Investigating Alternative Feedstuffs for Indonesian Feedlots

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Abstract

This project involved a research trip and investigation into alternative feedstuffs and feed treatment methods capable of reducing the feed cost of gain in Indonesian feedlots. A detailed listing of current and potential new commodity options was presented. Project recommendations include that feedlotters be encouraged to consider options involving greater use of high moisture feeds such as corn "earlage" and human food wastes, which will not be targeted by monogastric animal or bio-fuel industries. Options for the importation of commodities, such as tapioca chips from Thailand, should also be carefully considered, especially during the current financial downturn. It is suggested that training workshops be conducted for feedlotters in the topics of silage making, commodity buying groups, international commodity trading and 'least-cost feed formulation" techniques.

Executive summary

This project was instigated by the Livestock Export R&D Program, in collaboration with the Indonesian Feedlotters Association (APFINDO), to assess solutions to the problem of rising feed commodity prices experienced by Indonesian Feedlots during the period up to November 2008.

However, it is interesting that in light of the current global financial crisis, which began influencing the Indonesian industry from late November 2008, world commodity trading markets have fallen substantially, thereby reducing the international competitiveness of Indonesian cassava products. The world crude oil price fall has also reduced the feasibility of ethanol production ventures. Consequently, there is likely to be a glut of low priced cassava products on Indonesian markets, with feedlot ration costs likely to be at their lowest for the past two years over at least the next 12 months. However, the global economic scenario beyond this is difficult to predict and so the current project remains of importance in the sense of safeguarding the industry over the years ahead.

The key objectives of the project were to:

1) Conduct an audit of existing feedlot rations in Indonesia, Malaysia, The Philippines and other SE Asian countries, whilst considering the feeding value and availability of feedstuffs;
2) Investigate new alternative feedstuffs that could be used as cost effective components of Indonesian feedlot rations, including their feeding value and availability and;,
3) Investigate treatments / processes that could be applied to feedstuffs to make them more suitable / palatable as components of feedlot rations.

The investigation was conducted via industry research, observations and discussions with feedlot managers, personnel and scientific researchers during a research trip to Indonesia and The Philippines during October and November, 2008. A detailed listing of current and potential new feedlot commodity options is presented in this report. This listing includes estimates of prices, availability, nutritional data, suggested ration inclusion levels, and the likely presence of any anti-nutritional factors. Commodity options are then ranked on a cost per unit of energy or protein basis.

Key conclusions and recommendations emanating from this project are as follows:

1) Members of APFINDO and other participants in the Indonesian feedlot industry should be encouraged to carefully consider wherever possible the use of higher levels of feedstuffs which are uniquely well suited to ruminant digestive processes and feedlot handling systems, and therefore not keenly sought after by bio-fuel producers or the large Indonesian monogastric (poultry, pig and aquaculture) industries. Such feedstuffs will include corn “earlage” and other high moisture commodities such as wet brewer’s grains, cannery wastes, other human food and beverage industry wastes, and possibly wet by-products from newly established cassava-based bio-ethanol factories. However, with this new direction will come a necessity for further industry training in the handling and storage of high moisture commodities, in particular with regards to “ensiling” techniques. It is recommended that MLA and APFINDO discuss the concept of training workshops, conducted by the appropriate industry specialists.

2) Further to the above comments, an associated recommendation is that research be conducted into all main aspects of the practicality and economic feasibility of corn “earlage” production by suitably equipped Indonesian feedlots. A key consideration will be the area of cultivation country required, either managed as part of the feedlot premises, or sub-contracted to local farmers.

3) Relevant to the potential use in feedlots of glycerol, study should be undertaken to assess economic returns, animal performance and optimal ration inclusion rates. Glycerol is a high energy, bio-available substance generated from bio-diesel plants and may become available in large quantities across Indonesia as alternative fuel industries establish in the near future.

4) Under the peculiarities of the current global financial downturn, including record low shipping freight rates, it is recommended that all commercial feedlots give careful consideration to the option of importing feed commodities, potentially from a wide range of countries, including Australia, the USA and several Asian countries. The size and professionalism of the nearby Thai Tapioca Industry also clearly represents a potential opportunity for Indonesian feedlots under certain commodity pricing and shipping dynamics.

5) Partly in view of the above recommendation, and to increase feedlot industry competitiveness, a further recommendation is that MLA and APFINDO discuss the notion of training workshops for management in the concepts of Feed Commodity Buying Groups, as well as International Commodity Trading and Importation.

6) It is suggested that feedlotters keep in mind the future potential of the "cassava dregs" by-product of proposed ethanol factories in the provinces of Lampung and Java. This product may be available in large quantities as ethanol industries establish. However, it must be stressed that the product is anticipated to contain very little energy and will therefore play a role mainly as a low inclusion rate fibre supplement in finisher rations, or as a more substantial component of introductory rations, or rations for non-feedlot cattle.

7) It is suggested that the information provided in spreadsheet format in the Addendum to this report be made available to interested feedlotters as a downloadable Excel file from the MLA website, and also on CD, such that pricing, availability and nutritional data can be updated, kept relevant and used in feed formulating calculations.

8) Preferably as a component of other workshop programs, as suggested above, it is recommended that training sessions be conducted for relevant feedlot staff or advisors in the concepts of "Least Cost Ration Formulation". As described in this report, this technique is a key tool of the trade for professional feed formulators around the world.

9) Unfortunately there were no feed commodity treatment processes identified in this study that appear to offer significant benefits for the Indonesian feedlot industry. Most processes in operation have been developed for the improvement of low protein, low energy roughages, and so the relevance for feedlot fattening scenarios is greatly limited. However, it is recommended that developments in the research fields of enzyme supplementation of copra and palm kernel meals for ruminant applications be watched carefully.

Finally, dissemination of the results and conclusions from this project should, in a long term sense, result in improvements to the profitability and economic viability of the Indonesian feedlot industry. This in turn will lead to stimulation of the Australian live cattle export industry, and therefore also improve the viability of the northern Australian pastoral industry, due to cattle being turned off faster and in a more reliable manner.

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Contents

1 Background

1.1 Background

The value of the Indonesian market to Australia's important live cattle export industry is without question. During the 12 months of 2008, the Indonesian market represented 74.9% of all live cattle exported from Australia, with a total of 651,196 animals exported, having a total live value of approx $480 million (Livecorp statistics, 2008). However, concern has been raised by several Indonesian feedlot operators that feed commodity prices have increased substantially over the 2 years up to the end of November 2008, and in doing so have significantly impacted upon the economic viability of the industry. Reasons for this have centred on the well-recognised phenomenon of increasing worldwide demand for high protein foods and fuel supplies, these being especially prominent in Asian countries. This demand translates to increasing competition for animal feed inputs at a global level.

The Indonesian feedlot industry is mostly located in the Lampung Province of south Sumatra and the three main provinces of Java, for the reason of being centrally located to the largest cassava root growing regions of the country. Cassava roots are used to produce tapioca starch. By-products of this manufacturing process, together with raw, dried cassava root chips, have formed the basis of high energy, low priced feedlot rations since the inception of the feedlot industry in the mid 1990's. Over 40 tapioca starch factories are located in the Lampung Province. However, the dynamic has now changed with cassava products being increasingly exported and both commodities being, over much of the past two years, targeted by newly established ethanol factories. Similarly, the very commonly used proteins, copra and palm kernel meals, are being exported to many countries. In fact it has been estimated that approximately 80-90% of waste products from the huge Indonesian palm oil industry are now exported (Kusuma, pers. comm., 2008).

Instigated by the Livestock Export R&D Program, in collaboration with the Indonesian Feedlotters Association (APFINDO), the current project sought to find solutions to the current problem by investigating the availability of new alternatives to traditionally used feedlot ration commodities. Further detail of key project objectives is given in the section below.

It is worthy of comment that since late November 2008, world commodity trading markets have fallen substantially in response to the current global financial crisis. International grain prices have fallen sharply and cassava products and tropical protein meals have slipped significantly in trade competitiveness. With international crude oil now trading at around US$40 per barrel, the current feasibility of producing ethanol from cassava is extremely dubious. However, farmers have been encouraged to plant large acreages of cassava over recent years for the ethanol factories. Under the current crisis, there is in fact likely to be a glut of low priced tapioca chip on the market over the next 12 months at least, as farmers seek alternative markets. Similar scenarios will exist in the neighbouring major cassava producing countries of Thailand and Vietnam.

With regards to the all important cassava based feedlot commodities, the outlook for 2009 and beyond appears mixed. According to FAO (2008), on the one hand rising commercialisation through public and private support of the crop could provide an impetus for larger plantings, but on the other, falling international prices of cereals and energy will likely thwart any expansion in cassava cultivation. The current financial crisis also casts doubt on production prospects, as any meaningful expansion of cassava cultivation, particularly in relation to end use such as flour processing and ethanol production will necessarily rely on access to credit markets which afford investors reasonable returns.

In light of these recent unprecedented phenomena, it is likely that feedlot ration costs in Indonesia will be at their lowest for the past two years over at least the next 12 months.

However, the economic scene beyond this is difficult to predict and the current project still remains important to safeguard the industry over the years ahead.

2 Project objectives

2.1 Key Project Objectives

The key objectives of the project were to:

1.) Undertake consultation with industry stakeholders and researchers to:

  a.) Conduct an audit of existing feedlot rations in Indonesia, Malaysia, the Philippines and other SE Asian countries, in order to assess feed commodity feeding values and general availability to feedlotters.

  b.) Investigate alternative or new feedstuffs that could be used as cost-effective components of Indonesian feedlot rations, including their feeding value and availability.

2.) Investigate various treatments and procedures that could be applied to feedstuffs to make them more digestible / palatable as components of feedlot rations.

3 Methodology

3.1 Methodology – Ration Audit and Search for Alternatives

The audit of currently used commodities throughout Indonesia and other SE Asian feedlots and investigation of new commodities was conducted by phone and e-mail correspondence, literature searches, and discussions with feedlot managers, staff and scientific researchers during a 30 day research trip to Indonesia and 7 days in The Philippines during October and November, 2008. The month in Indonesia covered the Lampung province of Sumatra, the provinces of West, Central and East Java, as well as parts of the Nusa Tenggara Barat province. The week spent in the Philippines examined four feedlot operations in Luzon. The full trip itinerary is shown in section 9.1 Appendix 1, on page 59.

Details of the research scientists contacted, in addition to those highlighted in Appendix 1, are shown in section 9.2 Appendix 2, on page 60.

An initial introductory Letter and Questionnaire inviting suggestions from members had been e-mailed to the APFINDO Executive Officer and all members of the Indonesian Feedlotters Association prior to the commencement of the trip. A full copy of this letter and questionnaire can be found in section 9.3 Appendix 3, on page 61. (No formal feedback or responses/suggestions were received from this questionnaire.)

3.2 Methodology – Investigation of Treatment Processes

The investigation into methods of treating poor quality commodities to improve their utilisation by Indonesian feedlots was done via a desktop literature review of treatment methods for poor quality tropical feedstuffs throughout the world. The literature review was augmented by discussions with Indonesian Government research organisations and Universities, as well as the Australian Centre for International Agricultural Research (ACIAR), the University of Queensland, and the international feed additive and enzyme company Alltech Biotechnology Pty Ltd.

4 Results and discussion

4.1 Results – Ration Audit and Search for Alternatives

4.1.1 Results – Audit of Existing Rations

INDONESIA

The research trip to Indonesia incorporated meetings with the management of six of the largest APFINDO beef feedlots, a dairy feedlot, plus a large Stockfeed Milling group.

The photographs in Figure 1 below illustrate the broad range of feedlot ages and types observed during the Indonesian phase of the research trip.

Figure 1. *Variation in feedlot types and ages seen during the Indonesian research trip.*

A representation of commonly observed Indonesian feedlot finisher rations is shown in Table 1 below. The fairly wide range of ingredient inclusion levels is quite typical of the degree of variation seen from feedlot to feedlot, this generally being the result of widely differing availabilities of commodities from one location to another.

Table 1. Commonly observed Indonesian feedlot finisher rations.

Feed Ingredient Type	Ration Inclusion %	Protein %	Energy MJ ME/kg DM
ROUGHAGES			
Chopped Grass - Elephant or King (Napier)	10 - 20	12.5 - 14.0	9.5 - 9.8
Corn Silage or Chopped Corn Forage	10 - 20	8.5 - 11.0	8.5 - 8.7
Rice Straw	5 - 8	2.2	3.8
Corn Stover	5 - 15	5.5	8.0
ENERGY CONCENTRATES			
Dried Tapioca Pulp (Onggok)	20 - 45	2.2	11.0
Dried Tapioca Chips (Gaplek)	20 - 45	3.0	12.3
Rice Bran	5 - 15	13.5	11.3
Wheat Bran/Pollard	5 - 15	15.0	11.0
PROTEIN MEALS			
Kopra Meal	5 - 15	22.0	11.5
Palm Kernel Cake (PKC)	2 - 10	16.5	11.0
Soybean Meal	0 - 5	51.5	14.8
WET BY-PRODUCTS			
Brewer's Grain	5 - 20	25.5	12.5
Pineapple Waste	5 - 10	7.5	9.0
Molasses	3 - 8	3.5	12.5
MINERAL ADDITIVES			
Limestone	0.75 - 1.50	n/a	n/a
Dicalcium Phosphate	0.25 - 0.50	n/a	n/a
Sodium Bicarbonate	0 - 0.50	n/a	n/a
Salt	0.25 - 0.50	n/a	n/a
Vitamin/Mineral Premix	0 - 0.10	n/a	n/a
UREA	0.5 - 1.2	287.0	n/a
Typical Ration Analysis	**70 % DM**	**14.5 % CP**	**11.0 MJ ME**
Typical Ration Cost (Rp/kg)	**1,400**		
November, 2008			

Indonesian rations tend to be nutritionally better balanced than those in the Philippines and Malaysia, the result of a broader range of commodity options within each of the main feed ingredient types being generally available in feedlotting areas. Ration DM contents are often close to an ideal level of approx 73%. More importantly, Indonesian rations are also generally higher in energy, due to the availability of high starch Cassava root products - dried tapioca pulp ("onggok"), and tapioca chips ("gaplek") - which are ideal commodities for finishing cattle in feedlots. This particularly applies to feedlots in the Lampung Province of south Sumatra, and on the island of Java, which have the largest cassava plantation areas of Indonesia, as shown in Table 2 below.

Table 2. **Cassava plantation areas of Indonesia.**

Bahasa Indonesia Provinci	*English* Province	AREA Million Hectares	AVE. YIELD Tonnes/ha	PRODUCTION Million Tonnes/year
Lampung	Lampung	298.5	16.7	4,984.6
Jawa Timur	East Java	241.2	15.7	3,786.8
Jawa Tengah	Central Java	215.5	16.1	3,469.9
Jawa Barat	West Java	114.7	14.4	1,651.5
Nusa Tenggara Timur	NTT	75.5	10.7	808.0
D.I. Yogyakarta	D.I. Yogyakarta	47.5	16.1	764.4
Sulawesi Selatan	South Sulawesi	41.9	14.5	607.3
Sumatera Utara	North Sumatra	27.6	14.9	411.2
Banten	Banten	10.8	14.4	154.8
Nusa Tenggara Barat	NTB	8.3	10.7	88.6
Papua	Papua	3.8	10.7	41.0
(lagi)	(others)	154.6	14.9	2,304.1
JUMLAH	TOTAL	1,239.9	14.9	18,473.9

Source: Badan Pusat Statistik (2004)

The widely used “onggok” product is a waste product of tapioca starch factories, and is referred to in some countries, including Brazil, as cassava “bran” or “bagasse”. It is comprised of fibrous cassava root material, but also contains considerable quantities of residual starch that physically could not be extracted as the tapioca starch is separated. It therefore contains a highly significant energy component, which is well utilised by ruminant animals. It also has a large absorption capacity and often contains approximately 75% moisture as it leaves the starch factories.

Figure 2. *Young cassava plants growing in the Lampung district.*

Figure 3. *Harvested cassava plants, showing tuberous starch-containing roots.*

Figure 4. *Unloading of dried cassava roots at a tapioca flour factory. Dried, raw roots when sliced are known as tapioca chips (or "gaplek"), and are a valuable, high energy commodity used very commonly by many Indonesian feedlots.*

Figure 5. *Traditional and common method of sun-drying "onggok", after being trucked from the 40 or so tapioca starch factories located in the Lampung Province. The product arrives at approx 75% moisture and after 3-4 days drying (and protecting from rain), it is sold to feedlots at approx 12-16% moisture content.*

Figure 6. *Dry "onggok" is commonly delivered in bags such as these to feedlots. Depending on the soil in which the roots were grown and whether drying has taken place on soil or concrete, the product is typically contaminated to some degree with soil, sand, partly mouldy product, plus the odd leaves and pieces of bagging twine. Nonetheless, it is a valuable, high energy commodity used by many Indonesian feedlots.*

Figure 7. *Peeled and sun-dried cassava roots are called "gaplek". In Indonesia, this is sold for both human food and animal feed purposes.*

Figure 8. *The sun-drying of sliced roots to produce tapioca chips takes place wherever possible.*

THE PHILIPPINES

The final week of the research trip to the Philippines incorporated meetings with the management of three large feedlots in Luzon, as well as a prominent, emerging Brahman Stud. Rations in Luzon are often dominated by two key cheap commodities - wet brewer's grain ("spent grain") from the San Miguel breweries near Manila and rice straw. Although a safe and useful feedlot ingredient (high in energy, protein, fat & fibre, but low in starch), spent grain can comprise up to 60% of the ration, with resulting ration DM contents often only 40-50 %, and ADG's commonly below their Indonesian counterparts. A representation of commonly observed feedlot finisher rations in the Philippines is shown in Table 3 below.

Table 3. Commonly observed Filipino feedlot finisher rations.

Feed Ingredient Type	Ration Inclusion %	Protein %	Energy MJ ME/kg DM
ROUGHAGES			
Chopped Grass - Elephant or King (Napier)	10 - 20	12.5 - 14.0	9.5 - 9.8
Corn Silage or Chopped Corn Forage	5 - 25	8.5 - 11.0	8.5 - 8.7
Rice Straw	5 - 15	2.2	3.8
Sugar Cane Tops	5 - 20	6.0	7.7
Sugar Cane Bagasse	5 - 15	1.6	7.0
ENERGY CONCENTRATES			
Corn Grain	5 - 15	9.3	14.3
Banana Meal	0 - 15	8.0	10.9
Rice Bran D1 or D2	5 - 20	13.5	11.3
Wheat Dust/Flour	0 - 12	12.0	8.5
PROTEIN MEALS			
Palm Kernel Cake (PKC)	2 - 10	16.5	11.0
Copra Cake	5 - 15	22.0	11.5
Soya Waste	0 - 10	24.5	14.0
WET BY-PRODUCTS			
Brewer's Grain ("Spent Grain")	10 - 35	25.5	12.5
Molasses	3 - 8	3.5	12.5
MINERAL ADDITIVES			
Limestone	0.75 - 1.50	n/a	n/a
Sodium Bicarbonate	0 - 0.50	n/a	n/a
Salt	0.25 - 0.50	n/a	n/a
Vitamin/Mineral Premix	0 - 0.10	n/a	n/a
UREA	0.5 - 1.2	287.0	n/a
Typical Ration Analysis	**45 % DM**	**15.0 % CP**	**10.0 MJ ME**
Typical Ration Cost (Peso/T)	**3.35**		
November, 2008			

MALAYSIA

During the first few days of the SE Asian trip, considerable time was spent with the feed commodity manager from the National Feedlot Centre in Malaysia. Through this meeting and subsequent phone conversations with Dr Rosli Mai Lam from the RMLC Feedlot at Kluang, Malaysia, an update was gained on feedlot commodity options and characteristics in that country. Malaysian rations continue to be dominated by cheap Palm Kernel cake or meal from the huge palm oil industries, at levels of up to 40% or higher. Ration protein levels consequently appear high, but due to poor protein digestibility and high indigestible fibre (lignin) levels, ADG's again tend to run below the Indonesian feedlots. A representation of commonly observed feedlot finisher rations in Malaysia is shown in Table 4.

Table 4. Commonly observed Malaysian feedlot finisher rations.

Feed Ingredient Type	Ration Inclusion %	Protein %	Energy MJ ME/kg DM
ROUGHAGES			
Chopped Grass - Elephant or King (Napier)	10 - 20	12.5 - 14.0	9.5 - 9.8
Chopped Palm Fronds	0 - 12	12.0	5.0
Corn Stover	5 - 20	5.5	8.0
Leucaena Forage	0 - 10	26.0	6.6
ENERGY CONCENTRATES			
Wheat Bran/Pollard	5 - 15	15.0	11.0
Soybean Hulls	5 - 20	13.3	11.0
Rice Bran	5 - 15	13.5	11.3
Tapioca Chips (from Thailand)	0 - 45	3.0	12.3
PROTEIN MEALS			
Palm Kernel Meal (PKM)	10 - 30	17.0	10.0
Palm Kernel Cake (PKC)	10 - 30	16.5	11.0
Copra Cake	5 - 15	22.0	11.5
Soyasauce Waste (semi-dry)	0 - 12	24.5	14.0
WET BY-PRODUCTS			
Brewer's Grain	5 - 25	25.5	12.5
Pineapple Waste	5 - 20	7.5	9.0
Molasses	3 - 8	3.5	12.5
MINERAL ADDITIVES			
Limestone	0.75 - 1.50	n/a	n/a
Sodium Bicarbonate	0 - 0.50	n/a	n/a
Salt	0.25 - 0.50	n/a	n/a
Vitamin/Mineral Premix	0 - 0.10	n/a	n/a
UREA	0.5 - 1.2	287.0	n/a
Typical Ration Analysis	**55 % DM**	**17.0 % CP**	**10.0 MJ ME**
Typical Ration Cost (RM/T) November, 2008	**520.00**		

The close similarity between the "typical" feedlot finisher rations of the three SE Asian countries above is worthy of note.

MAIN AUDIT FINDINGS

A detailed outline of the main audit findings from the research trip is presented in an Excel file, "ADDENDUM - Indonesian Feedlot Commodity Options", which forms an Addendum to this main report document. (This Excel file will be available in downloadable form from the MLA website www.mla.com.au and also on CD.) This listing shows a large number of feeds which are either currently used in Indonesian feedlots (indicated in the "AUDIT - Current Usage?" column), or which are potential new options for future use. Indicative prices, as at November 2008, are given for many commodities, together with comprehensive nutritional data and an indication of feedlot finisher ration upper inclusion levels. Key nutritional components from this file are summarised in Table 5 below.

Table 5. Indonesian feedlot commodity options.

➡ Promise as new feedlot ingredient			Feedlot Finisher Upper INCL RATE (DM basis)	NUTRIENT ANALYSIS (Dry Matter Basis) approximate averages								
AUDIT - Current Usage ?	English equivalent name	Approx Cost Rp/kg Nov'08		Dry Matter %	Metab Energy MJ/kg	Crude Protein %	Crude Fat %	Starch %	ADF %	NDF %	Cal %	Phos %
	HIGH ENERGY INGREDIENTS											
	Dry Feedstuffs											
Yes	Dried Tapioca Pulp - 1st grade	850	45%	88.0	11.0	2.4	0.6	74.0	18.0	23.0	0.19	0.03
Yes	Dried Tapioca Pulp - 3rd grade	600	40%	82.0	9.0	2.0	0.4	57.0	24.5	27.8	0.23	0.03
Yes	Dried Cassava Root chips	1,800	45%	88.0	12.3	3.0	0.9	80.0	9.0	11.7	0.14	0.08
	"Cassapro" (Fermented & Treated Cassava)		50%	88.0		20.0					0.14	0.08
Yes	Tapioca Starch (2nd grade), harder grits	620	35%	88.0	12.0	0.7	0.6	75.0		8.5	0.10	0.10
Yes	Corn grain (ground)	3,350	80%	88.0	14.3	9.3	4.3	75.5	5.5	11.8	0.02	0.27
Yes	Corn Hominy	2,500	40%	88.5	12.3	11.9	4.2	47.4	6.2	21.0	0.03	0.65
Yes	Corn Bran	2,000	40%	89.0	13.6	11.2	7.3	30.3	20.2	41.6	0.03	0.26
Yes	Wheat Flour (2nds, reject)	2,000	25%	88.0	14.3	15.3	2.6	65.9	2.5	9.1	0.07	0.34
Yes	Wheat Bran/Pollard	2,100	40%	90.0	11.0	15.0	3.0	23.5	16.0	42.5	0.10	1.00
Yes	Sweet Potato Waste	1,800	40%	89.0	12.8	8.0	7.0		4.0	5.0	0.13	1.20
Yes	Soybean Hulls	1,800	40%	90.0	11.1	13.3	2.2	6.7	46.7	64.4	0.56	0.12
	Peanut Hulls		30%	96.0		18.5			20.0	28.0	0.67	0.39
Yes	Rice Bran - grade 1 (super)	1,890	25%	89.0	15.3	14.2	15.0	30.6	9.7	18.5	0.07	1.67
Yes	Rice Bran - grade 2	1,200	20%	89.3	11.3	13.9	12.0	25.8	28.0	36.9	0.05	1.37
Yes	Rice Bran - grade 3	750	12%	92.9	8.2	8.0	6.0	18.0	34.5	49.0	0.05	0.62
Yes	Rice Bran - grade 4	400	8%	93.3	6.0	6.0	4.0	12.9	48.7	54.7	0.05	0.60
	Fermented & Treated Rice Bran (3)		30%			13.5					0.05	0.62
	Starch residue from Arenga Pinata tree		20%	91.0	10.1	4.5	2.4			27.1 (CF)		
	Italian Millet (Setaria Italica)		30%	89.0	9.4	12.0	20.0		7.0	20.0	0.10	0.42
	Dried Sago Piths/Rasps	600	30%	89.0	10.0	0.5	0.6	60.0	19.0	20.0	0.40	0.10
	High Moisture ("opportunity") Feedstuffs											
Yes	Wet Tapioca Pulp, direct from press	250	35%	25.0	11.0	2.4	0.6	74.0	18.0	23.0	0.19	0.03
Yes	Brewer's Grains (wet)	550	50%	21.0	12.5	25.5	12.0	2.7	29.0	57.5	0.25	0.55
➡	Corn Earlage		85%	60.0	12.0	8.5	2.0	53.7	10.2	20.0	0.15	0.20
	Sago Starch, fresh		30%	20.0	11.5	3.0	0.6	65.0	15.0	20.0	0.45	0.10
	Bananas, fresh, green (reject)		60%	23.0	12.7	5.0	0.8	73.0	3.0	4.0 (CF)	0.06	0.20
	Thorny Fruit, seed, fresh		30%	47.8	10.8	7.6	1.1				0.03	0.17
	Jack Fruit Seed, fresh		30%	18.0	10.6	14.4	3.2			11.3 (CF)	0.23	0.25
	Jack Fruit Skin, fresh		20%	15.0	10.8	10.8	6.5			18.8 (CF)	0.32	0.17
	Cassava Roots Skin		10%	41.5	10.5	6.9	1.1			10.1 (CF)	0.26	0.13
Yes	Molasses (sugar cane)	950	25%	75.0	12.5	3.5	0.0	0.0	0.2	0.3	0.46	0.02
Yes	Crude Palm Oil	4,000	6%	99.5	38.8	0.0	99.0	0.0	0.0	0.0	0.00	0.00
	Palm Oil Sludge	500	8%	53.0	6.5	3.3	11.3		0.0	0.0	0.70	0.10
	Human Food 2nds/rejects											
Yes	Noodles (human grade, rejects)	3,000	50%	90.0	20.5	8.9	18.9	61.0		3.3 (CF)	0.01	0.09
	Cassava Chips (human grade, rejects)	3,500	30%	90.0	21.6	5.0	25.0	48.3		8.3 (CF)		
	Sweet Potato Chips (human grade, rejects)		30%	90.0	22.7	4.4	35.0	46.2	5.1	11.1	0.11	0.14
	Bread waste (human grade, expired)		40%	68.3	13.6	13.0	2.2	26.0	3.1	8.9	0.14	0.20
	Biscuit waste (human grade, reject)		25%	87.0	15.3	11.5	9.2	44.8	5.6	11.5	0.11	0.40
	Broken Rice (duck rice), 2nd grade	1,600	60%	89.0	14.2	6.0	1.0	77.6	1.0	16.0	0.01	0.13
	Rice waste, boiled (reject)		40%	38.0	14.2	6.0	1.0	77.6	1.0	16.0	0.01	0.13
➡	Hotel & Rest Waste, boiled, dried, ground		15%	92.0	14.8	17.4	21.3		5.0	11.3	0.46	0.35
	Import Potential											
➡	Tapioca chips	1,840	45%	88.0	12.3	3.0	0.9	80.0	9.0	11.7	0.14	0.08
	Corn Grain	2,813	80%	88.0	13.9	9.2	4.1	72.4	2.5	10.3	0.03	0.30
➡	Sorghum Grain	1,908	85%	88.0	13.7	10.9	3.4	71.3	2.9	9.2	0.03	0.32
	Barley Grain	1,946	70%	88.0	13.0	12.6	1.8	59.2	6.3	18.4	0.07	0.41
	Wheat Grain	2,134	60%	88.0	13.7	12.6	1.7	69.0	2.9	9.8	0.05	0.34
	Lupins, blue narrow-leaf (L augustifolius)	3,416	35%	88.0	14.1	35.1	5.7	3.4	20.7	25.3	0.34	0.46
Yes	Dried Distillers Grains + Solubles	3,200	25%	89.0	14.5	30.3	10.1	6.2	15.7	43.5	0.06	0.90
Yes	Corn Gluten Feed	2,000	25%	88.0	13.1	22.7	3.1	20.5	11.4	38.6	0.17	1.02
	Banana Meal (dried)	2,725	30%	90.0	10.9	8.0	1.1	68.0	9.5	17.0	0.13	0.13
➡	Glycerol (Glycerin or Glycerine)	6,500	10%	99.0	14.8	0.0	0.0	0.0	0.0	0.0	0.00	0.00

➡	Promise as new feedlot ingredient		Feedlot Finisher Upper INCL RATE (DM basis)	NUTRIENT ANALYSIS (Dry Matter Basis) approximate averages								
AUDIT - Current Usage ?	English equivalent name	Approx Cost Rp/kg Nov'08		Dry Matter %	Metab Energy MJ/kg	Crude Protein %	Crude Fat %	Starch %	ADF %	NDF %	Cal %	Phos %
	PROTEIN MEALS											
	Dry Feedstuffs											
Yes	Soybean Meal (expeller) - local	3,600	15%	88.0	15.6	30.7	9.1	4.5	7.5	12.5	0.34	0.66
Yes	Copra Meal/Cake (expeller)	2,200	20%	91.0	11.5	22.0	12.5	1.4	34.0	53.0	0.10	0.60
	Enzyme treated Copra Meal		35%									
Yes	Palm Kernel Cake (expeller)	1,450	15%	91.0	11.0	16.5	10.5	1.6	39.0	65.0	0.39	0.22
➡	Chemically treated PKC		20%									
	Enzyme treated PKC		30%									
➡	PKC treated with Rhizopus fungus		30%	90.0		22.0						
Yes	Borneo Tallow Nut Meal (or Illipe Meal)	800	15%	90.0	12.5	13.0	4.1	28.0	22.6	30.4	0.20	0.25
Yes	Cottonseed Meal (screw pressed)	1,600	15%	95.0	11.5	28.4	6.3	2.1	21.1	35.4	0.21	1.05
Yes	Kapok Seed Meal	1,900	8%	90.0	11.7	32.0	9.0		38.0	46.0	0.52	1.00
Yes	Ground Nut Meal, decorticated, extracted		25%	90.0	12.2	54.4	2.8	0.0	12.6	19.1	0.18	0.67
	Ground Nut Hulls		20%	90.6	9.9	18.3	3.5			34.2		
	Candle Nut						17.5					
	Leucaena Leaf Meal		15%	92.0	10.6	24.0	4.4	2.0	28.0	39.0	1.82	0.33
	Cassava Leaves		15%	92.0	7.8	21.5	6.0			35.0	0.70	0.50
	Sweet Potato Vine (after harvest)		10%	92.4	7.1	22.9				35.0	0.25	0.51
	Small Green Pea, dried		25%	88.5	7.9	20.4	2.7			17.1 (CF)	0.28	0.26
	Fish Meal Powder		4%	88.5		41.0	24.5			0.76 (CF)		
➡	Pond weed, dried		15%	90.0		21.4	2.7			36.8	1.16	1.29
➡	Algae (single cell protein), dried			94.0		10.6	42.6	0.0	0.7	1.1	0.23	0.12
➡	Feather Meal (hydrolysed)		10%	92.0	13.9	89.1	7.6	0.0	0.0	0.0	0.46	0.33
	Poultry Byproduct Meal		10%	93.5	11.9	61.5	12.0			3.0 (CF)	5.20	2.90
	Poultry Manure (layers in cages), kering			89.0	8.3	32.3	1.9		34.0	53.0	8.76	2.47
	Poultry Manure (broilers on floor), kering			85.0	8.3	29.8	2.7		34.0	53.0	2.94	1.88
	Poultry Litter (broiler farms)		5%	88.5	7.7	18.6	2.0		70.9	80.4	1.58	0.30
	High Moisture ("opportunity") Feedstuffs											
Yes	Soyasauce Waste (semi-dry)	1,250	10%	63.0	14.0	24.5	27.5	4.0	20.0	25.5	0.50	0.20
Yes	Soyasauce Waste (wet)	1,100	15%	30.0	14.0	24.5	27.5	4.0	20.0	25.5	0.50	0.20
Yes	Tofu / Soybean Curd Waste	1,000	10%	10.0	15.5	23.0	10.0			28.5 (CF)	0.59	0.37
	Papaya fruit skin		10%	12.6	7.6	21.0	3.7				1.30	0.67
	Import Potential											
Yes	Soybean Meal (solv extr) 47%	4,750	15%	91.5	14.8	51.4	1.7	2.3	12.3	18.3	0.48	0.55
Yes	Rapeseed / Canola Meal (solv extr) 34%	2,780	15%	91.0	11.6	37.3	3.8	6.6	19.8	24.2	0.88	1.21
Yes	Sunflower Meal (solv extr) 36%		15%	89.0	10.6	40.4	2.0	4.2	21.5	30.3	0.39	1.35
	Corn Gluten Meal		10%	89.0	14.8	69.7	2.8	15.7	2.1	5.6	0.04	0.34
	Whole (White) Cottonseed		15%	89.0	13.6	24.0	18.0		41.8	51.6	0.17	0.62
	Cottonseed Meal (solv extr) 40%		15%	90.0	10.6	44.4	1.7	2.2	20.7	32.7	0.21	1.11
	Palm Kernel Meal (solv extr)	1,200	15%	88.0	10.0	17.0	3.0	1.0	48.0	77.0	0.25	0.25
	Sesame Meal (expeller)		15%	94.0	13.7	45.7	11.7	0.0	10.6	20.2	1.91	1.28
	Shea Nut (Karite) Meal (solv extr)		10%	90.0		15.6	1.1			13.3 (CF)		
	Water Spinach Seed (Ipomoea aquatica)	1,000	20%	90.0		24.0	5.0					
	Spinach Seed (Amaranthus sp.)	900	15%	90.0		20.0	4.0					
	Fish Meal		4%	91.0	14.6	75.8	10.4	0.0	0.7	1.1	2.82	2.25
Yes	Urea	4,650	1%	95.0	0.0	283.0	0.0	0.0		0.0	0.00	0.00
Yes	Ammonium Sulphate	3,475	0.2%	95.0	0.0	125.0	0.0	0.0		0.0	0.00	0.00

AUDIT - Current Usage ?	English equivalent name	Approx Cost Rp/kg Nov'08	Feedlot Finisher Upper INCL RATE (DM basis)	NUTRIENT ANALYSIS (Dry Matter Basis) approximate averages: Dry Matter %	Metab Energy MJ/kg	Crude Protein %	Crude Fat %	Starch %	ADF %	NDF %	Cal %	Phos %
	ROUGHAGES											
	Dry Feedstuffs											
Yes	Corn Stover	**250**	**10%**	85.0	8.0	5.5	1.3	1.0	39.0	68.0	0.60	0.10
Yes	Rice Straw	**120**	**10%**	86.0	3.8	2.1	0.5	1.0	76.6	92.4	0.18	0.04
Yes	Fermented Rice Straw	**210**	**15%**	90.0	3.8	7.0	0.5	1.0		90.0	0.18	0.04
	Corn Cob		**10%**	90.0	7.0	3.0	0.6		42.2	86.2	0.10	0.06
Yes	Corn Cob Mix, fine	**470**	**10%**	88.0	9.2	7.2	2.3	2.0	33.3	54.8	0.11	0.20
Yes	Cocoa Bean Shells	**1,600**	**10%**	89.0	10.0	14.0	8.0	2.0	36.5	45.0	0.40	0.26
Yes	Coffee Skins	**500**	**8%**	88.0	4.0	9.7	2.0	1.6	52.0	60.0	0.50	0.11
	Pea/bean Skins		**10%**	92.0	4.0	7.0	1.3		65.0	74.0	0.20	0.07
	Sugar Beet Skin		**15%**	90.0	9.0	12.0	0.5		16.0	47.0	0.60	0.10
	Citrus Waste, dried		**15%**	90.0	12.4	6.7	3.7	1.0	14.0	18.0	1.88	0.13
	Banana Skins, dried		**20%**	88.0	9.0	10.0	8.1		11.0	8.0 (CF)	0.48	0.28
	Seaweed, dried. (Kelp most common)		**15%**	91.0	5.0	6.0	1.6		10.0	7.0 (CF)	2.72	0.31
	Oil Palm Trunk (OPT), chipped & dried		**10%**	92.6	6.7	2.6	0.6		52.2	74.4	0.18	0.05
	Rice Hulls	**175**	**2%**	95.0	2.9	3.2	0.7	0.2	58.5	61.5	0.19	0.04
	Cassava Dregs, dried		**20%**	90.0	negligible	11.7	4.6	negligible		35.5 (CF)		0.15
	Sugar Cane Bagasse	**110**	**5%**	91.0	7.0	1.6	0.5	1.0	59.8	86.5	0.51	0.29
	Fermented Bagasse	**275**	**8%**	91.0	11.2	3.6						
	Bagasse treated with 5% NaOH		**10%**	91.0	7.0	1.6	0.5	1.0	55.5	78.5	0.51	0.29
	Bagasse treated with 6% NH4OH		**10%**	91.0	7.0	7.0	0.5	1.0	59.8	86.5	0.51	0.29
	Bagasse + Culture Medium + Glucose		**10%**									
	Bagasse, steam & chemical treated		**10%**									
	Cocoa Pod Skins, fermented, dried		**10%**	90.0	5.5	13.5	1.4				0.34	0.82
	High Moisture Feedstuffs											
Yes	King (Napier) Grass	**175**	**20%**	18.0	9.5	14.0	3.4	1.1	47.8	63.2	0.13	0.30
Yes	Elephant Grass (lokal)	**145**	**20%**	15.0	9.8	12.5	5.2	1.0	51.2	77.3	0.32	0.31
Yes	Forage Corn (green)	**450**	**20%**	21.0	8.7	11.0	2.6	12.0	33.7	56.8	0.30	0.24
Yes	Corn Silage	**550**	**20%**	35.0	8.5	8.5	2.6	15.0	30.5	53.2	0.32	0.18
Yes	Forage Sorghum	**420**	**20%**	25.0	7.5	10.0	2.2	1.2	45.0	70.0	0.30	0.30
Yes	Forage Sorghum Silage	**520**	**20%**	35.0	7.5	10.0	2.2	1.2	45.0	70.0	0.30	0.30
Yes	Pineapple Waste	**250**	**20%**	20.0	9.0	7.5	1.8	1.7	33.9	64.8	0.39	0.20
	Banana Stems, fresh		**15%**	5.6	3.4	2.0	1.4			48.2 (CF)	0.12	0.06
	Oil Palm Trunk (OPT), treated with 6% NaOH		**12%**	32.6	7.7	2.0	0.5		46.3	62.3	0.23	0.05
	High Moisture Leaves											
	Leucaena Leaves, mature	**120**	**15%**	30.0	6.6	26.0	3.0	1.5	25.5	35.5	0.76	0.22
	Papaya Leaves (Carica spp.)		**15%**	21.3	7.0	26.4	13.9			10.7 (CF)	0.70	0.35
	Guava Leaves		**15%**	30.8	3.2	13.8	2.0		40.7	51.2	0.60	0.22
	Yam Root, Leaves		**15%**	37.2	7.1	27.6	5.8			10.7 (CF)	0.52	0.26
	Soybean Straw / Leaves		**15%**									
	Sweet Potato Leaves		**15%**	15.3		23.9	3.7		27.4	37.1	0.80	0.29
	Sweet Potato Leaves & Stalk		**15%**	12.2	6.8	18.0	3.8		29.8	44.6	0.70	0.39
	Jack Fruit Leaves		**15%**	39.3	7.2	13.6	4.5			19.3 (CF)	0.50	0.10
	Banana Leaves		**15%**	24.8	6.0	14.4	2.0		44.6	70.3	0.40	0.19
	Cabbage Leaves		**10%**	7.0	9.1	22.3	1.5			11.7 (CF)	0.67	0.91
	Pumpkin Leaves		**15%**	17.6	8.4	19.6	3.3		21.4	39.7	3.33	0.33
Yes	Oil Palm Fronds (OPF), young	**120**	**15%**	45.0	5.5	13.0	2.9		47.0	68.8	0.79	0.16
Yes	Oil Palm Fronds (OPF), old	**80**	**10%**	33.0	4.6	10.9	1.8		42.0	67.2	0.54	0.25
	OPF Silage, treated with NaOH		**16%**									
	Oil Palm Fronds (OPF), steam treated		**16%**									
	Import Potential											
	Sugarcane Tops, dried	**350**	**20%**	88.0	7.7	6.0	1.7	0.9	46.2	68.5	0.50	0.20
	Apple juice factory waste	**4,021**	**40%**	90.0	10.4	7.7	5.0		43.2	52.5	0.20	0.14
	Cavalcade Hay	**1,858**	**25%**	92.0	7.7	10.3	0.2	10.9	44.3	58.4	1.20	0.06

A ranking of feed commodities on a cost per unit of energy and cost per unit of protein basis is shown in spreadsheet format in the Excel file, “ADDENDUM - Indonesian Feedlot Commodity Options”, which forms an Addendum to this main report document.

Unfortunately when ranking commodities in the above tables, the exercise becomes limited by the current lack of a complete data set of prices, as well as energy and protein values. The completion of this data set would be dependent upon individual feedlot local knowledge of commodity acquisition and transportation costs, as well as nutritional profiles. The feed listings in this report have been constructed as spreadsheet templates such that accurate pricing and availability data can be sourced and kept up to date by individual feedlot commodity purchasing staff.

The ranking of feeds on a cost per unit of energy or protein basis is summarised below in Table 6 and Table 7, respectively, in which feeds are firstly grouped according to classification into energy or protein feeds on the basis of nutrient analysis. As such, all high roughage feeds are excluded. On this basis, the cheapest energy sources are: tapioca starch (2nd grade), dried sago piths/rasps, rice bran (grade 4), dried tapioca pulp (3rd grade), and dried tapioca pulp (1st grade). In reality, the first two here are not widely available to feedlotters, low grade rice bran is very high in indigestible lignin, while 3rd grade tapioca pulp is often significantly contaminated with sand, soil or mould. The cheapest protein sources were: urea, ammonium sulphate, water spinach seed, spinach seed, cottonseed meal (local, screw pressed), kapok seed meal, Borneo tallow nut meal, and palm kernel meal. Unfortunately, there are either anti-nutritional, palatability, availability or seed size limitations with each of these.

Rather than simple cost rankings on the basis of single nutrients, more powerful linear programming tools are required to effectively formulate rations from ingredients with complex nutritional matrices. This concept is discussed in more detail below, under the section titled “Least-cost feed formulation techniques”.

Table 6: Ranking of "energy" commodities (for which accurate pricing information is available), based on cost per unit of metabolisable energy.

English equivalent name	Nov'08			Feedlot Finisher Indicative Upper INCLUSION RATE (Dry Matter basis)	ANALYSIS (DM basis)		
	Importation & Transport Costs Rp/kg	Approx Landed Feedlot Cost Rp/kg	DRY BASIS Landed Feedlot Cost Rp/kg DM		Dry Matter %	Metabolisable Energy MJ/kg	COST PER UNIT ENERGY Rp/MJ (DMB)
	NEED FEEDLOT SPECIFIC DATA	NEED FEEDLOT SPECIFIC DATA					
Tapioca Starch (2nd grade), harder grits		620	705	35%	88.0	12.0	58.7
Dried Sago Piths/Rasps		600	674	30%	89.0	10.0	67.4
Rice Bran - grade 4		400	429	8%	93.3	6.0	71.5
Dried Tapioca Pulp - 3rd grade		600	732	40%	82.0	9.0	81.3
Dried Tapioca Pulp - 1st grade		850	966	45%	88.0	11.0	87.8
Wet Tapioca Pulp, direct from press		250	1,000	35%	25.0	11.0	90.9
Rice Bran - grade 3		750	807	12%	92.9	8.2	98.5
Molasses (sugar cane)		950	1,267	25%	75.0	12.5	101.4
Crude Palm Oil		4,000	4,020	6%	99.5	38.8	103.6
Rice Bran - grade 2		1,200	1,344	20%	89.3	11.3	119.4
Broken Rice (duck rice), 2nd grade		1,600	1,798	60%	89.0	14.2	126.6
Rice Bran - grade 1 (super)		1,890	2,124	25%	89.0	15.3	138.8
Palm Oil Sludge		500	943	8%	53.0	6.5	145.1
Sweet Potato Waste		1,800	2,022	40%	89.0	12.8	157.6
Sorghum Grain (IMPORTED)	400	1,908	2,168	85%	88.0	13.7	158.5
Wheat Flour (2nds, reject)		2,000	2,273	25%	88.0	14.3	158.7
Noodles (human grade, rejects)		3,000	3,333	50%	90.0	20.5	162.6
Corn Bran		2,000	2,247	40%	89.0	13.6	165.3
Dried Tapioca Chips		1,800	2,045	45%	88.0	12.3	166.3
Barley Grain (IMPORTED)	400	1,946	2,211	70%	88.0	13.0	169.5
Dried Tapioca Chips (IMPORTED)	300	1,840	2,091	45%	88.0	12.3	170.0
Corn Gluten Feed (IMPORTED)	400	2,000	2,273	25%	88.0	13.1	173.9
Wheat Grain (IMPORTED)	400	2,134	2,425	60%	88.0	13.7	177.3
Soybean Hulls		1,800	2,000	40%	90.0	11.1	180.0
Cassava Chips (human grade, rejects)		3,500	3,889	30%	90.0	21.6	180.0
PKP Cattle Pellet (Tribakti Sarimus)		1,800	2,000	80%	90.0	10.0	200.0
Brewer's Grains (wet)		550	2,619	50%	21.0	12.5	209.5
Wheat Bran/Pollard		2,100	2,333	40%	90.0	11.0	212.1
Corn Hominy		2,500	2,825	40%	88.5	12.3	229.7
Dried Dist Grains+Solubles (IMPORTED)	400	3,200	3,596	25%	89.0	14.5	247.6
Corn grain (local)		3,350	3,807	80%	88.0	14.3	266.2
Lupins, blue narrow-leaf (IMPORTED)	400	3,416	3,882	35%	88.0	14.1	274.6
Banana Meal (IMPORTED)	375	2,725	3,028	30%	90.0	10.9	277.8
Glycerol, also called Glycerin or Glycerine		6,500	6,566	10%	99.0	14.8	445.1

NOTE: Refer to page 19 above for a discussion of the limitations of the practical application of this table.

Table 7: Ranking of "protein" commodities (for which accurate pricing information is available), based on cost per unit of crude protein.

	Nov'08			Feedlot Finisher Indicative Upper INCLUSION RATE (Dry Matter basis)	ANALYSIS (DM basis)		
English equivalent name	Importation & Transport Costs Rp/kg	Approx Landed Feedlot Cost Rp/kg	DRY BASIS Landed Feedlot Cost Rp/kg DM		Dry Matter %	Crude Protein %	COST PER UNIT PROTEIN Rp/% CP (DMB)
	NEED FEEDLOT SPECIFIC DATA	NEED FEEDLOT SPECIFIC DATA					
Urea (IMPORTED)	400	4,650	4,895	1%	95.0	283.0	17.3
Ammonium Sulphate (IMPORTED)	400	3,475	3,658	0.2%	95.0	125.0	29.3
Water Spinach Seed (IMPORTED)	350	1,000	1,111	20%	90.0	24.0	46.3
Spinach Seed (IMPORTED)	350	900	1,000	15%	90.0	20.0	50.0
Cottonseed Meal (screw pressed)		1,600	1,684	15%	95.0	28.4	59.3
Kapok Seed Meal		1,900	2,111	8%	90.0	32.0	66.0
Borneo Tallow Nut Meal (or Illipe Meal)		800	889	15%	90.0	13.0	68.4
Palm Kernel Meal (solv extr) (IMPORTED)	350	1,200	1,364	15%	88.0	17.0	80.2
Soyasauce Waste (semi-dry) (IMPORTED)	300	1,250	1,984	10%	63.0	24.5	81.0
Canola Meal (solv extr) 34% (IMPORTED)	400	2,780	3,055	15%	91.0	37.3	82.0
Palm Kernel Cake (expeller)		1,450	1,593	15%	91.0	16.5	96.6
Soybean Meal (solv extr) 47% (IMPORTED)	400	4,750	5,191	15%	91.5	51.4	101.1
Copra Meal/Cake (expeller)		2,200	2,418	20%	91.0	22.0	109.9
Soybean Meal (expeller) - local		3,600	4,091	15%	88.0	30.7	133.3
Soyasauce Waste (wet)		1,100	3,667	15%	30.0	24.5	149.7
PKP Cattle Pellet (Tribakti Sarimus)		1,800	2,000	80%	90.0	13.0	153.8
Tofu / Soybean Curd Waste		1,000	10,000	10%	10.0	23.0	434.8

NOTE: Refer to page 19 above for a discussion of the limitations of the practical application of this table.

Comments on the likely availability of commodities for feedlot use and the likely presence or absence of various anti-nutritional factors which may limit usage, are given in Table 8 below.

Table 8. General availability and anti-nutritional factors in feed commodities for Indonesian feedlots.

Indonesian name	English equivalent name	General Availability	Anti-Nutritional Factors of concern for Cattle in Feedlots
		NCA - Not Commercially Available, in most cases	
HIGH ENERGY INGREDIENTS			
Dry Feedstuffs			
Onggok Kwalitat, kering	Dried Tapioca Pulp - 1st grade	Sth Sumatra (Lampung), East, Central & West Java	Cyanogenic Glucosides vary across varieties. Normal range 15-400 mg HCN/kg
Onggok Asalan, kering	Dried Tapioca Pulp - 3rd grade	Sth Sumatra (Lampung), East, Central & West Java	roots (up to 100 ppm generally safe). Statutory limit in many countries is max 50 mg
Gaplek, kering	Dried Cassava Root chips	Sth Sumatra (Lampung), East, Central & West Java	HCN/kg in finished feeds (Feeding Stuff Regulations, UK, 1995). ###
Singkong difermentasi dengan kapang +kimia	"Cassapro" (Fermented & Treated Cassava)	NCA - Specialist research organizations	Also Mycotoxin risk where product sun-dried on soil.
Tepung Elot / Lindur	Tapioca Starch (2nd grade), harder grits	Not available in large quantities	
Jagung Giling	Corn grain (ground)	Possible in many locations, but FOOD FOR HUMANS	
Jagung Grontol / Homini	Corn Hominy	Not available in large quantities	
Dedak Jagung	Corn Bran	Competition from Poultry (mainly) + Pig industries	
Tepung Gandum	Wheat Flour (2nds, reject)	Dependent on proximity to flour mills	
Dedak/Polard Gandum	Wheat Bran/Pollard	Dependent on proximity to flour mills	
Kentang Manis, residu ubi	Sweet Potato Waste	Dependent on proximity to processing factories	
Kulit Kedelai	Soybean Hulls	Some lokal, but also imported from Malaysia	
Kulit Kacang Tanah	Peanut Hulls	Dependent on proximity to processing factories	Possible Aflatoxins
Dedak Padi - satu	Rice Bran - grade 1 (super)	Widespread, but sought after by Poultry & Pig industries	High unsaturated fat content may lead to soft subcutaneous fat (+ rancidity)
Dedak Padi - dua	Rice Bran - grade 2	Widespread	High unsaturated fat content may lead to soft subcutaneous fat (+ rancidity)
Dedak Padi - tiga	Rice Bran - grade 3	Widespread	Relatively high unsaturated fat content may lead to soft subcutaneous fat
Dedak Padi - empat	Rice Bran - grade 4	Widespread	High Sekam (rice hull) levels
Dedak Padi - tiga, difermentasi	Fermented & Treated Rice Bran (3)	NCA - Specialist research organizations	
Ampas Pati Aren	Starch residue from Arenga Pinata tree	Mainly Central Java, but probably "NCA"	
Jawawut, biji, kering	Italian Millet (Setaria Italica)	NCA - Limited, as human food competitor	
Sagu, empulur kering	Dried Sago Piths/Rasps	NCA - only Sago Palm forests, N Sumatra, Kalimantan, Irian Jaya	
High Moisture ("opportunity") Feedstuffs			
Onggok Basah	Wet Tapioca Pulp, direct from press	Sth Sumatra (Lampung), East, Central & West Java	Cyanide risk highest in wet product; sun-drying generally reduces to < 100 ppm
Ampas Bir, segar	Brewer's Grains (wet)	Available within proximity to the larger cities	Should be fed within 3 days of delivery, or ensiled (see project Final Report)
Tongkol / Janggel Jagung, silase	Corn Earlage	POSSIBLE ON MANY FEEDLOTS, BUT LOGISTICS + PRICE ??	
Sagu, segar	Sago Starch, fresh	Sago Palm forest areas of N Sumatra, Kalimantan, Irian Jaya	
Pisang Mentah, segar (reject)	Bananas, fresh, green (reject)	Possibly, near large commercial plantations	
Durian, biji, segar	Thorny Fruit, seed, fresh	Possibly, near large minicipal markets (overripe fruit?)	
Nangka, biji, segar	Jack Fruit Seed, fresh	Possibly, near canning factories	
Kulit Nangka, segar	Jack Fruit Skin, fresh	Possibly, near canning factories	
Kulit Singkong, ubi kayu	Cassava Roots Skin	NCA - Limited quantities only, near Tapioca factories	Cyanogenic Glucosides (see Onggok & Gaplek above) ###
Tetes tebu	Molasses (sugar cane)	Many locations	
Minyak Kelapa Sawit Mentah (CPO)	Crude Palm Oil	Good lokal supply, but also can be imported - Malaysia	
Lumpur Minyak Sawit (POS)	Palm Oil Sludge	Dependent on proximity to CPO factories	Possible contaminants
Human Food 2nds/rejects			
Mie, sisa pabrik, kering	Noodles (human grade, rejects)	Eg., Indofood's "Supermi" - near big cities	
Singkong Keripik, sisa pabrik	Cassava Chips (human grade, rejects)	Eg., Indofood's "Qtela" - near big cities	High in Sodium, 0.6%
Kentang Keripik, sisa pabrik	Sweet Potato Chips (human grade, rejects)	Available within proximity to many large cities	
Roti, sisa pabrik	Bread waste (human grade, expired)	PT Bumiraya Technotama (trader), Jakarta	Moulds can develop quickly if not fed immediately
Biskuit, sisa pabrik	Biscuit waste (human grade, reject)	PT Bumiraya Technotama (trader), Jakarta	
Beras Menir Bebek	Broken Rice (duck rice), 2nd grade	Possible in many locations, but competition from humans	
Nasi, kelebihan, basah	Rice waste, boiled (reject)	Possible in many locations, but shelf life only 2-3 days	
Hotel & Restaurant, makanan sisa, rebus, kering	Hotel & Rest Waste, boiled, dried, ground	Big potential, but processing & meat removal necessary	
Import Potential			
Tapioca chips	Dried Cassava Root (Manioc) chips	Thailand	Cyanogenic Glucosides vary across varieties. Normal range 15-400 mg HCN/kg
Tapioca chips	Dried Cassava Root (Manioc) chips	Vietnam, Myanmar	roots (up to 100 ppm generally safe). Statutory limit in many countries is max 50 mg
Tapioca chips	Dried Cassava Root (Manioc) chips	Nigeria, Dem Rep of Congo	HCN/kg in finished feeds (Feeding Stuff Regulations, UK, 1995). ###
Tapioca chips	Dried Cassava Root (Manioc) chips	Brazil, Paraguay	Also Mycotoxin risk where product sun-dried on soil.
Corn Grain	Corn Grain	Australia, USA, China, Argentina, Brazil	
Sorghum Grain	Sorghum Grain	Australia	Would need grinding, cracking, steam-flaking or high moisture treatment
Barley Grain	Barley Grain	Australia, USA, Canada, Argentina, Brazil, Russia, Ukraine	
Wheat Grain	Wheat Grain	Australia, USA, Canada, Argentina, Brazil, Russia, Ukraine	
Lupins	Lupins, blue narrow-leaf (L augustifolius)	Australia (WA)	Alkaloids must be limited to 0.02% finished feed. Would need grinding.
DDGS (Corn)	Dried Distillers Grains + Solubles (fm Corn)	USA, Canada, Argentina, Brazil	Relatively high unsaturated fat content may lead to soft subcutaneous fat
Corn Gluten Feed	Corn Gluten Feed	USA, Canada, Argentina, Brazil	
Banana Meal	Banana Meal (dried)	The Philippines	
Glycerol	Glycerol, also called Glycerin or Glycerine	USA (now commonly a byproduct of Biodiesel production)	

Indonesian name	English equivalent name	General Availability	Anti-Nutritional Factors of concern for Cattle in Feedlots
		NCA - Not Commercially Available, in most cases	
PROTEIN MEALS			
Dry Feedstuffs			
Bungkil Kedelai - lokal	Soybean Meal (expeller) - local	Local production, but is growing	
Bungkil Kopra (exp)	Copra Meal/Cake (expeller)	Widespread	Lignin (indigestible) can average 11%
Bungkil Kopra (exp) + proses enzim	Enzyme treated Copra Meal	NCA - Specialist research organizations	
Bungkil Sawit (exp), PKC	Palm Kernel Cake (expeller)	Widespread	Palatability not high. High Shell content can --> ave 15% Lignin in PKC
Bungkil Sawit (exp) + proses kimia	Chemically treated PKC	NCA - Specialist research organizations	Palatability not high. High Shell content can --> ave 15% Lignin in PKC
Bungkil Sawit (exp) + proses enzim	Enzyme treated PKC	NCA - Specialist research organizations	Palatability not high. High Shell content can --> ave 15% Lignin in PKC
Bungkil Sawit (exp) + fermentasi dengan kapang	PKC treated with Rhizopus fungus	NCA - Specialist research organizations	Palatability not high. High Shell content can --> ave 15% Lignin in PKC
Bungkil Tengkawang	Borneo Tallow Nut Meal (or Illipe Meal)	Product of Kalimantan (mostly), also Sumatra	High in tannins, but generally safe at recommended inclusion
Bungkil Kapas (ekstraksi mekanis) - lokal	Cottonseed Meal (screw pressed)	East Java, Sulewesi and Lombok	
Bungkil Biji Kapuk (B. Klenteng?)	Kapok Seed Meal	Available mostly from East Java	Cyclopropenoid fatty acids toxic at higher inclusion rates; Protein poorly digestible
Bungkil Kacang tanah	Ground Nut Meal, decorticated, extracted	Widespread	Aflatoxin risk if poorly harvested & processed
Kulit Kacang tanah	Ground Nut Hulls	NCA - limited supply	Aflatoxin risk if poorly harvested & processed; also very high Iron content
Kemiri	Candle Nut	NCA for cattle, but wide variety of uses for humans	Mildly toxic to humans in raw state. Cattle ??
Tepung Daun Lamtoro (Ipil Ipil), kering	Leucaena Leaf Meal	Lokal, also import from Malaysia	Inoculation of unexposed cattle against Mimosine needed. Can --> yellow fat.
Singkong, daun, kering	Cassava Leaves	Widespread, but must be sun-dried & ground	Cyanide in fresh leaves up to 2,000 mg/kg, but chopping & drying reduces by 90%
Sisa Tanaman Ubi Jalar, sisa panen	Sweet Potato Vine (after harvest)	NCA, but is possible near large cultivation areas	???
Kacang Hijau, biji, kering	Small Green Pea, dried	USDA tried to promote this, but generally too expensive for cattle	
Tepung Ikan - lokal	Fish Meal Powder	Widespread, but price competition from Poultry & export markets	
Azolla, kering	Pond weed, dried	Widespread growth is possible	
Lumut, kering	Algae (single cell protein), dried	Widespread growth is possible	
Tepung Bulu Unggas (dihidrolise)	Feather Meal (hydrolysed, steam under pressure)	Dependent on poultry plants (keratin must be hydrolysed)	Pepsin digestibility must be > 75%, but < 80%
Tepung Limbah Sisa Pemerosesan Ayam	Poultry Byproduct Meal	Dependent on proximity to rendering factory	Salmonella risk. Must be heat sterilized & used within 3 days.
Najis Ayam (ayam petelur dikurung), kering	Poultry Manure (layers in cages), kering	Widespread, but DISEASE RISKS inc Botulism & BSE	Range of Pathogens possible, inc Botulism & BSE. Must be ensiled as minimum.
Najis Ayam (ayam pedaging di lantai), kering	Poultry Manure (broilers on floor), kering	Widespread, but DISEASE RISKS inc Botulism & BSE	Range of Pathogens possible, inc Botulism & BSE. Must be ensiled as minimum.
Habuk Kayu + Najis Ayam (peternakan ayam pedaging)	Poultry Litter (broiler farms)	Widespread, but DISEASE RISKS inc Botulism & BSE	Range of Pathogens possible, inc Botulism & BSE
High Moisture ("opportunity") Feedstuffs			
Ampas Kecap, setengah kering	Soyasauce Waste (semi-dry)	Some lokal, but also imported from Singapore	
Ampas Kecap, segar basah	Soyasauce Waste (wet)	Dependent on proximity to soy processing factories	
Ampas Tahu, segar	Tofu / Soybean Curd Waste	Dependent on proximity to soy processing factories	
Kulit Buah Papaya	Papaya fruit skin	Possible near juice factories, but generally "NCA"	Somewhat limited by sour taste
Import Potential			
Soybean Meal	Soybean Meal (solv extr) 47%	Argentina, Brazil, USA, China, India	
Rapeseed / Canola Meal	Rapeseed / Canola Meal (solv extr) 34%	India, Pakistan	Glucosinolates (older Rapeseed varieties only)
Sunflower Meal	Sunflower Meal (solv extr) 36%	India, Pakistan	
Corn Gluten Meal	Corn Gluten Meal	USA, Canada, Argentina, Brazil	
Whole Cottonseed	Whole (White) Cottonseed	China, India, Pakistan, USA	Free Gossypol, but unlikely concern in feedlots
Cottonseed Meal	Cottonseed Meal (solv extr) 40%	China, India, Pakistan, USA	
Palm Kernel Meal (solv), PKM	Palm Kernel Meal (solv extr)	Malaysia	Palatability not high. High Shell content can --> ave 15% Lignin in PKM
Sesame Meal	Sesame Meal (expeller)	China, India, Myanmar, Malaysia	
Shea Nut (Karite) Meal	Shea Nut (Karite) Meal (solv extr)	Africa	If Shea shells included in meal, these are high in tannin
Kangkung Darat, biji	Water Spinach Seed (Ipomoea aquatica)	Some lokal, but also imported from Malaysia	Very small seed size may require grinding for best utilisation by cattle
Bayam, biji	Spinach Seed (Amaranthus sp.)	Malaysia	Very small seed size may require grinding for best utilisation by cattle
Tepung Ikan	Fish Meal	Sth America - Chile, Peru	
Urea	Urea	China	NPN source; to be introduced gradually, up to 120 g/hd/day max.
Ammonium Sulphate	Ammonium Sulphate	China	NPN source; to be introduced gradually, up to 25 g/hd/day max.

Indonesian name	English equivalent name	General Availability	Anti-Nutritional Factors of concern for Cattle in Feedlots
		NCA - Not Commercially Available, in most cases	
ROUGHAGES			
Dry Feedstuffs			
Jerami Jagung	Corn Stover	Widespread	
Jerami Padi	Rice Straw	Widespread	Poor digestibility (43% of DM), due to high contents of lignin & silica
Jerami Padi, difermentasi	Fermented Rice Straw	On-farm process, possible anywhere	
Janggel Jagung	Corn Cob	Dependent on proximity to corn processing factories	
Janggel Jagung (Tumpi)	Corn Cob Mix, fine	Dependent on proximity to corn processing factories	
Kulit Biji Coklat	Cocoa Bean Shells	Dependent on proximity to processing factories	Theobromine (alkaloid) risk at high levels
Kulit Kopi	Coffee Skins	Lampung coffee bean factories	High Lignin, 26%; Caffeine risk at high levels
Kulit Kacang, kering	Pea/bean Skins	Java, Sth Sumatra and Sulewesi, but generally "NCA"	
Kulit Bit, kering	Sugar Beet Skin	NCA	
Limbah Citrus, kering	Citrus Waste, dried	Dependent on proximity to citrus fruit factories	Orange pulp contains Citral, a Vit A antagonist
Kulit Pisang, kering	Banana Skins, dried	Dependant on factory	
Seaweed (Kelp), kering	Seaweed, dried. (Kelp most commonly available)	Generally available in many places through traders	Approx 30% Ash (mineral). High in Salt (~ 6.5%) & Iodine (0.15-0.20%)
Batang Kelapa Sawit, dicincang dan kering	Oil Palm Trunk (OPT), chipped & dried	Palm plantation areas	
Sekam	Rice Hulls	Widespread, but very little feed value	High Silica (22%) dramatically lowers digestibility (3% fall in dig'y per % Si)
Singkong Ethanol Byproduct, kering	Cassava Dregs, dried	Dependent on proximity to Cassava Ethanol factories	Early indications suggest minimal risks, although acidic product (pH 4.5)
Ampas Tebu	Sugar Cane Bagasse	Dependent on proximity to sugar refineries	High Lignin (approx 27%)
Ampas Tebu, difermentasi	Fermented Bagasse	Dependent on proximity to sugar refineries	
Ampas Tebu + kimia, NaOH	Bagasse treated with 5% NaOH	Dependent on proximity to sugar refineries	Sodium hydroxide treatment improves digestibility but reduces palatability
Ampas Tebu + kimia, NH4OH	Bagasse treated with 6% NH4OH	Dependent on proximity to sugar refineries	
Ampas Tebu + culture medium + Glucose	Bagasse + Culture Medium + Glucose	Dependent on proximity to sugar refineries	
Ampas Tebu, diuapi + kimia	Bagasse, steam & chemical treated	Dependent on proximity to sugar refineries	
Kulit Buah Kakao, difermentasi, kering	Cocoa Pod Skins, fermented, dried	Riau, Sulawesi, Kalimantan, but 85% moisture at harvest	
High Moisture Feedstuffs			
Rumput Rajah (mid growth), segar	King (Napier) Grass	Widespread	
Rumput Gajah (young), segar	Elephant Grass (lokal)	Widespread	
Tebon Jagung, segar	Forage Corn (green)	Widespread	
Silase Jagung, segar	Corn Silage	Widespread, where modern farming machinery used	
Tebon Cantel, segar	Forage Sorghum	Currently limited, due to preference for Forage Corn	Prussic Acid risk (if > 600 ppm HCN) when new growth after drought stress
Silase Cantel, segar	Forage Sorghum Silage	Currently limited, due to preference for Forage Corn	Reduced Prussic Acid risk after drought stress if forage is ensiled
Ampas Nanas, segar	Pineapple Waste	Within proximity to pineapple factories, eg, GGPC, Sumatra	Do not allow to ferment for > 5 days after delivery, or ensile (see Final Report)
Batang Pisang, segar	Banana Stems, fresh	Possible near banana plantations, but generally "NCA"	
Batang Kelapa Sawit, segar + kimia	Oil Palm Trunk (OPT), treated with 6% NaOH	Palm plantation areas ??	
High Moisture Leaves			
Lamtoro (Ipil Ipil), daun, dewasa	Leucaena Leaves, mature	Availabile but very labour intensive	Inoculation of unexposed cattle against Mimosine needed. Can --> yellow fat.
Buah Papaya, daun	Papaya Leaves (Carica spp.)	NCA - very limited supply	
Jambu Batu, daun	Guava Leaves	NCA - very limited supply	
Keladi/Talas, daun	Yam Root, Leaves	NCA - limited supply	
Jerami Kedelai	Soybean Straw / Leaves	Periodically, small quantities available in Java, Sulewesi & Sumatra	
Ubi Keledek/Jalur, daun	Sweet Potato Leaves	Limited unless part of harvested vine	
Ubi Keledek/Jalur, daun dan tangkai	Sweet Potato Leaves & Stalk	Proximity to large cultivation area after harvest ?	
Nangka, daun	Jack Fruit Leaves	NCA - very limited supply	
Pisang, daun	Banana Leaves	NCA - used for packaging	
Kubis/Kol, daun	Cabbage Leaves	NCA, but very large volumes of cabbages grown in Indonesia	
Labu, daun	Pumpkin Leaves	NCA - very limited supply	
Kelapa Sawit, daun (muda)	Oil Palm Fronds (OPF), young	Palm plantation areas	
Kelapa Sawit, daun (tua)	Oil Palm Fronds (OPF), old	Palm plantation areas	
Silase Kelapa Sawit, daun + kimia	OPF Silage, treated with NaOH	Palm plantation areas	Sodium hydroxide treatment improves digestibility but reduces palatability
Kelapa Sawit, daun, diuapi	Oil Palm Fronds (OPF), steam treated	Palm plantation areas	
Import Potential			
Pucuk Tebu, kering	Sugarcane Tops, dried	Sugar mill at Cirebon, W Java, or import - Philippines	
Apple Pomace, kering	Apple juice factory waste, dried & pelleted	China	
Cavalcade Hay	Cavalcade Hay	Australia (Katherine, NT)	

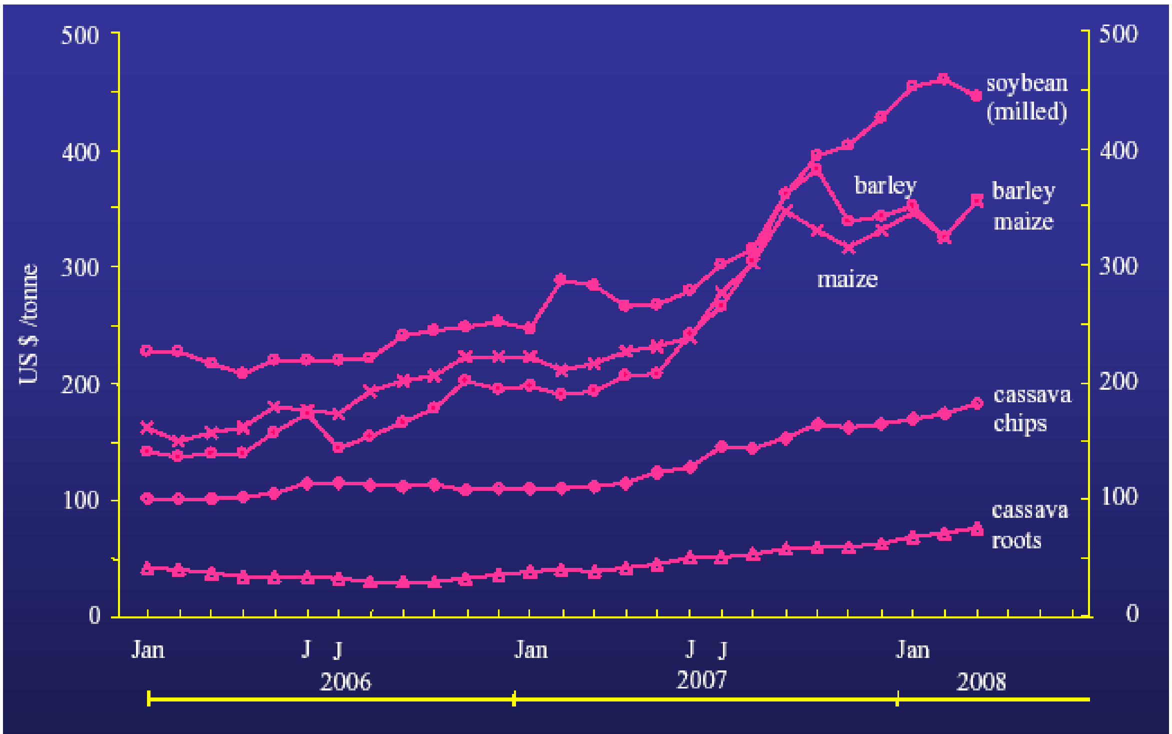
When feeding Cassava products, it is advisable that cattle rations be adequately supplemented with protein (or specifically methionine) and iodine (FAO and IFAD, 2004).

4.1.2 Results – Search for Alternatives

A search for alternatives to the current heavy reliance of Indonesian feedlotters upon cassava roots and cassava by-products in cattle fattening rations seems particularly justified in view of information presented at the recent World Tapioca Conference, held from 15-16 January, 2009 in Bangkok, Thailand.

Data presented in Diagram 1 below by Dr Reinhardt Howeler, Agronomist, CIAT - Cassava Office for Asia, Bangkok, illustrates how in Thailand, SE Asia's largest producer of cassava products, prices for cassava chips and cassava roots have remained considerably more attractive than for barley and maize grains. This has had the effect of increasing global competition for cassava products at the expense of more traditional cereal grains, and this trend is likely to continue to influence prices paid for cassava in Indonesia by cattle feedlotters.

Diagram 1. Change in the price of milled soybean, barley, maize, dry cassava chips and fresh cassava roots in Thailand from January 2006 to March 2008 (Howeler, 2009).



Sources: Thai Trade Center, The Netherlands (soybean, barley, maize), & Thai Customs Department (cassava products).

Competition for cassava from biofuel industries is also becoming highly relevant. In the words of Howeler (2009), "Cassava for fuel-ethanol is markedly increasing the demand for cassava roots, increasing prices and improving the livelihoods of many poor farmers in Asia." The competitiveness of cassava fresh roots and dry chips for the production of ethanol, albeit in Thailand, is clearly demonstrated in Table 9 below.

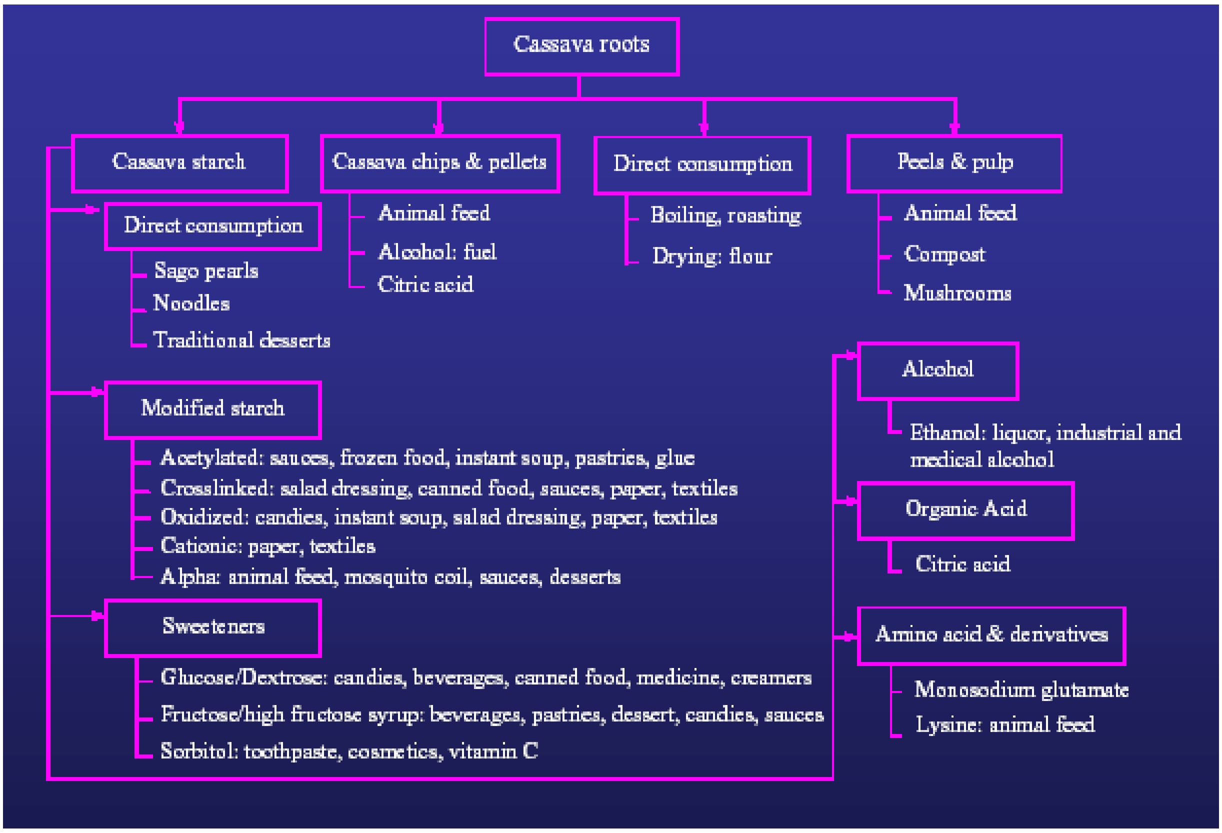
Table 9. Raw material costs per litre of ethanol produced from various crops potentially used for ethanol production in Thailand.

CROP	Planted Area '000 ha	Production '000 tonnes	Yield T/ha	Conversion kg/L Ethanol	Raw Material Price US $/T	Raw Material Cost US$/1000 L eth
Maize	1,258	4,461	3.55	2.7	104.00	281.00
Rice	9,761	25,608	2.62	-	-	-
Broken Rice	-	-	-	2.7	150.00	405.00
Sugar Cane	1,065	62,828	58.99	14.3	17.00	243.00
Molasses	-	3,000	-	4.0	37.00	148.00
Cassava - fresh roots	1,101	18,265	16.59	6.5	26.00	169.00
Cassava - dry chips	-	-	-	2.5	62.00	155.00

Source: Adapted from Piyachomkwan (2005), by Howeler (2009).

Further appreciation of the global competitiveness for cassava roots and products can be gained by examining Diagram 2 below, which details a sample of the great diversity of human foods, industrial products, fertilizers and fuel which are commonly developed from the cassava root.

Diagram 2. The great diversity of food, feed, fuel, fertilizer and industrial value-added products from the cassava root (Howeler, 2009).



ALTERNATIVES IDENTIFIED

As discussed in the previous section, Table 5 "Indonesian Feedlot Commodity Options" is a table listing a wide range of potential alternative commodity options for Indonesian feedlots. The column titled "AUDIT - Current Usage ?" indicates which commodities are potential new options. Those highlighted with the green arrow possibly hold the greatest promise as new alternative feedlot ingredients, and these are further discussed below.

Unfortunately, many of the "opportunity" feedstuffs listed as options may in general be difficult for feedlotters to secure in large regular quantities. Even if used at only 1 kg per head per day, an average sized 4,000 hd feedlot would require 28 tonnes per week of any newly acquired commodity.

Spreadsheets to be provided in downloadable form or on CD for individual feedlotters to update

Accurate pricing information for several of these alternatives, including the list of imported options, has also been difficult to acquire, and as discussed in the previous section, this then distorts any attempted ranking of commodities according to cost per unit of energy or protein. Pricing inaccuracy would also greatly limit the accuracy of least-cost feed formulation techniques. However, purchasing staff for individual feedlots are in the best position to accurately determine the pricing and availability of any feeds within proximity of their feedlot, together with an assessment of their ability to handle and store these commodities. It is recommended that information provided here in the Excel file forming the Addendum to this report be made available to interested feedlotters as a downloadable file from the MLA website www.mla.com.au and also on CD, such that accurate pricing, availability and nutritional data can be sourced, kept up to date and used in feed formulating calculations.

Least-cost feed formulation technique

As has been introduced during the previous discussion of commodity rankings, linear programming tools are required to effectively formulate rations rather than simple cost rankings on the basis of single nutrients. Long lists of available commodities with fluctuating prices and complex sets of nutritional data are extremely difficult to interpret and manage in ration formulations without the use of problem-solving mathematical software. A simple ranking of commodities according to price per unit of energy or protein reveals quite limited information when considering the complexity of scientific animal feed formulations. Even the fact that many commodities (such as copra meal) contribute significantly in terms of both energy and protein, confuses the ranking technique.

Appendix 5, in section 9.5, presents an explanation of the "Least-cost feed formulation" technique, which is the most biologically and economically sensible manner in which to formulate feedlot rations based on large volumes of pricing, availability and nutritional data. This technique has long been the mainstay of professional feed formulators around the world. It is a recommendation of this report that feedlotters interested in maximising the chances of formulating the lowest priced rations to meet the precise nutritional requirements of different classes of fattening, growing, breeder or young cattle, avail themselves of this technique, There are various commercial firms and consulting companies offering this service, whilst maintaining individual feedlot confidentiality.

Numerical formatting of the many feed commodity options identified, as has been done above in Table 5 and Table 8, is especially important if full utilization is to be made of the information found. In other words, as long as all components of information on commodities can be formatted as a numerical value (e.g., accurate landed feedlot pricing, availability, nutritional merits and limitations) then least-cost feed formulation programming can be used to pull together all possibilities and determine if there is a place for a commodity in an Indonesian feedlot ration, no matter from which country it may be imported or how many competitor commodities may be available. (Note that even palatability and odour assessments can be given numerical values and included in least-costing matrices.)

Commodities and methods appearing to hold the greatest potential with regards to new feeding alternatives for Indonesian feedlots are discussed in the sections which follow.

4.1.2.1 Better management of high moisture commodities through the use of ensiling techniques.

It is hoped that reporting of the current project may encourage the Indonesian feedlotting industry to increasingly consider the use of feedstuffs (for example corn earlage or other high moisture commodities such as wet brewer's grains and cannery wastes) which are uniquely well suited to ruminant digestive processes and feedlot handling systems, and therefore not keenly sought after by bio-fuel producers or the large Indonesian poultry, pig and aquaculture industries. However, for feedlotters to be able to best utilise wet commodities, they need a good understanding of the principals of silage making.

Several of the new alternative feeds listed on page 16 in Table 5 - "Indonesian Feedlot Commodity Options", are in fact high moisture commodities which would need to be used within 3-4 days of receival, or stored in some way, preferably through the implementation of "ensiling" techniques. "Silage" is any green forage harvested at high moisture levels before maturity and preserved by a controlled anaerobic fermentation process, in which Lactic Acid and other organic acids (from bacterial metabolism) build up to pH levels at which further bacterial action is prevented.

The basic principles of good silage making, as outlined below, can be applied to the successful storage of a variety of feedlot commodities which have moisture contents above the accepted safe storage level of approximately 12% moisture. In addition to commonly ensiled forages such as corn and sorghum forages, and improved tropical grasses such as king or napier grasses, other high moisture Indonesian commodities responding well to ensiling methods include most native grasses ensiled at a young stage of growth (generally around 60-80 days of age), as well as wet brewer's grain, wet pineapple waste, wet tapioca pulp ("onggok"), citrus pulp, fresh bananas, plus a wide variety of crop leaves, vegetable and fruit skins, peels or other by-products.

In the case of very wet commodities such as wet brewer's grain, pineapple and tapioca, prior to ensiling it is necessary to increase dry matter content by blending/pre-mixing with drier commodities (often in a feedlot mixer wagon), in order to reach approx 35% DM. When possible, such pre-mixing prior to ensiling is also an opportunity to increase the soluble carbohydrate or sugar levels (eg, with molasses) in order to enhance fermentation and the likelihood of producing a high quality ensiled product.

<u>Advantages of the ensiling technique</u>

Whilst there is some loss of nutrient content during the ensiling process, such as a substantial drop in sugar content and a lowering of "true" protein content (as opposed to "crude" protein, as calculated by multiplying total nitrogen content by 6.25), there are many advantages of the ensiling technique for a wide variety of high moisture commodities commonly available to Indonesian feedlotters.

1. Silage making is an excellent method of preserving high moisture forages at an optimal stage of nutritional composition for protein and energy,

2. The technique results in feed being stored at low cost, involving minimal investment in storage structures.
3. Silage will keep indefinitely IF correct ensiling methods are implemented and appropriate storage conditions maintained.
4. Ensiling can reduce certain toxins in some forages, eg. prussic acid in stressed forage sorghums, and nitrates in other forages. Quality degradation due to mould development can also be curtailed and the feeding risks minimised (provided that ensiling occurs prior to fungal toxin release).
5. Ensiled product is generally resistant to fire and vermin.
6. Newer, improved varieties of Corn and Forage Sorghum have been bred to produce silages with impressively high metabolisable energy contents. E.g., corn silages with 9.5-11.0 MJ ME/kg DM, and forage sorghum silages with 9.5-10.0 MJ ME/kg DM.

Technical requirements for effective silage production

1.) Fermentable carbohydrates, in the form of sugars or soluble starches, should be above 15%.

High sugar content feedstuffs include:
- Young forage corn and sorghums.
- Young, improved tropical grasses (eg. king or napier grasses), cut at approx 60-80 days of age.
- Wet pineapple waste.

High soluble starch content feedstuffs include:
- Cassava root or tapioca chips (“gaplek”) and tapioca pulp (“onggok”).
- Sweet potato waste.
- Corn or rice grain.

Low sugar content feedstuffs include:
- Mature, rank grasses of any species, particularly tropical grasses.
- Legume crops, especially when mature, and these must be cut and compacted rapidly to make reasonable silages.
- Wet brewer’s grains. (Molasses is often pre-mixed with WBG prior to ensiling.)
- Palm kernel meal or cake.
- Fibrous feeds such as rice bran or rice hulls, or coffee skins.

Low starch content feedstuffs include:
- Mature, rank grasses of any species, particularly tropical grasses,
- Wet brewer’s grains. (Tapioca chips or pulp are often included with molasses and pre-mixed with WBG prior to ensiling.)
- Wet pineapple waste. (Tapioca chips or pulp often pre-mixed with pineapple prior to ensiling.)
- Copra meal and palm kernel meal or cake,
- Fibrous feeds such as rice bran or rice hulls, or coffee skins.

2.) Moisture contents when ensiling should be in the approximate range of 65-75% (i.e., 25-35% DM). (Corn silage is ideally 65% moisture, 35% DM.)

3.) Anaerobic, high acid conditions should be maintained to minimise bacterial degradation and loss of nutritional value through “heating up”: This can be achieved by means of:

- Rapid filling and compaction (with tractors if possible).

- Precision (fine) chopping of forages (max 2 cm lengths), as shown in Figure 9 below.

Figure 9. *Precision chopping of silage into 15-25 mm lengths enables effective compaction, air exclusion and fermentation.*

- The use of **silage inoculants**, specific for the forage at hand, as recommended by commercial feed additive suppliers or nutritional consultants. Silage inoculants are important to encourage rapid fermentation and acidification, as well as to encourage subsequent high animal intakes and improved digestibility and performance. Well formulated inoculants contain cultures of fermentative lactic acid bacteria (such as *Lactobacillus buchneri*), as well as enzyme preparations to generate sugars from plant components not readily accessible to lactic acid bacteria, such as cellulose and starch (Woolford, 2000).

- The use of 1.0 - 3.0 % **urea** in the ensiling mix should assist in reducing populations of aerobic bacteria, whilst supplying a rapidly available nitrogen source for anaerobic species. Urea is especially beneficial when ensiling low protein commodities such as wet pineapple waste or wet tapioca pulp (onggok).

- Effective sealing of storage facilities to exclude air, by means such as:
  - The covering of large silage stacks above the ground surface, or below ground in pits (as shown in Figure 10 below), or in concrete bunkers – with plastic or polythene tarps, often weighed down with car tyres or with soil tossed on top.
  - Plastic wrapped round bale silage.
  - “Sausage” type silos, involving huge plastic bags, often 40 m long, containing up to 200 MT of wet silage, as seen in Figure 11 below.

- Management of the open face during feeding out, with rapid re-covering with tarps or plastic to minimise entry of air into the stack.

Guide to assessing silage quality

- Colour - dark brown or black indicates over heating due to excessive ingress of oxygen. Ideal colour for corn or sorghum silage is light yellow-green.
- Smell - mouldy, sour, rancid, alcoholic or sickly sweet smells are not good. Ideal odour is similar to vinegar.
- Feel - Wet and slimy texture is not good, and suggests excessive moisture content during ensiling. (Alternatively, this texture could be caused by excessive exposure to rain.)
- Stem length and thickness - Too long or thick stems imply a reduced chance of effective compaction, air exclusion, and the maintenance of anaerobic conditions. Chop length of forages should not exceed 2 cm.
- Grain content - Generally a reliable indicator of energy content. Good corn silages contain up to 35% grain.

Summary of usage and storage guidelines for wet feedstuffs for Indonesian feedlots

This information is presented in Table 10 on page 33 below.

Figure 10. *Large ensiling pit at an Indonesian feedlot, containing a mixture of wet pineapple waste and dry onggok, in a proportion to achieve a dry matter content of around 35% prior to ensiling. This pit will be covered after filling and compacting.*

Figure 11. *Large silage compacter and "sausage" type storage bags in East Java.*

Table 10. Guide to usage and storage of wet feedstuffs for Indonesian feedlots.

FEEDSTUFF	Max Shelf Life Fresh	Options for Long-Term Storage
Native or Improved Grass species (Rumput gajah atau Rumput rajah)	3-4 days	SILAGE PRODUCTION o Harvest at each 45 days of growth (approx), o Ideal DM content approx 35%, o Ensile directly - chop, compact & cover, o Use recommended silage inoculants.
Native or Improved Legume species (Tumbuhan polong)	3-4 days	SILAGE PRODUCTION o Harvest at each 70 days of growth (approx), depending on species of legume, o Ideal DM content approx 35%, o Ensile directly - chop, compact & cover, o Use recommended silage inoculants.
Forage Corn or Forage Sorghum (Tebon jagung atau Tebon cantel)	3-4 days	SILAGE PRODUCTION o Harvest at approx 60-70 days of age, o Ideal DM content approx 35%, o Ensile directly - chop, compact & cover, o Use recommended silage inoculants.
Wet Brewer's Grains (Ampas bir) 21% DM	5-7 days	A.) SILAGE PRODUCTION, after pre-mixing with dry commodities in a feedlot mixer wagon to achieve a mixture containing approx 35% DM. Example mix: 78% WBG + 11% Dry Onggok + 10% Molasses + 1% Urea. Propionic Acid included at 1.0 kg/T, or sprayed on top layer prior to covering, to reduce risk of mould. Mixture should be compacted and covered to exclude oxygen and protect from rain. B.) SUN-DRYING, or mechanical drying, to 90% DM and preserved with 5% Salt (Ffoulkes, 1999). Mixture must be covered or stored under dry conditions. C.) SHORT TERM HIGH MOISTURE STORAGE: Mixed in a feedlot mixer wagon with 10% Molasses + 5% Salt (Ffoulkes, 1999). Mixture should be lightly compacted and covered.
Wet Pineapple Waste (Ampas nanas) 20% DM	5-7 days	A.) SILAGE PRODUCTION, after pre-mixing with dry commodities in a feedlot mixer wagon to achieve a mixture containing approx 35% DM. Example mix: 77% Pineapple + 20% Dry Onggok (best) or Rice Bran + 3% Urea. Propionic Acid included at 1.0 kg/T, or sprayed on top layer prior to covering, to reduce risk of mould. Mixture should be compacted and covered to exclude oxygen and protect from rain. B.) SHORT TERM HIGH MOISTURE STORAGE: Mixed in a feedlot mixer wagon with 15% Forage Corn + 8.5% Molasses + 1.5% Urea (Ffoulkes, 1999). Mixture should be lightly compacted and covered.

Wet Tapioca Pulp (Onggok basah) 25% DM	3-4 days	A.) SILAGE PRODUCTION, after pre-mixing with dry commodities in a feedlot mixer wagon to achieve a mixture containing approx 35% DM. Example mix: 85% Wet Onggok + 12% Rice Bran + 3% Urea. Propionic Acid included at 1.0 kg/T, or sprayed on top layer prior to covering, to reduce risk of mould. Mixture should be compacted and covered to exclude oxygen and protect from rain. B.) SUN-DRYING to 86% DM minimum, and covered or stored under dry conditions.

Table 11. Example pre-mixing formulation, prior to ensiling wet brewer's grain.

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Indonesian Feedlot	WET BREWER'S GRAIN SILAGE			Oct, 2008
INGREDIENT	Inclusion AsFed %	Inclusion DM %	Ingredient Cost	Ration AsFed Contr
WET BREWER'S GRAINS	78.00	46.9	350	273.0
ONGGOK, kering	11.00	26.5	400	44.0
MOLASSES	9.90	23.6	900	89.1
UREA	1.00	2.7	2,000	20.0
Propionic Acid (buffered)	0.10	0.3	21,000	21.0
	100.00	100.00	Rp/kg	447.1

ANALYSIS SUMMARY (DM basis)					
Cost Rp/kg (AF)	447.1	C Protein %	20.4	ADF %	19.6
Cost Rp/kg (DM)	1,280.3	Adj CP %	19.9	NDF %	36.4
DM %	34.9	Avail CP %	19.3	eNDF as % NDF	0.0
ME MJ/kg	11.6	Soluble CP %	9.9	iv % Digest NDF	29.3
NE(g) Mcal/Lb	0.50	RDP %	54.5	iv % True Digest	77.0
Sugar %	15.9	UIP %	45.5	Lignin %	4.4
Starch %	19.9	ADICP %	1.4	Calcium %	0.39
TDN %	71.6	NDICP %	3.9	Phosphorus %	0.27
Crude Fat %	5.8	N/S Ratio	8.1	Sulphur %	0.39
				Sodium %	0.33

4.1.2.2 Corn "earlage"

The utilisation of corn "earlage" by Indonesian feedlots represents an opportunity which to date has been largely unexplored. The concept involves corn plants being harvested at approx 85 days of age, which is about 10 days later than when cut for conventional silage. The well developed corn ears are manually separated from the plant either in the field, or just prior to passing through a forage chopper. Ears are then chopped and ensiled in a pit or bunker which is separate to the pit or bunker used for the main plant. In this way, two distinct ensiled products are available for the cattle. This enables a far more versatile ration formulation system - the ears being a highly digestible, high energy ensiled commodity; the main plant being a more mature, low energy silage, but nonetheless valuable for starter rations and as a low cost, low inclusion rate fibre source for finisher rations. The system could be potentially implemented by individual feedlotters on their own farming land, or could be sub-contracted to local village farmers.

A prediction of possible economic returns from three different corn production scenarios: 1) Conventional Silage, 2) Corn Earlage, and 3) Conventional Dry Grain are illustrated in Table 12 below. (Note that full workings and extensions of this exercise are shown in the downloadable excel file forming the Addendum to this report.) Note that all prices, production schedules and yield estimates are open to significant variation, but under the data set and scenario used for this analysis, it is interesting that corn earlage yielded the highest gross return to corn growers of any option. (A fourth corn production option of “high moisture grain” is examined in the spreadsheets forming the Addendum, but is technically the most difficult of the four options and returned less than “corn earlage”. As such, it is not shown in the summary table below.)

A key consideration for such a system is the area of land required to grow corn earlage. As shown in Table 12, it is predicted that earlage can have an impressive metabolisable energy content of approx 12.0 MJ/kg, with 40% DM. If available in sufficient quantities, such a product could be relied upon as the sole high energy feedstuff in feedlot finisher rations - even up to approx 16 kg/hd/day fresh, or 9.6 kg/hd/day DM. (Rations would of course still require some degree of balancing for protein, fibre, minerals and micro-additives.) Under this feeding scenario, and assuming an earlage yield of 27.5 T/ha/yr fresh weight (based on 2.5 cuts/yr), a 1,000 hd feedlot could be expected to require an area of 212 ha/yr to supply this amount of corn earlage.

Success and viability of the earlage concept is highly dependent on a number of factors:

1. Actual corn grain and corn silage prices paid by a particular feedlot. These prices are strongly influenced by prevailing prices paid for human grade corn grain.
2. The double handling and mechanical processing capabilities of a particular feedlot.
3. The twin ensiled product storage capabilities of a particular feedlot.
4. The availability of an area of land large enough (possibly 212 ha per 1000 hd per year) to support earlage requirements, either owned by the feedlot, or owned by local supplying farmers.

Despite these substantial considerations, a corn earlage production system could render feedlots largely independent of other extraneous factors influencing the prices of high energy commodities such as the cassava products. The system does appear to warrant further study by individual feedlotters.

Table 12. Corn production options for Indonesian feedlots.

Exchange	IDR : AUD	7,541
	17-Dec-08	

CORN OPTIONS ASSESSMENT
SOUTHERN SUMATRA

A.) Conventional Silage

Harvest (days of age)	75		
Moist %	65	ME (MJ/kg DM)	8.5
DM %	35	Protein % (DM)	8.5
		Yield T/ha (fresh wt)	28.0
		Cuts/year	2.5
		Yield T/ha/yr (fresh wt)	70.0
		Rp/kg (fresh wt)	450
		Rp/MJ ME (DM)	151.3
		Rp/ha/yr (fresh wt)	**31,500,000** Gross Return to farmer

B.) Earlage

Assume high usage in finishing rations -

Area of Land Needed - Per 1000 hd Feedlot

	Fresh	DM
Daily Intake (kg/hd/day)	**16.0**	9.6
Feedlot Req't (T/yr)	5,840	
Yield (T/ha/yr)	27.5	
Area needed (ha/yr)	**212.4**	

Harvest (days of age) 85

i.) Corn on Cob + Husk

Moist %	40	ME (MJ/kg DM)	12.0
DM %	60	Protein % (DM)	7.0
		Yield T/ha (fresh wt)	11.0
		Cuts/year	2.5
		Yield T/ha/yr (fresh wt)	27.5
		Rp/kg (fresh wt)	2,000
		Rp/MJ ME (DM)	277.8
		Rp/ha/yr (fresh wt)	**55,000,000** Partial Gross Return to farmer

ii.) Remaining Low Energy Silage

Moist %	35	ME (MJ/kg DM)	7.0
DM %	65	Protein % (DM)	6.0
		Yield T/ha (fresh wt)	15.0
		Cuts/year	2.5
		Yield T/ha/yr (fresh wt)	37.5
		Rp/kg (fresh wt)	200
		Rp/MJ ME (DM)	44.0
		Rp/ha/yr (fresh wt)	**7,500,000** Partial Gross Return to farmer

Combination

Moist %	37.1	ME (MJ/kg DM)	9.0
DM %	62.9	Protein % (DM)	6.4
		Yield T/ha (fresh wt)	26.0
		Cuts/year	2.5
		Yield T/ha/yr (fresh wt)	65.0
		Rp/kg (fresh wt)	962
		Rp/MJ ME (DM)	169.5
		Rp/ha/yr (fresh wt)	**62,500,000** Gross Return to farmer

C.) Conventional Dry Grain

Harvest (days of age)	120		
Moist %	22	ME (MJ/kg DM)	14.0
DM %	78	Protein % (DM)	9.0
		Yield T/ha (fresh wt)	7.0
		Cuts/year	2.5
		Yield T/ha/yr (fresh wt)	17.5
		Rp/kg (fresh wt)	3,500
		Rp/MJ ME (DM)	320.5
		Est % Return to Farmer	60.0 (after selling to villages or corn drying units)
		Rp/ha/yr (fresh wt)	**36,750,000** Gross Return to farmer

4.1.2.3 Expanded use of molasses

Previous reports conducted for MLA have concluded that sugar cane molasses can be included in Australian feedlot finisher rations at substantial levels without compromising satisfactory performance. These reports include:

- MLA Tips & Tools (2000): Expanded use of molasses for Intensive Beef Cattle Feeding. Feedlot: FL05, November 2000. The conclusion was that when favourably costed, molasses can be feasibly and practically included at up to 25% in rations.

- Hunter, RA., Day, A. and Blakely, S. (2001): Role of High Molasses Diets in the Live Exports Supply Chain. This report pointed out that research conducted by CSIRO near Rockhampton has shown that liveweight gains up to 1.6 kg/hd/day with a feed conversion of 6.6:1 could be achieved in *Bos Indicus* steers fed complete diets containing up to 60% molasses on a dry matter basis. The researchers reported that these rations did not pose any handling or mixing difficulties, whilst cattle did not exhibit any signs of ill health from acidosis or molasses toxicity. In addition, feed costs per unit of liveweight gain compared more than favourably with conventional energy dense feedstuffs. The authors of this 2001 report claimed a 1.42 kg/hd/day growth rate in steers exported to The Philippines when fed a 50% molasses diet for 153 days. They also reported a reduced depth of subcutaneous fat at the P8 site as well as reduced yellowness of fat colour.

Sugar cane molasses is generally available in good quantities throughout southern Sumatra and across many parts of Java, within reasonable proximity of most APFINDO feedlots. However, inclusion in rations will be heavily price dependant. Table 13 below illustrates, in comparison to varying prices for molasses, the break-even prices for seven other commodities in order to supply metabolisable energy at the same price per unit as that supplied by molasses. For example, to be more energy cost effective than 1st grade onggok at 805 Rp/kg, or corn earlage at 599 Rp/kg, molasses can be purchased at anything below 700 Rp/kg.

Alternatively, Table 13 can be used to illustrate that to supply ME at a price not greater than that supplied by molasses at 900 Rp/kg, imported sorghum could be purchased to land at the feedlot for anything up to 1,289 Rp/kg, and tapioca chips up to 1,158 Rp/kg.

However, future competition for molasses from ethanol plants could be a limiting factor for molasses' on-going price viability and supply. An estimate of Indonesia's total potential ethanol production from one existing and four proposed factories was given in February 2007 by PT Pertamina, the Government owned national fuel and gas supplier (Pertamina, 2007). This estimate was for 250,000 T of ethanol per year. (Pertamina stated that feedstock for these ethanol factories would be sourced from cassava, sugar cane molasses and sweet potato.)

Table 13. Break-even feed commodity prices for energy, at varying prices for molasses.

Feedstuff	Rp/kg AF	DM%	ME MJ/kgDM	Rp/kg DM	Rp/MJ ME (DM)
Molasses	**500**	**75.0**	**12.5**	**667**	**53.3**
Onggok - 1st grade	516	88.0	11.0	587	53.3
Onggok - 3rd grade	394	82.0	9.0	480	53.3
Gaplek (Tapioca chips)	577	88.0	12.3	656	53.3
Corn Grain	671	88.0	14.3	763	53.3
Corn Earlage	384	60.0	12.0	640	53.3
Wheat Bran/Pollard	528	90.0	11.0	587	53.3
IMP Sorghum (Aust)	643	88.0	13.7	731	53.3
Molasses	**700**	**76.5**	**11.0**	**915**	**83.2**
Onggok - 1st grade	805	88.0	11.0	915	83.2
Onggok - 3rd grade	614	82.0	9.0	749	83.2
Gaplek (Tapioca chips)	900	88.0	12.3	1,023	83.2
Corn Grain	1,047	88.0	14.3	1,190	83.2
Corn Earlage	599	60.0	12.0	998	83.2
Wheat Bran/Pollard	824	90.0	11.0	915	83.2
IMP Sorghum (Aust)	1,003	88.0	13.7	1,140	83.2
Molasses	**900**	**76.5**	**11.0**	**1,176**	**107.0**
Onggok - 1st grade	1,035	88.0	11.0	1,176	107.0
Onggok - 3rd grade	789	82.0	9.0	963	107.0
Gaplek (Tapioca chips)	1,158	88.0	12.3	1,316	107.0
Corn Grain	1,346	88.0	14.3	1,529	107.0
Corn Earlage	770	60.0	12.0	1,283	107.0
Wheat Bran/Pollard	1,059	90.0	11.0	1,176	107.0
IMP Sorghum (Aust)	1,289	88.0	13.7	1,465	107.0
Molasses	**1,100**	**76.5**	**11.0**	**1,438**	**130.7**
Onggok - 1st grade	1,265	88.0	11.0	1,438	130.7
Onggok - 3rd grade	965	82.0	9.0	1,176	130.7
Gaplek (Tapioca chips)	1,415	88.0	12.3	1,608	130.7
Corn Grain	1,645	88.0	14.3	1,869	130.7
Corn Earlage	941	60.0	12.0	1,569	130.7
Wheat Bran/Pollard	1,294	90.0	11.0	1,438	130.7
IMP Sorghum (Aust)	1,576	88.0	13.7	1,791	130.7

4.1.2.4 Human food and beverage manufacturing wastes

Various human food manufacturing wastes, rejects, or expired products are currently being used successfully by certain Indonesian feedlotters. Some of these are achieving outstanding performance, although whether this is attributable mainly to the food wastes being used is difficult to determine. Examples of the types of reject foods or wastes currently being used or having the potential to be readily used by feedlotters include:

- Wet brewer's grains from breweries,
- Wet pineapple and citrus waste from canneries,
- Dry instant noodles from companies such as PT Indofood,
- Cassava chips and sweet potato chips,

- Expired breads and pastries,
- Expired soybean-based foods and soysauce by-products,
- Biscuit wastes and confectionery products,
- Broken rice (2nd grade, or “duck” rice),
- Boiled rice waste,
- Hotel and restaurant waste, of various types.

In a country with a population of 220 million, increasingly “westernising” people, there appears to be good opportunity for further utilisation of such human food and beverage wastes by Indonesian feedlotters, albeit they must often compete with dairy, aquaculture, and sometimes poultry and pig enterprises for available product. Table 14 below lists 35 food or beverage companies across Indonesia which appear to have a range of food or drink types which could be suitable for use as cattle feeds. An indication of the food or drink lines produced by these companies is included in this table.

An introductory e-mail enquiry has been sent to 11 of these 35 companies by the author of this report, with some positive interest shown. However, it is beyond the scope of this project to progress further with these communications. The 35 companies listed are among a total of over 300 company members of the Indonesian Association of Food and Beverage Manufacturers (GAPMMI).

However it is an unfortunate reality that many food waste possibilities may be difficult for feedlotters to secure in large regular quantities. Even if used at only 1 kg per head per day, an average sized 4,000 hd feedlot would require 28 tonnes per week of any newly discovered possibility. Regular supplies are important, as once introduced to rations for a particular shipment of cattle, it is far preferable not to be altering inclusion rates of commodities more so than is absolutely necessary.

An interesting concept that has been used in the US and other countries for many years is the utilisation in feedlots of hotel and restaurant wastes, following the processes of boiling, drying and grinding (Ensminger et al., 1990). However, an important consideration since the discovery of the link between the ingestion of animal proteins by ruminants and the occurrence of Bovine Spongiform Encephalopathy (BSE) is that all meat products would need to be removed from foods destined for cattle. The boiling, cooking and drying operations could potentially be achieved using an industrial rendering system, similar to that illustrated in Appendix 4 (section 9.4). Grinding operations would need to occur beyond this piece of machinery.

With accurate local pricing and availability data, together with estimates of palatability and nutritional composition, feedlot ration inclusion levels for food and beverage wastes could be determined for different classes of cattle using least-cost formulation software.

Table 14: Association of Food & Beverage Manufacturers, Indonesia.

Gabungan Pengusaha Makanan dan Minuman Indonesia

Listing of members appearing to have potential to supply reject or expired food or beverage products to Indonesian feedlots

Company	Main Products
ARTA MILLENIA PANGAN MAKMUR, PT	Production - Instant noodles (several brands)
BUDI MAKMUR PERKASA, PT (SUNGAI BUDI GROUP)	Production - Rice noodles, flour & associated products
CITRA NUSA INSANCEMERLANG, PT	Export distributor - Instant noodles, biscuits, instant coffee powder, ginseng coffee
DANONE INDONESIA, PT	Production - Biscuits, wafers, snack foods
GANDUM MAS KENCANA, PT/PT. SEELINDO SEJAHTERATAMA	Production - Breads, pastries & bakery items, flours, pancake mix, chocolate products, milk powders
GEMA ISTA RAYA, PT	Production / Distributor - Tinned sardines in tomato or chili sauce
GIZITATA PANGAN SEJAHTERA, PT	Production - Snack foods, chocolate snacks, chocolate biscuits
GUNACIPTA MULTIRASA. PT	Production - Chili and other sauces & condiments
HEINZ ABC INDONESIA, PT	Production / Distributor - Syrups, tomato & chili sauces
INDOFOOD FRITOLAY MAKMUR, PT	Production - Light weight snack foods, extruded prawn crackers (keripik), sweet potato & cassava chips
INDOFOOD SUKSES MAKMUR TBK., PT	Production - Instant fried noodles (many varieties)
INDOSENTRA PELANGI, PT	Production - Tomato & chili sauces
ISM TBK. BOGASARI FLOUR MILLS, PT	Production - Wheat based flours, starches & associated products; many brand names
JAKARANA TAMA, PT	Production & Export - Instant fried noodles; many flavours & styles
JAKLIN KOMODITINDO, PT	Importer / Exporter - Soybean foods, peanut products, onion & beef flavoured products
KARA SANTAN PRATAMA, PT	Production - Coconut milk & coconut sweets & deserts
KARUNIA ALAM SEGAR, PT (WING SURYA)	Production - Instant fried noodles, cold juices & drinks
KHONG GUAN BISCUIT FAC. IND. LTD., PT	Production - Biscuits, instant fried noodles
LANDKRONE INDO NUTRI, PT	Production - Margarines, butter, butter oil substitutes, buttermilk, emulsifiers, palm oil products
LASALLEFOOD INDONESIA, PT	Production - Syrups, margarines, sauces, salad dressings, fruit juice drinks
MAYORA INDAH, PT	Production - Candies, biscuits, wafers
MODERNFOOD INDUSTRI, PT	Distributor / Importer - Rice crackers, sweet biscuits
MONAGRO KIMIA, PT (MONSANTO)	Production - Hybrid corn seed - for planting & farming of corn for human & consumption
NIPPON INDOSARI CORPINDO, PT	Production / Distributor - Specialty breads, pastries & bakery items
NUSA INDAH, PT	Supplier - White sugar, wheat flour, soybean products
PRAMBANAN KENCANA, PT	Distributor - Biscuits (many brands), raisins, peanut & almond products
RAMEIN MAKMUR ABADI JAYA, PT	Production - Instant noodles (several brands)
RANDHOETATAH CEMERLANG, PT	Production - Frozen foods - vegetables, mushrooms, etc
SALIM IVOMAS PRATAMA, PT	Production - Cooking oils, margarines, shortening, etc
SELAMAT BISCUIT INDUSTRIES, PT	Production / Distributor - Wafers, biscuits, wafer sticks, etc
SUBAFOOD PANGAN JAYA., PT	Production - Rice noodles, corn-based noodles & associated products
ULTRA PRIMA ABADI, PT	Production & Export - Fruit drinks, wafer biscuits
UNGGUL INDO MODERN SEJAHTERA, PT (UNIMOS)	Production - Biscuits, wafer biscuits, wafer sticks
UNICAN SURYA AGUNG, PT	Production - Hard candies (assorted brands)
UNITED WARU BISCUIT MANUFACTORY, PT	Production - Chocolate biscuits, cream, milk drinks, assorted dairy products

NOTE: Further detail on the companies listed above can be found in the Excel file which forms the Addendum to this main report document.

4.1.2.5 Importation of feed commodities

Table 13 on page 38, whilst constructed to show the energy value of molasses at varying prices, also shows an interesting comparison of other feed commodity prices at which the cost per unit of metabolisable energy is identical. From this table, it is apparent that imported sorghum from Australia would represent a cheaper ME source than the widely used tapioca chips ("gaplek") at a price of only approx 100-150 Rp/kg more, landed feedlot. (Although it would need processing, such as roller-milling, sorghum grain would also be far superior to tapioca chips in protein content, whilst not having cyanide or mould issues to be wary of.)

From the ranking of Indonesian feedlot alternatives on the basis of cost per MJ energy (Appendices 5 and 6), it is interesting that if grain sorghum could be exported from Brisbane at $200/T, shipped to Indonesia and trucked to a feedlot for $400/T, it would be cheaper per MJ of ME than Tapioca Chips at 1800 Rp/kg (at the exchange rate of AUD:IDR = 7,541). However, with the current global financial crisis causing international grain prices to fall substantially and cassava losing it's trade competitiveness, together with the price of crude oil now hovering around US$40 per barrel and severely stifling any prospective Indonesian ethanol manufacturers for the time being, it is unlikely that tapioca chips will be as high as 1800 Rp/kg again in the foreseeable future. Nevertheless, international shipping trade and freight rates are very low at present, such that options for grain importation should be seriously considered by Indonesian feedlotters under the current economic climate.

The Baltic Dry Shipping Index (BDI) is the key gauge of shipping rates for the world's busiest 24 main shipping routes. The BDI has recently fallen the most it has since 1989, and highlights a potential opportunity for Indonesian feedlotters to import certain feed commodities from neighbouring, or even distant, countries. Table 5 on page 16 - "Indonesian Feedlot Commodity Options" - lists a range of commodities highly amenable to importation, provided the exercise is cost-effective. Accuracy of determination of full shipping and trucking costs, including insurance, together with customs, handling and clearance charges, and any import taxes, is critical.

Despite the absence of accurate pricing information for some commodities in Table 5, those appearing to hold some potential for importation by Indonesian feedlotters include:

- Tapioca chips from Thailand, or possibly Vietnam, Cambodia, Nigeria or Brazil,
- Sorghum grain from Australia or possibly the USA, or South American countries,
- Corn Gluten Feed and DDGS from the USA, and
- Glycerol either locally produced or from the USA, or possibly Malaysia.

As alluded to previously, with accurate landed-feedlot pricing and availability data, together with reliable data on nutritional composition, feedlot ration inclusion levels for imported commodities can be best determined for different classes of cattle by using least-cost formulation techniques. Any over-priced imported commodities will be rapidly "rejected" in favour of local commodities by the formulation software.

With regards to Indonesia's ability to economically import tapioca chips, or possibly dried tapioca pulp, from neighbouring countries, it is interesting to view in
Diagram 3 the location of intensive cassava production areas across the country itself and across Indonesia's close neighbours.

Diagram 3. **Cassava distribution in Asia, within close proximity to Indonesia. Each dot represents 10,000 ha of cassava (Howeler (2009).**

The Tapioca industry in Thailand

The following information is presented to highlight the size and degree of sophistication reached by the Tapioca industry in Thailand. This represents an opportunity for the importation of high quality, high energy cassava root chips (tapioca chips, or "gaplek") by Indonesian feedlotters. As shown in Table 15 on the following page, Thailand is clearly the largest producer of cassava in Asia and has among the world's highest yields per hectare. (Indonesia runs second to Thailand in production levels, but is well ahead of all other Asian nations.)

Thai Tapioca Industry statistics given by Sriroth (2009) at the World Tapioca Conference in Bangkok further highlight the position of Thailand as an industry world leader:

- Thailand is easily the world's largest exporter of tapioca chips and tapioca products, accounting for 81% of world production. (FAOSTAT, April 2008).
- Total cassava root production is 25-30 million tons annually (10% of world production).
- There are currently 73 tapioca starch factories registered by the Thai Tapioca Trade Association.
- For many years, cassava has been used extensively in Thai rations for pigs, beef and dairy cattle, broilers and fish, both at on-farm and commercial production levels (Kanto, 2009).

The photos below depict the clean, high starch content cassava roots and the efficient, hygienic method of sun-drying chips on vast open areas of concrete flooring, a method which substantially reduces the degree of contamination with soil, sand and other impurities.

Figure 12. *Photos displayed at the World Tapioca Conference 2009, 15-16 January, 2009, Bangkok, Thailand. Photo source: Howeler (2009).*

Table 15. World production of Cassava in 2007, with a focus on Asia (Howeler, 2009).

Country	Production '000 tonnes	Planted Area '000 ha	Yield T/ha
WORLD	223,756	18,395	12.16
Africa	117,888 (53%)	11,904	9.90
Americas	38,247 (17%)	2,897	13.20
Asia	67,438 (30%)	3,576	18.86
* **Cambodia**	2,000	96	20.83
* **China** (2006 data)	4,318	266	16.25
* **India**	7,600	242	31.40
* **Indonesia**	19,610	1,207	16.25
* **Laos**	175	17	10.29
* **Malaysia**	430	41	10.49
* **Myanmar**	211	16	12.79
* **Philippines**	1,829	210	8.71
* **Sri Lanka**	220	23	9.75
* **Thailand**	26,411	1,152	22.92
* **Timor-Leste**	50	12	4.14
* **Vietnam**	8,900	560	15.89

Source: FAOSTAT, April 2008.

Figure 13. *In Thailand, cassava roots are chipped and sun-dried on large concrete drying floors. Photo source: Howeler (2009).*

Figure 14. *When regularly turned, tapioca chips will dry in 2-3 days of sunny weather.* *Photo source:* *Howeler (2009).*

4.1.2.6 Glycerol from proposed bio-fuel factories

Glycerol would appear to have potential as a palatable, bio-available, high energy ingredient that may be used at up to approximately 10% of feedlot finisher rations in Indonesia. Glycerol, also commonly known as “glycerine” or “glycerine”, is a colourless, odourless, viscous liquid that is widely used in pharmaceutical formulations. It is sweet-tasting and of low toxicity. Until recently, synthetic glycerol has been mostly manufactured on an industrial scale from epichlorohydrin. However, glycerol is also a 10% by-product of biodiesel production (via the transesterification of vegetable oils or animal fats). This has led to a recent excess of crude glycerol on the world market, making the epichlorohydrin process no longer economical. Current levels of glycerol production are about 350,000 tons per annum in the USA, and 600,000 tons per annum in Europe (Wikipedia, 2008). These levels are set to increase in the immediate years ahead as governments in many countries, including Indonesia, implement directives to replace an increasing percentage of petroleum-based fuels with biofuels.

Glycerol is regarded as a “generally recognised as safe” animal food ingredient, as provided for in the Code of Federal Regulations, administered by the US Food and Drug Administration, as reported by Sellers (2008). Rapid expansion in the demand for biodiesel from fats and oils has increased the availability of and interest in glycerol as a potential feed ingredient for ruminants and other livestock species. It is a high energy ingredient, with a metabolisable energy content for ruminants of approx 14.8 MJ/kg DM.

Through a series of Presidential Decrees during 2006, the Indonesian Government established a Policy of National Energy for the supply and use of biofuels as alternative fuel. A Biofuel’s National Committee was formed for the “acceleration of poverty removal and reduction of unemployment”, and biodiesel and bioethanol were permitted to be blended with diesel and gasoline at maximum levels of 10% v/v. According to Panaka and Yudiarto (2007), Indonesian Government plans are to produce enough biofuel by 2010 to replace 10% of the country’s total oil-based fuel consumption, which reached 70 billion litres in 2006. Government incentives and tariffs are currently in place.

An estimate of Indonesia's total potential biodiesel production from two existing and four proposed factories was given in February 2007 by PT Pertamina, the Government owned national fuel and gas supply company. This estimate was for 4,110,000 T of biodiesel per year (Pertamina, 2007). Company personnel stated that feedstock for these factories would principally be crude palm oil, and oil from Jatropha trees.

Suitability of glycerol as a feed ingredient for ruminants

In reviewing the available literature, Drouillard (2008) reports that published literature pertaining to the utilization of glycerol in concentrate-fed animals is scarce, although studies currently are underway at several US institutions. Nevertheless, Drouillard reports that German researchers have claimed that glycerol can readily replace up to 10% of readily fermentable starches in ruminant diets. Crude glycerol has been reported to decrease DMI when included at 10% of diets that contain combinations of dry-rolled corn and grain co-products, although average daily gains did increase, thus resulting in feed conversion improvements of 16 to 23%, when compared to diets without glycerol.

Drouillard (2008) also reports that in flaked-corn diets, feeding glycerol has been recorded as having a quadratic effect on feed conversion efficiency ($P < 0.05$), with the greatest improvements associated with low levels of feeding. Efficiency changes were 11, 10, 8, 3, and -3% for diets containing 2, 4, 8, 12, and 16% glycerol, respectively. Adding glycerol to flaked-corn diets yielded a linear increase in longissimus muscle area ($P < 0.05$) and linear decreases in subcutaneous fat and marbling deposition ($P < 0.05$). Drouillard concludes by stating that crude glycerol is promising as a feed ingredient for finishing cattle, although much remains to be learnt about optimal levels of feeding, as well as implications for carcass quality, composition, and eating quality attributes.

In view of the prevailing global financial recession, several CPO-fuelled biodiesel factories proposed for the Lampung and Javanese provinces may not commence operations until considerably later than planned. However, when they do commence, it would certainly appear warranted that cattle feeding trials be conducted to explore the potential of glycerol in enhancing Indonesian feedlot rations. With accurate local pricing, availability and palatability data to match nutritional specifications and limitations, appropriate ration inclusion levels could then be best determined using least-cost feed formulation software.

4.1.2.7 Cassava wastes from proposed cassava ethanol factories

As discussed in the previous section, the current global recession has temporarily curtailed numerous proposed biofuel projects, including several cassava-fuelled ethanol factories planned for the Lampung and Javanese provinces. However, when these operations do commence, an interesting commodity potentially available for Indonesian feedlot cattle will be the "cassava dregs" by-product of the fermentation process.

Indonesia's initial ethanol pilot plant was commissioned in Lampung back in 1983, fermenting starch extracted from cassava roots. However, the national ethanol industry made very little progress until 2006, when the Policy of National Energy was established for the supply and use of biofuels. As stated above, Indonesian Government plans are to produce enough biofuel by 2010 to replace 10% of the country's total oil-based fuel consumption, which reached 70 billion litres in 2006 (Panaka and Yudiarto, 2007).

Due to the very slow industry start-up, nutritional analysis of cassava dregs from Indonesian ethanol plants has not been possible to date. However, analysis of a comparable Chinese product suggests that cassava dregs could be nearly 12% crude protein, as shown in Table 16 below. Unfortunately, the Chinese product is dominated by crude fibre, contains only a small amount of fat and has negligible starch, which means that metabolisable energy will be low (L Guo Tao, 2009, pers. comm.).

Table 16. **Indicative analysis of Cassava dregs from ethanol factories.** #

Parameter	Fresh Basis (%)	Dry Mater Basis (%)
Moisture	80.0	
Organic matter	14.6	73.0
Crude Protein	2.34	11.7
Crude Fat	0.92	4.6
Crude Fibre	7.1	35.5
Nitrogen □ N□	0.32	1.6
Phosphorus □ P2O5□	0.03	0.15
Potassium □ K2O□	0.03	0.15
pH	4.5	

Sample analysed by Xintiande Laboratory in Guangxi Province, China, August, 2006.
Source**:** Mr L. Guo Tao, Senior Engineer, Acro Bio-Tech Co., Ltd, Guangdong, China, e-mail correspondence, Jan 2009.

The anticipated low energy content of the dried cassava dregs dictates that the product will be of benefit in feedlot finisher rations only as a fibre source, in order to guard against rumen acidosis. However, it is a product which may find a more significant place in lower energy starter and intermediate rations, whilst also potentially playing a role in rations for sick cattle, or breeders and young cattle not involved in fattening programs. With accurate local pricing and availability data, alongside specific animal nutrient requirements, appropriate ration inclusion levels could be best determined using least-cost feed formulation software.

Figure 15. *Photograph of Cassava Dregs from ethanol production factory in China.*
Source**:** Mr L. Guo Tao, Senior Engineer, Acro Bio-Tech Co., Ltd, Guangdong, China, e-mail correspondence, Jan 2009.

Estimate of likely quantities of cassava dregs available for Indonesian feedlotters:

Projection Scenario 1.
Ethanol production estimates by Pertamina (2007), based on currently built or proposed ethanol plants, and assuming 33% of feedstock supplied by cassava roots.

Cassava being the sole feedstock source is a reasonable long term assumption given the widespread belief that cassava's agronomic characteristics and high starch content of it's roots - superior to corn, rice and wheat in starch content, as confirmed by Sriroth & Piyachomkwan (2008) - commonly make it a first choice bio-ethanol feedstock.

An estimate of Indonesia's total potential ethanol production from one existing and four declared proposed factories was given in February 2007 by PT Pertamina, the Government owned national fuel and gas supply company. This estimate was for 250,000 T of ethanol per year (Pertamina, 2007). Company personnel stated that feedstock for these ethanol factories would be sourced from cassava, sugar cane molasses and sweet potato.

Based on recent information supplied on the Chinese cassava dregs by-product (L Guo Tao, 2009, pers. comm.), average yields from ethanol factories in Guangxi Province are 1.0 T of cassava dregs from 16.0 T of fresh cassava (a yield of 6.25%). Working on a 22.2% yield of 96% pure ethanol from fresh cassava (based on a 30% starch content) (FAO, 2008), 250,000 T of ethanol per year equates to 371,622 T of cassava roots per year needed, when working on a 33% supply from cassava. Using the Chinese yield figure of 6.25% cassava dregs by-product from fresh cassava, this equates to a potential for 23,226 T cassava dregs per year to be produced from Indonesia's ethanol factories. Assuming this product may be fed to cattle at 1.0 kg/hd/day, or approx 6.5% inclusion in a finisher ration, this volume of dregs could be fed to almost 64,000 cattle per day, equating approximately to 16 feedlots with capacities of 4,000 hd. Under these assumptions, these estimates suggest this by-product from future ethanol factories could be a worthwhile addition to the stocks of available feedlot commodities, albeit that the product would not be a high energy fattening commodity.

Projection Scenario 2.
Estimates by Panaka & Yudiarto (2007), reflecting projected ethanol plant construction through to 2025, and again assuming 33% of feedstock supplied by cassava roots.

Table 17. Proposed bioethanol plant construction in Indonesia, as at 2007.

Presentation given at Asian Science & Technology Seminar, Jakarta, March 7, 2007.
P Panaka, PT Gikoko Kogyo Indonesia, and MA Yudiarto, Starch Technology Center, Agency for the Assessment and Application of Technology.

NEW BIOETHANOL PLANTS PROPOSED			
Period	**No Plants**	**KL/day/plant**	**Ethanol Totals**
2005 - 2010	104	60	6,240 KL/day
2010 - 2015	62	60	3,720 KL/day
2015 - 2025	114	60	6,840 KL/day
Total/Day			16,800 KL/day
Total/Year (KL) at 250 days/yr			4,200,000 KL/year
Total/Year (Tonne)			3,330,000 T/year

Panaka & Yudiarto (2007)

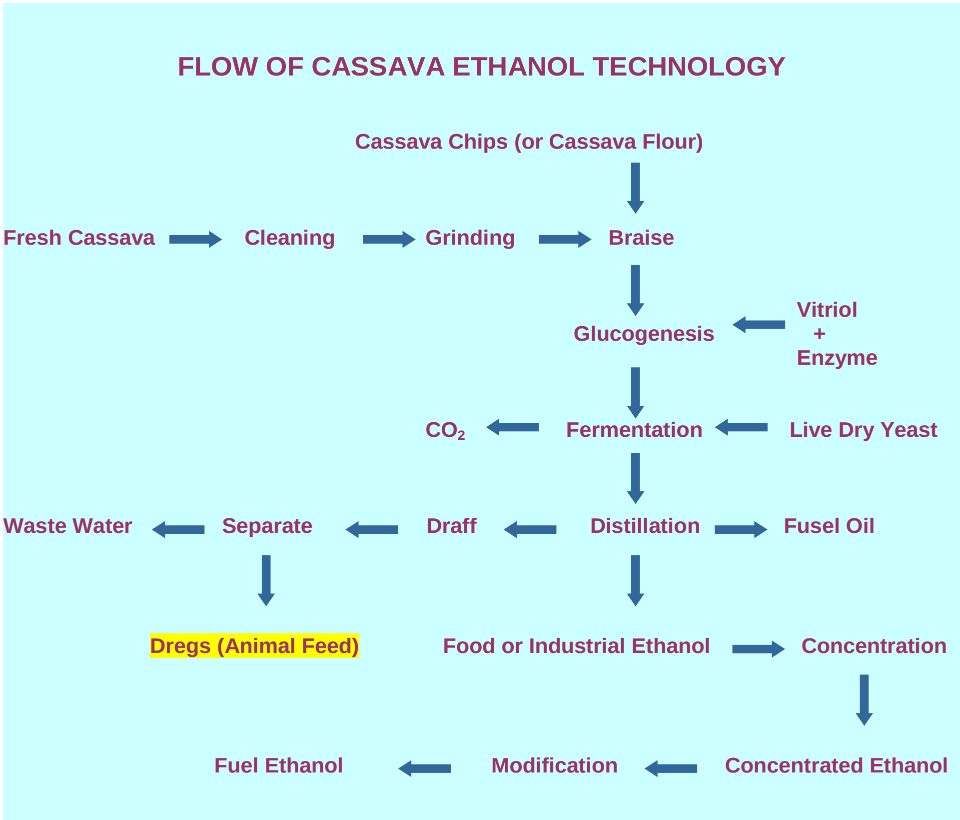
Working on a 22.2% yield of 96% pure ethanol from fresh cassava (based on a 30% starch content), 3,330,000 T of ethanol per year equates to 4,950,000 T of cassava roots per year needed, when working on a 33% supply from cassava. Using the Chinese yield figure of 6.25% cassava dregs by-product from fresh cassava, this equates to a potential for 309,375 T dregs per year. Based on including in feedlot rations at 1.0 kg/hd/day, or approx 6.5 % inclusion rate, this volume of dregs could be fed to nearly 850,000 cattle per day, equating approximately to a theoretical 212 feedlots with capacities of 4,000 hd, well beyond the current size of the Indonesian industry.

Diagram 4 below illustrates diagrammatically the process of ethanol production from cassava roots and indicates how the "cassava dregs" by-product originates.

However, it must be appreciated that the numbers in the two scenarios above are based only on unconfirmed projections of possible bio-ethanol industry development patterns. It should also be appreciated that these projections would most likely have assumed relatively stable global economic environments.

Diagram 4. Flow diagram of ethanol production from cassava.

Presentation given on CASSAVA INDUSTRIALIZATION,
Cali, Columbia, 22 March, 2007.
Mr Liang Guo Tao, Senior Engineer, South Crown Industry & Commerce Co. Ltd of Zhuhai.



4.1.2.8 Feather meal from poultry abattoirs

Feathers from poultry processing plants are in considerable abundance in Indonesia and other SE Asian countries having huge poultry industries. They represent an alternative feedlot commodity, but before use in animal feed rations, feathers must be hydrolysed with heat and pressure in order to render the keratin protein fractions more available. A quality standard for feather meal is that not less than 75% and not more than 80% of crude protein content must be digestible by the pepsin digestibility method. In the US, feather meal has been used generally up to 10% inclusion in ruminant rations (Ensminger, 1990).

However, feather meal's potential for Indonesian feedlots is limited by the fact that it consists almost totally of crude protein (85-90%), which is rather low in nutritional value. It is high in the sulphur containing amino acid cystine, but low in the important amino acids histidine, lysine, methionine, and tryptophan. Although less degradable than urea, it is not much superior in value to urea. Although ruminants can utilize hydrolysed feather meal quite well and benefit from its high bypass protein, feedlot cattle in Indonesia generally have access to a number of inexpensive sources of protein. These include copra meal, palm kernel cake or meal, ground nut meal, urea and ammonium sulphate, and in some cases wet brewer's grains.

With accurate local pricing and availability data, ration inclusion levels can be determined for different classes of cattle using least-cost formulation software.

4.1.2.9 Pond weed (Azolla) and algae (single-cell protein)

Indonesia's equatorial climate of high temperatures, rainfall and humidity and the country's abundant supply of labour, lend themselves extremely well to the production of potential animal feed protein sources from prolifically growing pond weeds such as Azolla, and from single-cell organisms such as yeast, bacteria, fungi and algae.

Single-cell proteins (SCP) are grown on specifically prepared growth media. Production of SCP can be attained through the fermentation of organic wastes or the culturing of photosynthetic organisms in specially illuminated ponds. A wide variety of growth substrates can be used, for example low value products such as rice straw, other cellulotic wastes, sawdust, food processing and cannery wastes, residues from alcohol production, petroleum derivatives, and animal excreta.

It has been known for many years that the potential of single-cell protein as a high-protein source for both humans and livestock is enormous. To put this into perspective, and quoting Ensminger et al. (1990), a 500 kg steer produces approx 0.5 kg of protein per day; 500 kg of rapidly growing soybeans produce approx 40 kg of protein per day; 500 kg of single-cell organisms can produce over 50 tonnes of protein per day. However, in the past 20-30 years, generally little progress has been made in solving the world's protein needs with SCP, as serious problems involving toxicities, gastrointestinal disturbances, uric acid accumulation, protein quality, palatability, and the economics and practicalities of mass production, harvesting and drying must be solved before wide-scale production becomes a reality.

Figure 16. *Azolla pond weed growing on a research farm in Solo, Central Java***.**

4.2 Results – Investigation of Treatment Processes

At the commencement of the project, a comprehensive literature review was conducted into “Methods of Improving the Digestibility of Poor Quality Tropical Feedstuffs”. Treatment processes for improving poor quality roughages and other potentially useful feedlot ingredients were also discussed with all research groups visited and communicated with throughout this project.

Treatment processes having some relevance for Indonesian feedlotters are listed in Table 18 below. This table also displays an indication of treatment methods, claimed benefits and the research groups involved. Unfortunately there were no treatment processes identified which appear to offer significant benefits for the Indonesian feedlot industry, as most processes have been developed for the improvement of low protein, low energy roughages. Justification for the expense and effort of treating these commodities under most feedlot scenarios, in which high energy/starch ingredients are of paramount importance, is difficult to find. Feedlot cattle in Indonesia also generally have access to a reasonable number of inexpensive sources of crude protein (including copra and palm kernel meals, ground nut meal, urea and ammonium sulphate), such that it is uneconomic to spend much money on treatment processes principally designed to improve protein content. Further explanation of these statements is outlined in the discussion following the table below.

Table 18. Treatments to improve the digestibility of poor quality tropical feedstuffs.

Commodity	"Cassapro" (Fermented & Treated Cassava)
Treatment Process	Cassava Roots (50-60% moist) + Urea + (NH4)2SO4 + NaH2PO4 + KCl + MgSO4 + FeSO4 + 0.2-0.5% Aspergillu niger
Claimed Benefits	Protein increased to 20% of DM.
Reference	*Wina, E., Research Institute for Animal Production, Ciawi, Bogor, West Java*
Commodity	Fermented & Treated Rice Bran (3)
Treatment Process	Rice Bran + Molasses + Aspergillus culture (2-3 weeks anaerobic conditions)
Claimed Benefits	Protein increase by 4-7 % units.
Reference	*Pamungkas, D., Beef Cattle Research Station, Grati, Pasuruan, East Java*
Commodity	Enzyme treated Copra Meal
Treatment Process	Copra Meal + "Hemicell" + "Allzyme SSF (Alltech)" + "Gamanase"
Claimed Benefits	Inc ADG, FCE & Digestibility in CHICKENS. (UNPROVEN IN RUMINANTS)
Reference	*Sundu, et al (2006):* International Journal Poultry Science, vol 5 (1), p 13-18
Commodity	Chemically treated PKC
Treatment Process	PKC + Formaldehyde + Tannins
Claimed Benefits	Increased rumen undegradability of protein (ie, by-pass content).
Reference	*Haryanto, B., Indonesian Centre for Animal Research & Development, Bogor, West Java*
Commodity	Enzyme treated PKC
Treatment Process	PKC + poultry specific enzymes, eg, "Allzyme SSF" (Alltech).
Claimed Benefits	Increased performance in Indonesian POULTRY. (UNPROVEN IN RUMINANTS)
Reference	*Alltech Biotechnology Pty Ltd., TROBOS, Indonesian Feed & Agribusiness Magazine, October, 2008*
Commodity	PKC treated with Rhizopus fungus
Treatment Process	PKC + newly isolated fungal strain Rhizopus stolonifer LAU 07
Claimed Benefits	Protein inc by 33.3%; Crude Fibre dec by 44.5%
Reference	*Lateef et al. (2008):* World Journal Microbiology & Biotechnology, vol 24 (10), p 2369-2374
Commodity	Fermented Rice Straw
Treatment Process	Straw (60% moist) + 6 kg/T Urea + 6 kg/T Starbio
Claimed Benefits	Protein inc by 5 % units, Crude Fibre dec by 2 % units
Reference	*Suharto, M., Lembah Hijau Multifarm Research Station, Solo*
Commodity	Fermented Bagasse
Treatment Process	Bagasse (60% moist) + Molasses + 10 kg/T Urea + 10 kg/T Starbio + 2 kg/T DCP + 2 kg/T (NH4)2SO4
Claimed Benefits	Protein inc by 2 % units, TDN inc by 28 % units, Lignin dec by 20 % units
Reference	*Suharto, M., Lembah Hijau Multifarm Research Station, Solo*
Commodity	Bagasse treated with 5% NaOH
Treatment Process	Bagasse + 50 kg/T NaOH
Claimed Benefits	NDF dec by 7.95 % units, ADF dec by 4.25 % units
Reference	*Fahmy, et al (1997):* Egyptian Journal Animal Production, vol 34 (1), p 27-39
Commodity	Bagasse treated with 6% NH4OH
Treatment Process	Bagasse + 60 kg/T NH4OH
Claimed Benefits	Protein inc by 5.5 % units
Reference	*Fahmy, et al (1997):* Egyptian Journal Animal Production, vol 34 (1), p 27-40
Commodity	Bagasse + Culture Medium + Glucose
Treatment Process	Bagasse + nutrient culture medium (KH2PO4, MgSO4, CaCl2 + Yeast extract) + 5% Glucose
Claimed Benefits	Lignin dec by 11.2 % units; Digestibility inc by 17.7 % units
Reference	*Abdullah & Zafar (1996): International Journal Mushroom Sciences, vol 1 (2), p 21-26*
Commodity	Bagasse, steam & chemical treated
Treatment Process	Bagasse heated to 197' C (at 35 atm) at a 4:1 (w/w) water ratio + 2.9% (w/w) Othophosphoric Acid
Claimed Benefits	In situ Rumen Degradability inc to approx 70%
Reference	*Fontana, et al (1995):* Applied Biochemistry & Biotechnology, vol 51/52, p 105-116
Commodity	OPF Silage, treated with NaOH
Treatment Process	OPF Silage + NaOH
Claimed Benefits	Increased Digestibility
Reference	*Kawarnoto, et al (2001):* Japan Agricultural Research Quarterly, vol 35 (3), p 195-200
Commodity	Oil Palm Fronds (OPF), steam treated
Treatment Process	OPF + steam treatment
Claimed Benefits	Increased Digestibility
Reference	*Dept Veterinary Services, Ministry of Agriculture, Malaysia.*
Commodity	Oil Palm Trunk (OPT), treated with 6% NaOH
Treatment Process	Oil Palm Trunk + 60 kg/T NaOH
Claimed Benefits	Increased Digestibility
Reference	*Dept Veterinary Services, Ministry of Agriculture, Malaysia.*
Commodity	Fermented Palm Oil Sludge
Treatment Process	
Claimed Benefits	
Reference	*Suharto, M., Bengkulu Research Station, Central Sumatra*

Fermentation of cassava with fungal cultures and urea.

Since the mid 1980's, researchers from the Institut Fancais de Recherché Scientifique Pour le Developpement en Cooperation (ORSTOM) in Cali, Columbia, have developed solid-state fermentation processes for improving the protein content of cassava, potatoes, bananas and other high starch commodities used for animal feed. Fungi, especially from the *Aspergillus* group, have been used to transform starch and mineral salts into fungal proteins. Such techniques have lead to fermented cassava products with 18-20% protein content, on a dry matter basis (Dufour et al., 1996). Results from work by the ORSTOM group are summarised in Table 19 below.

Table 19. Effects of *Aspergillus niger* on protein and sugar contents of different starches after 30 hrs of fermentation in solid state culture (Dufour, et al. (1996).

Substrate Starch	Initial Composition		Final Composition	
	Proteins % DM	Sugar % DM	Proteins % DM	Sugar % DM
Cassava	2.5	90	18	30
Banana	6.4	80	20	25
Banana waste	6.5	72	17	33
Potato	5.1	90	20	35
Potato waste	5.1	65	18	28

Largely through this group of researchers, it has been known since at least 1994, that protein enrichment of even crude, non-gelatinised cassava flours is possible, in either liquid or solid state culture, through the use of *Rhizopus oryzae* and various other strains of *Rhizopus sp.* fungi.

In Indonesia, scientists at the Research Institute for Animal Production, Ciawi, West Java, have used fermentation, culturing treatments involving *Aspergillus niger*, plus urea and other chemical compounds to produce a 20% protein cassava product known as “Cassapro”. However, according to Wina (pers. comm., 2008), the implications of this research and that of the ORSTOM group for Indonesian feedlotters are questionable in view of the substantial additional cost imposed by these treatments on the traditionally inexpensive and widely available “onggok” and “gaplek” products. Although these cassava products are inherently low in crude protein, while the above research is designed to boost protein content, there are several other widely available commodities throughout Indonesia which can normally balance feedlots rations for protein in a more cost effective manner. Examples of these are copra and palm kernel meal or cake, wet brewer's grains, imported or local soybean meal, and small quantities of urea and ammonium sulphate.

Treatment of PKM with formaldehyde and tannins

Work conducted over recent years at the Indonesian Centre for Animal Research & Development, Bogor, West Java, has centred on the treatment of palm kernel meal with formaldehyde plus tannins in order to improve rumen by-pass protein content. However, according to Haryanto (pers. comm., 2008), this work has yet to be fully published or commercialised. The value of research of this type on PKM is of dubious value for feedlotters, as by-pass protein is not a critical nutritional issue for most feedlot animals, while other commodities such as copra meal, and canola/rapeseed meal have high by-pass protein contents. (There are also safety queries for humans over the use of formaldehyde and tannins in feeds for food-producing animals.)

Treatment of copra and PKM with digestive enzymes

Treatment of two of the most commonly available protein and energy sources in Indonesian feedlot rations - copra meal and palm kernel meal - with enzyme preparations to improve digestibility has been the focus of considerable research effort by commercial feed additive companies over the past several years. Significant animal performance improvements have been reported for treated PKM in Indonesia by Noor (2008), and for treated copra meal in Australia by Sundu et al. (2006), but unfortunately to date these have related only to poultry applications. According to the Alltech Company, ruminant responses to enzyme treated copra and PKM can be anticipated under certain nutritionally limiting conditions, however further work is required before Alltech is prepared to offer registered claims (R Trainer, Alltech Biotechnology Pty Ltd., pers. comm., December 2008).

A very recent paper by Lateef et al. (2008) reported that palm kernel cake cultured with the newly isolated fungal strain *Rhizopus stolonifer LAU 07* experienced an in-vitro protein increase of 33.3% and a crude fibre decrease of 44.5%. (These phenomena are due to rapid fungal multiplication and digestion of fibre, together with a substantial contribution of fungal nitrogen.) The potential for commercial application of techniques like this to feedlot cattle is currently not known, although the prospects for benefits before too long appear quite reasonable.

Fermentation of low protein roughages with urea, other chemicals and fungal cultures.

Unfortunately, very little of interest for the Indonesian feedlot sector was revealed by information emanating from this category of the literature search. Various methods of improving protein content and digestibility of rice straw, rice bran, sugar cane bagasse, oil palm fronds and trunks have existed for several years, generally involving fermentation in the presence of urea and often *Aspergillus* fungal cultures and strong alkali chemicals (references are shown in Table 18 above). However, justification for the expense and effort of treating these low protein, low value roughages for most feedlot situations, in which high energy ingredients are of paramount importance, is difficult to find.

5 Success in achieving objectives

The project was successful in achieving the key stated objectives of conducting a feeds audit of Indonesian, Filipino and Malaysian feedlots, investigating alternative feedstuffs and searching for improved treatment methods. However, the outcomes from these investigations were not fully satisfying, in that no stand-out new high energy commodities available at the right price and in feedlot-viable quantities were "discovered". Similarly, no stand-out commercially viable and accessible new treatment methods boasting statistically proven performance enhancement suitable for SE Asian feedlot cattle were found.

Nevertheless, the project was successful in documenting and detailing a large number of commonly known and some not so commonly appreciated feed commodity options for Indonesian feedlots, including best-practice wet product storage methods and options that would involve importing from neighbouring or perhaps distant countries. The numerical formatting of all these options was especially important if full utilization is to be made of this information, as has been discussed previously in relation to the value of least-cost feed formulation programming.

The substantial nutritional data summarised in Table 5 and Table 8 above, and presented in more detail in the downloadable Excel file forming the Addendum, "ADDENDUM - Indonesian Feedlot Ingredient Options", should be regarded as work in progress, with a spreadsheet template having been established such that new data can be added as it comes to hand. The bottom line is that the more detailed numerical information that can be compiled on a large number of feedstuff alternatives, the greater the likelihood that maximum performance, least-cost rations will be formulated by feedlot nutritionists using the appropriate software.

6 Impact on meat and livestock industry – now and in five years time

The numerical investigation of new feed commodities, alternative treatments, processing and storage methods has the potential to improve ration quality so as to reduce feedlot cost of gain, increase ADG's, carcase composition and yield, as well as feedlot throughput rates and overall profitability.

This project may also encourage the Indonesian feedlot industry to increasingly consider feedstuffs (for example corn earlage or other high moisture commodities such as wet brewer's grains and cannery wastes, or by-products such as cassava "dregs") which are uniquely well suited to ruminant digestive processes, and therefore not keenly sought after by ethanol or bio-diesel producers or the large Indonesian monogastric (poultry, pig and aquaculture) industries. Such an outcome should improve industry sustainability, with the long term future not clouded by ever present threats posed by competing fuel or monogastric animal industries.

<u>Benefits to livestock exporters</u>

Improvements in the profitability and economic viability of the Indonesian feedlot industry should in turn lead to stimulation of the Australian live export cattle industry, and improve the viability and ecological sustainability of the northern Australian pastoral beef industry, due to cattle being turned off faster and more reliably.

7 Conclusions and recommendations

Key conclusions and recommendations emanating from this project are as follows:

1) Members of APFINDO and other participants in the Indonesian feedlot industry should be encouraged to carefully consider wherever possible the use of higher levels of feedstuffs which are uniquely well suited to ruminant digestive processes and feedlot handling systems, and therefore not keenly sought after by bio-fuel producers or the large Indonesian monogastric (poultry, pig and aquaculture) industries. Such feedstuffs will include corn "earlage" and other high moisture commodities such as wet brewer's grains, cannery wastes, other human food and beverage industry wastes, and possibly wet by-products from newly established cassava-based bio-ethanol factories. However, with this new direction will come a necessity for further industry training in the handling and storage of high moisture commodities, in particular with regards to "ensiling" techniques. It is recommended that MLA and APFINDO discuss the concept of training workshops, conducted by the appropriate industry specialists.

2) Further to the above comments, an associated recommendation is that research be conducted into all main aspects of the practicality and economic feasibility of corn "earlage" production by suitably equipped Indonesian feedlots. A key consideration will be the area of cultivation country required, either managed as part of the feedlot premises, or sub-contracted to local farmers.

3) Relevant to the potential use in feedlots of glycerol, study should be undertaken to assess economic returns, animal performance and optimal ration inclusion rates. Glycerol is a high energy, bio-available substance generated from bio-diesel plants and may become available in large quantities across Indonesia as alternative fuel industries establish in the near future.

4) Under the peculiarities of the current global financial downturn, including record low shipping freight rates, it is recommended that all commercial feedlots give careful consideration to the option of importing feed commodities, potentially from a wide range of countries, including Australia, the USA and several Asian countries. The size and professionalism of the nearby Thai Tapioca Industry also clearly represents a potential opportunity for Indonesian feedlots under certain commodity pricing and shipping dynamics.

5) Partly in view of the above recommendation, and to increase feedlot industry competitiveness, a further recommendation is that MLA and APFINDO discuss the notion of training workshops for management in the concepts of Feed Commodity Buying Groups, as well as International Commodity Trading and Importation.

6) It is suggested that feedlotters keep in mind the future potential of the “cassava dregs” by-product of proposed ethanol factories in the provinces of Lampung and Java. This product may be available in large quantities as ethanol industries establish. However, it must be stressed that the product is anticipated to contain very little energy and will therefore play a role mainly as a low inclusion rate fibre supplement in finisher rations, or as a more substantial component of introductory rations, or rations for non-feedlot cattle.

7) It is suggested that the information provided in spreadsheet format in the Addendum to this report be made available to interested feedlotters as a downloadable Excel file from the MLA website, and also on CD, such that pricing, availability and nutritional data can be updated, kept relevant and used in feed formulating calculations.

8) Preferably as a component of other workshop programs, as suggested above, it is recommended that training sessions be conducted for relevant feedlot staff or advisors in the concepts of “Least Cost Ration Formulation”. As previously described, this technique is a key tool of the trade for professional feed formulators around the world.

9) Unfortunately there were no feed commodity treatment processes identified in this study that appear to offer significant benefits for the Indonesian feedlot industry. Most processes in operation have been developed for the improvement of low protein, low energy roughages, and so the relevance for feedlot fattening scenarios is greatly limited. However, it is recommended that developments in the research fields of enzyme supplementation of copra and palm kernel meals for ruminant applications be watched carefully.

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9 Appendices

9.1 Appendix 1 - Itinerary of Research Trip

INDONESIA AND THE PHILIPPINES, 15 OCT - 27 NOV, 2008.

Highlighted yellow are meetings with Cattle Nutrition research groups.

15-Oct	Flights to Sydney, then Denpasar, Indonesia
16-Oct	**Inspection of 8,000 ha farming lease, Sumba Isl (potential cassava production)**
17-Oct	**Pk Tonny Widjayanto, Feed Commodity Mgr, NFC, 4,500 hd feedlot, Malaysia.**
20-Oct	**Pk Tonny Widjayanto, Feed Commodity Mgr, NFC, 4,500 hd feedlot, Malaysia.**
21-Oct	**Dr Suharto, Lembah Hijau Multifarm Research Station, Solo.**
22-Oct	**APFINDO meeting (Teguh Boediyana); PT Elders Indonesia (Dick Slaney), Jakarta**
23-Oct	**Prof Dr Kusuma and Dr Budi Haryanto, Indonesian Centre for Animal R & D, Bogor**
24-Oct	**Dr Elizabeth Wina, Research Institute for Animal Production, Ciawi**
27-Oct	**PT Pasir Tengah, Kandang Cikalong Kulon, 4,600 hd Feedlot, Cianjur**
28-Oct	**PT Kadila Lestari Jaya, 12,000 hd Feedlot, Bandung**
29-Oct	**Pk Ismail Ibrahim, Purchasing Mgr, PT Santosa Agrindo, 25,000 hd feedlot, Lampung**
30-Oct	**PT Agrinusa Unggul Jaya premix factory, Bogor**
31-Oct	Bogor office
1-Nov	**Dr Budi Tangendjaja, Research Institute for Animal Production, Ciawi**
3-Nov	**Pk Didik Eko, Beef Research Station and Feedmill, Grati, Pasuruan, East Java**
	Dr Dicky Pamungkas, Beef Research Station, Grati, Pasuruan, East Java
	Mr Brendan Collins, PT Agri Servis Sakti, Malang
4-Nov	Bogor office
5-Nov	**Green Global Multifarm Lestary, 150 cow Feedlot Dairy, Bandung**
6-Nov	**PT Agrinusa Unggul Jaya office, Jakarta**
7-Nov	Bogor office
10-Nov	**PT Agrinusa rep training day - cattle nutrition**
11-Nov	**PT Elders Indonesia, 4,000 hd feedlot; PT GGLC, 14,000 hd feedlot, Bandar Jaya**
12-Nov	**Pk Charles Mok, Mill Mgr, PT AustAsia Stockfeeds Mill, near Lampung**
	Mr Greg Pankhurst, PT Juang Jaya Abdi Alam, 18,000 hd feedlot, Sidomulyo
13-Nov	Lampung office
14-Nov	**"Brill" Feed Formulation program training, Jakarta**
16-Nov	Flights to Singapore, then Angeles City, Luzon, the Philippines
17-Nov	**Mr Fredie So, SPC Farms Inc, 2,000 hd feedlot, Magalang, Luzon**
18-Nov	**Mr Alex Lacson, RS Meats, 300 hd feedlot and future dairy, Luzon**
19-Nov	**Mr Mario Tang, North Point International Ventures, Cattle Stud, Magalang, Luzon**
20-Nov	**Mr Mario Ong, D'meter Fields Corporation, 2,000 hd feedlot, Pampanga, Luzon**
21-Nov	**Mr Fredie So, SPC Farms Inc, 2,000 hd Feedlot, Magalang, Luzon**
24-Nov	Singapore hotel
25-Nov	Singapore hotel
26-Nov	Flights to Darwin, Sydney, then Brisbane

9.2 Appendix 2 - Research Scientists Contacted

[in addition to those visited during the Indonesian trip]

Details of the research scientists contacted, in addition to those highlighted above in Appendix 1, are shown below.

- Dr Rafat Al Jassim
  School of Animal Studies
  University of Queensland, Australia.

  (Dr Al Jassim was visited in Australia prior to leaving for the research trip.)

- Dr David Shearer
  Australian Centre for International Agricultural Research (ACIAR)
  Canberra, Australia.

- Dr. Marsetyo
  Department of Animal Science
  University of Tadulako
  Palu - Central Sulawesi, Indonesia.

- Dr Atien Priyanti
  Indonesian Center for Animal Research and Development
  Ministry of Agriculture,
  Bogor, Indonesia.

- Dr Abdullah Bamualim
  Director, Indonesian Centre for Animal Research and Development
  Ministry of Agriculture,
  Bogor, Indonesia.

- Dr. Dahlanuddin
  University of Mataram
  Lombok, Indonesia.

9.3 Appendix 3 - Letter and Questionnaire sent to APFINDO

INTRODUCTORY LETTER AND QUESTIONNAIRE E-MAILED TO ALL APFINDO MEMBERS PRIOR TO COMMENCEMENT OF INDONESIAN TRIP.

EASYSTEMS
ENVIRONMENTAL & AGRICULTURAL
SCIENCE & ENGINEERING

Unit 4, 120 Campbell Street
PO Box 411
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AUSTRALIA
Telephone: +61 7 4638 7864
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info@easystems.com.au
www.easystems.com.au

8 October, 2008

Meat & Livestock Australia
Livestock Export R&D Program

Investigating Alternative Feedstuffs for Indonesian Feedlots

Background to Project

It is well-recognised that the demand for protein and energy is increasing globally, especially in South East Asia. This increasing demand also increases demand for cattle feeding inputs. As many Indonesian feedlotters are aware, demand for the key high energy commodities tapioca and tapioca waste has recently increased dramatically. Tapioca waste is now being exported and both commodities are being targeted by the newly established local ethanol industry. In a similar way, this is also happening with locally produced protein meals.

Project Objectives

MLA's Livestock Export R&D Program wishes to undertake an audit of products that could be used (or treated for use) as cost-effective components of feedlot rations in Indonesia. This will be achieved by:

1) An initial investigation in SE Asia of currently used cattle feed commodities, opportunities to source new commodities or more effectively store wet commodities, and options to effectively treat existing poor quality commodities to improve their digestibilities, and

2) A review and literature search of tropical feed stuff storage and treatment methods currently being used or researched throughout the world which may have application in improving the utilisation of poor quality commodities available to Indonesian feedlotters.

Commencement of Project

MLA have recently appointed the Australian based consulting company, EA Systems Pty Ltd, as the research organization to undertake this project. As Principal Agricultural Scientist with EA Systems, and having had considerable experience in formulating rations for some of the larger feedlots in Indonesia, Malaysia and the Philippines over the past 10 years, I will have the privilege of leading this project.

In order to conduct the initial commodity audit, I am planning to arrive in Indonesia on 15 October, meet with several research and commercial organizations over approximately one month, before travelling to Malaysia and the Philippines, each for one week. I will then return to Australia to complete the desktop review and literature searches.

Preliminary Questionnaire

As this project was initiated by members of APFINDO, before commencing the study trip I am interested to hear from members as to their own ideas and comments on the direction this project should take. This information will help me to get members a better result from the project. I would appreciate you completing the Questionnaire below and returning it to me as soon as convenient, via the e-mail address below.

Please note that this project is not simply a data collection exercise designed to look at every feedlot's rations and methods of sourcing feed commodities. The project is more a study of COST EFFECTIVE alternatives to current practices, whether they involve local or imported feeds, or different storage and treatment methods.

I am looking forward to meeting many of you in my travels over the next month.

Salam,

Greg Willis
Principal Agricultural Scientist
EA Systems Pty Ltd
Mob: +61 418 887 378
greg.willis@easystems.com.au
www.easystems.com.au

Please rank the options below in order of priority (1 - 8), in terms of areas you would most like to see me investigate, in order to help solve the problem of overly expensive feed commodities in Indonesian feedlots.

Please save this document to a directory, complete on screen and e-mail it back to me.

1.) Greater usage of waste products from human food factories. ☐

2.) Cheaper, more hygienic ways of drying and storing Onggok or Gaplek. ☐

3.) Better usage and storage of wet by-products such as:
Wet Onggok, Ampas Bir, Ampas Nanas, etc. ☐

4.) Better usage of Palm Plantation by-products. ☐

5.) Better utilization of low value commodities, possibly in association with Indonesian research organizations or Universities. Commodities such as:
Dedak/Katul, Jerami, Bungkil Sawit, etc, using enzymes or bacterial cultures or chemical additives. ☐

6.) Possible production and storage of High Moisture Corn
(or Corn "earlage", i.e., the kernel + cob + husk). ☐

7.) Possible production of improved species of tropical grasses and legumes ☐

8.) Options for the importation of commodities. ☐

If favouring this concept, which countries do you see as having the greatest potential in being able to supply useful high energy commodities to Indonesia? Please put X in the boxes below. (Remember that countries not having freedom from FMD would require special import permits.)

a.) Thailand ☐

b.) India ☐

c.) Malaysia ☐

d.) Philippines ☐

e.) Australia ☐

f.) USA / Canada ☐ ☐

g.) South America

h.) Other countries ... please specify:

9.) Please indicate any other ideas, comments or suggestions for the direction of this project.

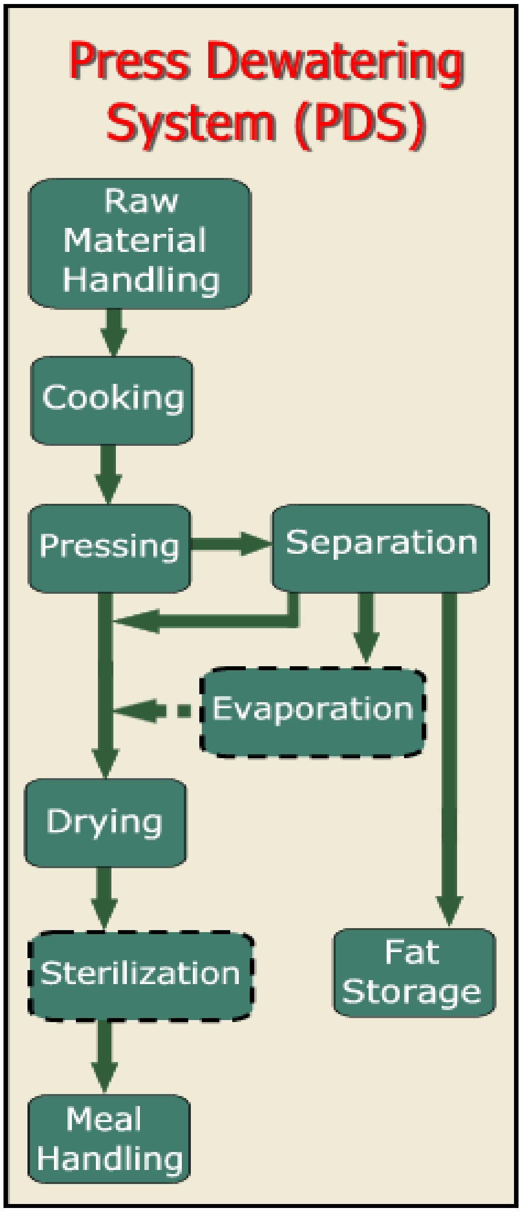
Terima kasih

9.4 Appendix 4 - Potential Rendering System for Food Wastes

RENDERTECH LIMITED

Rendering Processes

NEW ZEALAND: 110 Mays Road, Auckland. 1006. Ph. +64 9 634 5375.
enquiries@rendertech.co.nz
AUSTRALIA: PO Box 3263 Mornington. Vic. 3931. Ph. +61 3 5977 1181.



The Rendertech Press Dewatering System (PDS) is a rendering process suitable for the processing of food by-products. It produces high quality end products, has low energy consumption and is simple to operate and maintain. This environmentally friendly process is virtually 'zero waste', resulting in high product yields and with low wastewater loads.

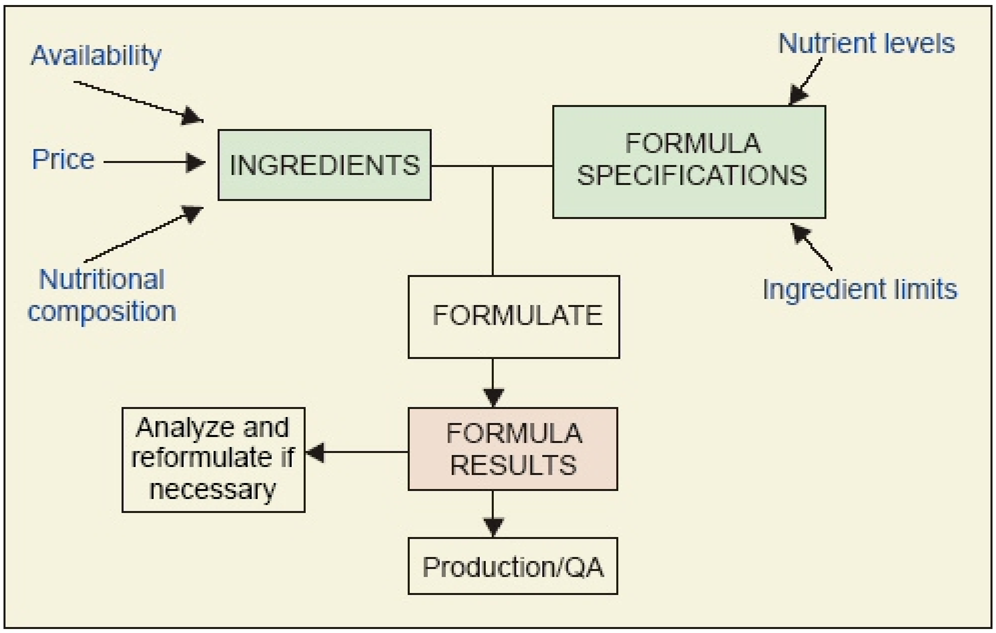
The main items of equipment employed in the process are the **Precooker** (PC), **Double Screw Press**, **Contact Drier** (CD), and **Waste Heat Evaporator** (WHE).

Beacause of its proven performance, the Press Dewatering System has been the main process supplied by Rendertech to the protein recovery industries.

9.5 Appendix 5 - Least-Cost Feed Formulation Technique

“Least-cost feed formulation” is the combination of many feed ingredients in a certain proportion to provide the target animal with a balanced nutritional feed at the least possible cost. Though least-cost formulation is a mathematical solution based on linear programming, it requires the professional knowledge of animal nutritionists who take into consideration the nutrient requirements of the target animal and its capability to digest and assimilate nutrients from various available ingredients. Feed formulators also need to be aware of the variations of nutritional requirements for different species at various stages of their lifespan. The linear programming is based on the information put in by the formulator.

The diagram below summarises the basics of the least-cost feed formulation process:



Available ingredients

The program provides a way of entering and managing the ingredients which are available for inclusion in the formulas. Available feed ingredients are listed along with their unit price.

Nutrient composition

Each feed ingredient available for inclusion in the formulas should have corresponding nutrient composition data. The nutrient values are preferably derived from chemical analysis of representative samples of the ingredient. When the nutrient composition is not available, tables of feed composition using average or typical values are used.

Formula specifications

Specifications are set for each formula to be solved. Formula specifications generally define the nutrient levels desired in the formula and the ingredient inclusion levels. Either a lower limit and/or an upper limit for each nutrient and ingredient are set.

Formulation

Once all the above necessary information is provided, the program will produce formulas that meet the desired specifications at the lowest possible cost. A requirement for proper formulation, however, is that the formula result must be feasible both from a mathematical and a nutritional standpoint. If infeasible results are obtained the ingredient and nutritional composition should be carefully scrutinised to make sure the solution is nutritionally acceptable for the target species.

One of the most important uses of least-cost feed formulation is in choosing among the available ingredients to be used, based on their nutritional composition and cost. Many times one ingredient can be substituted by another with similar nutritional value. The program helps the user to achieve the highest profit margin when market conditions favour the use of one ingredient over the other.
A number of tools are useful in the analysis of formulation results:

Marginal price changes

For those ingredients that were not included in the formula solution, the program indicates how much the cost of these ingredients will have to fall before they can be included in the formula. This cost change is called the marginal price change of the ingredient.

Shadow prices

Shadow price of an ingredient is calculated by subtracting the marginal cost change from the current ingredient cost. This amount represents the cost of the ingredient at which the ingredient will be included in the formula. Ingredients that are included in the formula results have a shadow price of zero.

Similarly, the change in formula cost with a change in a nutrient constraint is called the shadow price of the nutrient. The shadow price of a nutrient is zero if the level of nutrient use is not equal to the constraint level.

Nutrient ratios

The ability to specify that several nutrients must exist in the resulting formula in relation to one another is called Nutrient Factoring. The program provides this capability which allows setting a ratio between two nutrients, eg, Calcium and Phosphorus. The ability to specify nutrients in proportion to one another is another application of this function. For example, the user can specify that amino acids be proportional to the total amount of protein in the formula.

9.6 Appendix 6 - Ethanol Factories in Indonesia

Present ethanol factories in Indonesia, as at 2005

Name of Company	Location	Production Capacity (Kiloliter/y)	Feedstock
PT Aneka Kimia Nusantara	Mojokerto	5.000	Molasses
PT Basis Indah	Sulawesi	1.600	Molasses
PT Bukitmanikam Subur Persada	Lampung	51.282	Molasses
PT Indo Acidama Chemical	Surakarta	42.000	Molasses
PT Madu Baru	Yogyakarta	6.720	Molasses
PT Molindo Raya Industrial	Malang	10.000	Molasses
PT Perkebunan Nusantara XI	Bondowoso	6.000	Molasses
PT Rhodia Manyar	Gresik	11.000	Molasses
B2TP, BPPT	Lampung	~ 30	Cassava

Source: *Kompas* newspaper, Apr 19, 2006. Technical grade ethanol and raw spirit (ethanol: 95-97 % v/v).

Proposed future ethanol factories in Indonesia, as at 2005

Name of Company	Location	Production Capacity (Kiloliter/y)	Feedstock
PT Indo Lampung Distillery	Lampung	60,000	Molasses
PT Sampurna	Ponorogo	16,800	Cassava
PT RNI & Choi Biofuel Co.	Pasuruan	11,200	Molasses
Kanematsu Corporation	?	30,000	Cassava
CNOOC & PT Smart & Hongkong Energy	?	?	Cassava & Molasses
PT Medco Energi Internasional Tbk	Kotabumi	?	Cassava
PTPN X & PT Molindo Raya Industri	Kediri	120	Molasses

Source: *Kompas* newspaper and *Sinar Harapan*. July 2006 – March 2007.

10 Addendum

As mentioned previously throughout this report, a detailed outline of the main audit findings from the research trip is presented in an Excel file - "Indonesian Feedlot Commodity Options" - which forms an Addendum to this main report document. This Excel file will be available in downloadable form from the MLA website www.mla.com.au and also available on CD.)

More specific detail on the location of this file on the MLA website will be available over the coming months, as will information on the method of acquiring a copy of the CD containing this file.