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Study on cultivation of *cassava, leucaena* and *stylosanthes* grass for leaf meal production for chicken diet supplement

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Abstract

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The aim of this study was to determine leaf meal production performance and leaf meal product cost of *cassava, leucaena* and *stylosanthes* forage crops, in order to prioritize the rating of the leaf meal production for supplementation into poultry diets. The experimental forage crops were grown on up land in the north of Vietnam with an area of 500 m^2 per crop (100 m^2 x 5 replicates). The experiment was conducted in three years. The fresh biomass, fresh leaves, leaf meal productivity and the production cost of forage crops were examined. Leaf meal yield of *cassava, leucaena* and *stylosanthes* grass was respectively 9.225; 8.493 and 7.247 (tons/ha/ year). The ME yield (MJ/ha/year) was 76,434; 79,101 and 51,473, respectively. The crude protein yield (kg/ ha/year) was 1,997; 2,174 and 1,243. The production cost of 1kg DM, 1 MJ ME, 1kg CP of *cassava* leaf meals hereinafter considered as 100%, then that of *leucaena* was 95.2; 92.9 and 81.8%, that of *stylosanthes* was 142.2; 168.9 and 182.9%. With this result, the experimental crops grown for leaf meal production for chicken diet supplement were ranked in the priority order as follows: *leucaena, cassava* and *stylosanthes* grass, respectively.

Keywords: forage crops; cassava; leucaena; stylosanthes; fresh biomass; fresh leaves; leaf meal
Abbreviations: Ash*:* Total minerals, CF*:* Crude fiber, CP*:* Crude protein, DM*:* Dry matter, EAAI*:* Essential amino acid index, EE*:* Ether extract, NFE*:* Nitrogen free extract, ME*:* metabolizable energy

Introduction

In recent years, the consumers demand high quality products from poultry meat and eggs. The chicken skin must be bright yellow, the egg yolk must be dark yellow and the meat must be tasty and have a good flavor. The coloring agents (not natural nor artificial origin) which were added into diets, just increased the color of the chicken skin and darken the egg yolk but did not have any effect on the tastiness and flavor of the poultry products. On the other hand, the consumers are aware of the negative effect of these added color agents on consumer health. Therefore, study on the rich pigment content leaves in order to alter the above mentioned sources was focused. Leaf meals not only provide pigment, but also provide a considerable amount of protein and other important nutrients for farm animals. Thus, the supplement of leaf meals into poultry diets improved the growth, the feed conversion by the broiler, the yellow color of the skin and the flavor of the meat (Iheukwumere et al., 2008; Hien et al., 2008, 2013), improved laying percentage and feed utilization efficiency for egg production, improved egg yolk color and hatchability of incubated eggs (Abou-Elezz et al., 2011, Hoan et al., 2015, Hien and Trung, 2016). The inclusion of leaf meals into poultry diet does not only improve productivity but also produces safety products which has been consumer's years ago. There was a number of fodders that have been extensively studied in order to produce ruminant feeds but now the focus of studying of these fodders is for other purpose that is to produce leaf meals as the pigment and protein sources for poultry diets. In this trial, three types of forages were investigated, which were *cassava, leucaena* and *stylosanthes* with the focus on evaluation of fresh yield, leaf meal productivities and the cost of production. Based on these results, the recommendation of priority of production utilization should be made to poultry or feed industry.

Materals and Methods

Three forage crops including *Cassava* KM 94 (*Cassava*), *Leuceana leucocephala (Leuceana)*, *Stylosanthes guianensis grass* CIAT 184 (*Stylosanthes*) were used in this study. Each experimental forage crop was grown on an area of 500 m^2 (100 m^2 x 5 replicates), on up land in the north of Viet Nam.

Cassava for leaf collection

Planting, fertilizing and tending were carried out in accordance with technical recommendations for *cassava* forage crop.

Harvesting: the first leaf harvesting was done after 3.5 months after planting and *cassava* trees were cut at 40-50 cm above ground level; then the harvesting interval of 60 days during the rainy season and 75 days in the dry season. Early in the second and third year, *cassava* was cut at 30-40 cm above ground level, supplied with fertilizer to regenerate, then harvested the same as the first year.

Processing: *cassava* leaves were separated from their petioles, weighed to calculate the yield of fresh leaves, then chopped, dried, pulverized and weighed again to calculate productivity of leaf meal.

Leuceana leucocephala

Planting, fertilizing and tending were carried out in accordance with technical recommendations for *leucaena* forage crop.

Harvesting: Carried out similar to that of *cassava* for leaf collection

Processing: All harvested branches and leaves were sun dried from 10-11 am to 4-5 pm. Dry leaves were collected by beating the branches and removing stem, petioles; then were pulverized, and weighed to calculate leaf meal productivity.

Stylosanthes grass

Planting, fertilizing and tending were carried out in accordance with technical recommendations for *stylosanthes* forage crop.

Harvesting: the first cutting was done after 3.5 months after seeding, *stylosanthes* grasses were cut at about 15 cm above ground level; then the harvests were done after every 60 day interval in the rainy season and 75 day interval in the dry season.

Processing: after cutting, grasses were weighed to calculate the volume of fresh biomass, then young stems and leaves were weighed again after the old stems were removed to define useful parts for leaf meal production. The young stems and leaves were chopped and dried, ground into meal which was weighed again.

Parameters and monitoring methods

Meteorological features of the experimental area were taken from Thai Nguyen hydro-meteorological observation station. The soil nutrient composition was analyzed following Cung et al. (1998). The chemical composition of leaf meal was analyzed follows AOAC (1990). Carotenoids, β carotene and mimosine were analyzed by high pressure liquid chromatography (HPLC). Cyanhydric acid was determined follow TCPTN (2004). The fresh biomass, fresh leaves and leaf meal productivity and yield of forage crops were monitored and calculated following Hien et al. (2002).

Results and Discussion

Meteorological features

The average relative humidity (RH) of three experimental years was 81.3% and the lowest average RH was recorded in December (76.4%) and highest was in April (84.1%). The average annual temperature in the studied area was 24.2°C. The highest average monthly temperature was 29,3°C in June and lowest was found in January (14.6°C). The average rainfall recorded of the three years was approximately 1,946 mm/year. The average monthly rainfall of May, June, July, August and September was 187-342 mm/month; the other months got a very little amount of rainfall (from 13.8 to 82.5 mm/month).

The humidity, temperature and rainfall from March to November were favorable for the development of tested forage crops while from December to February of the next year; they had a negative effect on the growth and productivity of tested forage crops.

Soil nutrient composition

The soil pH is 4.52 which means the soil is acidic and has to be supplied with lime in order to increase soil pH value.

Nutrient content of the soil reached a moderate level; total nitrogen was 0.18%; total and digestible P_2O_5 were 0.09% and 23.46 mg/100 g, respectively; total and metabolic K_2O were 0.94% and 59.08 mg/100 g, respectively. However, to ensure the growth and development of the tested forage crops for a long time, before planting and seeding, we used basal fertilizers including manure, phosphorus, potassium and then adding of nitrogen after 15-20 days and after each harvest. The fertilizer amount was supplied in accordance with technical recommendations for each tested forage crop variety.

Fresh biomass productivity of experimental forage crops

Fresh biomass productivity is the volume of the whole stems, branches, leaves of forage crops (*cassava* for leaf collection, *leucaena*) or the entire stems, branches, grass leaves including hard and old parts *(stylosanthes* grass) collected in each harvest and then measured in quintal/ha/harvest.

The experimental forage crops were harvested 11 times in three years (there was no harvest from December of the first year to April of the next year). The productivity of each harvest and the average productivity of each year and of the three years were presented in Table 1.

The fresh biomass productivity of three experimental forage crops followed a rule, that the decrease of productivity from the first to the third harvest which was followed by the dramatic reduction to the fourth harvest during 3 experiment years. The productivity of the fourth harvest was significantly reduced because the nutrients in the soil was used up by the tested forages in the first, second and third harvests in addition to the unfavorable weather condition during this time of the year.

The average biomass productivity in the second year and the third year was different from that in the first year amongst 3 experimental forage crops; the productivity of *cassava* was decreased by 15.7-22.0%, of *stylosanthes* grass was significantly declined by 44.0-83.2% while that of *leucaena* was increased by 10.3-14.7%. The productivity of *leucaena* grew up because that is a perennial forage crop in which its productivity increases from the second year, while that of *stylosanthes* grass reduced notably because it is short-term forage crop (2-3 years) in which its productivity fell sharply in the 2nd year and gradually died after the third year.

The average fresh biomass productivity of the 3 years (quintal/ha/harvest time) was arranged in order from high to low as follows: *cassava* (170.44), *leucaena* (153.40) and *stylosanthes* grass (142.30). The average productivity of 3 tested forage crops had significantly differences at $p<0.001$. Productivity change of tested forage crops at 11 harvest times is presented in Fig. 1.

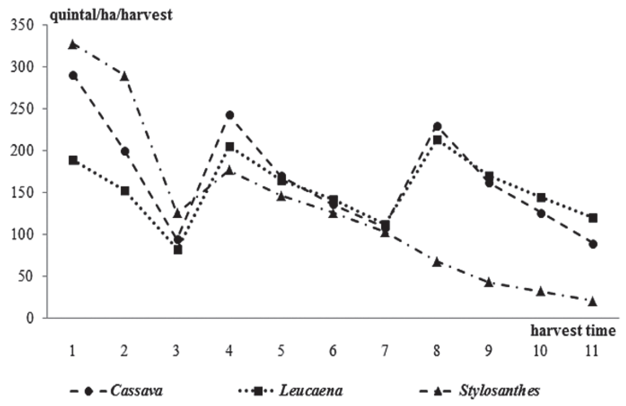

Fig. 1. Biomass productivity of tested forages at different harvests

Table 1
Fresh biomass productivity of experimental forage crops (quintal/ha/time)

Year	Harvest time	*Cassava*	*Leucaena*	*Stylosanthes*	SEM	P
1	1	290.79	188.85	326.91	4.071	0.0000
	2	199.63	152.91	289.28	3.667	0.0000
	3	94.43	83.08	125.27	1.463	0.0000
	$\bar{X}1$	**194.95 [b]**	**141.61 [c]**	**247.13 [a]**	**3.045**	**0.0000**
2	4	242.50	204.98	177.02	2.065	0.0000
	5	169.90	164.99	146.76	1.520	0.0000
	6	136.64	142.72	126.13	1.271	0.0001
	7	108.52	112.14	103.34	1.040	0.0012
	$\bar{X}2$	**164.39 [a]**	**156.21 [b]**	**138.31 [c]**	**1.452**	**0.0000**
3	8	229.97	212.92	68.36	2.549	0.0000
	9	161.77	170.25	43.68	1.963	0.0000
	10	126.00	145.20	32.51	1.638	0.0000
	11	90.18	121.12	21.33	1.348	0.0000
	$\bar{X}3$	**151.98 [b]**	**162.37 [a]**	**41.47 [c]**	**1.853**	**0.0000**
	$\bar{X}$	**170.44 [a]**	**153.40 [b]**	**142.30 [c]**	**1.521**	**0.0000**

Note: in the same row, the number carrying a different letter had a statistically significant difference

Fresh leaf productivity

Fresh leaf productivity depends on biomass productivity and the ratio between leaves and the biomass of fresh matter. The average proportion of fresh leaves/fresh biomass of the three forage crops were arranged in order from low to high as follows: *cassava* (47.48%), *leucaena* (50.97%), *stylosanthes* (69.56%). This rate of *cassava* and *leucaena* was lower than that of s*tylosanthes* grass because they contained stems and petioles which were unable to be used for the production of leaf meal while most parts of *stylosanthes* grass were useful except a small old part.

Based on biomass productivity in Table 1 and the ratio of leaves/biomass collected in all harvests, the productivity of fresh leaves of the experimental forage crops was identified as follows:

As shown in Table 2, the average fresh leaf productivity of 3 years (quintal/ha/harvest) ordered from high to low as follows: *stylosanthes* grass (98.99), *cassava* (80.92), and *leucaena* (78.19). The average fresh leaf productivity of three experimental forage crops was significantly different ($p < 0.001$) in each year, and of 3-year overall.

Fresh leaf productivity and fresh biomass productivity of tested forage crops have the significant correlation ($R = 99\%$) and was expressed by following equation:

Cassava $Y = -0.05065 + 0.4750x$
Leucaena $Y = -0.005009 + 0.5097x$
Stylosanthes $Y = -0.001130 + 0.6956x$

where Y is the fresh leaf productivity, x is biomass productivity.

Leaf meal productivity

Leaf meal productivity depends on fresh leaf productivity and the ratio between leaf meal and fresh leaf. The average ratio of leaf meal/fresh leaves of the three crops in 3 years were arranged from high to low as follows: *cassava* (31.50%), *leucaena* (29.42%), and *stylosanthes* grass (21.40%). It can be inferred from these results that to produce 1 kg of leaf meal, it is necessary to have 3.17 kg of fresh *cassava* leaves, 3.40 kg of fresh *leucaena* leaves or 4.67 kg of fresh *stylosanthes* grass. The ratio of fresh leaves/leaf meal has a close relationship with the rate of DM in leaves. If the leaves have high rate of DM, the rate of fresh leaves/leaf meal will be lowered and reverse. We have analyzed the content of DM in fresh leaves of the three experimental forage crops and got the results as follows: *cassava* (28.52 %), *leucaena* (27.06%), *stylosanthes* (19.74 %). These results explained the above ratio of fresh leaves/leaf meal.

Fresh leaves after being dried until containing only 10% moisture, was ground into leaf meal product. Leaf meal productivity was measured by quintal/ha/harvest. Based on fresh leaf productivity in Table 2 and ratio of leaf meal/fresh leaf mentioned above, the leaf meal productivity of each year and the average value of the three years were calculated and presented in Table 2.

Results presented in Table 2 has revealed that the mean value of leaf meal productivity (quintal/ha/harvest) for 3 years ranked in order from highest to lowest was: *cassava* (25.49), *leucaena* (23.00) and *stylosanthes* grass (21.18). The average leaf meal productivity of the first, second and third years and of the three years had significantly differed among the three tested forage crops ($p < 0.001$).

Leaf meal productivity and fresh leaf productivity of 3 tested forages have the significant correlation ($R = 99\%$) and was expressed by the following equation:

Cassava $Y = 0.000565 + 0.3150x$
Leucoena $Y = 0.001881 + 0.2942x$
Stylosanthes $Y = 0.0019411 + 0.2140x$

where Y is the leaf meal productivity, x is fresh leaf productivity.

The relationship between: fresh leaf productivity – biomass productivity, leaf meal productivity – fresh leaf pro-

Table 2
Fresh leaf and leaf meal productivity of the experimental forage crops (quintal/ha/time)

Year	*Cassava*	*Leucaena*	*Stylosanthes*	SEM	P
*Fresh leaf	–	–	–		
Year 1	92.56	72.18	171.90	2.370	0.0000
Year 2	78.05	79.62	96.21	1.033	0.0000
Year 3	72.16	82.76	28.85	0,797	0.0000
$\bar{X}$	**80.92** ^{b}	**78.19** ^{c}	**98.99** ^{a}	**1.080**	**0.0000**
*Leaf meal	–	–	–		
Year 1	29.16	21.24	36.79	0.452	0.0000
Year 2	24.58	23.42	20.59	0.216	0.0000
Year 3	22.73	24.35	6.17	0.278	0.0000
$\bar{X}$	**25.49** ^{a}	**23.00** ^{b}	**21.18** ^{c}	**0.227**	**0.0000**

Note: in the same row, the number carrying a different letter had a statistically significant difference

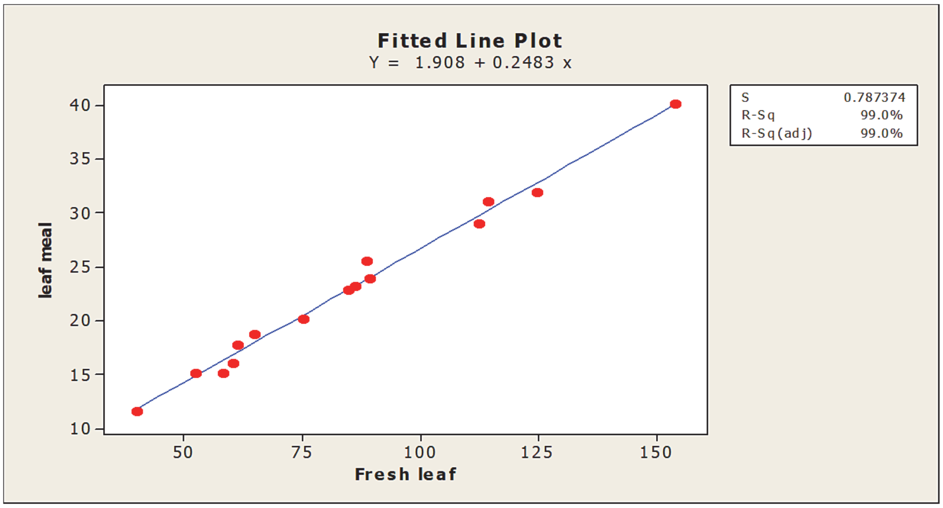

Fig. 2. The relationship between leaf meal productivity and fresh leaves productivity

ductivity have the common figure pattern of the equation y = a + bx (Fig. 2).

The production of experimental forage crops

Yields are calculated on the basis that the total productivity of harvests per ha per year or multiplication of average productivity per harvest per year with the total times of cutting per year and then converted into tons per ha per year. Biomass, fresh leaves, leaf meal yield of 3 experimental forage crops per 1 hectare per year are presented in Table 3.

Average biomass, fresh leaf, leaf meal yield of three experimental forage crop varieties have the same order (except fresh leaf) from the highest to lowest as following: *cassava, leucaena* and *stylosanthes*. Yield of biomass, fresh leaf, and leaf meals between the 3 forage crop varieties have statistically significant difference ($p < 0.001$).

The previous studies on *cassava, leucaena* and *stylosanthes* are with the focus on the biomass production for ruminants. This study has the different focus – on the production of leaf meals to supplement into chicken diets. However, the input materials still the green biomass of the forages. The higher green biomass yield gave the higher leaf meal yield and vice versa. The previous studies revealed that the green biomass yield (tons/ha/year) in the first 2 years of *cassava* was from 26.9-52.5 tons (Hoan et al., 2011) to 45.7-56.7 tons (Hien and Trung, 2016), that of *leucaena* – 31.3-55.0 tons (Quang et al., 2011), that of *stylosanthes guianen*sis CIAT 184 – from 55.0-88.1 tons (Ba et al., 2013) to 66.7 tons (Vien, 2015). In this trial, the average green biomass yield of the first two years was similar or even higher than previously reported. This proved that the 3 forage crop varieties have been adapted to the soil, the regional meteorological

Table 3

The production of experimental forage crops (ton/ha/year)

Targets	*Cassava*	*Leucaena*	*Stylosanthes*	SEM	P
*Fresh biomass					
Year 1	58.485	42.483	74.139	0.340	0.0000
Year 2	65.756	62.484	55.324	0.102	0.0000
Year 3	60.792	64.948	16.588	0.565	0.0000
$\overline{X}$	**61.678** [a]	**56.638** [b]	**48.684** [c]	**0.139**	**0.0000**
*Fresh leaf	–	–	–		
Year 1	27.769	21.654	51.571	0.338	0.0000
Year 2	31.221	31.848	38.483	0.105	0.0000
Year 3	28.864	33.104	11.539	0.231	0.0000
$\overline{X}$	**29.285** [b]	**28.869** [c]	**33.864** [a]	**0.070**	**0.0000**
*Leaf meal	–	–	–		
Year 1	8.747	6.371	11.036	0.050	0.0000
Year 2	9.835	9.370	8.235	0.016	0.0000
Year 3	9.092	9.739	2.469	0.085	0.0000
$\overline{X}$	**9.225** [a]	**8.493** [b]	**7.247** [c]	**0.021**	**0.0000**

experiments, the fertilizer application, technical procedure recommendations, and harvesting intervals. Moreover, it allowed us to confirm that the leaf meal yield in this trial was confident.

Chemical composition of leaf meal

The several mainly compositions

The several mainly compositions of the leaf meal including dry matter (DM), crude proteins (CP), ether extract (EE), crude fiber (CF), nitrogen free extract (NFE) and total minerals (Ash) were analyzed. The results of chemical analysis were presented in Table 4. They show that the 3 leaves meals types were rich in crude protein. The proportion of crude protein in leaf dry matter (% DM) of experimental forage crops ranked in order from the highest to the lowest content were: *leucaena* (27.83%), *cassava* (23.91%) and *stylosanthes* (18.59%), whereas, the fiber content was in another way around, *stylosanthes* (31.21%), *cassava* (14.69%) and *leucaena* (8.43%). High proportion of fiber in *stylosanthes* is an obstacle to the efficiently use of this leaf meal into chicken diets.

Compare to the CP content recommendation standard in broiler diet of Ross broiler breeder (2013), Arbor Acres (2012) and NRC (1994), this CP content in dry matter of 3 tested forages is completely adequate to the CP content in diet for laying hens, but for the broiler the CP content of *stylosanthes* did not meet requirement for starter diet and for the pullets. The ME content in dry matter basic of 3 tested forages was lower in order to meet the requirement for ME content in broiler and layer diets. Therefore, in order to include these leaf meals into diets, it's necessary to add vegetable oils to compensate for the shortage of energy content in the leaf meals.

Amino acid ratio in crude protein

The total of 17 amino acids in the leaves of each tested forage were analyzed. Table 5 presents the chemical analysis of 10 essential amino acids and essential amino acid index (EAAI). The data show that the amino acid content in dry matter basic and in protein tended to be as follow: that content of *cassava* was higher than that of *leucaena* and that of *leucaena* higher than that of *stylosanthes*. This content has effect on protein quality. The EAAI of *cassava*, *leucaena* and *stylosanthes* protein was 92.26; 83.18 and 74.13%, respectively.

Table 4
Chemical composition of leaves (%)

Indexes	DM	CP	EE	CF	Ash	NFE	ME(1) MJ
*Fresh leaf	–	–	–	–	–		
Cassava	28.52	6.82	2.16	4.19	2.72	12.63	2.61(2)
Leucaena	27.06	7.53	1.27	2.28	2.55	13.43	2.74(2)
Stylosanthes	19.74	3.67	0.43	6.16	1.90	7.58	1.52(2)
*Leaf DM	–	–	–	–	–	–	–
Cassava	100	23.91	7.57	14.69	9.54	44.29	9.15(3)
Leucaena	100	27.83	4.69	8.43	9.42	49.63	10.12(3)
Stylosanthes	100	18.59	2.18	31.21	9.62	38.40	7.70(3)

Notes: (1) ME in chicken; (2) Mj/kg fresh leaves; (3) Mj/kg DM of leaves.

Table 5
Several essential amino acids content in tested forages

Amino acid	***Cassava***		***Leucaena***		***Stylosanthes***		**Chicken egg(1)**
	% DM	% CP	% DM	% CP	% DM	% CP	% CP
Lysine	1.45	6.06	1.38	4.96	0.93	5.00	7.23
Methionine	0.61	2.55	0.34	1.22	0.30	1.61	3.45
Tryptophan	0.49	2.05	0.56	2.01	0.35	1.88	1.65
Histidine	1.94	3.93	1.16	4.17	0.79	4.25	2.09
Agrinine	1.44	6.02	1.65	5.93	0.72	3.87	6.22
Leucine	1.95	8.16	2.23	8.01	0.86	4.63	8.96
Isoleucine	1.53	6.40	1.71	6.14	0.97	5.22	7.87
Phenylananine	1.08	4.52	1.25	4.49	0.68	3.66	5.99
Threonine	1.12	4.68	1.28	4.60	0.84	4.52	5.09
Valine	1.07	4,47	1.20	4.31	0.78	4.20	7.23
EAAI		92.26		83.18		74.13	100

(1): Schutte and De Jong (2013)

The lysine, methionine and tryptophan contents in DM of *cassava* met the requirement for the content of these amino acids in broiler and layer diets at all stages. Whereas this content of *leucaena* is just adequate for lysine, but this content of *stylosanthes* was shortage all three amino acids to meet requirement. Thus, when include *leucaena* and *stylosanthes* leaf meals into diets, it's necessary to add these shortage amino acids.

Other chemical compositions

Carotenoids, β carotene, cyanide, mimosine, calcium and phosphorus were analyzed (Table 6). Data present in Table 6 showed that there was rich content of carotenoids and β carotene. This is the scientific fundamental for the utilization of these leaf meals as the pigment sources for poultry diets.

There were HCN content in *cassava* leaves and mimosine content in *leucaena* leaves. However, *cassava* and *leucaena* supplement ratio was just very low, it was 2-4% for broiler diet and 6-8% for layer diet. With these supplement ratio, the toxic content level was lowered than limited allowance. Thus, these toxins had no negative effect on animal performance as well as animal health.

Calcium content in the tested leaf meals is larger than that of phosphorus. It is good for balancing the Ca/P ratio in the animal diets, because grain meals in the diets have this ratio on the contrary.

Nutrients production and production cost

The DM yield ranked from the highest to the lowest as follow: *cassava, leucaena, stylosanthes*. Because the ME and protein contents in *leucaena* leaf meal were higher than that in *cassava* leaf meal therefore the ME and protein yields has the difference in ranking. The highest was from *leucaena* followed by *cassava* and the lowest was still *stylosanthes.*

The cost of production included: seeds, plantation stems, fertilizer, care, harvesting, processing. The cost for harvesting and processing accounted for the majority cost of production. These 2 expenses for *stylosanthes* was the highest, that of *leucaena* was the lowest. Thus, the total cost of production per ha per year of *stylosanthes* was the highest and that of *leucaena* was the lowest. Based on this information it can be seen that the cost for production of 1MJ ME and 1kg CP in *leucaena* was the lowest, followed by *cassava* and the highest production was that of *stylosanthes.*

For *cassava*, apart from leaves production, *cassava* roots were harvested at the 3rd year. This extra income had made the cost production of *cassava* leaf meal cheaper.

Conclusions

The tested forages such as *cassava, leucaena, stylosanthes* were well adaptable with the environmental conditions at the tested areas. They showed the best growth and gave high green biomass yield. The leaf meal yield (ton/

Table 6
Other chemical compositions

Indexes	Unit	*Cassava*	*Leucaena*	*Stylosanthes*
Carotenoids	mg % DM	87.6	84.2	59.6
β carotene	mg % DM	34.8	23.8	25.7
Cyanide	mg % DM	30.9	–	–
Mimosine	g % DM	–	1.05	–
Calcium	g % DM	1.20	1.75	1.87
Phosphorus	g % DM	0.53	0.27	0.22

Table 7
Nutrients production per 1 ha per year

Indexes	**Unit**	***Cassava***	***Leucaena***	***Stylosanthes***	**SEM**	**P**
***Yield**	–	–	–	–		
DM	Kg	8.352 a	7.812 b	6.685 c	0.179	0.0000
ME	Mj	76.434 b	79.101 a	51.473 c	0.327	0.0000
CP	Kg	1.997 c	2.174 a	1.243 b	0.107	0.0000
***Cost comparison**	–	–	–	–		
Cost/ha/year	%	100 b	89.1 c	113.8 a	2.691	0.0008
1 kg DM	%	100 b	95.2 c	142.2 a	3.261	0.0000
1 Mj ME	%	100 b	92.9 c	168.9 a	3.812	0.0000
1 kg CP	%	100 b	81.8 c	182.9 a	4.132	0.0000

Note: DM, ME, CP yields were calculated base on fresh leaves yield/ha/year ha/year) of *cassava, leucaena, stylosanthes* was 9.225 tons, 8.493 tons and 7.247 tons, respectively. The ME yield (MJ/ ha/year) were 76,434; 79,101 and 51,473. The crude protein yield (kg/ ha/year) were 1,997; 2,174 and 1,243. If considered production cost for 1 MJ ME and 1kg CP of cassava as 100% then the cost production for 1 MJ ME of *leucaena stylosanthes* was 92.9 and 168.9% respectively, and that of 1kg CP was 81.8 and 182.9% respectively. Based on the findings of nutrient yield and cost production of 1 MJ ME and 1kg CP the recommendation on production priority was followed: *leucaena, cassava* and the last was *stylosanthes.*

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