RESEARCH AND DEVELOPMENT ON ANIMAL FEED IN MALAYSIA

M. WAN ZAHARI and H.K. WONG

Strategic Livestock Research Centre Malaysian Agricultural Research and Development Institute (MARDI)
PO Box 1230J, GPO. 50774, Kuala Lumpur

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ABSTRACT

The growth of the non-ruminant sector to self–sufficiency in meat and eggs has been matched by massive importation of feed. Thus, a major thrust to reduce the burden of feed imports is to increase the use of indigenous feed resources and intensify research to look for alternatives and substitutes. Over the past 3 decades, local researchers have reported on the availability nutritive content, optimal inclusion levels and treatment methods to enhance nutrient value of many locally available feed ingredients in practical poultry rations. The list includes evaluation and utilization of feed rice, palm kernel cake (PKC), broken rice, bran, sorghum, cassava, sago, fishmeal and commercial grain corn production; but the goal of import substitution and self-sufficiency is still unfulfilled. Although PKC, feed rice, local maize and specialty fats has potential to be viable energy feed sources and local fish meal is a promising protein feed source, more large scale Research and Development (R & D) is needed. In the ruminant sub-sector, emphasis is towards maximizing use of locally available agro-industrial byproducts and crop residues for the production of cost-effective feeds. The utilization of local feed resources is highly dependent on the supply of agro-industrial byproducts or crop residues from the oil palm and rice industries. In order to encourage a sustainable ruminant industry in Malaysia, local feed production has to be maximized and strengthened. Current emphasis is towards the development of practical and low-cost feeds for various classes of livestock species, particularly by utilizing local forages, tree fodders, crop residues and agro-industrial byproducts. This paper highlights the research and development on animal feed in Malaysia over the last three decades and discusses various aspects of livestock feeding.

Key words: Feed, resources, indigenous, ruminant, non-ruminant

ABSTRAK

PENELITIAN DAN PENGEMBANGAN PAKAN TERNAK DI MALAYSIA

Pertumbuhan sektor non-ruminansia untuk mencapai swasembada daging dan telur telah didukung oleh impor pakan dalam jumlah besar. Oleh karena itu, untuk mengurangi impor tersebut perlu peningkatan penggunaan sumberdaya pakan lokal dan mengintensifkan penelitian untuk mencari sumber bahan pengganti. Tiga dekade terakhir ini telah banyak peneliti melaporkan ketersediaan, kandungan nutrisi, tingkat pemanfaatan optimum dan teknologi peningkatan nilai nutrisi bahan pakan lokal pada ternak unggas. Diantaranya adalah evaluasi dan pemanfaatan *feed rice*, bungkil inti sawit, bekatul beras pecah, dedak padi, sorghum, singkong, sagu, tepung ikan serta biji-bijian komersial, namun upaya pengurangan impor dan swasembada belum berhasil. Meskipun bungkil inti sawit, *feed rice*, jagung lokal serta lemak merupakan sumber energi yang potensial, dan tepung ikan yang potensial sebagai bahan pakan sumber protein, penelitian dan pengembangan masih tetap diperlukan. Pada subsektor ruminansia, penekanannya adalah pada memaksimumkan penggunaan limbah agro-industri dan limbah tanaman pangan untuk menghasilkan pakan murah. Pemanfaatan bahan pakan lokal sangat tergantung pada suplai limbah agro-industri dan limbah tanaman pangan dari kawasan perkebunan kelapa sawit dan pertanian tanaman pangan. Untuk menunjang keberlangsungan produksi ruminansia di Malaysia maka perlu peningkatan produksi pakan lokal. Penekanan yang dilakukan saat ini adalah pada pengembangan pakan murah untuk semua jenis ternak, terutama melalui penggunaan pakan hijauan, legum, limbah pertanian dan limbah agro-industri lokal. Makalah ini menjelaskan tentang penelitian dan pengembangan pakan ternak di Malaysia selama 3 dekade terakhir dan membahas berbagai aspek pemberian pakan ternak.

Kata kunci: Pakan, sumberdaya, lokal, ruminansia, non-ruminansia

INTRODUCTION

The 2008 ex-farm production value of the non-ruminant sector in Malaysia was estimated to be RM 9003 millions while the ruminant subsector was valued at RM 849 millions (IDVS, 2008). Malaysia is highly dependent on feed imports especially for the non-ruminant subsector (poultry and swine) and aquaculture. Maize and soya bean meal are the main imported energy and protein feeds, respectively. The value of importation is approximately RM 2.5 billion per year of which over 50% is for maize. The dependence of this industry on imported feed is not a healthy development as it causes price fluctuations and high cost of production. Various strategies have been introduced to reduce the importation bill as about 70% of the cost of livestock production is attributed to feed. The rapid increase in global oil prices in the last three years has led to the diversion of feed grains for bio-fuel production and this has resulted in feed supply shortages and high feed prices. Furthermore, world global warming is beginning to have a negative impact on grain production.

Over the past three decades, local researchers have reported on the availability, nutritive value, optimal inclusion levels and treatment methods to enhance feeding values of many locally available feed ingredients in poultry and ruminant rations. These include evaluation and ulilization of various. agricultural byproducts and crop residues from oil palm, rice and other minor plantasion industries.

R & D on the utilization of feed resources for the non-ruminant and aquaculture sub-sector

Increased global demand of maize for livestock including those in the producing countries (example: China and United States) has partly contributed to the high cost in Malaysia. Significant price increase was observed in 2003 – 2004 at the rate of about 40% resulting in higher feed costs. Malaysia imports all the grain corn requirements, amounting to more than 2.2 million tons annually and this is growing at the rate of 10% annually. Even though the cost of maize is currently within acceptable limit, i.e., about RM 840/ tonne (Sept 2009), the need to find alternative feeds is required.

Energy sources from local feeds

Apart from locally planted maize, potential feed sources to substitute for imported maize include feed rice, PKC, rice bran, sorghum, banana, sweet potato, cassava and sago.

Feed rice

Feeding trials at MARDI show that feed rice can be used effectively in poultry diets to completely replace corn at a level of 60% in the diet. The rate of growth of the feed-rice fed broiler is comparable to those fed commercial corn-soy diets. However, supplementation with xanthophylls is recommended in the former diet in order to rectify the pale color of the chicken associated with high level of feed rice feeding. Similarly, feed rice can be used as a main energy source in diets for aquaculture.

Planting of feed rice in the "non-granary" area (approx. 73.368 hd) is estimated to produce about 550.260 tonne feed rice at the rate of 10.0 tonne padi per ha. This amount could substitute for about 25% of imported maize. Over 221.222 ha of idle land (TAN, 1998) in Malaysia could be targeted for feed rice production. Further R & D is required to increase the efficiency of feed rice production: development of better varieties, as well as improvements in agronomic practices and nutritive values to livestock. However, many related issues need to be considered. These include the economics of production which is related to subsidy allocation, incentives to the growers and feed millers, and more importantly possible competition in the rice farming area, as the country is pushing for 100% self sufficiency level in rice production for human consumption.

Palm kernel cake

Over 2 million tonnes of PKC are produced per year and 94% of the volume is exported, leaving about 120.000 tonne for local consumption. In early 2000, the price was in the range of RM 100 – RM200 per tonne. Since then, it has reached RM 660 in April 2008, partly attributed to increased demand by the export market and the domestic ruminant sub-sector. The use of PKC in poultry diet by local feed millers is very limited and inclusion level is usually less than 5%. Under the present situation, about RM 184 million in imports can be saved if quality PKC is used at the rate of 100% in poultry diets.

Bio-processed PKC has been developed by MARDI using methods which include improving the availability of energy through fungal treatment and the use of specific microbes and enzymes (WAN ZAHARI *et al.*, 2009b). Some constraints during the up-scaling process have been identified which require rectification. Inconsistencies in the quality of PKC are one of the major problems. particularly attributed to the high shell content (> 10%). Maximum inclusion level of bio-processed PKC in poultry diets is 30% with crude protein and fiber content of 23% and 8%, respectively. The trend for usage of PKC in poultry diets in the near future is dependent on its cost competitiveness against imported feed grains. More efficient and advanced biotechnological methods are needed to improve the feeding value of PKC if it is to be exploited on a larger scale for non-ruminant and aquaculture feeding in the future. Earlier studies indicated that PKC can be fed at up to 30% in catfish (*Clarias gariepinus*) and 20% in Tilapia *Orcochromis niloticus* (WAN ZAHARI and ALIMON, 2006). In a separate study, tilapia fed enzyme pretreated PKC had superior growth and feed efficiency compared to fish fed similar levels of untreated PKC (NG *et al.*, 2002). Up to 30% enzyme treated PKC could be incorporated into red tilapia diets.

Local maize

Commercial scale planting has been tested by MARDI and the economic data showed that it is not cost-effective. Yields ranged from 1.31 tonne/ha to 4.6 tonne/ha based on the trials at two estates in Peninsular Malaysia. About 84,000 ha of land has been identified in Northern Peninsular Malaysia and Sabah as suitable for grain maize production. This area is estimated to be able to produce about 252.000 tonne of maize per year which is equivalent to 12.6% of the total requirement, giving a saving of RM 161.000.000 per year.

Successful large-scale grain maize production is dependant on several factors. These include a high level of mechanization. availability of large tracts of suitable land with good drainage and terrain not exceeding 60° slopes, suitable rainfall quantity and distribution 10 facilitate mechanized field operations and good crop growth and harvesting, and the availability of post-harvest facilities for drying and storing grain (ATTA MOHAMMAD, 2009). With limited suitable land for large scale planting, coupled with unpredictable weather conditions for optimum drying at harvesting, the use of locally produced maize for poultry production is likely to be very limited.

Sorghum

Previous research at MARDI revealed that there were no significant differences in feed intake, growth rate and feed conversion efficiency (FCE) when sorghum at levels of 15, 30, 45 and 60% was directly substituted for maize in broiler diets. No problems which could be attributed to the presence of tannin in sorghum were encountered. Deficiency of xanthophylls at high levels of sorghum inclusion was observed to affect skin and shank pigmentation of the birds but this could be corrected by the addition of synthetic xanthophylls in the diets (SYED ALI *et al.*, 1975a). In layers, sorghum at levels of 15, 30, 45 and 60% was directly substituted for maize in laying diets and egg production, feed conversion, egg weight and mortality data were comparable to the maize-soybean meal control diet the paler egg yolk colour was remedied by supplementing with synthetic xanthophylls (SYED ALI and YEONG, 1977).

Broken rice

Studies have also shown that the production performance of layers fed broken rice at levels of 30 and 60% in the diet was comparable to layers fed conventional maize-soybean meal diets. Broken rice at levels of 15, 30, 45 and 60% in broiler diets also show comparable performance for feed intake, growth rate and feed efficiency to the maize-soybean meal diet. Due to the lack of xanthophylls in the broken rice diet the skin and shank colour appear paler and was less attractive to consumers. (SYED ALI *et al.,* 1973; 1975b).

Tapioca

The use of 30% tapioca in layer diets was also comparable to the conventional maize-soybean meal diet but use of tapioca of 45 and 60% resulted in significantly lower layer performance. The lack of xanthophylls in the tapioca diet caused the yolk colour to become pale but this deficiency was easily corrected by the use of synthetic xanthophylls. Further studies showed that supplementation with 0.2% methionine to the 45 and 60% tapioca based diets can correct the deficiency resulting in comparable egg production. feed conversion and total egg mass to the control diet (YEONG and SYED ALI, 1976). For broiler production, researchers have shown that tapioca can be used at up to 50% in broiler diets when the diet was supplemented with 0.2% methionine. Body weight gain, feed conversion and meat to bone ratio were comparable to control diets. Absence of yellow pigment in the skin shank and depot fat was observed in broilers fed high tapioca diets (YEONG and SYED ALI, 1974).

Sago

Researchers in MARDI reported that a level of 30% sago in layer diets showed similar performance in egg production and egg quality compared to the maize-soybean meal diet. Sago levels of 40 and 50% resulted in significantly lower egg production and feed conversion compared to the control (YEONG and SYED ALI, 1976).

Unconventional energy feed sources

Unconventional sources from the oil palm refineries can be used at a higher rate as an energy source. This include specially fats like palm fatty acid distillates (PFAD) and other related products which are currently being promoted in the local market. Crude palm oil (CPO) has been used as a high energy source in poultry formulations at inclusion level of < 5%. The use of CPO in non-ruminant diets is likely to be minimal, mainly due to the high cost at present. A few local companies and the Malaysian Palm Oil Board (MPOB) are presently developing feeds based on selected specialty fats. A premium MPOB-Q-PKC introduced by the MPOB has higher protein content (20%) and less crude fibre content (< 10%) than the existing PKC (about 16%) (ATIL, 2009). In addition;

the true protein value as a percentage of total protein was more than 96% and ash content was less than 3%.

Protein feed sources

Imported soya bean meal (SBM) and fish meal are extensively used as protein sources for non ruminants and aquaculture feeding in Malaysia. Total requirement of SBM and fish meal are 800,000 and 120,000 metric tonnes respectively. In the case of SBM, about 400,000 tonne is met by importation as compared to 100,000 tonnes for fish meal. Owing to its uniform quality (CP content 60 – 70%), imported fish meal is used by the feed millers. Conventional and novel sources of animal protein for poultry production had been extensively reviewed by WONG (2009).

Local protein feed sources

Fish meal

Local fish meal can fulfill about 20% of the total requirements. Generally the quality is inferior to imported fish meal with a lower CP content (50 – 55%), higher ash (26 – 28%), higher fat (> 10%) and salt (> 3.5%) content. The quality of the product is dependent on thrash) fish or fishery wastes which are inconsistent in terms of supply and CP content. Utilization of local fish meal in non ruminant formulations his promisine for the future, in view of the current interest in deep sea fishing, fish oil production and the availability of fishery wastes from the processing of various edible human fishery products. There exist a lot of interest in Tilapia (*Oreochromis niloticus*) and catfish (*Clarius gariepinus*) farming throughout the country which may have some potential for local fish meal production. The economics of production is not encouraging under the present situation, unless strategies to reduce cost of aquaculture production are found, which is mainly related to high feed cost.

Unconventional protein feed sources

Lately field cricket (*Gryllus testaceus Walker*), house crickets (*Acheta* domesticus L) and earthworm farming are becoming popular in Malaysia. Crickets are high protein feed while earthworms are used for vermiculture. Apart from composting, current interest in earthworm farming is also for high protein meal production. Suitable earthworm species include *Lumbricus rubellus* (red worm) and *Eisenia foetida* (tiger worm). Protein from these sources can be used as partial supplement for imported fish meal or soya bean meal. There is also some interest in large scale planting of high protein legumes for leaf meal production. which include kenaf (*Hibiscus cannobinus*), gliricidia and flemingia. These resources have some potential as protein supplements for non-ruminant and aquaculture feeding, although their CP is very much lower than those of animal origin.

To reduce the cost of livestock production: broken rice, tapioca, sweet potato, sago, molasses, rice bran, palm oil, grass meal, oyster shell and limestone can be utilized in the formulations for the non-ruminant livestock. Rice bran as an ingredient has anti-nutritional factors which restricts its usage of high levels. The oil in the bran is also hydrolysed rapidly to free fatty acids, but this process does not appear to affect the feeding value. Dehydrated POME and coconut meal are high in fiber and law palatability and the inclusion rate is low. It is deficient in several amino acids, low in available lysine and usage is more often determined by the price relationship with other protein supplements and the cost of balancing amino acids content of the diet.

UTILIZATION OF FEED RESOURCES FOR THE RUMINANT SUB-SECTOR

Low utilization of available fiber resources, lack of practical techniques to convert local feedstuffs to quality feeds, low efficiency of collecting and harvesting of raw materials, high cost of drying of raw materials, inefficient storage and handling of forage based feeds and lack of established quality assurance protocols for prepared feeds are some of the limitations in the development of practical and cost-effective feeds for ruminant animals. Appropriate strategies to enhance rumen function and the means to administer supplements are of importance to ruminant feeding, as well as increase utilization of potential feed resources under the plantation environment.

As the population of beef cattle and goats will be increasing in the near future, with an estimated 1.2 million heads by 2010, the supply of feeds should be of good quality, practical and cost-effective. Utilization of feed resources to feed ruminants is greatly dependent on the supply of agro-industrial by-products and crop residues, both from the oil palm and rice industries. Agro-industrial by-products from the oil palm industry include PKC oil palm fronds (OPF), palm oil mill effluent (POME), spent bleaching earth (SBE). and palm press fiber (PPF) (Table 1). From the rice industries, by-products suitable for ruminant feeding are rice straw, rice bran and rice husk.

Table 1. Chemical composition (% dry matter) and nutritive values of oil palm fronds and other oil-palm byproducts

Byproducts	CP	CF	NDF	ADF	EE	Ash	ME (MJ/kg)
Palm kernel cake	17.2	17.1	74.3	52.9	1.5	4.3	11.13
Palm oil mill effluent	12.5	20.1	63.0	51.8	11.7	19.5	8.37
Palm press fibre	5.4	41.2	84.5	69.3	3.5	5.3	4.21
Oil-palm fronds	4.7	38.5	78.7	55.6	2.1	3.2	5.65
Oil-palm trunks	2.8	37.6	79.8	52.4	1.1	2.8	5.95
Empty fruit bunches	3.7	48.8	81.8	61.6	3.2	–	–

CP: Crude protein; CF: Crude fibre; NDF: Neutral detergent fibre; ADF: Acid detergent fibre; EE: Ether extract; ME: Metabolisable energy

Source: WAN ZAHARI *et al.* (2000)

Feed resources from the oil palm industry

Palm kernel cake

PKC is a high energy fiber source and is a popular ingredient in ration formulations for various ruminant species. Feedlot cattle are normally fed up to 80% PKC with live weight gain (LWG) of 0.6 – 0.8 kg per day and 1 – 1.2 kg per day for local (Kedah Kelantan) and crossbred cattle, respectively. PKC at almost 100% has been fed to feedlot cattle with no adverse effects provided that the supply of Co and vitamins (in particular A, and E) is sufficient to meet their requirements. PKC based compound feeds either in the form of pellets or cubes, as well as total mix ration (TMR), will continue to be popular for local livestock feeding. Beef production utilizing PKC-based diets is more economical under the local dietary and management systems compared to non-PKC based diets. Apart from PKC, other common ingredients are rice bran, brewer's grain, palm oil mill effluent (POME), tapioca waste, urea, salt and minerals (WAN ZAHARI *et al.*, 2000; 2003). In dairy cattle rations, PKC is used as a source of energy and fiber at inclusion levels of 30 – 50%. PKC-based dairy cattle pellets are popular in Malaysia and are commonly fed with grass and other concentrates. Under Malaysian conditions. a milk yield of 10 – 12 liters per head per day can be achieved and with good dietary formulations even higher yields can be obtained. The recommended inclusion level of PKC in sheep rations is 30% as long-term feeding of PKC at high levels can cause copper toxicity.

The availability of PPF, OPF and POME will provide avenues for more practical and cost effevtive rations when combined with PKC. The use of "specialty fats" like formaldehyde protected fat, calcium soaps, calcium salts and palm fatty acid distillates (PFAD) can boost-up energy content in PKC-based feeds, especially for dairy catlle. As 90% of the PKC produced in the country is exported (particularly to Europe, New Zealand, Japan, Korea, China and Middle East), some measures need to be implemented to provide some PKC for local use. It is estimated that about 100.000 tonnes of PKC will be required to feed local livestock by 2010, or about 5% of the total PKC production. In order to stabilize the cost of PKC in the local market, pricing should be based on its quality which requires both standardization and enforcement.

Oil palm fronds

Presently, oil palm fronds (OPF) is extensively used as one of the main ingredients in ruminant feeding, either in the form of silage, pellet or cube (WAN ZAHARI *et al.*, 2006). Complete feeds based on OPF is in high demand for beef cattle, dairy catlle and goat rearing in Malaysia. The establishment of a commercial OPF-based feed factory (owned by FELDA, production capacity 5 ton/hour, production 27.000 metric tones per year, plantation area: 10.000 acres) in Bukit Sagu, Kuantan in 2007 will further expand the use of OPF in the domestic ruminant industry. Another factory of similar production capacity will be established by Sawit Kinabalu Sdn. Bhd in Lahad Datu, Sabah to cater to the needs of East Malaysia and the global market.

Feed resources from the rice industry

Rice straw

The use of rice straw for ruminant feeding in Malaysia is very limited even though processing technologies have been well established. Abundant supplies of rice straw in rice producing areas like MADA, KADA and TRANS-PERAK, can offer tremendous opportunities in the development of feeds for livestock feeding. Apart from converting rice straw into silage, it can also be processed into complete rations. Several formulations based on *rice* straw at an inclusion level of 30% have been tested in beef cattle in Kuala Selangor with promising results. There is a trend towards utilizing rice straw as an ingredient or as part of a complete feed for beef and dairy cattle, particularly in rice growing areas.

Other rice byproducts

Rice bran and to a limited extent rice husk, are often used as energy or fiber sources in combination with rice straw in livestock feed formulations. Several newly established feed mills in Kelantan and Kedah are using ground rice-husk as the main feed ingredient for livestock. Satisfactory growth performance of beef cattle utilizing rice-husk as feed is *yet* to be seen.

Other potential byproducts

Other products of interest to be utilized for ruminant feeding are rather location specific. These include cocoa pod husk, coconut cake, bagasse, sugar cane tops, maize stover, cassava leaves, sweet potato leaves, ground nut cake, pineapple waste, coffee seed hulls and various others.

Pasture and fodder as feed

Various reports are available on R & D related to the development of pasture and fodder in Malaysia. It is evident that R & D activities were active in the last two decades and its revival at present is due to greater feed demand. Grasses commonly used under small-holders condition in Malaysia are *Brachiaria decumbens*, *Brachiaria humidicola*, *Panicum maximum*, *Pennisetum* purpureum *and Setaria sphacelata.* These grasses are grown mostly for the cut and carry system. Nitrogen (N)-fixing fodder trees commonly used include *Gliricidia sepium. Leucaena leucocephala* and *Sesbania grandiflora.* Two promising hybrid lines of acid tolerant and phsyllid resistant leucaena have been selected by MARDI in the last decade but large-scale planting for forage production is still limited. *Acacia mangium* and *Acacia aneura* are used in certain areas. Foliage of multipurpose trees such as cassava (*Manihot esculenta*) banana, jackfruit (*Atrocarpus heterophyllus*) and kenaf (*Hibiscus cannabinus*) are widely used for feeding small ruminants. Under Malaysian conditions, the latter two species are effective for parasite control. *Centrosema pubescens* has potential to be grown as a legume that can persist in lallang pastures. Commercial planting of kenaf for livestock feed is still at the growing stage in Sabah. *Flemingia congesta*, a legume plant, is being reintroduced into the small farming system in certain areas (WAN ZAHARI *et al.*, 2009a).

Integration under major plantations

A sizeable population of cattle and sheep has been introduced into the plantations over the last three decades to utilize the natural feed resources growing under the plantation trees. Advances in the process of integrating various ruminant species with tree crops have been published (SIVARAJ *et al.,* 1993). The integrated system involving ruminants and oil palm are gaining interest in the government and private sectors. This is reflected in the increased number of grazing projects under the Rubber Industry Smallholder Development Authority (RISDA), Federal Land Development Authority (FELDA), Federal land Consolidation and Rehabilitation Authority (FELCRA). Malaysian Palm Oil Board (MPOB), DVS, MARDI, states governments and private sectors like Sime Darby.

Strategic feeding and supplementation

Introducing forage supplements at a maximum inclusion of 20 – 25% is an alternative strategy for increasing nutrient intake and improving ruminant performance, especially when crop residues with poor nutritive values are used as the basal diets. Under Malaysian conditions, combining glyricidia or mulberry with rice straw or OPF at the ratio of 1 : 4, for example, is adequate to allow positive livestock growth. Previous studies showed that the protozoa population tended to decrease more quickly with supplemental feeding. Any feeding strategies that can enhance adhesion of rumen microbes to feed particles and improve fibrolytic activity may be beneficial to feed utilization. Apart from highly digestible forages, productive performances can be greatly improved by supplementing with protein sources, concentrate or combinations of both.

Incorporation of shrub and tree fodder into the feeding system of intensively reared ruminants in particular, have not yet been thoroughly studied. Their feeding value in raw and processed forms must be evaluated for maximum utilization, more so if anti-nutritional factors exist in those feeds. Plants with high protein content and leaf to stem ratio as well as low anti-nutritive factors will be important for intensive planting under the small-holders condition in Malaysia. Current emphasis is on gliricidia, flemingia, and mulberry. Prospecting for new feed resources and tissue culture of these plants is under investigation by MARDI for large-scale planting. The rate of degradability of other potential non-leguminous tree leaf is being evaluated to diversify the sources of local feeds.

Deficiencies and imbalances of nutrients are widespread throughout Malaysia, notably for protein and minerals (phosphorus, copper, sodium, selenium and cobalt) apart from energy. Most of the mineral and vitamin supplements are imported. These include salt block, dicalcium phosphate (DCP) and specific macro and micro supplements for various species of livestock. Locally produced salt and mineral supplements are also available, but the usage is not as widespread compared to the imported products, Feeding supplementary urea molasses mineral blocks (UMMB) has been shown to improve performances of goats, sheep, beef cattle and dairy cattle in Malaysia.

PROCESSING OF CROP RESIDUES AND OTHER AGRO-INDUSTRIAL BYPRODUCTS

Most of the agro-industrial by-products and crop residues, particularly from the oil palm and rice industries can be turned into good quality silage for livestock feeding. Several methods of ensilation have been practiced using borrels or containers. Otosil (to silage making machine) was developed locally to cater to the need for better silage compaction. The yield produced by Otosil was found to be 50% higher than that produced manually (GHAZALI *et al.*, 2009). More recently, commercial maize stover-based silage was successfully produced in Porit Makasor. Pontian, Johore for the southern Region of Peninsular Malaysia. Small and medium scale *in situ* silage production have been observed in different locations, utilizing either OPF, maize stover, rice straw, sago waste and pineapple wastes. Large scale rice straw or OPF silage production is urgently needed to cater to the needs of bigger livestock operations. The current trend is towards more effective and economic use of crop residues and other agro-industrial by-products for local ruminant feeding.

Potential grasses for hay making include Guinea (*P. maximum*) and Dwarf Napier (27 and 30 tonnes DM yield/ha/year, respectively). Local grass hay made from Guinea grass and Signal grass (*B. decumbens*) is comparable to imported hay (CP ranging from 11 to 14%). Hay feeds are often in dried compressed bale or cube forms (semi-processed).

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