation forest and support more food in the midnight at cattle barn). Grazing under plantation often happens within a small householder scale only.

The forage species found here is similar with ones in the tropical monsoon dry habitats.

3.3. Ecological seasonal rhythm and ability to food support for the cattle

In the CH, most districts have been dry in 6 months (from November to April next year) but sometimes, the other districts have a shorter dry

season (4-5 months). The 5 months dry was found as Dak Glei, Dak To, Kon Plong, Kon Ray (Kon Tum), Ayun Pa, Kung Chro, Ia Pa, Krung Pa, Phy Thien (Gia Lai), Gia Nghia, Dak Glong, Dak Song, Dak R'lap, Tuy Duc (Dak Nong) and all districts of Lam Dong province while the 4 months dried season was found as Dak Po, Mang Yang, K'Bang, An Khe districts of Gia La province.

Based on the field surveys conducted in two last years in both of rain and dry seasons, within 12 main habitats, located at 5 provinces through 33 districts in a total of 62 district-level units of the HC, in general, the forage grasses for the cattle would be harvested in 5-7 times in the rain season (mean time for regeneration of the vegetation is in about 32-35 days) and 1-2 times in the dry season (regeneration in about 60-85 days). During the field survey, we also measured productive for each vegetation unit to calculate the eaten volume in each season, the productive of forage grass is different between the habitats, lowest within the forest and highest within the dry grass, it is different between the seasons mostly in dry habitats. Besides that, the ratio in use of habitat for grazing is also different between the habitats and two seasons. That means the capacity food supportable for the large cattle is different between two seasons. Based our field collection data of 87 plots that was a analyzed by Statistic Method on Microsoft Excel, the average productive, average ration in use for grazing of each habitat in two seasons is shown in Table 2.

Table 2. Field survey results of seasonal green food exploitation by the cattle in the CH

Vegetation	Productive (tons/ha)		Used Ratio (%)		Food supported (tons/ha)	
	Rainy	Dry	Rainy	Dry	Rainy	Dry
Tropical evergreen monsoon moisture secondary forest	1	1	5	5	0.05	0.05
Tropical evergreen monsoon moisture scrubs	6	6	10	10	0.6	0.6
Tropical evergreen monsoon moisture grasslands	18	18	10	10	1.8	1.8
Tropical open semi-deciduous broadleaved monsoon dry forest	15	1.5	10	15	1.5	0.15
Tropical open deciduous broadleaved monsoon dry forest	15	1.5	10	15	1.5	0.15
Tropical open deciduous broadleaved monsoon dry secondary forest	15	1.5	10	15	1.5	0.15
Tropical deciduous monsoon dry scrubs	20	3	10	25	2	0.3
Tropical deciduous monsoon dry grasslands	30	5	10	30	3	0.5
Sub-tropical evergreen monsoon moisture secondary forest	1	0.8	5	5	0.05	0.04
Sub- tropical evergreen monsoon moisture scrubs	5	5	10	10	0.5	0.5
Sub- tropical evergreen monsoon moisture grasslands	15	14	10	10	1.5	1.4
Plantation forest	3	3	10	20	0.3	0.3

Together with the above data (Table 1), total natural green food supportable for the cattle in the CH of each habitat is calculated for the rainy season (Table 3) and dry season (Table 4). Even the largest grazable is evergreen forests but the largest exploitation productive of the cattle is from the open deciduous forests and deciduous grasslands. In the rain season, total green food supportable for the cattle is 7,050,463 tonnes included 1,432,165 tonnes from the tropical evergreen monsoon moisture grasslands and 2,758,396 tonnes from the tropical open deciduous broadleaved monsoon dry secondary forest; the forests support 60%, the scrubs support only 9 % and the grasslands support 31% (Table 3).

Table 3. Capacity (tons) of natural green food supportable for cattle in rainy season

Vegetation	HC	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Tropical evergreen monsoon moisture secondary forest	224,091	74,806	45,981	22,379	21,092	59,833
Tropical evergreen monsoon moisture scrubs	246,456	117,905	74,036	22,740	20,813	10,962
Tropical evergreen monsoon moisture grasslands	1,432,165	562,469	318,062	239,003	205,170	107,461
Tropical open semi-deciduous broadleaved monsoon dry forest	204,311	-	-	6,830	197,481	-
Tropical open deciduous broadleaved monsoon dry forest	388,416	-	27,577	280,085	80,754	-
Tropical open deciduous broadleaved monsoon dry secondary forest	2,758,396	1,795	1,365,690	1,320,510	70,402	-
Tropical deciduous monsoon dry scrubs	394,991	1,332	184,363	201,228	8,068	-
Tropical deciduous monsoon dry grasslands	659,454	5,439	278,530	336,780	38,705	-
Sub-tropical evergreen monsoon moisture secondary forest	12,306	277	-	152	66	11,812
Sub- tropical evergreen monsoon moisture scrubs	6,881	-	658	718	-	5,504
Sub- tropical evergreen monsoon moisture grasslands	94,267	-	-	66,682	-	27,585
Plantation forest	628,729	166,727	160,140	86,729	72,136	142,998
Total	7,050,463	930,750	2,455,037	2,583,834	714,686	366,155

In the dry season, most of the green food would be supported by the tropical evergreen monsoon moisture grasslands (1,149,369 tonnes) and plantation forest (509,411 tonnes); the dry vegetation supports very limited (182,554 tonnes, about 8%); the forests support 35%, the scrubs support 10% (similar with their role in the rain season) and the grasslands support 55% (Table 4).

According to the results showing in Table 3&4, the total food capacity for cattle of each province is calculated and descript on Table 5. Therefore, nature green food support for the cattle in the CH during the dry season has been counted for 33% against the rain season.

The highest capacity of food support for the cattle in the dry season is Kon Tum with 86% while the highest riskiness of insufficient food in the dry season is Dak Lak (Table 6), this province can support only 19% green food during the dry season.

Table 4. Capacity (tons) of natural green food supportable for cattle in dry season

Vegetation	HC	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Tropical evergreen monsoon moisture secondary forest	173,559	63,953	32,038	19,536	15,814	42,218
Tropical evergreen monsoon moisture scrubs	199,249	97,037	59,208	20,582	14,686	7,735
Tropical evergreen monsoon moisture grasslands	1,149,369	492,563	234,814	201,398	144,770	75,825
Tropical open semi-deciduous broadleaved monsoon dry forest	8,270	-	-	271	7,999	-
Tropical open deciduous broadleaved monsoon dry forest	15,463	-	857	11,335	3,271	-
Tropical open deciduous broadleaved monsoon dry secondary forest	99,834	72	43,429	53,482	2,852	-
Tropical deciduous monsoon dry scrubs	20,696	81	9,030	11,095	490	-
Tropical deciduous monsoon dry grasslands	38,291	367	13,470	21,840	2,613	-
Sub-tropical evergreen monsoon moisture secondary forest	6,998	174	-	119	37	6,668
Sub- tropical evergreen monsoon moisture scrubs	5,055	-	464	707	-	3,884
Sub- tropical evergreen monsoon moisture grasslands	79,388	-	-	61,221	-	18,167
Plantation forest	509,411	150,203	127,031	76,702	54,574	100,900
Total	2,305,583	804,450	520,342	478,288	247,105	255,397

The above tables show that the rhythm of the food is not much change between two seasons within the tropical or sub-tropical moisture habitats but it is much difference within the dry habitat. The largest change between dry and rainy season happens in the dry vegetation, including forest, scrubs and grasslands (4-6%) while the moisture vegetation including tropical and sub-tropical forests, scrubs and grassland is about 73-84%. The subtropical evergreen moisture secondary forest supports only 57% in the dry season because in this period, the plant has been affected by the cold climate, reducing the capacity.

Figure 1 shows the highest capacity of food for cattle is belonging to Dak Lak province where the dry habitats (grasslands, scrubs and forest) have area much more than the other provinces. The dry grassland and scrubs also are the main reason of changing between 2 seasons because in the dry season, those habitats have a very low capacity of food. In Dak Lak, the dry habitats locate in the national park (Yok Don) so that have been nature ecological succeeding while the same habitats at other provinces have been smaller area because of other impacts such as cultivation, construction and forestation.

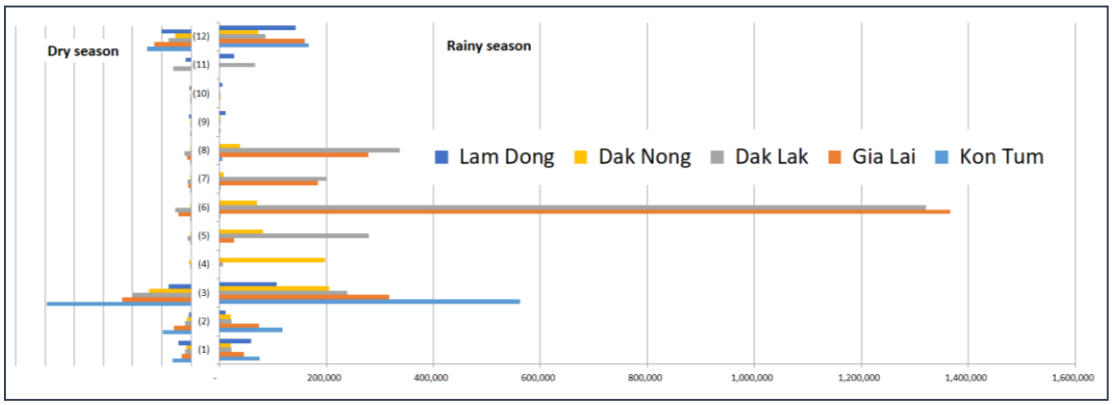

Figure 1. Seasonal Capacity (tons) of natural green food supportable for cattle in 5 CH provinces. (1) Tropical open semi-deciduous broadleaved monsoon dry forest, (2) Tropical open deciduous broadleaved monsoon dry forest, (3) Tropical open deciduous broadleaved monsoon dry secondary forest, (4) Tropical deciduous monsoon dry scrubs, (5) Tropical deciduous monsoon dry grasslands, (6) Tropical evergreen monsoon moisture secondary forest, (7) Sub-tropical evergreen monsoon moisture secondary forest, (8) Tropical evergreen monsoon moisture scrubs, (9) Sub- tropical evergreen monsoon moisture scrubs, (10) Tropical evergreen monsoon moisture grasslands, (11) Sub- tropical evergreen monsoon moisture grasslands and (12) Plantation.

Table 5. Seasonal Capacity (tons) of natural green food supportable for cattle in CH

Vegetation	Rain season (tones)	Dry season (tones)	Annual (tones)	Ratio for dry season
Tropical open semi-deciduous broadleaved monsoon dry forest	224,091	173,559	397,650	77%
Tropical open deciduous broadleaved monsoon dry forest	246,456	199,249	445,705	81%
Tropical open deciduous broadleaved monsoon dry secondary forest	1,432,165	1,149,369	2,581,535	80%
Tropical deciduous monsoon dry scrubs	204,311	8,270	212,581	4%
Tropical deciduous monsoon dry grasslands	388,416	15,463	403,879	4%
Tropical evergreen monsoon moisture secondary forest	2,758,396	99,834	2,858,231	4%
Sub-tropical evergreen monsoon moisture secondary forest	394,991	20,696	415,687	5%
Tropical evergreen monsoon moisture scrubs	659,454	38,291	697,744	6%
Sub- tropical evergreen monsoon moisture scrubs	12,306	6,998	19,305	57%
Tropical evergreen monsoon moisture grasslands	6,881	5,055	11,936	73%
Sub- tropical evergreen monsoon moisture grasslands	94,267	79,388	173,655	84%
Plantation	628,729	509,411	1,138,140	81%
Highland Central	7,050,463	2,305,583	9,356,046	33%

Table 6. Seasonal capacity food for the cattle supporting by the nature vegetation of each province in the HC

Seasons	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong	CH
Rain season (tons)	930,750	2,455,037	2,583,834	714,686	366,155	7,050,463
Dry season (tons)	804,450	520,342	478,288	247,105	255,397	2,305,583
Annual (tons)	1,735,201	2,975,379	3,062,122	961,791	621,552	9,356,046
Ratio (%)	86	21	19	35	70	33

Because exist of the evergreen monsoon moisture secondary forest, scrubs and grasslands in the northern districts of Kon Tum province (Tu Mo Rong, Dak Glei, Ngoc Hoi, Dak To), in the Eastern districts of Gia Lai province (K'Bang, Chu Pah, Dak Po, Ia Pa, Kong Chro), in the southern district of Dak Lak province as Krong Bong, or subtropical forest, scrubs and grasslands in Mang Yang (Gia Lai province), Krong Bong (Dak Lak province), the natural food for cattle is not much change between rain and dry seasons. Therefore, the livestock there has an advantage even the free grazing during the year has happened at Tu Mo Rong, Dak Glei districts but in fact, within some districts as Krong Bong, K'Bang, Dak To and Mang Yang where the number of cattle heads is too high, so the local people need to plant grasses and utilize other food types (most is straw rice) to maintain for their cows in the dry season.

In another way, because of not considerable exit of dry habitat, Lam Dong province has constant production of green food support for the cattle through the year. So that, in general the livestock in Lam Dong has an advantage, but in fact, within some districts as Lac Duong, Duc Trong, where the number of cattle heads is too high, people need to plant grasses and utilize other food types (maize, corn, straw rice, sugarcane top and leaves and special with fermentation foods) to support for their cows, special with milk cows (even use pure and nutrient foods). The same situation happens in Ea Kar and M'Drak districts (Dak Lak).

The supporting food from the plantation forest (including rubber, cashew and durian gardens) depends on the cultivation/sylviculture methods, so the natural vegetation succession has been not ecological regularly happened and we cannot calculate the green food production of this habitat, unable forecasting the ecological succession trend for all communities under this habitat.

The time for one of the grass regenerations recycle is different between dry and rainy seasons within the dry ecosystems. Because of water limiting in the dry season, the regeneration recycles of grass is often happened in 80-85 days while it is shorter in the rain season (30-35 days). Therefore, it looks like almost grass plants have been delayed growing in the dry season, only cryptophytes or hemi-cryptophytes are still living as their terms covered by the soil, even there are a lot of species have been died and only their seeds still exit for next growing season (in the rain season). It makes the green biomass productive (food for the cattle) of dry habitats is considerably reducing. Some evergreen grasses exit in those habitats are mostly dicotyledonous and *Oxytenanthera nigrociliata* or *Vietnamosasa pusilla*. The dry season has not been a considerable impact to the evergreen habitats, special with the tropical ones because most of the grasses there are evergreen species. The cold weather in the dry season also lightly affect to the grasses in the sub-tropical evergreen habitats but not serious as the happening in the dry habitats. Therefore, within the evergreen habitats, the green biomass productive has been reduced within the sub-tropical evergreen habitats only.

3.4. Ecological succession forecast

Ecological succession has been happening within all the ecosystems. Through that, the grassland would be successes to the scrubs, the scrubs would be succeeded to the secondary forest but in the contract, the secondary forest

would be succeeded to the scrubs and the scrubs also would be succeeded to the grassland even all of those ecosystems would be bared land under serious impacts such as forest fire, flooding and other natural hazards. Based on the ecological succession related to the grazing lands in the HC, finding in the field survey, including local interview and expert consultation, according to the study of Vo Dai Hai and Tran Van Con [15] on potential rehabilitation of natural evergreen broad-leaved forests after slash-and-burn cultivation in the Central Highland, duration for regeneration of evergreen habitats is estimated as: grassland (1st year), of scrubs (1-3 years), scrubs with small trees (4-7 years), young secondary forest (8-10 years), secondary forest (10-20 years) and primary forest (20-30 years); according to Ha et al. [15], Dung et al. [12], study on recovery of tropical moist deciduous dipterocarp forest in Southern Vietnam, duration for regeneration of evergreen habitats is estimated as: deciduous grassland (1-2 years), deciduous scrubs (3-10 years), secondary deciduous forest (10-30 years) and dipterocarp forest (30-40 years).A trend of vegetation succession of each main habitat is forecasted in following diagram (Figure 2).

Tropical open semi-deciduous broadleaved monsoon dry forest: This ecosystem is in climax situation (primary forest) and in a normal condition, this is not changed. The impact of grazing is also occasionally to this because it mostly locates far from the residential area. The negative impact would have happened in the late haft of the dry season when the other natural food within the tropical dry bioclimatic area is insufficient and local people take their cattle to graze far from their home as in this habitat. Because this habitat mostly locates within the boundary of the special-used forest, so by the protection, even under the impact of grazing, in the near future, this has been forest cast as no change.

Tropical open deciduous broadleaved monsoon dry forest: this ecosystem is also in climax situation (primary forest) and in a normal condition, this is not changed. The impact of grazing has been happening during the rainy season. By the protection of the local authorities, this forest as the special-used forest would be not changed, both of nearly or further future. But the forest in the other places would be the easy impact of the human activities along with the impact from the grazing, that would make this ecosystem be tropical open deciduous broadleaved monsoon dry secondary forest, special with a serious impact such as forest fire, this ecosystem would be changed to the worst situation such as the scrubs or the grasslands or even to the bared land.

Tropical open deciduous broadleaved monsoon dry secondary forest: some areas with a high density of cattle grazed would be changed to scrubs (further future) or worst situation secondary forest (nearly future) but in fact, most area of this ecosystem is in protection, so in general, this would be not changed in nearly future. If the protection were continuously maintaining, may after 15-30 years (or 15-40 years with other areas), this would be succeeded as the open deciduous broadleaved monsoon dry forest (primary forest).

Tropical deciduous broadleaved monsoon dry grasslands: the grasslands located in the special-used forest would be not changed so much because of the protection and mostly it is in the climax situation, the secondary grasslands locate at small areas (often after a forest fire) and mostly has been using as grazing area at the moment. The considerable change would be found in the areas that have a medium and high density of grazed cattle. The over trampling to the ground makes the grass injured both in the dry and rainy seasons. If this situation has been happening in the long period, it does not make the habitat changed to another habitat but their biomass and food quality would be considerably reduced, it also leads to growing by the other plants that the cattle cannot exploit for food, reducing the food support capacity of the habitat.

Tropical evergreen monsoon moisture secondary forest: at the moment, the density of cattle grazing in this habitat is low, so the forest regeneration has been happening. The plants also have been not impacted by the dry season or cold

weather, so in nearly future, without another serious impact, the quality of the forest would be improved. That ecosystem is hopefully to be an ecological success to the closed forest after 15-30 years.

Sub-tropical evergreen monsoon moisture secondary forest: the same situation with the tropical evergreen monsoon moisture secondary forest has happened with this ecosystem, but the plants in this habitat have been lightly impacted by the cold weather in the dry season, it makes the growing speed of the plant is lower than it in the tropical habitat and the ecosystem is hopefully to be an ecological success to the closed forest in the next 15-20 years.

Tropical evergreen monsoon moisture scrubs: most areas have been grazed in the low or medium density of the cattle. With the low-density areas, the ecosystem would be changed to the secondary forest in about 10 years but with the medium density areas the ecosystem wouldn't change to the secondary forest or even it would be the worst change to grassland if the density of cattle would be higher.

Sub-tropical evergreen monsoon moisture scrubs: it has been not many cattle grazing in this ecosystem. With the primary scrubs (often in the summits or stead slopes), there is no change. With the secondary scrubs, because of low grazing density, also because of cold weather impact in the dry season, the ecological succession in the near future seems to do not happened. It would be found the change only after 15 years or more when those areas would be changed to secondary forest.

Tropical evergreen monsoon moisture grasslands: mostly in serious impact by the grazing because most areas are in a high density of the cattle. The forage grasses have been competitive with the other plants in the situation of over trampling that makes the ecosystem can not ecological success to the scrubs and also reducing the food support capacity for the cattle.

Sub-tropical evergreen monsoon moisture grasslands: this is in the same situation with the Sub-tropical evergreen monsoon moisture scrubs and the time for ecological succession to the better situation as the scrubs is sooner. The change would be found there only after the next 5-15 years.

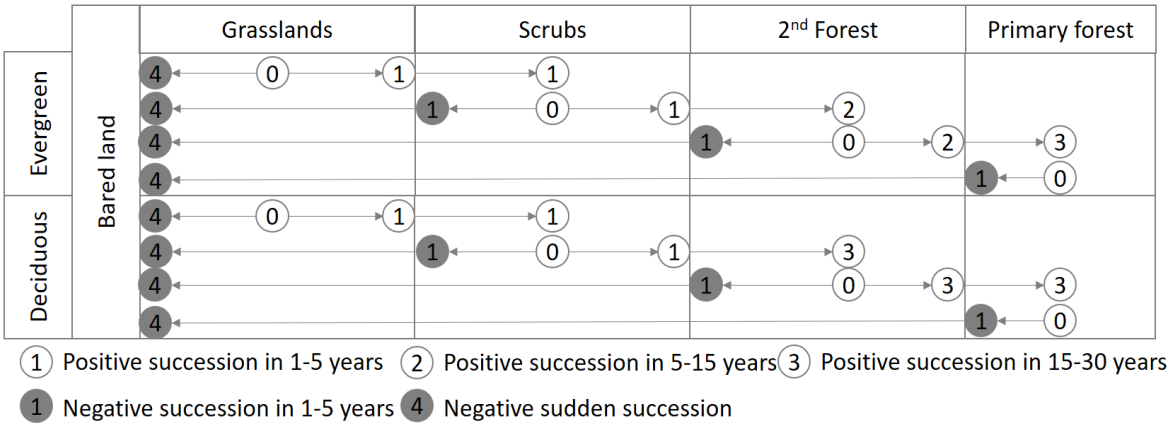

Figure 2. Forecast ecological succession trend of grazing habitats in CH.

4. Conclusion

In this report, we have described characteristics of 12 grazing habitats in the Central Highland of Vietnam, include area, distribution, general structure (layers, forage species, canopy), seasonal rhythm and capacity of food supportable for large cattle both in rainy and dry seasons. Therefore, the main food was found in dry grasslands and scrubs in the rainy season but in the dry season those habitats have support food not considerable. The capacity of food for large cattle is reduced considerable in Dak Lak and Gia Lai provinces, the similar situation it better in Kon Tum and Lam Dong province.

Because of the high density of cattle, the negative ecological succession within the grazing habitats located in western area of Dak Lak and Gia Lai provinces, most areas of Kon Tum and Dak Nong provinces except the habitat inside the boundary of the special-use forest (national park, nature reserves). The positive succession would be found at all of the special-use forest, Lam Dong province, Southeastern area of Dak Lak province, Central areas of Gia Lai province.

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