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Composition and Potential Values of Species in the Agricultural Area of Kupang Indonesia

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ABSTRACT

This research was conducted to investigate the composition and potential value of species in an agricultural area of Kupang, Indonesia. Two sites (dry and wet site) were selected subjectively. In each site, three stands (100 m x 100 m) were placed subjectively and in each stand 25 plots (1 m x 1 m) were placed randomly (Σ 150 plots). In each plot, all weed present were recorded and their density and percentage cover calculated. Each species was grouped into broad-leaves, sedges, and grasses. To determine the potential value of the weeds, all weeds were grouped into whether they medicinal plants, animal feed or food ingredients. For each species, the number of individuals, dominance, frequency, and Importance Value Index (IVI) were calculated. Species diversity was also calculated using the Shannon-Wiener Diversity Index (H'). Overall, 46 weed species were found. The weeds with the highest IVI (>5.00%) were *Panicum repens* L (IVI 14.80%), *Bolboschoenus maritimus* L. Palla (IVI 10.32%), *Alternanthera sessilis* L. (IVI 7.47%), *Cyperus rotundus* L., (IVI 6.97%), *Digitaria ciliaris* (IVI 6.69%), *Cyperus elatus* L (IVI 6.63%), and *Ischaemum timorense* Kunth (IVI 5.02%). In general, the composition of weeds between the dry and the wet sites were relatively different. Based on the number of species and diversity index, the weed community in the wet site was relatively higher than that in the dry site. Based on the IVI, the dry site tended to be dominated by grasses and broad leaves, while the wet site tended to be dominated by sedges. Based on IVI, 42.80% of all the weed species present had the potential to be used as medicinal plants, 39.81% as animal feed, and 17.39% as human food. Overall, most weed species studied had the potential to be used as medicinal plants, animal feed, and food ingredients. The potential of this weed needs to be studied more deeply in the future, including their use as an alternative source of medicine and food, especially as demand increases in the future.

INTRODUCTION

Weeds are plants that are considered undesirable in certain situations, growing where they conflict with human preferences, needs or goals (Harlan & deWet, 1965, Bridges & David, 1994). The concept of weeds is very important in agriculture because the presence of weeds on land used for farming can cause significant crop losses (Chauhan, 2020). In agriculture, weeds can reduce the quantity of crop yields. The decrease in yield quantity was caused by competition between weeds and plants for groundwater, sunlight, nutrients, growing space and air, which causes crop growth to be hampered. Competition between crops and weeds can suppress crop growth, hamper the smooth running of agricultural activities, reduce environmental aesthetics, and increase maintenance costs (Kilkoda *et al.*, 2015, Ngatiman & Fajri, 2018). Weeds cause major damage to crop as they increase the cost of different cultural practices, decrease the effectiveness of agricultural equipment and the value of fertile land, and decrease the germination ability of crop seeds due to phytotoxins or allelochemicals. Weeds have obvious characteristics, such as short seed dormancy, high seed germination rate, environmental plasticity, rapid seedling growth and high reproductive

ability, short life cycle, self-compatibility, efficient and well-organized seed crushing methods, produce various types of allelochemistry, and tolerance to abiotic and biotic stresses (Baker, 1974). This allows weed species to survive and grow in different ecological habitats. Therefore, weeds have become dominant worldwide and are destroying local biodiversity (Holm *et al.*, 1979) Based on their morphology, weeds are classified into grasses, sedges, and broadleaves (Caton *et al.*, 2011, Tohari, 2017). Grass weeds generally come from the Gramineae family. This weed has narrow leaves and produce stolon's that form a complicated network difficult to overcome mechanically. The lifeform of grass weeds varies, some are upright, spreading, seasonal, or annual. Sedge weeds are of the Cyperaceae family with narrow-leaves similar to those of grasses but has stems consisting of only one long segment triangular in shape. The sedge weeds group has extraordinary resistance to mechanical control because it has stem tubers in the soil that can survive for months. In addition, this weed carries out the C4 photosynthesis pathway which makes it very efficient in quickly colonizing agricultural areas. Broadleaf weeds generally belong to the Dicotyledoneae and Pteridophyta families. These weeds usually grow at the end of the

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cultivation period. Competition against crops takes the form of competition for light.

In studying weed diversity, it is important to determine the composition and structure of weeds in crop fields. Weed composition is influenced by environmental conditions. Many factors influence the diversity of weeds in an agricultural field, such as light, nutrients, soil processing, plant cultivation methods, crop spacing, crop density, and crop age. Weed species are also influenced by soil fertility, cultivation patterns, and tillage (Aldrich & Kremer, 1997). Identification of weeds and recognition of dominant weed types is the first step in determining the success of weed control. Weed structure is important in determining the level of weed infestation in cultivated fields. Weed structure is also influenced by several factors, including light, nutrients and cultivation techniques, soil type, and the types of plants present in the surrounding area. Weed structure is also influenced by fertility, density, soil processing, and cultivation patterns (Imaniasita *et al.*, 2020). Weed diversity was influenced by environmental factors, namely light, nutrients, plant cultivation methods, soil processing, plant spacing and planting age, plant spacing and plant age.

Analysis of the diversity, composition, and potential values of weeds species in the Kupang, Timor Island has not been widely published. This research will analyse weed communities in two different environments condition

(dry and wet sites). Specifically, this research were to determine the species diversity and composition of weed communities in the dry and wet sites, to find out whether different land areas (dry vs wet sites) influence diversity and species composition of the weeds present, and to determine the potential of the weeds present to be used as medicinal plants, animal feed, and food ingredients. This information is needed in determining weed control priorities and potential benefits weed present.

MATERIALS AND METHODS

Study Area

Kupang is part of West Timor, Indonesia, which has a dry or semi-arid climate of types D4 and E4 according to the Oldeman climate classification (Monk *et al.*, 2000). The rainy season is very short, usually from December to March, with an average annual rainfall of less than 1,000 mm/year. The air temperature ranges from 24-34°C and humidity ranges from 75-76%. In the dry season, most plants shed their leaves, leaving only a few plants that remain green, especially those that grow in areas where the water level is quite high, such as on riverbanks or in places whose basin is relatively wide. The topography of this region is mostly mountainous and hilly, with an average slope of 45°. The land surface is generally bare, so it is sensitive to erosion. However, the lowlands are more fertile where the majority of the population usually resides.

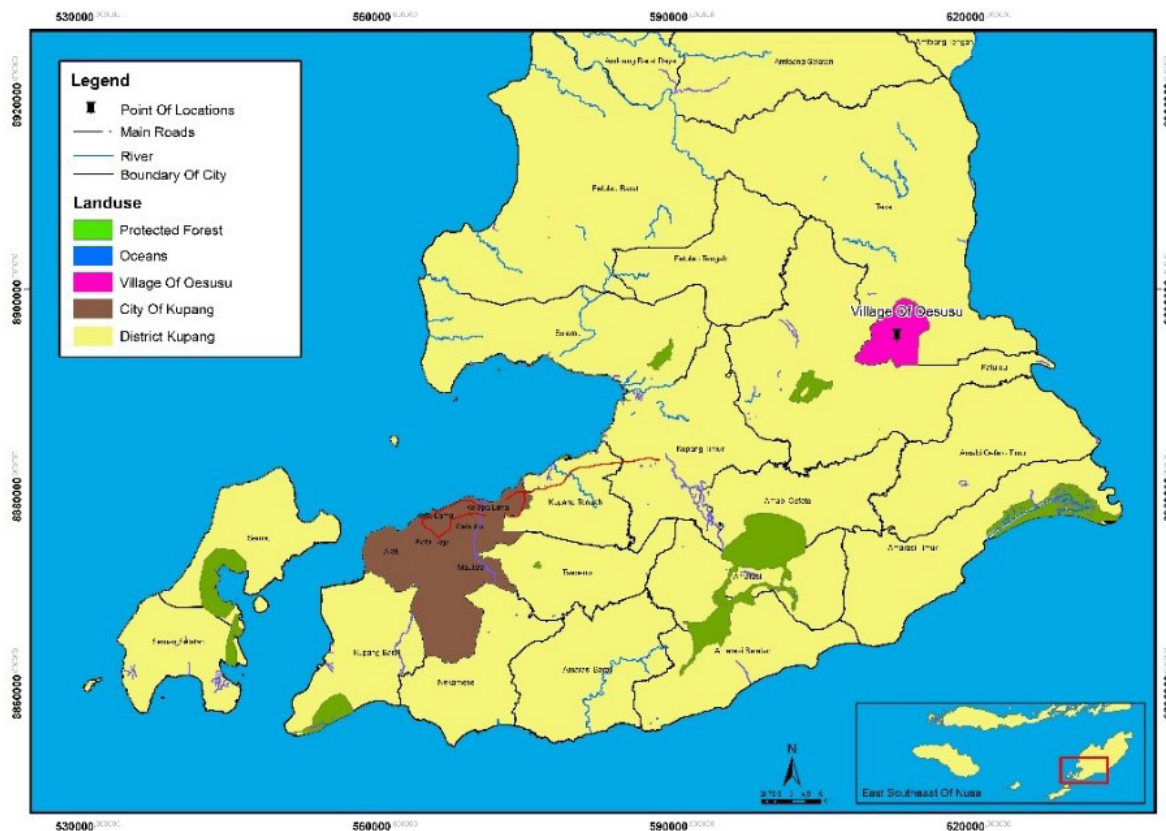


Figure 1: Map of the research study sites Oesusu Takari Kupang

This research was conducted in Oesusu, Takari Sub-district (Figure 1). Two research sites were chosen subjectively. One was a dry post-maize planting site that

was never irrigated at all the time and one the other was a wet post-rice planting site that had received irrigation during the period of rice cultivation. Both research

sites were presumed to have different environmental conditions and different gradient of soil moisture availability. The dry site was part of the 53 838 ha non-irrigated agricultural land, and the wet site was part of the 885 ha irrigated agricultural land in Takari Sub-district (BPS Kupang Regency, 2024).

Procedures

The method used in this research was an exploratory descriptive method. At each site, three stands (100 m x 100 m) were placed, which were chosen deliberately. At each selected stand, 25 plots (1 m x 1 m) were placed randomly (Σ 2 x 3 x 25 = 150 plots). In each plot, all herbaceous weed present were recorded, their density was calculated, and the percentage of land cover was measure on a scale of 0 to 100%. Each species of herbaceous plant that existed was identified and specimen of plants whose names were unknown were taken, then collected and taken to the Biology Laboratory, Faculty of Science and Engineering (FST), Nusa Cendana University, for identification. Each species found in the area studied was grouped into broad-leaf, sedge, or grass type of weeds.

Data Analysis

For each species present, the number of individuals (density), dominance, frequency, and Importance Value (IVI) was calculated (Mueller-Dombois & 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. The dominance (DO) of each species was expressed in percent plant cover. The relative dominance (RDO) of a species was calculated as the cover of a species divided by the total cover multiplied by 100. The frequency (FE) of a species was the percentage of sample points of a species 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 determined as the sum of relative density, relative dominance, and

relative frequency (IVI = RDE + RDO + RFE). Species diversity was calculated using the Shannon-Wiener Diversity Index (H') with the following formula: $H' = - [(ni/N) \log (ni/N)]^2$, where H' = General Shannon diversity index. Ni = Importance Value index of a specie, and N = Total importance of a species (Mueller-Dombois & Ellenberg, 2003). The magnitude of the species diversity index according to Shanon - Wiener was defined as follows: The value of $H' > 3$ indicates that species diversity in the site was high; a value of $1 \geq H' \leq 3$ indicates that species diversity in the site was moderate, and a value of $H' < 1$ indicates that species diversity in the site was low (Soerianegara & Indrawan, 1998). The Similarity Index (SI) between two sites was also calculated to determine the similarity of the flora composition of the weed community between the dry and wet sites using the Sørensen coefficient (Ss), with the formula $Ss = 2a / (2a + b + c)$, where a = the number of species that are the same at both areas, b = the number of unique species at the first areas, and c = the number of unique species at the second areas (Mueller-Dombois & Ellenberg, 2003). To determine the potential value of weeds, an ethnobotanical analysis was carried out through literature study. All the weeds presents were classified for their potential to be used as medicinal plants, animal feed, and food ingredients.

RESULTS AND DISCUSSION

Structure and Composition of Weeds

Of three research stands on dry area, a total of 25 weed species were found (Figure 2a). Species were grouped into categories of very high (IVI > 15), high (IVI 10 < 15), medium (IVI 5 < 10), low (IVI 1 < 5), and very low IVI (IVI < 1). Of all the species present, one (8.00%) species was in the very high IVI, two (16%) species were in the high IVI, and 19 species (76.00%) were in the low and very low IVI (Figure 2b). So, the dry site was dominated by weed species in the low and very low IVI categories. The weed species in the very high IVI category was *Panicum repens* L (IVI 29.60%) and the high category was *Digitaria ciliaris* (Retz.) Koeler (IVI 12.26%), and *Ischaemum timorense* Kunth (IVI 10.01), while all other species were in medium, low, and very low IVI categories.

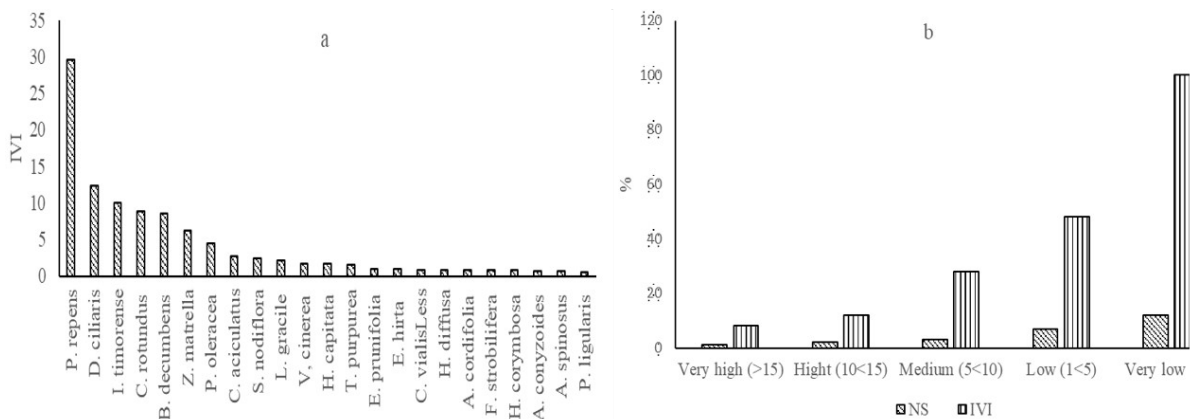


Figure 2: Importance Value Index (a), Importance Value Categories (b) of weed species in the dry site in Kupang, West Timor (IVI = Importance Value Index, NS = Number of Species)

Of all weed species present in dry site, the plants consist of 12 families. Based on number of species, the existing weeds were dominated by the Poaceae [7 species (28.00%)], then followed by the Asteraceae [4 species (16.00%)], Rubiaceae [3 species (12.00%)], Euphorbiaceae and Fabaceae [each of 2 species (8.00%)], while all other family were represented by only one species (Figure 3a). Based on IVI, weed was dominated by Poaceae (IVI 71.49%), Cyperaceae (IVI 8.82%), Asteraceae (IVI 5.59%), while all other family IVI were <5.00%. Therefore, the Poaceae

family dominated the dry site. The most dominant species of the Poaceae were *P. repens* (IVI 29.60), *D. ciliaris* (IVI 12.26), and *I. timorensis* (IVI 10.01). Of species present in dry site, a total of 7 (28.00%) species were grass (IVI 71.49%), 17 (68.00%) species were broadleaf (IVI 19.86%), and only one (4.00%) species belongs to the sedges (IVI 8.82%). So, based on the number of species, the dry area was dominated by the broadleaf (68.00%). However, based on IVI, the dry area was dominated by the grass (IVI 71.49%) (Figure 3b).

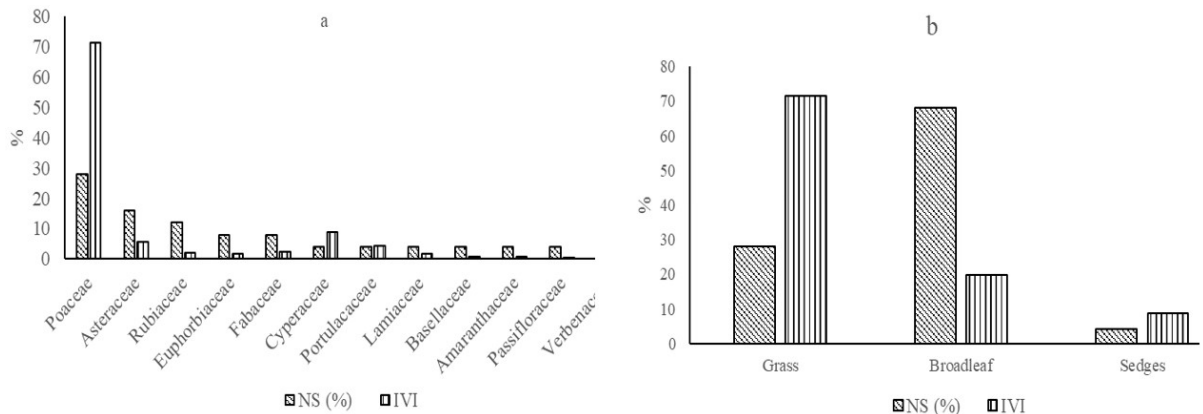


Figure 3: Weed families (a) and groups (b) in the dry site in Kupang, West Timor (IVI = Importance Value Index, NS = Number of Species)

In the wet site, a total of 28 weed species were found (Figure 4a). Species were grouped into categories of very high (IVI > 15), high (IVI 10 < 15), medium (IVI 5 < 10), low (IVI 1 < 5), and very low IVI (IVI < 1). Of all the species present, one (3.7%) species was in the very high

IVI category (*Bolboschoenus maritimus* L. Palla), two (7.14%) species were included in the high IVI (*Alternanthera sessilis* L. and *Cyperus elatus* L.), one (3.7%) species was in the medium IVI category (*Cyperus rotundus* L.), while all other species were in the low and very low IVI category (Figure 4b).

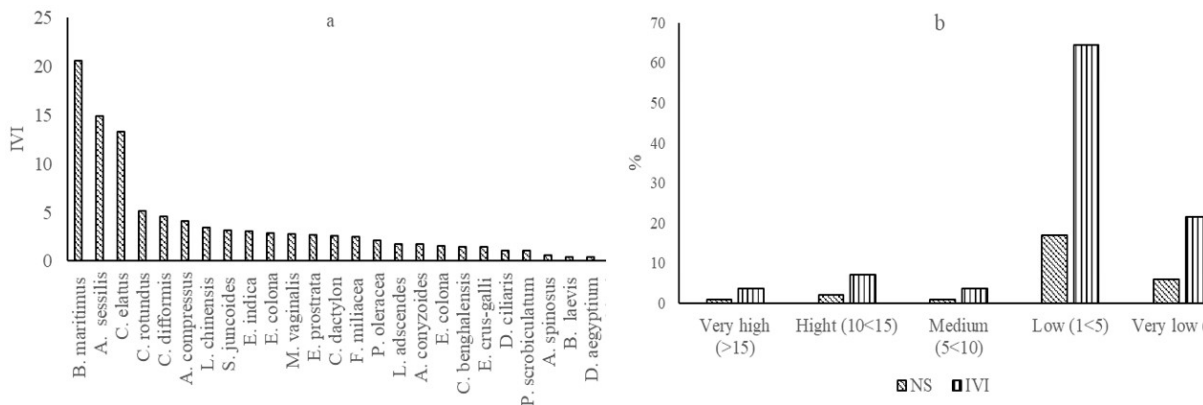


Figure 4: Importance Value Index (a), Importance Value Category (b) of weed species in the wet site in Kupang District, West Timor (IVI = Importance Value Index, NS = Number of Species)

Of all weed species present in the wet site consist of 10 families. Based on the number of species, the wet site was dominated by the Poaceae family [10 (37.04%) species], followed by the Cyperaceae [6 (22.22%) species] while all the other families were only represented by one or two species. However, based on the IVI, the wet site was dominated by Cyperaceae with IVI almost 50.00% (Figure 5a). The dominant species of Poaceae were *Axonopus compressus* (Sw.) P.Beauv (IVI 3.65%), *Leptochola chinensis* L.

Ness, (IVI 3.48%), and *Eleusin indica* L. Gaertn (IVI 3.09%) while the dominant species of the Cyperaceae were *B. maritimus* (IVI 20.63%) and *C. elatus* (IVI 13.26%). Of all weed's species in wet area, 10 (37.04%) belong to the grass (IVI 21.75%), 11 (40.74%) broadleaf (IVI 28.96%), and 6 (22.22%) sedges (IVI 49.29%). So, based on the number of species, the wet area was dominated by the grass and broad leaf weed. However, based on the IVI, the wet area was dominated by the sedges (IVI 49.29%) (Figure 5b).

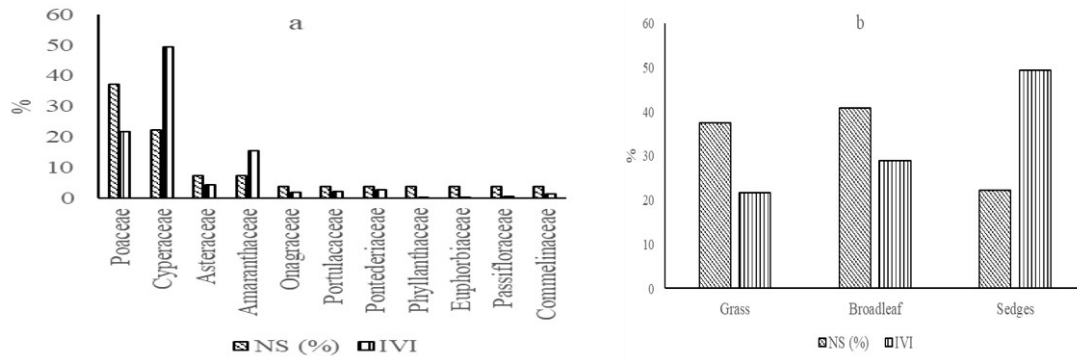


Figure 5: Weed families (a) and groups (b) in the wet site in Kupang District, West Timor (IVI = Importance Value Index, NS = Number of Species)

The average number of weed species present per stand in the dry site was 8.33 (3.78) and the average diversity index (H') was 1.1754 (0.5203). The average number of species present per stand in the wet site was 14.33 (3.51)

and the average diversity index (H') was 1.6725 (0.0493). So, in general both the number of species and the species diversity index were relatively higher in wet site compared to those in the dry site (Table 1).

Table 1: Number of species and Diversity Index (H') of weed species in the dry and wet sites of agricultural lands in Kupang, West Timor

	Number of species	Number of species/stand	H'
Dry area	25	8.33 (3.78)	1.18 (0.52)
Wet area	27	14,33 (3.51)	1.67 (0.05)

Potential Values of Weed Species

Of the 25 species present in the dry sites, 54.55% found of having the potential to be used as medicinal plant (IVI 34.25%), 24.24% of having the potential to be used as animal feed (forage crop) (IVI 56.68%), and 21.21% of having the potential to be used as edible plant (human food) (IVI 9.07%). Based on the number of species, the dominant potential values of weeds in the dry site were as medicinal plants, then animal feed, and the lowest as food plants. However, based on the IVI, the dominant potential values of weeds species were for animal feed, followed by medicinal plants, and the lowest was food

plants (Figure 6a).

Of the 27 of weeds species present in wet site, 40.54% were recorded as being used as medicinal plants (IVI 51.36%), 35.14% were useful as animal feed (IVI 22.94%), and 24.32% were edible for humans (IVI 25.712%). Based on the number of species, the dominant potential values of weeds in wet site had the potential to be used as medicinal plants, then animal feed, and the lowest as food ingredients. However, based on IVI, the dominant potential values of weeds had the potential to be used as a medicinal plant, followed by food and the lowest as animal feed (Figure 6b).

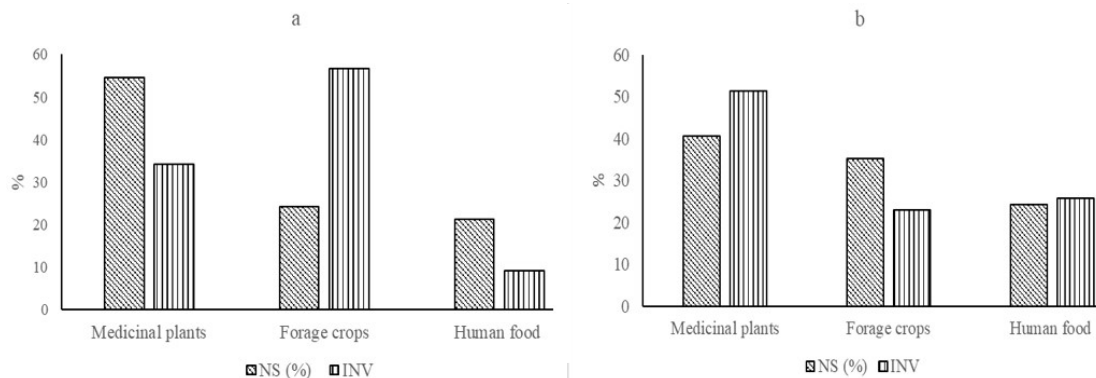


Figure 6: Potential values of weed species in the dry (a) and wet (b) sites in Kupang District, West Timor (IVI = Importance Value Index, NS = Number of Species)

Overall, in both the dry and the wet sites in agricultural lands in Kupang, a total of 46 weeds species were found. Of those species, the highest IVI (IVI >5.00%) were *P. repens* (IVI 14.80%), *B. maritimus* (IVI 10.32%), *A. sessilis*

(IVI 7.47%), *C. rotundus* (IVI 6.97%), *D. ciliaris* (IVI 6.69%), *C. elatus* (IVI 6.63%), and *I. timorensis* (IVI 5.02%). Those seven species contribute a total of 60.00% IVI of weed species present. Importance value is the measure

of how dominant a species is in a given ecosystem, and summarizes the predominance of species. The dominance of those seven species is most likely because their high level of fecundity, wide tolerance to various environment factors, relative adaptive and tolerant to dry climate, and ability to dominate various agricultural areas of West Timor. Species that have a high IVI indicate their ability to be adaptive and to adjust their life to environmental conditions better than other species, to utilize available resources better than other species, and to spur growth and maintain the sustainability of the species better than other species (Soerianegara *et al.*, 1998).

In general, the plant composition between the dry and the wet site was relatively different. The dry site was dominated by *P. repens* (IVI 29.60%), *D. ciliaris* (IVI 12.26%), and *I. timorensis* (IVI 10.01%). Those three species contributed 51.87.00% IVI of weed species present in the site. This dry site was dominated by grass weeds. On the other hand, the wet site was dominated by *B. maritimus* (IVI 20.63%), *A. sessilis* (IVI 14.94%), *C. elatus* (IVI 13.26%), and *C. rotundus* (IVI 5.11%). Those four species contribute about 53.94.00% IVI of weed species present in site. This wet site was dominated by sedges. The origin of *P. repens* is unknown (Hossain *et al.*, 1999; Stone & Katharine, 2011). This plant occurs in many places as an introduced species as a noxious weed. *P. repens* is classified as one of the worst weeds in the world. This grass grows throughout the world in tropical and subtropical areas. This plant was intentionally planted in South Florida as livestock feed and escaped cultivation, eventually becoming one of the most serious weeds in Florida (Stone & Katharine, 2011). *D. ciliaris* is believed to originate from Asia, but is now found throughout the planet's tropical belt, as well as in some temperate regions (*Digitaria ciliaris* - CABI). This grass is an invasive species that is considered an aggressive weed in several countries, including China, Mexico, and the United States (*Digitaria ciliaris* - CABI). *D. ciliaris* is usually one of the first species to colonize degraded environments. *I. timorensis* is native to tropical and temperate Asia and was naturalized in Central and South America. It generally occurs in disturbed areas (roadsides, banks or terraces, forest margins, etc.) and also in rice fields (Cook *et al.*, 2005). *I. timorensis* may become a weed in annual crops as it establishes readily, spreads through rooted stolon's and is tolerant of shade and short droughts. In Indonesia, it is a common weed of rice (Ipor *et al.*, 1992). It does not require added fertilizers and it can resist fires because it is capable of growing from the stolons and seeds. It is listed as an environmental invasive species by the PIER (Pacific Islands Ecosystems at Risk) (Cook *et al.*, 2005). *B. maritimus* is a facultative halophyte from the Cyperaceae family which is known as a cadmium accumulating plant (Madejón *et al.*, 2006). This plant is widespread in shallow waters of temperate climates, namely in wet plains, seasonal and permanent wetlands, pond edges and salt marshes in coastal systems. *B. maritimus* can survive in saline and non-saline conditions. This species

is a cosmopolitan species and occurs in many places in the world. This annual plant reaches a height of 1.2 m (Lillebø *et al.*, 2003) and has rhizomes or tubers which are the main reserve of carbohydrates for plant growth. *A. sessilis* is found throughout tropical and subtropical regions. This herbaceous perennial species is classified as a weed in several southern US states, found usually in wet or damp places. This plant grows wild, but is also used for food, herbal medicine, and as an ornamental plant. In certain regions of Southeast Asia, the leaves and young shoots are consumed as vegetables (Grubben & Denton, 2004). It has been used for the treatment of dysuria and hemorrhoids (Tanaka *et al.*, 2007). *C. elatus* is a species of Cyperus in the sedge family, Cyperaceae. This plant is a perennial or rhizomatous geophyte and grows primarily in wet tropical biomes. *C. elatus* is a grass-like perennial plant that produces clumps of sturdy stems about 50-300 cm high from short, hardy rhizomes. This plant is harvested from nature for local use for mat-making. Its habitat is around ponds and rivers; from near sea level to 1,500 m asl. This plant is an annual plant that grows in swamps, seasonally flooded areas, ditches, along rivers and rice fields (Cook, 1996). The leaves are used to make hats and bedding. *C. rotundus* is one of the most invasive weeds known, having spread out to a worldwide distribution in tropical and temperate regions. It has been classified as the world's worst weed (Holm *et al.*, 1977) as it is known as a weed in over 90 countries and infests over 50 crops worldwide (Omezine *et al.*, 2009).

The difference of weed composition between the dry and the wet sites is likely to be related to habitat preferences, where grass prefers to dry sites, while the sedges prefer moist sites. The distribution, diversity, and primary productivity of plant communities are reported to be closely related to gradients in soil moisture availability (Gaviria *et al.*, 2017). According to non-equilibrium ecological theory, groundwater availability is the most important factor in ecosystem dynamics (Gaviria *et al.*, 2017). Therefore, soil moisture availability can be one of the main factors influencing plant associations (Sollins, 1998). A study carried out by Chaturvedi *et al.*, (2017) shows a relationship between drought and increased mortality rates and reduced growth rates of tropical plants. Differences in drought resistance between species may be the main factor influencing the composition and diversity of plant species in the dry tropics. Variations in soil moisture cause changes in ecosystem structure and function. These changes can benefit some species to thrive and can also lead to the disappearance of other species.

The diversity index (H') of weed species in the dry [1.18(0.52)] and the wet sites [1.67(0.05)] was moderate category (Soerianegara & Indrawan, 1998). In general, both the number of species and the species diversity index were relatively higher in the wet site [number of species/stand 14.33 (3.51), diversity index (H') 1.67(0.05)] than in the dry site [number of species/stand 8.33 (3.78), diversity index (H') 1.18(0.52)], meaning that weed

composition were more diverse in the wet than in the dry site. The research of Zulfa *et al.*, (2023) on corn fields in Belayu Village, Tabanan, Bali, revealed that the weed diversity index ranged from 2.29 to 2.77. This species diversity index was relatively higher than the diversity of weeds found in the sited of West Timor. The research of Pertiwi & Arsyad (2018) on maize in Marisa District indicated that the weed diversity index ranged from 1.63 to 1.76. This diversity index was almost the same with that found in West Timor. Suryatini (2018), in her research on rice fields in Subak Tegal, Bali, found about 27 weed species belonging to 13 families with a weed species diversity index of 1.06. This diversity index was relatively lower than that found in West Timor. Rahmadi *et al.*, (2023) found in organic and conventional lowland rice cultivation in Lampung that the weed diversity index in an organic cultivated land was 2.31 and on conventional cultivated land was 1.93, relatively higher than that found on West Timor. Utami & Purdyaningrum (2012) found that weed communities in an organic and inorganic cultivated rice in Ketapang, Semarang, that weed diversity index for inorganic rice was higher (1.94) than in organic rice weeds (1.54), but were slightly higher than those found in West Timor.

The biodiversity of weed communities in a cropland can be influenced by tillage systems, fertilization practices, and environmental conditions (Fried *et al.*, 2008). Changes in crop management are likely to act as filters on the weed community by removing or limiting species that lack specific traits or combinations of them (Storkey *et al.*, 2010). Each agricultural practice has a higher or lower potential to influence the diversity of weed species in a crop field. Both positive and negative effects of reduced tillage intensity on weed diversity have been reported. In many cases, annual broadleaf species tend to be more abundant in frequently disturbed conventional tillage systems (Streit *et al.*, 2003), while perennial weeds are favoured by the absence of disturbance (Buhler, 1995). Differentiation in the concentration and availability of plant nutrients may also affect weed populations (Murphy & Lemerle, 2006) and fertilization has a strong impact on weed species diversity (Cheimona *et al.*, 2016). Research of Oksari (2014) in maize cultivated land in Lambung Bukit found diversity index of weed species was 1.20, (moderate diversity). Odum (1996) stated that the level of diversity of an organism in a community depends on the number of individuals in the community. Environmental conditions greatly influence the diversity of plant species. Very extreme conditions will cause disruption to the stability of life and the distribution of various plants (Ewusie, 1990). High species diversity is an indicator of the stability of environment. High stability indicates a high level of complexity, this is due to high levels of interaction so that it will have a higher ability to withstand disturbances.

The 46 weeds species found in the dry and wet agricultural areas in West Timor consisted of 17 families. Based on number of species, the community were dominated by

the family of Poaceae (32.52%), Cyperaceae (13.11%), Asteraceae (11.71%), Rubiaceae (6.00%), Euphorbiaceae (5.85%), and Amaranthaceae (5.71%), while all other families were <5.00%. Based on IVI, the weed communities were dominated by Poaceae (IVI 46.62%), Cyperaceae (IVI 29.01%), Amaranthaceae (IVI 8.08), and Asteraceae (IVI 5.02%), while the IVI of all other families was <5.00%. Therefore, agricultural lands in West Timor was dominated by Poaceae with almost 50.00% IVI. Based on IVI, the dry site was dominated by the family of Poacea (IVI 71.49%), whereas the wet site was dominated by the Cyperaceae (IVI 49.29%). According to Johnston & Gillman (1995), a family is said to be dominant in an area if it has a percentage >20%. Ndam *et al.*, (2014) found on maize land in Southwest Cameroon about 53 weed species belonging to 28 families, with Asteraceae was the most dominant (15%) followed by Poaceae (8%), and Amaranthaceae, Euphorbiaceae, and Fabaceae (6%). Analysis of weed vegetation in a maize field in Lambung Bukit by Oksari (2014) showed that there were 10 families, 15 genera, 16 species, and 1892 individuals of weeds, mostly from the Rubiaceae family (50.69%) consisting of 959 individuals. Apart from the Rubiaceae family, two other families that frequently found were Poaceae (143 individuals) and Compositae (735 individuals). Meanwhile, the family that was found the least individual was Cyperaceae (1 individual). Golmohammadi *et al.*, (2017) found about 65 weed species on post-harvest weed populations in rice fields belonging to 27 families. The families Cyperaceae and Poaceae showed the highest frequencies of 13 species (20%) and 8 species (12%) respectively. The most dominant weeds after rice harvest based on relative cover were Echinochloa, Cyperus, Azolla, and blue-green algae species, of 57.8%, 39.6%, 17.2%, and 14.4%, respectively. Haris & Ngabekti (2023) found on a eight (8) week old rice field in Banyubiru Village, Semarang Regency, a total of 17 species within 11 families. The weed species that had the highest IVI was *Cyperus difformis* L. At eight-week old, the dominant family was Cyperaceae (68.25%). Cyperaceae dominates due to its ability to produce seeds in large quantities. Nithya & Ramamoorthy (2015) found the composition and diversity of weed flora in five rice field locations in Villupuram District, Tamil Nadu, India, 56 species within 45 genera and 23 families distributed in various life forms, consisting of herbs (40), grasses (8), sedges (4) and ferns (1). Echinochloa colona (L.) Link was the most abundant weed in the five fields. The following families: Amaranthaceae (8 species), Poaceae (8 species), Cyperaceae (5 species), Asteraceae (4 species), Malvaceae (4 species), Solanaceae (3 species) were found as the leading flora of the 23 families whereas the other families were relatively less diverse.

Based on number of weed species found in the agricultural areas in West Timor, weed community was dominated by broadleaf (54.37%), then grass (32.70%), and the lowest was sedges (13,11%). However, based on IVI, weed community were dominated by grass (IVI 46.62%), then

sedges (IVI 29.06%), and the lowest was broadleaf (IVI 24.41%). Although the number of broadleaf weed was relatively high, however their IVI were the lowest as many broadleaf weeds had small stature and relatively low cover. Based on the number of species, the dry site was dominated by the broadleaf (68.00%), however based on the IVI, the weed community was dominated by the grass (IVI 71.49%). Based on the number of species, the wet site was dominated by the broadleaf (40.74%), however based on the IVI it was dominated by the sedges (IVI 49.29%). The diversity of sedges was relatively lower in the dry site than in the wet site. All sedge species appear to grow well in the wet site. Setiawan *et al.*, (2022) found that in the intercropping soybeans with corn, the number of broadleaf weeds (56%) was more dominant than grasses (31%) and sedges (13%). According to research of Gawaksa & Darlian (2016), the number of broadleaf species on a maize field was 82%, grasses was 9%, sedges was 9%, indicating the field was dominated by broadleaf weeds. In three pineapple areas, Noorsuliyana *et al.*, (2023) found that broadleaf weeds were more dominant compared to other types of weeds, accounted for 78.95%, 93.14%, and 87.05%, respectively, while grasses and sedges were relatively low. The dominance of broadleaf weeds in pineapple areas is probably due to the fact that such weeds usually have a tap root and a creeping root systems that more easily absorbs water and nutrients from the soil compared to other weeds. Variations in the distribution of weed composition in the three pineapple areas may also be influenced by previous control practices. Rahayu *et al.*, (2019) found on land that cultivated with various corn cultivars that the weed species that grew most frequently in all treatment combinations were also broadleaves. The number of weed types growing in corn plantations at 4 week after planting (WAP) was 30 species, consisting of 3 species of Cyperaceae, 7 species of grasses, and 20 species of broadleaves. The composition of weed species growing at 8 WAP consisted of 26 species, 3 species of Cyperaceae, 6 species of grasses, and 17 species of broadleaves. The same results were also reported by Oksari (2014) that the weeds that were most widely distributed on maize fields in Bukit Padang, were broadleaf (1748 individuals). Most of the broadleaf weeds include species of Dicotyledoneae from various families. These broadleaf weeds are widespread because they generally have tap roots (Suryaningsih *et al.*, 2011). Such tap root systems makes broadleaf weeds grow much vigorously than grasses and sedges, allowing the broadleaf weeds dominate the maize field.

The Index of Similarity (IS) of weed community between the dry and the wet sites was 23.08%. Thus, the weed composition between these two communities was relatively different. According to Chao *et al.*, (2006), communities that have less than 65% IS can be considered different. Barbour *et al.*, (1998) suggested that relatively homogeneous microhabitat conditions will be occupied by individuals of the same species, because the species naturally develops adaptation mechanisms and tolerance

to these conditions. Loveless (1999) stated that the factors that determined the existence of a plant species or plant community included not only physical and chemical conditions, but also animals and humans which had a major influence on both plants and their habitat. Of all species of weeds present in the dry and the wet site in West Timor, six species were present in both sites [(*Digitaria ciliaris* (Retz.) Koeler, *Cyperus rotundus* L., *Portulaca oleracea* L., *Euphorbia hirta* L., *Ageratum conyzoides* L., and *Amaranthus spinosus* L.)]. These six species are thought to have relatively wide tolerance to various habitat, especially in relation to soil moisture, allowing them to have a relatively wide distribution, making the six species need special attention in relation to weed control in the region. Tena *et al.*, (2012) found the IS of weed species composition between locations in several cotton fields was < 60%. Taye & Yohannes (1998) stated that weed communities that had an IS <60% between locations and seasons were considered different. Differences in altitude, climate, soil type, and management practices applied were factors that influence the distribution, abundance, and dominance of weed species. Likewise, the composition of weed species was not the same between crop stages. weed growth, population density, and distribution vary from place to place depending on soil and climatic factors that influence weed flora and management practices. Firehun & Tamado (2007) stated that different plant stages, soil types, and locations had different weed communities (<60%). Differences in the altitude of sugarcane fields, climate, soil type, and management practices applied by growers were thought to be the causes of the difference in the distribution, abundance, and dominance of weed species. Sarmah (2019) analysis the similarity of weed communities in various plant ecosystems in the Jorhat District India, noted that the highest similarity (0.79%) was found in the weed community of mixed winter vegetable crop fields with greengram/blackgram crop fields, followed by mustard and greengram/blackgram (0.65%), rice and greengram/blackgram (0.57%), mustard and mixed winter vegetables (0.56 %), and between potato and greengram/black (0.29%).

Of all weed species present in the dry site, 54.55% have the potential to be used as medicinal plants (IVI 34.25%), 24.24% as feed (IVI 56.68%), and 21.21% as edible plants (IVI 9.07%). Based on the number of species, weeds in the dry site having the potential medicinal use were the most dominant, followed by having potential feed use and having food potential use. However, based on the IVI, weeds in dry site having the potential feed use were of the highest IVI, followed by having the potential medicinal use and having the potential food use. Weed species with potential medicinal use consisted of: *Digitaria ciliaris* (Retz.) Koeler; *Lophatherum gracile* Brongn.; *Vernonia cinerea* Less; *Ageratum conyzoides* L.; *Euphorbia prunifolia* Jacq.; *Euphorbia hirta* L.; *Flemingia strobilifera* (L.) W.T. Aiton; *Hedyotis diffusa* Willd; *Richardia brasiliensis* Gomes; *Chrysopogon aciculatus* (Retz.) Trin; *Synedrella nodiflora* (L.) J. Gaertner; *Tephrosia purpurea* (L.) Pers.; *Hedyotis corymbosa*

L.; *Cyperus rotundus* L.; *Portulaca oleracea* L.; *Hyptis capitata* Jacq; *Anredera cordifolia* (Ten.) Steenis; *Amaranthus spinosus* L, and *Lantana camara* L. (Liu *et al.*, 2022, Panda *et al.*, 2018, Pinto *et al.*, 2008, Firmansyah *et al.*, 2016). Weed species with feed potential included: *Panicum repens* L.; *Ischaemum timorense* Kunth; *Brachiaria decumbens* Stapf; *Zoysia matrella* (L.) Merr.; *Calyptocarpus vialis* Less.; *D. ciliaris*; *Tephrosia purpurea* (L.) Pers., and *Portulaca oleracea* L. Weed species with the potential food use included: *Passiflora ligularis* Juss.; *Lophatherum gracile* Brongn.; *Synedrella nodiflora* (L.) J. Gaertner; *P. oleracea*; *Anredera cordifolia* (Ten.) Steenis; *A. spinosus*, and *Calyptocarpus vialis* Less.

Of all weeds species present in the wet site, 40.54% had been previously recorded as being used as medicinal plants (IVI 51.36%), 35.14% as feed (IVI 22.94%), and 24.32% as edible for humans (IVI 25.712%). Based on the number of species, weeds having the potential medicinal use were the most dominant, followed by having potential feed use and having food potential use. However based on IVI, weeds in wet site having the potential medicinal use were of the highest IV, followed by having the potential food use and the potential feed use. Species with the potential medicinal use consisted of: *Bolboschoenus maritimus* L. Palla; *Cyperus rotundus* L.; *Fimbristylis miliacea* (L.) Vahl; *Eclipta prostrata* L.; *Ageratum conyzoides* L.; *Ludwigia adscendes* L.; *Alternanthera sessilis* L.; *A. spinosus*; *Monochoria vaginalis* (Burm. f.) C. Presl; *Phyllanthus urinaria* Linn; *E. hirtai*; *Cynodon dactylon* (L.) Pers; *Paspalum scrobiculatum* L.; *Cyperus difformis* L, and *P. oleracea* (Nantana and Chayan 2014, Panda *et al.* 2018, Kandwal *et al.* 2011). Species with potential feed use included: *Eleusine indica* L. Gaertn; *Axonopus compressus* (Sw.) P. Beauv; *Echinochloa colona* L. Link; *C. dactylon*; *Leptochloa chinensis* L. Ness; *Dactyloctenium aegyptium* (L.) Willd; *Axonopus compressus* (Sw.) P. Beauv; *Digitaria ciliaris* (Retz) Koel; *Echinochloa crus-galli* L. P. Beauv; *P. scrobiculatum*; *Echinochloa colona* L. Link; *C. difformis*, and *P. oleracea*. Species with the potential food use included: *Commelina benghalensis* L.; *E. prostrata*; *A. sessilis*; *A. spinosus*; *M. vaginalis*; *P. scrobiculatum*; *E. colona*; *C. difformis*, and *P. oleracea*. The weed species with the potential food use mostly belong to broadleaves, with their leaves being used as vegetables. Thus, despite being generally considered nuisance to humans, especially in relation to agricultural management, weed species also have the potential to be used by humans for various purposes. Some weed species were also beneficial to the environment and agriculture by improving soil fertility and structure and providing cover to protect soil from erosion. Weed roots that are strong and spread quickly will also help to reduce soil erosion. The well managed weeds can also prevent the soil from becoming dry, cracked and brittle to allow plants to grow. Some types of weeds are also useful for providing shelter for beneficial insects in agriculture that help in the pollination process and pest control as natural enemies.

Of all weeds species found in both the dry and the wet sites of agricultural lands in West Timor, based on the number of species, 47.54% had medicinal, 29.69% had

feed, and 22.77% had food potentials. Based on the IVI, 42.80% had medicinal, 39.81% had feed, and 17.39% had food potentials. Based on the number of species, weeds in the dry site having the potential medicinal use were the most dominant, followed by those having the potential feed use and the lowest, the potential food use. However, based on the IVI, weeds having the potential feed use were the most dominant, followed by those having the medicinal and the food potentials. Based on the number of species, weeds in the wet site having the potential medicinal use were the most dominant, followed by those having feed and food potentials. However, based on IVI, weeds having the medicinal use were the most dominant, followed by those having food and feed potentials. The dry site tends to be dominated by weeds having feed and medicinal potentials, while wet site tends to be dominated by weed having medicinal and food potentials, while those with feed potentials were relatively limited. Based on the IVI, the number of weeds in wet site having feed potential was lower than that in dry site. This is most likely related to the dominance of sedges in the wet site which are generally not preferable as livestock feed.

The research of Nithya & Ramamoorthy (2015) on the composition and diversity of weed flora in five rice fields in Villupuram District, Tamilnadu, India showed that 51% of weeds were commonly used to cure various diseases such as colds, coughs, fever, liver complaints, kidney stones, wound healing, diabetes, toothache and others. Of the 56 species of weeds they found, there were 29 species that were commonly used by the community, of which 48.2% of the species were used overall as medicinal plants, 24% of the species were used as a combination of roots and leaves, 10% of the species were used as a combination of roots, bark, and seeds, 6.8% of the species were used as a combination of leaves and fruit, and 3.5% of the species were used as a combination of roots, seeds, bulbous, and tubers. Although weeds were often thought to be harmful, most of them were useful for human being. A large number of weeds were consumed by animals as feed or consumed by humans as a food or medicines. Weeds help the poor landless farmers to obtain fodders for their animals and green vegetables for their household economy. Many weeds are good-quality forage plants as they meet most of the recommended values for cattle maintenance (Dora *et al.*, 2008). Ngawit & Farida (2022), after studying the potential of weed as raw material for feed for integrating cattle with coconut plantations, found that the most widely used weed group as animal feed was the Poaceae family. More than 10 species of weeds from Poaceae family they found fell into the livestock preference level category from liked to very very liked. Whereas weeds from the Cyperaceae group were underutilized and in some samples were not utilized at all. Six species of Poaceae [(*Ottobloa nodosa* (Kunth) Dandy, *Axonopus compressus* (Sw.) P.Beauv., *Panicum conjugatum* (P.J.Bergius) Roxb., *Paspalum distichum* L, *Digitaria sp.*, and *Panicum repens* L.], as well as six broadleaf weed species, [*Calopogonium*

caeruleum (Benth.) C. Wright, *Desmodium scalpe* DC, *Mucaena pruriens* (L.) DC., *Mimosa pudica* L, *Hyptis capitata* Jacq., *Asystasia intrusa* (Forssk.) Blume, and *Crotalaria striata* DC)] found in the intensively managed coconut plantation had a very high palatable value within the the category of preferred to very preferred by cattle.

The research of Yuliana & Ami (2020) in a post-maize planting field in Penggaron, Mojowarno, Jombang, Java, listed 23 weed species, of which 13 species were having the potential to be used for various human needs, including food, herbal medicines, and feed. Weed species used as food included *Amaranthus viridis* L., *Amaranthus hybridus* L., *Cucumis sativus* L. and *P. oleracea* and those used as herbal medicine included *Peperomia pellucida* (L.), *Cyperus rotundus* L., *Heliotropium indicum* L., *Eleusine indica* (L.) Gaernt, *Ageratum conyzoides* L., and *Phyllanthus urinaria*. According to Lestaridewi et al. (2017), the benefits of using medicinal plants were very high within the economic situation of the community. The use of traditional medicine will save the cost of life because the basic materials for traditional medicine can be obtained easily in nature. Treatments using herbal medicines are also cheaper, safer and do not have side effects such as those of modern medicines. The use of weeds as animal feed has also been practiced for a long time by local communities. According to Michiels *et al.*, (2000), all types of Poacea were palatable for ruminants. Awaludin & Masurni (2003) added that the weeds of *Asystasia gangetica* (L.) T.Anderson and *Paspalum conjugatum* P.J. Bergius, were palatable for cattle. Gaol & Mudita (2023) found in the grasslands of West Timor that of the 134 herbaceous plants species present, based on the number of species, weed with the potential medicinal use (77 species, 67.46%) were most dominant, followed by food use (43 species, 31.34%), fodder use (23 species, 17.16%), and ornamental use (14 species, 10.45%).

For thousands of years, humans have relied on various plant species, including those categorized as weed, to cure illnesses. In the past, most villages had shamans or wise elders who could treat various ailments in everyday life. Since only recently have humans become more dependent on pharmaceutical drugs to maintain health and treat disease. However, traditional communities remain relied on traditional herbs in treating various medical conditions and to this day there are still many plants used in herbal medicine, especially in Asia and Europe, or as ingredients. In Mexico, more than 20 weeds were used for herbal medicines (Linares & Aguirre, 1992). In local Korean markets, 112 wild plants were sold at higher prices than cultivated species. In addition, eleven species (some of which are weeds) were exported to the US and used to prepare Korean and Chinese specialties (Pemberton & Lee, 1996). Likewise, Moroccan weed was exported for the same purpose to the United States, Spain, Italy and Greece (Tanji & Nassif, 1995). More than 24% of the 700 weeds registered in Mexico were edible and of the 320 exotic weeds recorded in northwestern Patagonia,

Sout America, 90 species (28%) were edible (Rapoport & Brión 1991). The Mexican Weed Catalog lists 168 species of edible weeds of which 36.3% were perennial and 63.7% were annual and/or binal. Likewise, in Argentina, 160 species of weeds were edible, of which 35.0% were perennial and 65.0% were annual or binal (Marzocca *et al.*, 1976). Finding new alternative food is becoming increasingly urgent in the future as the world population is expected to continue to grow. Thinking about how the food system can be improved to feed more people in the future is crucial, including looking for alternative food sources. Weeds can be the food of the future because weeds are easy to grow, rich in nutrients, and taste good. More importantly, finding weed species as food will diversify diet out of only 120 plant species grown for human food, nine of which account for three-quarters of our plant-based energy intake.

CONCLUSION

This research concluded that in the context of weed management, the seven most dominant weed species present in West Timor (*P. repens*, *B. maritimus*, *A. sessilis*, *C. rotundus*, *D. ciliaris*, *C. elatus*, and *I. timorensis*) need special attention to avoid the detrimental impact of these weeds in agricultural management practices in the future. Apart from that, six weed species (*D. ciliaris*, *C. rotundus*, *P. oleracea*, *E. hirta*, *A. conyzoides*, and *A. spinosus*) also need special attention as those weeds are thought to have greater tolerance and wider distribution compared to other weed species present. Although weeds are commonly known as nuisance plants, most weed species found on West Timor have the potential use for various human needs (based on IVI, 42.80% have the potential medicinal use, 39.81% have the potential feed use, and 17.39% have the potential food use). The potential value of those weed needs to be studied in the future to reveal their use as alternative source of medicine and food, as the demand for medicine and food will increase in line with the increasing population in the future.

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