AGRICULTURE BY-PRODUCTS AS ANIMAL FEED

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The Feed Resources

- Forages
- Crop residues
- Agro-industrial by-products (AIBP)
- Non-conventional feed resources (NCFR)
CROP RESIDUES

- Mainly fibrous materials – by-products of crop cultivation
- Generally low in CP (3.3 – 13.3% DM)
- Most deficient in fermentable energy
- Low organic matter digestibility
- Low mineral digestibility
- Examples: Cereal straws / rice straw, bagasse etc.
AGRO-INDUSTRIAL BY-PRODUCTS

- By-products derived in the industry due to processing of the main crop or animal products
- Usually less fibrous and more concentrated
- Generally have a higher nutrient content
- Examples: molasses, rice bran, PKC, pineapple waste, POME, coconut cake etc.
NON COVENTIONAL FEED RESOURCES (NCFR)

- All those feeds that have not been traditionally used in animal feeding and/or are not normally used in commercially produced rations for animals.
- Examples: POME, PPF, SCP, stubles, vines, slaughterhouse by-products, derivatives from chemical or microbial processes.
- No clear demarcation between traditional feeds and NCFR. Utilization/emphasis differ by countries.
MAJOR BY PRODUCT FEEDS FROM TREE AND FIELD CROPS

- **Cocoa**
  - Cocoa bean waste
  - Cocoa pod husks

- **Coconut**
  - Coconut meal

- **Oil palm**
  - PKC, PPF, POME
MAJOR BY PRODUCT FEEDS FROM TREE AND FIELD CROPS

Rubber
  Rubber seed meal

Sago
  Sago pith / refuse

Coffee
  Coffee hulls
  Coffee pulps
MAJOR BY PRODUCT FEEDS FROM TREE AND FIELD CROPS

Cotton
Cotton seed meal
Maize
Maize bran
Maize germ meal
Maize stover
Rice
Broken rice, Rice bran, Rice husk, Rice straw
MAJOR BY PRODUCT FEEDS FROM TREE AND FIELD CROPS

Sugar cane
Bagasse, Green tops, Molasses
Cassava
Tapioca waste
Wheat
Wheat bran, wheat straw
MINOR BY-PRODUCT FEEDS FROM VARIOUS SOURCES

Cassava leaves, Dhupa meal, Ground-nut vines (stems plus leaves), Ground-nut meal, Guar meal, Kakan meal, Karaj meal, Kakum meal, Kusum meal, Mahua meal, Mango kernel, Nahor meal, Neem meal, Oak meal, Pineapple waste, Pisa meal, Sal seed meal, Sesame cake, Soybean, Sweet potato vines, Tamarind seed hulls, Tamarind seed kernels
CURRENT CONSTRAINTS TO UTILIZATION

- Production scattered – low quality esp for processing
- High cost of collection eg: rubber seeds
- Non competitive costs / unremunerative prices
- Processing difficult and costly
- Lack of managerial and technical skills to utilise the feeds in situ
- Uncertainty about the marketability of the end products
- Lack of institutional and support services for large-scale on-farm testing with farmers participation
BIOMASS FROM TREE

OPF

EFB

OPT

FEED INGREDIENTS FROM PROCESSING

PPF

PKC

FATS FOR FEED

POME
Feed Materials From Oil palm

MILLING PROCESS

FFB

Kernels
CPO
EFB
POME
PPF

Cleaning
Grinding
Steaming
Extraction

PKC
PKO
Usage

As a source of roughage (fibre) & energy for ruminant animals.
PKC - Nutritive values

- Dry matter – 93%
- Crude protein – 16%
- Crude fibre – 17%
- ME for ruminants – 10.5 MJ/kg
- ME for poultry – 6.5 MJ/kg
- Highly digestible
- Palatable to all animals
- Minerals highly available
PKC in Rations For Ruminants

- PKC is widely used in many ruminant rations
- Commonly used in rations for cattle, buffalo, sheep, goats and also deer
- Suitable for combination with other low energy roughages
PKC in Rations For Beef and Dairy Cattle

- Widely used in beef and dairy cattle formulations
- Safe and can be used up to 80%
- In Malaysia cattle in feedlots are fed up to 90%

Performance of cattle
- Local cattle: 600 – 800g/day
- Crossbreds: 1000 – 1200g/day
PKC in Poultry Rations

- Due to high crude fibre the use of PKC in poultry rations is limited
- Broiler chickens can tolerate up to 20% PKC
- Layer chickens can tolerate up to 25% PKC
- Ducks can tolerate up to 30%
Fermentation of PKC and Exogenous Enzyme

Fungal fermentation – *Aspergillus* spp. and *Rhizopus* spp.

- Exogenous Enzymes – mannanase, cellulase, and combinations, phytase, etc.
Oil Palm Fronds (OPF)

Continuously available in the plantation

Collected during pruning and replanting

Made up of a petiole (70%) and rachis & leaflets (30%)
Oil Palm Fronds - Advantages

• Superior roughage source
• Good palatability
• Supply energy and fibre
• Nutritive value between hay and straw
• Meets maintenance requirements for energy and protein
• Practical and cost effective
• Ideal for total mixed ration (TMR) or complete feed
### Oil Palm Fronds - Nutritive Value

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter (DM)</td>
<td>32.6 %</td>
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<tr>
<td>Crude protein (CP)</td>
<td>4.5 %</td>
</tr>
<tr>
<td>Crude fibre (CF)</td>
<td>25.4 %</td>
</tr>
<tr>
<td>Ether extract (EE)</td>
<td>0.6 %</td>
</tr>
<tr>
<td>Ash</td>
<td>3.6 %</td>
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<tr>
<td>N-free extract (NFE)</td>
<td>54.5 %</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>0.18 %</td>
</tr>
<tr>
<td>Phosphorus (P)</td>
<td>0.05 %</td>
</tr>
<tr>
<td>Total Digestible Nutrient (TDN)</td>
<td>46.5 %</td>
</tr>
<tr>
<td>Metabolisable energy (ME)</td>
<td>6.76 MJ/kg</td>
</tr>
</tbody>
</table>


OPF SILAGE MADE IN DRUMS
OTOSIL – BERPOTENSI UNTUK DIKOMERSIALKAN
Palm Oil Mill Effluent (POME)

- Discharge from palm oil extraction in the mill.
- Residue left from the purification of CPO
- Includes various liquids, residual oil and suspended solids.
- Contains about 95% water.
- Wide variability in ash content
- Wide different in feeding values
- Usually utilized as organic fertilizer in crop cultivation
Palm Press Fibre (PPF)

- More than 2 million tonnes /year
- Mainly used for fuel in palm oil mills.
- A fibrous by-product of crude oil extraction of the mesocarp.
- Low CP (4 %) and ME value
- Low digestibility (about 22.3 %)
- Optimum inclusion level 20 %
- Fed in the form of fresh or silage.
- Bolus formation and impairment of rumen activity at higher levels.
OPF PELLET
HIGH FIBROUS DIETS AS FEDS FOR LIVESTOCK
SOYBEAN WASTE
UTILIZATION OF CROP RESIDUES IN THAILAND
Hampas kacang soya
Corn cob skin
Pineapple Wastes As Livestock Feds
OTHER CROP RESIDUES AND AGRICULTURAL BY-PRODUCTS
EXCESSIVE INTAKE OF HIGH ENRGY DIET

EXCESSIVE INTAKE OF PKC

PELLET PROCESSING REDUCED PARTICLE SIZE

MICROBES COULD NOT FUNCTION EFFECTIVELY

TRAPPING OF GAS CAUSING BLOAT – NEED FIBROUS DIETS WITH LONGER PARTICLE SIZE
Cow Rumen Protist and Bacilli

Kingdom: Eubacteria and Protist
Scientific Name: Diplodinium
Image Courtesy of: C.L. Davis, University of Illinois
Image Width: 35 microns
Image Technology: SEM (Scanning Electron Microscope)

The large creature in this view is a protist that lives in the rumen (one of the stomachs) of a cow. The protist is covered with many other microbes that look like strings of beads or sausage links. The smaller microbes are bacilli, a type of bacterium. Bacilli (the singular form is bacillus) is a term used to refer to any of the many types of rod-shaped bacteria.

Several kinds of plant-eating animals related to cows, called ruminants, have similar microbe populations in their guts. Goats, reindeer, camels, giraffes and deer are all ruminants.
Rumen Symbionts

Kingdom: Protist, fungi, eubacteria
Scientific Name: Entodinium caudatum et al.
Image Courtesy of: Yokoyama, Mel; Cobos, Mario A.
Image Width: 40 microns
Image Technology: SEM

Cattle, like other ruminant animals such as goats, deer, and giraffes, have billions of microbes inside their guts which help them digest their food. These are some of the many types of microbes that live in the rumens (stomachs) of cows. The large microbe is a type of protist. The creature that looks like a tadpole attached to the side of the protist is a fungal spore. The smaller, rod-shaped beasts lining the underside of the protist are bacteria.
This is a protist found in the rumen. This protist moves around the rumen to find tasty bits of food to eat. It moves by the little rope-like whips that wiggle around (undulate). These undulating ropes are called "undulipodia." These unulipodia are similar in function (analogous) to the flagella of bacteria.
Ophryoscolex

Kingdom: Protist
Scientific Name: Ophryoscolex
Image Courtesy of: Yokoyama, Mel; Cobos, Mario A.
Image Width: 17µm
Image Technology: SEM

This is one of the biggest rumen protists.

THE BIGGEST PROTIST IN RUMEN OF CATTLE
PROCESSING OF CROP RESIDUES AND AGRO-INDUSTRIAL BY-PRODUCTS

Activities to change the physico-chemical characteristics of crop residues / agro-industrial by-products in order to improve their nutritive or feeding values for livestock feeding
Physical Treatment:

- Addition / Excretion of moisture
- Heat treatment
- Pressure

Chemical Treatment

- Altering chemical structure of CHO and protein
- Increase digestibility

Physico-Chemical Treatment

- Physical and chemical together

Biological
THANK YOU