



Biodiversity and Biotechnology for Sustainable Development

Amazon Week, Brussels

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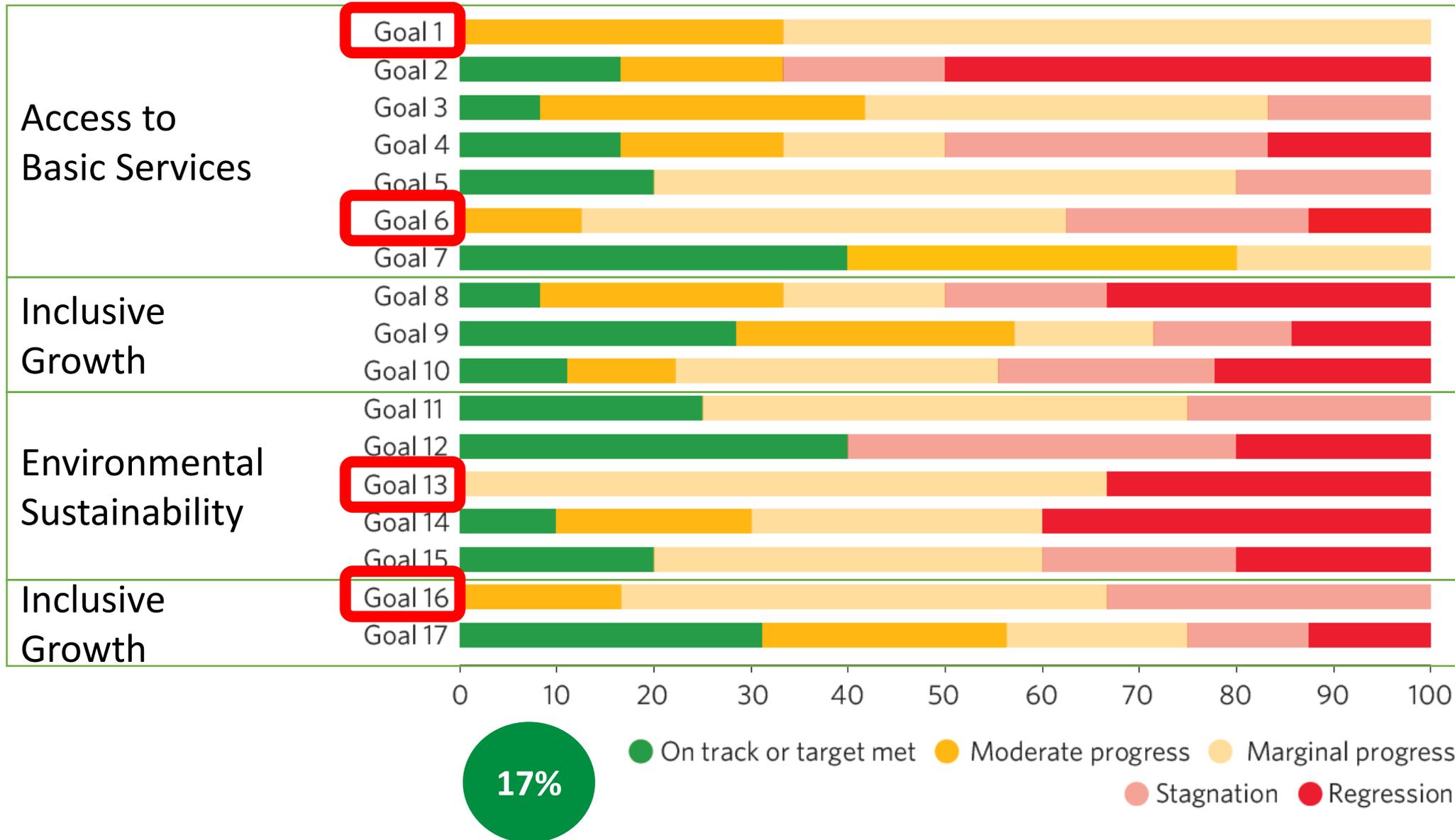
September 25th, 2024



The world is off track to realize the 2030 Agenda

promote
integrated
frameworks

to address
knowledge
fragmentation



Knowledge Fragmentation and the Global Environmental Crisis

Adapted from UNEP Annual Report (2023)

Bio-based industrialization

climate emergency

pollution

defossilization

circularity

Reforestation

ecosystem degradation

ecosystem balance



Knowledge Integration for the Ecological Transition

Restoration of ecosystems
(carbon storage)



Biomass for biorenewables
(fossil substitution)



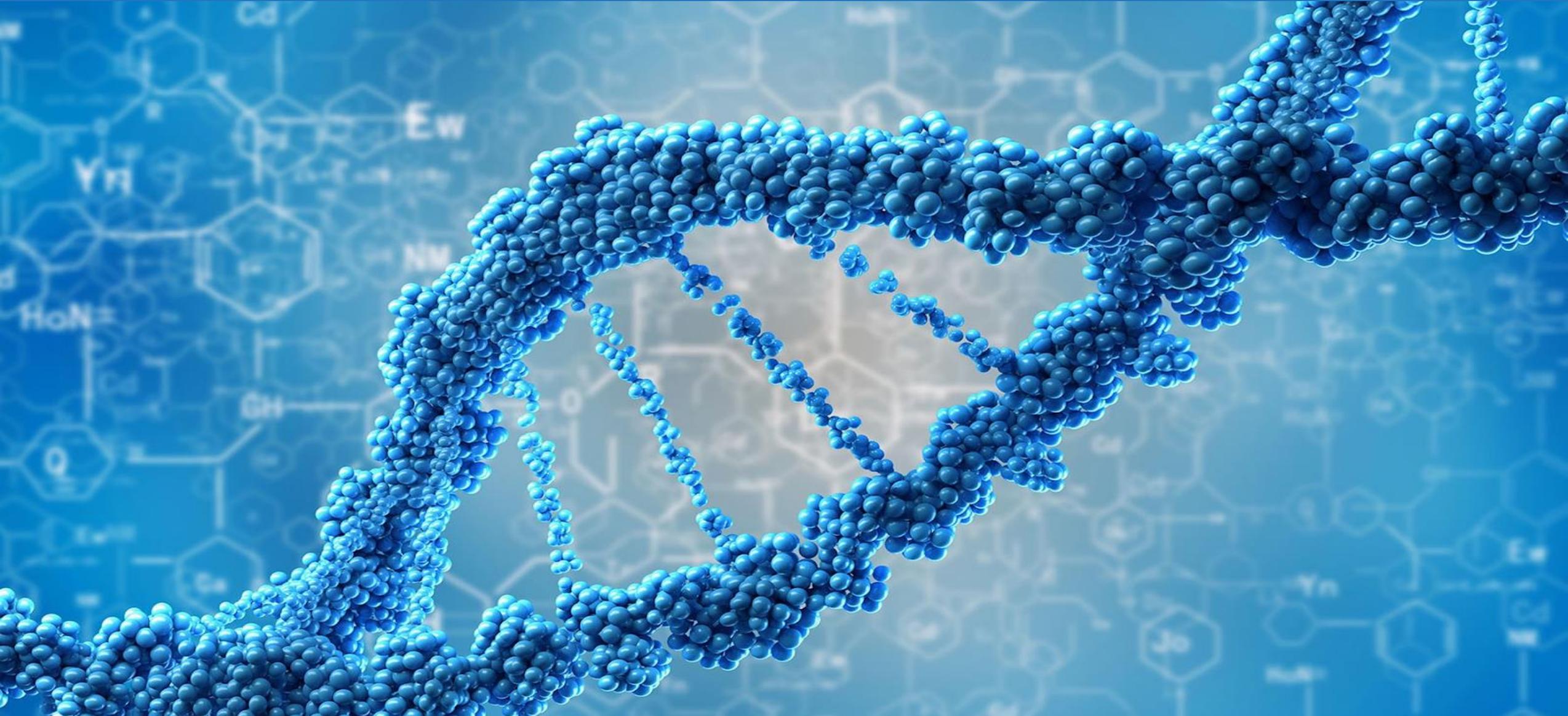
Synergy and trade-offs are central elements



Agroforestry systems
(social equity)



Central elements for bio-based industrialization Technology & Renewable feedstocks



Biomass Feedstocks

Intermediate Platforms

Building Blocks

Secondary Chemicals

Intermediates

Products/Uses

Starch

Hemicellulose

Cellulose

Lignin

Oil

Protein

Biobased Syn Gas

Sugars
Glucose
Fructose
Xylose
Arabinose
Lactose
Sucrose
Starch

Global South
relies on
biotechnology
imports

SG

C2

C3

C4

C5

C6

Ar

Direct
Polymers & gums

- H₂
- Methanol
- Mixed alcohols
- Higher alcohols
- Oxo synthesis products
- Iso-synthesis products
- Fischer-Tropsch Liquids

- Glycerol
- Lactic
- 3-Hydroxy-propionate
- Propionic acid
- Malonic acid
- Serine

- Succinic acid
- Fumaric acid
- Malic acid
- Aspartic acid
- 3-Hydroxy-butyrolactone
- Acetoin
- Threonine

- Itaconic acid
- Furfural
- Levulinic acid
- Glutamic acid
- Xylonic acid
- Xylitol/Arabitol

- Citric/Aconitic acid
- 5-Hydroxymethyl-furfural
- Lysine
- Gluconic acid
- Glucaric acid
- Sorbitol

- Gallic acid
- Ferulic acid

- Ammonia synthesis, hydrogenation products
- Methyl esters, Formaldehyde, Acetic acid, Dimethylether, Dimethylcarbonate, Methyl amines, MTBE, olefins, gasoline
- Linear and branched 1° alcohols, and mixed higher alcohols
- Olefin hydroformylation products: aldehydes, alcohols, acids
- Iso-C4 molecules, isobutene and its derivatives
- α-olefins, gasoline, waxes, diesel

- Fermentation products, Propylene glycol, malonic, 1,3-PDO, diacids, propyl alcohol, dialdehyde, epoxides
- Acrylates, L-Propylene glycol, Dioxanes, Polyesters, Lactide
- Acrylates, Acrylamides, Esters, 1,3-Propanediol, Malonic acid and others
- Reagent, propionol, acrylate
- Pharma. Intermediates
- 2-amino-1,3-PDO, 2-aminomalonic, (amino-3HP)

- THF, 1,4-Butanediol, γ-butyrolactone, pyrrolidones, esters, diamines, 4,4-Bionelle, hydroxybutyric acid
- Unsaturated succinate derivatives (see above)
- Hydroxy succinate derivatives (above), hydroxybutyrolactone
- Amino succinate derivatives (see above)
- Hydroxybutyrate, epoxy-γ-butyrolactone, butenoic acid
- Butanediols, butenols

- Diols, ketone derivatives, indeterminant
- Methyl succinate derivatives (see above), unsaturated esters
- Many furan derivatives
- δ-aminolevulinic, 2-Methyl THF, 1,4-diols, esters, succinate
- Amino diols, glutaric acid, substituted pyrrolidones
- Lactones, esters

- EG, PG, glycerol, lactate, hydroxy furans, sugar acids
- 1,5-pentanediol, itaconic derivatives, pyrrolidones, esters
- Numerous furan derivatives, succinate, esters, levulinic acid
- Caprolactam, diamino alcohols, 1,5-diaminopentane
- Glucanolactones, esters
- Dilactones, monolactones, other products

- Glycols (EG, PG), glycerol, lactate, isosorbide
- Phenolics, food additives

- Fuel oxygenates
- Reagents-building unit
- Antifreeze and deicers
- Solvents
- Green solvents
- Specialty chemical intermediate
- Emulsifiers
- Chelating agents
- Amines
- Plasticizers
- Polyvinyl acetate
- pH control agents
- Resins, crosslinkers
- Polyvinyl alcohol
- Polyacrylates
- Polyacrylamides
- Polyethers
- Polypyrrolidones
- Phthalate polyesters
- PEIT polymer
- Polyhydroxypolyesters
- Nylons (polyamides)
- Polyhydroxypolyamides
- Biaphenol A replacement
- Polycarbonates
- Polyurethanes
- Phenol-formaldehyde resins
- polyhydroxyalkanoates
- polysaccharides
- polyaminoacids

Industrial
Corrosion inhibitors, dust control, boiler water treatment, gas purification, emission abatement, specialty lubricants, hoses, seals

Transportation
Fuels, oxygenates, anti-freeze, wiper fluids molded plastics, car seats, belts hoses, bumpers, corrosion inhibitors

Textiles
Carpets, Fibers, fabrics, fabric coatings, foam cushions, upholstery, drapes, lycra, spandex

Safe Food Supply
Food packaging, preservatives, fertilizers, pesticides, beverage bottles, appliances, beverage can coatings, vitamins

Environment
Water chemicals, flocculants, chelators, cleaners and detergents

Communication
Molded plastics, computer casings, optical fiber coatings, liquid crystal displays, pens, pencils, inks, dyes, paper products

Housing
Paints, resins, siding, insulation, cements, coatings, varnishes, flame retardents, adhesives, carpeting

Recreation
Footgear, protective equipment, camera and film, bicycle parts & tires, wet suits, tapes-CD's-DVD's, golf equipment, camping gear, boats

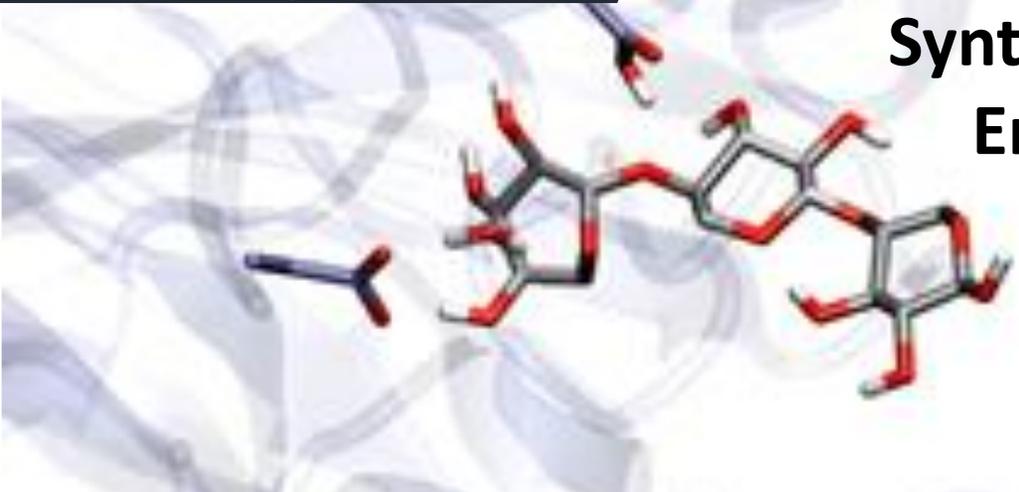
Health and Hygiene
Plastic eyeglasses, cosmetics, detergents, pharmaceuticals, suntan lotion, medical-dental products, disinfectants, aspirin



Computational Simulations
QM/MM

Scientific Computing
Synthetic Biology
Engineering

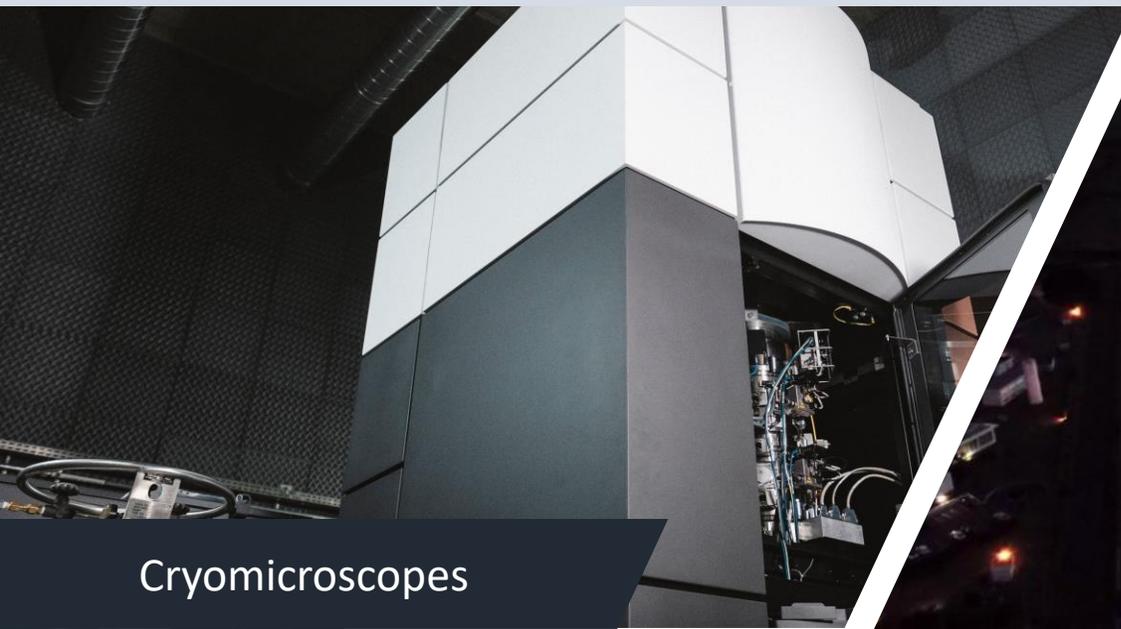
Scaling-up



CNPEM approach to advanced biofuels and biochemicals

multiscale and multidisciplinary R&D to design, control and scale-up complex biological systems

open-access facilities free of charge for academic use



Cryomicroscopes

Sirius

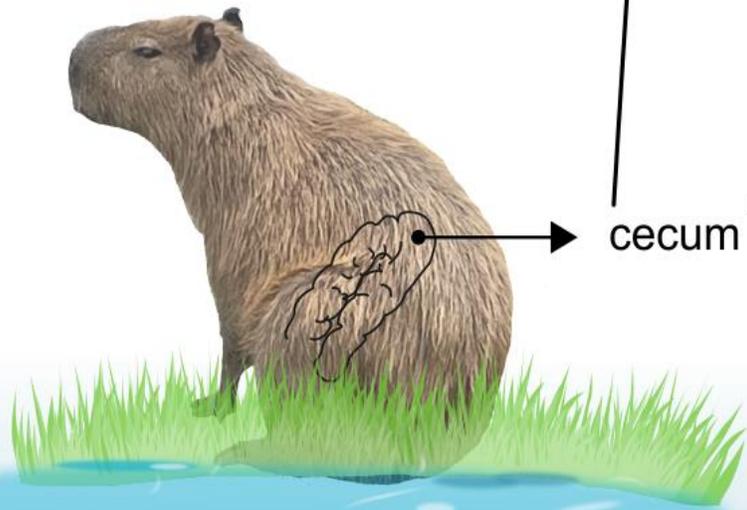


Megadiverse Countries

*enzymes and microorganisms from biodiversity
for industrial biotechnology*

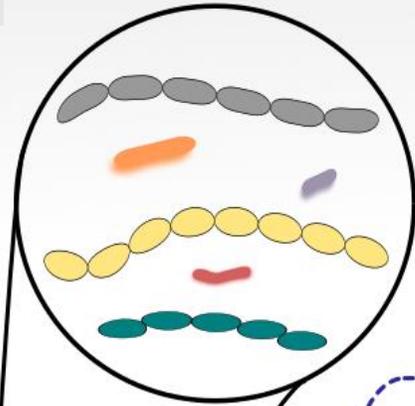
Capybara
(eats sugarcane)

**Microbiome as
source of enzymes**



cecum

Fibers need to be depolymerized



Main degraders of dietary fibers

**Fibrobacteres
(cellulose)**

+

**Bacteroidetes
(hemicelullose
and pectin)**

New enzymes with biotechnological potential



biofuels



Food and beverages

Multidisciplinary approach

Metagenomics e metatranscriptomics – structure and composition of microbial community and their enzymes

Metabolomics – routes to convert sugar in energy

Synchrotron – structure of new enzymes

Cabral L et al, *Nature Communications*. 2022, 13(1):629

International Collaboration

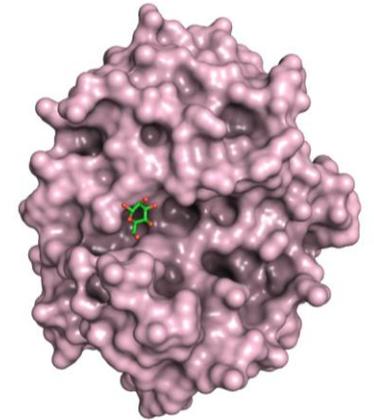


Microorganisms and Enzymes from Amazon Biodiversity

Enzyme from the microbiome of manatee has the potential to valorize residues of local value chains



Sirius



Industrial Biotechnology Platform
(LNBR/CNPEM/MCTI)

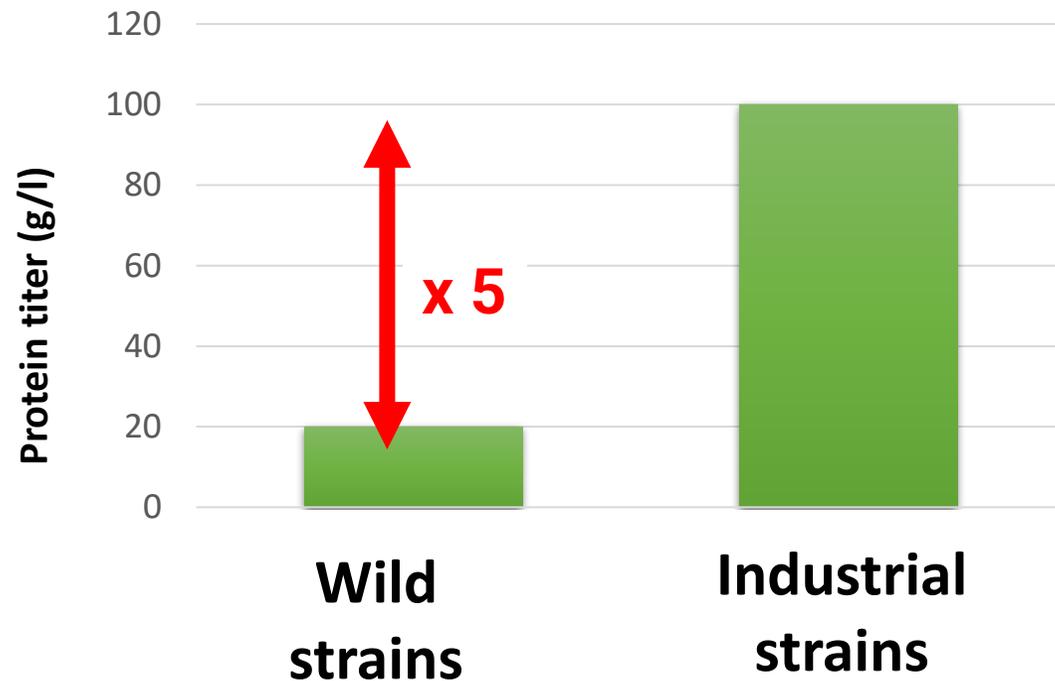
Mapping the Brazilian Genetic Heritage

Biomanufacturing and Industrial Biotechnology

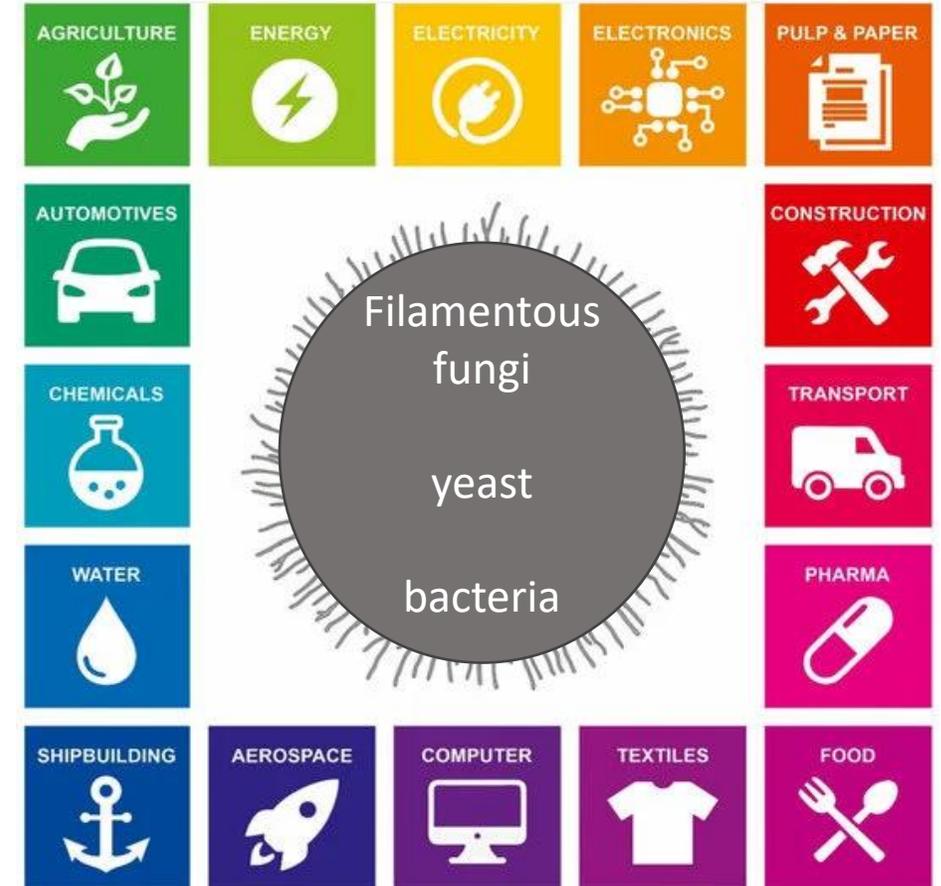
Challenge

... that can be addressed by synthetic biology

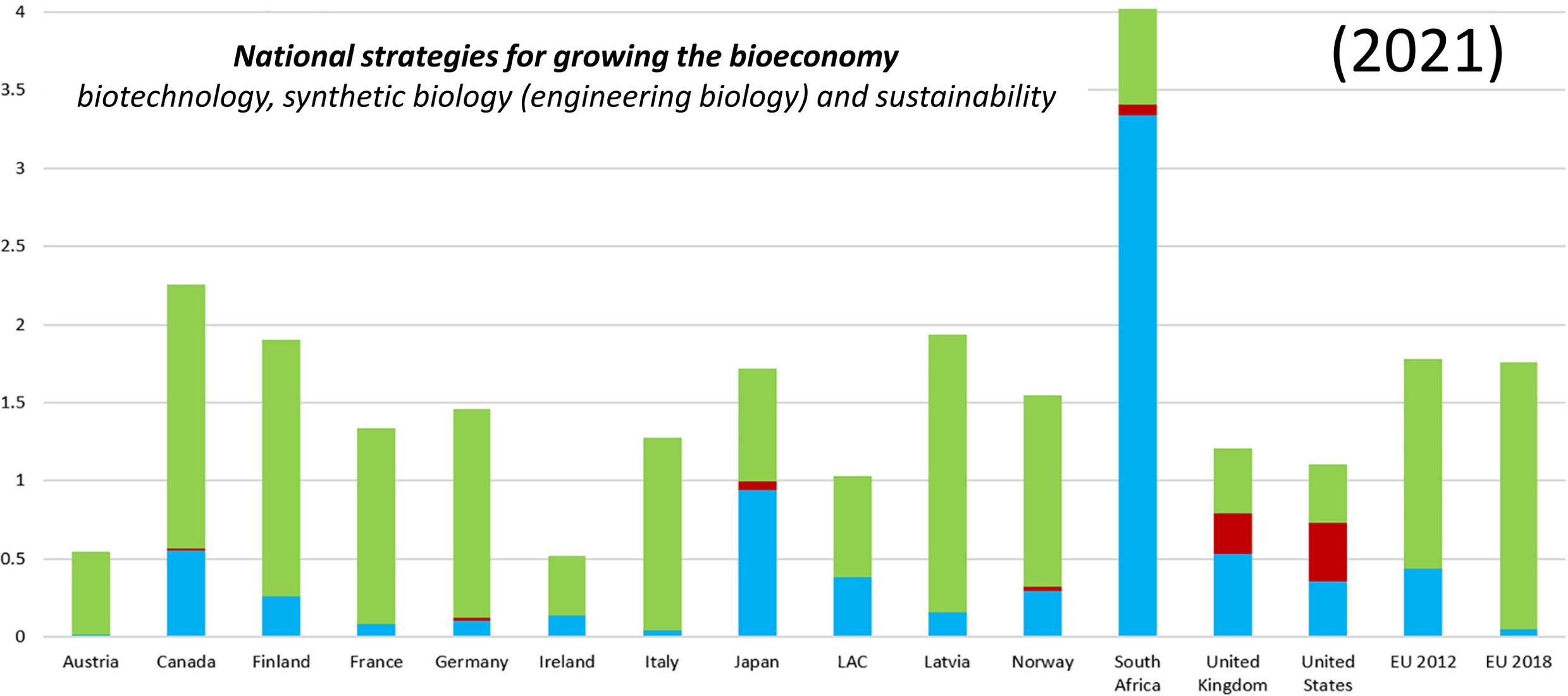
Micromorganisms found in Nature **produce low enzyme rates** for industrial applications



Adapted from Cairns, T. et al, *J. Fungi* 2021, 7(7), 535;

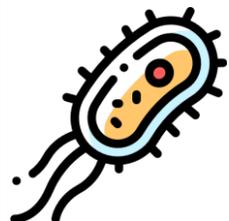


■ Biotechnology ■ Synthetic Biology ■ Sustainable



Is there a risk to increase R&D asymmetries between Global North and South?

Bioprospection



New microbe from biodiversity

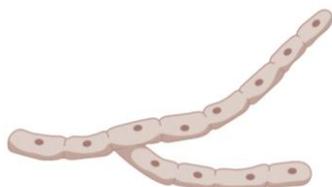
Telluricellulosum braziliensis
(pending registration)



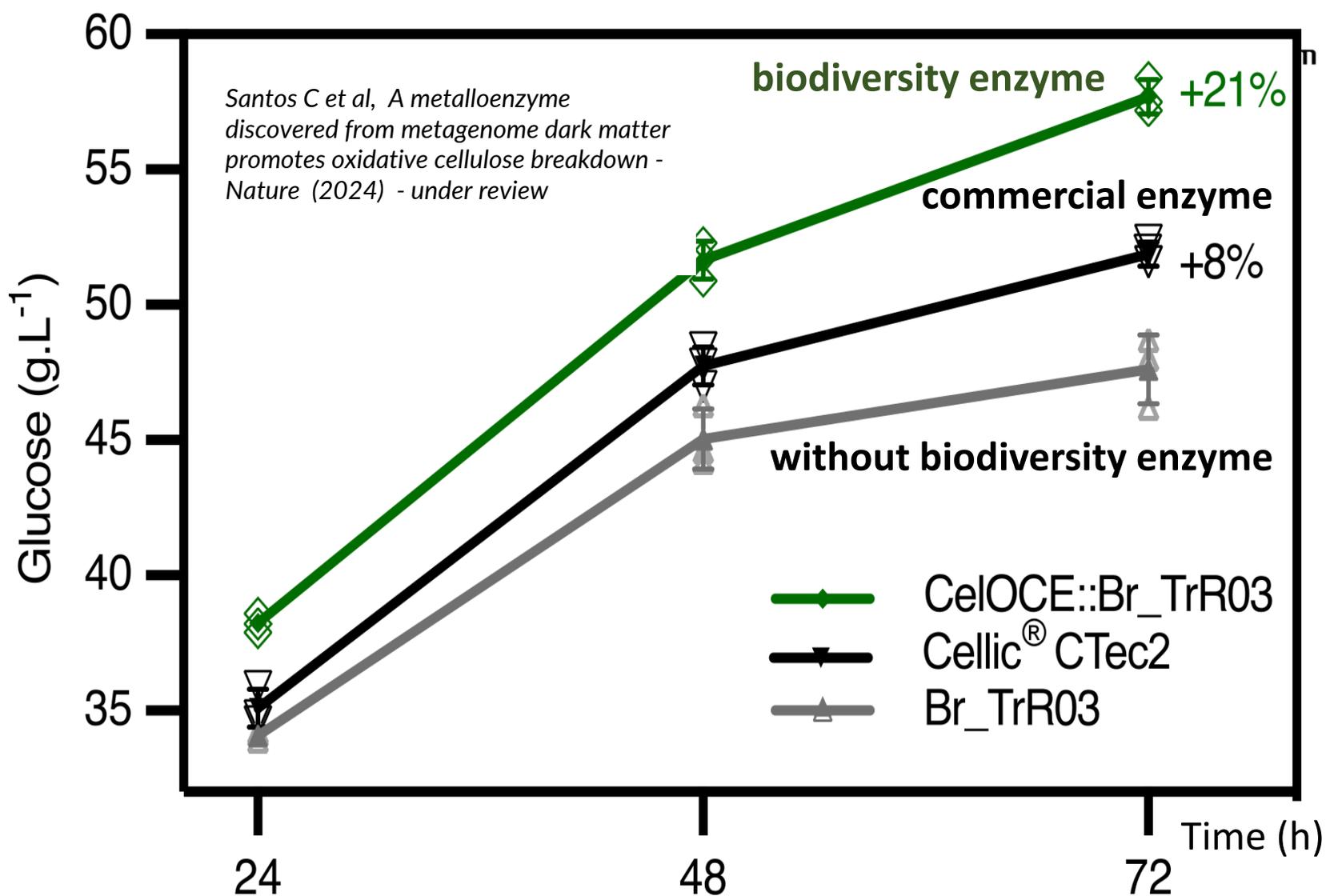
Novel enzyme
(CelOCE)



Synthetic Biology



Fungal strain co-expressing new enzyme (CelOCE)



Brazilian sugar platform enhanced by biodiversity enzyme

(for production of renewable hydrocarbons and biofuels)

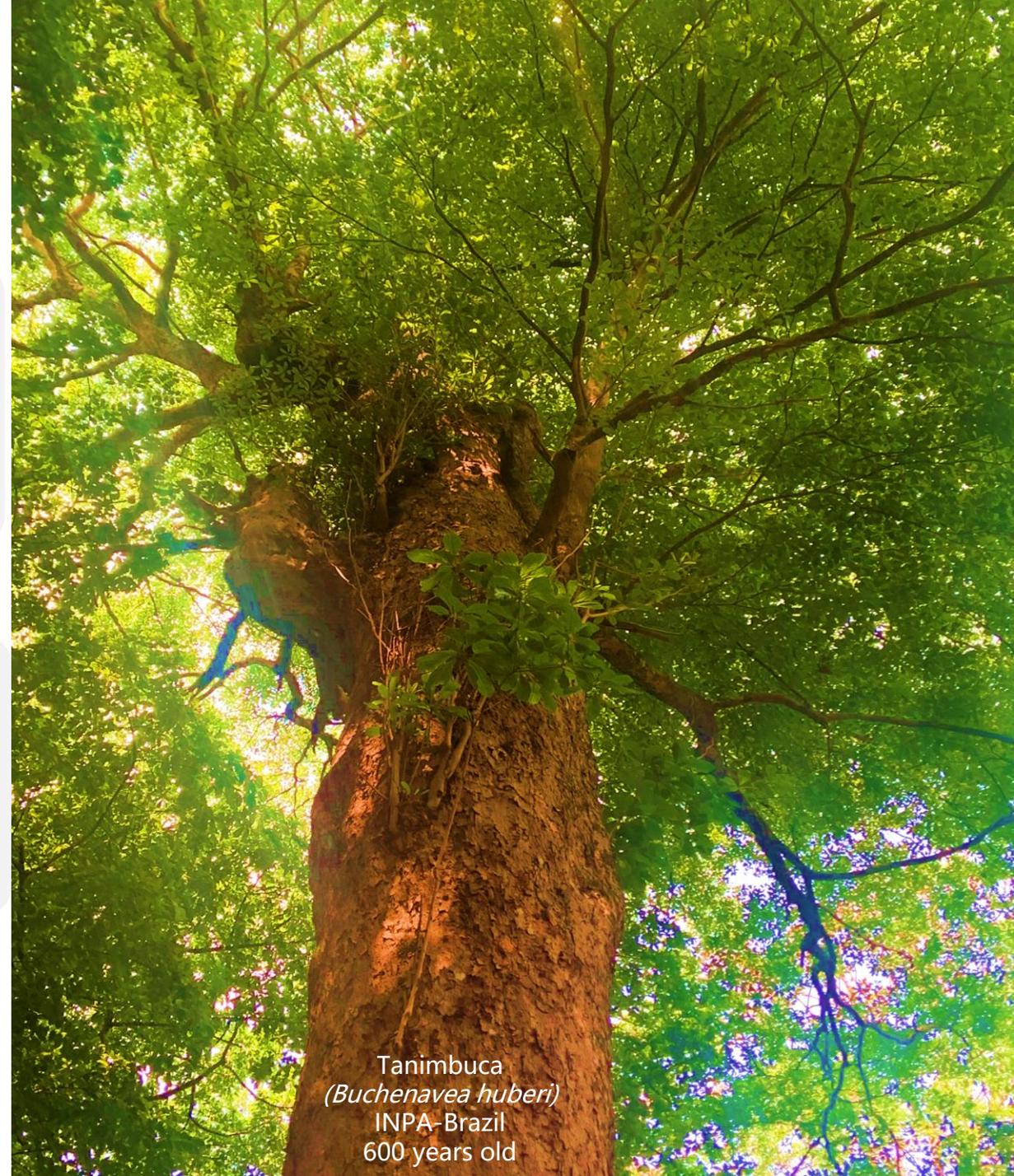
Take-Home Messages



Restoration of equilibrium of **ecosystems** and **bio-based industrialization** can **integrate biodiversity knowledge** while dealing with the global environmental crisis



We may be witnessing a **biorevolution** that will lead to **new industrial production and consumption models**, but that should not increase the divide between North and South



Tanimbuca
(*Buchenavea huberi*)
INPA-Brazil
600 years old

Thank you

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