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Weed Availability as A Ruminant Forage Source on Coffee Farmers' Land in Kandang Village, Indonesia

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ABSTRACT: The study aimed to calculate the availability of weeds as a source of forage for livestock in coffee farmers' land, Kandang Village, Seberang Musi District, Kepahiang Regency, Indonesia. The study employed the survey approach, with observations in the field and a questionnaire distributed to 81 families as the research sample. The research sample comprises 42 hectares of land. Weed samples were collected on a 1 m x 1 m square plot. The 17 squared plots were set randomly on the research site to identify weed species, production, nutrient content, and land-holding capacity of ruminants. The results of the study showed that there were 14 types of weeds in the field, namely *Setaria plicata*, *Asystasia gangetica*, *Imperata cylindrica*, *Mikania micrantha*, *Crassocephalum crepidioides*, *Arachis pintoi*, *Kyllinga monocephala Rottb.*, *Digitaria adscenden*, *Peperomia pellucida*, *Ageratum conyzoides*, *Chromolaena odorata*, *Borreria alata*, *Clidemia hirta*, and *Mimosa pudica*. Weed production was estimated at 26.4 tons/ha/year. Five types of weeds contain good nutrition to be used as feed for ruminants. The weeds were *S. plicata* with water content (11.87), ash (7.11), fat (0.50), protein (11.15), crude fiber (26.43); *B. alata*, water content (9.52), ash (8.92), fat (1.66), protein (13.14), crude fiber (19.67); *C. crepidioides*, water content (15.80), ash (21.03), fat (1.47), protein (19.46), crude fiber (9.37); *M. micrantha*, water content (11.40), ash (6.53), fat (2.08), protein (12.93), crude fiber (17.35) and *A. gangetica*, water content (11.405), ash (9,135), fat (1,635), protein (13,645), crude fiber (23,91). The land-holding capacity of ruminants reaches two livestock units per year.

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KEYWORDS: animal feed, ruminant livestock, weed production, weed nutrition content, livestock holding capacity

INTRODUCTION

Plants are often classified as either valuable or hazardous. Humans have grown or purposely planted profitable plants because they have promising economic value. Plants that do not want to exist are known as weeds. Another definition of weeds is plants with unknown benefits, leading people to consider that weeds have a negative value higher than their economic value. Natural pasture is the primary source of livestock feed in Indonesia. However, it cannot fulfill the nutritional requirements of the animals, particularly during the dry season, due to poor management and their inherent low productivity and quality.

Feed is one of the most critical parts of a livestock's life. Forage is animal feed made from fresh plants, specifically grass, and legumes. Forage serves as the primary feed for livestock containing the nutrients required to meet basic life needs and reproduce. Forage contains various nutrients required by animals, including crude protein, crude fiber, nitrogen-free extract materials, and minerals. Feed for livestock is commonly grown in the yard of a house and around cattle barns in the tropics. Most forage used for livestock feed is derived from native grasses, legumes, or cultivation (planted). Fiber feed and reinforcing feed are the two types of animal feed. Forage, specifically legumes and grass, is fibrous feed, whereas concentrate is supporting feed. Most of Indonesia consists of areas with important livestock and agriculture development potential. Some farmers and ranchers prefer forage that grows in the shade around the garden or on agricultural lands, such as field grass or weeds. However, some breeders or farmers already have forage land for feed planted with cut grass, and legumes are also commonly found in plantations or on agricultural land. Tropical forage often has significant levels of crude fiber, protein, phosphorus, and varying degrees of anti-nutrients. Green

fodder supply in the tropics varies widely according to geography, weather, temperature, water availability, soil quality, and sunlight. Forage is vital because it is the main component, especially for ruminants (Patriani and Apsari, 2022).

Forage is the primary feed for ruminants and is essential for the success of livestock production, particularly meat and milk, in Kandang Village. Kandang Village, which covers an area of 4,000 ha, is located in a hilly area at an altitude of 460-700 m above sea level. Most of the area's topography is hilly and has many hillsides (Central Bureau of Statistics of Kepahiang Regency, 2018). Kandang Village is the center of coffee plantations and weeds as a source of forage for livestock growing in the shade of coffee plants. Weeds that grow in coffee fields can help farmers meet their livestock's demands for forage. The type of weed used as ruminant feed should be inventoried to calculate their availability. This animal feeds inventory effort is necessary because it provides knowledge concerning locally available feedstocks. With the availability of information, it is possible to estimate the fulfillment of ruminant forage requirements.

RESEARCH METHODS

The research was carried out from March to April 2020 in Kandang Village, Seberang Musi District, Kepahiang Regency. This research employed a direct survey method in the field. The research area was selected intentionally. Data was also gathered from the Agricultural, Fisheries, and Forestry Extension Agency, Field Extension Officers, and the Kandang Village profile.

Weed samples were collected from the field using 1m × 1m square plots. The coffee plantation area employed as a sample in this study represents 30% of the entire land area. The study was conducted on flat, slope, and steep terrain, and the observation data were then averaged. Square plots were randomly thrown 17 times at 17 coffee farm observation sites. All weeds used as a forage source in the square plot are cut. Weeds that had been cut were stored in a plastic bucket with a ten (10) kg capacity, then weighed to measure their weight.

Weeds taken from squared plots were then identified to identify species. In addition, the weeds are dried, crushed, and ground into flour. A laboratory measured the weeds' lipid, protein, and fiber composition. The following calculation is used to calculate weed production per square plot:

$$X = \frac{\Sigma xi}{n}$$

Noted:

X = Average weed production in one squared plot
Σ xi = Weed production per square plot
n = Number of squared plot

Furthermore, to calculate weed production/ha/year using the formula:

Production/ha/year = X x (frequently weed harvest) x 10.000

Noted :

X = Average weed production in one squared plo
10.000 = one Ha in m^2

Data analysis

Weed production was analyzed for its nutritional content, taking 30% of the total weed species growing on the coffee farmer's land in Kandang Village, Seberang Musi District, Kepahiang Regency. Furthermore, the capacity of livestock is calculated in Cattle Livestock Units (LU), and each LU is assumed to consume forage as much as 10% of body weight. The standard forage requirement for livestock body weight is 2-3% forage dry matter. This study used the standard feed requirement of 2.5% weed dry matter, with a body weight of 350 kg per LU.

RESULTS AND DISCUSSION

Weed Species

Table 1. Weeds type in Kandang village's coffee farmers' land

No	Weeds		
	Common name	Scientific name	Family
1.	Setaria (G)	*Setaria plicata*	Poaceae
2.	Chinese violet (BL.)	*Asystasia gangetica*	Acanthaceae
3.	Cogongrass (G)	*Imperata cylindrica*	Poaceae
4.	Bitter vine (BL)	*Mikania micrantha*	Asteraceae
5.	Fireweed (BL)	*Crassocephalum crepidioides*	Asteraceae

6.	Forage Peanut (BL)	*Arachis pintoi*	Fabaceae
7.	Nut grass (N)	*Kyllinga monocephala Rottb*	Cyperaceae
8.	Crabgrass (G)	*Digitaria ciliaris*	Poaceae
9.	Pepper elder (BL)	*Peperomia pellucida*	Piperaceae
10.	Goat weed (BL)	*Ageratum conyzoides*	Asteraceae
11.	Devil weed (BL)	*Chromolaena odorata*	Asteraceae
12.	Borreria (BL)	*Borreria alata*	Rubiaceae
13.	Soapbush (BL)	*Clidemia hirta*	Melastomataceae
14.	Mimosa (BL)	*Mimosa pudica*	Fabaceae

Source: primary data, March-April 2020. Note: G= grass, BL= broadleaf, N=nutsedge

Setaria (*Setaria plicata*) weed spreads by vegetative organs such as stolons and rhizomes. Rhizomes are creeping stems that generate new plants at each node as they grow under the soil's surface. Weed propagation through stolons and rhizomes resulted in faster weed growth, allowing it to take over the land of coffee farmers in Kandang Village. The Sum Dominance Ratio (SDR) of 36.27% shows that Setaria weeds can grow well on dry land. Setaria weeds are also highly responsive to fertilizers and water. Weeds will grow faster and be able to dominate the growing space in a fertile and wet growing environment, suppressing the growth of other types of weeds that are less responsive to nutrients and water (Mangoensoekarjo and Soejono, 2015).
Setaria, apart from growing on coffee plantations, is also found on cassava plantations (Azizu and Azizu, 2021), oil palm, cocoa and sugarcane plantations (Widiyani et al., 2023).

Chinese violet (*Asystasia gangetica*) weed has high palatability and digestibility so it can be used as feed for goats, sheep, and cattle (Grubben, 2004). Chinese violet is adapted to a wide range of water availability and shade levels. Under extreme conditions, the growth of this weed slowed (Sahid and Juraimi, 1998). Based on the nutrient balance, Chinese violet as a cover crop increased the available N, P, and K soil by 16.25%, 86.33%, and 426.99% in treatments without shade, and 13.10%, 171.06%, and 560.43% in treatments with shade 50% (Asbur et al. 2020). Humans also consume Chinese violet leaves and flowers (Eilu et al. 2003). Chinese violet was the dominant understorey plant under rubber monoculture, with a critical value index of 33.01%. The average plant biomass in rubber monoculture was 0.94 tons/ha (Muhdi et al. 2020).

Cogongrass (*Imperata cylindrica*) is very easy to grow and develop. Cogongrass belongs to the grass weed group, which is detrimental to agricultural land (Wibisono, 2011). Cogongrass grows upright with green leaves, long straight leaves, and fine hairs. Besides being used as livestock feed, cogongrass can also be used as medicine (Kusumawati, 2022).

Bitter vine (*Mikania micrantha*) is a weed with allelopathic chemicals that can inhibit the growth of neighboring plants, with a pointed tip, sharp leaf edges, a small round lower stem, a taproot, and fibers. Bitter vine prefers moist habitats, either open or shady. The leaves of the bitter vine will completely cover the tree and other plants, which disturbs plantation crops (Sankaran, 2015).

Fireweed (*Crassocephalum crepidioides*) is an aromatic herb with soft stems, with a plant height of up to 1 m. This plant is commonly found as a weed in plantations and grows wild in fertile and moist areas. The leaves, which are elongated elliptical or inverted egg-shaped with a narrow base, pointy tip, and serrated edges, have a distinctive scent. The flowers are compound flowers with heads arranged in panicles and red color at the ends. After becoming fruit, the tubers are green with orange-brown to brick-red tips, nodding and upright (Badrunasar and Santoso, 2016). According to Murdiono et al. (2018), 19 weed species in the Arabica and Robusta coffee plantation in Kalibendo, Banyuwangi, Indonesia, including fireweed. Aside from being used as animal feed, fireweed also has potential as a medicine (Samiha, 2019).

Forage peanut (*Arachis pintoi*) is a plant that is closely related to the peanut plant (*Arachis hypogea*). This plant is also tolerant of high Al saturation and can adapt well to low soil fertility and very acidic pH. Furthermore, forage peanut is shade tolerant up to 50% of the time, and their growth is better and faster during the rainy season (Fanindi et al., 2012). In addition to being used as animal feed, forage peanuts can also be used as a cover crop for controlling weeds on plantations (Santos et al. 2013; Santos et al. 2014).

Nutsedge (*Kyllinga monocephala Rottb*) is commonly seen in open fields with direct sunlight. The grass is green and has small white flowers. Nutsedge is an invasive weed that typically infests lawns, vegetable and flower gardens, and home landscapes. They can be challenging to remove, and control will likely take a long time. Nutsedges are distinguishable from grasses by their triangular or V-shaped stems, whereas grass stems are hollow and round. Their leaves are thicker and stiffer than other grasses and are arranged in threes at the base. The leaves of nutsedge are creased, with noticeable mid-veins. Established nutsedge plants can also flourish in moist soil. They spread through small tubers, creeping rhizomes, or seeds. Conversely, nutsedge has medicinal values and other economic uses (Sarwar et al. 2011).

Crabgrass (*Digitaria* ciliaris) is an annual grass that grows decumbently, with roots at the nodes and spreading to form untidy patches up to 1 m across and 50 cm high. In contrast, it grows more erectly in crowded environments with culms up to 1 m

tall. The leaves can reach up to 25 cm in length and 1 cm in width. The sheaths and lower sections of the leaves are hairy on both surfaces. Membranous ligule, 1-3 mm long. The inflorescence is composed of 2-9 racemes 5-10(-15) cm long sub-digitate (the generic Latin name means 'fingers') with one or more inserted up to 1 cm below the others on a long culm that is usually much taller than the foliage. The raceme rachis can be up to 1 mm broad. The spikelets are 2.5-3.5 mm long, tapering to an acute tip, and are grouped in pairs, one sessile and the other briefly pedicelled. The lower glume is a tiny but distinct scale around 0.3 mm long; the top glume is at least half the length of the spikelet, generally nearly 3/4 the length, with three nerves. The top lemma has the same length as the spikelet and contains 5-7 nerves, with a space on either side of the central one. The lateral nerves are smooth and lack the scabrid appearance of D. sanguinalis. They vary in hairiness, with some having long hair. The top lemma is smooth with only one nerve and ranges in color from grey to light brown. Grain length 1.5-2 mm (2). D. ciliaris grows well in various soil conditions at elevations ranging from 1 to 1800 meters above sea level (Budiman et al., 1988). Crabgrass is also one of the dominant weeds in banana plantations (Eufemio et al. 2012).

Pepper elder (*Peperomia pellucida* (L.) HBK) is a weed with small annual plants that can grow up to 45 cm high. The stem is round, pale green, and slightly transparent. The weed has a single leaf, thick but soft, crosswise positioned, roughly oval with a pointy tip, heart-shaped leaf base, and light green bottom edge. The flowers are compound, 1-5 cm long, green, and positioned at the stalk's tip or in the leaf axils. It has a tiny green spherical fruit shape. The seeds of the fruit are small, stony, and brown (Syamsulhidayat and Napitupulu, 2015). Pepper elders grow well in agroforestry (Wiryono et al. 2016). Kusumawati et al. (2022) reported that pepper elder functions as medicine, food, animal fodder, and hedges/ornamental.

Goat weed (*Ageratum conyzoides*). Goat weed is a wild plant in Indonesia that is usually referred to as a weed that grows in gardens and fields. Goat weed can grow up to 1 m in height and has fine white hairs on its leaves. Goat weed flowers are small, pale purplish white flowers that resemble sunflowers and have a 5-8 mm diameter. The stems and leaves are covered with fine white hairs, and the leaves grow to be 7.5 cm long. The fruit disperses quickly, whereas the seeds are light and easily blown by the wind. (2011, Prasad). The goat weed is an invasive alien plant species (IAPS) in Nepal (Shrestha, 2016).

Devil weed (*Chromolaena odorata*). Devil weed is a particularly harmful plant because it competes with cultivated plants for water and nutrients in the soil, reducing the productivity of crops and plantation crops (Shackleton, 2017). Devil weed is highly adaptive and potentially threatens native plant biodiversity and agroecosystem sustainability (Codilla and Metillo, 2011). Devil weed, on the other hand, is beneficial to humans as a biopesticide, organic fertilizer, and medicine. Devil weed can also be used as a herbicide (bioherbicide) (Sugiyanto, 2013).

Borreria (*Borreria alata*) is a broadleaf weed that grows on Red Yellow Podzolic soil and reproduces through seed. Borreria is an annual plant in the Rubiaceae family. The taproot of borreria is hairy, the stems are rectangular, the leaves are opposite each other, the margins are flat, the surface is smooth, and the color is yellowish green. The flowers are purple, with white flowers in certain species. The plant is propagated by seed and grows in open or partially shaded areas up to 1700 m above sea level. Borreria has also been found to be invasive in agroecosystems and rangelands in Nepal (Shrestha, B.B. 2016). Borreria occurs in pastures, but cattle dislike it as a forage (Ernawati and Ngawit, 2015).

Soapbush (*Clidemia hirta*) is a shrub that grows wild in open forest environments. It is 0.5-2 m tall, woody, densely hairy or scaly, and bears sympodial branches. It has an oval leaf shape, 2-20 m long, 1-8 cm wide, flat edge, hairy, and green. This weed has compound flowers, linked petals, and hairy stamens and is 3 cm long. The fruit is oval in shape and purple in color, and it is termed buni fruit. Soapbrush has yet to be utilized, or its applications are unknown (Wiryono et al., 2016). Soapbrush consider serious invasive plants that penetrate montane rainforests on several islands (Stork and Turton, 2008).

Mimosa (*Mimosa pudica* Linn.) grows in tropical climates such as Indonesia with an altitude of 1 - 1200 m above sea level, grows in vines, or sometimes forms like a bush with a 0.3 - 1.5 m height. Mimosa grows in open, sunny areas such as roadsides, fields, and abandoned ground. The stems are hairy and thorny, with a spherical shape. The leaves are small and compound, oval with a pointed apex, and green in color (some are reddish). When the leaves are touched, they close (sensitive). The flowers are pink, spherical-like balls, and stemmed (Badrunasar and Santoso, 2016). The Mimosa is indigenous to South and Central America. Mimosa is a plant that exhibits contact sensitivity (Kumar et al., 2009) and forms a dense ground cover that inhibits the growth and reproduction of native plants by obstructing sunlight and preventing seeds from reaching the soil (Lucci, 2012).

Weed Production

Table 2. Total Weed Production

G	A (Ha)	SP	FW (kg) in…			FW (kg)	DW (kg)
			Flat area	Sloping area	Steep area		
A	5	17	4.44	5.68	0.78	10.9	2.11

B	5	17	1.93	6.95	1.80	10.68	2.07
C	5	17	2.93	6.69	0.77	10.39	2.01
D	5	17	3.35	7.20	0.69	11.24	2.18
E	5	17	4.73	4.80	0.91	10.44	2.02
F	5	17	4.33	5.00	1.44	10.77	2.08
G	5	17	6.13	4.88	0.95	11.96	2.32
H	5	17	7.18	5.25	0.83	13.26	2.57
I	2	17	7.07	4.46	0.69	12.22	2.37
Total	42	153	42.09	50.91	8.86	101.86	19.73

Note: G: Group; A: Area; SP: Number of Square Plot; FW: Weed fresh weight; DW: Weed dry weight

The results showed that fodder production on coffee producers' land was 101.86 kg, with 50.91 kg of weed production on sloping ground and 42.09 kg on flat land. According to field observations, weed growth on sloping terrain was higher than on flat or steep land. These findings are due to the irregular spacing of the coffee plants on sloping soil, allowing sunlight to infiltrate the weeds under the shade of the coffee plants. Weeds thrive as a result. Another factor is that weed control is less productive on sloping ground. Many weeds are left behind after weed control activities on sloping ground. As a result, weed growth on sloping soil accelerates. Due to the uniform spacing of coffee trees, weed generation on flat land is lower than on sloping terrain. Coffee leaves that are evenly spaced shade more weeds that grow beneath the coffee plants due to this circumstance. Weeds receive less sunlight as a result. The findings of this study support Lakitan's (2011) assertion that environmental factors, such as temperature, rainfall, and light intensity, influence forage plant growth.

The hilly land yielded the least amount of weeds, 8.86 kg. Steep land has adverse soil conditions because soil nutrients are more easily drained by rain or soil erosion, causing weeds to grow poorly. Land damage or degradation can occur due to several factors, including loss of nutrients and organic matter from root areas, salt accumulation in root areas (salinization), which is harmful substances to plants, waterlogging, and erosion (Arsyad, 2010).

The weed production calculated using the weed production/ha/year equation is 26.4 tons/ha/year. Kandang Village's coffee farmer's field is 140 hectares. Thus, weed production on coffee farmer's fields in Kandang Village is predicted to be 3,696 tons yearly. This output is determined before the rainy season. During the rainy season, weed growth can be estimated to be twice as high. Prawiradiputra et al. (2012) stated that forage production could triple in the rainy season compared to the dry season.

Weed Nutrition Content

Table 3. The approximate composition of five different species of weeds.

Weed species	Water content	Ash	Fat	Protein	Fiber	Dry matter
	%					
Setaria plicata	11.87	7.11	0.50	11.15	26.43	26.00
Borreria alata	9.52	8.92	1.66	13.14	19.67	16.74
Crassocephalum crepidioides	15.80	21.03	1.47	19.46	9.37	9.96
Mikania Micrantha	11.40	6.53	2.08	12.93	17.35	17.72
Asystasia gangetica	11.405	9.135	1.635	13.645	23.91	15.95

Source: data primer

Table 3 compares the dry weights of various species. Weeds have a dry weight that ranges from 9.96% to 26.0% of their fresh weight. According to Hartadi et al. (1991), dry matter is composed of organic stuff, specifically minerals required by livestock in sufficient quantities for bone development, as well as enzymes and hormones. According to the studies, forage contains ash in the 6.53 - 21.03% and fat in the 0.50 - 2.08% range. As a result, the mineral content of the forage ingredients is high. The ash content of a substance created from the residual combustion of organic compounds is a mix of inorganic and mineral components (Sudarmadji et al.1989).

Protein is an essential nutrient for livestock. Weeds that contain a minimum of 20% protein are classified as protein-source feed ingredients. If protein is less than 20% and crude fiber is less than 18%, weed is included in the energy source feed ingredients. The crude fiber of the five weeds varied, starting from the smallest weed in *Crassocephalum crepidioides* (9.37%) and the largest

in weed *Setaria plicata* (26.43%). Hartadi et al. (1993) state that forages are parts of plants, especially weeds used as feed, usually containing around 18% crude fiber.

The method of integration used for a specific farming system mainly depends on the type of forage crops, food crops, soil type, rainfall pattern, and other social and economic factors. By adopting strategies, which integrate livestock and cropping systems, there is considerable potential to not only increase crop yields but also increase the quantity and quality of forage for ruminant livestock. Using forage legumes frequently increases soil nitrogen available for food crops because of their ability to fix nitrogen. Generally, improved forage legumes and browse species provide a sustainable protein source, enhancing ruminant livestock productivity (Mengistu et al., 2016). the primary feed resource is crop residue which is low quality, high fiber content, and low digestibility of roughages; as a result, livestock productivity will be decreased due to malnutrition with reduced disease resistance (Birhan and Adugna, 2014).

Land Capacity for Livestock

One livestock unit requires at least 10% of the cow's body weight in fresh forage (Guntoro, 2002), or around 35 kilograms of forage per day if the livestock weighs 350 kg. According to the findings of this study, weed production in the coffee growers' fields of Kandang Village was 26.4 tons/ha/year. Thus, weed production can meet the needs of 2.06 livestock units yearly, or the equivalent of 2 cows or 14 mature goats. Mengistu et al. (2016) stated that, in general, different research studies demonstrate that integrating forage and food crops with different strategies increases the productivity and sustainability of farming systems and improves the quantity and quality of livestock feed available from such systems. Therefore, benefits from integrated forage and crop production systems are substantial, prolonged, and complementary. There are many constraints (problems) of livestock feed resources like poor quality and quantity, drought, ecological deterioration, overgrazing, land tenure/change of ownership, border conflict, weed, and bush encroachment, soil infertility, and lack of seed and planting material (Birhan and Adugna, 2014).

The feed availability varies over different seasons. Crop residues (38.9%) were found to be the major feed source in the dry season which is followed by natural pasture (30.4%), fodder trees (25.1%), and crop aftermath (5.6%). In the wet season, most respondents (95.6%) use natural pasture as a primary feed source, which is highly supported by tinned cereal crops like maize and weed materials (Biratu and Haile, 2017). In Goma, small ruminants are mainly kept for cash generation and saving in case of coffee failure. In general, sheep are the dominant and most preferred species over goats by farmers, and it was observed that most farmers with more extensive perennial cropland do not choose to have small ruminants, especially goats (Shenkute et al., 2010). Dávila-Solarte et al. (2019) stated that keeping herds of sheep grazing on weeds in coffee plantations is economically profitable, agronomically, and environmentally beneficial.

CONCLUSIONS

There are 14 types of weeds growing on the coffee farmer's land in Kandang Village, Seberang Musi District, Kepahiang Regency, with a production of 26.4 tons/ha/year and a capacity of 2 livestock units/ha/year. Analysis of the nutritional content of weeds shows that weeds growing on coffee grounds are suitable for animal feed.

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