



Change your Mind about Phosphorus:

High(er) Quality Products from Low Quality Rock or Urban Waste

Rob de Ruyter contact data for:

P-recycling (Ecophos): rob.deruyter@ecophos.com

Circular Economy (TNO): rob.deruyter@tno.nl

Linear vs Circular/New Economy

Some facts of today's linear economy

- 2700 l water to produce one T shirt
- 140 l water to produce one cup of coffee
- 1500 kgs waste to produce one laptop
- 2000 kgs waste to produce one golden ring
- 2 million plastic bottles each 5 minutes (globally)
- Microplastics found in German beer
- 30 million CD's wasted every day in the US
- 6000 die per day because of lack of water
- 925 Million sleep with hunger (13%) of the world's population

Do we need to change?

Or are we defending that everything is under control?

Business as usual?

Linear vs New/Circular Economy

What can we, the P industry, do?

The Fertilizer industry spends less than 1% on innovation today!

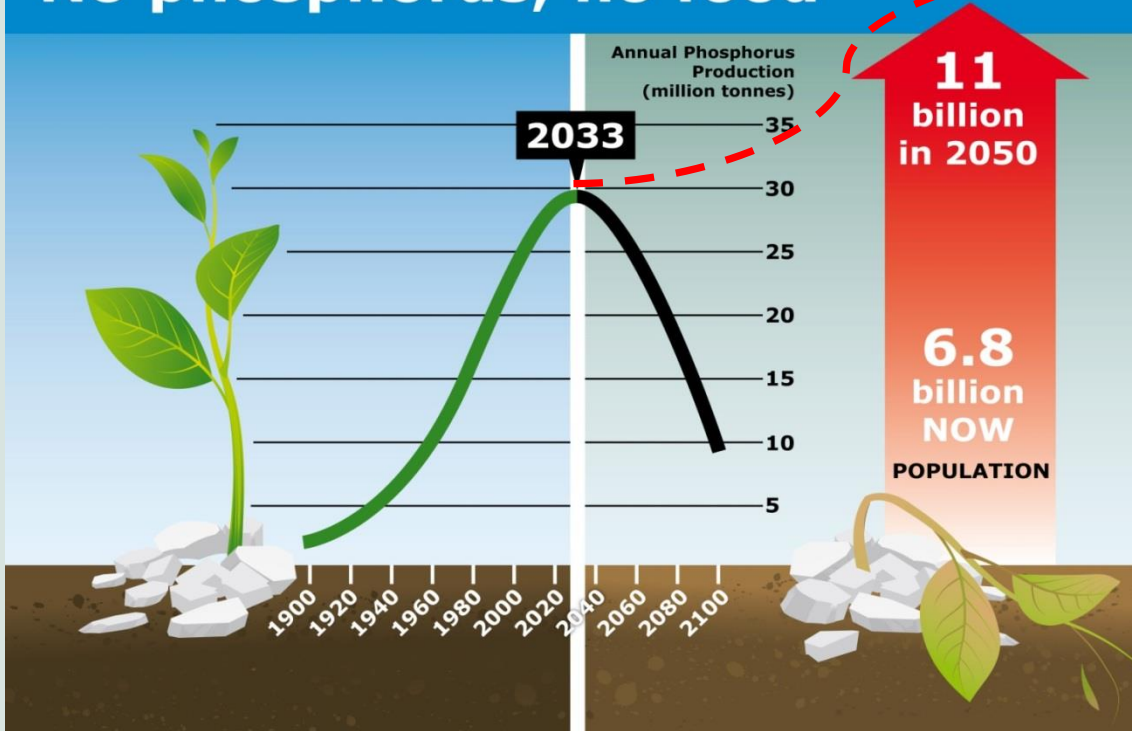
Let's create more value in the chain: ecologically, financially and socially based on the right DESIGN:

- **Reduce waste**
- **Increase quality/performance (purity, preferred composition, plant availability)**
- **Decrease use of natural resources/get access to alternative resources (limiting geopolitical risks)**

PEAK of High Grade Phosphate & Geopolitical Risks

No phosphorus, no food

→ Ecophos Process



The element phosphorus (P) is essential for all life on earth, from micro-organisms and plants to animals and man.

Every cell of every living organism on earth contains phosphorus.

It is an essential element
There is no alternative

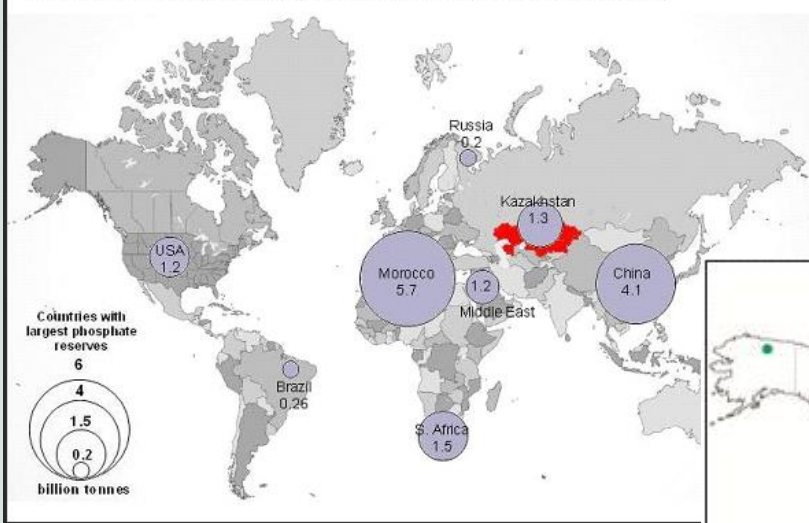


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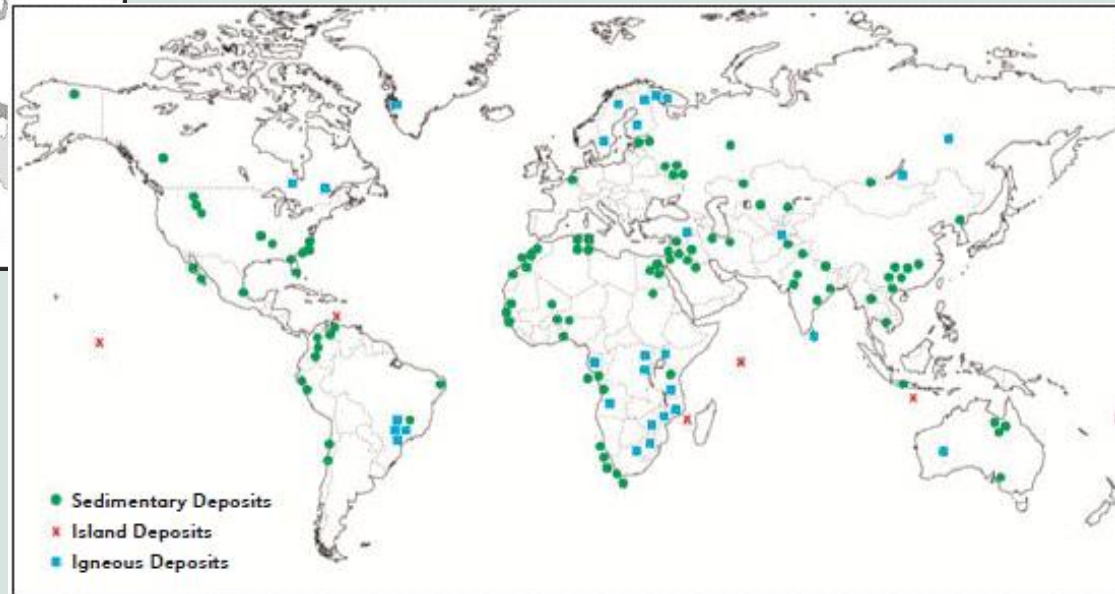
What does that imply?

Regions with largest Phosphate Rock reserves 2007, in billion tonnes



If we can use the low grade rock phosphate, the map of available phosphate dramatically changes.

The only condition : **to have the right technology**



Alternative P sources (kt P/a)

	Waste Water	MBM	Manure
EU	300	130	>1000
NA	150	60	800
China	600	200	>1000

Manure (work to be done)

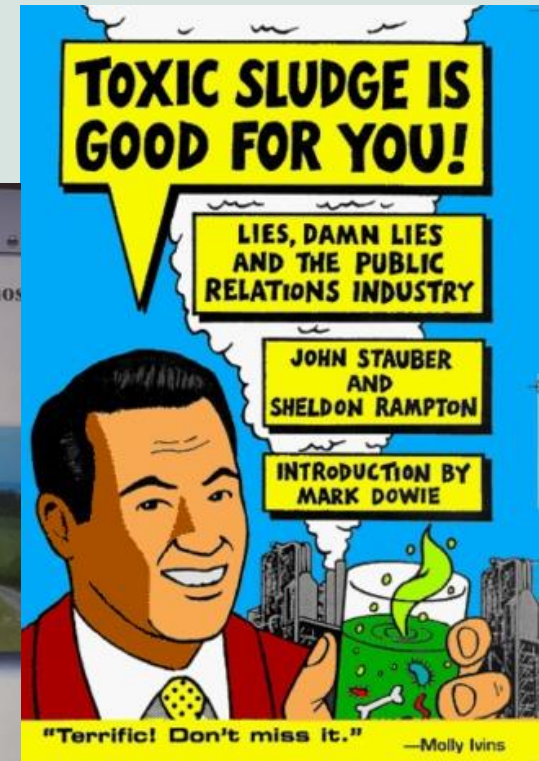
- Nutrient imbalance (N/P/K/C)
- P content is limiting spreading
- Local oversupply and transport issue, negative value, e.g. NL
- Fragmented stakeholder structure
- Try to align 3000 farmers
- NO TECHNOLOGY – NO MARKET PRODUCT
- NO BUSINESS CASE

SEWAGE SLUDGE



foods requirement sewage sludge

- 4.4. The dairy farm sets up plant nutrient balances for nitrogen (N) and phosphorus (P).
(Arla Foods recommendation)
- 4.5. Sewage sludge is not spread on fields cultivated by the dairy farm.
(Arla Foods and agricultural sector requirement)
Documentation: Fertilisation plan (Requirement)
- 4.6. The dairy farm complies with special rules and regulations concerning liquid manure from biogas plants and the spreading of composted materials



STRUUVITE ($\text{NH}_4\text{MgPO}_4 \cdot 6\text{H}_2\text{O}$)

- Generates a lot of attention (50+ operators)
- Access to everybody's own phosphate
- Saves WWTP costs and down time
- Nutrient imbalance
- Magnesium? → Ca, K deficiencies
(DEFRA HH3504SPO (White/Hammond - field trials))
- Low recovery rate (3-25% on P) – Ostara up to 40%(sludge hydrolysis at 150 degr C)
- Quality (Organics, Pathogens, drugs, Pharmaceuticals) → why not incinerate?
- Product – niche fertilizer on golf courses

SLUDGE INCINERATION

- All P in the ash
- More industry compatible material
- Large scale, centralized, mono-incinerators
- No organics, pathogens, drugs, et cetera
- Energy recovery possible
- Processes leading to known/accepted products (solving nutrient imbalance)
- Loss of N, C
- Large investments

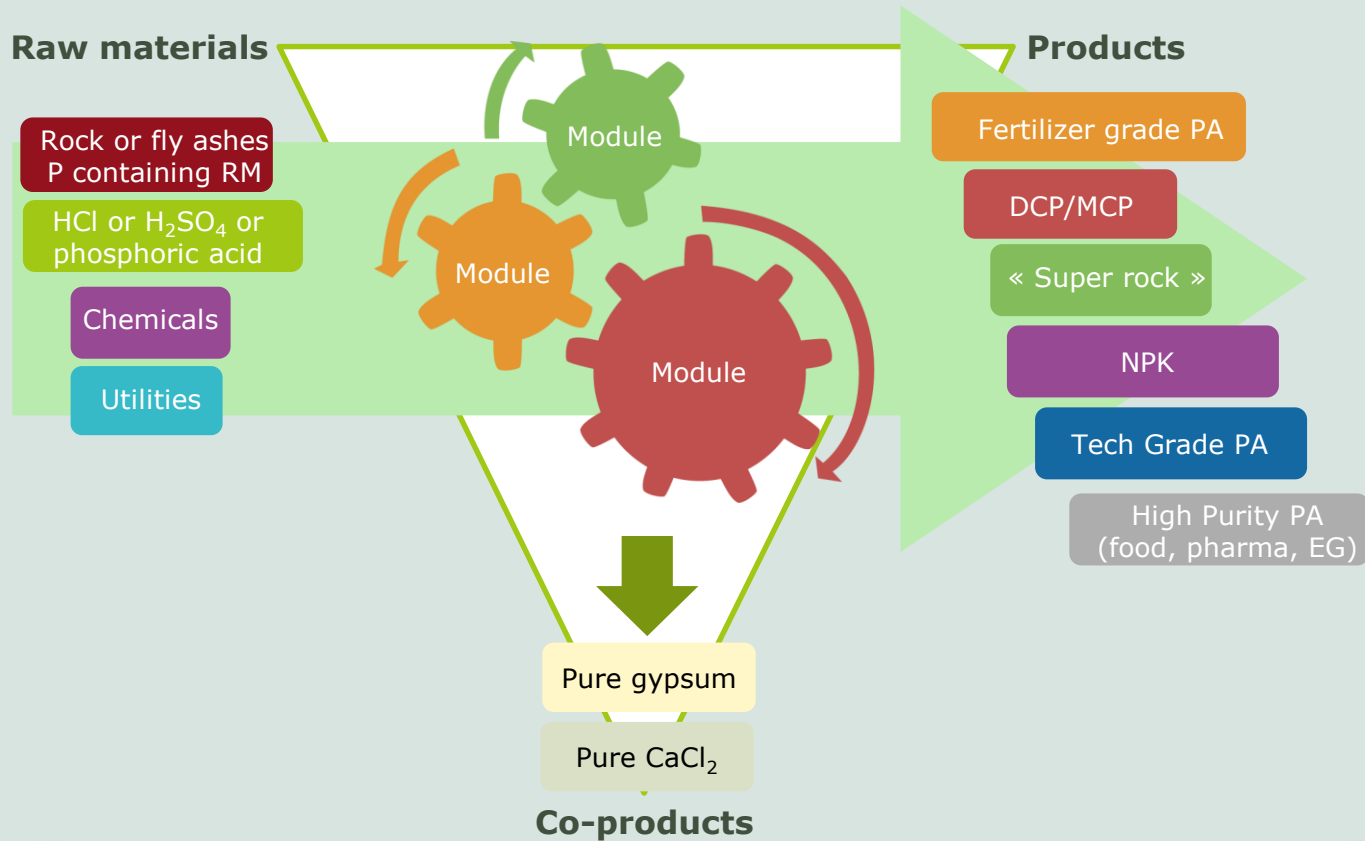
Fly ashes vs. Phosphate rock

Element	Unit	Fly ash	Phosphate rock
P ₂ O ₅	%	23.6	20-27
Ca	%	12.7	35
Si	%	10	1.1
Al	%	6	0.2
Fe	%	9.4	0.9
Mg	%	1.7	0.9
K	%	2.2	0.09
Na	%	0.77	1
As	ppm	35	9.3
Cd	ppm	3.8	49
Cr	ppm	130	200
Cu	ppm	1200	200
Ni	ppm	67	125
Pb	Ppm	250	21
Ti	ppm	2900	160
Zn	ppm	3300	230
F	%	0	3.2
SO ₄	%	7.7	2.7
TOC	%	0	3.35
CO ₂	%	0	7.2

- **Need of an innovative approach to get rid of impurities**
- **Mono-incineration is a must to avoid P₂O₅ dilution**

EcoPhos technology

- Modular Technology:
 - Adapt process to raw-material, products and co-products



An ECO-feasible Solution based on the right design

- **Same market products, new process design**
- **40% lower investment cost compared to conventional process**
 - No rock beneficiation, Short residence time (45min-1h), High process yield (up to 99%)
 - Reasonable temperature, atmospheric pressure, Simple material of construction
 - Highly concentrated phosphoric acid out of filter (min 42% P₂O₅)
- **Up to 50% lower variable cost**
 - Low-grade phosphate rock, no beneficiation, Low energy consumption
- **Green process:**
 - Low levels of Cd (or other HM): easily below 20mgCd/kgP₂O₅
 - 6 times less waste !
 - Low energy consumption !
 - Pure and valuable co-products: non radioactive pure gypsum, Al/FeCl₃ solution
- **Highly flexible plants:**
 - Process adapted to client's raw materials and products



THANK YOU FOR YOUR ATTENTION