What links exist between agricultural practices and their impacts on human health and the environment?

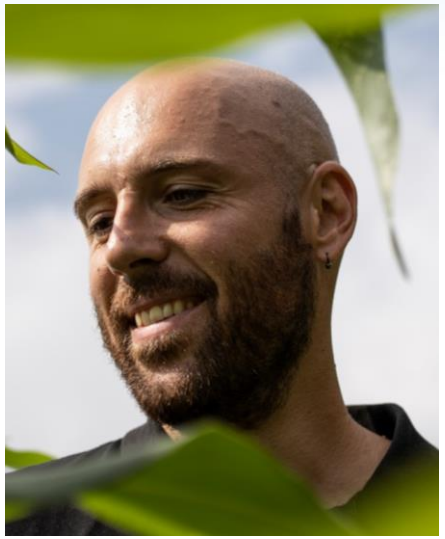
MAY 29TH 2024

MARIE-LAURE EYCHENNE

Responsable
Développement Durable

MICHEL DURU

Directeur de recherche, actuellement chargé de mission à l'INRAE, membre de l'Académie d'Agriculture



FELIX NOBLIA

Agriculteur et co-fondateur de ReGeneration

MICHEL DURU

Impacts of agricultural practices on health and the environment

Michel Duru Research Director, project manager at INRAE
Agronomy and global health

Member of the Academy of Agriculture

Formation ONE HEALTH

Context: environment, health and hidden costs of food system

Agroecology for :
- **cropping systems** and plant products
- **livestock systems** and animal products
- **food system** and diet quality

Lessons for regenerative agriculture

Which future for regenerative agriculture and food systems?

Our food system affects all the fields of health: soils, ecosystems, Earth system and human health

- Local (diffuse pollution) and global (climate) environment
- Resources: land, water, energy, phosphorus
- Health: chronic diseases, antibiotic resistance

Exceeding planetary limits

Worsening, degradation

1 € for food is almost 1 € to repair health and nature
4 main factors, excess of:
- nitrogen fertilizers
- pesticides
- farming unconnected with the soil and consumption of animal proteins
- ultra-processed foods

PLANÈTE · CLIMAT

La Banque mondiale appelle à « réorienter drastiquement » le système agroalimentaire mondial

Les solutions proposées par l'institution financière sont toutefois jugées insuffisantes pour aller vers un modèle durable et résilient.

Need for TRANSFORMATIVE change: ***Le Monde 7 mai 2024***
Fundamental and systemic reorganization of economic, social and technological factors: paradigms, objectives, values

Agriculture and environment: reducing impacts or/and increasing services

Impacts

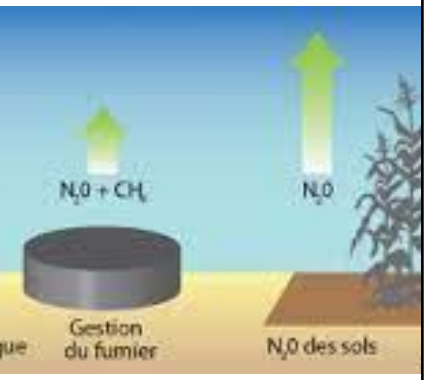
Agricultural goods and bio-sourced products

Ecosystem services

Use of resources
- Land
- Water
- Energy

Agriculture

Agricultural services
- Pollination
- Regulation of pests
- Mineral nitrogen supply
- Water storage and restitution
- Soil structuring



Impacts on ecosystems and human health
- Greenhouse gas emissions
- Water eutrophication
- Fine particles
- Habitat destruction

Services to society
- Climate regulation
- Natural pesticide mitigation
- Water quality regulation
- Water storage and restitution
- Products' nutritional value

Duru, M., Sarthou, J. P., & Therond, O. (2022). L'agriculture régénératrice: summum de l'agroécologie ou greenwashing?. *Cahiers Agricultures*, *31*.

Ecological agriculture: biodiversity before technologies

ONLY TECHNOLOGIES

Productivist agriculture (extractivist) ⟷ **Ecological agriculture (regenerative)**

Impacts

Agricultural goods and bio-sourced products

Ecosystem services

Use of resources
- Land
- Water
- Energy

Impacts on ecosystems and human health
- Greenhouse gas emissions
- Water eutrophication
- Fine particles
- Habitat destruction

Agriculture

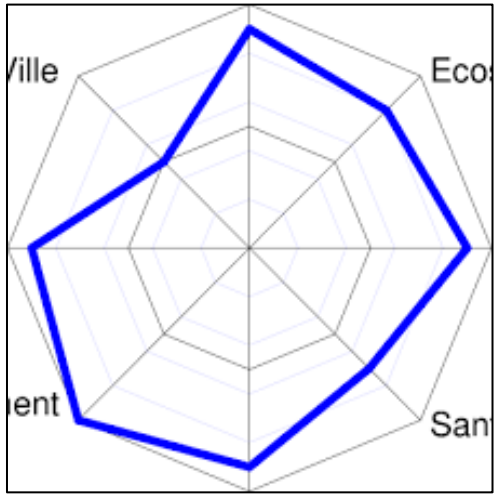
Agricultural services
- Pollination
- Regulation of pests
- Mineral nitrogen supply
- Water storage and restitution
- Soil structuring

Services to society
- Climate regulation
- Natural pesticide mitigation
- Water quality regulation
- Water storage and restitution
- Products' nutritional value

BIODIVERSITY FIRST

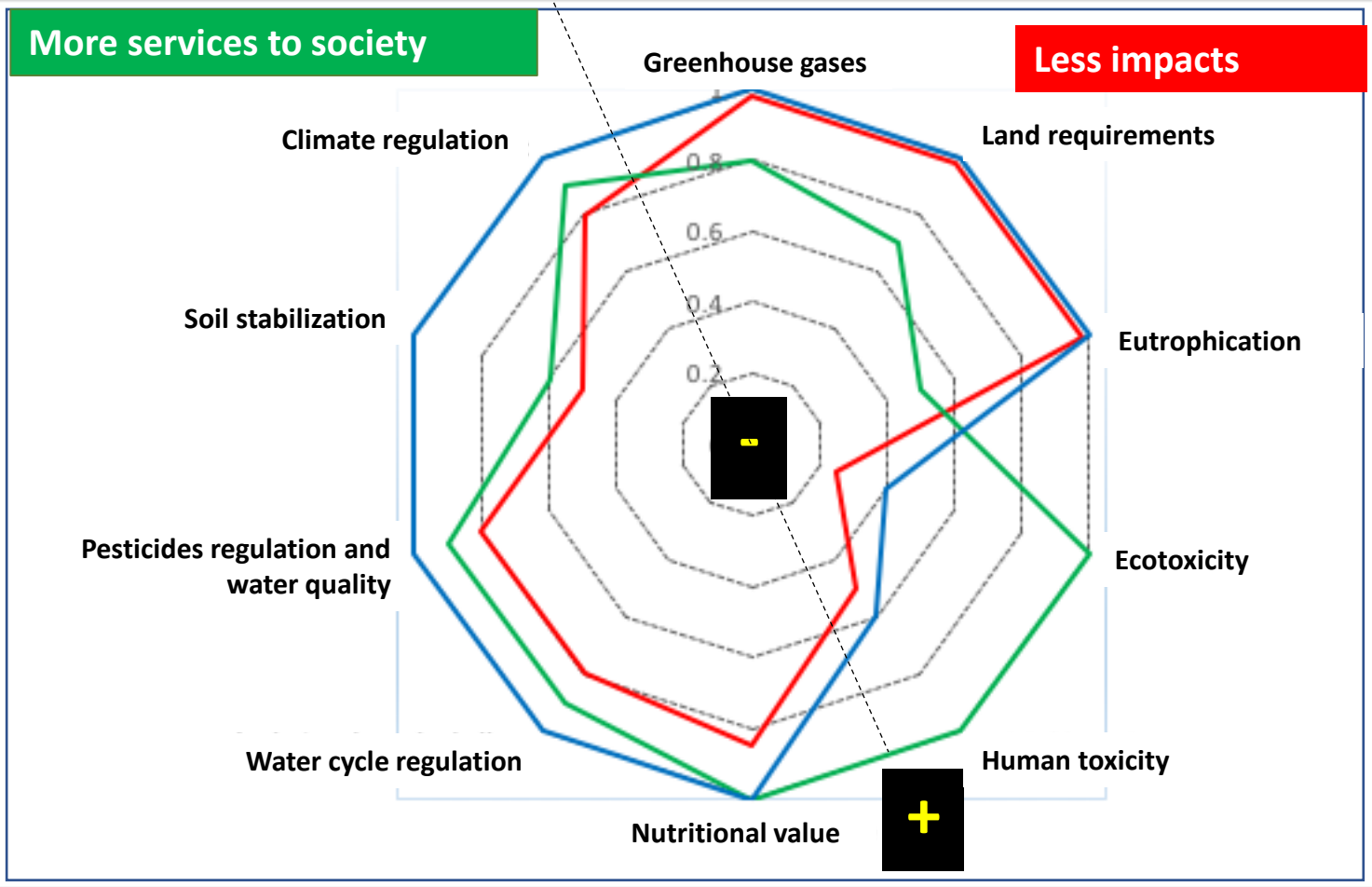
Assess impacts and services of cropping and livestock systems

1- Given the antagonisms and synergies between practices, it is **difficult to reduce all impacts and increase all services at the same time** → **Multi-criteria analyses**



2- **Agricultural practices are indicators of means that do not prejudge the level of impacts and services, given the climate and interactions with the soil** → **From practices to measurements if possible**

Multi-criteria analysis of three types of agriculture well-documented for their effects: impacts and services



ARTICLE

L'évaluation des systèmes agricoles à l'aune des services écosystémiques et de l'économie circulaire

M Duru (1), O Therond (2)
http://www.agronomie.asso.fr/aes
(1) UMR 1248 AGIR, INRAE, Université Toulouse, INPT, 31326 Castanet Tolosan, France
(2) UMR 1132 – LAE, INRAE, 28 rue de Herrlisheim, 68 000 Colmar, France

Conventional agriculture: reducing impacts

Organic farming: fertilizers and synthetic pesticides prohibited (15% of farms)

Soil conservation agriculture: increasing services (4% of farms)

Impacts: different strengths and weaknesses depending on the forms of agriculture practices
Services to society: better for agroecological agriculture

Weighting between criteria on a scientific and/or political basis

Regenerative agriculture:
To go even further in reducing impacts and providing services

Regenerative agriculture : go further for providing ecosystem services through biodiversity

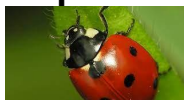
Excess

- tillage

- pesticides

- synthetic fertilizers

Crop auxiliaries (incl. pollinators)



Managed plant cover (rotation, cover crops, associations, trees, hedges…)

Soil micro-organisms and fauna

Landscape

Organic Matter

- Quantity/Distribution
- Quality/Diversity

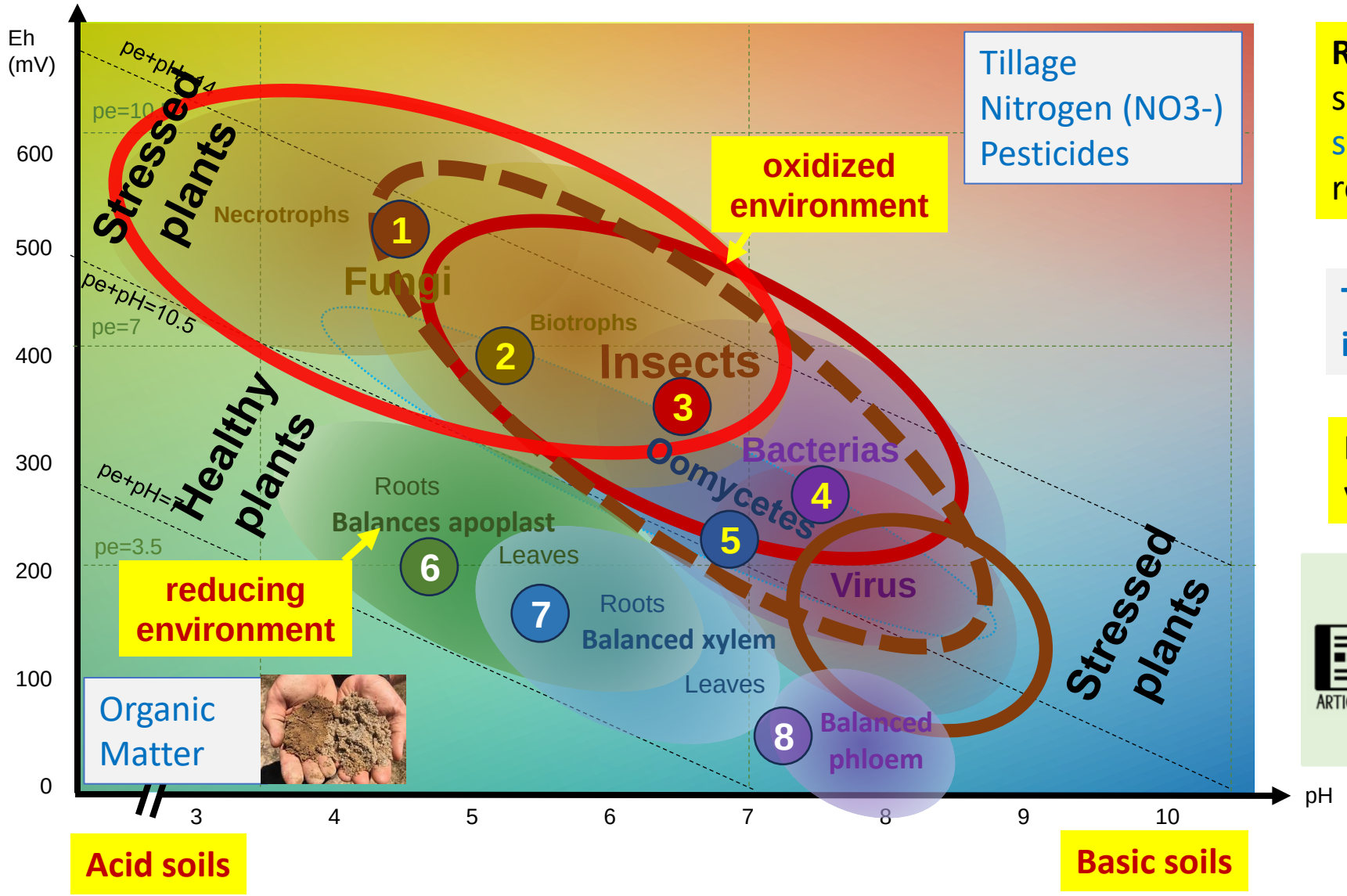
Services to agriculture and society

- Pollination
- Pest/disease control
- Weed seed control
- Erosion control
- Water storage and restitution
- Nutrient supply
- Soil structuring
- Carbon sequestration

Adapted from Therond et al. 2017

Carbon is the primary limiting factor for soil microbes

Regenerative agriculture is first and foremost based on soil biodiversity



Regenerative agriculture need to suppress oxidative practices (tillage, some N fertilizers and pesticides) to reduce the risk of pathogens

The soil organic matter / clay ratio is a simple indicator of soil health

Regenerating soil can take 10 to 15 years

ARTICLE

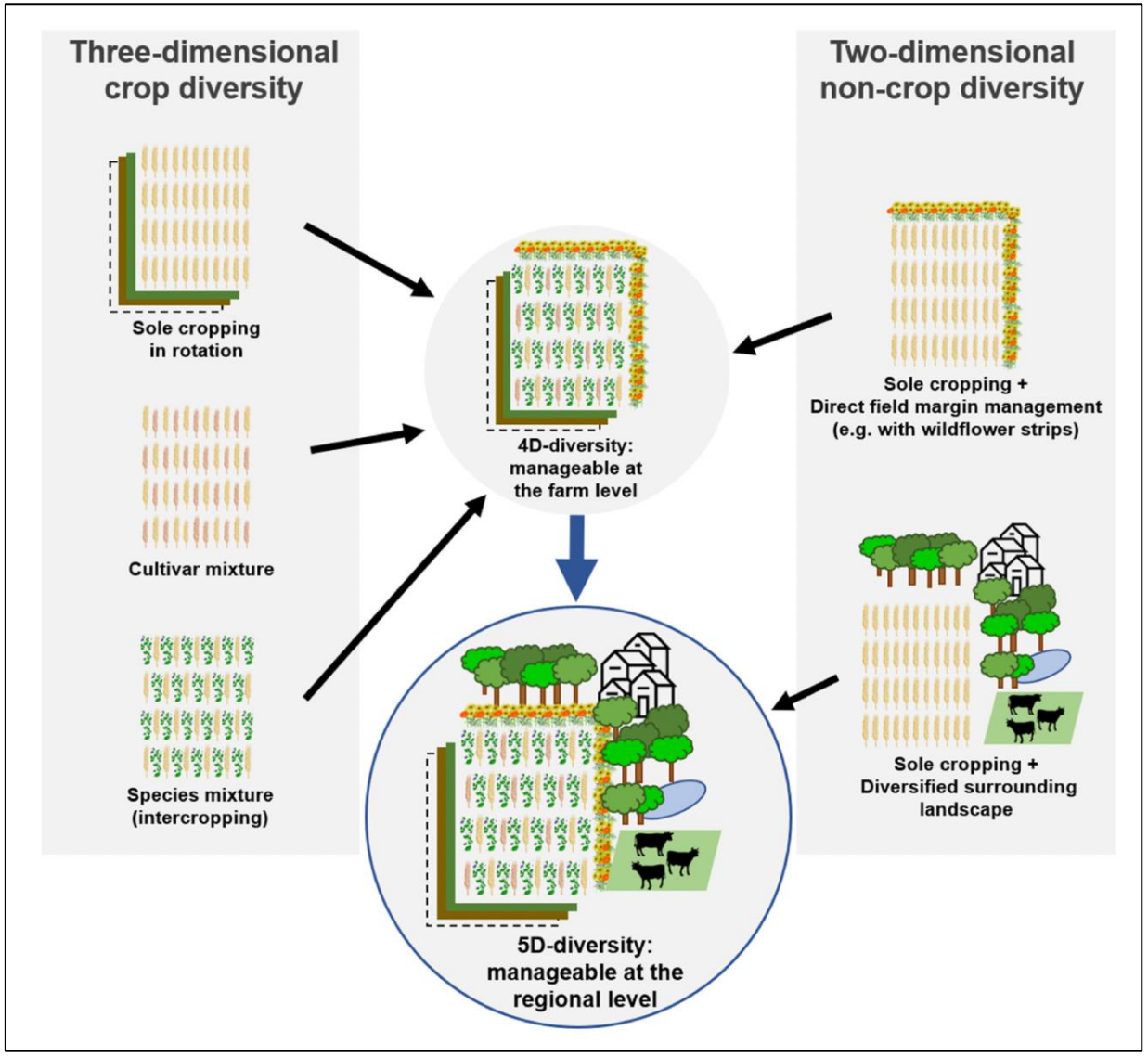
Référentiels et nouveaux indicateurs pour fonder une agriculture régénératrice

Olivier Husson, Jean-Pierre Sarthou** et Michel Duru****

* CIRAD, UPR AIDA, Avenue Agropolis F34398, Montpellier, France et AIDA, Univ. Montpellier, CIRAD, Montpellier, France, olivier.husson@cirad.fr
** Ensat et UMR LEFE CNRS-INPT-UT3, Université de Toulouse, jean-pierre.sarthou@toulouse-inp.fr
*** UMR 1248 AGIR, INRAE, Université Toulouse, INPT, 31326 Castanet Tolosan, France, michel.duru@inrae.fr (auteur correspondant)

Regenerative agriculture is also based on biodiversity in plots and landscapes.

Regenerative agriculture needs to **increase biodiversity from field to landscape** to favour natural ennemies of bioagressors and to reduce plant sensitivity to bioagressors (plant mixtures….)



Thomas, F D; Doring, 'Designing Pest Suppressive Agroecosystems : Principles for an Integrative Diversification Science', *Journal of Cleaner Production*, 432 (2023) <http://dx.doi.org/10.1016/j.jclepro.2023.139701>

Effect of regenerative agriculture on nutrient concentration in plants

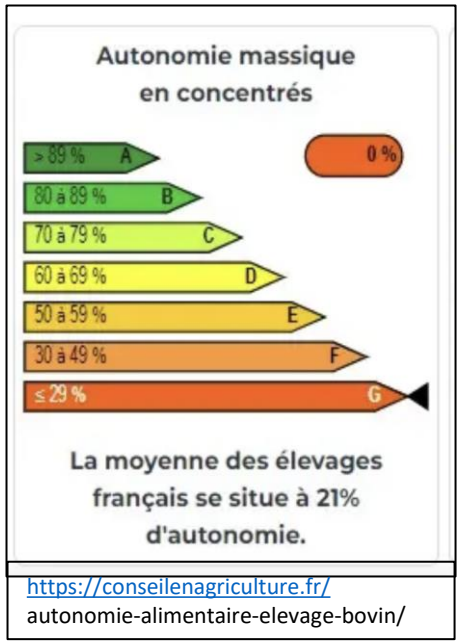
Average ratio of concentrations of individual nutrients for paired regenerative and conventional farms.

Nutrient	All crops
Vitamin K	**1.34**
Vitamin E	**1.15**
Vitamin C	1.03
Vitamin B1	**1.14**
Vitamin B2	**1.17**
Vitamin B3	1.08
Vitamin B5	1.04
Vitamin B6	*0.83*
Total Phenolics	**1.20**
Total Phytosterols	**1.22**
Total Carotenoids	**1.15**

Regenerative agriculture tends to increase some **nutrient density** in plants mostly via miccohrizes (if none pesticides and tillage) and some bacteria (if enough organic matter)

Montgomery, David et al 'Soil Health and Nutrient Density : Preliminary Comparison of Regenerative and Conventional Farming', *PeerJ*, 2022, 1–20 <http://dx.doi.org/10.7717/peerj.12848>

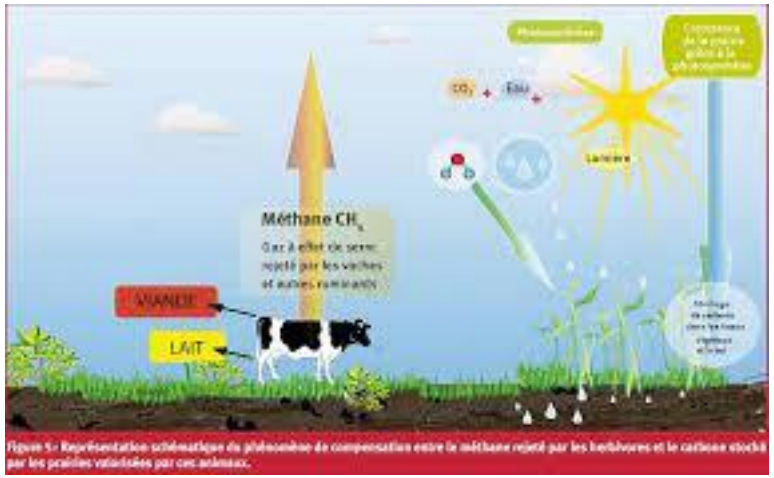
Sustainability assessment of livestock in 3 dimensions



https://conseilenagriculture.fr/autonomie-alimentaire-elevage-bovin/

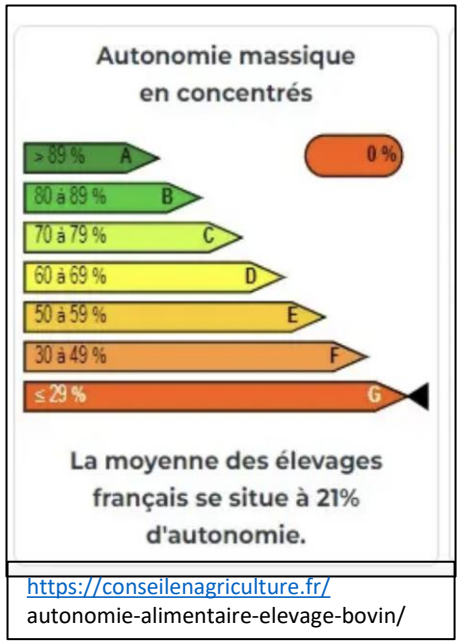
Increase services

Reduce impacts

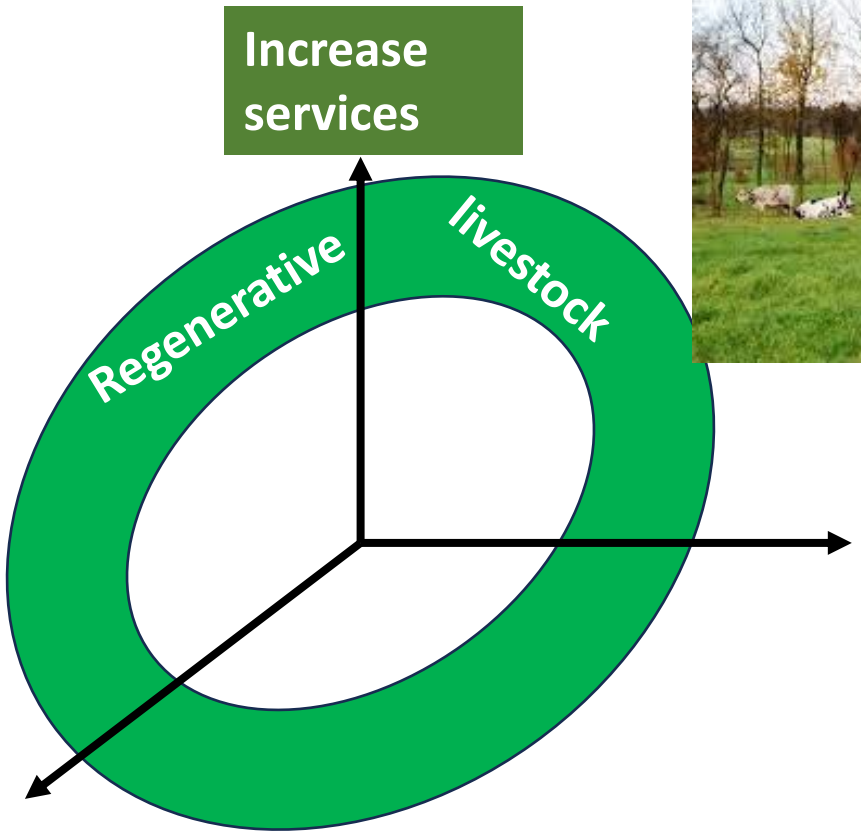


Reduce competition feed/food (food autonomy)

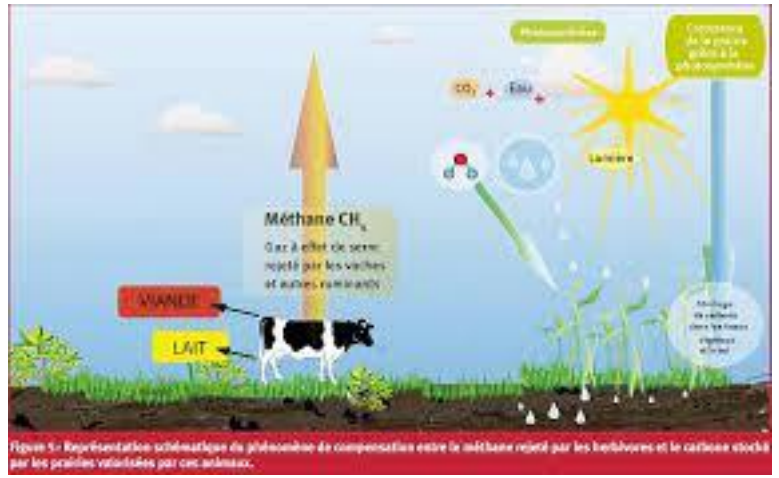
Regenerative livestock: grassland-based & high integrated crop/livestock



https://conseilenagriculture.fr/autonomie-alimentaire-elevage-bovin/



Reduce competition feed/food (food autonomy)



Focus on the effect of animal feed on the products health value and environment

Animal products	Animal feeding system	Strength for our health		Strength for environment	Market
		Omega-3 (anti-inflammatory FA)	Omega 6/ omega 3 (target : 4 to be anti-inflammtory)	GHG and N emissions	
Milk 	Corn and soya (imported)	x	8	-	65%
	Grass feed	2 x	2	+	35% (most often organic)
Pork, poultry, egg  	Cereal+ soya (imported)	x	10	-	90-95%
	Cereal+ legumes (French) + linseed	2 x	2	+	5-10% (Bleu Blanc Cœur)

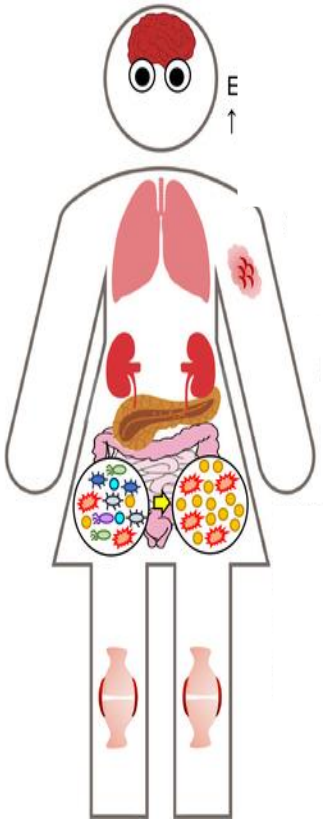
The omega-3 fatty acids content is doubled when:
- cow is feed with grass ;
- pigs and poultries with linseed

Duru, M., & Magrini, M. (2016). Consommer des produits dont les animaux ont été alimentés à l ' herbe est-il suffisant pour équilibrer notre alimentation en acides gras poly-insaturés ? *Fourrages*, 301–312.

Regenerative food system: one health perspective

Increase nutrients that are good for gut microbiota :
omega-3 (animal products) and anti-oxidants (crops) that respectively depend on **livestock and crop management**

Decrease contaminants and foods that are bad for gut microbiota
- exposure to pesticide residues and heavy metals (Cd) that depend on **crop management**
- ultra-processed foods (low nutrient density, additives) that depend **on food processing**



Diseases

brain

lung

heart
kidney

Immune system

obesity
diabetes

Moreira-Rosário, A., et al (2021). Gut Microbiota Diversity and C-Reactive Protein Are Predictors of Disease Severity in COVID-19 Patients. *Frontiers in Microbiology*

Through our diet, we can "control" our gut microbiota through diet and thus influence the risk of chronic diseases

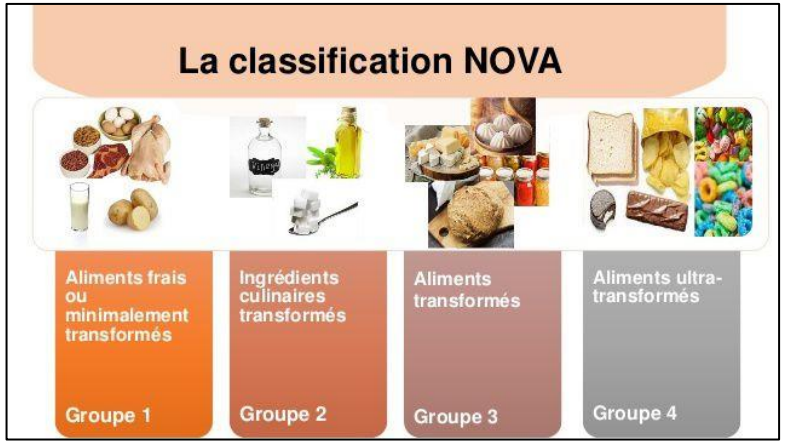
Our ongoing work on regenerative agriculture

Summum of agroecology or greenwashing? (ongoing)

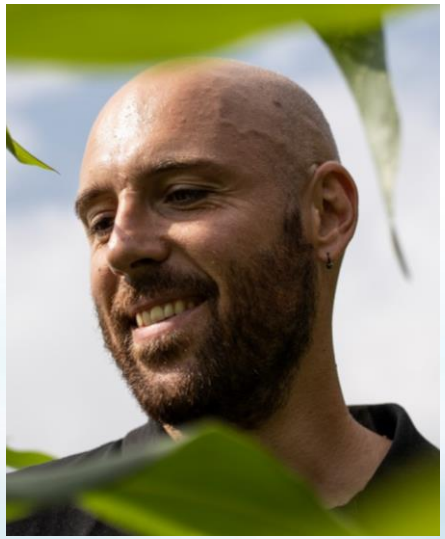
- Depends on whether the different **levels of biodiversity** (plants, soils, ecosystems) are taken into account
- Requires **coordination between manufacturers** to value a variety of crops

What is a regenerative food system? (in prospect)

Be regenerative from field to plate -> do not use products from regenerative agriculture to make **ultra-processed food**



FERME LARROUS
FELIX NOBLIA



FELIX NOBLIA

alliance
AGRICULTURE RÉGÉNÉRATRICE

When I started growing

Organic matter and carbon, keys to the future and to soil life

Loss of soil = desert as future

Buy equipment to reduce costs... less fuel, end of soil tillage

Plant diversity

Rape seed+ Afalfa, Fenugreek, Nyger, Red clover

Plant diversity

Maintain alfalfa cover in the following wheat crop

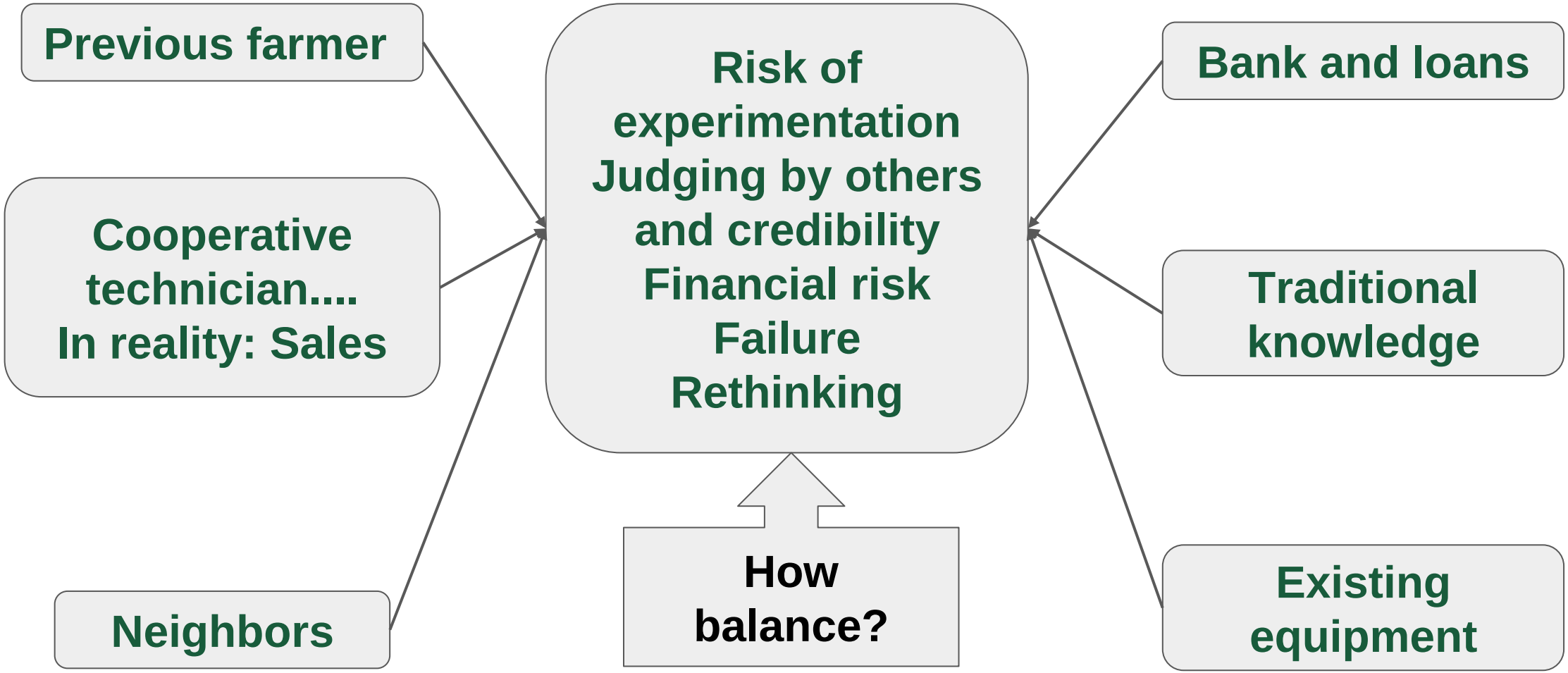
Complementary roots and plants for a healthy ecosystem

Complementarity between livestock and crops


1274
1274

Learn to…..
Unlearn


Previous farmer
Cooperative technician....
In reality: Sales
Neighbors
Risk of experimentation
Judging by others and credibility
Financial risk
Failure
Rethinking
Bank and loans
Traditional knowledge
Existing equipment


Previous farmer
Cooperative technician....
In reality: Sales
Neighbors
Risk of experimentation
Judging by others and credibility
Financial risk
Failure
Rethinking
How balance?
Bank and loans
Traditional knowledge
Existing equipment

Unlearn,
Relearn,
to understand

Trying..

Never lose..
Win or learn

Unlearn,
Relearn,
to
understand..
Not alone

Making regenerative agriculture more profitable

- ★ **Sequestrated soil organic carbon**
- ★ **Biodiversity impact**
- ★ **Impact on water resources and the water cycle**

Measurement and transparency = Proof of virtue and value

Measuring results

REGENERATION the trusted third-party company

Long-term progress contract

Meeting environmental objectives, GHG, Carbon credits, Biodiversity and water impact

Organization of agronomic support and reporting

Corporates

Farmers

Robust measurements of soil carbon,biodiversity and water retention

Detailed, reliable and verifiable impact measurements

Q&A

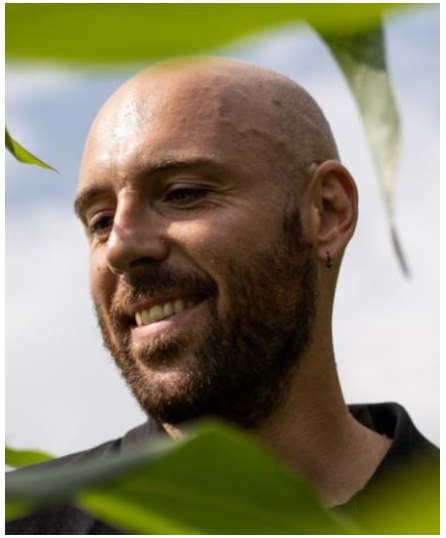
A l'écoute de vos questions

MARIE-LAURE EYCHENNE

Responsable
Développement Durable

MICHEL DURU

Directeur de recherche, actuellement chargé de mission à l'INRAE, membre de l'Académie d'Agriculture



FELIX NOBLIA

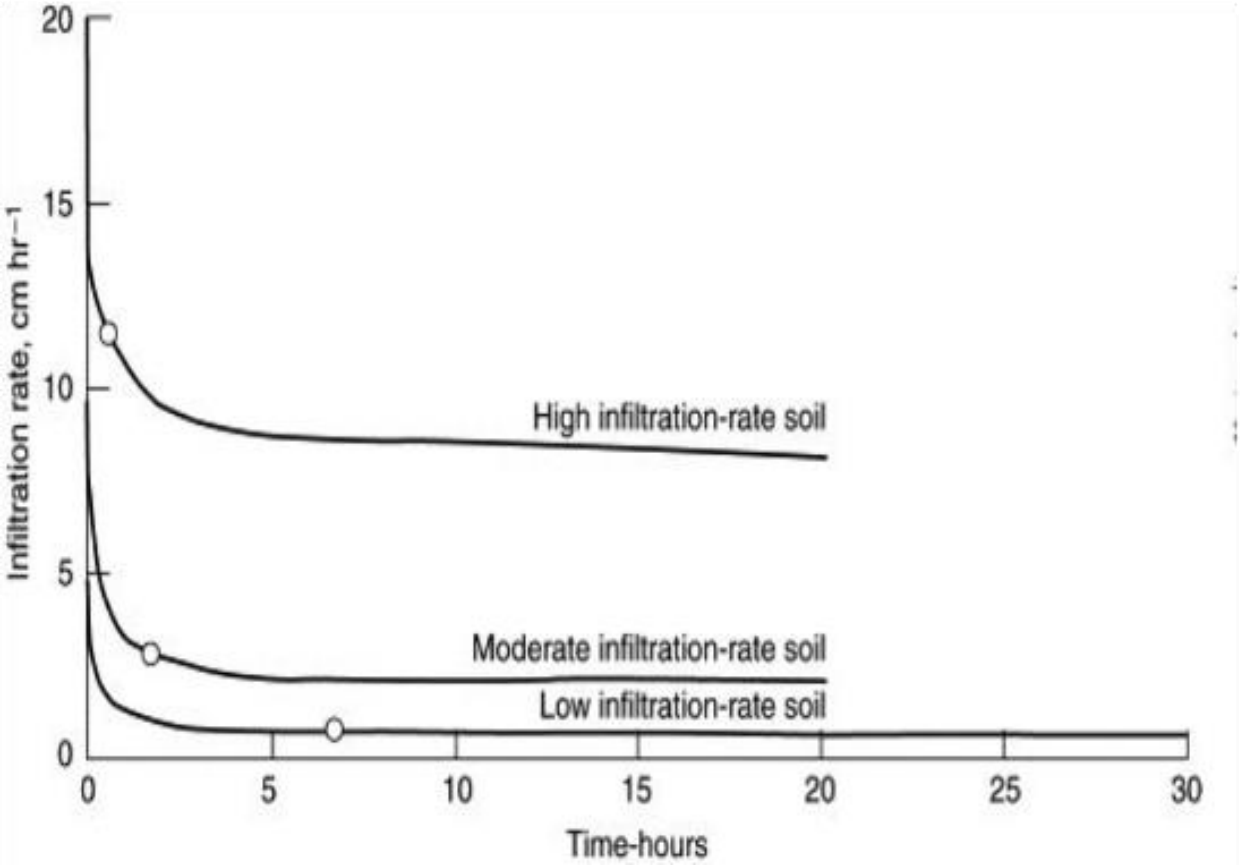
Agriculteur et co-fondateur de ReGeneration

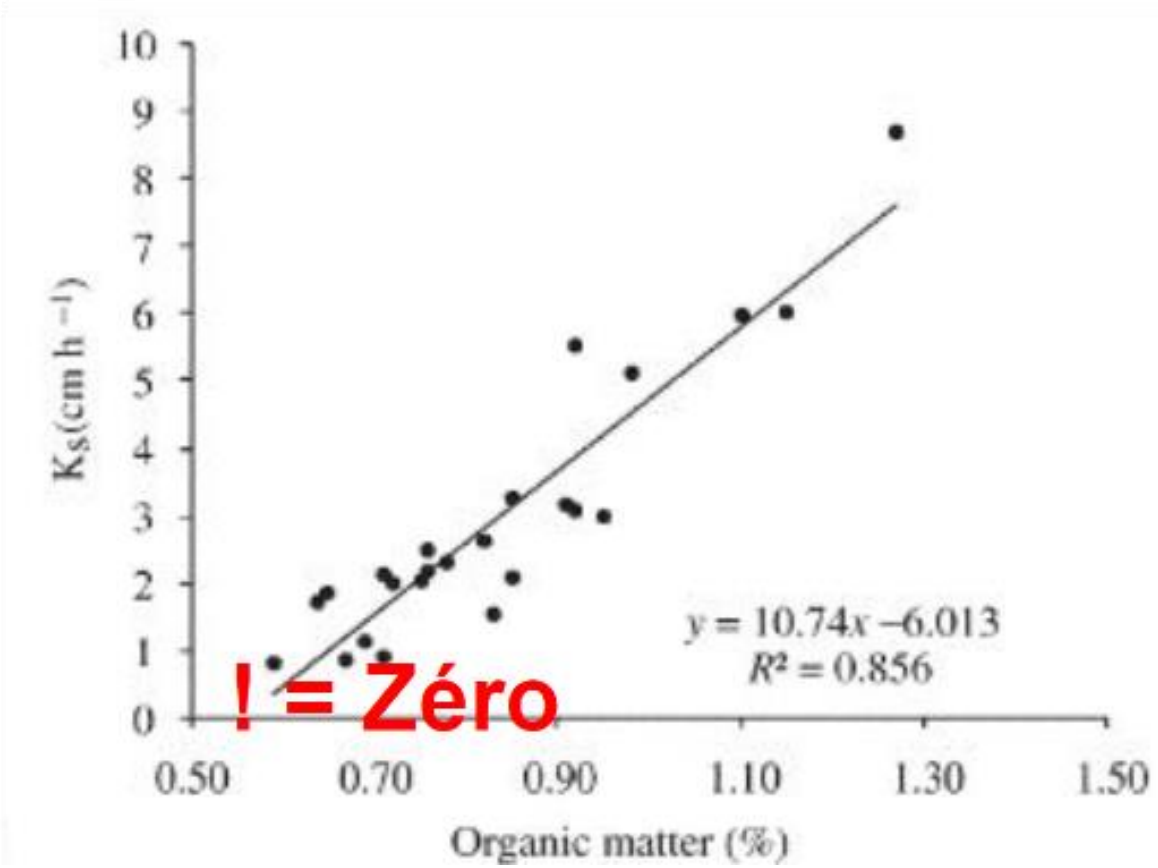
MERCI

Follow-up Webinar :

Annexes

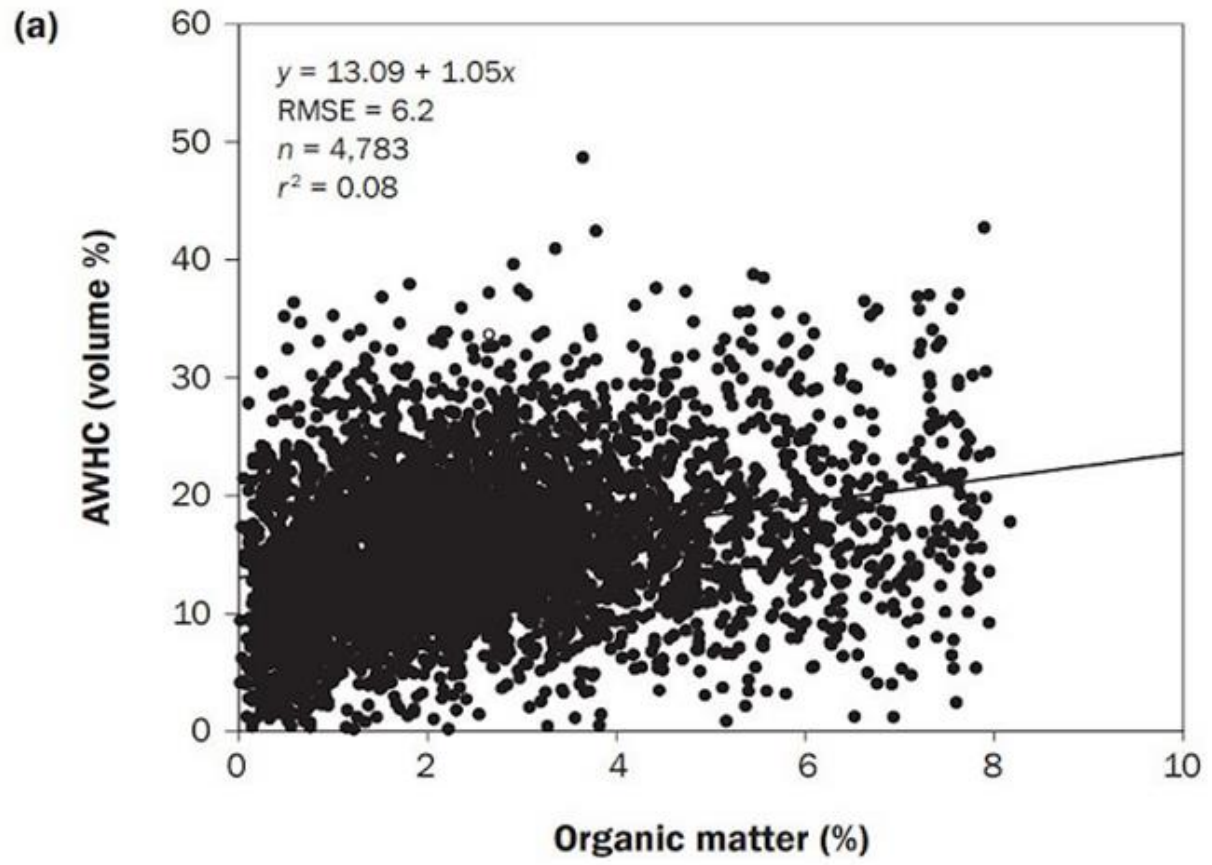
Desert


Infiltration rate, cm hr⁻¹
20
15
10
5
0
High infiltration-rate soil
Moderate infiltration-rate soil
Low infiltration-rate soil
0
5
10
15
20
25
30
Time-hours

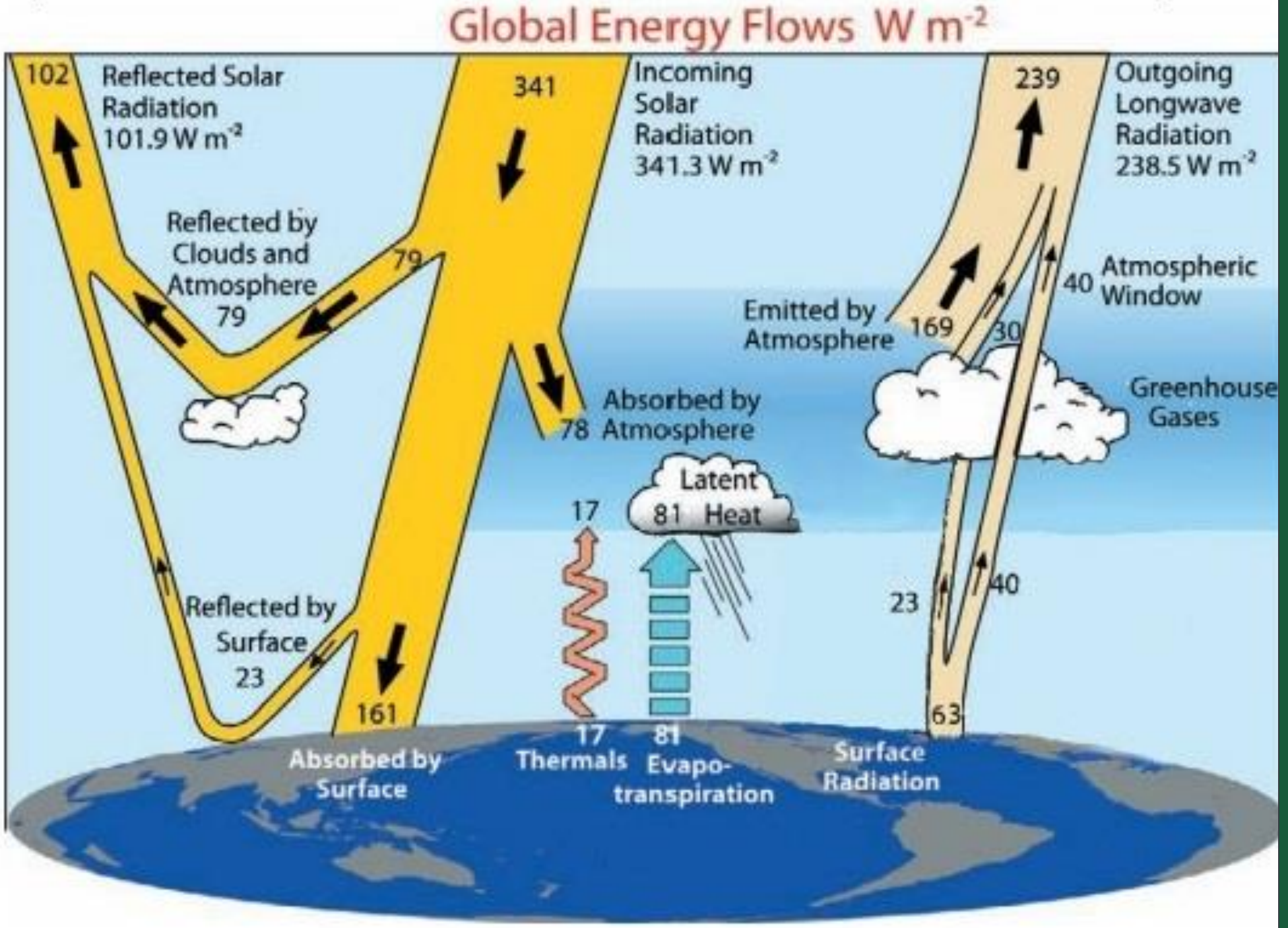

K_s(cm h⁻¹)
10
9
8
7
6
5
4
3
2
1
0
$y = 10.74x - 6.013$
$R^2 = 0.856$
0.50
0.70
0.90
1.10
1.30
1.50
Organic matter (%)

!= Zéro

Figure 6
Soil available water-holding capacity (AWHC) versus soil organic matter (SOM) for (a) 0% to 8% range and (b) 0% to 100% range of SOM.

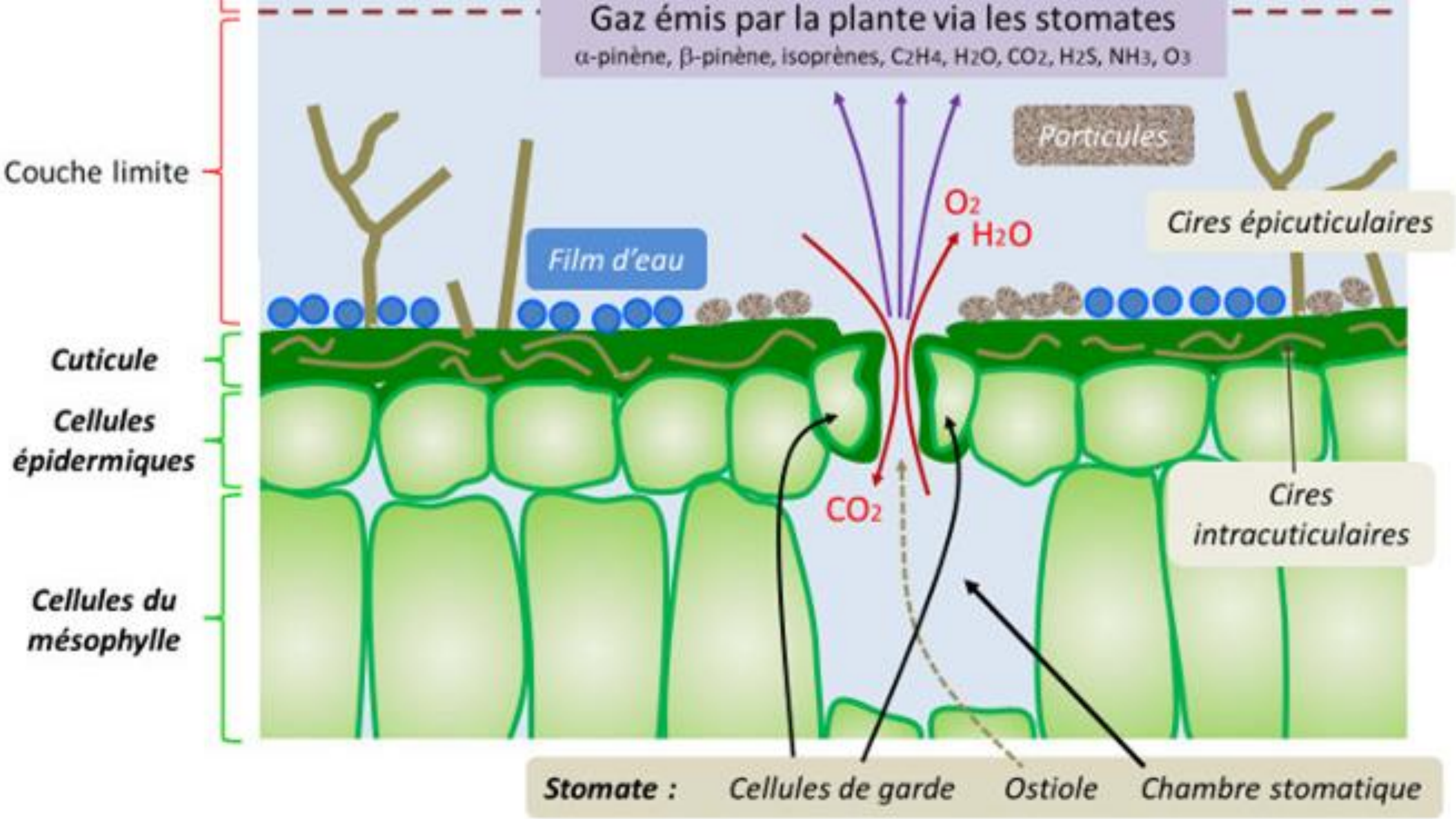


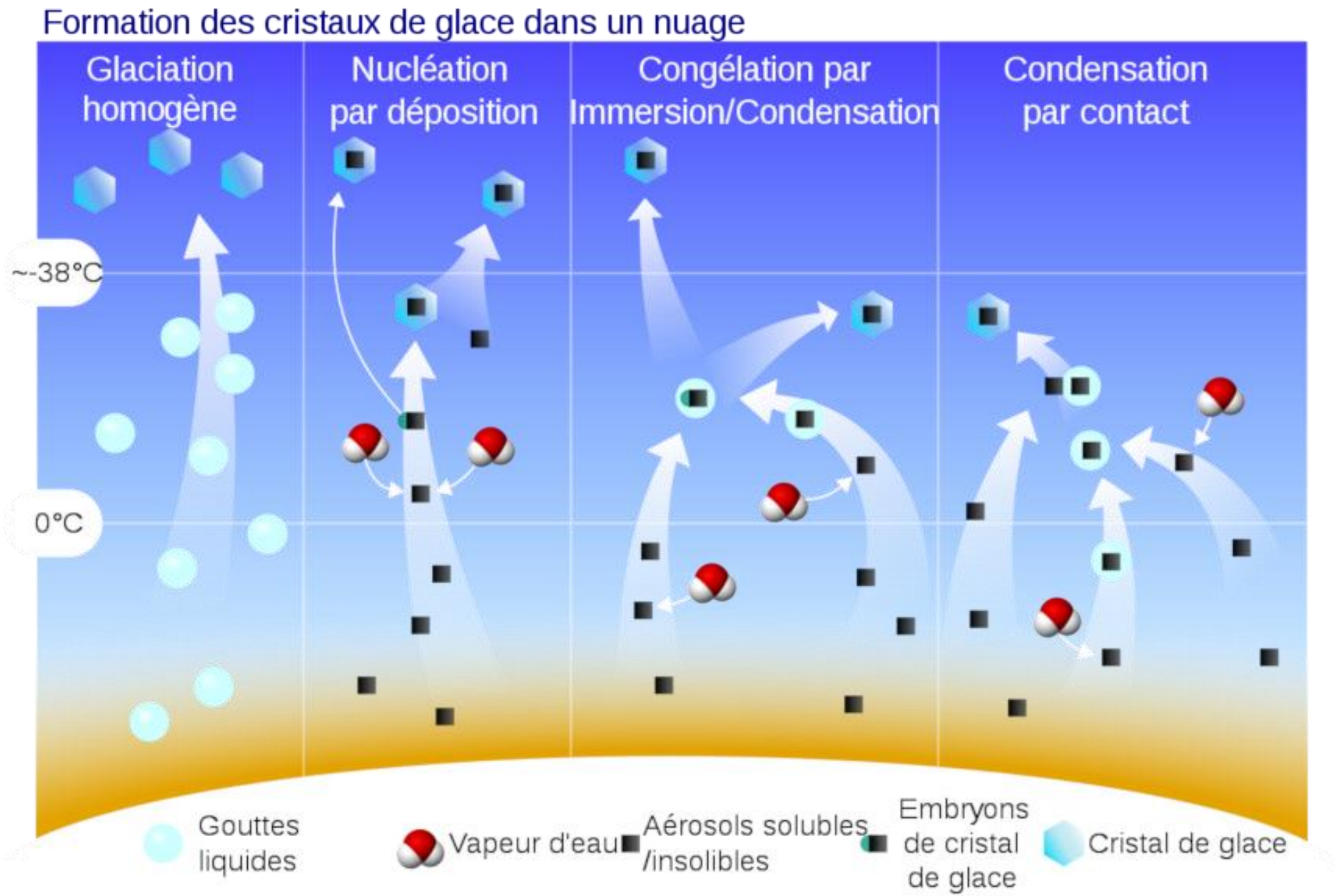
Relation entre teneur en O des sols et réserve faicilement utilisable (Libohova et al. 2018)

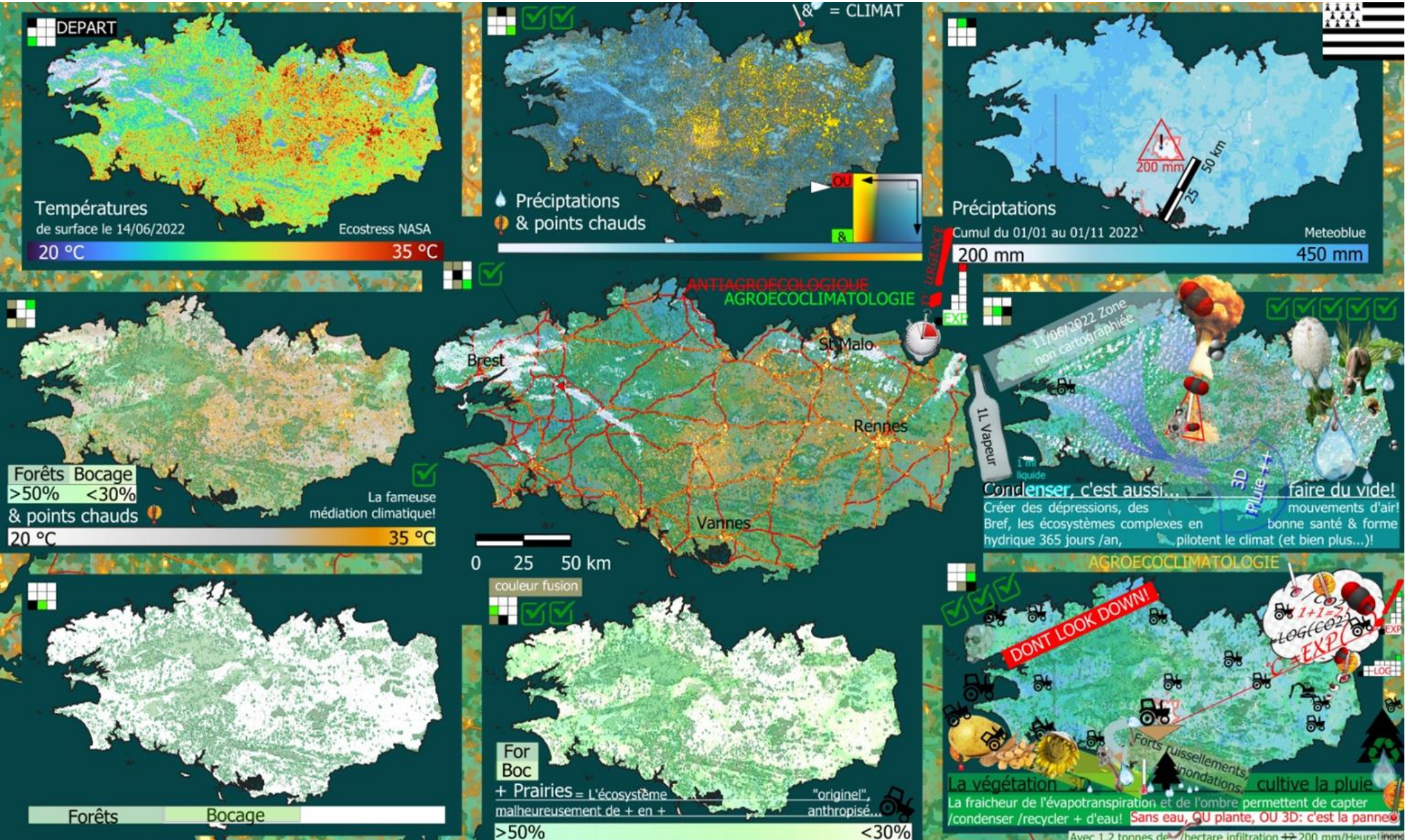


Water cycle in climate

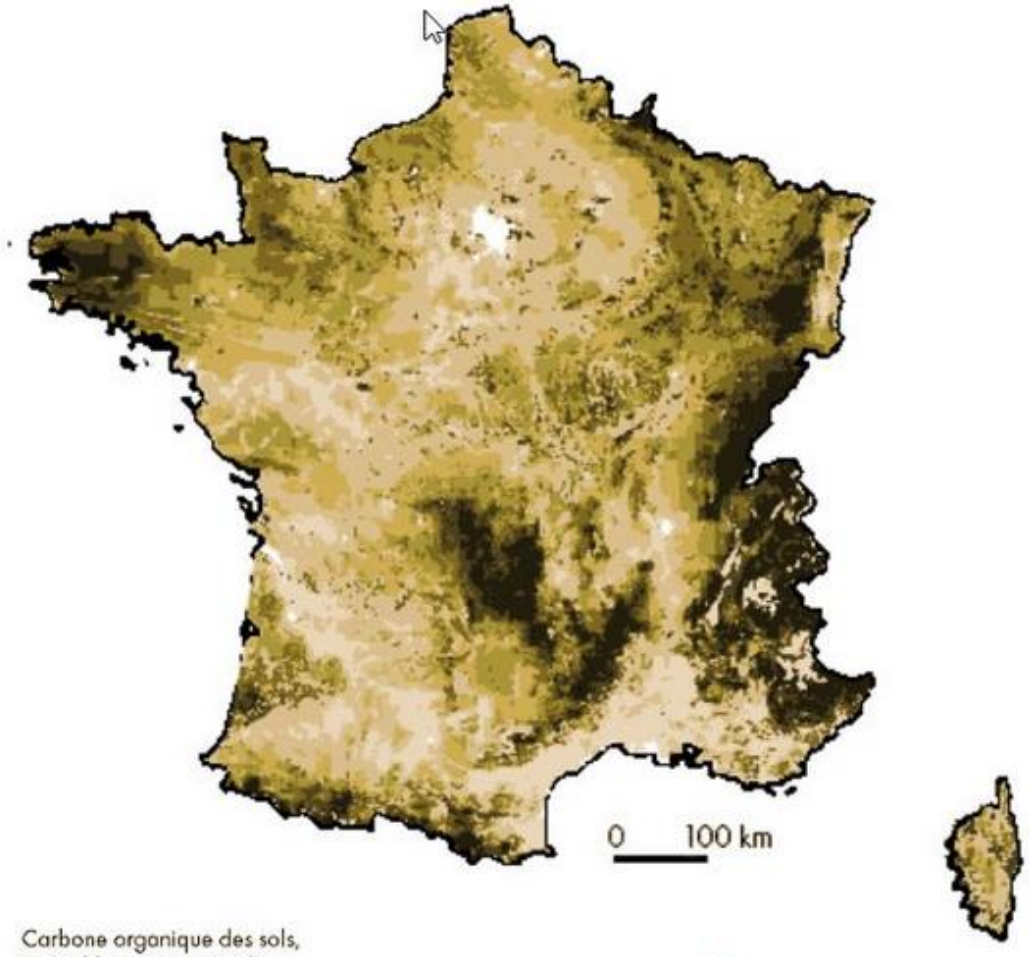
Importance of plant transpiration in cloud creation.


Gaz émis par la plante via les stomates
α-pinène, β-pinène, isoprènes, C2H4, H2O, CO2, H2S, NH3, O3
Couche limite
Particules
O2
H2O
Cires épicuticulaires
Film d'eau
Cuticule
Cellules épidermiques
CO2
Cires intracuticulaires
Cellules du mésophylle
Stomate :
Cellules de garde
Ostiole
Chambre stomatique


Formation des cristaux de glace dans un nuage
Glaciation homogène
Nucléation par déposition
Congélation par Immersion/Condensation
Condensation par contact
~-38°C
0°C
Gouttes liquides
Vapeur d'eau
Aérosols solubles /insolibles
Embryons de cristal de glace
Cristal de glace


DEPART
Températures
de surface le 14/06/2022
Ecostress NASA
20 °C
35 °C
& = CLIMAT
Préciptations
& points chauds
OU
&
Préciptations
Cumul du 01/01 au 01/11 2022
Meteoblue
200 mm
450 mm
200 mm
50 km
25
ANTIAGROECOLOGIQUE
AGROECOCLIMATOLOGIE
URGENT
EXP
Brest
St Malo
Rennes
Vannes
0 25 50 km
Forêts Bocage
>50% <30%
& points chauds
20 °C
35 °C
La fameuse
médiation climatique!
11/06/2022 Zone
non cartographiée
1L Vapeur
1 ml
liquide
3D
Pluie ++
Condenser, c'est aussi... faire du vide!
Créer des dépressions, des mouvements d'air!
Bref, les écosystèmes complexes en bonne santé & forme
hydrique 365 jours /an, pilotent le climat (et bien plus...)!
AGROECOCLIMATOLOGIE
DONT LOOK DOWN!
1+1=2
LOG(CO2)
C=EXP
EXP
LOG
Forts ruissellements,
inondations,
La végétation cultive la pluie
La fraicheur de l'évapotranspiration et de l'ombre permettent de capter
/condenser /recycler + d'eau! Sans eau, OU plante, OU 3D: c'est la panne!
Avec 1,2 tonnes de /hectare infiltration ++ 200 mm/Heure!
Forêts
Bocage
couleur fusion
For
Boc
+ Prairies = L'écosystème
malheureusement de + en +
"originel",
anthropisé...
>50%
<30%

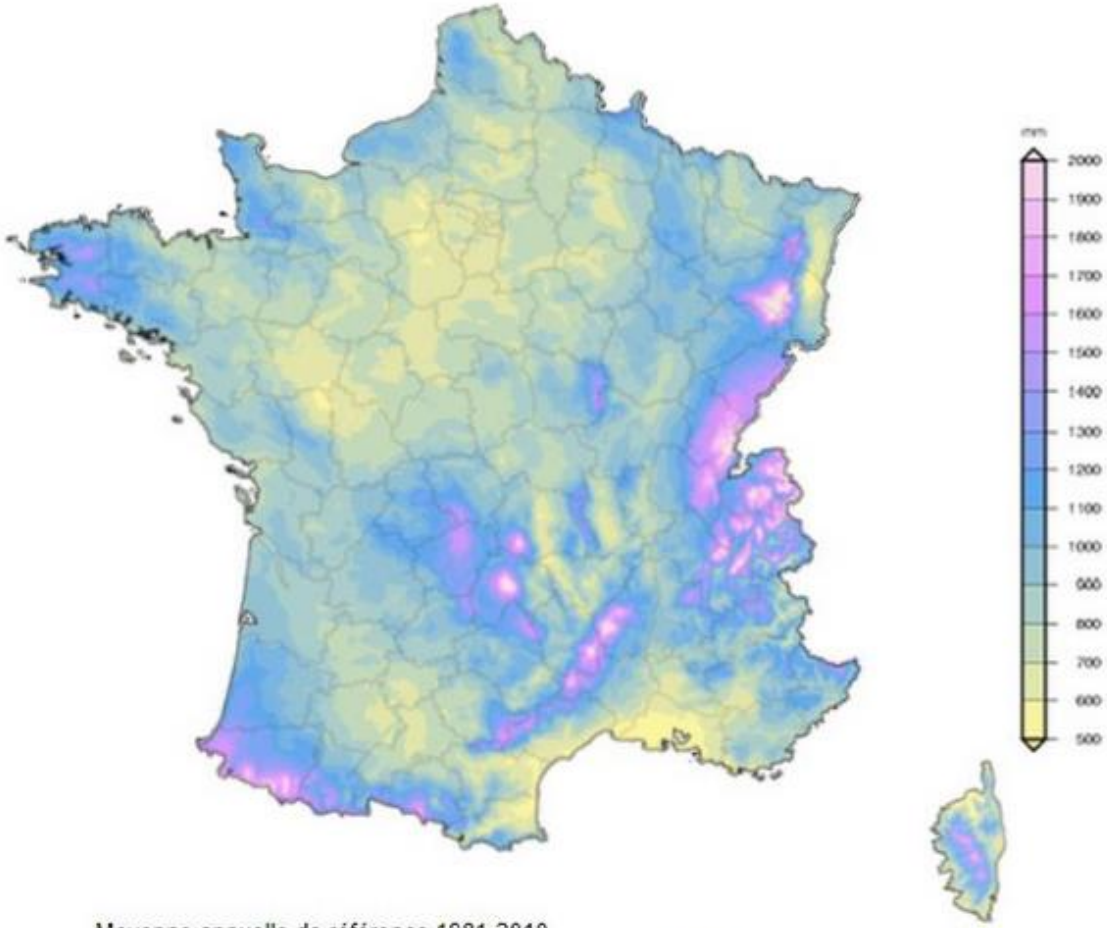
Carbone



Carbone organique des sols,
sur les 30 premiers cm, en %

4 5 6 7 8 9

Pluies



Moyenne annuelle de référence 1981-2010
des précipitations

Crédit Cédric Cabrol