

Challenges and Opportunities in Agro-waste Management: An Asian Perspective

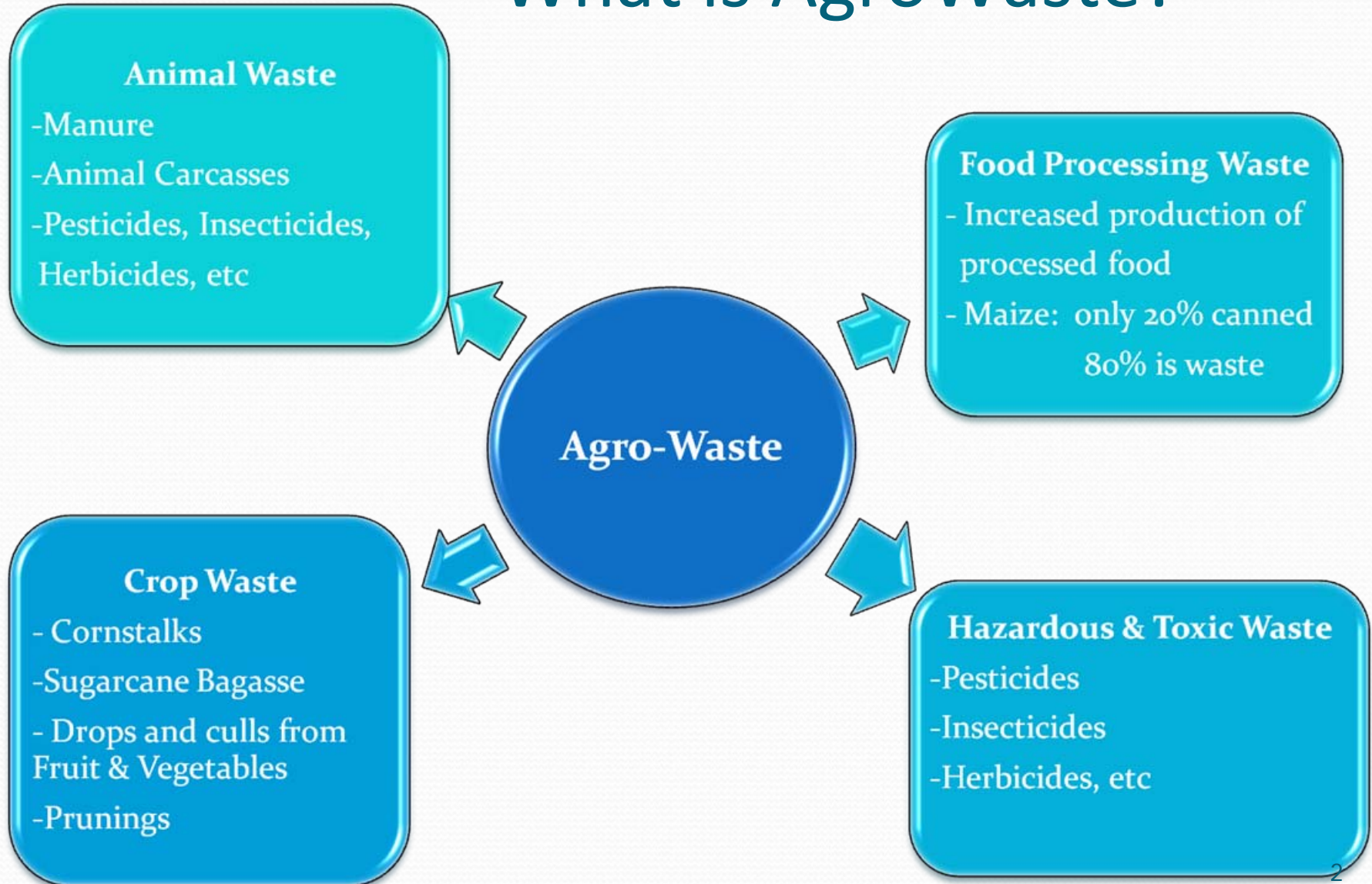
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What is AgroWaste?



Agricultural Waste Generation



- Globally, 998 million tonnes of Agricultural Waste is produced in a year.
- In Malaysia, 1.2 million tonnes of agricultural waste is disposed into landfills annually.

AgroWaste Generation in Asia

Country	Agricultural Waste Generation (kg/cap/day)	Projected Agricultural Waste Generation in 2025(kg/cap/day)
Brunei	0.099	0.143
Cambodia	0.078	0.165
Indonesia	0.114	0.150
Laos	0.083	0.135
Malaysia	0.122	0.210
Myanmar	0.068	0.128
Philippines	0.078	0.120
Singapore	0.165	0.165
Thailand	0.096	0.225
Vietnam	0.092	0.150

- An estimated 15% of total waste generation consists of AgroWaste (Hsing et. al. 2001).

AgroWaste Generation in Asia (cont'd)

Country	Agricultural Waste Generation Rate (kg/cap/day)	Projected Agricultural Waste Generation in 2025 (kg/cap/day)
Nepal	0.060	0.09
Bangladesh	0.04	0.09
Mongolia	-	0.09
China	0.12	0.135
Sri Lanka	0.03-0.14	0.150
Republic of Korea	0.15	0.210
Japan	0.17	0.195

- An estimated 15% of total waste generation consists of AgroWaste

AgroWaste Utilization

AgroWaste	Utilization
Rice Husk Ash & Charcoal	<ul style="list-style-type: none"> • Additive in cement mixes • Water glass manufacture • Active carbon
Rice Husk	<ul style="list-style-type: none"> • Electricity production
Banana Peel & Sugarcane fibers	<ul style="list-style-type: none"> • Paper making pulp
Oil Palm Empty Fruit Bunch (EFB)	<ul style="list-style-type: none"> • Mulching, Organic Fertilizer
Oil Palm stems, Rubber wood	<ul style="list-style-type: none"> • Particleboards • Softwood furniture
Onion skin, Groundnut husk	<ul style="list-style-type: none"> • Heavy metal removal
Husk, Bagasse	<ul style="list-style-type: none"> • Mushroom cultivation
Bagasse, Banana Fruit Reject	<ul style="list-style-type: none"> • Ethanol production • Animal feed



AgroWaste Utilization (cont'd)

AgroWaste

Utilization

Husk, Straw, Cow Dung

- Biogas production
- Electricity generation

Sunflower stalk

Corn Stalk

Bagasse Fibers

- Reinforcement for thermoplastics

Animal waste (dung)

- Compost
- Fertilizer



Greenhouse Gas Emissions from Agricultural Sector

- Global mitigation potential is 5,500-6,000 megatons of CO₂e / year by 2030
- Carbon sequestration - nearly 90% of this potential
- Potential to reduce methane (CH₄) emission from rice fields by China and India by 26%
- Up to 50% of emissions (1,100-3,000mt CO₂-eq/yr) can be mitigated by 2030 through soil carbon sequestration
- Potential to reduce emissions by 277 Mt CO₂-eq/year at carbon price of \$20 per ton, equivalent to benefit of \$5.5 billion a year

Biomass as an Alternative

- **Shifting of paradigm towards BIOMASS**
 - Renewable energy
 - Sustainable
 - Environmentally friendly
 - Abundant
 - Untapped energy
- **Uncertainties of BIOMASS**
 - Technological proven ?
 - Economically feasible ?
 - Constant supply ? (quality and quantity)
 - Availability & distribution ? (worldwide)

Biomass utilization

- Thermal conversion - power/electricity generation
- Biological conversion – CH₄ generation
- Biological Conversion - Organic acids generation
 - acetic, propionic and butyric acids
- Biological Conversion – Bioplastics
 - organic acids into poly-hydroxyalkanoates
- Biological Conversion - Bio-compost
 - Good properties such as pH 6-8, C/N 20 and comply to USEPA standards

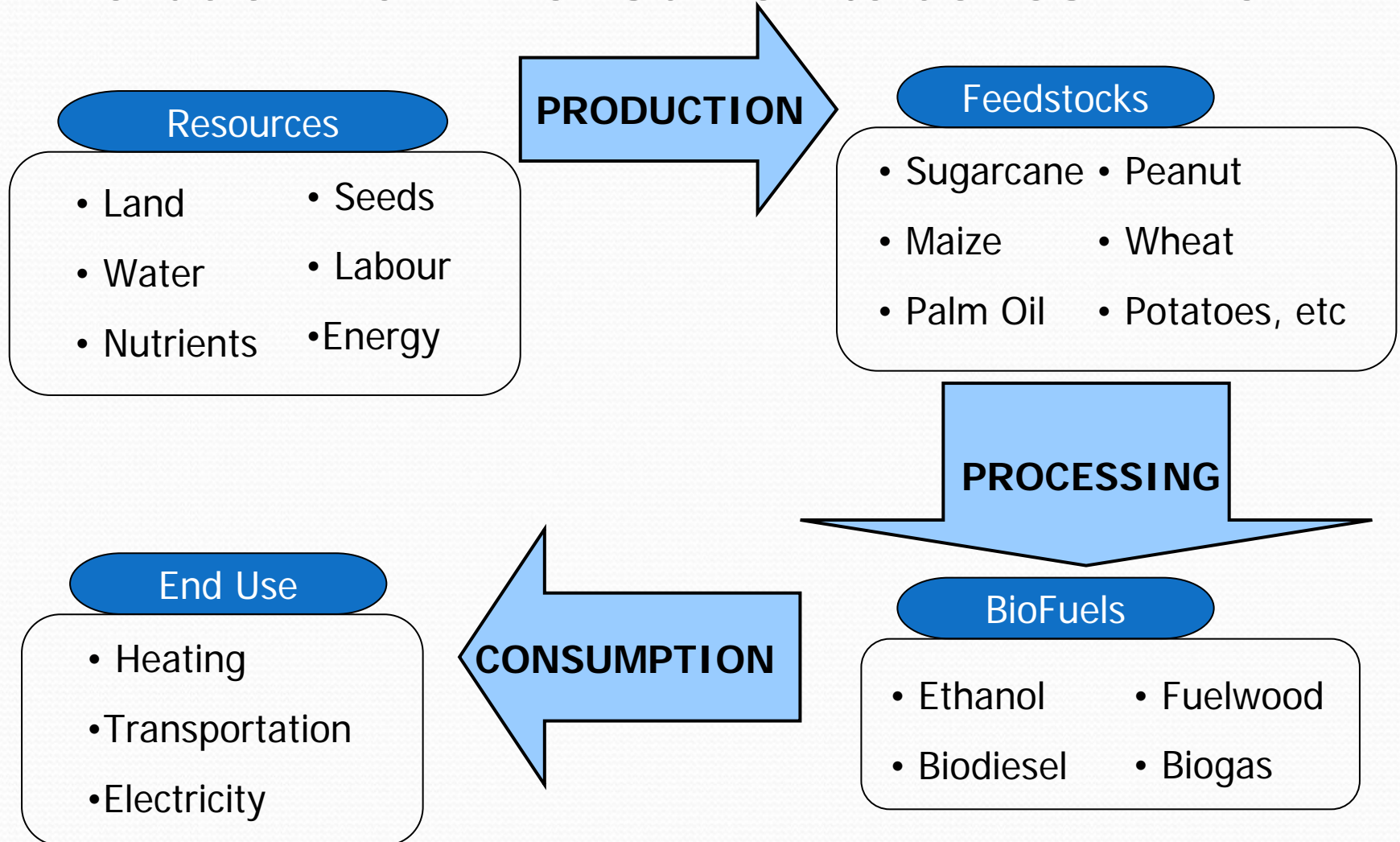
3R's AgroWaste Opportunities

- **Heat Production** *agricultural residues burnt as fuel
 - 92% as thermal output (EIA 2008)
 - 12.9 and 14.6 million btu/tonne of agricultural residues
- Production of Cellulosic Ethanol as a **Biofuel**
- **Biogas production** as a substitute for cooking gas instead of fuel wood (in rural villages) and to meet urban demands for cooking biogas

3R's AgroWaste Opportunities (cont'd)

- **Compost** production in efforts of sustainable farming – organic fertilizers substituting chemical fertilizers
- **Electricity Generation**
- NCFR – Non Conventional Feed Resources
 - cattle/livestock is fed straw, spent grains, and other agricultural waste
- AIBP- Agro Industrial By Product

BioFuels : From PRODUCTION to CONSUMPTION



Conversion of agricultural feedstocks into liquid biofuels

SUGAR CROPS

- Sugar cane
- Sugar beet
- Sweet sorghum

STARCHY CROPS

- Maize
- Wheat
- Barley
- Rye
- Potatoes
- Cassava

CELLULOSIC MATERIALS

- Switchgrass
- Miscanthus
- Willow
- Poplar
- Crop stover

OIL CROPS

- Rapeseed
- Oil palm
- Soybean
- Sunflower
- Peanut
- Jatropha

Fermentation
and
distillation



Saccarification,
fermentation
and distillation



Extraction
and
esterification

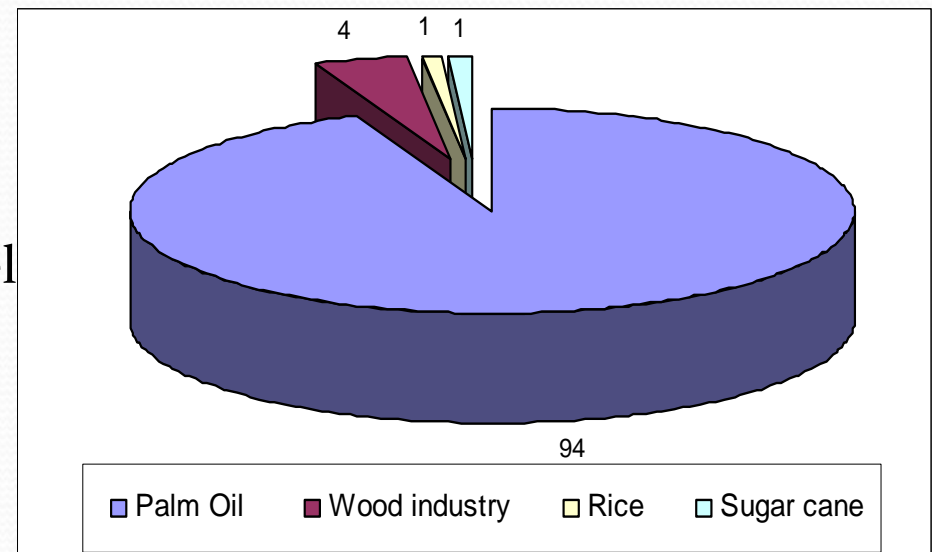


ETHANOL

BIODIESEL

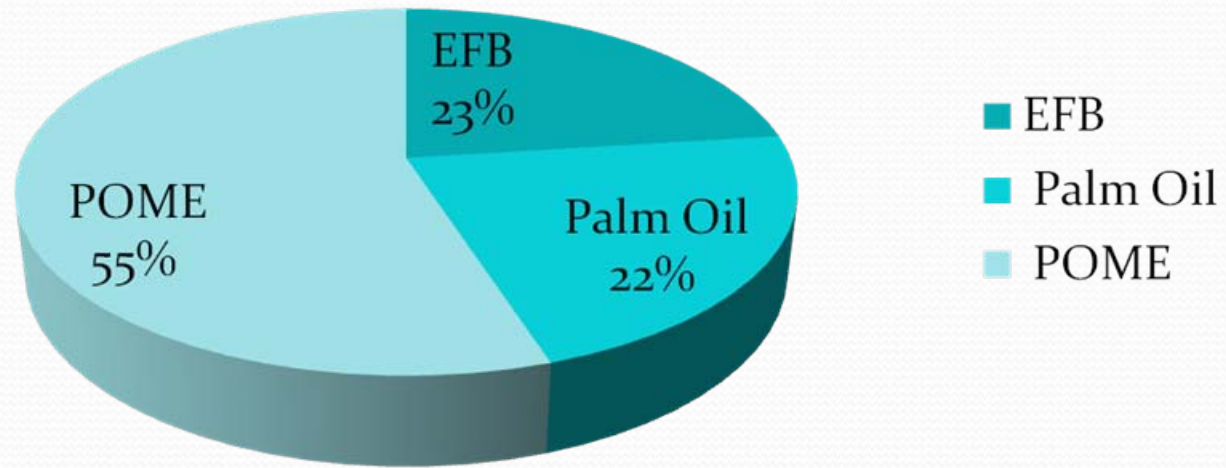
Biomass resources from Agricultural residues

- **Most abundant in Malaysia (> 70 million tonnes annually)**
- **Production of biomass throughout the year**
 - high sunlight intensity/time and high rainfall
- **Main contributor of biomass – palm oil industry (in 2003)**
 - 14 mil tonnes EFB
 - Palm oil mill effluent
 - 5 mil tonnes mesocarp fiber
 - 8 mil tonnes palm kernel shell
 - Palm kernel cake (residue)
- **Ligno-cellulosic materials**



Palm Oil Industry: A Case Study

- Malaysia is the largest producer of Palm Oil
- 18 million tonnes of CPO was produced in 2008.
- 18-22% Palm Oil
- 23 % is solid waste : Empty Fruit Bunches, EFB



Palm Oil Production and Waste Generation



Oil Palm

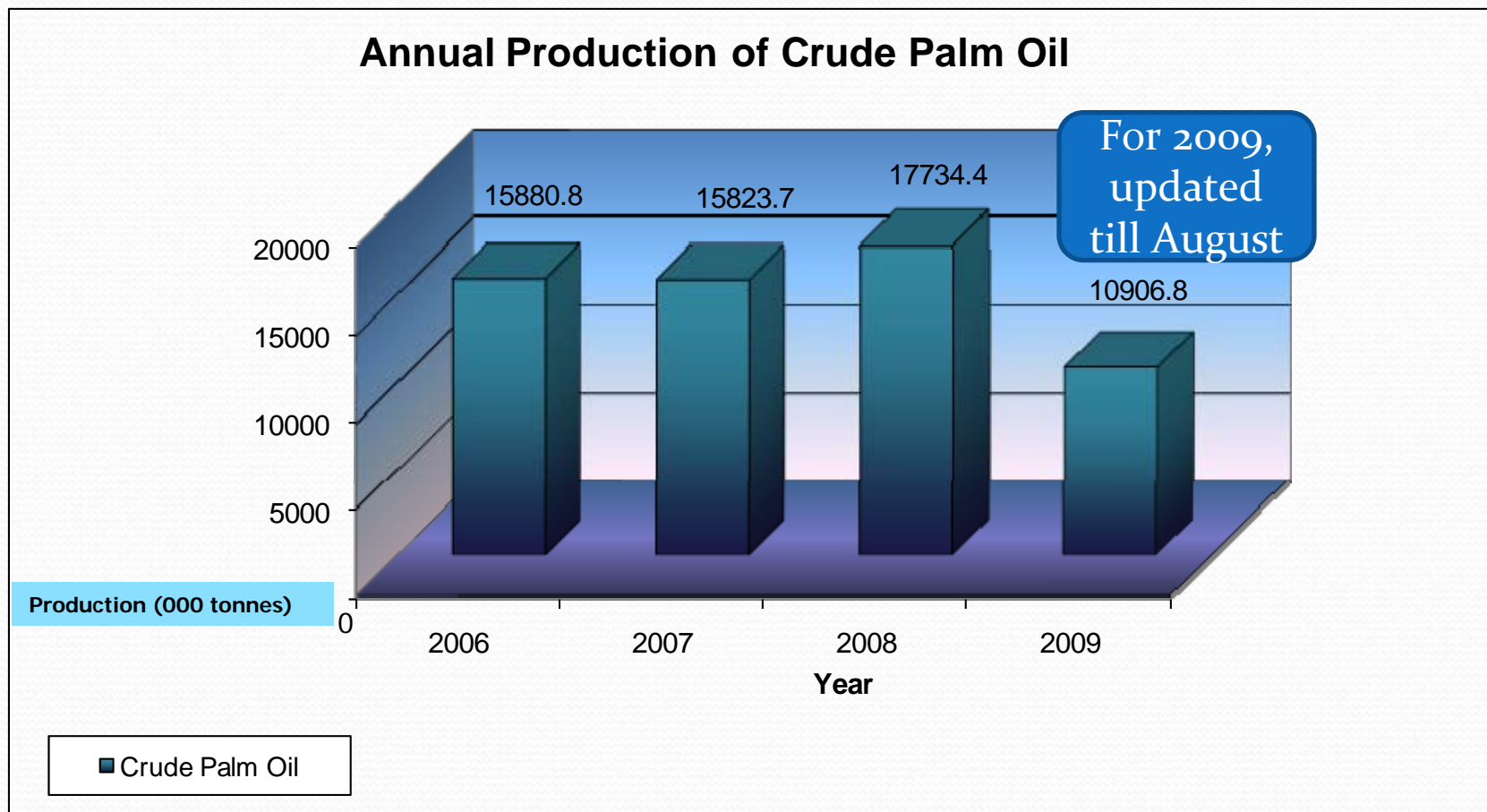


Palm Oil Full
Fruit Bunch
(FFB)



Application of empty fruit bunch (EFB) as covering material

Annual Production of Crude Oil



Where does all the waste go?



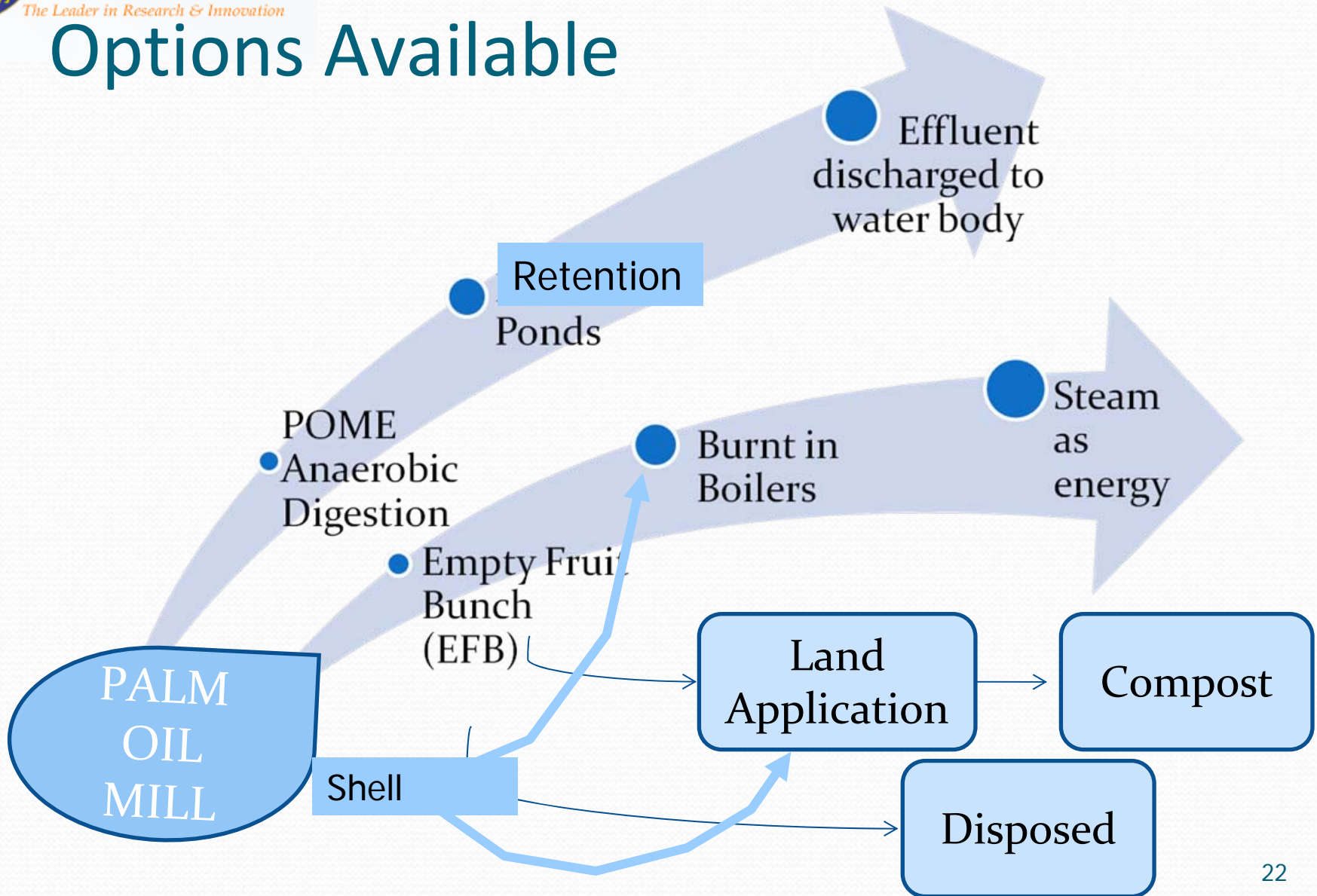
18 million tonnes
of Crude Palm Oil
produced

2008



63 million tonnes
of EFB & POME
(waste) produced

Options Available



Palm oil Industry: Towards Zero Emission



Concentration of biomass



Oil Extraction

Empty Fruit Bunch



Compost



Cellulose

Sugars (Polylactate)

Bio-plastics Bio-acids (PHA)

Bio-acids

Palm Oil Mill Effluent

Methane

Biofuel

Bio-plastics Bio-acids (PHA)

Bio-acids

Summary

- With technology advancement and research findings, agricultural waste is no longer an environmental issue but a resource for energy production.
- ‘Waste-to-Wealth’ perception of Agricultural Waste
- A tremendous potential in improving the general state of sanitation, positive environmental actions to reduce GHG emissions.
- Significantly improve the crop yield, soil fertility
- Reduces the global dependence on chemical fertilizers, fossil fuel, etc.

THANK YOU