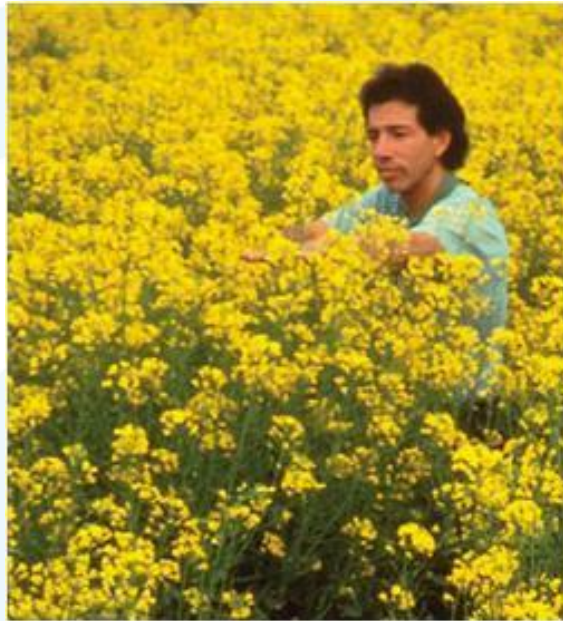
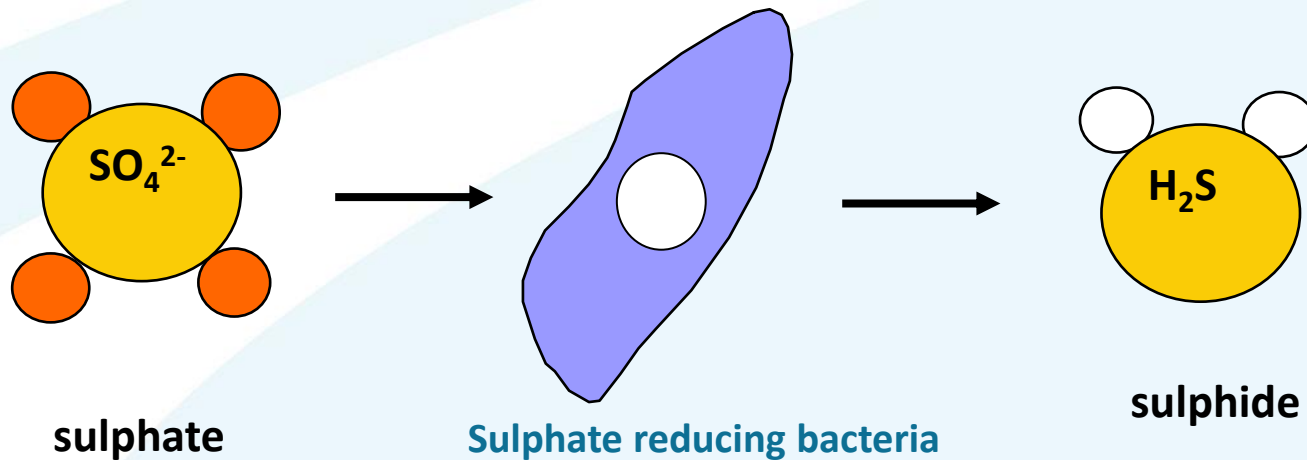


Production of Sulphur from biogas applied as fertilizer in Agriculture



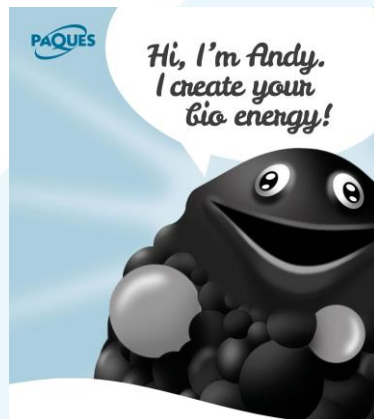
Date: 9 November 2017
Place: Wageningen
Speaker: ir. Leo Habets
l.habets@paques.nl

Bacterial conversions in the anaerobic digestion

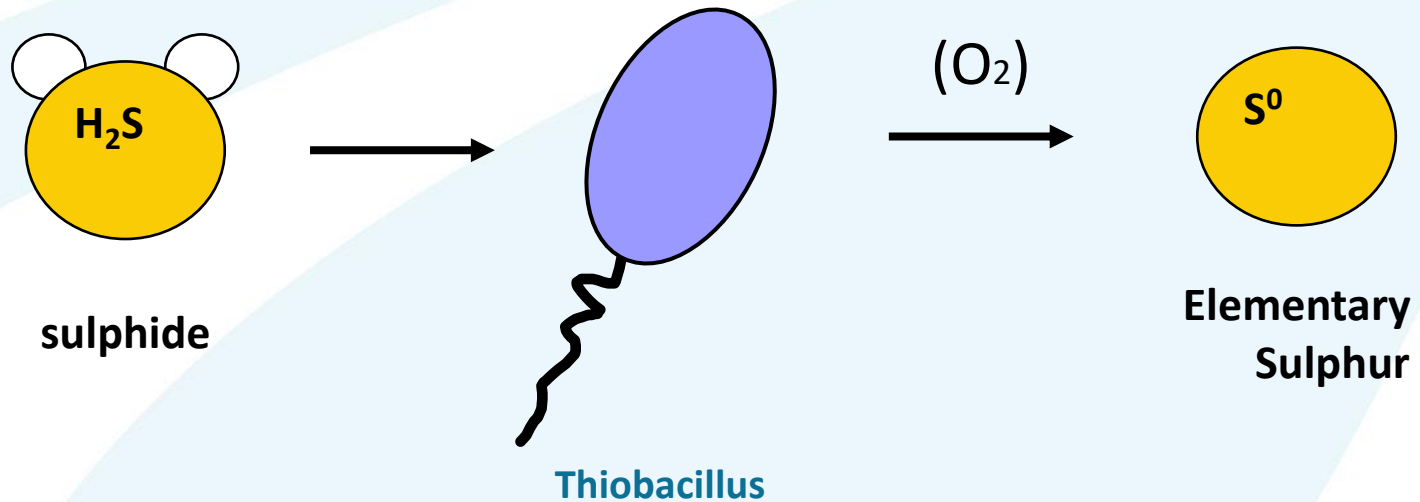


Average Biogas composition

Methane CH ₄	70 – 85%
Carbon dioxide CO ₂	15 – 30%
Hydrogen Sulphide H ₂ S	0.5 – 2%

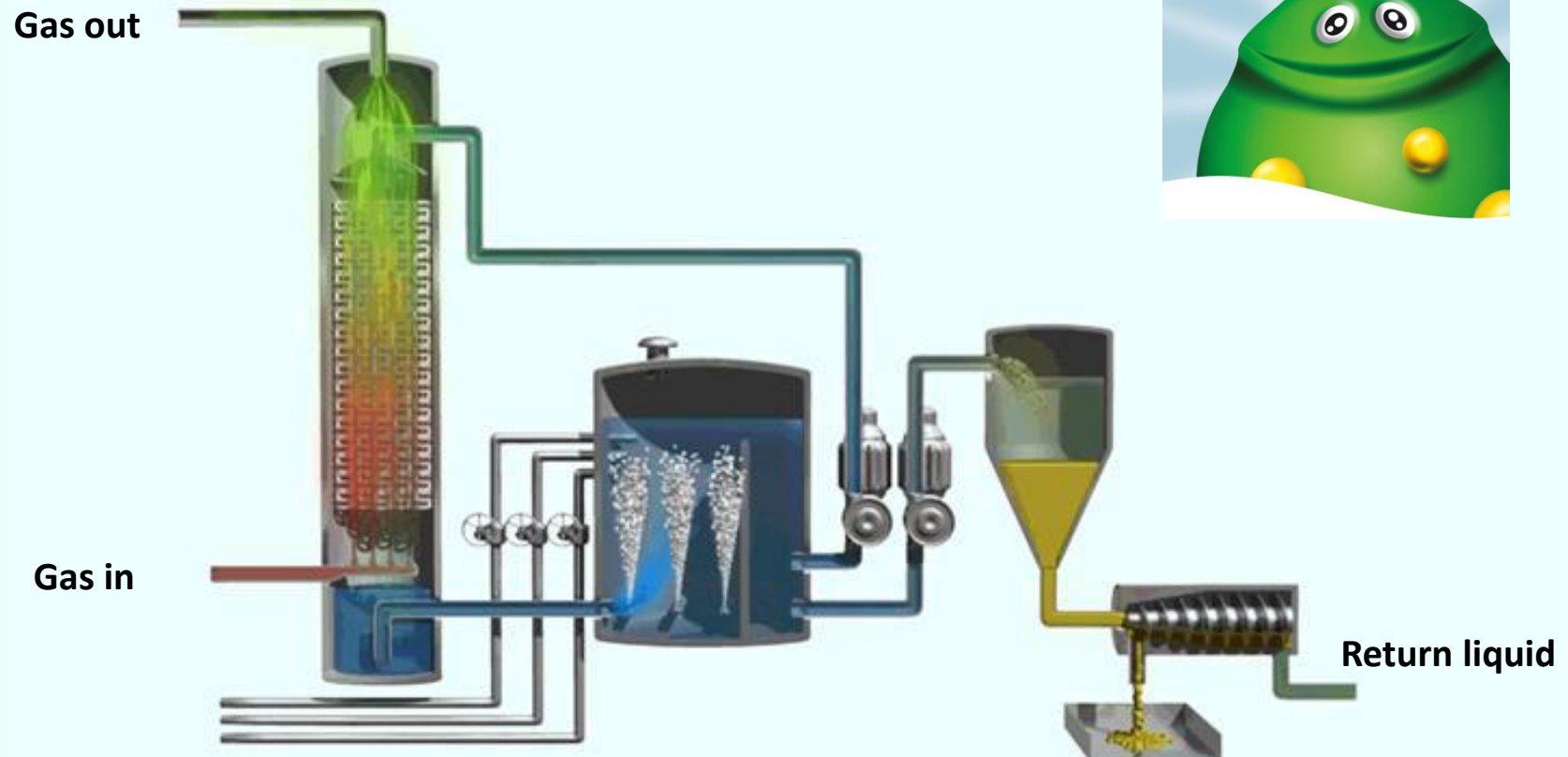
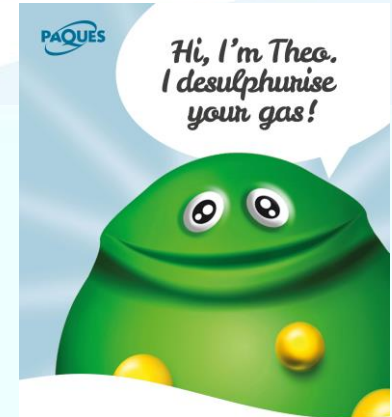


Bacterial conversion in the Thiopaq process



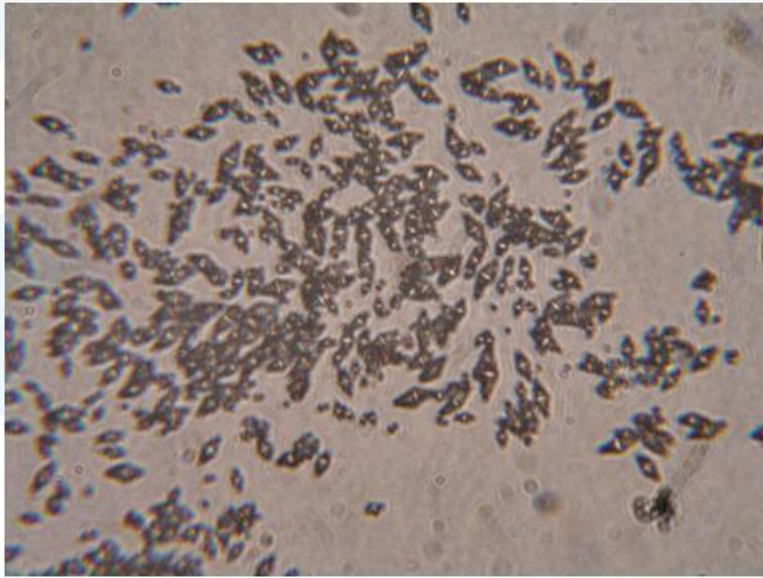
Thiopaq: bioconversion of H₂S into Sulphur

“Alkaline washing with washing liquid recovery”

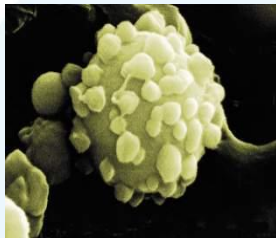
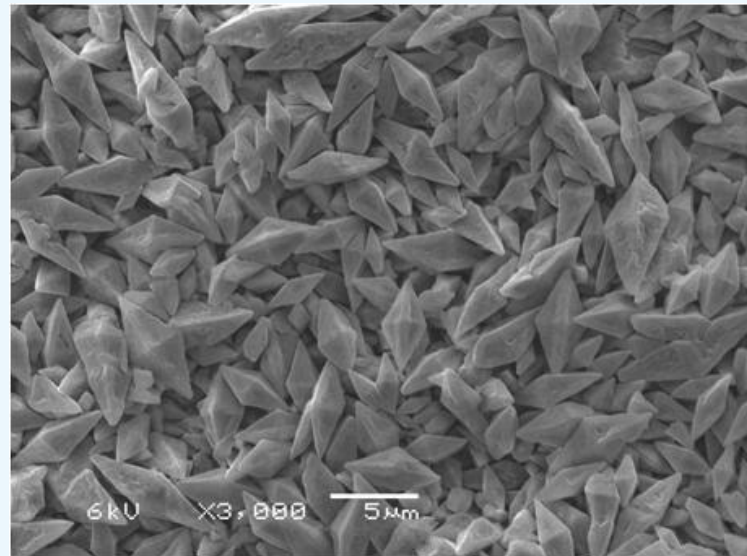


Rhombic Bio-Sulphur particles as seen via microscope

Optical microscope 1000 x



Electron microscope 3000 x



Bio-Sulphur allows better growth



No Sulphur

Complete

Shortage of chlorophyll
means:

Less capture of sun light

→ Less growth

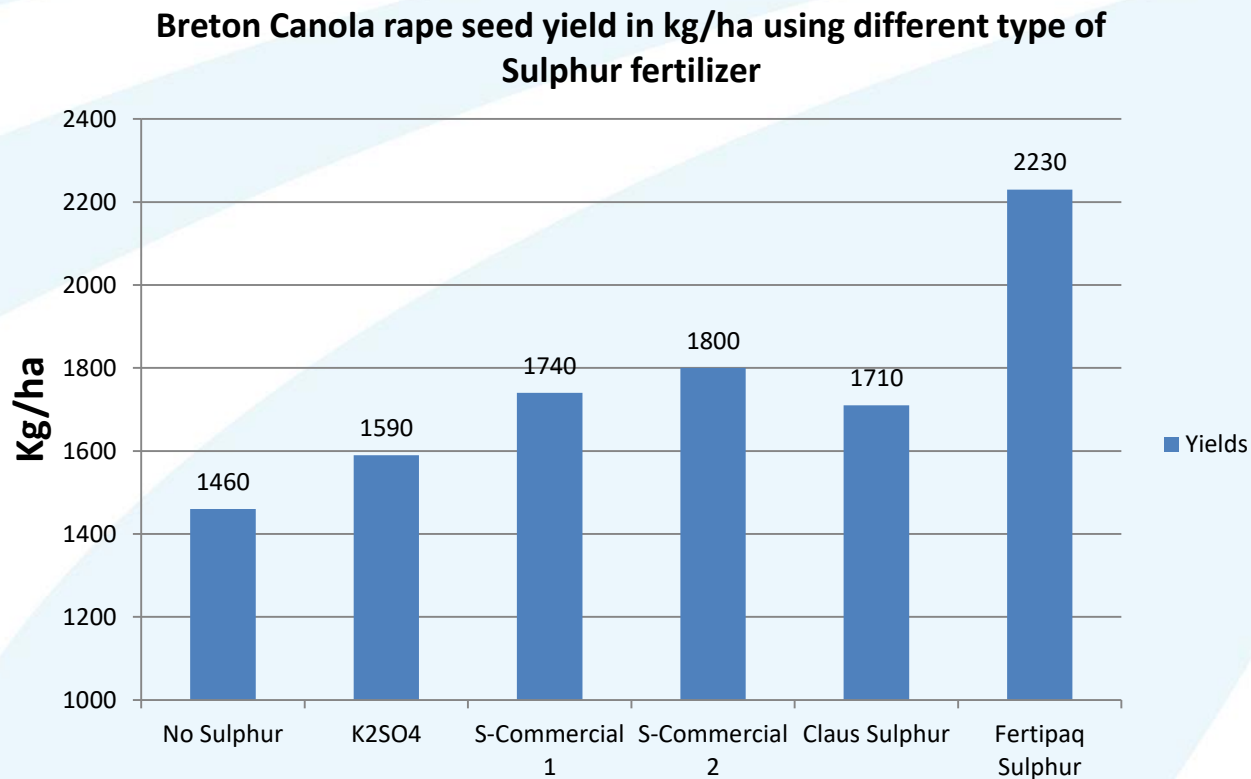
→ Less yield !

You can see it when looking over a field



Growth stimulant for rape seed

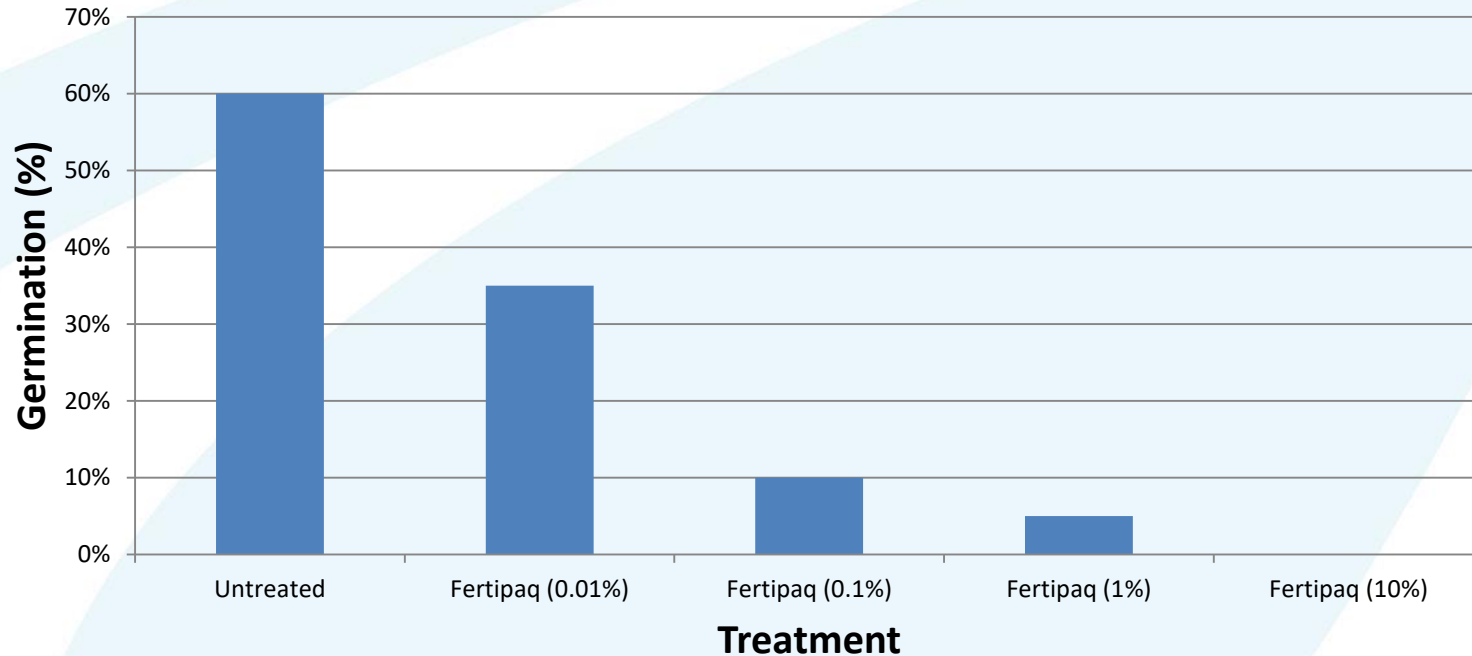
research at University of Alberta Canada shows 23 tot 40% more yield



Inhibition of apple scab germs

tested at PPO Fruit

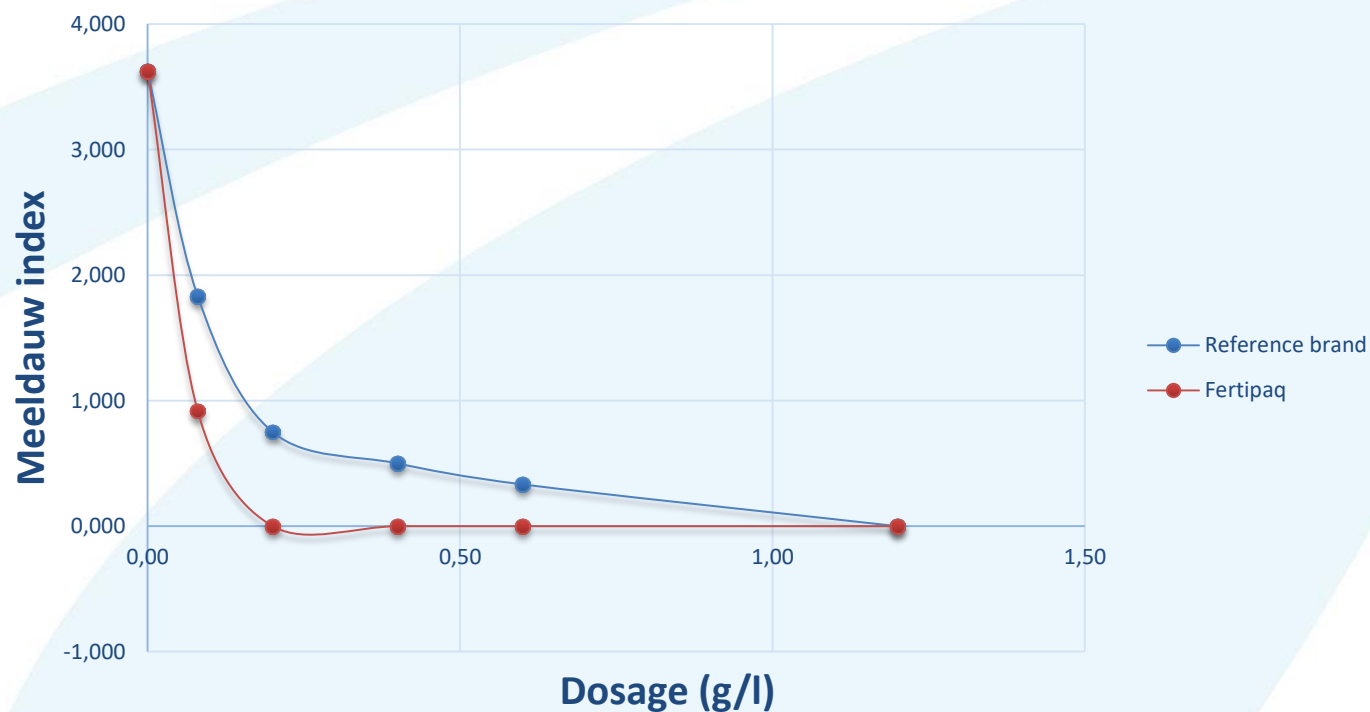
Germination of scab spores on agar plates, at different dosage Fertipaq Bio-Sulphur



Dosage-effect ratio for mildew on cucumber

Tested at PPO Fruit

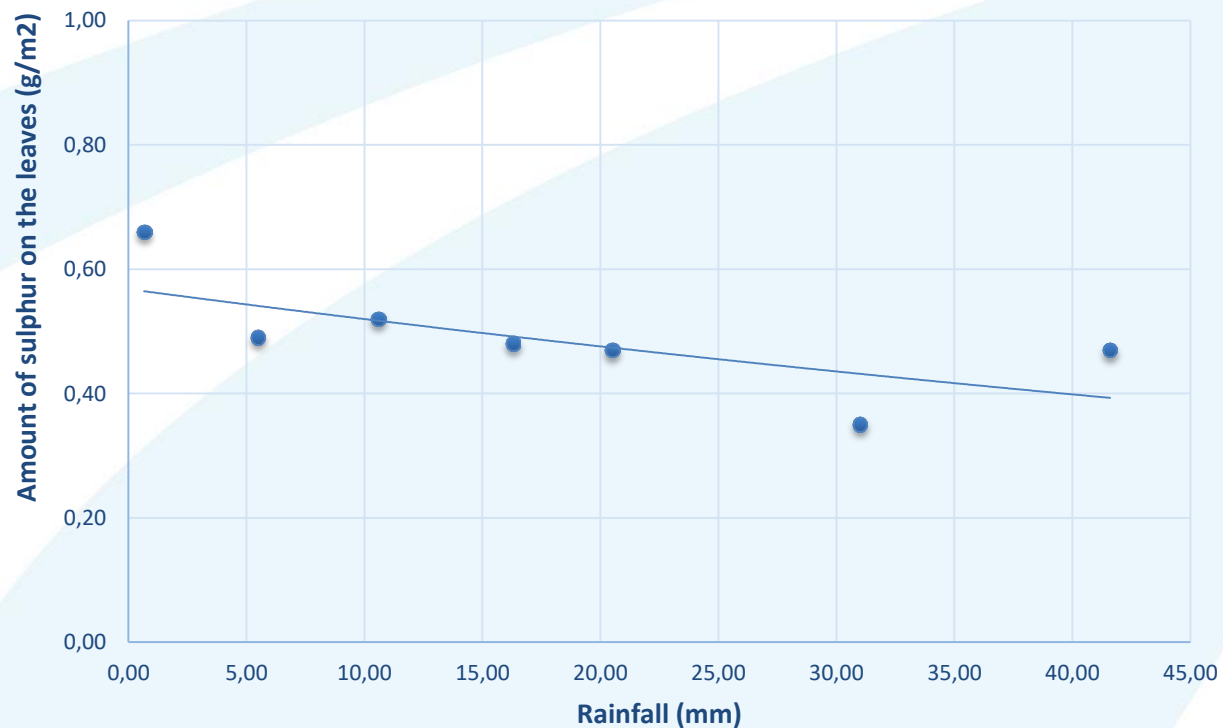
Dosage-effect ratio of Fertipaq Bio-Sulphur and one other Sulphur product for mildew on cucumber



Rain fastness of Bio-Sulphur

Tested at PPO Fruit

Residue of Fertipaq Bio-Sulphur on the leaves during rainfall

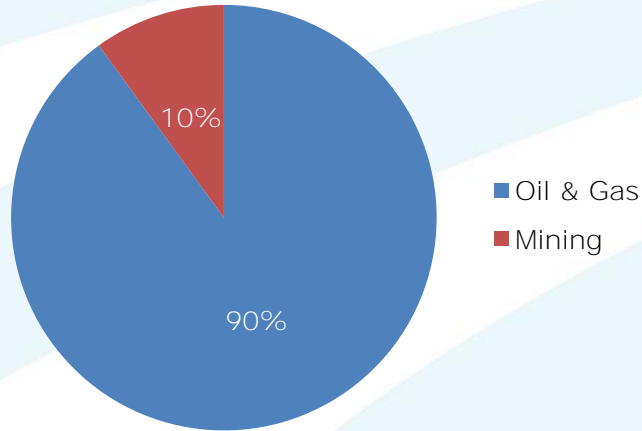


Summary of test results

- **Bio-Sulphur has very good properties as fertilizer**
- **it shows very high rain fastness on leaves**
- **Is very effective against fungi spores such as from apple scab and mildew**
- **In total less dosing is needed compared to established products**

Since fuel is all desulphurized
the world Sulphur production has become huge

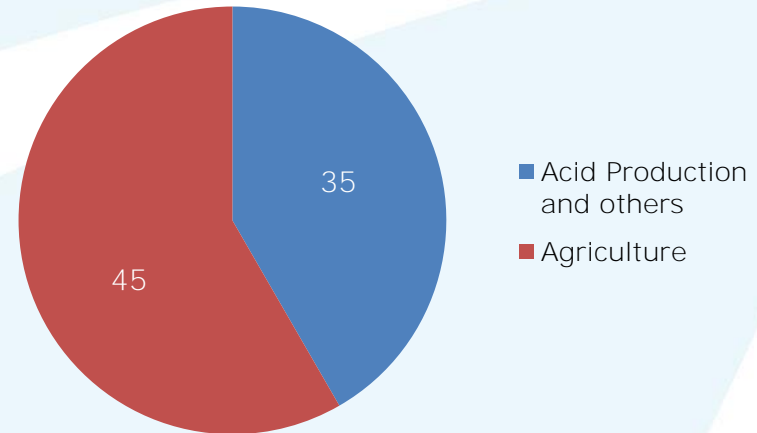
Production



World: >80 million ton/y



Use



(China import: 10 million ton/y
but demand 60 million ton/y)

(Bio-Sulphur 30.000 ton → 50.000 ton/y)

The use in agriculture is significant !

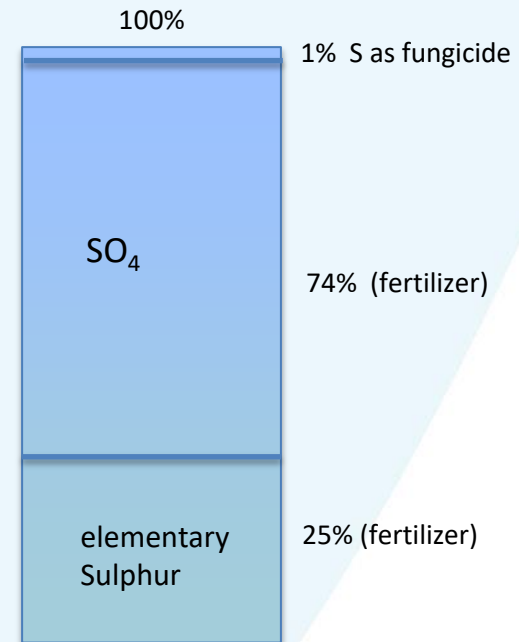
Sulphur demand in agriculture increases by 14% per year

Why?

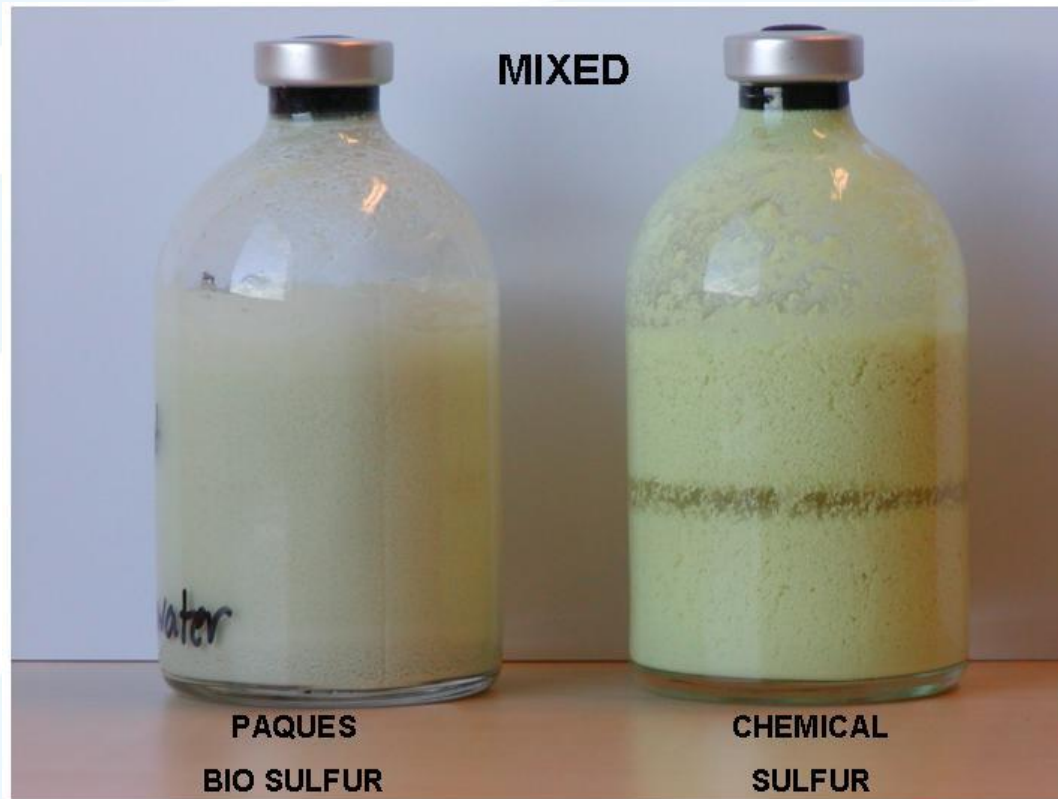
- Modern intensive agriculture needs more S
- Flue gas desulphurization leads to shortage in the soil
- S is important for N uptake by plant (synergy)
- S becomes more important for crop protection

(Prices for S are low and depend on application and package size)

Agricultural use of Sulphur:



Visible difference between hydrophylic and hydrophobic



How did Fertipaq become alive?

- Paques has the desire to give a new and sustainable live to the residues of its installations
- The use of Bio-Sulphur for business generation had won 2nd prize in Paques Innovation Award in 2010
- Marketing study was done resulting in Business plan.
- Fertipaq has been established to recover Sulphur but also nutrients and minerals in order to market them for sustainable use

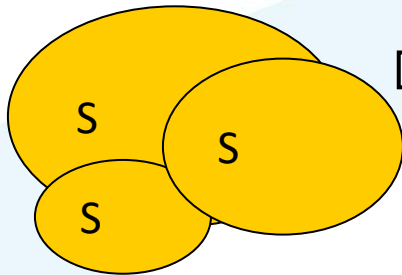
Questions to be solved beforehand

1. In which form to supply the Sulphur to the market?
2. How to collect and transport (Logistics)?
3. Who will be our customers; farmers; distributors?
4. Do we need a permit for fertilizer application?
5. Do we want/need fungicide registration?
6. How to organize the business structure?
7. Can we integrate the activities in the existing Paques departments?

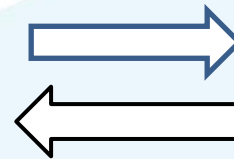
Business model

PAQUES
Holding

THIOPAQ customers



FERTIPAQ BV
|
(FERTIPAQ
Shanghai
Trading Ltd)



Blenders



flakes



Mining industry?



Cake; flakes; powder



Fertilizer producers



Distributors

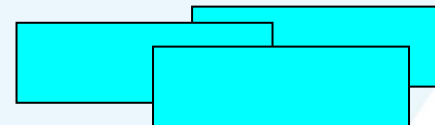


Farmers

Suspension concentrate



Distributors



Farmers

Packages of SC for large and small customers



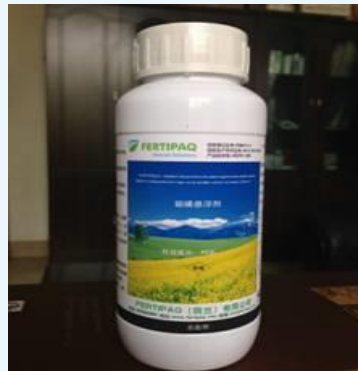
800 litres IBC



75 x 10 litres



10 litres



300 ml



100 ml

Amount of raw material to be processed is still a challenge !



Conclusions

- A sustainable solution for our gas scrubber residue has been realized.
- Bio-Sulphur has advantages over established Sulphur products
- Bio-Sulphur SC can be applied in organic farming.
- Business has grown to break-even.
- New destinations of Bio-Sulphur such as for metal precipitation are under investigation.

**Thanks for
your
attention !**

