



ON-SITE STIMULATED PHYTOMANAGEMENT APPROACHES OF CONTAMINATED SITES : A tool to foster the remediation market via a sustainable and economically feasible way

Panagiotis Gkorezis

Intersoil - Brussels 2020



About TERRACORRECT

- **Founded in 2014**
- **Based in Ooigem [Between Ghent (BE) and Lille (Fr)]**

Relatively Young but “so” ambitious!

The ambition is to find a solution for every problem today, tomorrow and in the future within our market



TerraCorrect delivers products and solutions for vapor, sludge, soil, and groundwater treatment with an “Environmentally Green” approach by:

- Enhancing existing remediation technologies;
- Investing in the future to expand the limits of current technologies;
- and
- Supporting and investing in new technologies (technical, economical, sustainable, safe)



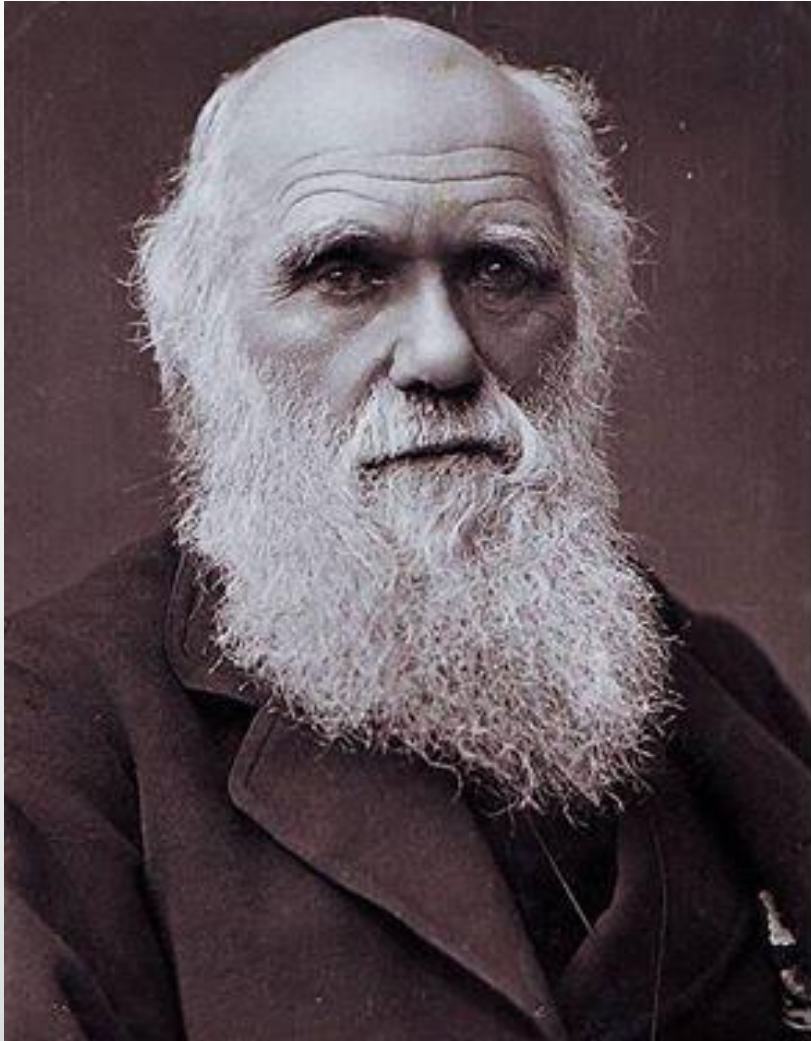
TerraCorrect



TerraCorrect offers solutions for:

- In-situ chemical oxidation
- In-situ anaerobic bioremediation
- Elimination of pure products in groundwater
- Pump and treat
- Air-sparging and soil air extraction
- Reactive walls
- Products for stimulating ex-situ soil treatment
- Surfactants
- Phytoremediation /Bioremediation

Our mission Ecological Soil Remediation!



It is not the most intellectual or
the strongest of species that survives;
but the species that survives is the
one that is able to adapt to and adjust
best to the changing environment in
which it finds itself.

- Charles Darwin

[fb/TraumaAndDissociation](https://www.facebook.com/TraumaAndDissociation)

TerraCorrect



Common practices in soil remediation





But is there no
technology with a
better carbon footprint?



**Soil remediation
with
phytoremediation
&
bioremediation**



Relevant publications



International Biodeterioration & Biodegradation 65 (2011) 1119–1127
Contents lists available at SciVerse ScienceDirect
International Biodeterioration & Biodegradation
journal homepage: www.elsevier.com/locate/ibiod

Bioremediation of petroleum hydrocarbon contaminated soil: Effects of strategies and microbial community shift
Grace Liu^{a,*}, Tsung Chain Chang^b, Liang-Ming Whang^{c,d,e}, Chun-Hsuan Kao^c, Sheng-Shung Cheng^{c,d,**}

Hydrocarbon degradation, plant colonization and gene expression of alkane degradation genes by endophytic *Enterobacter ludwigii* strains
Sohail Yousaf^a, Muhammad Afzal^{a,b}, Thomas G. Reichenauer^c, Carrie L. Brady^d

^aAIT Austrian Institute of Technology GmbH, Bioresources Unit, A-2444 Seibersdorf, Austria
^bNational Institute for Biotechnology and Genetic Engineering (NIBGE), Faisalabad, Pakistan
^cAIT Austrian Institute of Technology GmbH, Environmental Resources & Technologies Unit, A-2444 Seibersdorf, Austria
^dForestry and Agricultural Biotechnology Institute, Department of Microbiology and Immunology, University of Guelph, Guelph, Ontario, Canada

ORIGINAL PAPER

Persistence and degrading activity of free and immobilised allochthonous bacteria during bioremediation of hydrocarbon-contaminated soils
Valentina Rivelli · Andrea Franzetti · Isabella Gandolfi · Simona Cordon · Giuseppina Bestetti

Evaluation of Plant–Microorganism Synergy for the Remediation of Diesel Fuel Contaminated Soil
Xin Lin · Xiaojun Li · Peijun Li · Fei Li · Lei Zhang · Qixing Zhou

Soil type affects plant colonization, activity and catabolic gene expression of inoculated bacterial strains during phytoremediation of diesel

Muhammad Afzal^{a,b}, Sohail Yousaf^a, Thomas G. Reichenauer^a, Melanie Kuffner^a, Angela Sessitsch^{a,*}
^aAustrian Institute of Technology GmbH, Department of Health and Environment, A-2444 Seibersdorf, Austria
^bNational Institute for Biotechnology and Genetic Engineering (NIBGE), Faisalabad, Pakistan

Received: 17 July 2007 / Accepted: 14 April 2008 / Published online: 21 May 2008
© Springer Science+Business Media, LLC 2008

Draft Genome Sequence of the Hydrocarbon-Degrading and Emulsan-Producing Strain *Acinetobacter venetianus* RAG-1^T

Marco Fondi,^{a,d} Valerio Orlandini,^a Giovanni Emiliani,^a Maria Cristiana Papaleo,^a Isabel Maida,^a Elena Perrin,^a Mario Vaneechoutte,^b Lenie Dijkshoorn,^c and Renato Fani^a

Stimulated phytoremediation

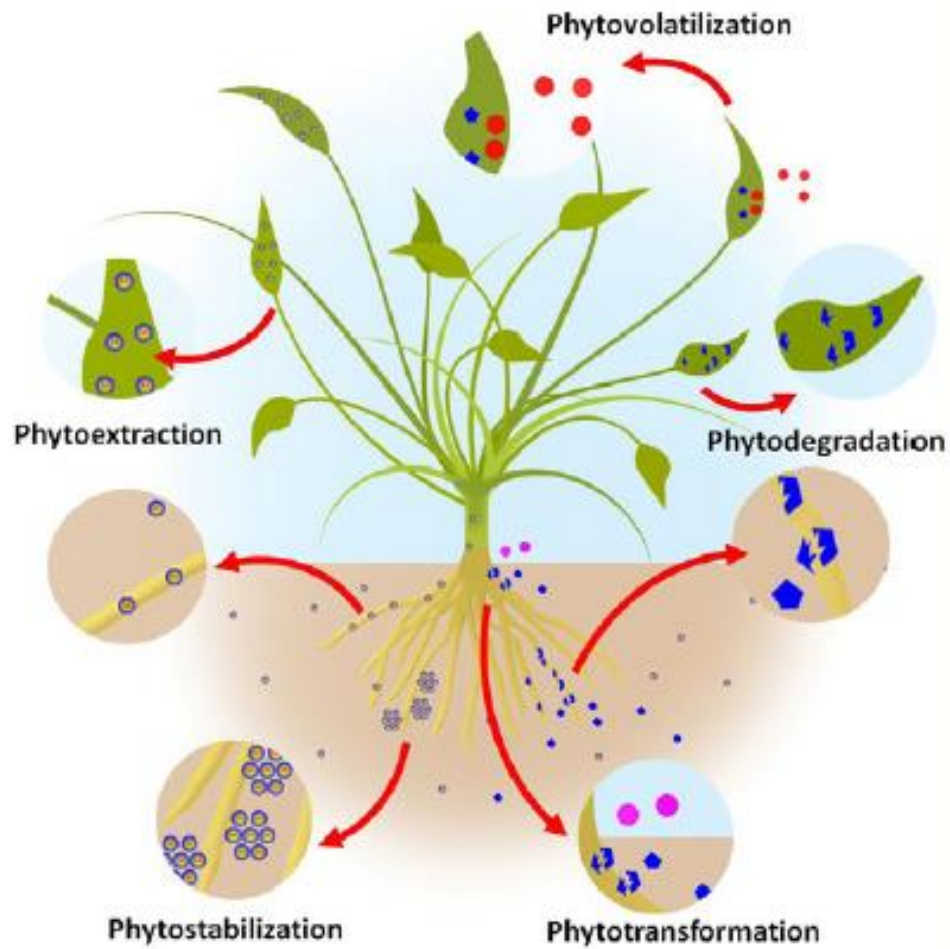
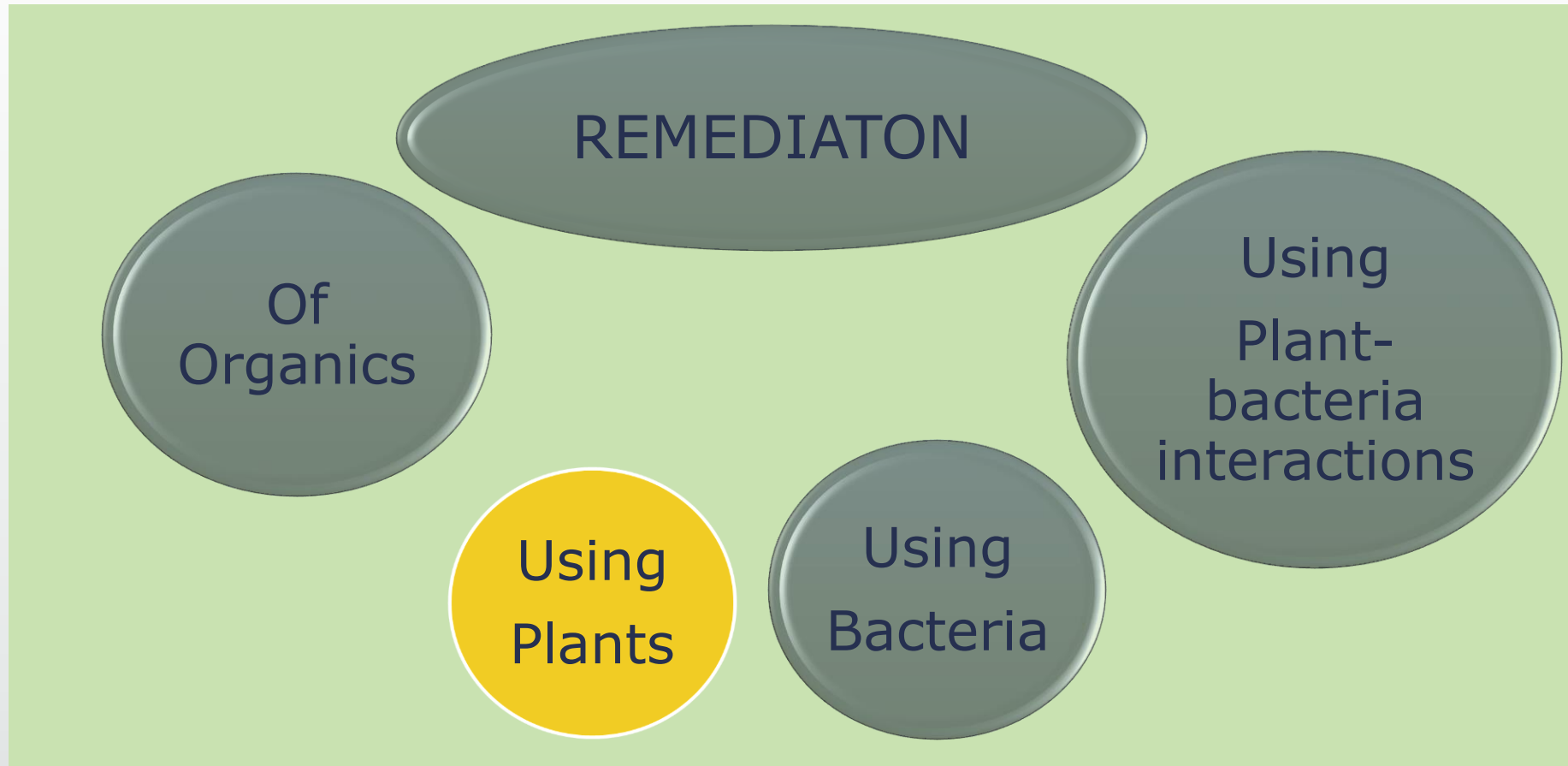


Figure 1: Schematic representation of phytoremediation approaches.



Phyto/ Bioremediation and organics



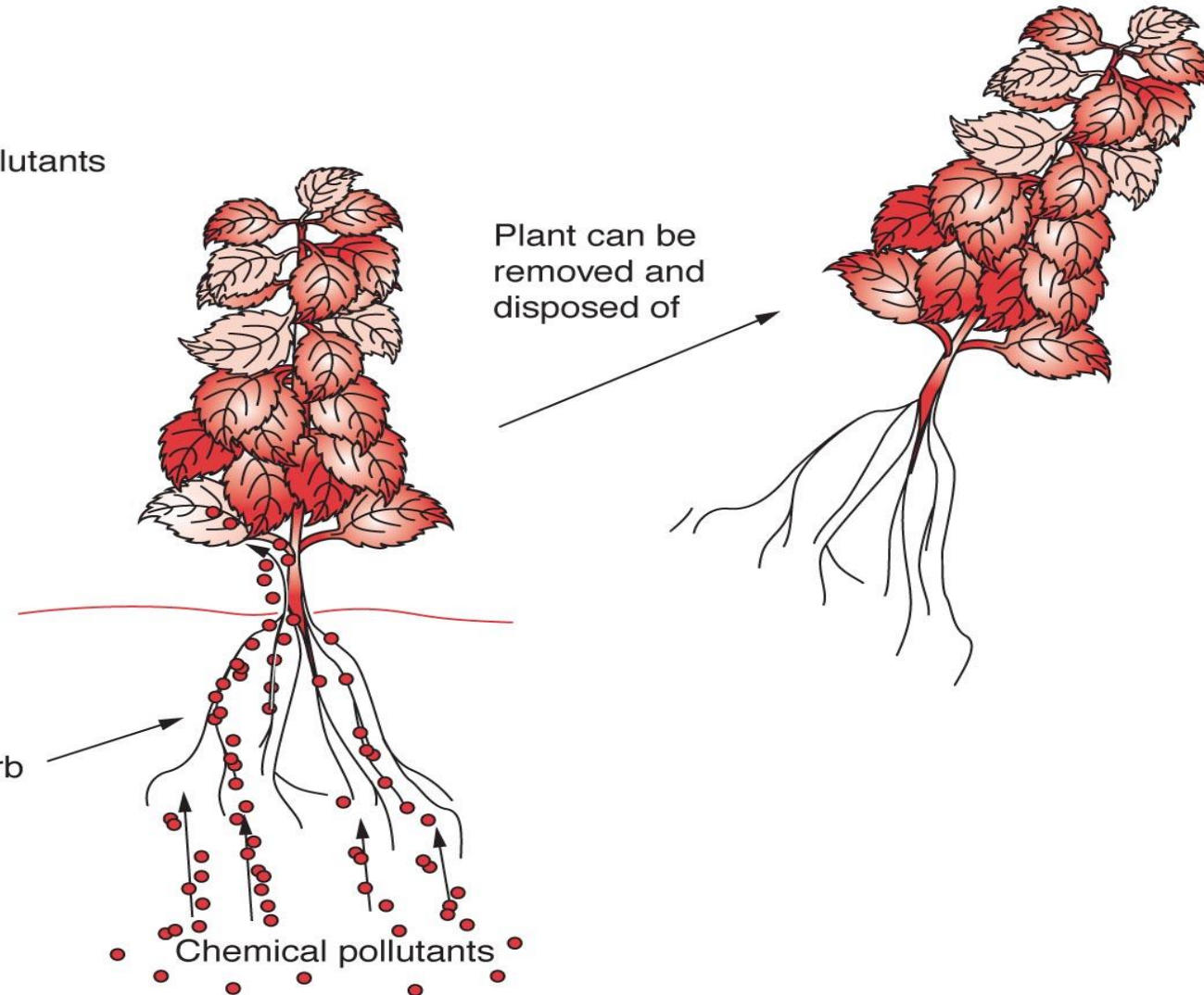
TerraCorrect



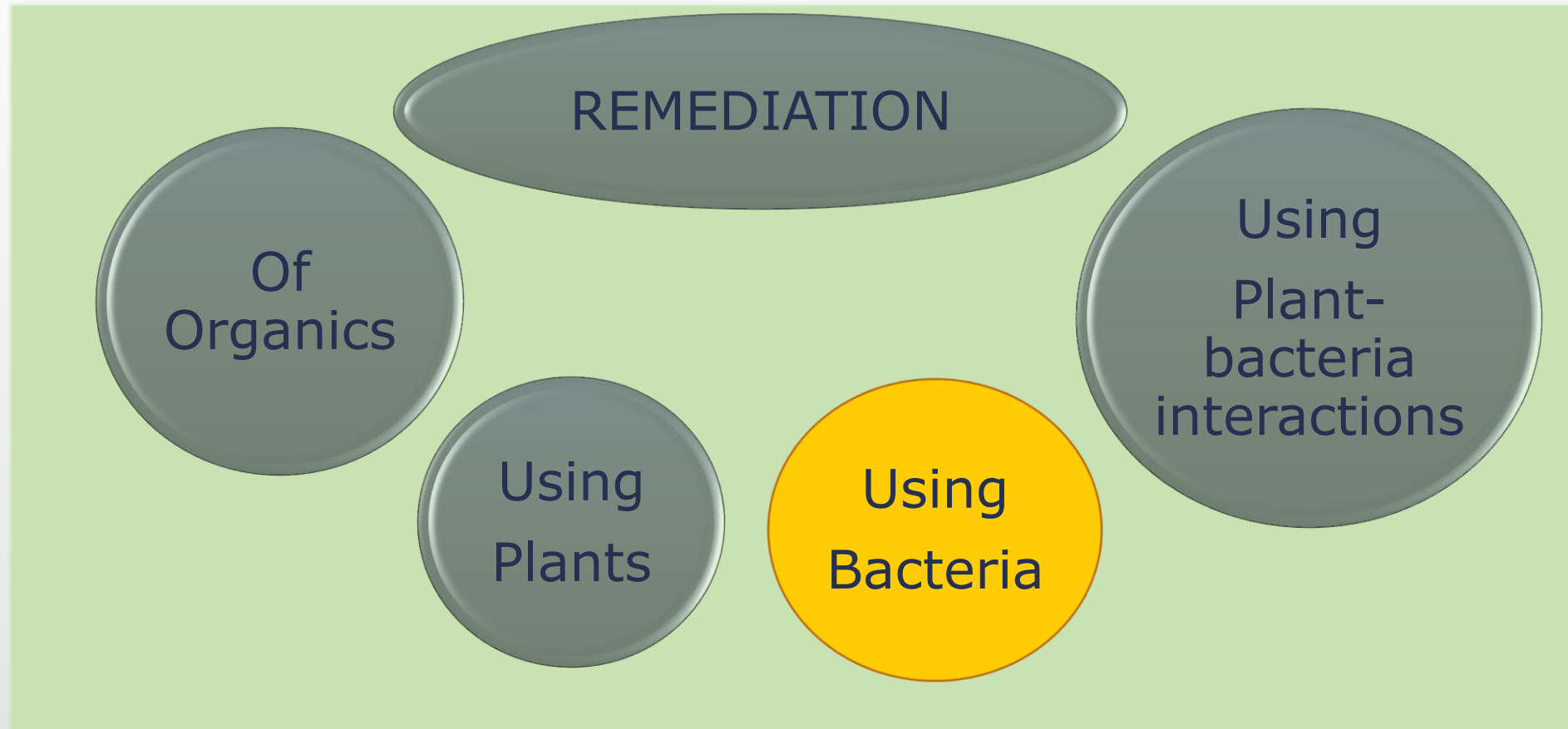
Elucidating the role of plants



Plant cells
degrade pollutants
directly



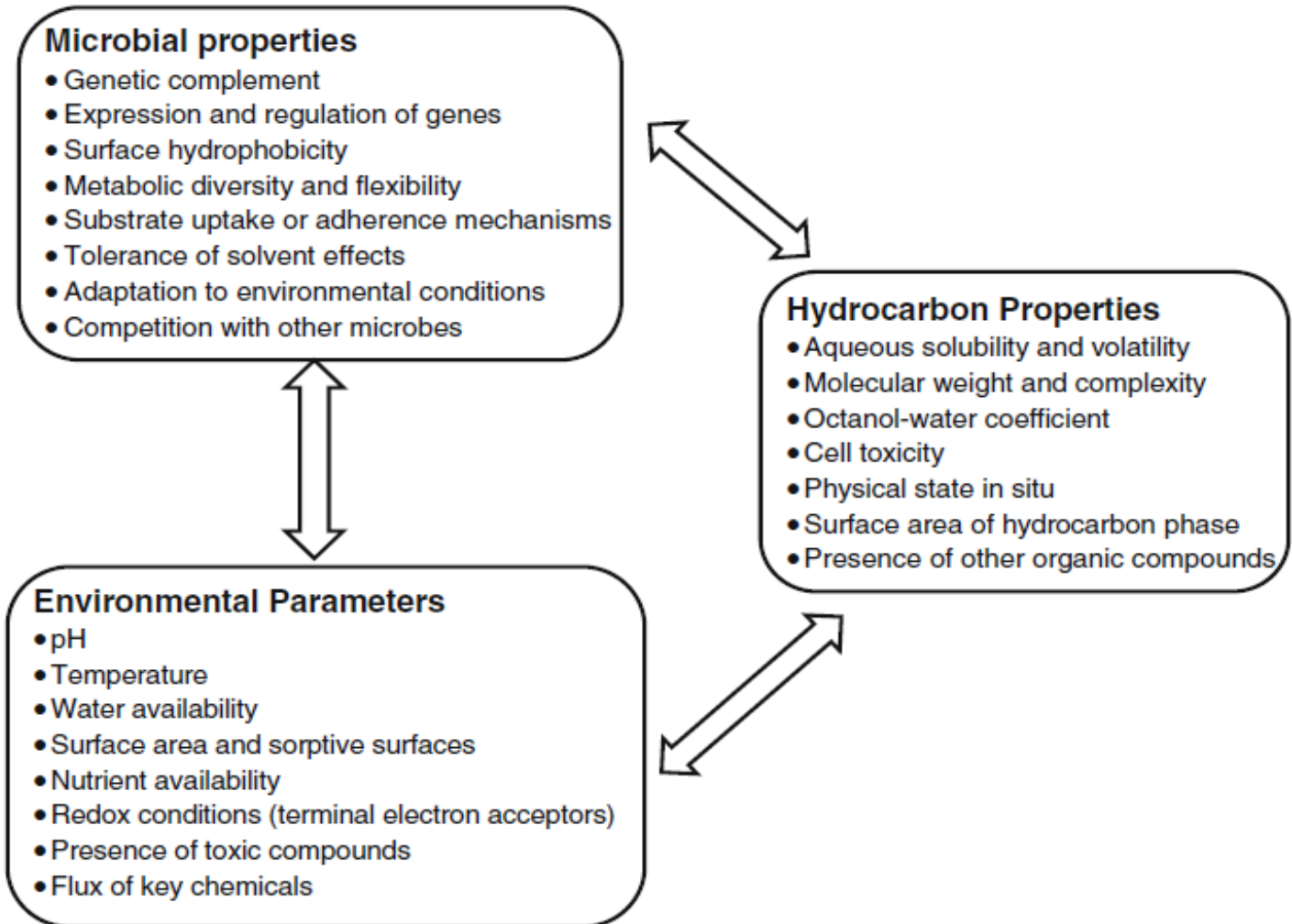
Phyto/ Bioremediation and organics



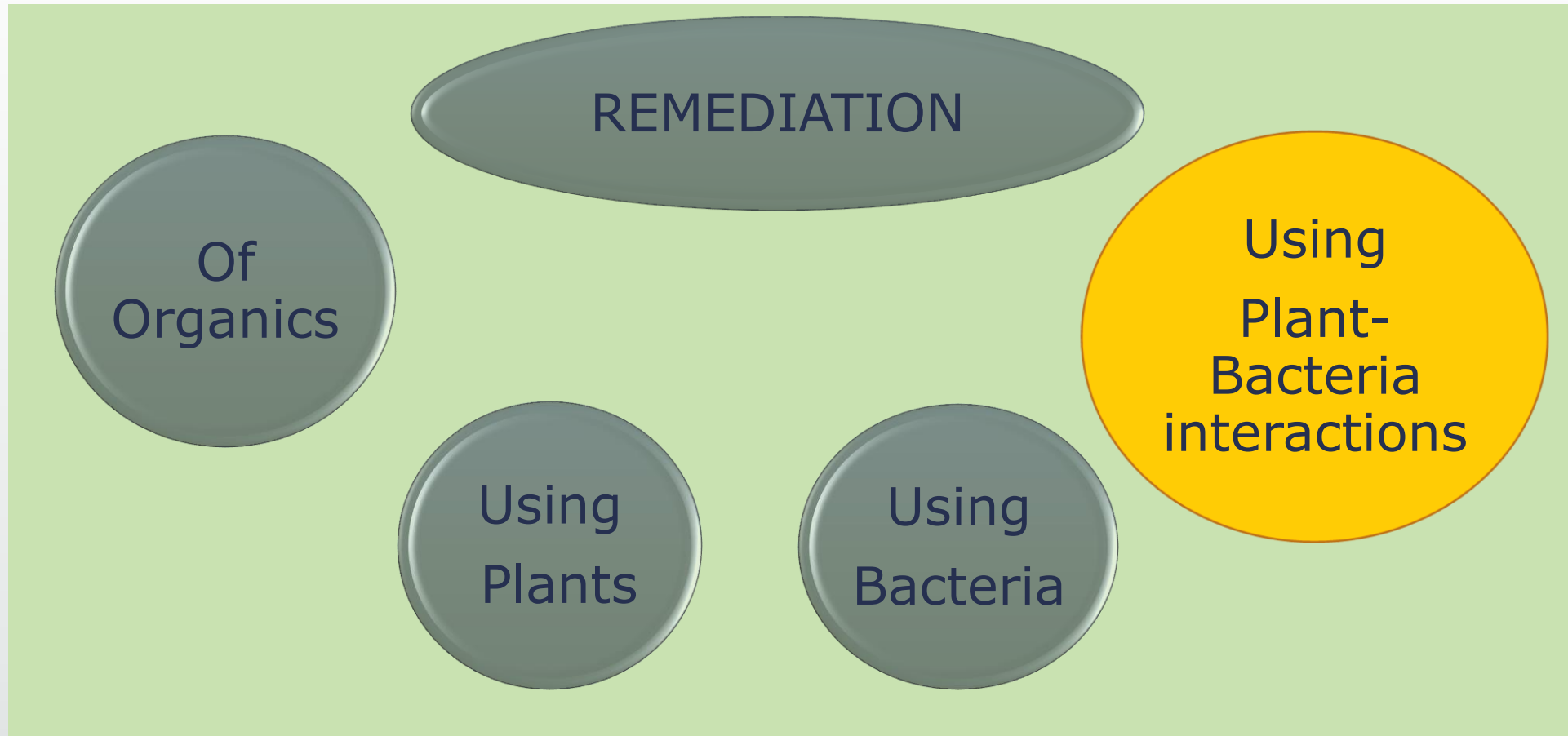
TerraCorrect



Factors affecting bioremediation processes



Phyto/ Bioremediation and organics



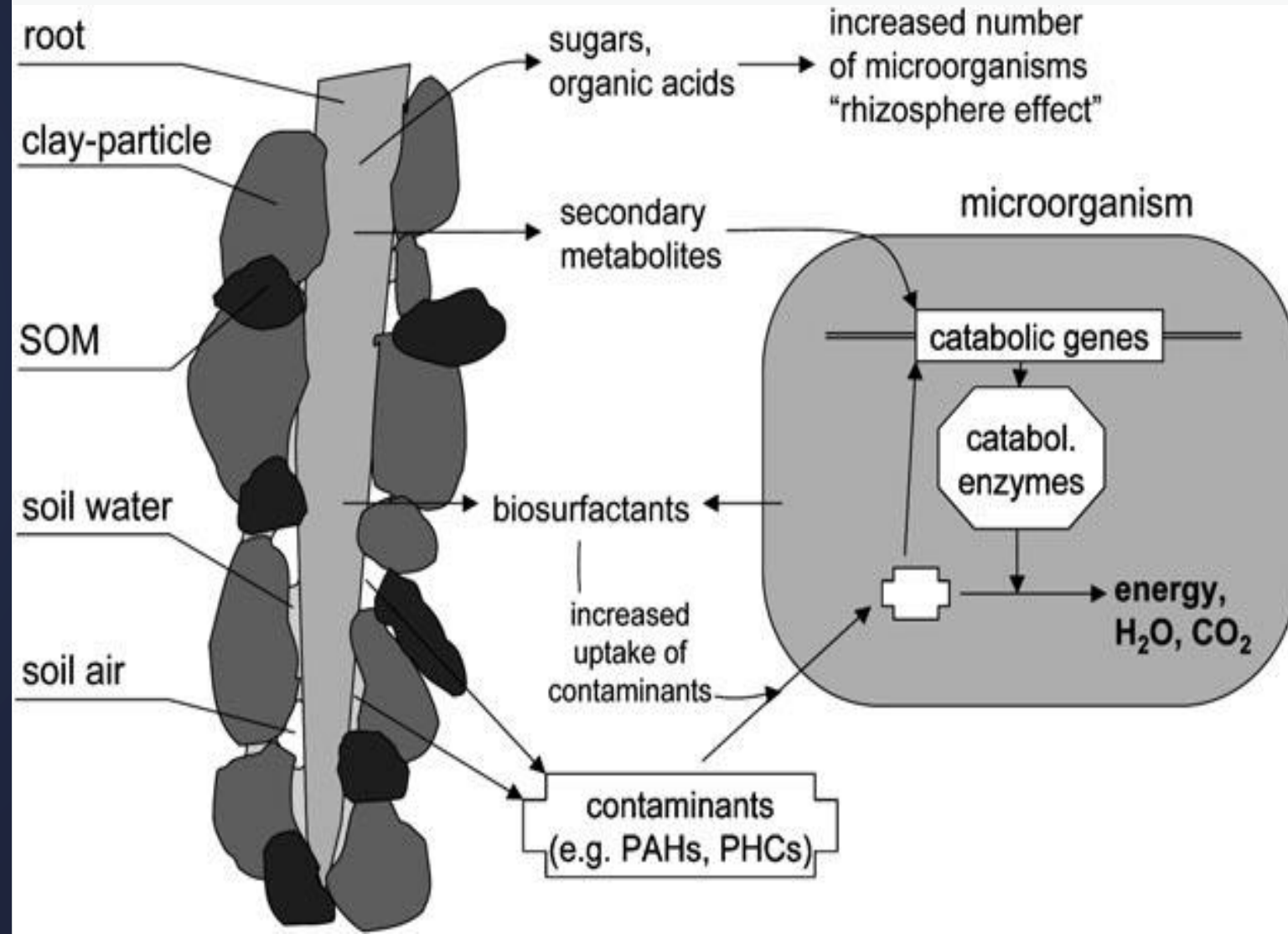
TerraCorrect



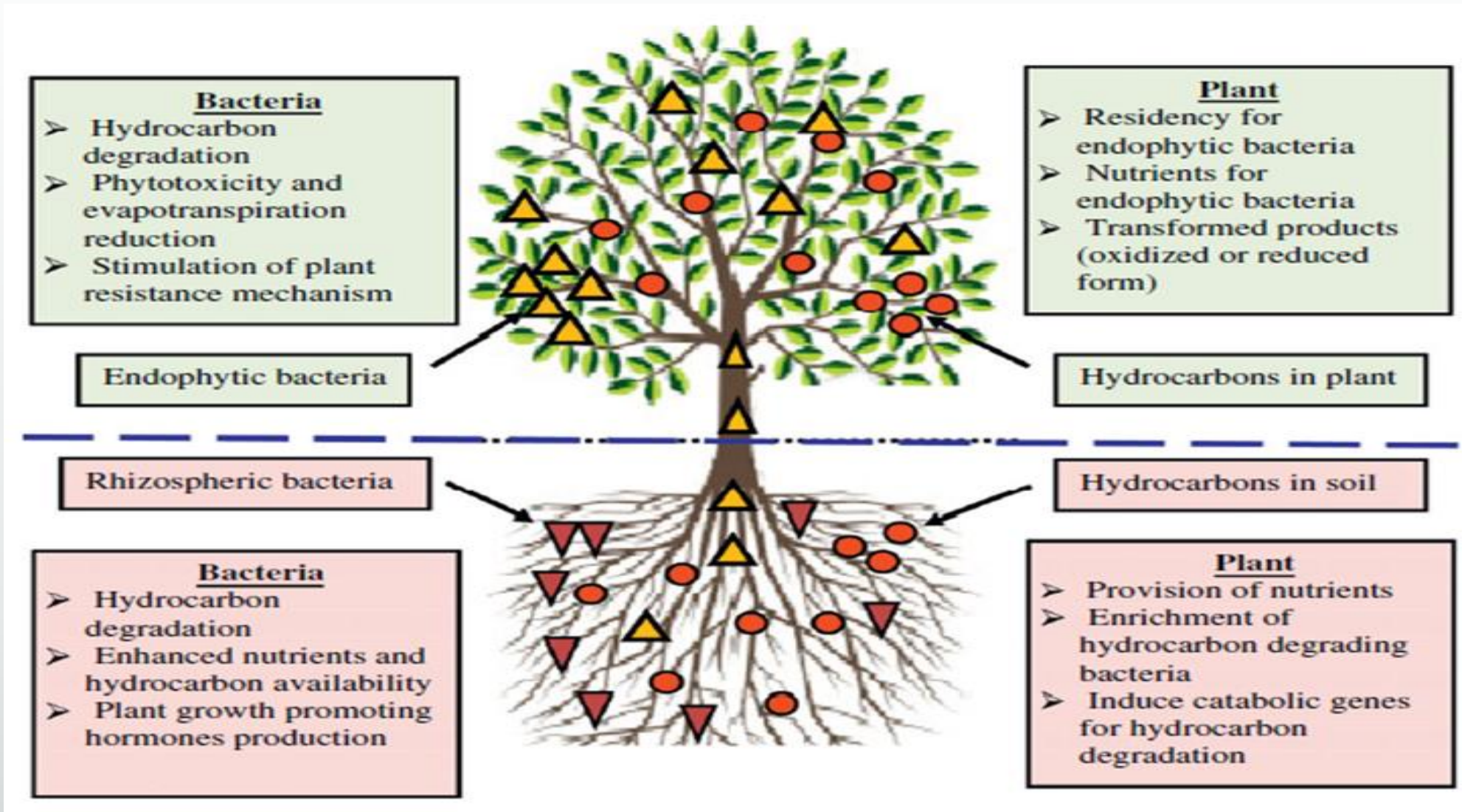
The « Rhizosphere » effect



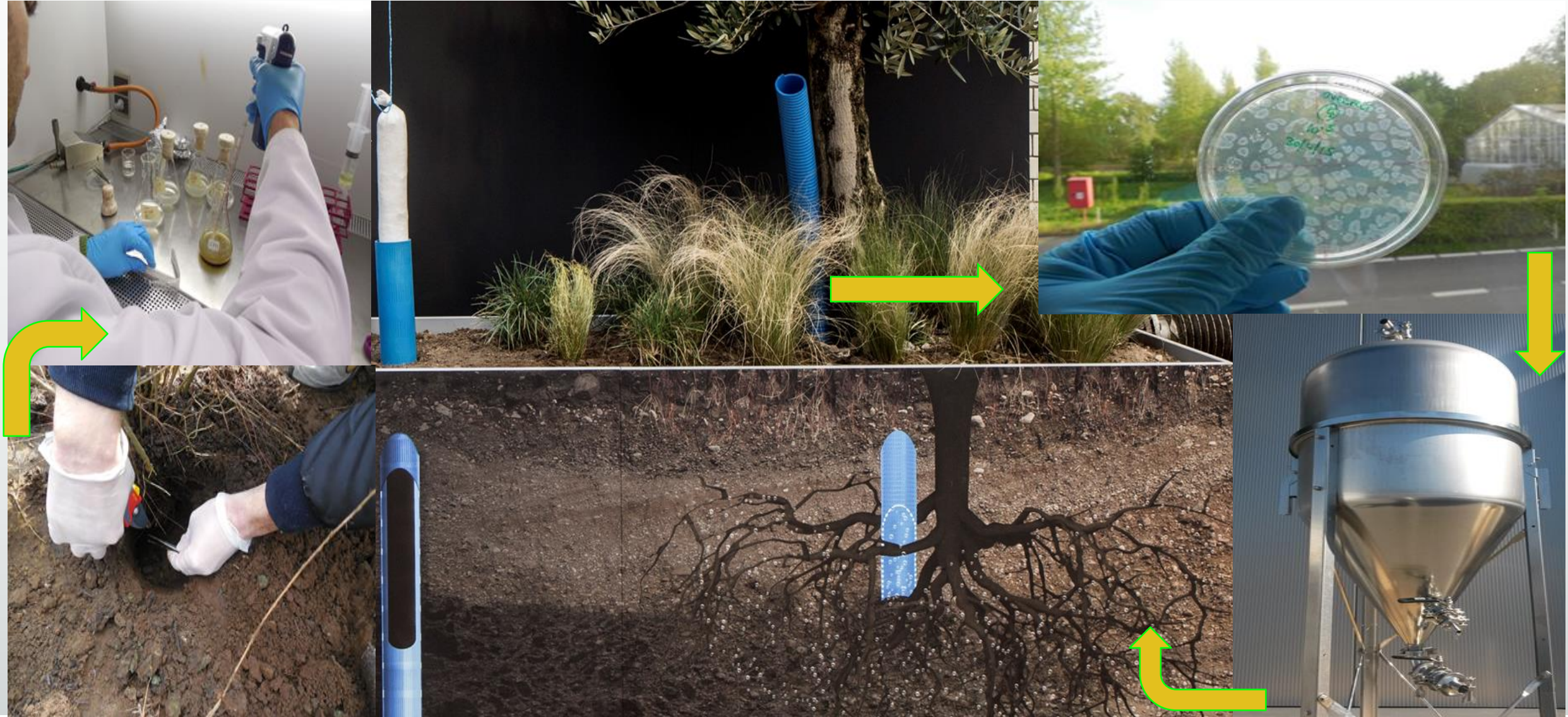
TerraCorrect



PHC's ecologically enhanced remediation



Bio-based remediation of residual pollution



Field cases of bio-based remediation of residual pollution



TerraCorrect





REFERENCES

Private Property :

Phytoremediation

Soil Investigation 2013:

- Soil : Mineral oil with max 10.000 mg/kg ds
- Groundwater : Mineral oil ca. 1900 µg/l
- Puur product was removed

TerraCorrect



PRIVATE PROPERTY

Phytoremediation



Private property Bioremediation



RESULTS

**Non -contaminated,
Normal vegetation**

**Contaminated
Conditioned vegetation**

REFERENCES

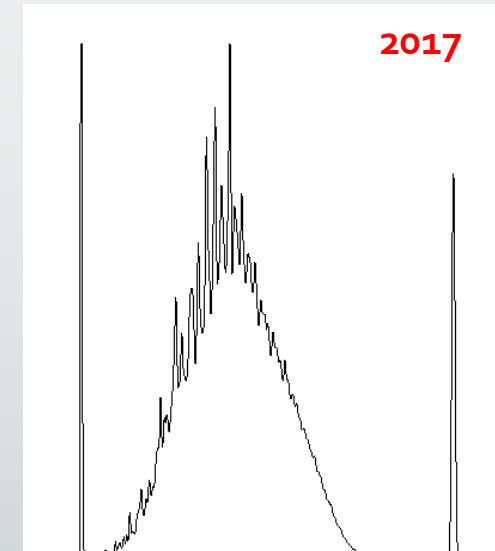
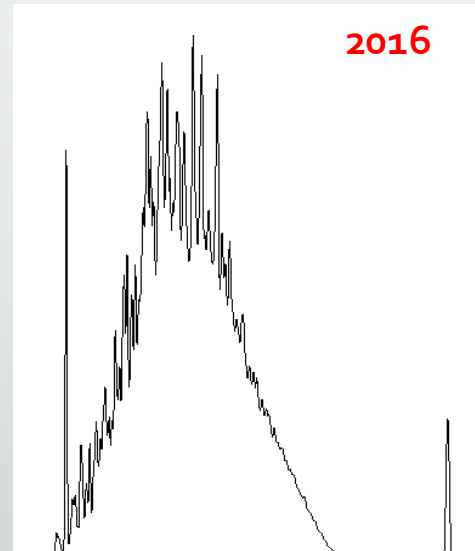
Phytoremediation

Results:

- October 2017 concentration < 3600 mg/kg ds

End of 2018

- concentration < 710 mg/kg ds in fixed part of the soil
- concentration < 50µg/l in the groundwater





Why poplar or willows ?

- Fast growth
- High biomass production
- Phreatophytes
- Those trees can “pump” huge volumes of groundwater
- They are simple for propagation

TerraCorrect



BUT THERE IS MORE!

**Where can we help you find the best environmental solution
for your soil remediation?**

Genomic tools

Bacterial degradation capacity

Cultivation the micro-organism

Testing the plant-bacteria system

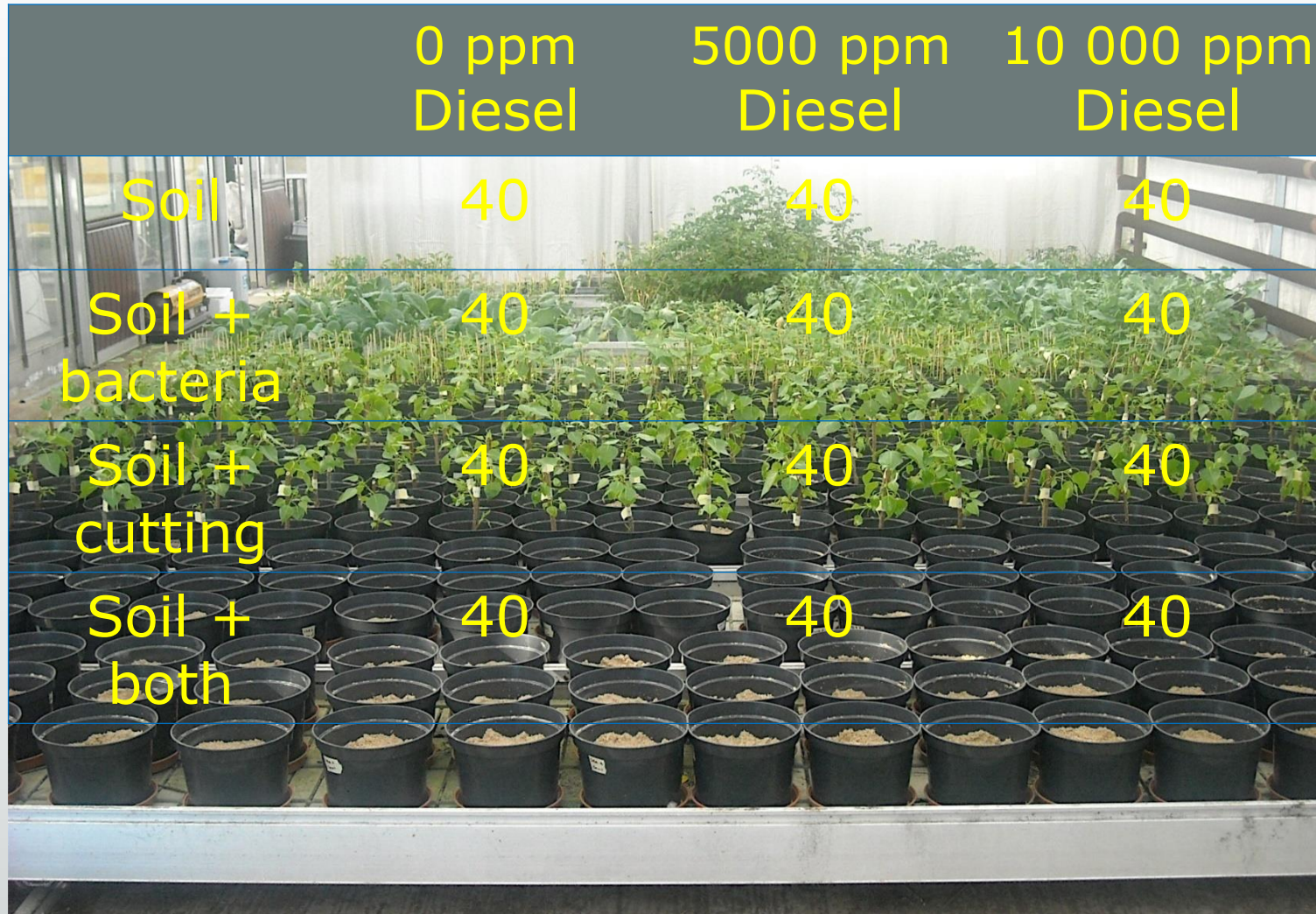
Microcosm

It's all about the understanding



Testing the plant-bacteria system in a model greenhouse trial

	0 ppm Diesel	5000 ppm Diesel	10 000 ppm Diesel
Soil	40	40	40
Soil + bacteria	40	40	40
Soil + cutting	40	40	40
Soil + both	40	40	40





TerraCorrect



Workflow to select the most promising strains

Degradation potential

Biosurfactant production

Chemotaxis

Degradation capacity (GC-MS/GC - FID)

Strains isolation



Strains were '+' for both tests



\"/>

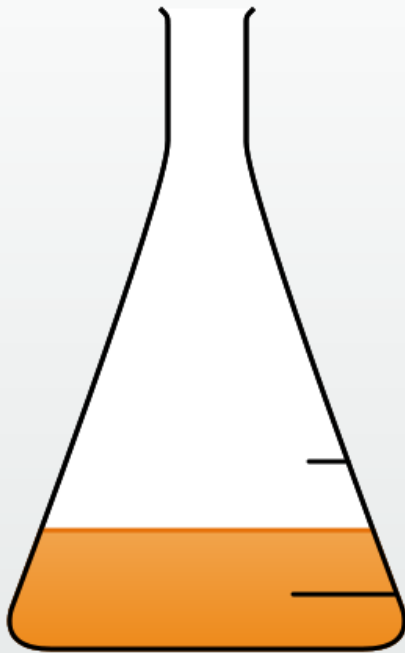


Genome Sequencing

TerraCorrect



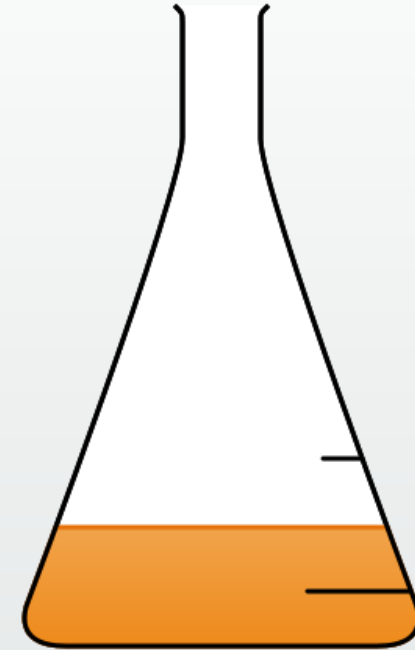
Testing bacterial degradation capacity



BH medium + Diesel
+ bacteria



BH + Diesel
+ autoclaved bacterial cells



BH medium + Diesel

Sampling: 14 days

Bacterial cell growth was monitored by measuring Optical Density

TerraCorrect



In progress

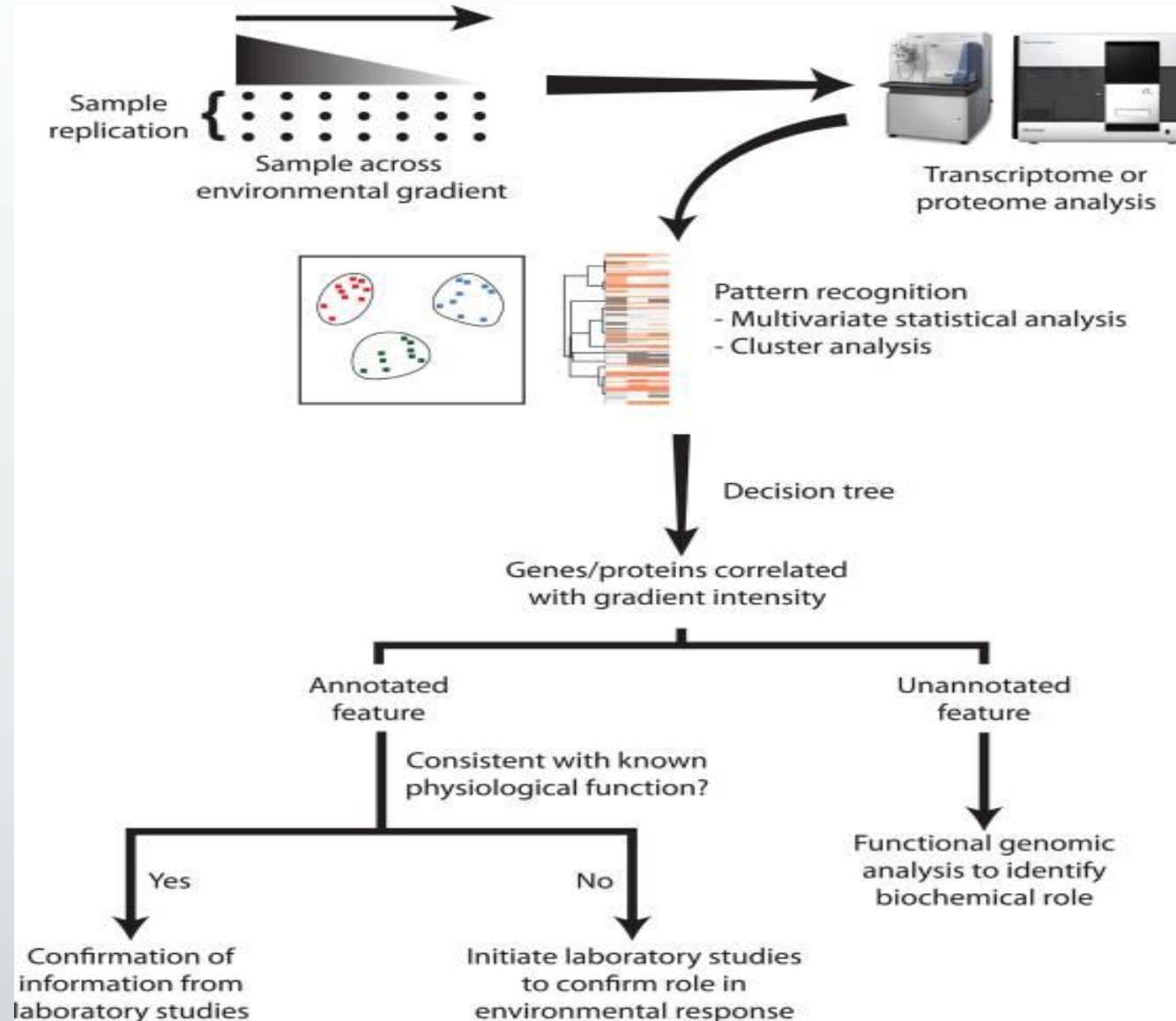
- Does inoculation with our tailored bacterial consortium modify the rhizobiome?
- Does this correlate with enhanced contaminant-removal rate?



Future research needs

Manipulation and re-directing of the root-endosphere microbiome to further enhance the degradation of various contaminants of concern

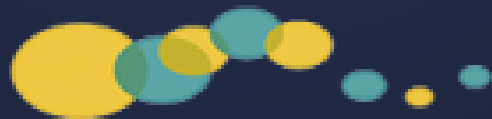
The discovery of novel physiological responses via data mining of transcriptome or proteome data



Terra Correct's genes technology



TerraCorrect



- The advent of new genomics tools can help decipher the who, what, where and how
- Knowing who's there provides important information on capabilities
- Knowing what key genes are present identifies potential
- Showing which genes are functional indicates who is active



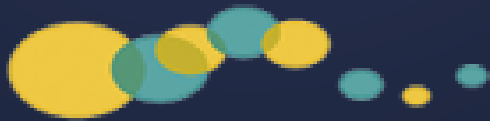
Terra Correct's novelty in the Remediation Business

- Pre-assessment of biodegradative capacity of an environment
- Enhanced phytoremediation activity
- Monitoring in situ phytodegradation performance
- Assisted selection of functional strains/communities

CONCLUSIONS



TerraCorrect



- Seems to hold promise that suitable plant species recruit a specific bacterial community in the rhizosphere under contamination-stress
- Isolation and genome sequencing of promising candidates provides valuable information about the potential of plant – bacteria partnerships to restore contaminated sites
- Modification of the microbial community seems to affect the transformation of the contaminants of concern



TerraCorrect bvba
Sluistraat 7
8710 Ooigem
E-mail: panos@terracorrect.be
Website: www.terracorrect.be

