Utilization of Feed Resources in Relation to Nutrition and Physiology of Ruminants in the Philippines

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Abstract

During the last decade, the population of cattle and water buffaloes in the Philippines declined while the goat population showed an increasing trend. Ruminants subsist mainly on vegetation from open grasslands and forested areas, agro-industrial by-products, crop residues and weeds from idle or vacant lots. The supply of feeds for ruminants, however, is relatively adequate during the rainy season but once the dry season sets in, it becomes scarce especially in terms of quality.

To correct the problem, R and D activities were directed towards the utilization of crop by-products and farm residues. Rice straw, being abundant, is most studied. Feeding trials determined the growth and physiological responses of animals fed treated (by physical, biological and chemical means) crop residues. Legume supplementation to poor quality roughage was also implemented. Grazing trials, on the other hand, determined animal performance on pastures that were either fertilized or overseeded with legumes with or without mineral supplementation.

To date, however, technologies generated towards the improvement of nutrition and physiology of ruminants are not well adopted by farmers. Hence, future R and D efforts are directed to the development of low cost technologies and dissemination of existing technologies.

Introduction

In the Philippines, the bulk of the ruminant population is in the hands of smallholder raisers. Feeding is primarily based on available fibrous crop residues or whatever grasses there are in the farm and grazing on idle lands or communal pastures. Concentrate is rarely used for economical reasons. Livestock production technologies are generally traditional and cash inputs minimal. As such, productivity of the animals is considerably low.

Local beef and milk supply is insufficient. The country produces only about 2% and 40% of its milk and beef supplies. The gaps are being filled by importation. In 1989, it is estimated that about $228 million worth of dairy products and $16.36 million worth of beef were imported.

It is quite ironical because the country has a favorable climate for fodder production, while crop residues and fibrous feeds are abundant and offer a cheap source of ruminant feeds.

Ruminant population

From 1980-1990, the cattle and carabao population exhibited a downward trend while the

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Table 1 January 1st inventory by animal type, Philippines, 1980–1990

(,000 Head)

Year	Carabao	Cattle	Goat
1980	2,870	1,883	1,671
1981	2,850	1,940	1,696
1982	2,908	1,942	1,783
1983	2,946	1,938	1,859
1984	3,022	1,849	2,362
1985	2,983	1,786	2,191
1986	2,984	1,314	2,177
1987	2,865	1,747	2,016
1988	2,890	1,700	2,120
1989	2,842	1,682	2,212
1990[z]	2,765	1,629	2,193
Ave. annual growth rate	0.37	1.44	2.75

[z] Preliminary estimates
Source : Bureau of Agricultural Statistics, 1989.

goat population increased (Table 1). Carabao population shrank from 2.87 M in 1980 to 2.76 M head in 1990. Cattle population, on the other hand, decreased from 1.88 M to 1.63 M head in 1990. Goat population grew from 1.67 M to 2.19 M head. For sheep, the 1987 survey conducted by a PCARRD team reported that there were only about 7,164 sheep in the country.

The decline in the cattle and carabao population is mainly attributed to the increasing extraction rate (Table 2) due to the high demand for meat. Low productivity of the animals is another reason which can be attributed to the following problems a) production-related: nutrition, animal health and reproduction; b) support services: credit, financing, marketing, and extension: c) peace and order in the countryside.

Feed resources for ruminants

The feeding requirements of ruminants are largely supported by the open grasslands (about 7 M hectares), and forested areas (about 15 M hectares), and weeds growing along rice bunds, irrigation canals or vacant lots. Availability of feeds in these areas, however, is affected by the season of the year. Fig. 1 shows that during hot months, carabaos barely maintain their body weights (Cabaccan, 1985).

Production of crop residues and agro-industrial by-products is estimated to be 16 M tons which can support about 4 M animal units (A. U.) (Table 3). Among these, the rice straw (51.7%) and corn by-products (30.3%) are the most abundant (PCARRD, 1990).

In spite of their abundance, crop residues have not been well utilized as feed. Most crop residues are low in digestible protein, energy and certain minerals. Digestibility is also low since most of the residues originate from mature plant parts whose cell walls are highly lignified.

In many areas, ruminants graze in open grasslands dominated by cogon (*Imperata cylindrica*) and *Themeda* sp. Productivity of these areas is low as they can support only about 0.25 animal unit per hectare per year. Dry matter production, protein and mineral contents are generally low to support animal requirements for production. In the northern Philippines (Isabela), a survey of beef cattle farms showed that cattle are deficient in minerals (phosporus, potassium, magnesium, sodium, manganese, copper and zinc). Forage magnesium was insufficient for lactating animals (Nacino, 1982).

Animals are also raised under plantation crops. Besides supplementing the income of farmers from the main crop, the animals serve as "biological sweepers" and reduce the requirement for chemical fertilizer (through the feces and urine).

When fully utilized, areas under coconut plantations can support about 0.8 M animal unit per year. In the Bicol region, average daily gain of animals grazing fertilized and unfertilized

Table 2 Total number of head slaughtered by type of animal and by year, Philippines, 1980–1989

(,000 Head)

Year	Carabao	Cattle	Goat
1980	149	382	804
1981	137	382	900
1982	149	371	1,189
1983	137	331	1,337
1984	150	357	1,309
1985	155	404	1,546
1986	167	452	1,607
1987	211	481	1,799
1988	247	489	1,907
1989	270	510	2,039
Ave. annual growth rate	6.85	3.26	10.89

Source : Bureau of Agricultural Statistics, 1989.

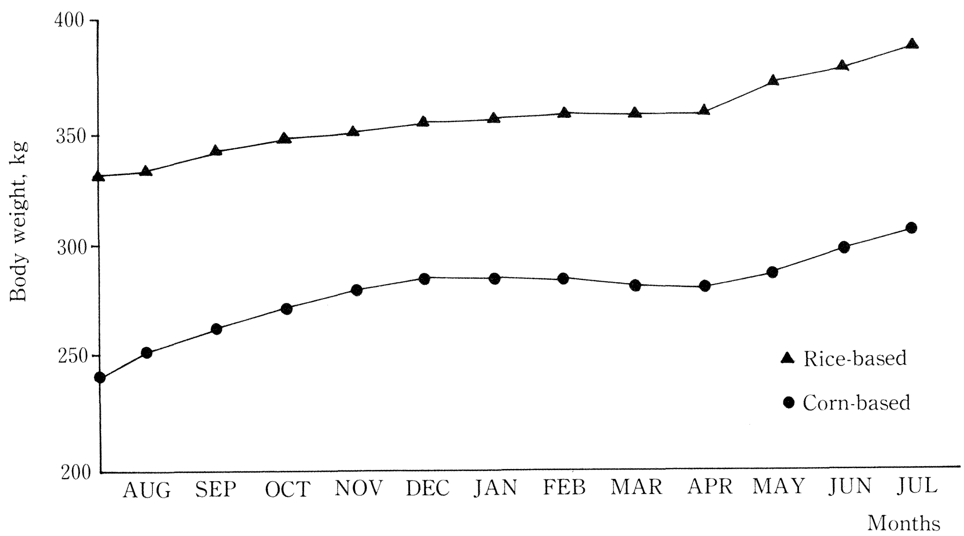

Fig. 1 Monthly body weight of draft carabao raised under two dominant cropping systems.
Source : Cabaccan, 1985.

Table 3 Crop residues/agro-industrial by-products available from different crops (1,000t)[Z]

Region	Rice straw[Y]	Corn stover and cobs[X]	Beans and peas hay[W]	Camote vine[V]	Cassava leaves[U]	Peanut hay[T]	Sugarcane tops[S]	Sugarcane bagasse[R]	Ramie leaves[Q]	Pineapple pulp[P]	Total	Carrying capacity (1.000a.u.)[O]
Ilocos	873.30	85.30	12.40	15.40	1.10	8.60	20.00	1.56		0.50	1,018.16	275.18
Cagayan Valley	1,162.10	440.80	3.70	10.40	0.40	30.20	14.00	0.68		0.45	1,662.73	449.39
Central Luzon	1,593.00	11.60	7.20	13.00	0.60	1.50	167.50	14.31			1,808.71	488.84
Southern Tagalog	932.90	300.12	3.00	17.20	4.00	3.50	175.50	21.13		23.00	1,480.35	400.09
Bicol Region	637.30	161.30	0.60	72.00	31.60	1.30	19.00	0.92		10.77	934.79	252.65
Western Visayas	148.60	63.24	5.80	16.00	4.70	2.10	705.00	73.36	0.85	2.34	1,021.99	276.21
Central Visayas	407.30	311.80	2.20	45.20	21.80	3.10	127.50	14.94	0.10	0.66	934.60	252.59
Eastern Visayas	407.30	256.90	0.40	76.80	14.60	1.80	53.00	4.27		0.94	816.01	220.54
Western Mindanao	350.40	254.80	0.90	12.80	23.50	2.10				0.43	644.93	174.31
Northern Mindanao	331.50	314.00	1.40	20.80	6.00	0.70	47.50	5.83	0.20	388.12	1,116.05	301.64
Southern Mindanao	630.00	1,516.90	6.10	20.40	3.60	0.90	30.00	2.04	4.15	358.85	2,572.94	695.39
Central Mindanao	747.50	1,101.20	4.30	7.20	13.60	1.20	12.50	0.55	0.10	0.20	1,888.35	510.38
Total	8,221.20	4,817.96	48.00	327.20	125.50	57.00	1,371.50	139.59	5.40	786.26	15,899.61	
Carrying capacity	2,221.95	1,302.15	12.97	88.43	33.92	15.41	370.68	37.73	1.46	212.50		4,297.19

[Z]Based on 1987 crop area and production data, BAS: [Y]At 1:1 grain-straw ratio: [X]At 1:1.2 grain-straw and cob ratio: [W]At 1t DM/ha: [V]At 2t DM/ha: [U]At 0.5t DM/ha [T]At 1t DM/ha: [S]At 5t DM/ha: [R]At 15% of cane produced: [Q]At 0.5t DM/ha: [P]At 40% of fruit produced: [O]At 3.7t DM per animal unit (a.u.) per year.

Paspalum pastures under coconuts was estimated at 0.46 kg and 0.28 kg, respectively. Native vegetation under coconuts in Southern Luzon during the dry season (December-April) was found to be higher in digestibility, dry matter, crude protein and calcium contents compared to those growing in the rainy season, May-December (Trung, 1990a).

R and D activities in ruminant feeding

1 Utilization of fibrous residues and farm by-products

The increasing population has diverted many grazing lands into crop production while others are converted into residential areas. To support the feed requirements of ruminants, efforts had been geared to optimize the use of abundant fibrous residues which would otherwise be burned or left to rot in the farm. Majority of the research output is on the use of rice straw.

Treatments of fibrous residues

Research efforts to improve the utilization of fibrous residues included the following treatments:

1) Physical treatments (chopping, soaking)
2) Biological treatment using fungi
3) Chemical treatments (using sodium hydroxide, calcium hydroxide, ammonia, or urea)

1) Physical treatments. Chopping and soaking rice straw had been tested with carabaos. Plain soaking increased the voluntary dry matter intake but the nutrient composition and digestibility of the rice straw did not improve (Castillo *et al.*, 1982: Roxas *et al.*, 1987). Weight gain was not also significant. Similar results were observed with chopped rice straw (Castillo *et al.*, 1982). However, reducing the particle size increased the rate of passage and removal of the digesta from the rumen. Soaking and chopping may be adaptable under field conditions because they do not require sophisticated equipment. However, benefits so far documented involve only the increase in the dry matter intake.

2) Biological treatments. Studies on biological treatments of fibrous residues are limited. Current studies at the National Institutes of Applied Microbiology and Biotechnology at UP Los Baños involve the production of cellulase and ligninase from fungi for treatment of ground corn cobs, coconut coir dust, corn stover, rice straw and sugarcane bagasse with and without pretreatment (Dalmacio and Argañosa, 1989). Economical production of enzymes and feeding studies on ruminants are yet to be done.

3) Chemical treatments. A lye solution prepared from rice straw ash was found to improve *in vitro* dry matter digestibility of rice straw treated with the lye solution (6.4%) at 1 liter/kg DM. This practice was found to be comparable with 2% sodium hydroxide used at the same rate for one week (San Pedro and Roxas, 1987).

Feed efficiency was improved when rice straw was treated with lime resulting in increased daily gain of animals. Rice straw soaked for 3 days in 3% CaO and fed to goats showed higher crude fiber digestibility and digestible energy (Dumlao and Perez, 1976). Grade Zebu bulls also showed 21 to 38% improvement in growth performance when fed lime-treated rice straw (2% CaO) at 60% of the total ration (Pacho *et al.*, 1977).

Among the chemical treatments, urea treatment particularly of rice straw appears promising. Studies on the use of urea-treated rice straws for dairy cows showed improved animal performance.

2 Concentrate supplementation of fibrous residues

Early studies dealt with supplementing crop residues with concentrate at higher levels. While satisfactory production had been attained (Table 4), the present economic situation of many smallholder farmers limits concentrate feeding to the monogastric animals. More

Table 4 Liberal supplementation of rice straw (RS) for growing and lactating ruminants

Ration/Study	DM intake % live-weight	Daily gain (g)	Feed / Gain or Milk
Philippine goat fattening, 84 days (Rasjid and Perez, 1980)			
30%RS+70% Ipil-Ipil (I)	3.16[a]	35.7[b]	12.56[b]
30%RS+50% I+20% Rice bran	3.10[a]	68.6[a]	7.65[a]
30%RS+50% I+20% molasses	1.28[a]	50.0[ab]	10.54[a]
Cattle fattening, 126 days (Sevilla, 1976)			
50%RS+50% concentrate (C)	2.74[a]	540[a]	11.51[b]
35%RS+35% I+30%C	2.84[a]	710[a]	9.36[a]
Growing heifers, yearling to calving (Trung *et al*., 1987a)			
35%RS+65%C	2.19[a]	450[a]	12[a]
35%RS+45% I and poultry manure+20%C	3.10[b]	450[a]	18[b]
Dairy cattle, first lactation (Trung *et al*., 1987b)		kg milk	
35%RS+65%C	2.70[a]	1,882[a]	1.1[a]
35%RS+45% I and poultry manure+20%C	3.50[a]	1,862[a]	1.4[a]

Note : Column means in a study without superscript are different (P<05).
Source : PCARRD, 1990.

recent studies involve feeding crop residues with limited concentrate supplementation while providing sufficient fermentable carbohydrate and nitrogen for rumen microbes.

Table 5 shows the results of studies on urea-treated rice straw (UTS) with limited concentrate supplementation using cattle. *Ad libitum* UTS plus 0.87 kg daily concentrate (15% of the total ration DM) fed to replacement heifers showed 0.30 kg average daily gain and feed efficiency of 20. With dairy replacement, UTS plus 0.66 kg daily concentrate (12.4% of total ration DM) gave 0.44 kg daily gain and 12.6 feed efficiency. For lactating cows, UTS plus 1 kg concentrate for every 3.5 kg milk produced 5.8 kg of 4% fat-corrected-milk with feed efficiency of 1.4. This feeding technology is now being tested with smallholder dairy farmers in Laguna (Trung, 1990b).

3 Other farm by-products and feed supplements

Other farm by-products evaluated included corn stover, sugarcane tops and pineapple pulp. Corn stover could constitute as much as 60% of the total ration for fattening cattle. Average daily gain would be about 0.56 kg and 15.9 feed efficiency (Perez, 1976). Ensiled sugarcane tops at 60% of the total air dry ration could produce an average of 0.41 kg daily gain with 12.6 feed efficiency (Tuazon *et al*., 1975).

Dried poultry manure (DPM) is recommended for dairy cattle feeding at 23% of the total ration. DPM can supplement rice straw-based diets of cattle from yearling to the end of first

Table 5 Dry matter intake (DMI) as percent liveweight, average daily gain (ADG, kg) and daily milk yield (DMY, kg) of cattle receiving urea-treated straw with limited supplementation

Animal/supplementation	DMI	ADG/DMY	Feed / Gain or Milk	Reference
Growing/fattening cattle				
1kg G[Z]+0.7 kg C[Y]	2.3	0.44	12	Trung *et al.*, 1988a
1kg G+0.9 kg C	2.6	0.29	20	Trung *et al.*, 1988b
Cattle milk production				
2kg G+1.5 kg C	2.2	5.80	-	Lanting *et al.*, 1988

[Z] G ; Green grass ; [Y] C ; Concentrate
Source : PCARRD, 1990.

lactation. Studies showed that the animals gave 2,055 kg milk in 273 days of lactation with a feed efficiency of 1.3. Milk composition and organoleptic tests were not affected by DPM feeding (PCARRD, 1986).

4 Legume supplementation

Compared to their temperate counterparts, tropical grasses are relatively low in protein. Tropical legumes, on the other hand, contain high levels of protein and minerals. Supplementing grasses with legumes is expected to improve the nutritive value of the feed, hence, better animal performance.

Among the legumes, ipil-ipil (*Leucaena leucocephala* Lam de wit) is widely accepted as a ruminant feed. Ipil-ipil is valued in terms of its lower cell wall content (27%), high crude protein content (24%) and high *in vitro* dry matter digestibility (about 80% for leaves).

For growing/fattening and breeding goats, ipil-ipil can be fed at a rate as high as 75% of dry matter with 25% concentrate supplementation. No adverse effects on reproductive functions were observed based on the regularity of the estrous cycle (21.2 ± 1.9 days), estrus duration (3.0 ± 1.0 days), services per conception (1.1), gestation length (146 days), kidding rate (1.5) and kid viability (79-100%) and preweaning growth rates of single and twin birth kids (Abilay *et al.*, 1981).

Use of ipil-ipil for ruminant feeding was however severely affected in 1986 when the plant was devastated by the infestation of jumping lice (*Heteropsylla cubana*). Scientists then tested alternative legume species. *Sesbania* and *Glyricidia* are among the tree legumes studied.

Sesbania forage contains about 15.4% digestible crude protein, 51.3% total digestible nutrients and a digestible energy of 2,200 ± 300 kcal/kg. *Sesbania* when used to supplement rice straw, gave significantly higher crude protein and digestible energy intakes in carabaos compared to those fed concentrates. *Sesbania* can replace part if not all of the concentrate and can be used at 30% of total dry matter intake (del Barrio, 1981).

5 Pasture inprovement

Imperata cylindrica L. Bauev (locally known as cogon) and *Themeda* species dominate the native grasslands. Dry matter production from the native pastures is low with about 0.088 ton dry matter per hectare per year (Sajise *et al.*, 1975). Native pasture can produce about 21.6 kg in Masbate and 77kg/ha/yr of beef in Bukidnon (Moog, 1986).

Studies conducted in different parts of the country showed that *Themeda* grasslands are also low in protein and deficient in minerals (Nacino 1982; Castillo *et al.*, 1988).

Fertilizer application to improve forage quality has also been evaluated. With phosphorus application, a linear increase in dry matter yield (largely due to increase in legume yield) was observed in native/stylo pasture. Carabulls grazing the fertilized pastures gained 37% more (0.37 kg/day) than those grazing unfertilized pastures (0.27 kg/day). Fertilizer application also increased the crude protein digestibility (44.02% vs 15.17%) and digestible crude protein intake (0.17 g/kg BW to 0.78 g/kg BW). However, the effect of superphosphate application to soil phosphorus and plant growth was found to be short-lived (Salces, 1990).

Significant improvements in pasture quality and animal performance had been observed with fertilizer application. However, considering the present cost of inorganic fertilizer, legume introduction in native pastures appears to be the quickest and most practical approach to improve native grasslands. This approach increases forage production and improves herbage quality, enabling the pasture to support more animals per unit area (1.0 AU vs 2.0. AU/ha). Among the legumes, centro (*Centrosema pubescens*) overseeded in native pasture gave the most stable dry matter production (PCARRD, 1991).

Future prospects in nutrition and physiology of ruminants

Current and future efforts to improve the feed resource base for the ruminants will be focused on two main areas: a) increased utilization of agro-industrial by-products at the farmer's level: b) increased technology promotion.

Increased utilization of fibrous agricultural residues is expected to contribute significantly to the productivity of the animals. Wider use of available feeds, particularly the non-conventional feedstuffs, will be carried out by conducting a larger number of on-farm trials. There is a great need to demonstrate the value of new feeds and feeding technologies since the adoption of new technologies by smallholder raisers is still low. Appropriate extension strategies and support services are also necessary.

Current efforts are aimed at increasing the adoption rates of new technologies. The National Research and Development Areas for 1900-2000 indicated a priority for the strengthening of technology promotion and transfer activities for ruminant feeding.

Emphasis should also be placed on increasing feed resources of smallholders by encouraging them to plant forage crops to sustain the productivity of their animals. Fodder tree legumes, aside from being a good source of fuel wood, can also supplement the feed requirements of the animals particularly during summer months where good quality feed is insufficient. Conservation of surplus feed should be encouraged to provide a steady supply of feed for the animals.

Considering the limitations of smallholders, the R and D efforts on feeding of ruminants will continue to focus on development of low-input technologies for ruminants. This strategy will ensure that whatever technologies generated from research stations will likely be acceptable to smallholders.

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Discussion

Kudo, H. (Japan) : Is Ipil-Ipil synonymous with Leucaena?

Answer : Yes.

Haryanto, B. (Indonesia) : How could you maintain the grass/legume ratio in the pasture?

Answer : With *Centrosema* as the introduced legume, grass/legume pasture is maintained by not allowing heavy grazing during the first 3 years after legume introduction. At this time, the *Centrosema* component is already well established and moderate to heavy grazing can be allowed.