الجامعة الإسلامية العالمية ماليزيا
INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA
يونيرسيتي إسلام انتارابغسا ملايسيا

ICBioE 2016, 25-27 July 2016, IIUM

Environmental Biotechnology for Sustainable Development

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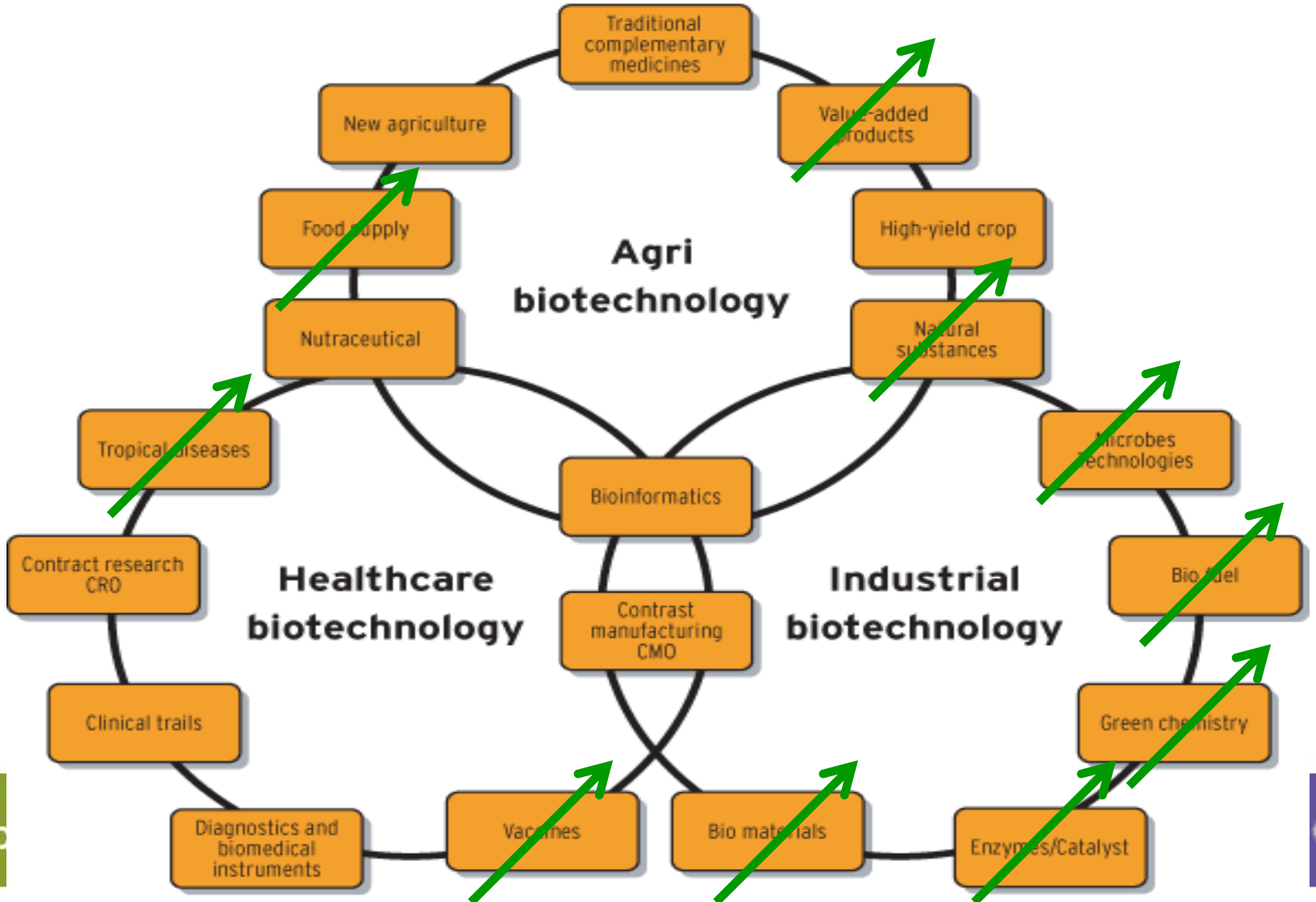
International Islamic University Malaysia

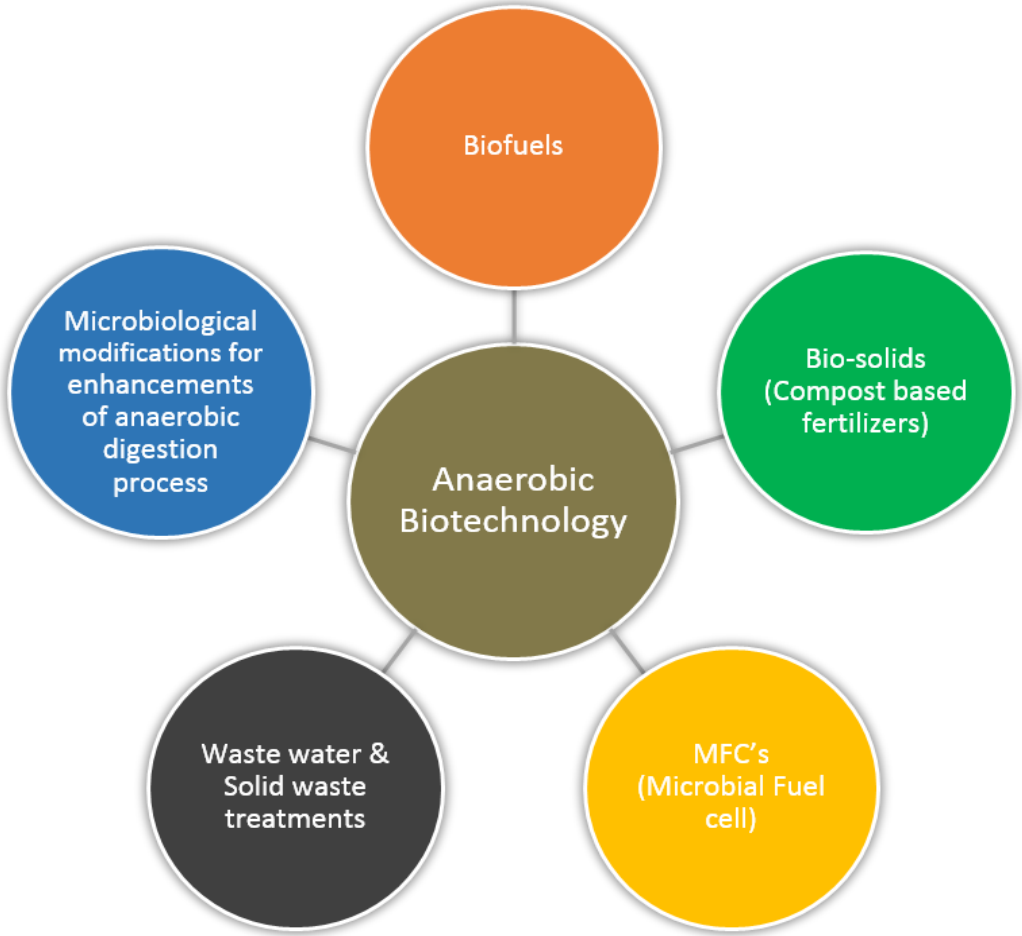
A short video: Environmental Sustainability

https://www.youtube.com/watch?v=GnYHFRq7-5s

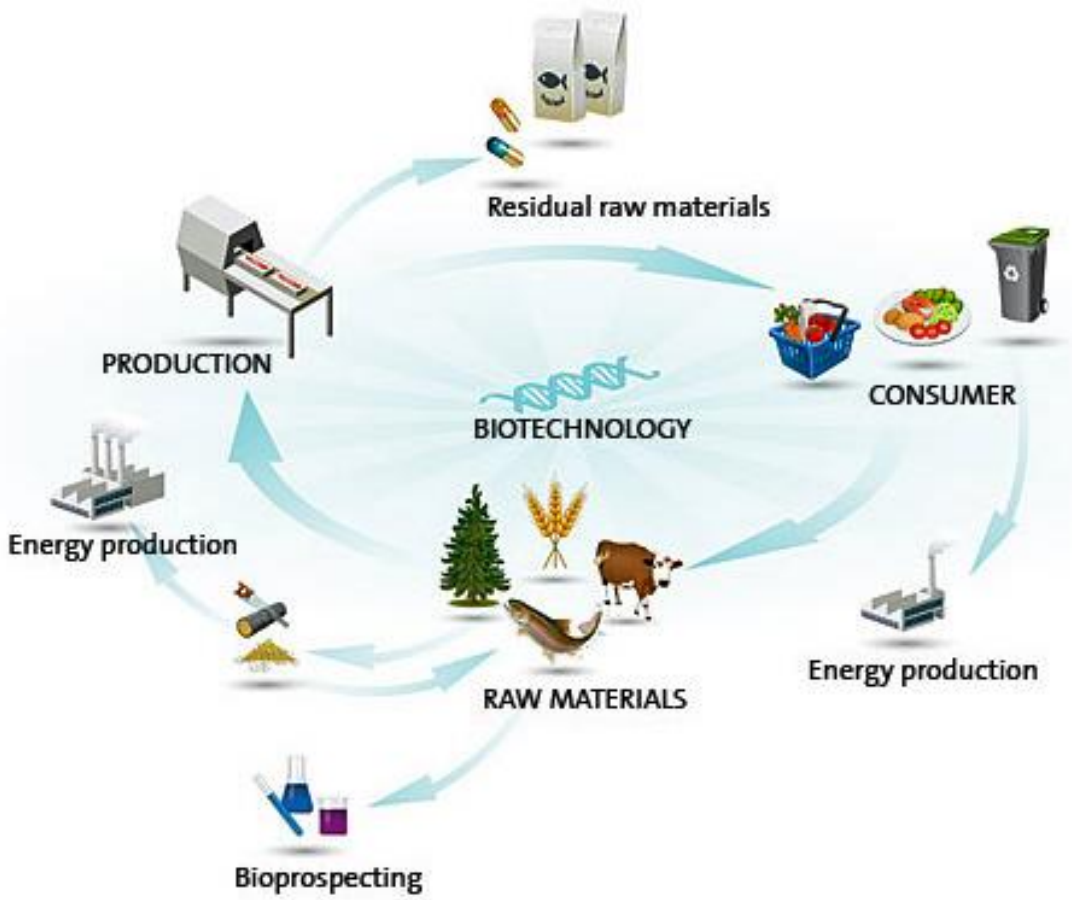
Biotechnology: Recent Advances for Sustainable Development



Environmental Biotechnology

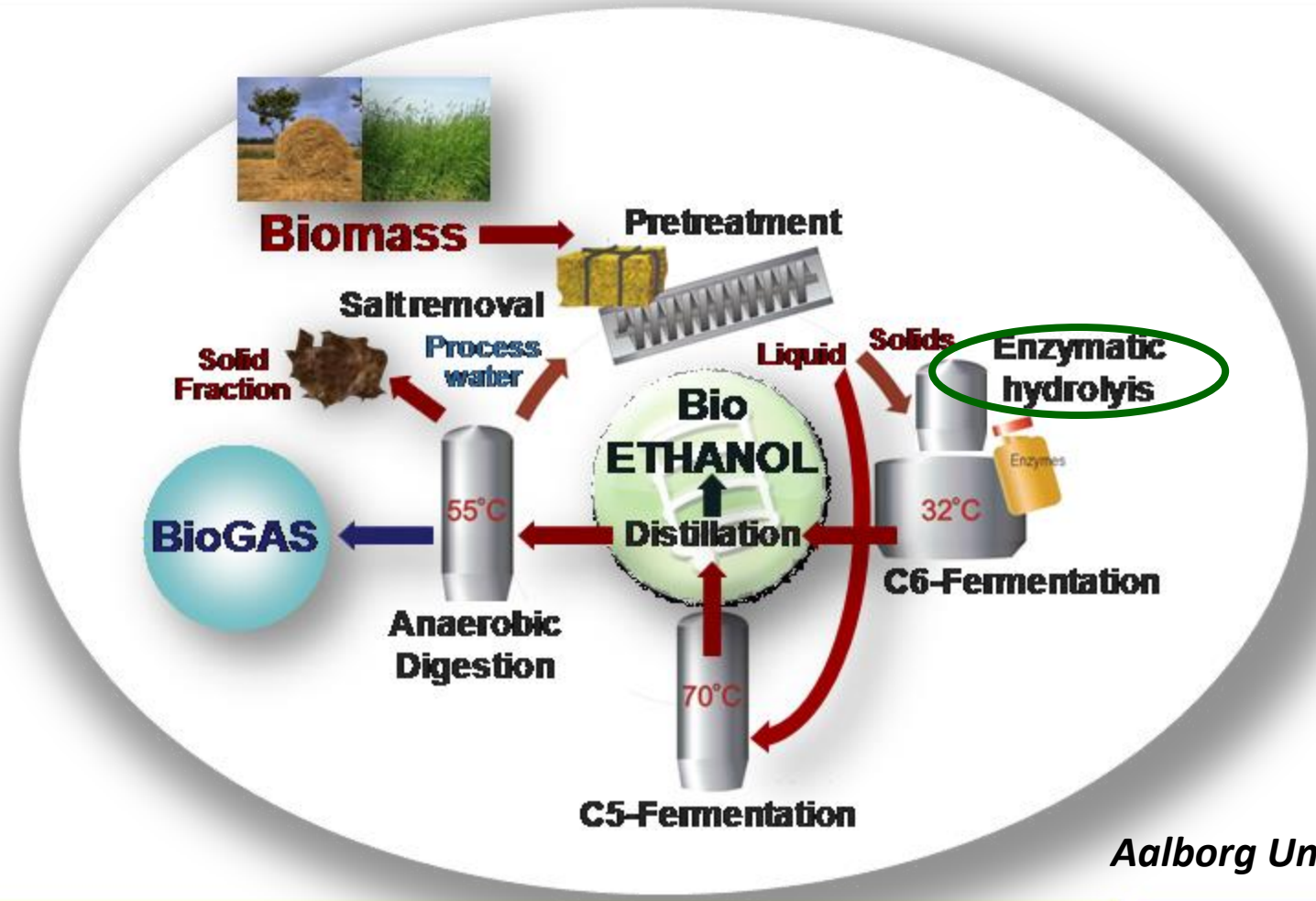


Towards a bio-based society



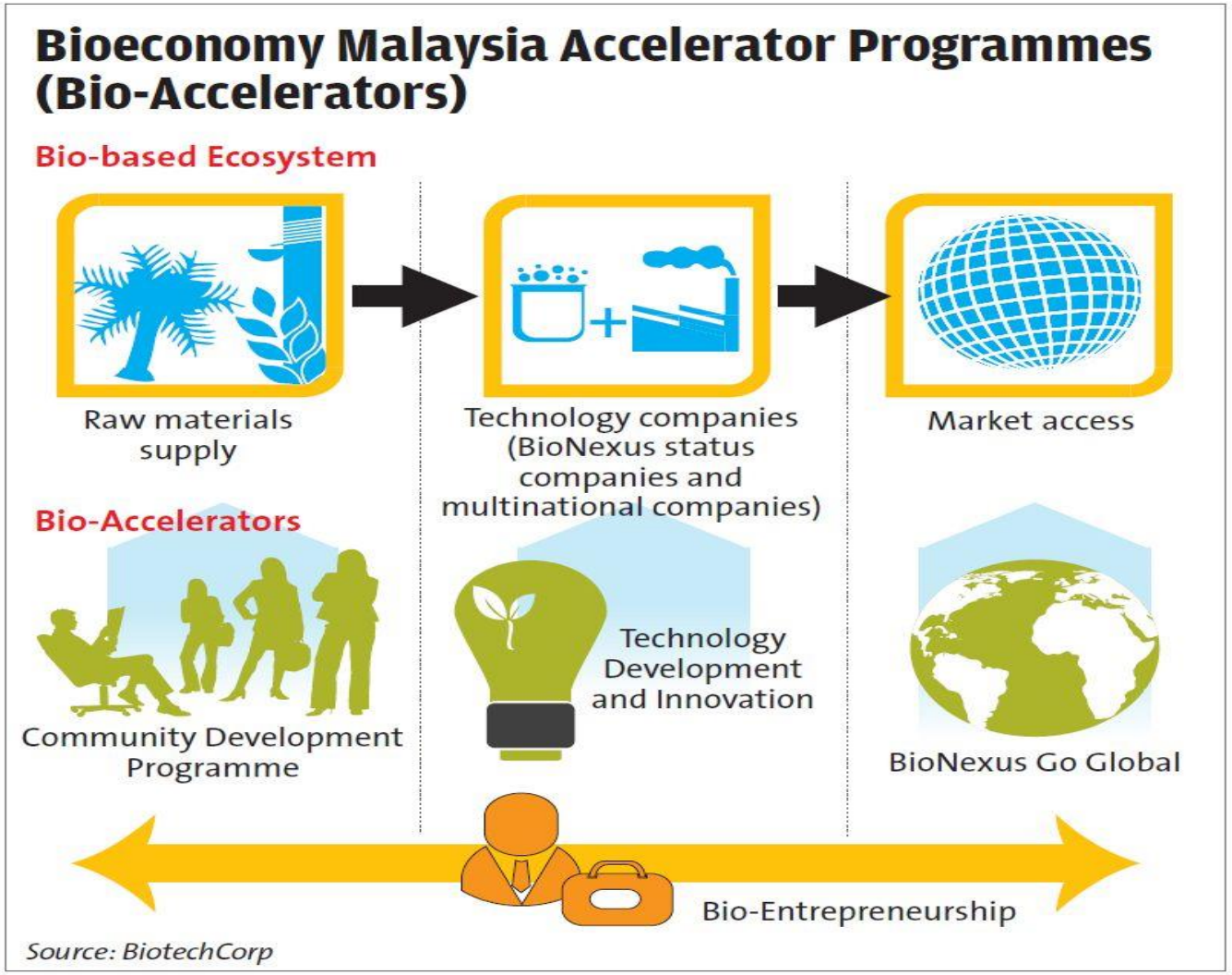
Source: The Research Council of Norway

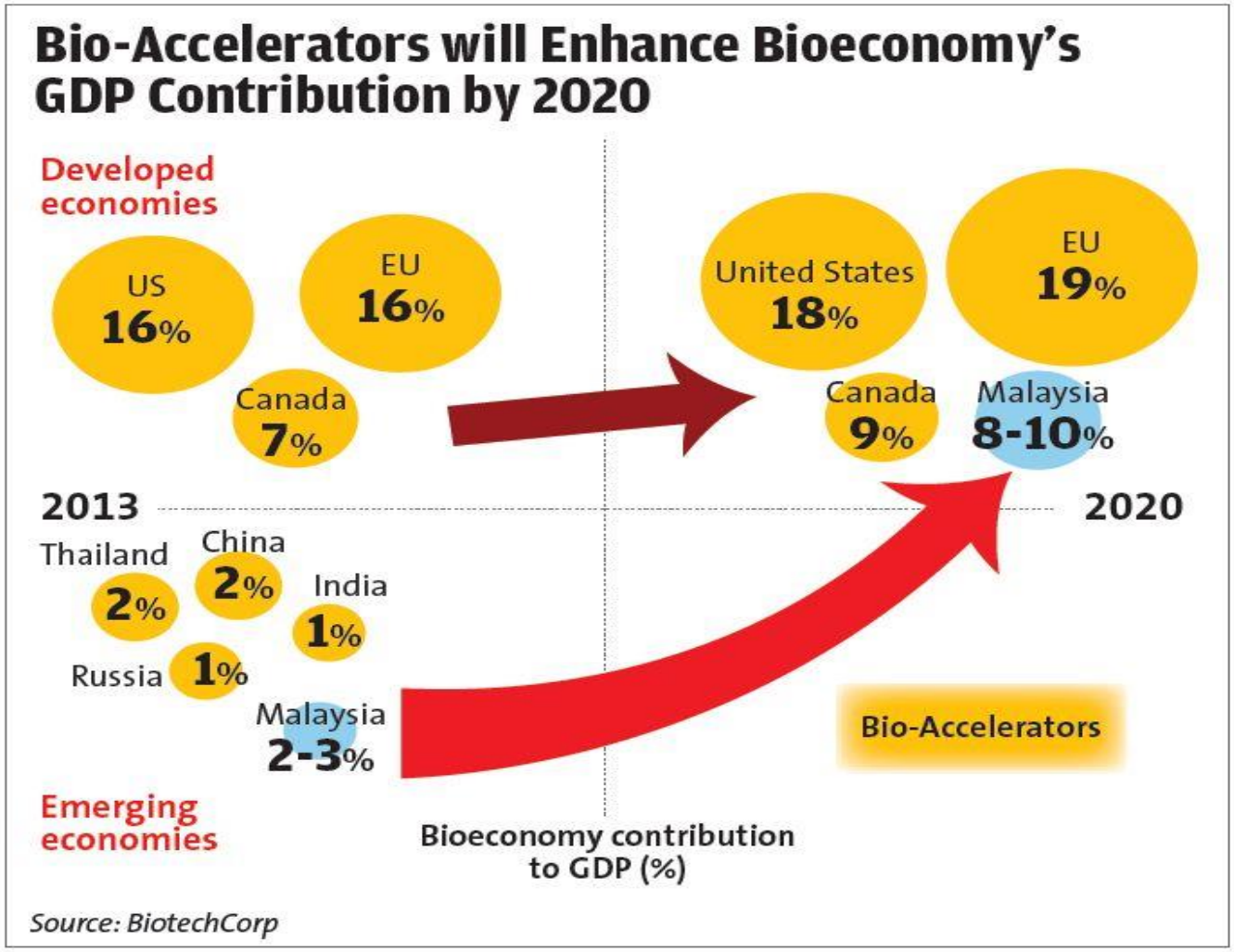
Sustainable Biotechnology



Aalborg University

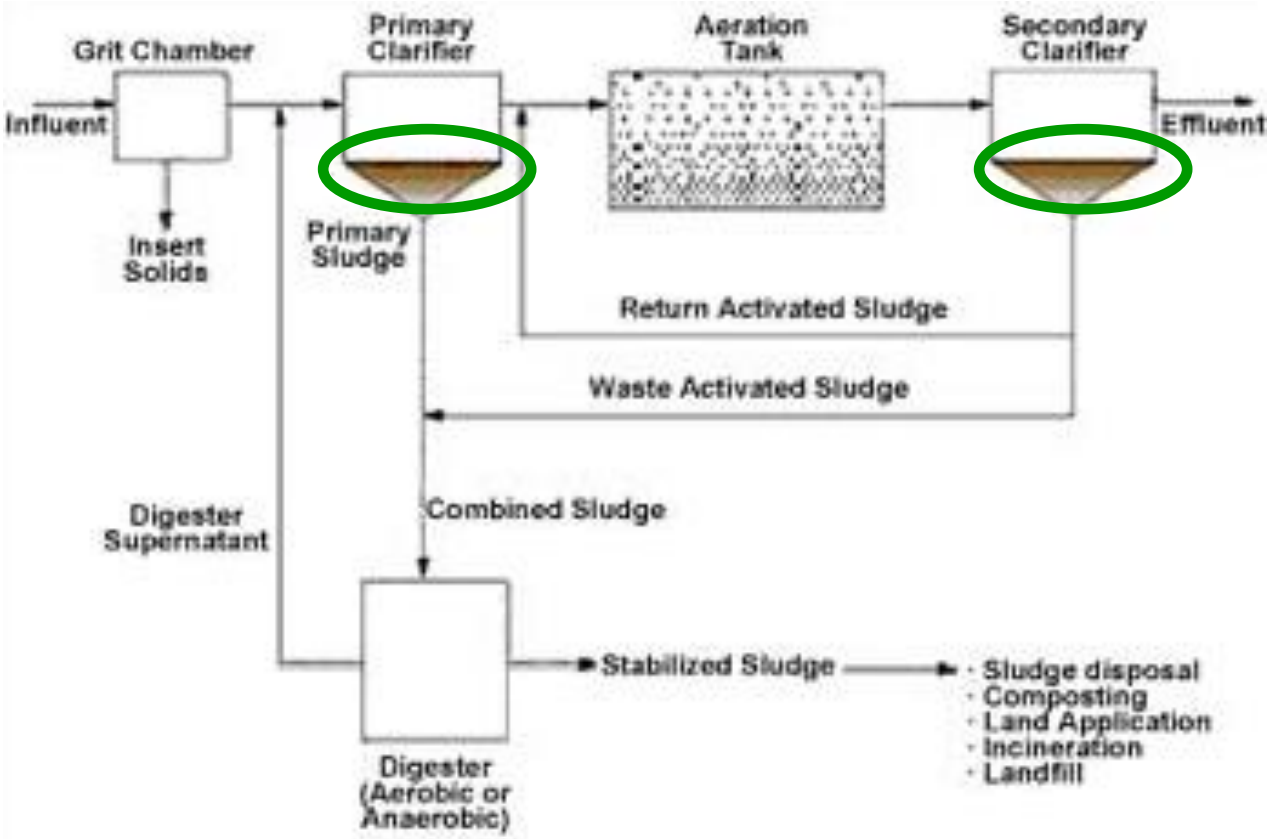
Budget boost for bioeconomy



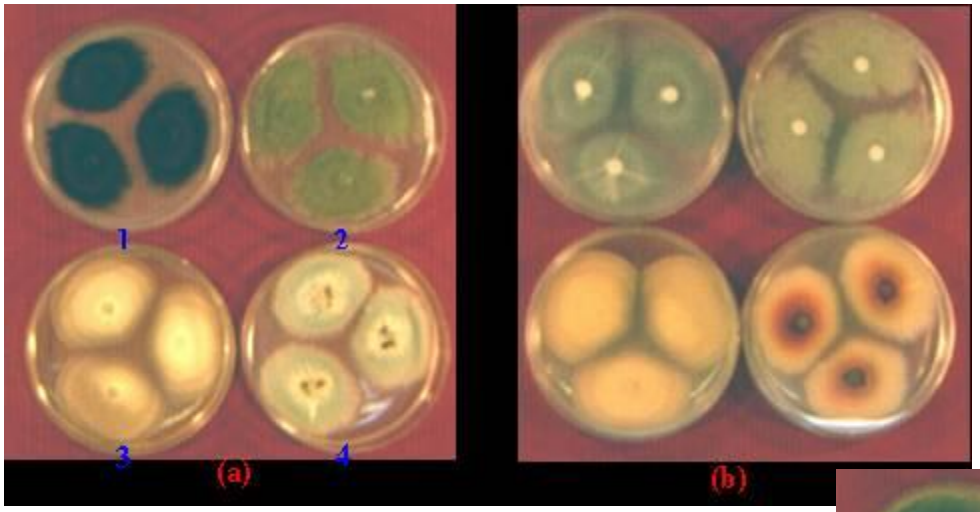

Bio-Accelerators will Enhance Bioeconomy's GDP Contribution by 2020
Developed economies
US 16%
EU 16%
Canada 7%
United States 18%
EU 19%
Canada 9%
Malaysia 8-10%
2013
2020
Thailand 2%
China 2%
India 1%
Russia 1%
Malaysia 2-3%
Bio-Accelerators
Emerging economies
Bioeconomy contribution to GDP (%)
Source: BiotechCorp

Background of Resource Recovery from Wastewaters

Wastewater Treatment Plant



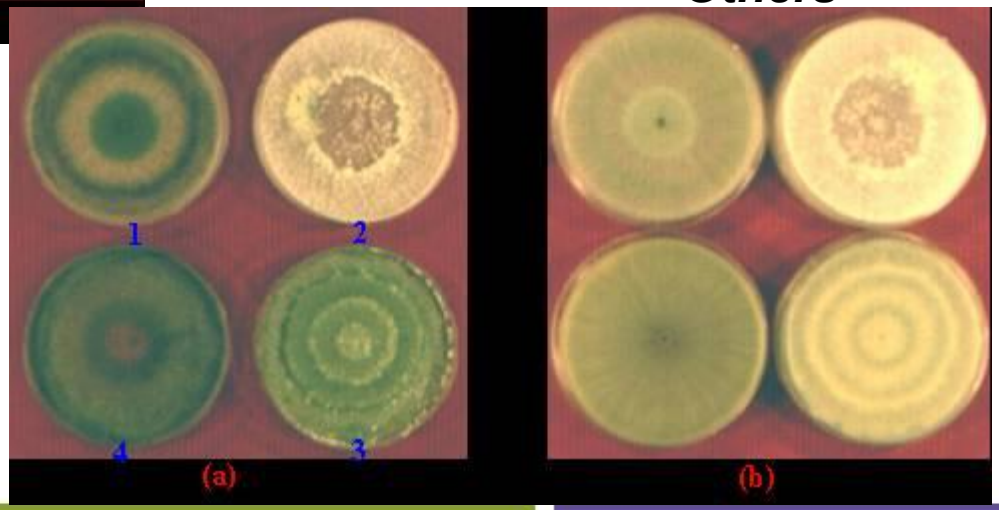
Fungal strains from STP sludge



Penicillium

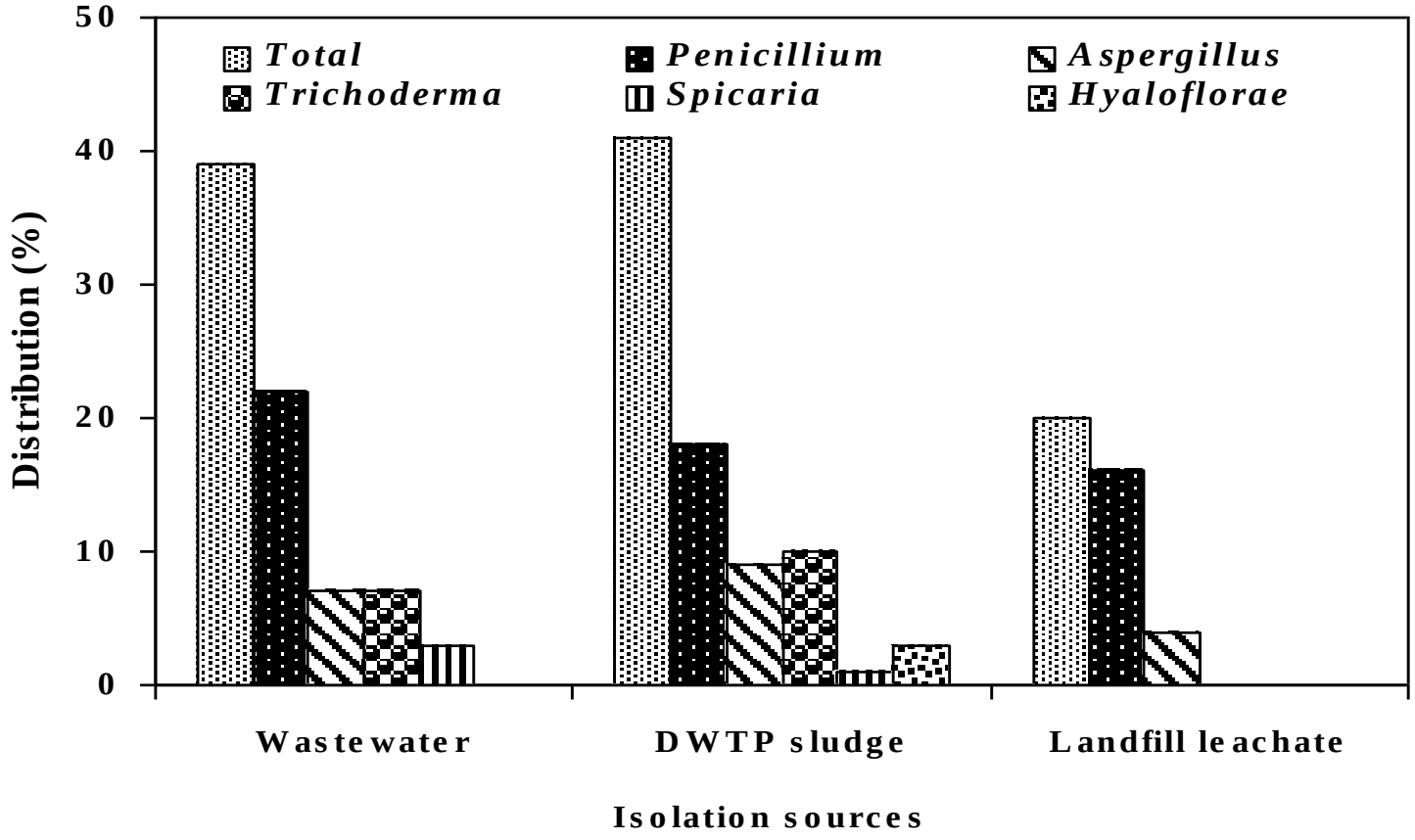
Aspergillus

Others



Trichoderma

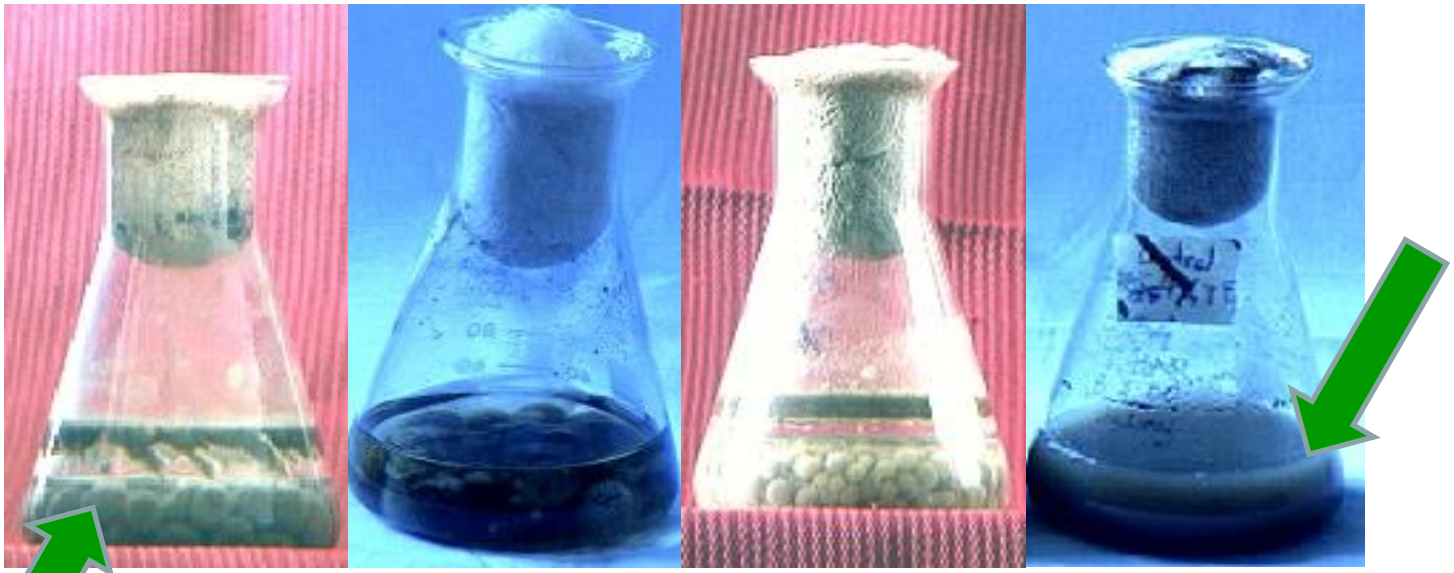
Distribution of filamentous fungi in wastewaters



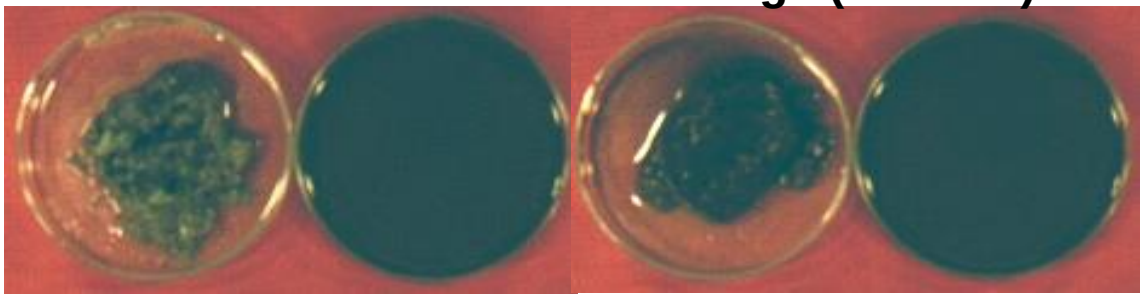
Liquid State Bioconversion of Sludge

(a) *Penicillium corylophilum* (b) Control

Liquid State Bioconversion of Sludge



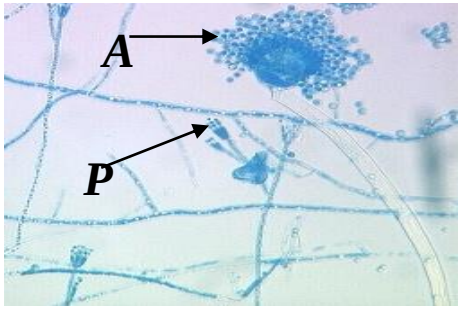
Lower solid content of sludge (1% TSS)

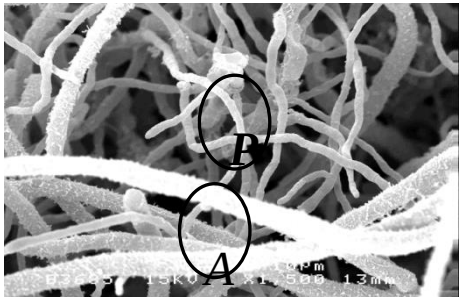


Higher solid content of sludge (2-3% TSS)

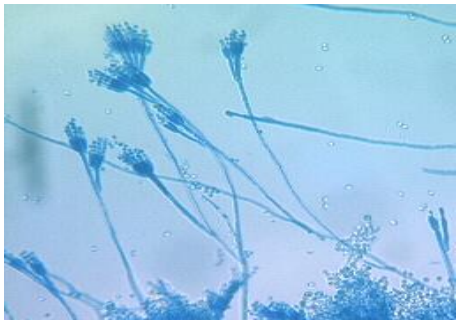
Microscopic and SEM

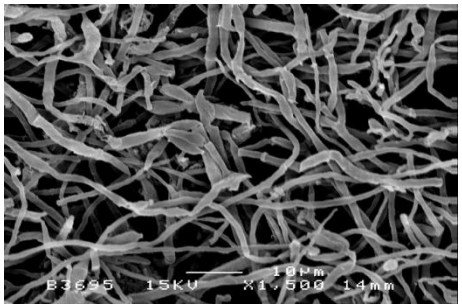
Mixed culture



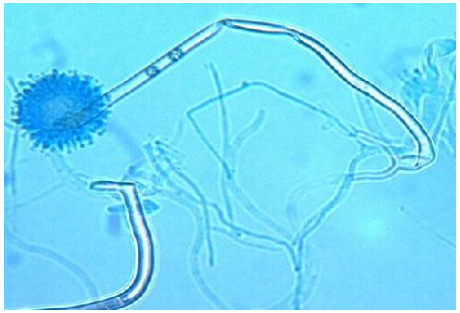


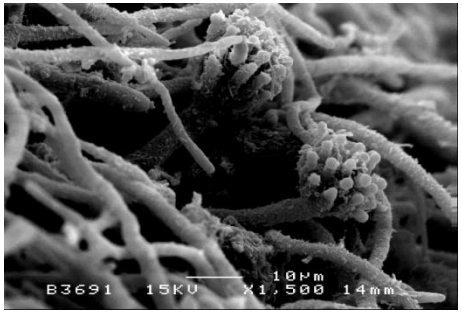
Single culture



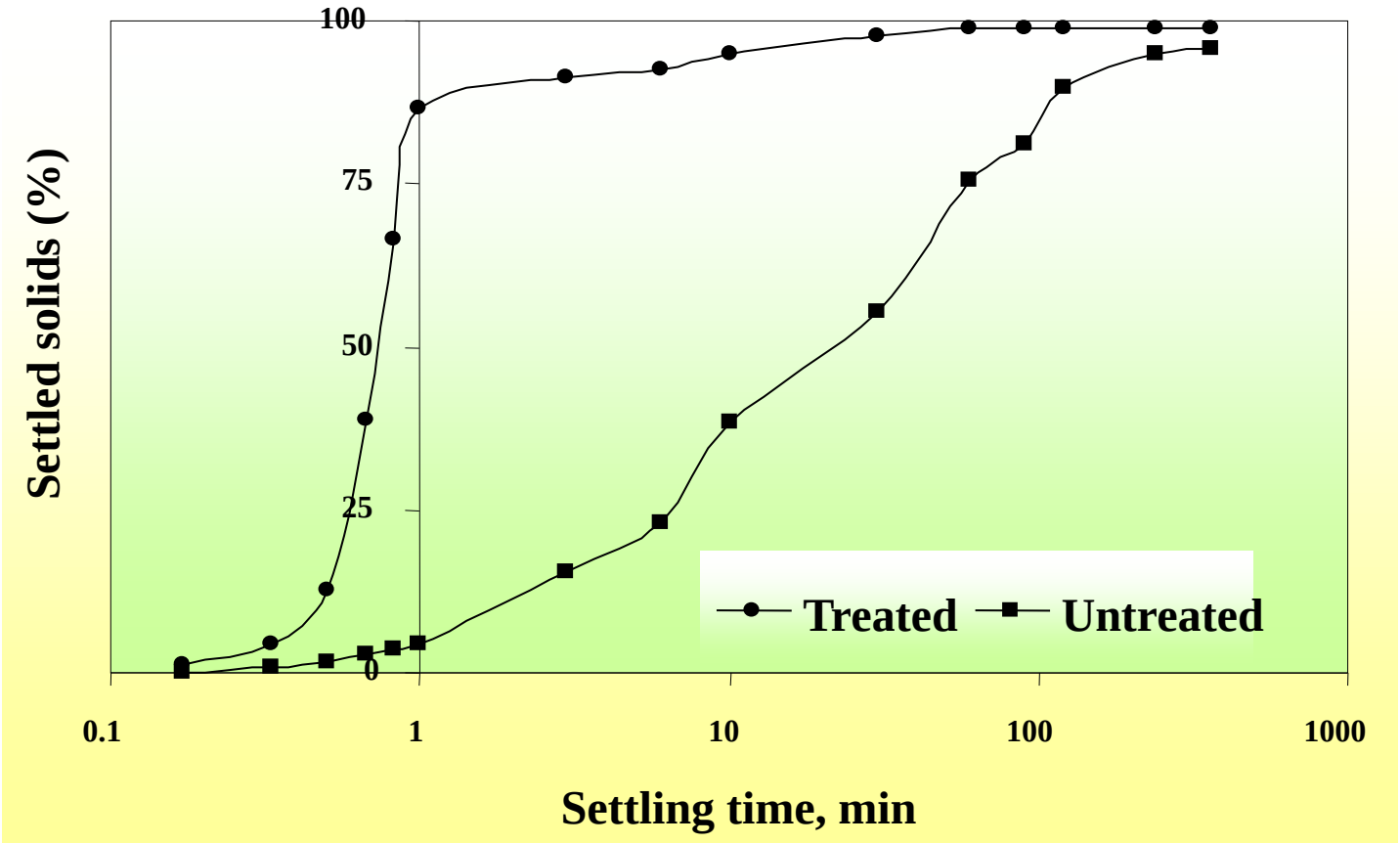


Single culture

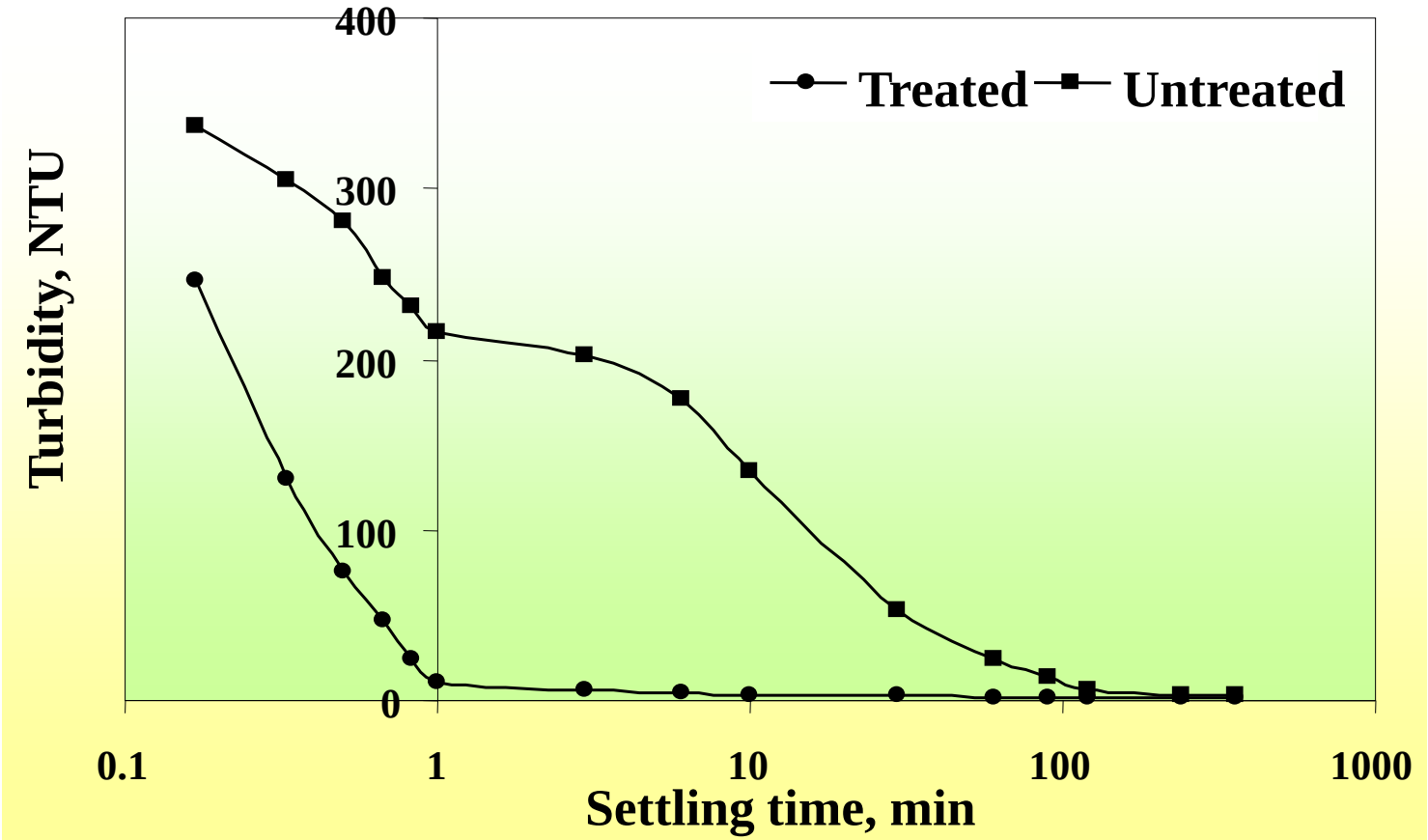




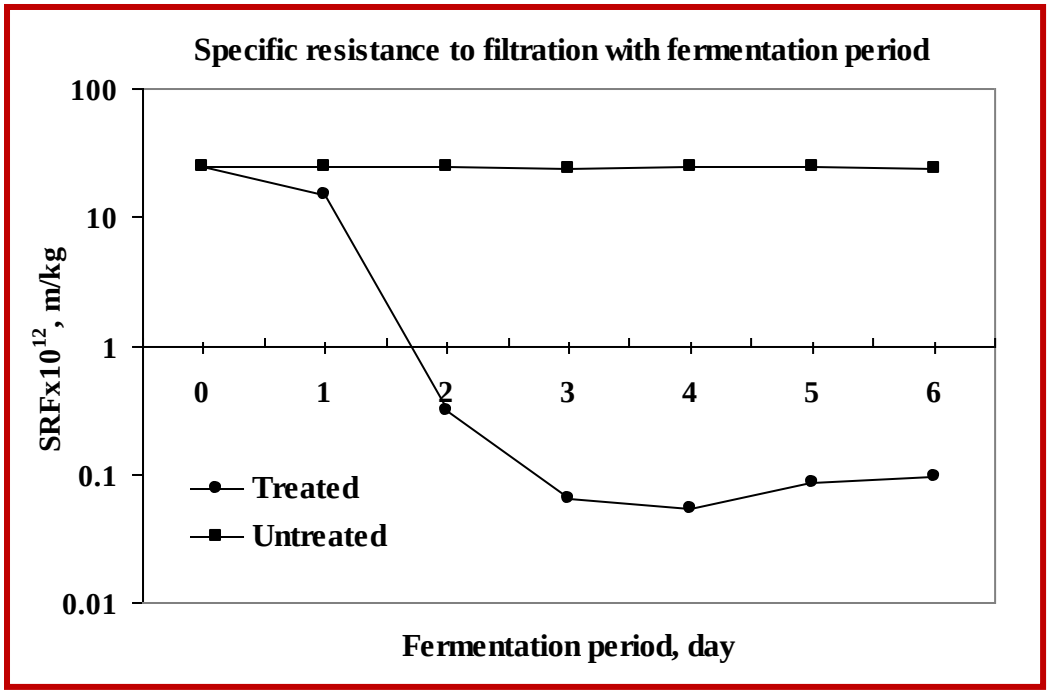
Settleability



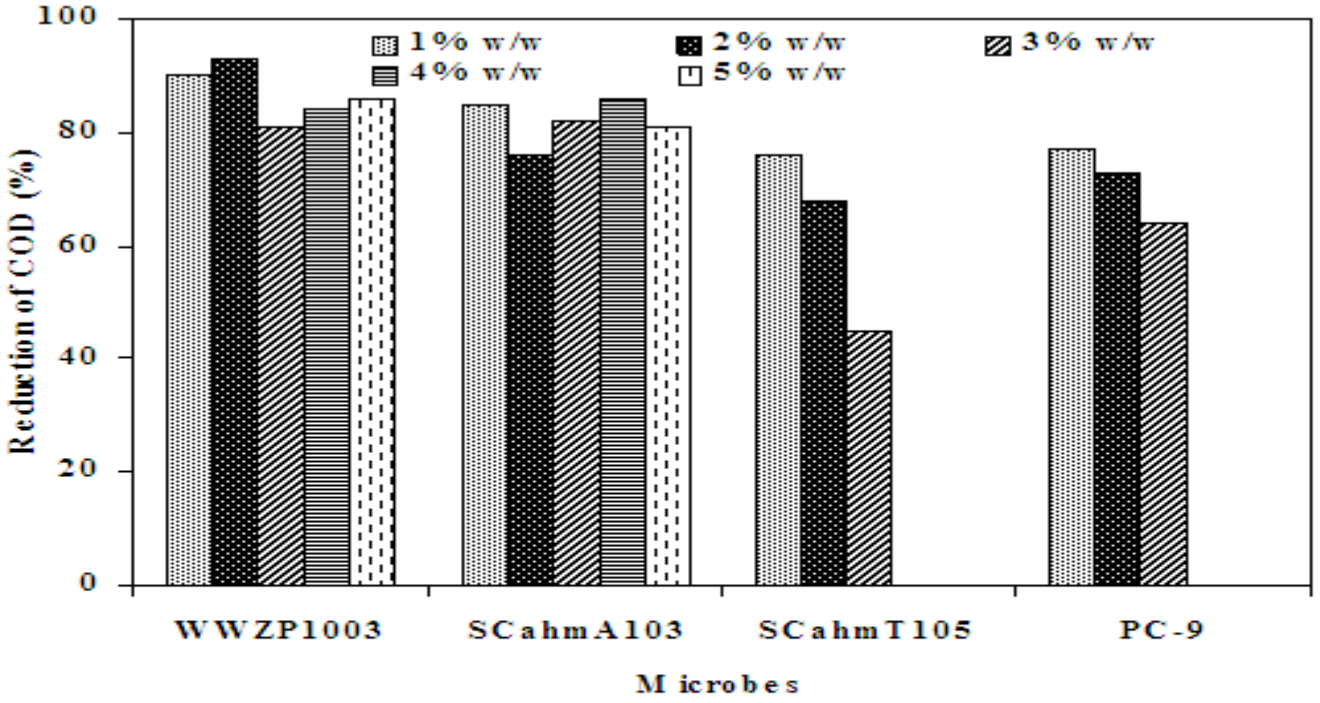
Turbidity


Treated
Untreated
Turbidity, NTU
400
300
200
100
0
0.1
1
10
100
1000
Settling time, min

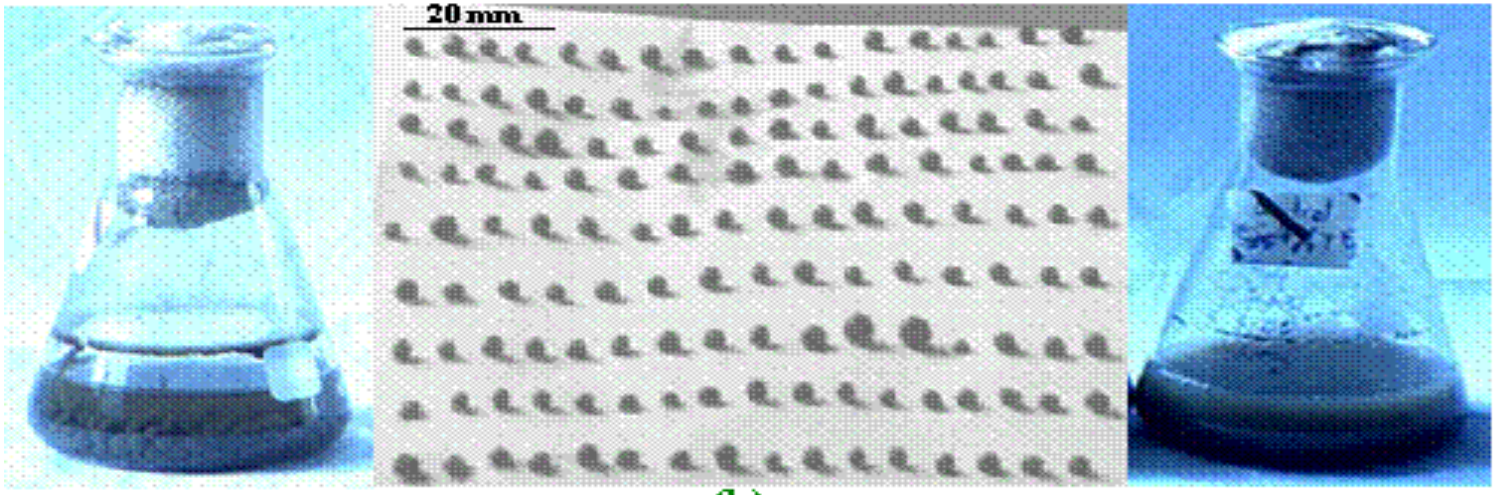
Dewaterability/filterability



Reduction of COD



Treated Sludge as Pellets



(a) (b) (c)

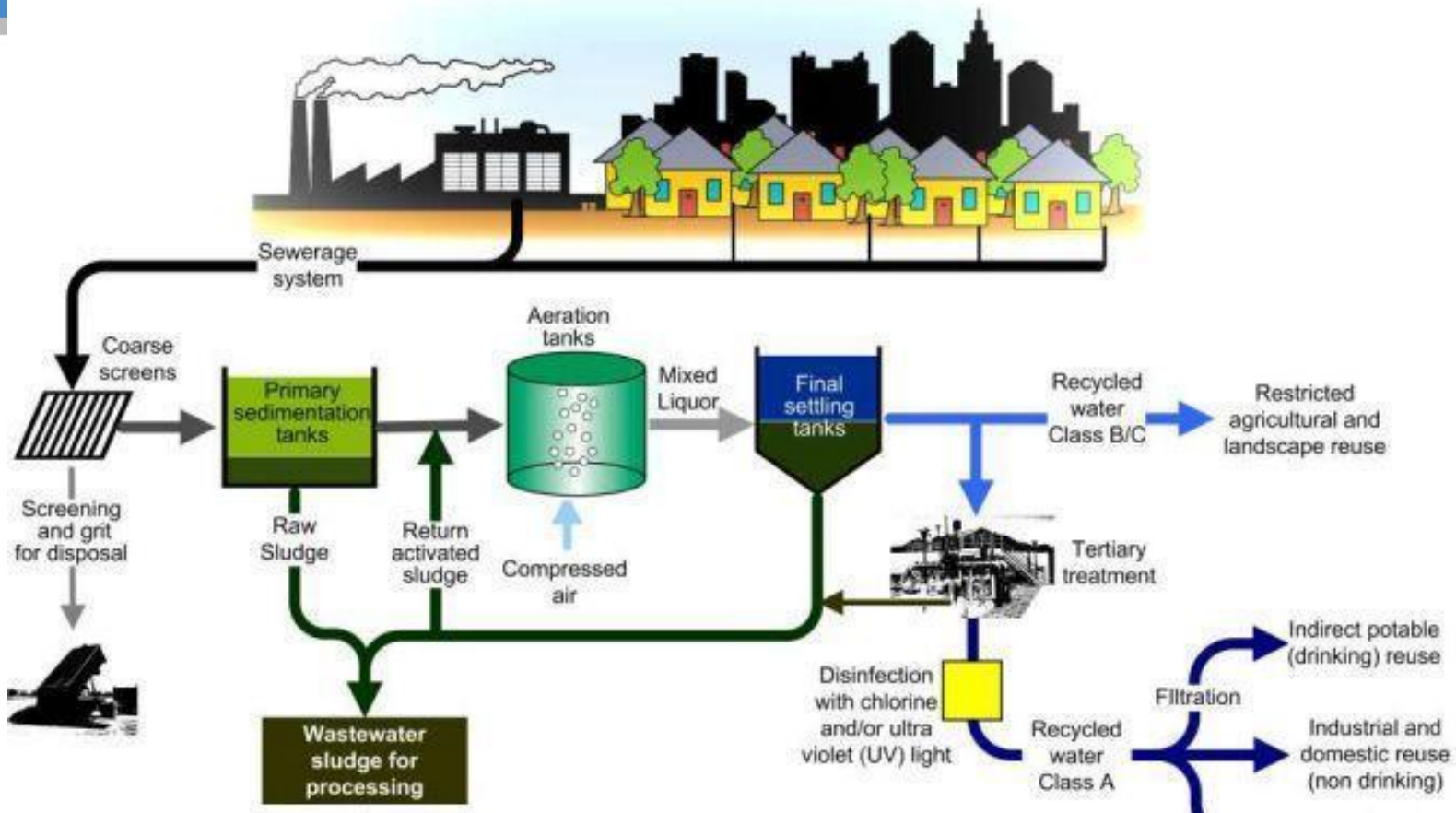
Focus in Green Technology for sustainable development

- Technologies/processes for converting waste to reusable/valuable materials that generate revenue.
- Potential microorganisms and their metabolites (enzymes) involve to convert different waste into value added bio-products.
- Environmental Biotechnology offers such solution for making income from waste.

Wastes as Resources in Malaysia

- **Wastewater Treatment Plant**
  - **Sludge**

Generation of Wastewater



Waste Water Treatment Process

IWK Treatment Plant

WWTP/STP Sludge

Sustainable Bio-products

Biofuels

- Bioethanol from lignocellulosic waste
- Biodiesel from low grade and non-food oils
- Biogas from IWK sludge and POME
- Biocatalyst (cellulase, lipase, amylase, protease, ligninase, etc.) from organic waste i. e. IWK sludge, POME, EFB, PKC, etc.

Focus on Sustainability

- Utilization of a cheap and renewable substrate that greatly lessen the production cost for value added products i.e. enzymes, bioethanol, biodiesel, etc.
- Exploiting renewable resources for the alternative of existing raw materials for value added applications.
- Introduce environmental/eco friendly waste treatment system for better environment and life for sustainable development.

Case Study: Cellulase from IWK sludge

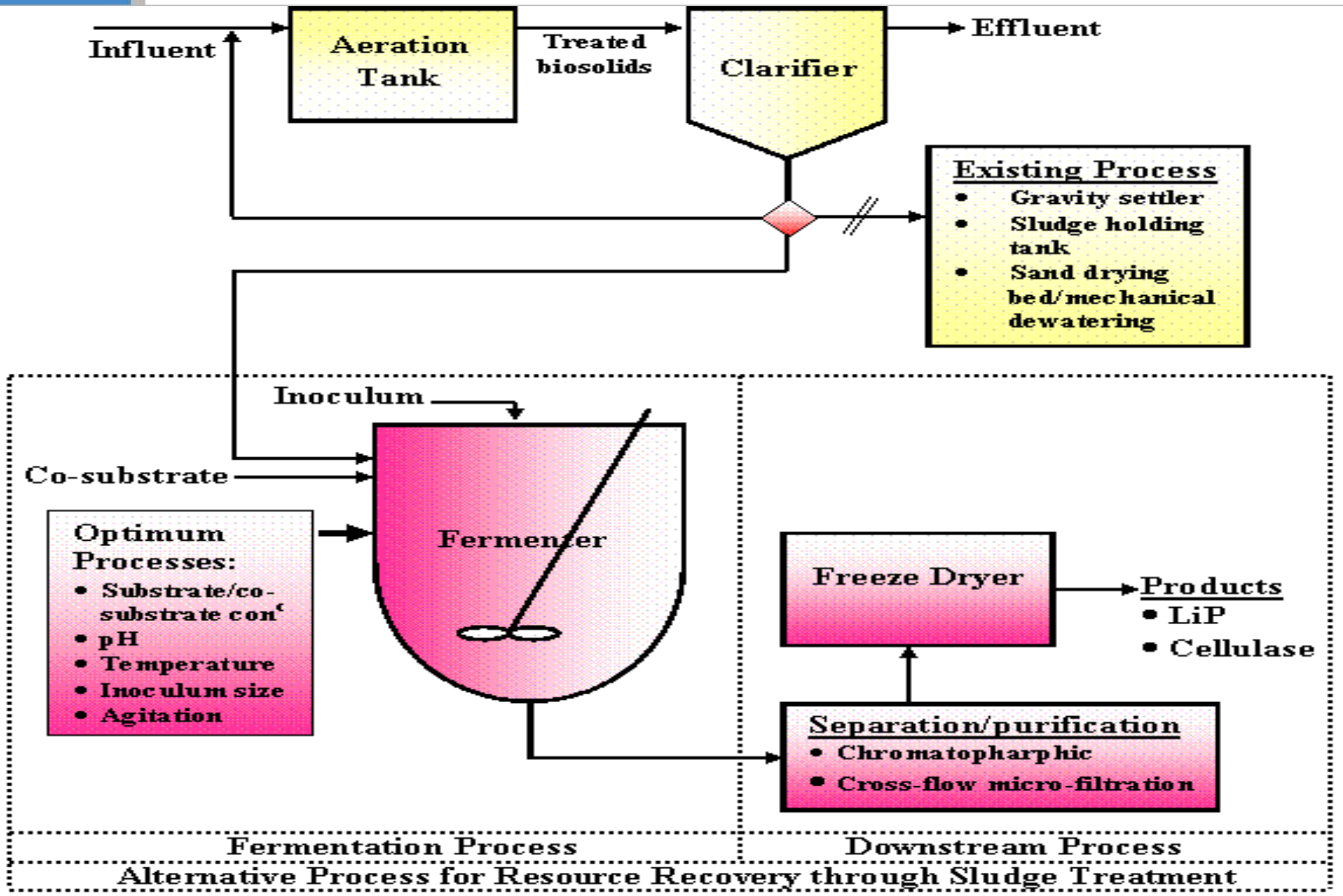
IWK sludge

- About 6 million cubic meters of sewage sludge is produced by Indah Water Konsortium (IWK) annually in Malaysia and the total cost of managing was estimated as more than RM 1 billion.
- Wastewater sludge is very good source of carbon, nitrogen, phosphorus, and other nutrients for many microbial processes that could add value to sludge by producing certain valuable metabolic products.

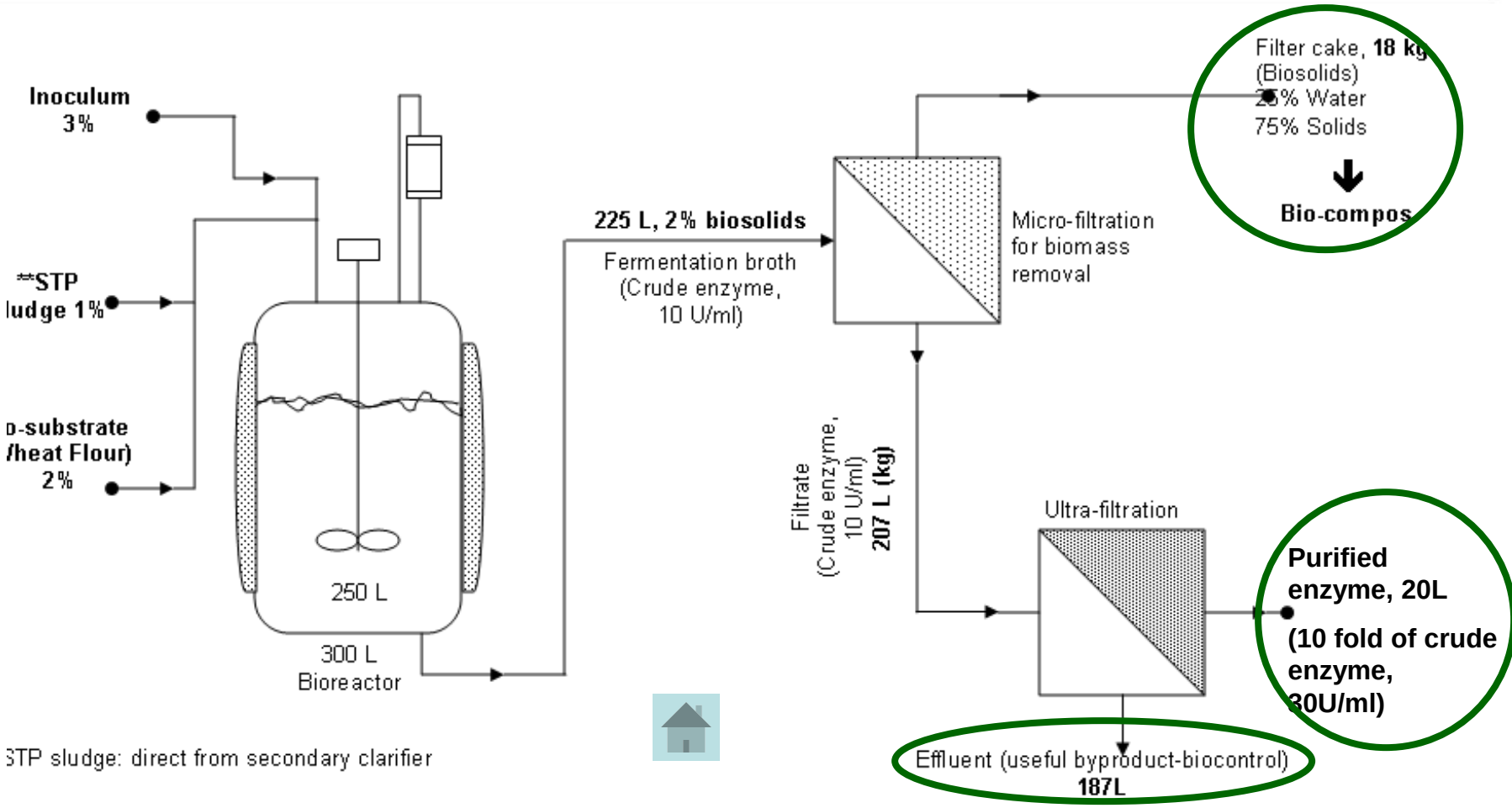
Characteristics of sludge

Parameters	STP sludge
%C	32.2
%N	3.6
C/N	8.9
P(mg/kg)	14,000
K (mg/kg)	502
Ca (mg/kg)	1281
Mn (mg/kg)	405
Na (mg/kg)	171
Cu (mg/kg)	69
Zn (mg/kg)	291

Green Technology: STP sludge

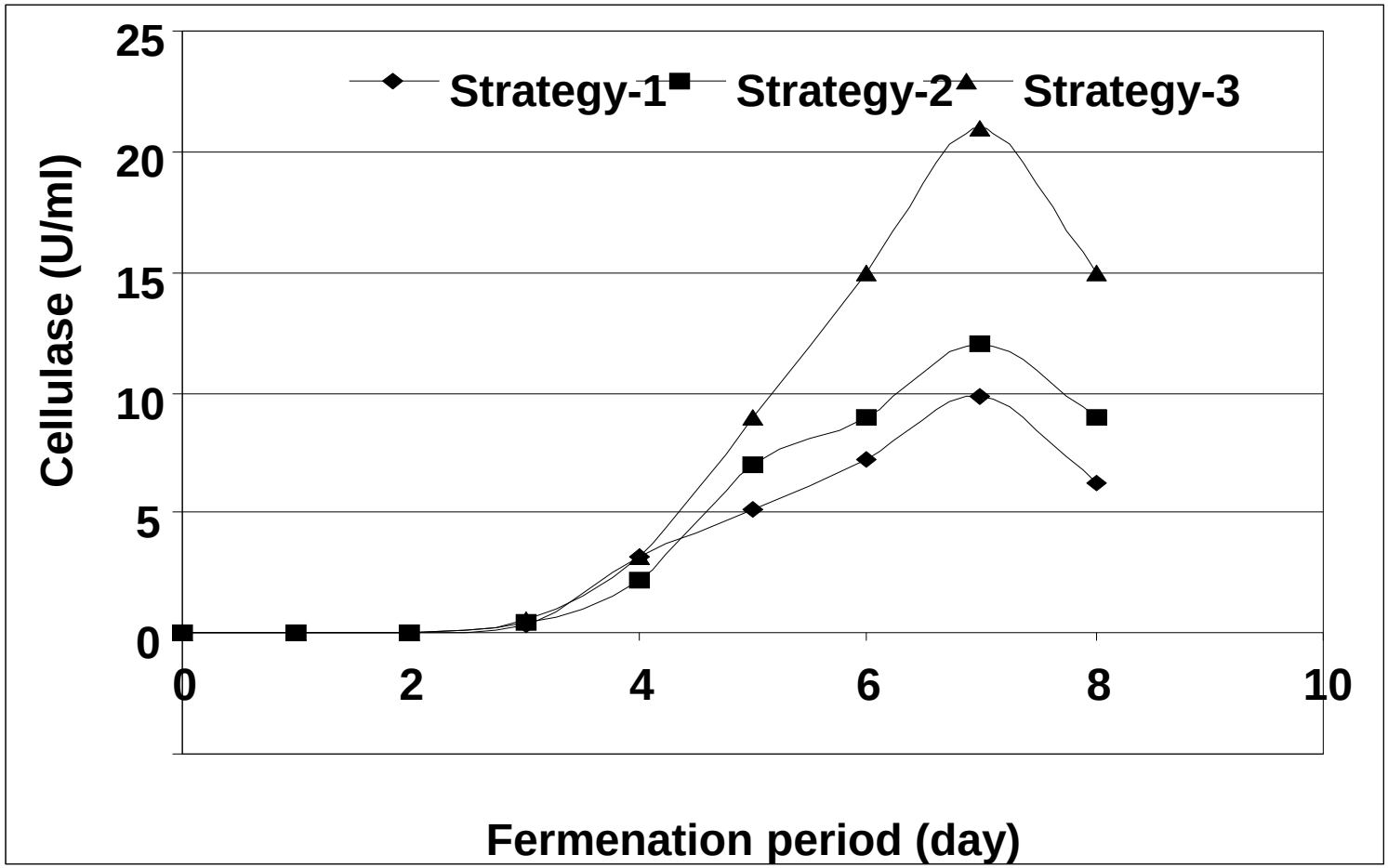


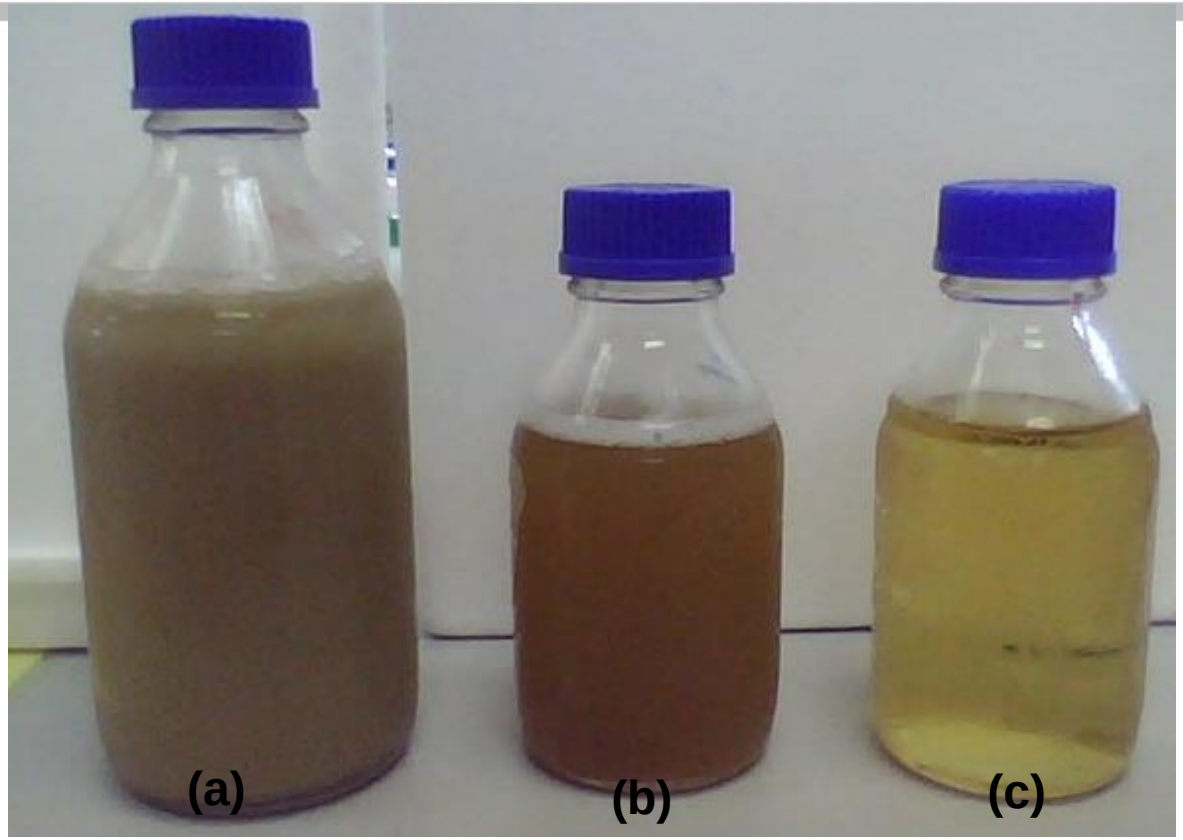
Renewable Sludge for Cellulase Production



Set up of pilot plant for cellulase production

Cellulase production at pilot scale





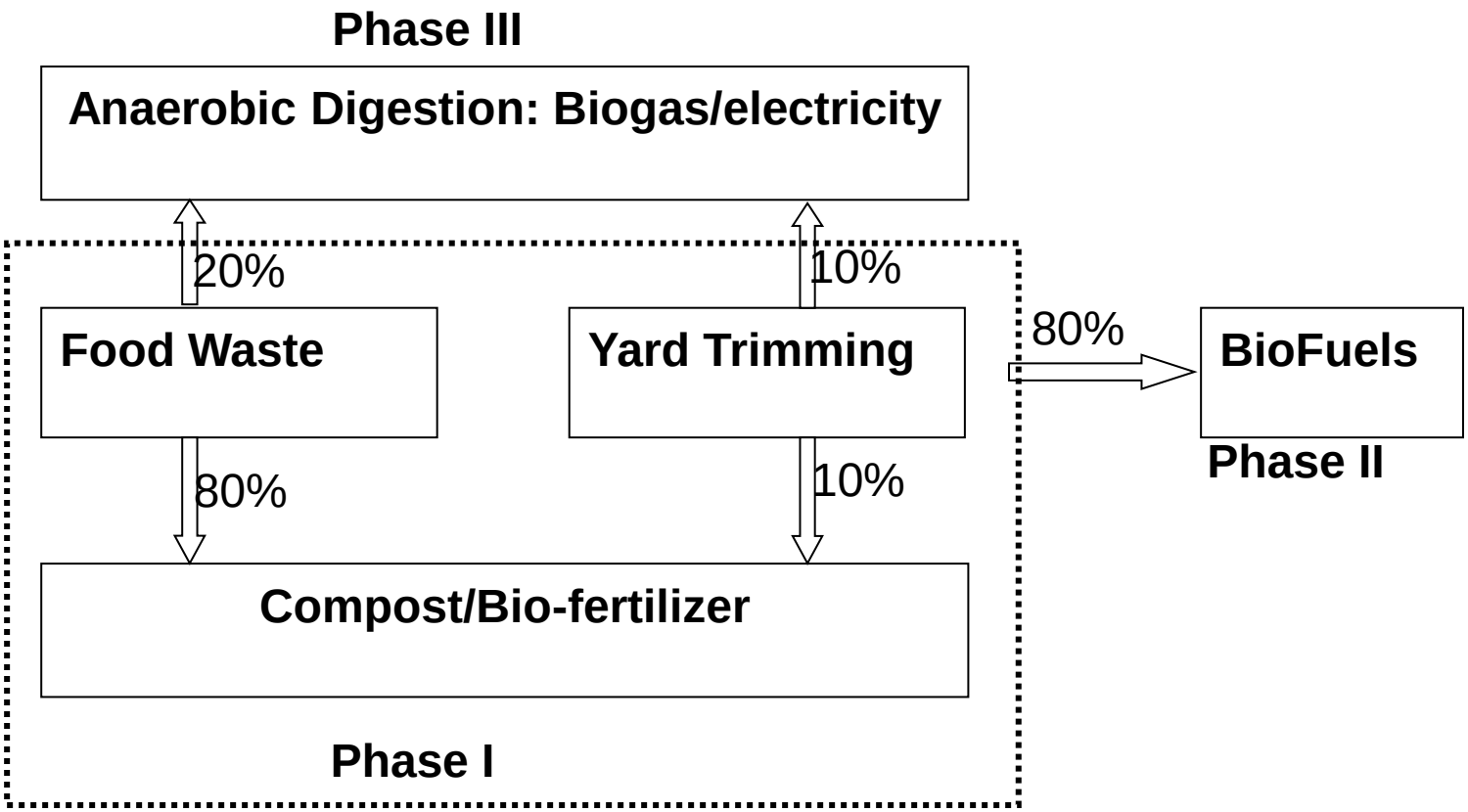
Cellulase: (a) fermentation broth including biomass; (b) cellulase from centrifugation; (c) cellulase from 0.45 µm microfiltration

Production cost and income

Basis: 250 L of sludge/cycle@40 cycles per year

		Cost
Save	**Total sludge management cost/year for 16.25 m^3 of sludge**	**RM 500**
Expenditure	**Total cellulase production cost/year for 800 L: (require 16.25 m^3 of sludge)**	**RM 65,000**
Income	**Current market price of cellulase for same amount**	**RM400,000 (800L @RM 500)**

An integrated waste management system at IIUM for sustainable development



Cost estimation at pilot scale compost

Item	Cost (RM)
Fixed Capital Cost	
Pilot scale composter (1000L/day)	800,000
Lab set up (building space and others)	100,000
Total	900,000
Annual operating cost	
Raw materials (recycling and transportation)	12,000
Utilities (Power, water, etc)	40,000
Manpower (2 workers@RM1500/month	36,000
Depreciation	90,000
Packaging and others	20,000
Total cost	198,000

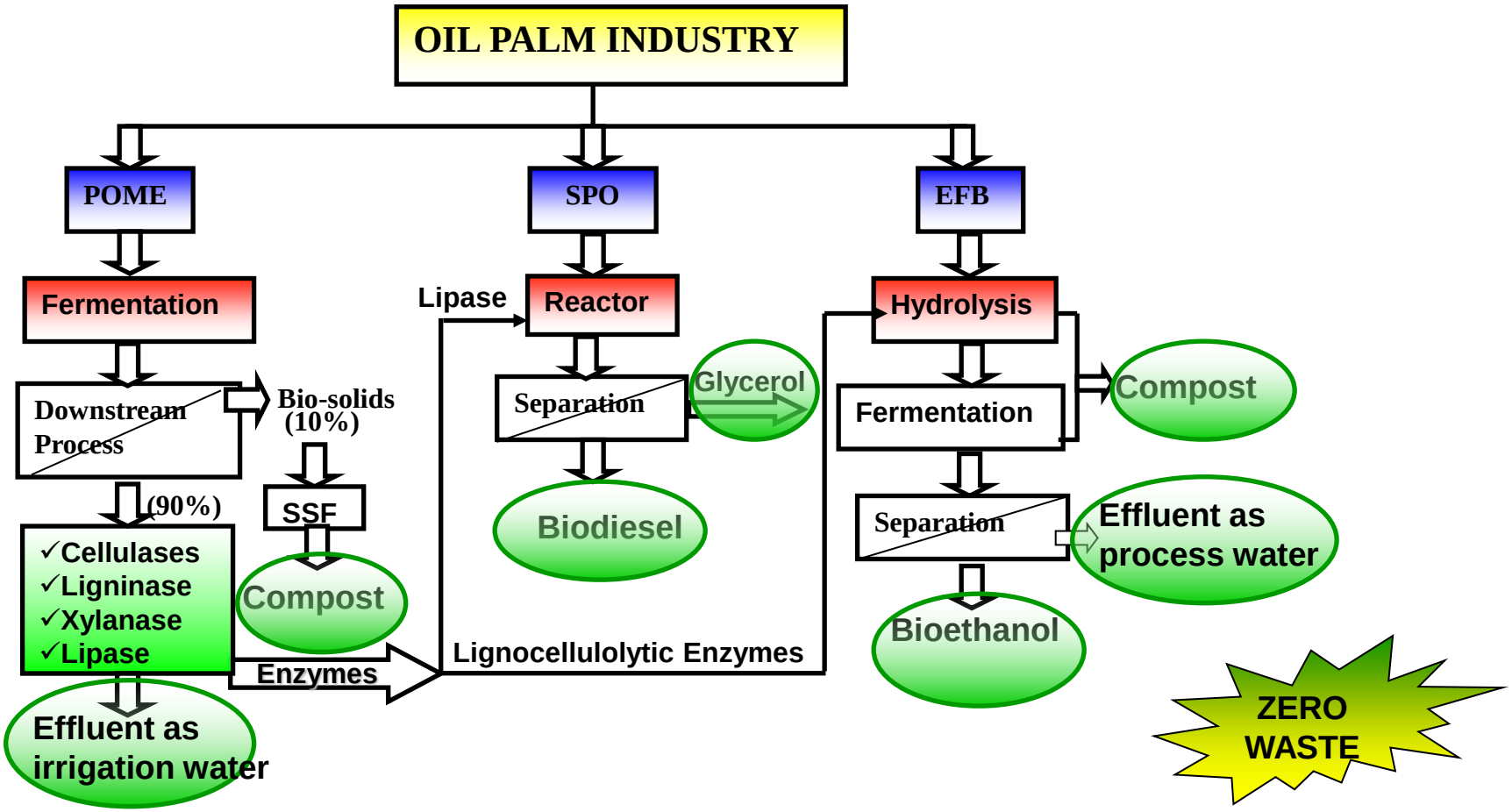
Item	Cost (RM)
Total investment (R&D, equipment)	1,020,000
Selling price of compost (RM1.0/kg)	100,000
Management cost savings (40%)	326,400
Annual net profit	228,400
Return on investment (ROI)	4.4 years

IIUM BioLizer: Food Compost

IIUM BioLizer: Food Compost

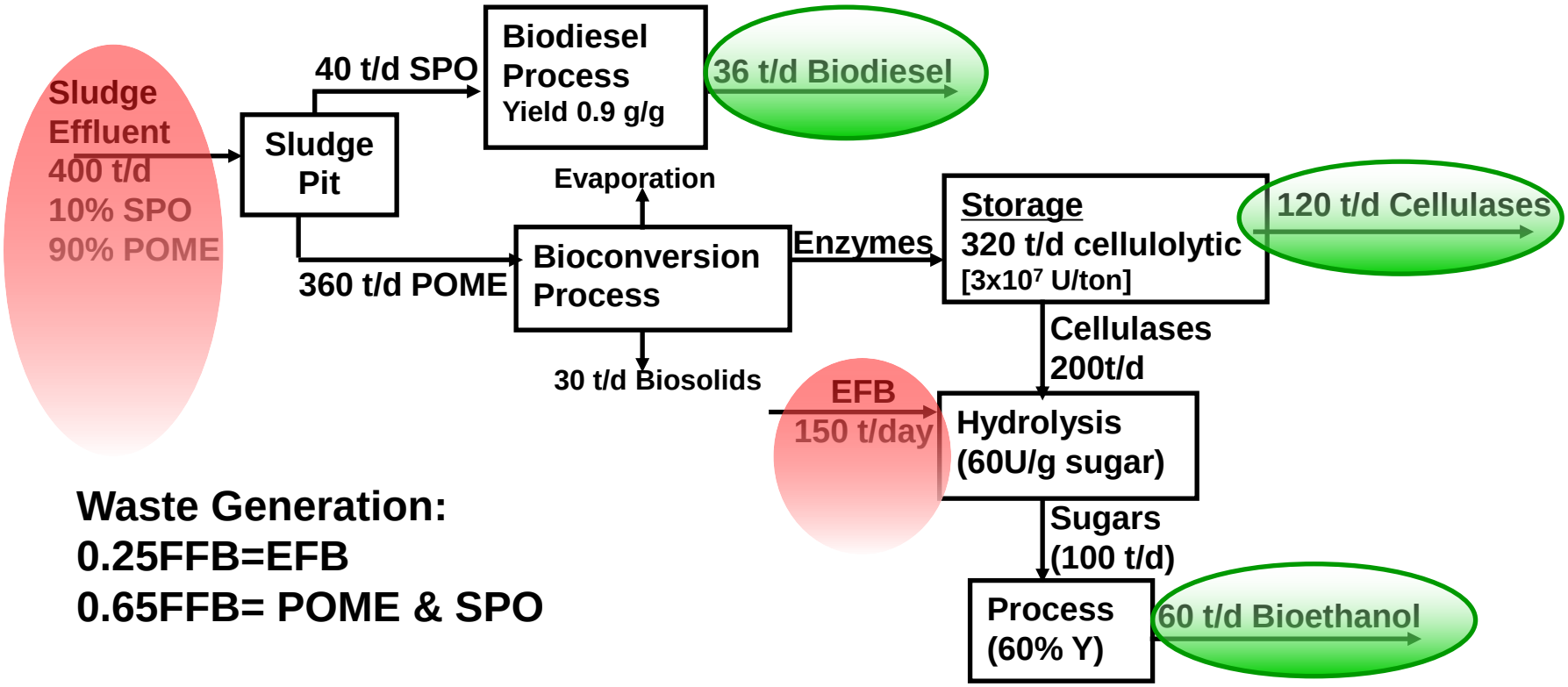
IIUM BioLizer: FW Compost

A Holistic Model for Sustainable Development



Estimated Production of Biofuels from a typical palm oil mill (West Oil Mill)

Basis: 600 tons FFB/day



Waste Generation:
0.25FFB=EFB
0.65FFB= POME & SPO

Future Direction for sustainable development

Based on capacity of 600 tons/day of FFB in a Mill with the recovery of Biodiesel, bioethnaol and cellulase enzyme, total production daily from 426 mills could be determined to explore the biofuels demand in Malaysia.

Bioethanol: 26,000 tons
Biodiesel: 15,000 tons
Cellulase: 51,000 tons

Conclusion

- **Environmental Biotechnology is expected to have a big role in developing the future for the betterment of lives towards sustainable development !!!!**

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Thank you

....for your attention

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