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The potential of cassava-goat integration in aerial and fertilizer production in Lampung

Potensi integrasi singkong-kambing dalam produksi aerial dan pupuk di Lampung

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ABSTRACT

This study aimed to evaluate the integration potential of cassava plants with goats in aerial production and goat manure-derived fertilizers. This research was conducted by purposive sampling with the consideration that Lampung Province is the central region of cassava production in Indonesia and is the region with the highest population of goats outside Java Island. Sampling was carried out in Central Lampung and East Lampung with high-production cassava and goats. Analysis using LQ, FPCI, carrying capacity, and fertilizer production from goat manure. The data obtained was then presented descriptively. The results showed that FPCI was located in Central Lampung, East Lampung, North Lampung, Tulang Bawang, and Tulang Bawang West. The highest aerial carrying capacity of cassava, 31.6%, was concentrated in Central Lampung, thereby affecting the livestock carrying capacity. LQ analysis obtained showed that around 66.7% of the area in Lampung was a goat livestock base. The highest production of fertilizer from goat manure was obtained by South Lampung, which covers around 24.5% of the total area of Lampung. The conclusion from this study was that areas that have potential for development supported by the provision of feed sourced from aerial sources from cassava plant waste if integrating cassava plants and goat livestock were East Lampung, Central Lampung, North Lampung, Tulang Bawang, and Tulang Bawang Barat districts.

ABSTRAK

Penelitian ini bertujuan untuk mengevaluasi potensi integrasi tanaman singkong dengan ternak kambing dalam produksi aerial dan pupuk asal kotoran kambing. Penelitian ini dilaksanakan secara purposive sampling dengan pertimbangan bahwa Provinsi Lampung merupakan wilayah sentral produksi singkong di Indonesia serta merupakan wilayah dengan populasi ternak kambing tertinggi di Luar Pulau Jawa. Pengambilan sampel dilakukan di Lampung Tengah dan Lampung Timur yang merupakan wilayah dengan kategori produksi tinggi baik singkong dan kambing. Analisis menggunakan LQ, FPCI, daya dukung, dan produksi pupuk asal kotoran kambing. Data yang diperoleh selanjutnya disajikan secara deskriptif. Hasil penelitian menunjukkan bahwa FPCI berada pada daerah Lampung Tengah, Lampung Timur, Lampung Utara, Tulang Bawang, dan Tulang Bawang Barat. Daya dukung aerial singkong tertinggi 31,6% terkonsentrasi di Lampung Tengah, sehingga turut mempengaruhi kapasitas tampung ternak. Analisis LQ yang diperoleh sekitar 66,7% wilayah di lampung merupakan basis ternak kambing.

Kata kunci:
Aerial singkong
Kambing
Sistem integrasi
Pertanian berkelanjutan

Produksi pupuk asal kotoran kambing tertinggi diperoleh Lampung Selatan sekitar 24,5% dari total wilayah Lampung. Kesimpulan dari penelitian ini daerah yang memiliki potensi pengembangan yang didukung dengan penyediaan pakan yang bersumber dari aerial asal limbah tanaman singkong yang mengintegrasikan antara tanaman singkong dan ternak kambing adalah kabupaten Lampung Timur, Lampung Tengah, Lampung Utara, Tulang Bawang, dan Tulang Bawang Barat.

INTRODUCTION

The development of agribusiness-based countries to face free competition needs to increase the ability to produce good products, especially livestock commodities. This situation needs support for the utilization of regional resource factors, especially livestock because it is an inherent livelihood for farmers in Indonesia. Livestock that has the potential to be developed, especially in Lampung Province, such as goats, considering that Lampung Province is an area with the largest population of goats outside Java Island. The report (DITJENPKH, 2022) states that the national goat population will be 18.9 million in 2021, while the population in Lampung Province is 1.6 million or 8.5% of the national population. The prospect of small ruminant livestock to fulfill the domestic market requires at least 5.6 million head/year taking into account the birth rate of 1.22% as a result of religious activities, as well as being open for export to neighboring countries which have not been fulfilled (BPS, 2022; Maesya & Rusdiana, 2018).

The potential for goat farming in Lampung is because it is close to market access (Java Island and other parts of Sumatera) and supports feed sources from cassava waste. The total area of cassava was 222,746 hectares, with 2021 production of 5.64 million tonnes/year and a national production of 15.73 million ton/year which accounts for one-third of national production (KEMENTAN, 2022). The ratio of the top of the cassava plant to the tubers at harvest reached 1:1 to 3:2. When 25% of the plant proportion is used as a feed from the top of the plant, it has the potential to produce 3.34 million tonnes of feed/year. Upper waste is generally highly available at any given time. Preservation technology was needed, as well as techniques to reduce cyanide, namely with silage, hay, and complete feed silage (Basri et al., 2015; Ndaru et al., 2014; Sandi et al., 2018).

Limited land, management, capital, and technology lead to low goat productivity. The main problem with the low productivity of goats was caused by the availability of feed sources, and the lack of nutritional quality, especially during the dry season. Goat productivity in Lampung was reported to be 46.58 g/head/day (Basri et al., 2015); 52.77 g/head/day (Artanti et al., 2019) lower than in other areas 98.2 g/head/day (Rudiah, 2011); 160.12 gr/head/day (Sahaba et al., 2018). Therefore, a strategy is needed to increase the productivity of beef goats by providing adequate feed in quality and quantity. Forage feed from cassava waste in the form of leaves was reported to have a crude protein content of 19.8% and a combination of leaves and stems of 12.76% (Suharti et al., 2017); ether extract of 1.8%, crude fiber of 33.7% (Fanani et al., 2022).

The management of livestock and crops by farmers tends to be sub-sectoral which runs on its own, so that income becomes less than optimal. In addition, the conversion of agricultural land due to population growth is increasing. This is a problem because of reduced productive land but the need for food continues to increase. Even though it has been controlled by Law no. 41 of 2009 concerning the Protection of Sustainable Food Agricultural Land, the area of agricultural land in 2014 from 36.89 million Ha to 34.83 million Ha in 2018 shrank by 5.6% (DPR RI, 2023; KEMENTAN, 2023). In addition to area shrinkage, cassava productivity in Lampung has also decreased from 26.4 tons/ha in 2014 to 26 tons/ha in 2018 (KEMENTAN, 2020). Cultivation of cassava in Lampung is mostly done on dry land which has a deficiency of low nutrient content. The report of Prabowo et al. (2015) was cassava farmers in Lampung sometimes do not apply the use of organic fertilizers. Even though returning crop residues as organic fertilizer to the land provides higher yields than just chemical fertilizers (Radjit et al., 2014).

Therefore, the development of efficient sustainable livestock must go hand in hand and complement each other with agriculture. The application of a system that was suitable for the

situation of farmers needed to be developed so that it became a comprehensive plan to increase motivation and optimize production and benefits (Tani, 2017). One solution that can be adopted is the utilization of regional resources by integrating goats and cassava, where cassava waste is used as goat feed while goat manure is used for fertilizer which is an important element needed by plants and improving soil nutrients. Based on the above, it is necessary to evaluate the potential of goat livestock and cassava plant integration systems in the production of aerial cassava and goat manure.

MATERIALS AND METHODS

Location and Time of Research

The research was carried out in Lampung Province in January-February 2021. Location determination purposive sampling takes into account the areas that have an average production of goat meat, the existence of cassava land which is commonly cultivated on dry land, and the highest number of goat populations outside Java Island.

Data Collection

Primary data collection of waste sampling was carried out in East Lampung and Central Lampung which are production areas located in Lampung. Secondary data sources were collected from related agencies including statistical data on an overview of the area, land potential, cassava plant resources, and livestock. Supporting data were study reports and various literature sources related to this research.

Data Analysis Methods

Analytical method of Location Quotient (LQ) which functions to determine the basis and non-base of a commodity in an area in the same sub-sector and the LQ formula used was as follows:

$$LQ = \frac{Ri/Rt}{Ni/Nt}$$

Information: Ri = value of commodity i (goat) in sub-district, Rt = total ruminant livestock sub-sector in sub-district, Ni = value of commodity i (goat) in the district, Nt = total ruminant livestock sub-sector in the district (Fanani et al., 2020).

Aerial production of cassava (stems, stalks, leaves) was cut 40 cm above the ground as well and waste carrying capacity was calculated for the production of DM, CP, and TDN of cassava aerial/ha multiplied by the cassava land and divided by the demand for animal feed for a year (Rab et al., 2016). Assuming the requirement for 1 animal unit (AU) is equivalent to an adult cow weighing 450 kg ADG 0.5 kg with a consumption of 9.1 kg DM/day (Kearl, 1982). The basis of the regional ability to produce aerial was the value of the feed production concentration index (FPCI) obtained from the district crop waste production divided by the provincial average crop waste production (Mariam & Syamsu, 2021). Regency areas with FPCI values ≥ 1 were areas that had superior production with a high category in the type of plant waste compared to other regions. Goat manure production was obtained by multiplying the number of livestock (AU) by goat feces production (kg/day), while nutrient production was obtained from the total goat manure production multiplied by each nutrient value of goat feces (%).

The data obtained was presented descriptively. This method was used to determine the character of research observations as well as a benchmark in continuing research and was the fastest analysis to describe conditions in the field (Suhardi et al., 2023).

RESULTS AND DISCUSSION

Aerial Production of Cassava Plants

Based on aerial production surveys of cassava plant waste, the average of fresh yield, DM, CP, and TDN was shown in Table 1. Data on the harvested area of cassava plant waste was calculated for the fresh yield of waste production. The total fresh yield of cassava plant waste in Lampung Province was 2.46 million tons, or an average of 11.84 tons/ha, with DM production of 677.7 thousand tons. Based on TDN production, cassava plant waste in Lampung was 380.4 thousand tons and the amount of CP production was 85.7 thousand tons. The production of CP and TDN in cassava plant waste was related to the CP content and TDN of the plant waste; therefore its use as an animal feed ingredient requires other feed ingredients. According to Kurniawan et al. (2021), that the factor that could affect livestock growth was feed. Furthermore, in animal husbandry, the availability of feed is a problem that is often encountered (Abadi et al., 2019; Wardah & Poernomo, 2020).

Table 1. Fresh yield, production of DM, CP, and TDN of cassava plant waste in Lampung

Regency	Area Size	Production				FPCI
		Fresh	DM	CP	TDN	
	ha	(tonnes/year)				
West Lampung	167	1,897	522	66	293	0.01
Tanggamus	191	2,061	567	72	318	0.01
South Lampung	4,342	47,633	13,099	1,657	7,352	0.29
East Lampung	30,776	445,552	122,527	15,500	68,774	2.71
Central Lampung	61,180	778,288	214,029	27,075	120,135	4.74
North Lampung	39,441	479,640	131,901	16,685	74,036	2.92
Way Kanan	10,870	120,957	33,263	4,208	18,671	0.74
Onion bones	21,573	242,506	66,689	8,436	37,433	1.48
offer	4,339	57,790	15,892	2,010	8,920	0.35
Pringsewu	707	7,386	2,031	257	1,140	0.04
Mesuji	1,051	12,157	3,343	423	1,876	0.07
West Onion Bones	24,507	265,844	73,107	9,248	41,035	1.62
West Coast	118	1,254	345	44	194	0.01
Bandar Lampung	68	776	213	27	120	0.01
Metro	56	784	216	27	121	0.01
Amount	199,386	2,464,522	677,744	85,735	380,417	

Note: DM= dry matter; CP=crude protein; TDN = total digestible nutrients; FPCI = concentration index of feed production.

The production of cassava plant waste for each district in the table above showed that the largest production contribution from the provinces sequentially was Central Lampung Regency with 29.21% (214,029 tons of DM), North Lampung 22.14% (131,901 tons of DM), East Lampung 18.78% (122,527 tons of DM). Nearly three-quarters of cassava plant waste production in Lampung was in these three districts. The high production of cassava plant waste was caused by the high area of cassava plants which affected the production of DM and TDN. It was further reported that aerial cassava contains CP and TDN respectively 15.3 g/100 g and 61.3 g/100 g (Fanani et al., 2022).

The results of the feed production concentration index on cassava plant waste were calculated based on DM production. The production of cassava plant waste was in the high production category in Central Lampung, North Lampung, East Lampung, Tulang Bawang, West Tulang Bawang, and the medium production category, in Way Kanan. The high FPCI value was due to the fact that the basis for the development of cassava plants was in the central part of Lampung to the east, supported by the presence of a tapioca processing factory. FPCI value ≥ 1 was an area that had a high production advantage compared to other regions (Mariam & Syamsu, 2021).

Carrying Capacity of Cassava Aerial

The carrying capacity of cassava plant waste is the ability of the region to provide feed from food crop waste, which can accommodate a number of livestock based on forage production. Carrying capacity was a comparative method utilizing forage sources (Wantasen et al., 2016). Calculating the carrying capacity of cassava plant waste was carried out using the assumption that 1 animal unit (AU) equivalent to the weight of a 450 kg adult cow which requires 9.6 kg/day of dry matter, 0.67 kg/day of crude protein and 5.1 kg/day total digestible nutrient (Kearl, 1982). The carrying capacity analysis was carried out based on the consumption of these assumptions and the availability of cassava plant waste in each region.

The results of the carrying capacity analysis are presented in Table 2. Based on the analysis of the cassava plant waste production, Lampung Province had great potential. Lampung Province could provide feed for goats in Lampung based on the carrying capacity with a DM basis of 193,420

Table 2. The carrying capacity of cassava plant waste based on the requiring of DM, CP and TDN in Lampung Province

Regency	Carrying Capacity of Cassava Plant Waste (AU)		
	DM	CP	TDN
West Lampung	149	269	157
Tanggamus	162	293	171
South Lampung	3,738	6,766	3,950
East Lampung	34,968	63,286	36,946
central Lampung	61,081	110,547	64,536
North Lampung	37,643	68,128	39,772
Way Kanan	9,493	17,181	10,030
Onion bones	19,032	34,445	20,109
offer	4,535	8,208	4,792
Pringsewu	580	1,049	612
Mesuji	954	1,727	1,008
West Onion Bones	20,864	37,760	22,044
West Coast	98	178	104
Bandar Lampung	61	110	64
Metro	62	111	65
Amount	193,420	350,058	204,361

Note: DM= dry matter; CP=crude protein; TDN = total digestible nutrients; AU = animal units.

AU or the equivalent of 1.4 million small ruminants, as well as 350,058 AU and 204,361 AU based on CP and TDN, respectively. Each carrying capacity of DM, CP, and TDN showed a different value based on livestock needs. The region that had the highest carrying capacity compared to other districts was Central Lampung with the carrying capacity of cassava plant waste based on dry matter was 31.6% of the province's availability. Meanwhile, the lowest carrying capacity of cassava plant waste in Lampung Province is Bandar Lampung City and Metro because they are administrative cities. Lampung Province had potential from plant waste of aerial cassava and strategic geography in the development of ruminants, especially goats (Bilyaro & Lestari, 2022; Fanani et al., 2020; Sirat et al., 2022; Habsari & Irwani, 2021).

The calculation between the carrying capacity of cassava plant waste (AU) and the number of goat livestock (AU) in each district was used to determine the carrying capacity index of cassava plant waste. The division of the carrying capacity index category was into 4 namely safe, vulnerable, critical, and very critical (Jumiyanti, 2018). It could be seen that the districts included in the safe category were Central Lampung, North Lampung, East Lampung, Tulang Bawang, and West Tulang Bawang. The vulnerable category was Way Kanan Regency and the rest were critical and very critical categories. Safe and critical areas were districts that were able to provide feed sources from cassava plant waste for goats so that they could still maximize the potential of cassava plant waste for livestock. Regions in the low and very low categories were because the district was not an area for developing cassava plants with more coffee, banana, and cocoa commodities which tend to dominate the central region to the south and the topography was uneven (BPS, 2022). Food crop waste was a source of feed for livestock that could be utilized, so adequate feed availability was needed to obtain optimal livestock yields (Rusdiana & Praharani, 2019; Agustono et al., 2017; Khalil et al., 2017).

Total Population of Goats and Location Quotient

The goat population in Table 3 was based on an analysis of the goat population according to the animal age and animal unit of population in the Lampung Province, which was 142,972 AU. The total goat population, which reaches 95%,

Table 3. Goat population in 2021 and LQ in Lampung Province

Regency	AT			Amount	Amount	Percentage from province	LQ
	Child	Time	Mature	(AT)	(tail)	%	
West Lampung	747	1,721	4,854	7,322	80,600	5.12	3.02
Tanggamus	1,713	3,947	11,134	16,794	184,859	11.75	3.82
South Lampung	3,359	7,739	21,831	32,929	362,469	23.03	1.40
East Lampung	1,616	3,723	10,503	15,842	174,380	11.08	0.68
central Lampung	2,700	6,219	17,544	26,463	291,293	18.51	0.46
North Lampung	666	1,534	4,328	6,527	71,852	4.57	1.12
Way Kanan	489	1,127	3,179	4,796	52,789	3.35	0.83
Onion bones	1,071	2,467	6,959	10,496	115,537	7.34	1.40
offer	502	1,157	3,265	4,924	54,205	3.44	1.22
Pringsewu	399	919	2,591	3,908	43,023	2.73	1.29
Mesuji	406	934	2,636	3,976	43,769	2.78	2.03
West Onion Bones	695	1,600	4,515	6,810	74,964	4.76	1.58
West Coast	71	165	464	700	7,705	0.49	0.45
Bandar Lampung	28	64	181	273	3,000	0.19	1.41
Metro	124	285	804	1,212	13,342	0.85	0.65
Amount	14,586	33,600	94,786	142,972	1,573,787	100	

Note: AU = animal unit; LQ=Location Quotient

was dominated by the small ruminant population. Regencies with high populations were South Lampung of 32,885 AU; Central Lampung at 22,009 AU; Tanggamus at 17,166 AU; and East Lampung at 15,090 AU.

LQ analysis was used to predict the ability of livestock commodities in a district area to serve as a base location for the same sub-sector coverage at the provincial level. Based on the comparative advantage mapping, the LQ value > 1 was obtained, for the districts based on goat livestock, such as West Lampung, Tanggamus, South Lampung, North Lampung, Tulang Bawang, Pesawaran, Pringsewu, Mesuji, West Tulang Bawang, and Bandar Lampung. Thus, it could be seen that the sub-districts in Central Lampung Regency were not the basis for goats by 33.3%. The region showed the potential as a supplier that had advantages over other regions. A high level of specialization compared to the reference area was a category in the base area (Jumiyanti, 2018; Hajeri et al., 2015). There were factors that could influence livestock development and population including environmental potential which were feed availability, socio-cultural conditions, and breeder characteristics (Ikun, 2018).

Production of Goat Fertilizer and Nutrients

The analysis of manure production from goat manure was calculated based on total goat livestock (AU) multiplied by a coefficient of 2.4 kg/AU/day, then linked to the nutrient content of nitrogen (N), phosphate (P), and potassium (K) in the fertilizer. Based on Table 4, the production of manure in Lampung was as much as 117,808 tons/year, and the production of N, P, K were 2,014.5 tons/year, 506.6 tons/year, and 801.1 tons/year, respectively. The highest district production was in South Lampung with production reaching 24.5%, followed by Central Lampung with 16.4% of provincial production.

The role of fertilizer produced from goat manure was as a source of nutrients for plants and to improve the biological condition of the soil as a growing medium (Junaidi & Tyasmoro, 2022; Hartatik et al., 2015). It was explained that the addition of organic matter was used to maintain and increase soil fertility in Lampung so that cassava productivity increased (Soelaeman & Haryati, 2012). Furthermore, the aerial waste of the cassava plant was used as goat feed, so there was a symbiosis between sub-sectors.

The application of crop-livestock

Table 4. Manure production, N production, P production, and K production

Regency	Manure	N production	P production	K production
	tons/year			
West Lampung	6,508	111.29	27.99	44.26
Tanggamus	15,038	257.14	64.66	102.26
South Lampung	28,807	492.6	123.87	195.89
East Lampung	13,219	226.04	56.84	89.89
central Lampung	19,280	329.69	82.9	131.11
North Lampung	5,447	93.14	23.42	37.04
Way Kanan	4,259	72.83	18.32	28.96
Onion bones	7,662	131.02	32.95	52.1
offer	4,178	71.45	17.97	28.41
Pringsewu	2,709	46.33	11.65	18.42
Mesuji	3,377	57.74	14.52	22.96
West Onion Bones	5,592	95.63	24.05	38.03
West Coast	590	10.09	2.54	4.01
Bandar Lampung	267	4.56	1.15	1.81
Metro	875	14.97	3.76	5.95
Amount	117,808	2,014.50	506.6	801.1

Note: N = nitrogen; P= phosphate; K = potassium.

integration was faced with two phenomena. On the one hand, agriculture was required to provide fast food, so it was highly exploratory for existing natural resources. On the other hand, there was a correction to the agricultural model, which indicates the need for sustainable agro-ecosystem-based agricultural development (Lagiman, 2020; Arham et al., 2019). The crop-livestock integration system needed to consider aspects of sustainability that were environmentally friendly, socially acceptable to the community, economically feasible, and politically acceptable (Anwar, 2022; Ningsih & Sjaf, 2015; Suhendrata, 2020). Therefore, agricultural development in an integrated manner, when carried out by farmers, would provide a synergy effect between branches of farming, such as food crops, livestock businesses and maybe even other commodities, so that the application of integration needed to pay attention on the carrying capacity of an area.

CONCLUSION

Areas that have the potential to develop goat livestock with the support of providing feed sourced from aerial sources of cassava plant waste during the integration of cassava plants and goat livestock were the regencies of East Lampung, Central Lampung, North Lampung, Tulang Bawang, and Tulang Bawang Barat.

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