

OIL-PALM FRONDS AS A ROUGHAGE FEED SOURCE FOR RUMINANTS IN MALAYSIA

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ABSTRACT

Oil palm (Elaeis guianensis) grows well in wet, humid parts of tropical Asia (mainly South-east Asia), Africa, and Central and South America. A tremendous amount of fibrous biomass from both the palms and the fruit processing are generated by the industry. Currently, Malaysia is still the leader in oil palm/palm oil production, which produced approximately 18.77 million mt (on a dry matter basis) of oil palm fronds in 1994.

A major reason for the slow growth of the ruminant industry in Malaysia is the lack of good-quality feed resources. Oil-palm fronds can be used as a substitute for grasses in cases where forage or fodder is a limiting factor. The recommended level of oil-palm fronds in the total mixed rations (on a dry matter basis) are 50% for beef cattle, and 30% for dairy cattle and goats.

INTRODUCTION

The strength of agricultural production in Malaysia lies in the large plantations of commercial crops such as rubber, oil palm, cocoa and pineapple. These crops occupy most of the arable land. Malaysia does not have natural grasslands, while improved pastures are still limited to a few commercial and government farms. Prospects for the increased use of farmland for grass or fodder production are not favorable (Joseph 1991), because national policy states that any conversion of tropical rainforest to pastures for grazing animals has no justification from either the economic or the environmental point of view. Commercial large-scale ruminant production is rare. It is smallholders who are traditionally the main ruminant producers. The smallholders have to use their limited land and capital, and diminishing communal grazing reserves, and integrate their live-

stock production with their rubber or oilpalm holdings. This has perpetuated the pattern of low-input/low-outputs traditional production systems which sometimes lead to feed supply shortages (Chen and Shamsudin 1991).

This situation is compounded by the rapid development and industrialization of Malaysia. The self-sufficiency rate for ruminant products is about 24.07 for beef, 4.67 for dairy products, and 9.03% for lamb/mutton. (The figure of 4.67% self-sufficiency for dairy is based on a liquid milk equivalent for dairy and dairy products). These self-sufficiency rates are declining, due to an increased demand for the products with a higher population and income levels. Poultry and swine production are heavily dependent on imported feed ingredients, mainly corn, soybean and fishmeal. Even though Malaysia is self-sufficient in swine and poultry products, and is able to export some pork, poultry meat and eggs, Malay-

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sia is still a net importer of animal products (Mahyuddin 1993).

The ruminant sector in particular is well suited to maintaining competitiveness through the use of plantation and processing by-products (Abu Hassan *et al.* 1995). Of the commercial plantation crops, oil palm produces the most abundant biomass, and oil palm fronds have been shown to be a very promising source of roughage for ruminants. This paper examines the use of oil palm fronds as live-stock feed, and discusses the potential of using local raw materials to boost the production of ruminants in Malaysia.

AVAILABILITY OF OILPALM FRONDS

The average economic life-span of the oil palm is 25 years. A marked increase in the cultivation of oil palm began in 1960 (Kamaruddin *et al.* 1991), so that the year 1990 onwards will see a peak in replanting. This will be a good opportunity to harness the ligno-cellulosic biomass or by-products of the oil palm, including the fronds (Table 1). Oil-palm fronds are available daily throughout the year when the palms are pruned during the harvesting of fresh fruit bunches for the production of oil.

Currently, oil-palm fronds are left rotting between the rows of palm trees, mainly for soil conservation, erosion control and ultimately the long-term benefit of nutrient recycling. The large quantity of fronds produced by a plantation each year make these a very promising source of roughage feed for ruminants.

PROCESSING AND UTILIZATION OF OIL-PALM FRONDS AS A ROUGHAGE SOURCE FOR RUMINANTS

Whole oil-palm fronds (the petiole and leaflets), chopped into lengths of about 2 cm, are utilized as cattle feed either green, or conserved as silage in combination with other ingredients as total mixed rations (Abu Hassan and Ishida 1991, Ishida and Abu Hassan 1992). The chemical analysis and metabolizable energy (ME) value of oil-palm fronds (Table 2) indicate that they are suitable as a roughage source (Alimon and Hair Bejo 1995, Wong and Wan Zahari 1992, Mat Rasol *et al.* 1993).

Oil-palm fronds belong to the category of fibrous crop residues, which also includes by-products such as rice straw. Previous studies comparing oil-palm trunks as a roughage feed (Oshio *et al.* 1990) with rice straw supported the use of the oil-palm materials as a source of roughage for ruminants, as did a long-term feeding trial of oil-palm trunks for beef production (Abu Hassan *et al.* 1991). Table 3 shows the percentage of dry matter, crude protein content and digestibility of oil-palm fronds made into silage, and with added urea.

A digestibility study conducted using mature Kedah-Kelantan bulls (Abu Hassan and Ishida 1992) indicated a dry matter digestibility value of about 45% for oilpalm frond silage. This encouraging result was further tested for the suitability of oilpalm fronds in long-term feeding/production trials on beef cattle (growing and finishing), and also on lactating dairy cows (Tables 4 Table 5 Table 6), (Abu Hassan *et al.* 1993, Ishida *et al.* 1994).

Table 1. Estimated availability of oil-palm trunks and fronds (mt, dry matter basis) in Malaysia

Year	Trunks	Fronds		Total
		Replanting	Pruning	
1990	1.32	0.25	16.92	18.49
1992	2.39	0.64	17.64	21.67
1994	4.60	0.88	17.89	22.37
1996	4.36	0.83	19.09	24.28
1998	7.48	1.42	18.18	27.08
2000	7.02	1.34	17.85	26.21

Source: Mohamad, H. *et al.* PORIM 1986

Table 2. Chemical composition (% dry matter) and nutritive values of oil palm fronds and other oil-palm by-products

By-products	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 fiber	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	-	-

Source: Alimon and Hair Bejo 1995, Wong and Wan Zahari 1992, Mat Rasol *et al.* 1993

Table 3. Mean values for % dry matter, crude protein and dry matter digestibility (DMD - *in vivo*) of oil-palm fronds under various treatments

Oil-palm fronds	%		
	Dry matter	Crude protein	Dry matter digestibility
1. Made into silage	30.02	5.67	45.00a
2. Silage with 3% urea	30.58	12.50	44.20a
3. Silage with 6% urea	28.58	20.89	35.80b

Mean values with different letters within each column differ significantly ($P < 0.05$).

Source: Abu Hassan and Ishida 1992

A feeding trial was conducted, using 24 bulls fed on oil-palm frond silage and concentrates based on palm kernel cake (Table 4). After the growing and finishing stage, the bulls were slaughtered for carcass evaluation. The feed required for bulls for a given body weight gain was generally lower with higher levels of oil-palm silage in the diet. When feed intake was compared to fat and meat production (Table 5), there was found to be less excess carcass fat in treatments with higher levels of oil-palm frond silage.

Lean meat production was not significantly reduced by the incorporation of up to 30% oil-palm frond silage in the diet (on a dry matter basis). These observations clearly showed that oil-palm frond silage could be utilized as a feed source for raising beef cattle. Since the fronds cost little or nothing, including them in the diet resulted in lower feeding costs.

A trial of silage made from oil-palm fronds as a source of roughage for lactating dairy cows was also carried out (Table 6). The cows fed 30% oil-palm frond silage produced milk more efficiently

than other groups, while generally the cows in all treatment groups were healthy. The trials confirmed that oil-palm frond silage made of oil-palm fronds could be fed to lactating dairy cows as a roughage source without adverse effects on animal condition or milk flavor. The optimum level of inclusion of oil-palm frond silage in the diet should be 30% (on a dry matter basis).

According to these studies where the supply of grass or fodder is a limiting factor, feeding oil-palm fronds to dairy cattle is a satisfactory alternative. The animals were able to perform at a level comparable to when they were fed cut grass, and there were no nutritional disorders or other negative effects on the animals.

TRANSFERRING THE TECHNOLOGY

Since the release of the technology in 1992, both the mass media and extension staff have made the information available to farmers. The effectiveness of these two methods of communication varied,

Table 4. Effect of the level of oil-palm fronds in diet on the performance of beef bulls (Australian Commercial Cross bulls - 6 bulls/treatment)

Parameter	Treatment			
	T1	T2	T3	T4
Live body weight, kg				
Initial weight	229.10	226.50	232.90	229.40
Final weight	396.3a	366.4ab	333.8b	357.2ab
Daily gain, kg/day	0.75a	0.62ab	0.45c	0.57bc
Feed intake, kg DM/day				
Total diet	7.02a	6.10ab	5.48b	5.58b
Feed/gain (conversion)				
Total diet	9.65b	10.09b	12.39a	9.92b

OPF = Oil-palm fronds. PKC = Palm kernel cake.
T1 = 10% OPF silage with urea + 90% PKC based concentrate
T2 = 30% OPF silage with urea + 70% PKC based concentrate
T3 = 50% OPF silage with urea + 50% PKC based concentrate
T4 = 50% OPF silage without urea + 50% PKC based concentrate

Means in a row with different letters differ significantly ($p < 0.05$)

Source: Ishida *et al.* 1994

Table 5. Effect of the level of oil-palm fronds in the diet on the carcass quality of beef bulls (Australian Commercial Cross - 6 bulls/treatment)

Parameter	Treatments			
	T1	T2	T3	T4
Carcass weight, kg	237.2a	210.2ab	189.0b	195.2b
Dressing %	60.6a	58.2ab	57.6ab	55.4b
Weight of carcass components, kg				
Meat	127.8	121.5	107.0	116.7
Fat	76.4a	58.1ab	45.8b	46.0b
Bone	37.6	33.4	33.2	36.1
% of carcass				
Meat	53.6	58.2	57.2	59.2
Fat	31.6a	27.6ab	24.2b	23.7b
Bone	16.0	16.1	17.7	18.4

OPF = Oil-palm fronds. PKC = Palm kernel cake.
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Means in a row with different letters differ significantly ($p < 0.05$)

Source: Ishida *et al.* 1994

Table 6. Effect of feeding different levels of oil-palm frond silage on milk production (Sahiwal Friesian crossbred dairy cows, 9 cows/treatment)

	Initial mean milk yield 4% FC (kg)	Mean milk yield, 4% FC (kg)	Mean milk yield, 4% FC, per MJ of ME intake (kg/MJ)
1	8.20	6.93	0.109a
2	8.15	5.73	0.088b
3	8.06	6.48	0.096b

Source: Abu Hassan *et al.* 1993

Means values with different letters within each column differ significantly ($P < 0.05$).

FC = Fat Corrected

1 = 30% oil-palm frond silage + 70% Concentrates

2 = 50% oil-palm frond silage + 50% Concentrates

3 = 50% Cut grass/fodder + 50% Concentrates

according to the type of farmer and the stage of his decision-making process.

The mass-media (TV, radio and printed media) were more effective for early adopters, and those at the knowledge stage of the innovation decision process. Interpersonal channels (training courses and demonstrations), were more favorable for later adopters, as well as for those at the persuasion stage of the innovation decision process.

Adoption of the Technology by Extension Agencies, Farmers and Producers

A high level of interest in, and acceptance of, the technology was indicated by the following trends (Abu Hassan *et al.* 1995):

- Repeated requests for information by producers, farmers and extension agencies, and repeated visits to demonstration and training sessions.
- More than 100 units of the chopping machines have been sold.
- The emergence of duplicate chopping machines, based on the machine used in field demonstrations. A number of new chopper machines, such as the Bandit, the Tomahwk, etc, have been introduced onto the market.
- Evidence that successful enterprises and farmers are using oil-palm fronds as the roughage source in their feeding programs.

- The strength of oil-palm frond technology - evidence of early technology push transforming ultimately into technology pull (i.e. whereas in the early stages this use of oil-palm fronds had to be actively promoted by demonstrations and mass media, farmers themselves are now becoming much more active in learning about it, and adapting the technology).

Selected Examples of Early Adopters of the Oil Palm Frond Technology

Generally, the producers who have adopted the technology have confirmed that the supply of fresh oil-palm fronds is plentiful, and there is no urgent need to conserve them as silage. Feeding fresh chopped fronds is easier and requires less labor than cutting grass. By using oil-palm fronds as a roughage source for livestock, feeding, operational and management costs are tremendously reduced. Table 7 shows the profile of some of the early producers who adopted the oil-palm technology. It also shows why they needed to acquire the technology.

All five producers reported that using oil-palm fronds did not compromise the performance or production potential of their animals. Their serious problem of a roughage/feed shortage was completely solved, and in the case of the dairy cattle, the milk quality (fat %) produced on the farm improved tremendously.

Table 7. Profile of selected early users of oil-palm fronds as livestock feed

Producer	Enterprise	Feeding system	The NEED to use OPF
A	Beef	Semi-intensive system integrated with oil palm. 60 head	Feed deficit
B	Beef	Intensive/feedlot, 140 head	Limited roughage
C	Dairy	Intensive system, 200 head	No roughage
D	Sheep	Semi-intensive system integrated with oil palm and rubber. 10,000 head	To minimize grazing time
E	Dairy 17 head	Intensive system, smallholder.	Limited supply of roughage

Table 8. Technical capacity and other attributes of early adopters of oil-palm frond technology

Adopters	A	B	C	D	E
Land holding size	6	4	8	10	4
Capital available	7	6	9	10	5
Knowledge	8	7	8	9	5
Experience	8	8	8	8	5
Social contact-range	8	8	8	8	6
Innovativeness	9	7	7	7	5
Size of operation	7	7	9	9	5
Culture/background (attitude)	8	8	8	8	5

Ranking ability: 1 = lowest 5 = average 10 = highest
A = beef/plantation crop B = beef/intensive/feed lot
C = dairy/intensive D = sheep/semi-intensive
E = dairy/intensive/smallholder

Technical Capacity of Producers (Early Adopters) in Utilizing the Oilpalm Frond Technology

The success of the transfer of oil-palm frond technology depends on two factors: the appropriateness of the technology, and the technical capacity of the users.

Table 8 shows that the technology is appropriate for a wide range of users, with small or large land holdings, and with only average amounts of capital and experience.

Why Oil-palm Frond Technology was Well Sustained as a Viable Enterprise by Producers

The oil-palm frond technology was well received because it met five attributes of innovations favorable for adoption (Roger 1983, Ahmad Tajuddin 1993) (see below).

There do not seem to be any negative attributes with regards to oil-palm frond technology, except perhaps the cost of the chopping machine. In some cases, this high cost has been overcome by reverse engineering and local fabrication of the ma-

Attribute	Contributing factors
• Relative	Removes drudgery of cutting and collecting grasses (time- and cost-saving)
• Complexity	Simple technology
• Compatibility	Supplies technology to replace the drudgery of cutting and collecting grasses, as well as a suitable substitute for grass, on a sustainable basis
• Testability	Although the chopper has to be purchased, some sellers allow demonstration and testing of these machines
• Observability	Field demonstrations at the source of the technology, and also on farms of early adopters

chines. One common factor recognized among the producers was the cost-saving effect of using oil-palm fronds in their production (especially in terms of feeding and labor costs). This is very significant in the context of the Malaysian animal industry, as in production elsewhere.

CONCLUSION

Oil-palm fronds have been success-fully used as a substitute for tropical grasses by ruminant producers in Malaysia. The optimal levels of inclusion of the fronds in the total mixed rations on a dry matter basis were 50% for beef cattle, and 30% for dairy cattle and goats/sheep. Continuous promotion of the technology needs to be implemented in all production systems, adapted according to the needs of producers. Development should include utilization both on oilpalm plantations themselves, as part of an integrated crop livestock system, and on nearby livestock farms.

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