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Potential Ecology Suitability Distribution of Forage Availability for Dairy Cattle. Case study: Lembang District Area, West Java

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ABSTRACT

Dairy cattle have a highly depend on forage for its daily diet that will influence milk production. Therefore forage supply is the core issue in dairy farming productivity in Indonesia. Hence, it is very important in securing forage supply in order for sustainability of dairy farming. However, the forage availability is becoming rare due to the limitation of farming land owned by the farmers. The aim of this research was to determine geospatial distribution of forage availability for dairy cattle in Lembang Area, West Java. GIS software (ArcView 3.2) was used in this research. Secondary data, including maps (Land use, rainfall, slope, ect) were required in this research. As we know that the ecological suitability was the primary requirements for forage management. Moreover, the ecological suitability was assessed by criteria classification in order to achive optimum forage production. The result of map overlapping has resulted the potential ecology suitability for forage management. Furthermore, land suitability was physically divided into 4 classes; highly suitable (S1), moderate suitable (S2), marginally suitable (S3), not suitable (N) and constrain (C) that became the restriction point for forage management.

Keywords : Dairy Cattle, Forage, Geographic Information System

INTRODUCTION

In fact milk consumption increases every year due to increasing awareness of the public health. It is proofed by the data from Directorate General of Livestock Services (Ditjenak 2010) that showing milk consumption in Indonesia was 1.76 million in 2011, and this amount is predicted will continuously increase for following years. Dairy cattle highly depend on foragethat will influence not only milk production but also its quality. Forage is defined as the feed that come from the plant, formed in grass, legume, and others plant that coming from forage groups. Forage may deliver as fresh material or as fed. It's well known that the good management feeding system to improve forage consumption will raise farmer income (Chapman et al. 2007). Furthermore, it is important to secure forage availability for sustainability of dairy cattle production. There are some problems related with forage availability in Indonesia (1) unpredictable production due to the weather condition, (2) the low quality of forage produced, (3) higher land conversion, (4) limitation of land area for forage plantation. Anappropriate management systems applied will lead forage production therefore it will eventually render increase farmer's income. This is due to the reason that the cost per kg dry matter (DM) spent by farmers is lower compared to the concentrate (Johnson et al. 2008).

The availability of forage supply is no doubt required for the dairy. In simple calculation, it is assumed if a dairy cow requires at least 25 kg of fresh forage (moisture at around 87%), it will equal to 4 kg DM. However, if the size of the population reaches 445.000 heads then the amount of forage that is needed per day will be 11.125 ton which adds up to 4.060.625 ton of forage required per year (Lestari 2006). This large demand for forage forms a huge challenge for dairy farmers. However, Java Island is the center of dairy cattle farming in Indonesia, due to the suitable environmental conditions (proper temperature, humidity and others microclimate conditions). West Java province is known as the one of central production of dairy cattle and almost 50% of the total milk production in West Java is derived from dairy farms located in the sub-district Lembang (West Java). In contrast, it is noticed that West Java is one ofthe most densely populated area in Indonesia. The competitiveness both the land for human and the land for forage can't be avoided in this province. Therefore to ensure sustainability of dairy farming in Indonesia, spatial distribution of forage production should be conducted firstly. Therefore, the aim of this research is to analyze geospatial distribution of forage availability for dairy cattle in Lembang district area, West Java.

METHOD

Geographic Information System (GIS) can be used as tools for land-use, agricultural and rural development policies. By understanding geography and people's relationship to location, we can make informed decisions (ESRI 2009). Geographic Information System (GIS) is

different from other information systems due to they contain spatial data. These spatial data include the coordinates defining the location, shape, and extent of geographic objects (Bolstad 2002). GIS technology has grown rapidly to become a valuable tool in the analysis and management of spatial ecological problems (Andre et al. 2003). GIS is widely used as tools for land-use, agricultural and rural development policies (Bertaliga 2007). Spatial models, as an import tool to enhance spatial analysis ability, integrated with GIS to solve more sophisticated and special problems. Prahasta (2002) stated the GIS have the ability to combine data both in spatial data and attribute data to outcome the information that very valuable for management system associated with the location/spatial information.

This research was conducted in Lembang Sub-district, West Java province. The research spent for 4 months, since November 2011- February 2012. The location of study area could be seen on Figure 1.

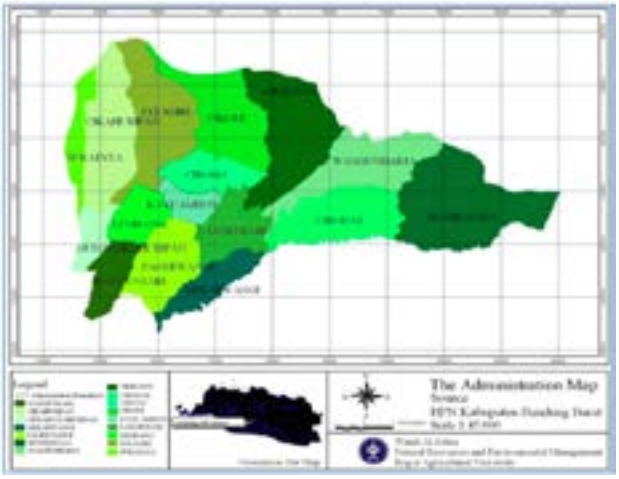

Figure 1. Location of Study

The spatial analysis was carried out to determine the ecological suitability for forage. This analysis was used software Arc View 3.2. The questioner sheets, measurement equipment for forage production, scale and measurement band were used for validation method. The secondary data were obtained from the KPSBU, Animal Livestock Services of West Bandung District (Table 1)

Table 1. Supporting data type and source

No	Data	Unit	Source
1	Base map of Lembang	-	BPN KBB
2	Rainfall map of Lembang	-	BPN KBB
3	The effective depth soil map of Lembang	-	BPN KBB
4	The elevation map of Lembang	-	BPN KBB
5	Land use map of Lembang	-	BPN KBB
6	Annual rainfall data	mm/year	BMKG
7	Temperature data	oC	BMKG
8	Dairy cattle population	heads	KPSBU
9	Milk Production	litter	KPSBU

The spatial analysis of ecology suitability for forage in Lembang was initiated by considering suitability of forage management. The ecological suitability was constructed by classified the land Suitability that has been appointed (Table 2).

Table 2. General criteria of ecological suitability for forage (pennisetum purpureum SCHUM)

Quality/ land characteristic	Critical Limits For			
	S1	S2	S3	N
Annual Rainfall (mm)	1.700-2.000	2.000-3.000	3.000-5.000	>5.000
Effective depth soil (cm)	>50	>50	30-50	<30
Slope elevation(%)	< 8	16-Aug	16-30	>30

Source : Balai Penelitian Tanah (2003)

The spatial analysis presented the suitability class for forage management. The stage of working with GIS was overlaying two polygon layers combined into a single layer analysis on every single digital mapping to obtain suitability area for forage (Figure 2). Furthermore, the using of GIS was giving probability in achieving the geographical data/geospatial data for policy analysis.

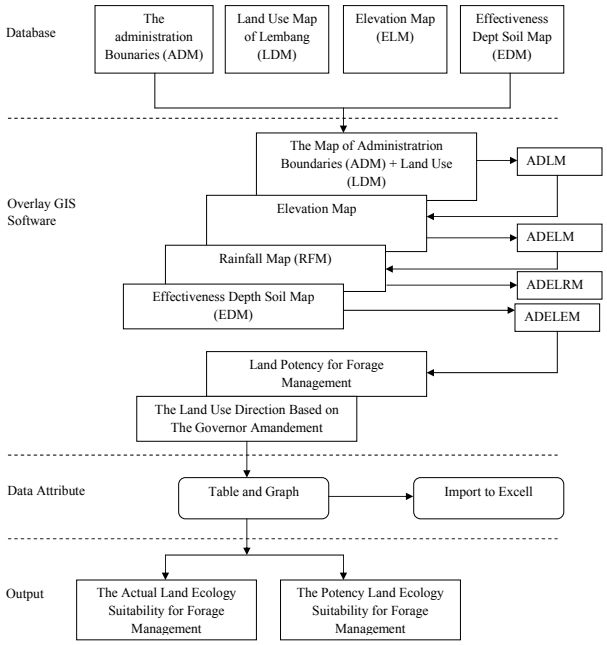

Figure 2. Flow chart in working with GIS software

RESULT AND DISCUSSION

Geographic information systems (GIS) are computerised information systems that allow for the capture, storage, manipulation, analysis, display and reporting of geographically referenced data (Sanson 1991) while forage use patterns are important influences on rangeland ecosystems (Brent 2000). Forage is the most important component in the diet of dairy cattle due to the dramatic impact on the dry matter and nutrient

Table 3. Demography data of Lembang Sub-district

No	Villages	Population		Amount	Population Density	Growth Rate (%)
		Male	Female			
1	Lembang	6,737	6,558	13,295	8.571,87	26,84
2	Jayagiri	8,347	8,299	16,646	2.043,56	0,36
3	Kayuambon	3,85	3,682	7,532	3.530,76	4,09
4	Wangunsari	4,785	4,529	9,314	2.783,39	0,94
5	Gudangkahuripan	6,121	5,759	11,88	6.927,57	14,21
6	Cikahuripan	5,183	4,874	10,057	1.171,16	1,01
7	Sukajaya	5,429	5,161	10,59	1.968,01	1,9
8	Cibogo	5,088	4,989	10,077	3.484,76	7,32
9	Cikole	5,819	5,601	11,42	1.663,72	14,8
10	Cikidang	3,638	3,57	7,208	918,28	3,68
11	Wangunharja	3,519	3,384	6,903	930,91	6,75
12	Cibodas	4,927	4,971	9,898	1.688,54	2,28
13	Suntenjaya	3,594	3,334	6,928	413,14	5,38
14	Mekarwangi	2,595	2,422	5,017	1.362,01	0,48
15	Langensari	5,603	5,587	11,19	3.182,64	0,2
16	Pagerwangi	3,953	4,17	8,123	1.973,95	0,23

consumptions required. The quality and form of forage effect to dry matter consumptions and milk produce in dairy cattle. Forage plays critical roles due to economical and environment reason. Devandra (1994) stated that the sustainability on animal livestock enterprises needed to be developed without harming the natural resources.The supply of forage highly dependent on (1) climate factors, including temperature, humidity, and annual rainfall, (2) soil fertility, (3) forage variety (4) management system, (5) environmental adaptation. The supply of tropical forage forced many problems, especially when there was a lack of nutrient soil that lead lower forage production. In addition, the different stage of forage growth might be influence.

The demography condition of the area study was showed on Villages, Population, Population Density and Growth Rate (Table 3).The major climatic factor which influences plant growth was rainfall. It accordance with the amount of water could be sullied for plant. Temperature was also very essential for forage management. It linked to the rate of photosynthesis from the land for the growth. Lembang has a tropical climate that affected by the mountainous temperature. The annual rainfall in Lembang was 2000-3500 mm/year and monthly rainfall was 150-280 mm/month. The highest rainfall was on March (576.2) and the lowest was on April (106.1 mm) in 2009-2010. The maximum temperature in Lembang was 21,1^{o}C and the lowest temperature was 19,1 ^{o}C.

Table 4. Elevation level in Lembang Sub-district

Elevation level	Total Area (Ha)
0-8%	1,53
15-25%	5,201
>45%	2,97

Source : West Bandung District in Figure (2007)

In addition, relief/slope had a dramatic role in topography condition. It connected with land management and erosion hazard for forage management, while elevation was associated with temperature and solar radiation. Topography was frequently major factor in irrigation evaluation as itsimpact to selection of irrigation method, drainage, erosion efficiency, cost of land development ect. According to the topography condition, in Lembang area, we could find many disparity elevations and slopes in the range of 0-8% to >45% (Table 4) and the height ranging from 950-1750 meter above the sea level.

Additionally spatial information is imperatively important in improving farm practices for the following decades. Land suitability evaluation and agricultural land use planning is critical for the basic information for decision making afterward. The activities in land evaluation that were specifically concerned with the choice and evaluation of cropping, irrigation and management systems (FAO 1993). The ecological suitability was the primary requirements for forage management in Lembang. The ecological suitability was conducted firstly by classified some criteria'sin order to achieve optimum forage production. The ecological suitability carried out for the land evaluation and it was completed by the overlapping analysis to obtain the ecology suitability map. It combined two polygon layers into a single layer. The layers were used Land Use 2009, Elevation Map, Rainfall Map, The Effectiveness depth soil map. Subsequently, the single layer resulted was The Potential Ecology Suitability Map. Land use of Lembang in 2009 presented that Lembang has 9748,22 Ha area. The land use of Lembang was classified into water source, shrubs, residential, field area, forest, plantation area, forage, building sectors, irrigated rice field and rain fed rice field (Table 5).

Table 5. The land use classification in Lembang on 2009

Information	Hectares
Water Source	9,796
Shrubs	365,378
Residential	986,27
Field Area	3604,141
Forest	1502,787
Plantation Area	2368,636
Foraging Area	190,284

The land evaluation conducted as the process to estimate the potency of the specific area for its utilizations. The result of land suitability described as the base map for planning. In addition, the result of overlapping obtained the potential ecology suitability for forage management. Land suitability was physically divided into 4 classes; highly suitable (S1), moderate suitable (S2), marginally suitable (S3), not suitable (N) and constrain (C) that became the restriction factor for forage management. The overlapping layers with the land use map of Lembang seen as the potential area for forage (Figure 3). Moreover, the calculation of area could be used for forage management analysis (Table 6).

Based on the GIS analysis, it could be calculated that the most probability areain Lembang used for foraging was in S2 class, with the percentage for 45.03%. The amount of constraints (C) became limitation area for almost 33.68%. There was a 11.80% area for the S1 class and 9.04% for the S3 class. Dealing with GIS analysis alsoturn out that S1 class at around 1.150,71 Ha consisted of shrubs (7.08%), forest (5.86%),plantation area (20.85%), forage plantation (6.62%), irrigated rice field (1.51%), rain fed rice field (7.10%) and field area (50.94%).

It was also detected for S2 class as 4.390,07 Ha, which consisted of shrubs (3.74%), forest (20.63%), plantation area (28.45%), forage plantation (2.15%), irrigated rice field (3.47%), rain fed rice field (3.08%) and field area (38.44%). The land evaluation of S3 was calculated at around 881.06 Ha that consisted of shrubs (6.02%), forest (12.58%), plantation area (18.64%), forage plantation (0.16%), irrigated rice field (5.76%), rain fed rice field (4.45%) and field area (52.36%). The class of N calculated for 1115.17 and it consisted of shrubs (0.51%),

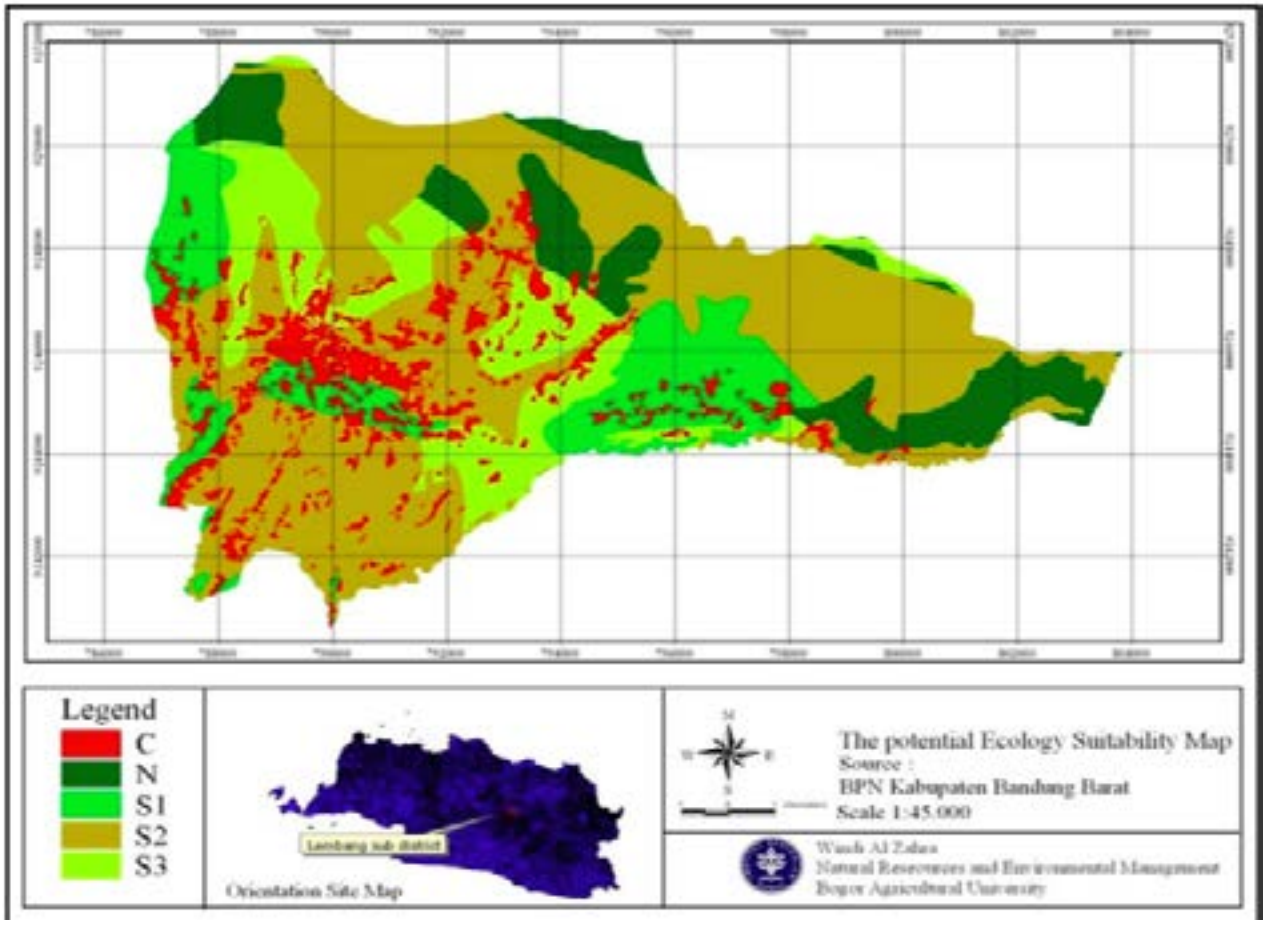

Figure 3. Potential Ecology for forage suitability

Table 6. The calculation of potential ecology area for forage suitability

No.	Land Suitability classes	Area (Ha)	Percentage (%)
1	S1	1.150,71	11,80
2	S2	4.390,07	45,03
3	S3	881,06	9,05
4	N	1.115,17	11,44
5	C	2.211,22	22,68

forest (21.06%), plantation area (38.99%), irrigated rice field (3.19%), rain fed rice field (6.73%) and field area (29.49%). The amount of restricted area (C) was measured for 2.211,22 Ha that consisted of water source (0.96%), building (1.75%) and settlement (97.27%).

Furthermore, by using the GIS analysis it could be calculated that the potency in each village in Lembang particularly. Based on data analysis, it has been identified there were 16 villages in Lembang which have different potency in forage production (Table 7).This information was very essential in supporting policy management fordecision maker in future. It has been calculated that Suntenjaya Village has the biggest potency in improving forage in S2 class (18.66%) and N class (40.83%). Sukajaya village has the biggest potency in S1 class (11.63%) and Jayagiri in S3 class (21.23%) and it found many constrain in Langesari village (11.4%) (Table 8).

The GIS analysis deals with the actual suitability for forage management. It was conducted by combining two polygon layers into a single layer; The Governor Direction Map. The single layer resulted was The Actual Ecology Suitability Map. It has been investigated that there were four classes for land suitability andone class for constrain. GIS analysis put out the class for S1 was 1.055,31 Ha which consisted of The Agriculture Wetlands (9.96%), The Agriculture Drought land (35.27%), Protection Forest (33.90%) and Plantation Area (20.87%). Theclass for S2 was 4.377,98 Ha that consisted of The Agriculture Wetlands (10.01%), The Agriculture Drought land (15.74%), Protection Forest (48.15%) and Plantation Area (26.08%). The class for S3 was 1.108,97 Ha, that consisted of The Agriculture Wetlands (11.98%), The Agriculture Drought land (34.20%), Protection Forest (39.38%) and Plantation Area (14.42%). The amount of class N was 1.105,71 that consisted of The Agriculture Wetlands (16.37%), The Agriculture Drought land (18.88%), Protection Forest (61.11%) and Plantation Area (3.62%). It was found the constraint (C) dealing with the limitation for forage management. It has been calculated that the C was 2.100,26 Ha, which consisted of the residential (84.72%), the forest conversation (15.15%) and the green open space (0.11%). In addition, it was known the potency in every village in Lembang. The actual information was very important in supporting the policy for increasing the amount of forage production in Lembang. Based on this information, it suggested the potency villages in Lembang (Table 9). Based on the GIS analysis it could be calculated that Suntenjaya Villagehas the biggest potency to improve forage in S2 class

Table 7. The potential area for ecology sustainability for forage (villages)

Villages	C	N	S1	S2	S3	Total
Cibodas	174,3	3,04	488,78	30,95	60,7	757,77
Cibogo	256,94	0,35	0	72,4	54,84	384,53
Cikahuripan	74,9	105,67	138,47	376,5	155,07	850,62
Cikidang	147,78	320,89	1,57	492,27	65,14	1027,64
Cikole	142,72	144,56	2,86	481,34	36,57	808,05
Gudangkahuripan	68,3	0	85,32	44,19	4,45	202,26
Jayagiri	171,91	18,35	0,05	505,27	222,26	917,85
Kayuambon	211,04	3,5	1,34	2,44	2,3	220,62
Langensari	268,5	0,08	5,53	62,37	137,35	473,81
Lembang	202,43	1,35	70,49	47,95	5,76	327,97
Mekarwangi	154,34	0,35	10,37	172,62	39,52	377,19
Pagerwangi	173,51	0	10,26	419,21	2	604,99
Sukajaya	53,13	7,84	168,38	42,73	0,82	272,9
Suntenjaya	31,94	488,9	5,76	819,59	25,94	1372,12
Wangunharja	20,9	20,25	153,63	578,81	61,24	834,83
Wangunsari	58,57	0,06	7,9	241,44	7,11	315,08
Total	2211,22	1115,17	1150,71	4390,07	881,06	9748,22

Table 8. The calculation of actual ecology area for forage suitability

No.	Land Suitability classes	Area (Ha)	Percentage (%)
1	S1	1.055,31	10,83
2	S2	4.377,98	44,91
3	S3	1.108,97	11,38
4	N	1.105,1	11,34
5	C	2.100,26	21,55

(11.539%) and N class (36.57%). Cibodas village has the biggest potency in S1 class (13.2%), Cikahuripan village in S3 class (21.59%) and found many constrain in Langensari (13.20%).

CONCLUSION

The spatial analysis was used to analyze ecological suitability for forage management. It was obtained the Land suitability into 4 classes; highly suitable (S1), moderate suitable (S2), marginally suitable (S3), not suitable (N) and it was found constrain (C) that became the restriction for forage management.There are some villages that can be improved for forage production such as Suntenjaya, Cibodas and Cikahuripan based on potential ecology and actual ecology suitability map. The result of this research may be use to deliver recommendationfor decision-makers in local government in determining the direction of agriculture policy in forage availability in Lembang Sub-district, West Java in particular regional development planning process, especially in calculating the carrying capacities of a region in providing forage. This is the beginning research; the model is really depending on the data input and process inside. Regarding to the conditions, it need to be improved the model in the future.

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