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An Analysis of Functional Groups and Potential Values of Herbaceous Species of Grasslands in West Timor, Indonesia

Mangadas Lumban Gaol[1*] I Wayan Mudita[2]
1. Department of Biology, Faculty of Science and Engineering, Universitas Nusa Cendana. PO box 85001, NTT, Indonesia
2. Department of Agrotechnology, Faculty of Agriculture, Universitas Nusa Cendana. PO box 85001, NTT, Indonesia
* E-mail of the corresponding author: lumbanbio@yahoo.co.id.

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Abstract
This study was to determine the composition of plant functional groups and the potential value of herbaceous species present in grassland communities of West Timor. Ten stations in grassland of Kupang West Timor (Penfui, Alak, Bakunase, Tode, Mulafa, Oesapa, Tanah Merah, Tilong, Bukit Cinta, and Naketuka) were selected and at each stations, 15 plots 1 m x 1 m (∑150) were randomly place. In each plot, all herbaceous presents were recorded. Each plant was further classified into four functional groups, whether grasses, sedges, legumes, or forbs. Plants were also grouped based on their potential whether they were food plants, medicinal plants, ornamental plants, forage plants, or poisonous plants. For each species present, the number of individuals, dominance, frequency, and Importance Value Index (IVI) were calculated. From 150 plots, there were 134 herb species from 32 families. Of these species, grass (Poaceae) was 26 (19.40%) species (IVI 25.24%) while non-grass was 108 (80.60%) species (IVI 74.76%). Grasslands were dominated by non-grass species. Based on the IVI, plants were dominated by *Euphorbia hirta* L. (IVI 13.93%), *Eleusine indica* (L.) Gaertn. (IVI 12.46&), *Cyperus rotundus* L. (IVI 11.72%), *Digitaria ciliaris* (Retz.) Koeler (IVI 11.12%), *Senna tora* (L.) Roxb. (IVI 9.54%), *Stenotaphrum secundatum* (Walt.) Kuntze (IVI 9.35%), and *Tridax procumbens* L. (IVI 9.17%). Of the 134 species, the forbs was 77 (57.46%) species (IVI 54.75%), grass 26 (19.40%) species (IVI 26.25%), legumes 20 (14.93%) species (IVI 12.41%), and sedges 10 (7.461%) species (IVI 6.09%). Grasslands were dominated by forbs based on the number of species and IVI. Of the existing species, 43 (31.34%) were food plants (IVI 34.62%); 77 (67.46%) were medicinal plants (IVI 61.97%); 14 (10.45%) were ornamental plants (IVI 11.45%), 23 (17.16%) were forage plants (IVI 25.14%), and 5 (3.73%) were poisonous plants (IVI 2.31%). The grassland was dominated by food plants and medicinal plants. Although the herbaceous in the grasslands of West Timor were generally seen as weeds, the potential of grassland to provide medicinal, food, ornamental plants, and fodder was quite large. Nearly 70% of the species were potential for medicinal, almost 50% were potential for food, and more than 10% were potential for ornamental plants. It is necessary to further explore the economic potential of these grasslands. The high dominance of forbs compared to grasses and legumes may be an indication that this grassland has been severely invaded by weeds and has experienced disturbances. The composition of grassland vegetation, in general was less than ideal as a grazing area. Efforts were needed to improve the legume, suppressing weed invasion and poisonous plants, and human interference in the area must also be reduced.

Keywords: grasslands, herbs, Importance Value Index, food plant, medicinal plants
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1. Introduction

Grasslands are the world's major ecosystems, covering almost a third of the earth's surface (Lemaire et al., 2011). Like any other ecosystems, the existence of the grasslands is very important for the survival of all creatures on earth. In addition to having high conservation value and supporting food production, grasslands also contribute to other ecosystem services (Modernel et al., 2016). Grasslands are an important source of medicinal plants. More than half of the population of South Africa uses medicinal plants on a regular basis, with an annual trade in one province of more than 4000 tons of plant material consisting of more than 700 species. More than half of the species and the most traded were from the grasslands (Mander, 1998). Grasslands are essential for providing forage, and livestock production for meat and milk was the most extensive use of pasture worldwide (Gibson, 2009). Grassland habitat was also very important for the diversity of the many species that live in it and for the functions and services the ecosystems provide. Grasslands provide carbon sequestration services, control soil erosion, regulate water flow, and provide cultural and recreational services. Grasslands contribute to several ecosystem services, such as food, genetic resources, pollination, invasion resistance, and many cultural services.

The monetary value of grassland ecosystem services has been quantified in several countries in Eastern Europe (Hönigová et al., 2012). The value of grassland ecosystems has been discussed and assessed by several studies. Heidenreich (2009) has reviewed recent research on the total economic value of temperate grasslands. Wilson (2009) has reviewed and assessed the value of grassland ecosystem services in British Columbia. The role of ecosystem services indicators has been recognized as one of the key components for assessing pasture ecosystem services (Maczko and Hidinger 2008). The UK National Ecosystem Assessment has also included semi-natural grasslands as an important source of ecosystem services (Bullock et al., 2011). Current evidence suggest that the ecosystem services of grasslands have declined as the number and size of pastures decreased dramatically (Harrison et al., 2010). This decline was related to the abandonment of traditional small-scale agriculture and the conversion of grassland areas to cultivation (Poschlod et al., 2005).

The grassland ecosystem was an important terrestrial ecosystem. With the intensification of global climate change and human activities, the community composition of grassland ecosystems has changed significantly (Li et al., 2000). In order to better summarize and analyse changes in vegetation in grassland communities, plants with similar attributes were classified into groups called plant functional groups (Solbrig, 1993). Plant functional groups link individual plant traits and community ecological processes and serve as an important method of simplifying community-level processes. Changes in some of the dominant species in a community will have a major impact on the composition of plant communities (Hooper and Vitousek, 1997). The effects of plant functional groups on community structure and function were mainly due to the different ecological strategies of species in response to environmental changes. Species richness can change ecosystem function, and different functional groups have different effects on species richness (Fischer et al. 2015). In addition, plant functional groups play an important role in determining the impact of species loss on ecosystems (Mclaren and Turkington, 2010). In very dry environments, the composition and ecological strategies of plant functional groups to deal with environmental extremes vary. Herbaceous plants invest preferentially in structure for persistence (K-strategy) in alpine meadows (Patty et al., 2010). Therefore, different plant functional groups have different adaptations in mountainous or arid environments. Research shows that with degradation of alpine meadows, the density per unit area of vascular plants, grasses, and sedges decreases on the Qinghai-Tibet Plateau (Yang et al., 2013). In an arid environment, the allocation of plant functional group biomass differs in humid and sub-humid areas in response to stresses caused by a dry environment (Carlsson et al., 2017). Drought will reduce legumes and increase grass functional groups (Stampfli et al., 2018). At the same time, changes in plant functional groups can also affect the environment by modifying the water cycle. Due to differences in root biomass, leguminous functional groups can increase surface soil water content, while grass functional groups can decrease surface soil water content (Ravenek et al., 2014).

In Indonesia, the largest grasslands can be found in East Nusa Tenggara (549,026.80 ha) (BPS NTT 2023). Even though the grassland vegetation was extensive, there has been relatively little research conducted on grasslands. As such, not much information is available about the diversity of flora, the composition of plant functional groups, the potential use of species presents in the grasslands. Therefore, studying the grasslands of a region is necessary to better understand the ecology of the coexisting species. In such a study, plant functional groups can provide information about the main functions of ecosystems. and provide important information for pasture management. This study was carried out to investigate the variations in the characteristics of different plant functional groups in the the grassland community of the West Timor region. The functional groups were divided according to their nature into grasses, sedges, legumes, or forbs group, whereas the potential value of the herbaceous plant species was divided according to their potential benefit into food plants, medicinal plants, ornamental plants, forage plants, or poisonous plants. The Importance Value Index (IVI) of each species present in the community was also calculated.

2. Methodology

2.1. Research Areas

West Timor has a dry or semi-arid climate of type D4 and E4 according to Oldeman climate classification (Monk et al. 2000). The rainy season is very short, normally December to March, while the rest is the dry season, with the average annual rainfall of less than 1,000 mm/year. Air temperatures range 24-34^{0}C and humidity ranges 75-76%.. During the dry season, most plants shed their leaves, leaving a few plants remain evergreen, especially those growing in areas where the water level is quite high, such as on the banks of rivers or in places with relatively wide basins. The topography of the region is mostly mountainous and hilly, with an average slope of 45°. The soil surface was generally bare, so it was sensitive to erosion. However, the lowlands are more fertile where the majority of the population is usually settled.

This research was conducted in a grassland area in the Kupang District of West Timor, which was located in the southwestern part of Timor Island. The research was conducted at ten stations (Penfui, Alak, Bakunase, Tode, Mulafa, Oesapa, Tanah Merah, Tilong, Bukit Cinta, and Naketuka). The selection of research stations was based on representation of grassland in the district. The grasslands in East Nusa Tenggara were the most

extensive compared to any other place in Indonesia. Grasslands in East Nusa Tenggara were concentrated mainly in Sumba, Timor and several locations in Flores which were generally communal lands. According to BPS NTT (2023), the area of grasslands or grazing land in East Nusa Tenggara was 549.026.80 ha and Kupang district alone has 29 381 ha of grassland.

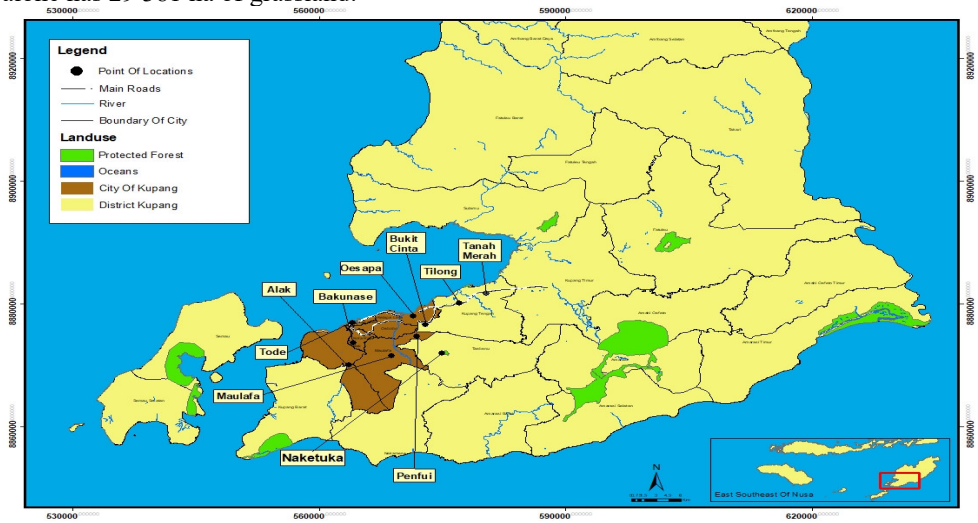

Figure 1. Study area (Penfui, Alak, Bakunase, Tode, Mulafa, Oesapa, Tanah Merah, Tilong, Bukit Cinta, and Naketuka)

2.2. Data Collection and Data Analysis

The ten stations of grassland areas in West Timor were chosen purposely. In each selected station, an observation stand (100 m x 100 m) was placed, and at each of these stations, 15 plots (1m x 1m) were randomly place (∑150 plots). In each of these plots, all species of herbaceous plants were recorded, their density was counted, and percent coverage were calculated on a scale of 0 to 100%, excluding the bushes and trees as well as their respective seedlings. Specimens of unknown species were taken, then collected and brought to the Biology Laboratory, Faculty of Science and Engineering, University of Nusa Cendana, for later identification.

All identified species were classified into functional groups into grasses, sedges, legumes, or forbs (Solbrig, 1993, Skarpe ,1996) and also grouped based on their benefits into: edible, medicinal, ornamental, forage, or poisonous plants. For each species present, individual numbers, dominance, frequency, and Importance Value Index (IVI) were calculated (Mueller-Dombois and Ellenberg, 2003). Species density (DE) was estimated as the proportion of places where a species was found multiplied by the estimated density of all species. The Relative Density (RDE) of each species was calculated as a percentage of the total number of observations for that species. Dominance (DO) of each species was expressed in percent plant cover. Relative dominance (RDO) for a species was defined as the cover for a species divided by the total cover times 100. The frequency (FE) of a species was the percentage of sample points at which a species was present. Relative frequency (RFE) was calculated by dividing the frequency of each species by the total frequency of all species multiplied by 100. The Importance Value Index (IVI) for a species was defined as the sum of relative density, relative dominance, and relative frequency (IVI = RDE + RDO + RFE).

3. Results and Discussions

3.1. Functional Groups of Herbaceous Plants

Of 10 stations and 150 plots in the grassland vegetation of West Timor, 134 herbaceous species of 32 families were present. Of all species, grass (Poaceae) was 26 (19.40%) species (IVI 25.24%) while non-grass was 108 (80.60%) species (IVI 74.76%). Grasslands were dominated by non-grass, both based on species richness and IVI. Based on the IVI, plants were dominated by *Euphorbia hirta* L. (IVI 13.93%), *Eleusine indica* (L.) Gaertn. (IVI 12.46%), *Cyperus rotundus* L. (IVI 11.72%), *Digitaria ciliaris* (Retz.) Koeler (IVI 11.12%), *Senna tora* (L.) Roxb. (IVI 9.54%), *Stenotaphrum secundatum* (Walt.) Kuntze (IVI 9.35%), and *Tridax procumbens* L. (IVI 9.17%). Based on number of species, grassland was dominated by forb (77 species, 57.46%), follow by grass (26 species, 19.40%), legumes (20 species, 14.93%), and sedge (10 species, 7.461%) (Figure 2.a). Based on IVI, grasslands were also dominated by forb (IVI 54.75%), followed by the grass (IVI 26.25%), legumes (IVI 12.41%), and sedge (IVI 6.09%) (Figure 2.b). So, both based on the number of species and the value of importance, the grassland was dominated by forbs. The very high forb in this grassland compared to the grass and legume could be an indication that the grassland was heavily invaded by weed species. However, further research is needed to confirm this.

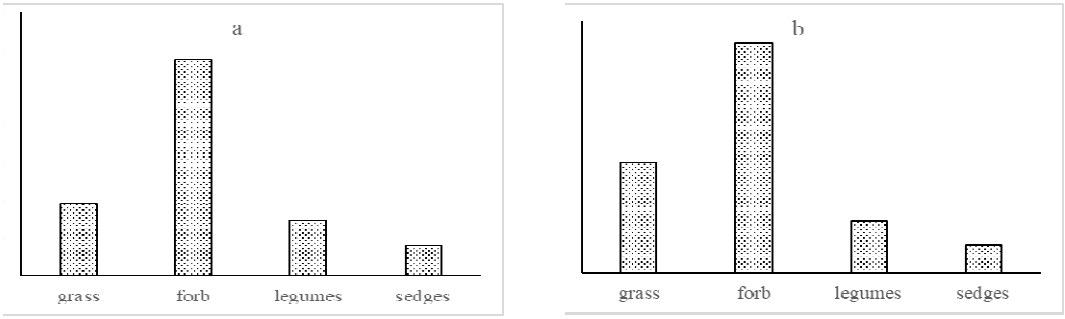

Figure 2. Groups of plants based on functional groups. a. Number of species. b. Importance Value Index

Research conducted by Zhang et al., (2022) concerning the variations in the characteristics of different plant functional groups in the northern Qinghai-Tibet grasslands identified 22 species, which were divided into four groups according to their functional groups, namely forbs, grasses, legumes, and sedges. They found that grassland communities were dominated by forbs and grasses, which accounted for more than 50% of the importance value to the community. The importance value of legumes and sedges was relatively low and only present in a few sample locations. In general, the percentage of forbs and grasses in the grasslands of West Timor was relatively higher compared to the grasslands of northern Qinghai-Tibet. According to Zhang et al., (2022), the grasslands of northern Qinghai-Tibet have a dry and cold climate, so the dominant community functional groups were grasses and forbs. This was mainly due to forbs having strong adaptability to dry environments and grasses having a conservative resource use strategy and being very cold tolerant, so grasses and forbs can adapt well to upland environments. The results of this study were also consistent with the findings of Niu et al., (2019) on the central Tibetan plateau at the same elevation, where the grassland vegetation type was dominated by grasses and forbs. Legume growth consumes more water, and legumes cannot survive in nutrient-poor desert areas, especially in moving sand dunes (Cui et al., 2018). Therefore, in area of the central Tibetan plateau the dominant functional group at each sample site was forbs or grasses, with an importance value of both reaching more than 50% of the community composition.

The role of forbs was important in the structure and function of grasslands. Forbs contributes to a large part of the functional richness of grasslands, influence nutrient and water cycles, determine soil physical characteristics, provide habitat and food sources for vertebrates and invertebrates, and serve as an important source of foodstuffs and medicines (Siebert and Dreber, 2019). Forbs provides a variety of functions and services, such as forage for livestock, and nutritious food for insects, and therefore, play an important role in food chain and in pollination. Forbs was known as a nutritious food for livestock and were an alternative food source when grass was depleted during long dry seasons or when there was overgrazing of pastures. However, forb species have not yet become a major research focus in grasslands (Bråthen et al., 2021). Such treatment has resulted in a knowledge gap regarding the ecology of forb communities and their responses to environmental, abiotic, and disturbance gradients in grasslands (Siebert and Dreber, 2019). One of the reasons prairie forbs receive relatively little attention compared to grasses is that many prairie forb species are ephemeral having shallow roots which make forb species transient or unobserved throughout the year, so they cannot be observed for long periods of time most of the year and consequently, were under-represented in grassland sampling (Pokorny et al., 2004), although they and their functional diversity can contribute up to 80% of the total herbaceous layer richness (Siebert and Scogings 2015). In terms of species richness, forbs dominate grasslands worldwide (Seabloom et al., 2013. Forbs has the properties of tolerance to disturbance or being able to avoid disturbance. In semi-arid and arid prairie biomes, forbs are able to tolerate or avoid the effects of long periods of drought. Forbs was functionally equipped to withstand natural disturbances. As a species-rich group with a long co-evolutionary history with herbivores (Veldman et al., 2015), forbs have developed a wide variety of adaptations to herbivores. Physical and chemical defenses were common in forb species (Strauss et al., 2002), and some unpalatable forb species sometimes dominate grasslands, thereby impairing pasture quality for ungulate herbivores (Augustine and McNaughton, 1998).

In the grasslands of West Timor, the number of legume species was relatively large. However, of the 20 legume species, only eight species were recorded as important animal feed, namely: *Trifolium repens* L., *Alysicarpus vaginalis* (L.) DC., *Rhynchosia minima* (L.) DC., *Desmodium incanum* DC., *Chamaecrista nictitans* (L.) Moench, *Macroptilium atropurpureum* (DC.) Urb., *Medicago lupulina* L., and *Lespedeza cuneata* (Dum.Cours.) G.Don). Jin et al., (2013) investigated Legume species in Chinese prairies and found 12 legume species, and these legumes were generally an important forage in China. The number of legume species in the grasslands of China was relatively lower than that found in the grasslands of West Timor. Research conducted by Infitria and Khalil (2014) concerning forage quality in Padang grasslands found 12 species, consisting of five species of Gramineae, four species of Leguminosae, and three types of browses. Gramineae cover about 61.75%, Leguminosae 13.14%, and weeds 25.11%. The Leguminosae group was dominated by *Calopogonium*

mucunoides Desv. (5.29%), followed by *M. pudica* (3.68%), and stylo (*Stylosanthes*) (2.89%). A stufy by Yoku et al., (2015) concerning the botanical composition of local forage types of natural pastures in West Papua found grass ranged from 82-87%, legumes 1%, and non-fodder forage groups ranged from 12-17%. Another study by Sriagtula et al., (2022) in the pastures of North Sumatra found 20 types of forage consisting of ten types of grass, one type of legume and nine types of browse and weeds. Yet another study by Seo et al., (2022) in the natural pastures of Timor Tengah Selatan found forage species (90.14%); legumes (5.36%); and weeds (4.50%). Thus, in general, the number of legume species present in this West Timor grassland was relatively higher than in some other grasslands.

Grass-legume mixtures were commonly used in pastures because they have the potential to increase productivity with lower requirements for nitrogen (N) fertilizers. Legumes play an important role in producing quality forage due to their high fiber and N and protein content. Legumes can also increase soil fertility through N_2 fixation. Introducing legumes to pasture can increase crop productivity and change the quality and quantity of plant C and N inputs to the soil, thereby helping to maintain dry matter and high N yields in pastures (De Deyn et al., 2009). Investigating the impact of long-term application of mineral fertilizers on the proportions of grasses, legumes and other herbs in the semi-natural grasslands of the Chec Republic, Knot et al., (2015). found that the number of species in the forages harvested was 43.0% consisting of grass species, 5.9% legume species, and 51.1% other herbs species. A study by Magiera et al., (2018) in subalpine grasslands in the high mountain region of Kazbegi, Greater Caucasus, Georgia, at 90 relevé showed that there were 177 plant species belonging to 35 families (26 graminoid species, 125 herbaceous species, 22 species of fabaceous, and four types of sedge). Investigating the botanical composition in seven locations of native grasslands in Haharu District East Sumba, Watuwaya et al., (2022) found the grass species occupy the highest proportion, namely 94 .42%, while legumes and weeds were only 3.55% and 2.07%, respectively.

The availability of legumes in pastures is very important because legumes have a higher nutritional (protein) content than grass. Lűscher et al., (2014) reported that the most effective botanical compositions in mixed pastures were those with a legume proportion of 30-50%. The poor quality of forage in native pastures was likely due to continuous grazing of native pastures without rest periods. Grassland that was used continuously will cause the forage in the meadow, both grass and legumes, to experience severe pressure, causing the growth of the forage to be stunted. Legumes were the species most affected by this impact. Legumes were vulnerable due to excessive grazing because they have roots that were not strong and cannot stand the stomping of livestock (Gonzalez and Ghermandi, 2021). The quality of the forage was determined by the composition of the forage in the pasture, the composition of which can change due to the influence of climate, soil conditions and the influence of utilization by livestock. Specific measures that can be taken to improve pasture quality include allowing pastures to rest from grazing, so the legumes have a better chance to grow, increasing the abundance and variety of legumes on pasture, and regulating the time and number of individual animals grazed on pasture. The introduction of legumes to pastures will increase the sustainability of pasture-based animal production as they can increase forage yields and improve soil fertility by biological nitrogen fixation mechanisms.

In the grasslands of West Timor, ten species of sedges and rushes were found. Of the ten species, eight species belong to the Cyperacea family, namely *Acorus calamus* L, *Cyperus rotundus* L., *Carex incisa* Boott, *Carex vulpinoidea* Michx., *Carex halleriana* Asso, *Scirpus fluviatilis* (Torr.) A. Gray., *Cyperus haspan* L., and *Cyperus eragrostis* Lam. and two species from the Juncaceae family, namely *Juncus articulatus* L. and *Juncus effusus* L. The seedges and rushes groups were mainly dominated by *C. rotundus*. Sedges (Cyperaceae) are a large cosmopolitan family that have global ecological and economic significance (Simpson and Inglis, 2001). Sedges form a major component of most wetland vegetation units worldwide and make an enormous contribution to nutrient cycling and habitat formation in these ecosystems (Chambers et al., 2008). Carex, with 2000 species, is one of the largest genera in the world with great distribution and significance in wetlands and seasonally moist habitats worldwide (Waterway and Starr, 2008). Cyperus, with about 600 species, is another well-known genus that includes important economic and horticultural species (Simpson and Inglis, 2001). Many species of the Cyperaceae family occur in dryland habitats that were only seasonally moist (Goetghebeur, 1998). Australia and temperate Africa both have large numbers of dryland sedges (Goetghebeur 1998).

The functional groups of plants, in this case grasses, herbs and legumes, and their spatial distribution can provide information about the main ecosystem functions such as species richness, nitrogen fixation, and erosion control. Knowledge of the spatial distribution of plant functional groups provides important information for grassland management. Magiera et al., (2018) described and mapped the distribution of grass, herb, and legume cover in the subalpine grasslands of the high mountain region of Kazbegi, Greater Caucasus, Georgia. The grasslands tested showed characteristic differences in species richness; in grass, herb, and legume cover, and in related structural properties such as yield. The grass *Hordeum brevisubulatum* (Trin.) Link was found as the dominant species in the biomass-rich hay meadows. Grassland rich in herbaceous plants had the highest species richness and evenness, whereas legume-rich meadows were in areas with high open ground cover and showed dominance of one species, *Astragalus captiosus* Boriss. The content of grassland legume stands was closely

related to various ecosystem functions. With their ability to fix nitrogen, legumes influence soil nitrogen poll which in turn influences root systems and biomass production and vegetation cover (Spehn et al., 2002), important factors for erosion mitigation (Wiesmair et al 2017). Therefore, detailed spatial knowledge of the distribution of plant functional groups of plants (grasses, herbs, legumes) that share similar properties and perform similar ecosystem functions, provides valuable information for grassland management (Blondel, 2003). Fernandez and Rubianti (2015) examined grazing land at three stands in Raknamo Village, Kupang Regency and found that at all observation points, the proportion of grass species reached 63.31-74.64%, while legumes were only 18.41%, and weed invasion rate reached 11.69%. The composition of natural grassland vegetation indicated insufficient ability to support sustainable livestock development, or the composition of the vegetation was not ideal as a natural grassland area.

From the results of this study, it appears that the dominance of the forb group in the West Timor grassland area, both based on the number of species and IVI > 50%, was very significant. The high dominance of the forb compared to the grass may be an indication that the grassland area was heavily invaded by weed species. However, further research is needed to confirm this. The dominance of forbs may be also related to the ability of these plant groups to adapt to climatic and soil conditions in West Timor. The dominance of forbs can also indicate a high disturbance of grasslands, giving space for non-grass species to invade and suppress the growth of the existing grass species. However, further research is also needed to confirm this. Based on the composition of the vegetation, in general it can be stated that the quality of West Timor's grasslands is less than ideal as a grazing area and lacks its ability to support sustainable livestock development where the presence of grasses and legumes is relatively low and weed intervention is suspected to be quite high. Whiteman (1980) stated that the ideal vegetation composition of a pasture area was 60% grass and 40% leguminous with no weed invasion. If weed invasion reaches 40% of the vegetation, then the grassland area can be said to have been damaged and requires rehabilitation. In this case, it is necessary to rehabilitate or improve the components of the grassland vegetation in West Timor, such as by increasing the Leguminosae component and suppressing weed invasion. Increasing the legume component is important because legume has several advantages, which can improve the nutritional value of forage pastures and improve soil fertility because of its ability to fix free N from the air. In addition, it is necessary to suppress weed invasion because weed growth in the pasture can drive the pasture to form a weed climax vegetation (Schaffner et al., 2022). If the grassland changes its climax direction to become a weed field, there will be a degradation of the carrying capacity of the grassland resources as grazing land. In addition, human intervention in grassland areas, especially natural grasslands, must also be suppressed because disturbance can facilitate weed invasion (Renne & Tracy, 2013).

3.2. Herbaceous Plants Benefits

All of herbaceous plants found in the grasslands of West Timor were grouped according to their use, whether they are food, medicinal, ornamental, fodder, or poisonous plants. Of the 134 species present, based on the number of species, grasslands were dominated by medicinal plants (77 species, 67.46%), followed by food plants (43 species, 31.34%), fodder plants (23 species, 17.16%), ornamental plants (14 species, 10.45%), and poisonous plants (5 species, 3.73%), while the other plant were generally used as ground cover for land conservation, erosion control or green manure. The grassland was dominated by medicinal plants with about 77 species or 70% of the species present (Fig. 3a). Based on the IVI, grasslands were also dominated by medicinal plants (IVI 61.97%), followed by food plants (IVI 34.62%), forage plants (IVI 25.14%), ornamental plants (IVI 11.45%), and poisonous plants (IVI 2.31%) (Figure 3b).

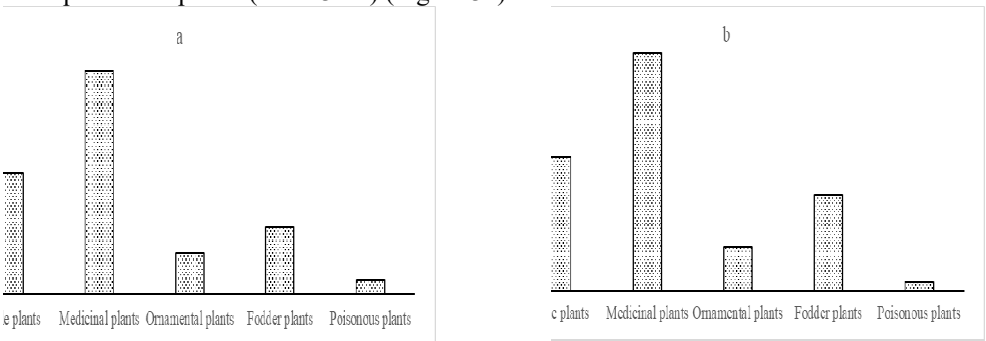

Figure 3. Groups of plants based on utilization: a. Number of species. b. Importance Value Index

Dzerefos and Witkowski (2001) investigated the density and potentials of medicinal grassland plants in the prairie area of South Africa's Abe Bailey Nature Reserve. They found 120 species of medicinal plants from 54 families. The number of medicinal plant species was relatively higher than that found in the grasslands of West Timor. However, in this list they also included plants belonging to the category of shrubs and trees. Kose et al., (2022) studied the potential of medicinal plants available in grassland ecosystem in several types of semi-natural

grassland habitats in Estonia. They found as many as 538 species of medicinal plants, and obtained the largest number of medicinal plant species from the type of wooded meadow (330 species) and the second most diverse from floodplain meadow (194 species). Belgica et al., (2021) examined the types of medicinal plants used by residents of Barangay Malinao, Ibay, Philippines and found a total of 74 species of medicinal plants belonging to 72 genera from 38 families. Among the Families they found, Lamiaceae was the best representative with eight species, followed by Compositae with six species and Euphorbiaceae, Malvaceae, Moraceae with four species each. About 35% of the medicinal plants were herbaceous, 27% were trees, 24% were shrubs, 7% were ornamental plants, and 7% were grasses. In addition, of the 74 medicinal plants collected, 44 plants had therapeutic value and were collected from nature, and 30 medicinal plants were cultivated. Of the 74 plants collected, five were on the Department of Health's (DoH) list of approved herbal medicines in the country**.**

Apart from medicinal plants, the herbaceous species found in the West Timor grasslands also have the potential to be used as food. Of the species present, more than 30% were plants that can be eaten or processed as food ingredients. A study by Dad and Anisa (2011) in the Kashmir Alpine Grasslands revealed that there were many edible wild plants. Of the three mountain meadows in study location, there were 26 species from 21 genera and 14 families used as wild edibles. The number of these edible species was lower than that found in the grasslands of West Timor. In the Croatian prairies, the transformation of grassland to other land uses has been quite intensive, resulting in a reduction in pasture area and the loss of a number of species, especially wild plants that can be used as food and medicinal ingredients which contribute substantially to the biodiversity of various types of grasslands in the country (Pfeiffer et al., 2018). In the north-eastern Croatian steppe, the diversity of vascular plants was relatively high (177 species in total) and most of them are usable, both for human food (28 taxa), and for the treatment of various diseases (60 taxa) whereas some other taxa are also of nutritional value to humans and livestock (17 taxa) (Pfeiffer et al., 2018). Pfeiffer et al., (2018) concluded that the Croatian prairie was an important sanctuary for a variety of valuable plant species and that this habitat should therefore be protected, at least locally. In a study examining the contribution of edible plants in North Wollo, Ethiopia, Hassen (2021) found 66 species, consisting of the family Moraceae (11 species) followed by Rhamnaceae (5 species). Tiliaceae, Cucurbitaceae, and Amaranthaceae (4 species each). Of these species, 28 species (43.08%) were trees, followed by 17 species (26.15%) of shrubs, and 16 species (24.62%) of herbs. The local vegetation has considerable diversity which contributes to the diversity of the food (diet) of the local population.

In addition to medicinal and food plants, the herb species found in West Timor's grasslands were also potentially used as animal feed. Of the 23 species potentially used as animal feed, 11 species (47.83%) belong to the grass (Gramineae) with an IVI of 12.78% and 12 species (52.17%) belong to non-grass with an IVI of 13.23%. The two species of the grass that were most dominant (highest IVI) were *Digitaria ciliaris* (Retz.) Koeler and *Stenotaphrum secundatum* (Walt.) Kuntze while the most dominant non-grass was *Euphorbia hirta* L. and *Tridax procumbens* L. Of the 23 herb species that could potentially be used as animal feed, eight species belong to the legume which were listed as important animal feeds. Timor Island was one of places where ruminants were usually released into grasslands and some corralled only at night. This was possible because it was supported by the natural potential of grassland savanna of the island. According to statistical data from 1,399,980.824 ha of the land area of the province, the land in East Nusa Tenggara used for grazing is 549,026.80 ha and the District of Kupang alone has 29 381 ha of grassland (BPS NTT, 2023). Therefore, to support livestock production in this area, it is necessary to maintain and improve the quality of grasslands as pastures.

Of all the herb species present in West Timor's grasslands, as many as 14 species were plants that have the potential to be used as ornamental plants. The most dominant species were *Dichondra micrantha* Urb., *Elsholtzia ciliata* (Thunb.) Hyl., *Ruellia tuberosa* L, and *Pennisetum setaceum* (Forsskal) Chiovenda. *D. micrantha* was a prostrate plant, with creeping stems, was often used as a ground cover and as grass substitute for lawns. *E. ciliata*, apart from its potential as an ornamental plant, was used as cooking spices and medicinal ingredients. *R. tuberosa* was a herb with blue or purple flowers popularly used as an ornamental plant and medicinal plant. *P. setaceum* was a popular ornamental plant and was widely grown in warm and arid climates, escaping cultivation to grow wild. Ornamental plants were plants that have artistic value of their leaves, flowers, or their trees (Rahman and Bukhari 2010). Ornamental plants were one of the plants that were grown by humans because they have the function of adding freshness and beauty to the environment, indoors and outdoors.

Of all the herb species present in the grasslands of West Timor, five species, namely (*Crotalaria sagittalis* L., *Rhynchosia minima* (L.) DC., *Ageratina adenophora* (Spreng.) King & H.Rob., *Asclepias verticillata* L., and *Gomphocarpus physocarpus* E.Mey, were poisonous plants. All parts of *C. sagittalis* were toxic to livestock because of its high alkaloids content. *R. minima* can be poisonous, but is commonly used as animal feed and often harvested from the wild for local use as a medicine and food source. *A. adenophora* is a poisonous plant, so it is usually avoided by livestock, but its leaves are also often used for traditional medicine. *A. verticillata* is toxic to livestock, but this plant is also used as a medicinal plant to treat snake bites, to increase breast milk in nursing mothers, and others. The leaves and stems of *G. physocarpus* produce a toxic milky sap, but traditionally it is often used for treatment of warts and is often grown as an ornamental plant.

Poisonous plants were natural components of grassland ecosystems and were widespread in China, consisting of about 1,300 species (in more than 140 families) (Zhao et al. 2008). Of these, about 300 species affect livestock development, with species such as Oxytropis and Astragalus, *Achnatherum inebrians* [Hance] Keng ex Tzvelev and *Stellera chamaejasme* L. posing the most severe threat (Zhao et al., 2013). The immediate threat of poisonous plants was livestock poisoning, causing weight loss, decreased reproduction and death. Their indirect threat to livestock production was through pasture degradation. Many species of poisonous plants tolerate drought and alkaline (Xing et al., 2001), allowing them more competitive in overgrazied pastures where they become dominant, reducing forage quality and accelerating degradation of such pastures. According to Bai (1997), *Stellera chamaejasme* L. has established a dominant community in the Horqin Banner grasslands which occupy about 400×104 hectares which accounts for 7% of the available grassland area in Inner Mongolia. The livestock industry in the western United States loses more than $500 million annually in deaths and abortions due to toxic plants (Holechek, 2002). Actual losses from poisonous plants were much greater due to wasted forage and increased management costs. Plant poisoning occurs worldwide, for example infested 333 million hectares pastures in China (Xing et al., 2001) and 60 million hectares in Brazil (Low, 2015).

4. Conclusion

From the results of this study, it can be concluded that although the herbaceous plants present in the grasslands of West Timor were generally seen as weeds on various agricultural lands, the potential of grassland species to provide medicinal, food, ornamental plants, and animal feed services were high. Nearly 70% of the species present have the potential to be used as medicinal plants, almost 50% have the potential to be used as food ingredients, and more than 10% have the potential to be used as ornamental plants. However, this potential has not been explored and exploited. Even though the percentage of poisonous plant species was relatively small (3.73%), the existence of these plants needs to be watched out. The presence of poisonous plants can cause disturbances in the plant community, causing death and poor growth in livestock. They need to be identified, their spread need to be monitored, and a strategy of control need to be developed. West Timor's grassland was an important resource for a large part of the population. The quality of pasture grass affects the profit of the farmer. The number of farmers involved in animal husbandry in NTT is quite large, an estimated 41,960 farmers raised livestock as their main source of income in 2018 (BPS NTT 2023).

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