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The Potential Forage Area in the Enclave Village of Ranu Pani

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Abstract— *Ranu Pani Village is one of the TNBTS enclave areas with an altitude of 2,337 masl and a steep slope topology (> 40%) which can cause erosion. To overcome this, the government uses an integrated farming system to protect nature from soil erosion by planting grass. The revitalization plan can be an opportunity for ruminant livestock development in the village. However, there is a lack of sustainability research on the carrying capacity of livestock. Therefore, the study is designed to assess the carrying capacity of livestock in Ranu Pani by considering the types of local plant species, the potential forage areas, and their carrying capacity. Use of the location survey method supported by facilitators and village administrators. Identification of the results of the best development patterns using the cut and transport pattern of nine local plant species from four regional sources. This village produces 276.58 ha of forage with production of DM 4,869,006 tonnes / year and CP 3,545,280 tonnes / year and produces livestock carrying capacity of 1,326.61 AU. The cut and transport pattern with an intensive care system is the best pattern. The use of land for the potential forage is still too broad. The current livestock population is only able to utilize resources as much as 8.5%. Extensification is not necessary, and is sufficient to optimize the forage production area to increase livestock population.*

Keywords— *Integration, carrying capacity, forage production, forage.*

I. Introduction

Agricultural farming and ranching in rural areas have long been used and are the backbone of sustainable economic growth for poor farmers (Wright et al., 2011). Ranu Pani Village is a traditional and tourist village in the enclave of Bromo Tengger Semeru National Park (TNBTS). In overcoming limited feed sources, Ranu Pani Farmers use feed sources from horticultural agricultural land and tropical forest areas from TNBTS. For decades, the Tengger culture has used an integrated agricultural system to enter environmental wisdom (Wimmy, 2016).

Through an integrated agricultural system, agricultural areas on the mountains' slopes have local wisdom to regulate the natural balance. Because farmers can use manure from livestock and agricultural waste can be used as animal feed. Besides, livestock can also serve as a flexible financial guarantee to replace the land lost in the productive agricultural land struggle. Also, grass can inhibit the erodibility of the field soil. The integration cycle has sustainable value in agricultural systems, as ruminants can produce meat that can be sold, manure becomes organic fertilizer, and agricultural product waste can become animal feed. The cultivation system can cover each other so that the environment is protected from the risk of soil erosion and soil erodibility (Horden et al., 2018). Some parts of the agricultural land can be planted with grass to maintain the erodibility so that they do not end up in the source, namely the Ranu Pani Lake (Reva dkk., 2018). As with using the alley harvest pattern, the soil can be protected from sedimentation (Rahmat, 2016).

The influence of government regulations on opening imported taps to live animals has caused enormous losses for smallholders in villages (Kholifah, 2019). The trend towards integrating crops and livestock in rural areas is now decreasing (Listumbinang et al., 2012). As a result, there have been many changes in the cultivation patterns in the communal agricultural area in polyculture with an intermediate cultivation pattern (Sandi dkk., 2020). Another trend is that chemical fertilizers in horticultural crops for plant growth tend to be high (Siswati and Nizar 2012). In the rainy season, the fields' hydrological holding area cannot withstand the rapid flow of water due to the slope. Some of the flowing water will seep into the ground and seep through the crevices, and some will bring sedimentation to Lake Ranu Pani. This lake is created naturally due to infiltration and downward hydrological routes. The lake is used as a source of water for the residents of Ranu Pani Village. However, fertilizer residues and solid and liquid waste make this lake unusable (Reva et al. 2019).

As part of the RPJMD (Regional Medium Term Development Plan) program, Lumajang Regency's purpose is revitalizing the watercourse in agricultural areas upstream of the lake water quality problem. Planting standing trees and or grass can reduce the erossibility of the soil (Deddy 2013). Meanwhile, farmers have an integrated farming system model strategy of the local wisdom taught by their ancestors. The potential wisdom and regulations can be an opportunity for residents to develop the livestock sector in the TNBTS enclave area. TNBTS tropical forests also support forage livestock that can be used for residents' needs (Syamsu, 2015). When related to the Ranu Pani ruminant development plan and the expansion of grass planting as above, there are various questions such as (1) how the local community practices the forage-gathering pattern, (2) whether the land-use side is still the option has to extend the grass planting, (3) What is the capacity of the Ranu Pani village area for the development of ruminants?

So far, no studies have been carried out to assess the availability of feed in the village. Therefore, the article aims to empirically measure the productivity of feed and its use, as well as the possibilities for its development in the village of Ranu Pani. The availability of such information provides an opportunity to anticipate potential obstacles in developing Ranu Pani Village as a ruminant farm.

II. Materials and Methods

A. Study Area

This research was conducted at the site of Ranu Pani Village, Senduro District, Lumajang Reign. This village is one of the enclave villages of TNBTS, which is part of the Ranu Pani Resort (area: 5,201.07 ha). The climatological condition of the village is 20 - 5 ° C, precipitation, based on the classification of climate type 2 with Q = 20, and has two seasons, namely the rainy season from October to July (342 mm) and the dry season from August to September (122 mm). The village topology is a steep hill with an average slope of 78.68% and most of the slopes in several places in the north (25.87%), east (25, 59%), south (24.41%) and west (24, 13%).

B. Data Collection

In this study, a survey method was used in which primary data (e.g. potential forage areas, cultivation patterns and number of animals) and secondary data (e.g. land use) were recorded.

The process of obtaining primary data related to ruminant farms is carried out with the participation of observations with village assistants who are local breeders with at least 5 years of experience. The selection of the village assistants was made on the basis of specific suggestions from the village chief and the head of the agricultural group. The village facilitator has the task of pointing out transection points for potential cattle feed areas and cattle sheds in the village. In addition, an interview process was conducted with key respondents made up of community leaders, village leaders, farmers group leaders, agricultural advisors, and TNBTS National Park officials.

The process of obtaining secondary data comes from previous research and the Senduro District Central Statistics Bureau.

C. Plant Classification Method

The classification in this area follows the ethnobotany approach (Arifin et al. 2014) and the measurement production follows the recommendations of the Rangeland Assessment and Monitoring Committee of the Society for Range Management, (2018). The calculation of the estimated forage production results from the area of the potential area multiplied by the percentage area of forage conversion and multiplied by the yield of the quadrant production. Estimate the total foraged production in a potential area multiplied by the number of harvests per year. The data on the usage percentage area of forage conversion follow the Laurence-Traynoe equation, (2020), which is based on statistical data of the village, previous research, phenology and the caretaker of the respondents. The data is visually analyzed on site by looking at the condition of the plant vegetation.

The job of the village facilitator is to recommend transection points for harvesting forage production. The value of feed production is calculated based on cutting and carrying activities, then production is measured per m2. This is done descriptively by randomly harvesting and weighing the feed per m2 from 20 locations. Food samples were taken in bulk samples and analyzed in the vicinity (dry matter, crude protein, total digestible nutrients) (AOAC, 2005). The analysis was performed at the Food and Feed Science Laboratory in Blitar, East Java, Indonesia.

D. Identification of Forage Species

On the recommendation of the village fasilitator on site, forage was from the activity of cut and carrying surfaces. The fasilitator also gives the name of the local forage. The plant species in the photo were created using the international botanical application Pl@ntNet such as Joly et al., (2016) to find out the Latin name of plants.

E. Carrying Capacity of Cattle

According to Rahmat, (2016), the carrying capacity is determined from the balance between feed resource production and feed demand, whereby the production of feed sources is divided by the consumption of dry matter per year. The consumption for DM and CP per year according to the Ashari equation (1995) is that for an 1 animal unit (AU) requirement is 3.650 DM (tons/year) and 1.567 CP protein (tons / year).

F. Statistical Analysis

The data analysis was carried out using the approach of Newing et al. (2011) where grasslands and diversity with a survey method using descriptive narrative analysis.

III. Results and Discussion

A. Land Use

In the enclave village area, TNBTS has at least four-zone areas, and Ranu Pani is included in zone two, namely section PTN Region III, Resort Ranu Pani with an area of 5,212.05 ha. According to Syamsu (2015), the tropical forest of National Parks (NP) adjacent to village settlements aims to maintain the protection of tropical forests and enable residents to use their natural resources for particular purposes. The area that can be used is the traditional use zone with an area for the Ranu Pani Village of 119.71 ha. The NP's conservation value in the village is the protection of the springs at the lakes Ranu Pani, Ranu Regulo, and Sumber Amprong; cause hydrological paths are in the village of Ranu Pani.

Ranu Pani Village covers an area of 3,578.75 hectares, with the largest proportion of 92.47% being the area of Ranu Pani Lake, Regulo, and public facilities. The second portion of 5.70% is the horticultural area, consisting of potatoes (36.38%), leeks (48.66%), cabbage (13.84%), and corn (1.12%). Then the rest of the residential area is 1.83%. (BPS Senduro District 2019). Elephant grass is a feed that is used in agricultural areas. It is expected that the landscape used is agricultural side area (Galengan) with two types of patterns, namely system A 60% (122.36 ha) with two galengan and B 40% (81.57 ha) with four galengan.

B. Livestock Populations

Based on the number of a peasant in the village of Ranu Pani there are 321 people, and only 20 people (6.23%) own cattle (Table I).

TABLE I. Livestock population at Ranu Pani Village

Livestock	Number (heads)	AU	Species
Beef cattle	13	11,5	Brahman cross, Simental, Ongole, Fries holland
Goats	5	0,595	kacang, etawah
Sheep	4	1,235	Fat-tail and thin-tail lamb
Total	22	13,33	

According to BPS Senduro District (2019), the livestock population had an average population of 441 heads in 2014-2018. Primary data show that the animal population has decreased by 95.02% compared to the previous year. Besides, Ranu Pani contributed 0.015% to the livestock population of the Lumajang Regency (Edi, 2020). The growth of the livestock trade can only grow by 5.91% per year compared to agriculture. The population has declined due to unstable market prices compared to more profitable agricultural prices (Kholifah, 2019).

C. Paddock Area

The paddock in Table II and Tabel III shows the area of natural resources and the amount of production per year. The paddock consists of horticultural cultivation areas (potatoes, cabbage, and maize), areas on the side of agricultural land (galengan) (elephant grass), weed grass areas, and TNBTS forest grass areas.

TABLE II. Forage area and dry metter production

Forage	Area (ha)	DM Production (Kg / ha)		Total DM	Total DM per harvest (ton / ha)
		RS	DS	(ton / ha / th)	
Elephant grass	7,35	40.365	12.330	26.348	158.085
Weed	119,71	1.223.432	235.041	729.236	2.916.946
Native grass	81,58	626.065	429.798	527.931	1.583.794
Potatoes	59,30	312.516	0	156.258	156.258
Cabbage	8,58	36.635	17.289	26.962	53.923
Maize	0,06	0	143	71	0
Total	276,58			1.466.806	4.869.006

DM = Dry Matter, RS = Rainy Season, DS = Dry Season, yr = years, ha = acres.

The integrated cultivation system in the Peddock area provides a feed production value based on Table II and Table III, which is the number of forage areas and the value of DM and CP production in two seasons (wet months and dry months) in one year. The area of potential forage is 276.58 ha with DM production of 1.466.806 tonnes / year and CP of 3.545.280 tonnes / year. The highest production in each area was TNBTS tropical forest with an area of 119.71 ha (59.90%), 81.58 ha (32.52%) of weeds, 67.94 ha (4.31%) of agricultural waste, galengan area 7.35 ha (3.24%).

The availability of forage production currently still depends on weather conditions, where the rate of decline from the rainy season to the dry season reaches 76.3% for DM production and 83.66% for CP production. Even though the feed in the paddock was unstable, the daily body weight gain (ADG) reached an average of 1.01 kg / head / day. Currently, breeders still tend to use spatial extension patterns by doing cut and carrying. The extensification pattern is a term for traditional breeders who still use forest vegetation and weeds as animal feed needs (Edi, 2020). Local breeders still use natural grass as basalt feed because natural resources are still able to produce during dry months. The living habitat of natural grass in the TNBTS national park forest is indeed high, but if it is exploited too high the natural balance will be disrupted. On the one hand, regulations prevent breeders from overexploiting. Relying on weed grass is difficult to expect, where this plant is a wild plant and is often eradicated by farmers with fungicides (Bambang and Edi 2013; I Wayan 2013).

TABLE III. Forage area and crude protein production

Forage	Area (ha)	DM Production (Kg / ha)		Total CP	Total CP per harvest (ton / ha / yr)
		RS	DS	(ton / ha / th)	
Elephant grass	7,35	28.654	8.753	18.704	112.222
Weed	119,71	855.775	64.408	510.091	2.040.365
Native grass	81,58	564.299	161.426	362.862	1.088.587
Potatoes	59,30	377.080	0	188.540	188.540
Cabbage	8,58	78.486	37.040	57.763	115.526
Maize	0,06	0	81	40	40
Total	276,58			1.138.000	3.545.280

CP = Crude Protein, RS = Rainy Season, DS = Dry Season, yr = years, ha = acres.

Ranu Pani's natural conditions also complicate the application of fermentation technology due to an altitude of 2.337 masl which affects temperature and humidity in the area (Deddy, 2013; Buton et al., 2016). This influence local farmers prefer fresh, wooded forage to be given to livestock. One of the sources of forage in the elephant grass area is focused as a place for cultivation and retaining soil erodibility (Dedi, 2013). The struggle for land for agricultural production and the lack of intense attention has made the elephant grass production level only 3.16%. In fact, this area is an important source of forage in the village. Then, agricultural waste (potatoes, cabbage leaves, and corn straw) is very perishable and the availability of forage is influenced by the growing season (6 months). The use of the integrated system has been carried out but has not been maximized because farmers' responses are still faced with risk factors (climate, temperature, and rainfall). On the one hand, agriculture must provide food quickly in order to be very resource efficient (Rina et al., 2018 and Saptan and Nyak, 2015).

D. Carrying Capacity

The value of the forage carrying capacity is calculated from the value of dry matter in Table IV.

TABEL IV. Carrying capacity of forage in each potential area

Potential Forage Areas	Forage Production (DM ton / ha / th)	*Carrying Capacity* (AU)
Galengan	158.085	43,31
National Park forest (TNBTS)	2.916.946	799,16
Weed grass areal	1.583.794	433,92
Agricultural waste areal	183.291	50,22
Total forage production	4.842.116	1.326,61

The total feed production of 4,842,116 tons / year produces one animal unit of 1.326,61 AU. The value of the animal unit (AU) is due to the potential for green forest in the national park and weed grass. Although most of the natural grass, the carrying capacity of the galengan area and agricultural waste is still able to protect the nutritional needs of livestock. Due to the high overall potential, breeders can only use 7.30% of the current 13.33 AU population. Based on Sendero Regency (2019) there were 441 people in the last five years. However, primary data show that the animal population decreases by up to 95.02%. This data is confirmed based on Edi's research, (2020) that Ranu Pani only contributed 1.05% of the population capacity in Lumajang Regency. Compared to Community Farm Growth Index. The trend of livestock growth is only 5.91%, lower than agriculture (BPS, Kabupaten Senduro 2019).

E. Local Botani

The observations show that nine species of plants are used as animal feed. This species is native to the TNBTS tropical forest area, the Galena area, and the horticultural agricultural areas, as shown in Table V with the value of their nutritional content.

TABLE V. Analyses proxymate of forages

Local name	Latin name	TDN	DM	CP	CF	Cfat
Field						
Jerabangan	*Digitaria argyrostahya*	64,17	14,90	13,43	17,92	3,76
Dewer	*Spergula arvensis L.*	66,82	38,61	14,5	31,98	1,38
Crop by product						
Cabbages	*Brassica oleracea L*	64,53	9,76	20,91	14,11	3,01
Maize stover	*Zea mays L.*	65,32	23,64	13,39	21,32	2,03
Potatoes	*Solanum tuberosum L.*	79,80	13,65	16,47	6,12	0,38
Farmyard/Galengan						
Elephant grass	*Pennisetum purpureum*	70,43	22,06	15,66	14,37	1,91
Deep Forest						
Peketek	*Isachne rhabdiana*	64,18	21,00	13,08	22,2	1,67
Dibal	*Pogonatherum paniceum Hack.*	69,60	23,79	12,2	17,59	2,24
Empritan	*Eragrostis amabilis*	68,83	31,66	9,98	22,2	1,87

It is known that in TNBTS tropical forests there are 44 types of forage that can be used for livestock (Jati et al., 2018). The three species commonly used by breeders are Isachne rhabdiana and Eragrostis amabilis, because they have more leaves with a maximum height of 5 m. Then Pogonatherum paniceum has small tall stems and soft leaves. The vegetation of natural forest forage is relatively high compared to other forests, because Alfison's soil type contains organic nutrients due to the high soil humus near Mount Semeru (Bohari and Baiq, 2015). According to Sandi (2017) the increase in organic matter is caused by the role played by insects such as Cyclocephala Castanea, Nicrophorus guttula, and Pennsylvania Ponera. The observations showed that nine plant species were used as animal feed. This species is native to the TNBTS tropical forest area, Galena area, and horticultural farming areas, as shown in Table III with the value of their nutritional content.

Weed grass comes from agricultural land after harvest. The agricultural area is not used for a month, because it is used to restore soil nutrients. Farmers allow the soil to grow weeds to provide the soil with organic nutrients. At that time the weeds were still alive. Two types of weeds live in different seasons, namely the wet season Digitaria argyrostahya and the dry season Spergula arvensis. The growth of this type of plant is relatively fast and fertile because the resulting soil still contains nutrients due to residual fertilization. Spergula arvensis species have a rich diet and fast growth, but their anti-nutritional substances, so their use for ruminants must be limited (Salvandor et al. 2012; Sundarapandian et al., 2016).

Agricultural waste is not only high in nutrition but also high in water content. Cabbage waste classification used is the leaves and stems which have a nutritional CP of 20.91% and DM 9.76%. The classification of potato waste is potato tubers that have been sorted, but are still suitable for use as animal feed. The TDN content value of potatoes was higher than other potatoes (79.80%). Corn waste is corn stalks. The DM content (23.64) of corn stalks was higher than other wastes. This straw is rarely used as animal feed because the planting time is very long, up to 10 months.

The function of the galengan area is not only as an elephant grass cultivation area but also to maintain soil erodibility and maintain sedimentation (Bambang and Edi 2013; Arif, 2013). Elephant grass is very efficient on hillside farms (Siswo et al., 2011). Elephant grass is the only grass that is cultivated. However, the extensive system without fertilization reduces the elephant grass vegetation. In addition, there is a struggle for land between forage and horticultural agriculture. The age of elephant grass is only 40 - 60 days, and in a year breeders can harvest up to three times in the galengan. Due to the high levels of nutrients in TDN, DM, and CP, the increase in these nutrients is caused by the age of the production period (Mufarihin et al., 2012).

IV. Conclusion

Ranu Pani Village has a population (beef cattle, goats and sheep) of 13.33 AU. DM production in each potential area consists of National Park forest (TNBTS) 2,916,946 tons / ha / year, Weed grass area 1,583,794 tons / ha / year, Agricultural waste area 183,291 tons / ha / year, and galengan area 158,085 tons. / ha / year. The carrying capacity of forages reaches with a potential feed of 4,869,006 DM tonnes / ha / year and 3,545,280 CP tonnes / ha / year, so it has the potential for livestock development to reach 1.326,61 AU. Then, there are nine types of forage that can be used as animal feed. The cut and transport pattern with an intensive care system is the best pattern. The use of land for the potential forage is still too broad. The current livestock population is only able to utilize resources as much as 8.5%. Extensification is not necessary, and is sufficient to optimize the forage production area to increase livestock population.

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