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Synbiotics for Sustainable African Farms

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Menu

- URBANE context & WP contribution
- What are synbiotics?
- Materials for Sustainable African farms
- Methodology
- Bacillus screening & biofertilizer effect on tomato
- Conclusion

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URBANE project

(https://urbane-project.eu/)

LIÈGE université Gembloux Agro-Bio Tech

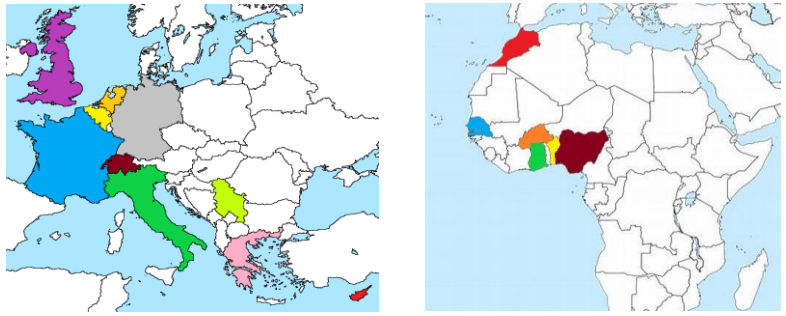
ONE HEALTH APPROACHES TO SUPPORT AGROECOLOGICAL TRANSFORMATION OF PERI-URBAN FARMING

Objective: URBANE aims to develop & demonstrate through 6 case studies in Africa a series of **technology-** and **nature-based solutions**, applying a **One Health approach** for tackling issues related to the application & intensification of peri-urban agriculture (e.g., food nutrition security, zoonotic diseases, environmental degradation, antimicrobial resistance, etc.)

Sustainable Development Goals:

- Contributing directly to meeting several SDGs
- Overlapping with the objectives of the Paris Agreement on climate change.

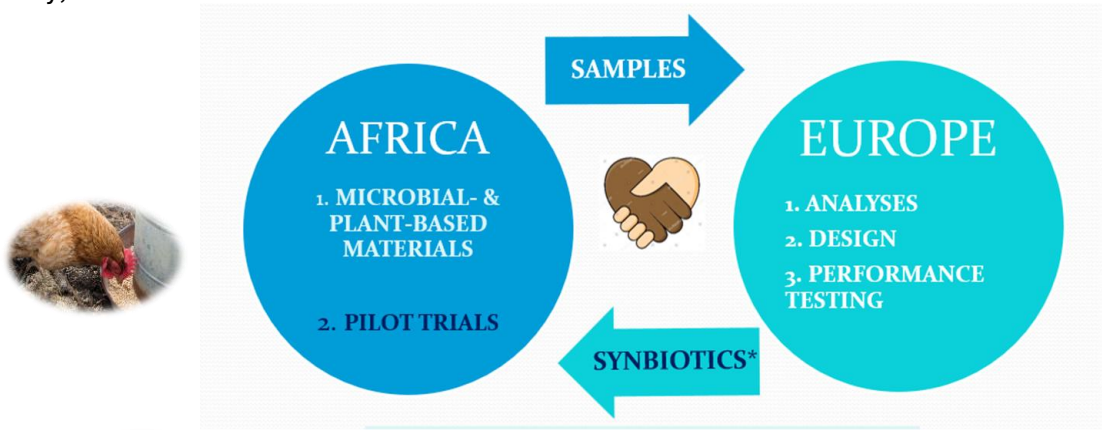
16 COUNTRIES (10 EU & 6 AU) & 27 PARTNERS



Type of action:	HORIZON Research and Innovation Actions Project
Project duration:	48 months (2022-2026)
Total budget:	5 .015. 233,25 €
Coordinator:	CYPRUS RESEARCH AND INNOVATION CENTER LTD (CY.R.I.C)

SYNBIOTICS FOR SUSTAINABLE ANIMAL & PLANT FARMING (WP4)

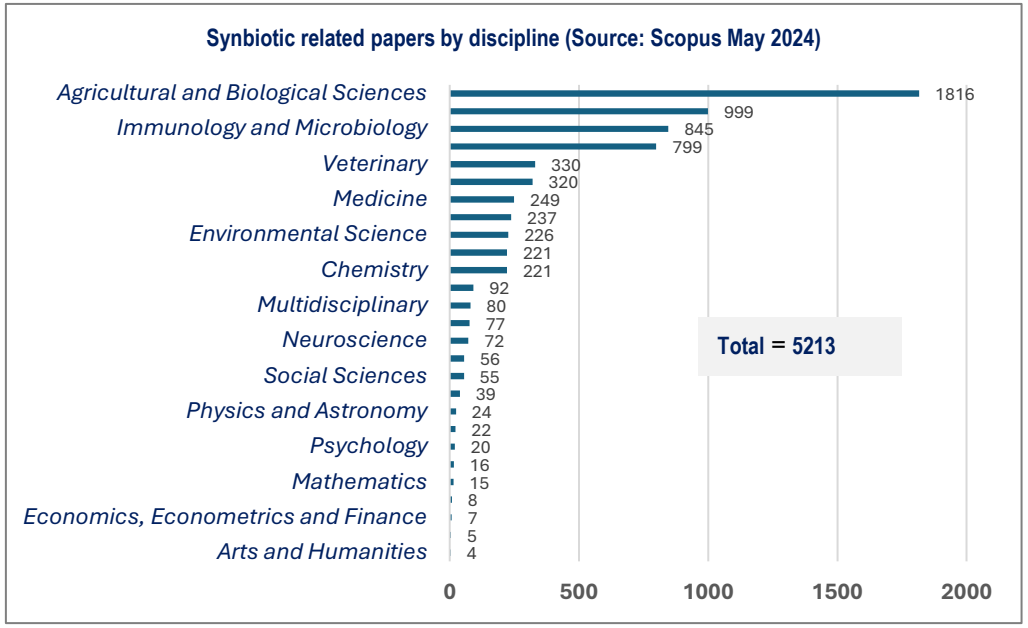
Partner : ULIEGE – Gembloux Agro-Bio Tech (BELGIUM)
Participant : Laboratory of Microbial Processes and Interactions (TERRA, Gembloux)

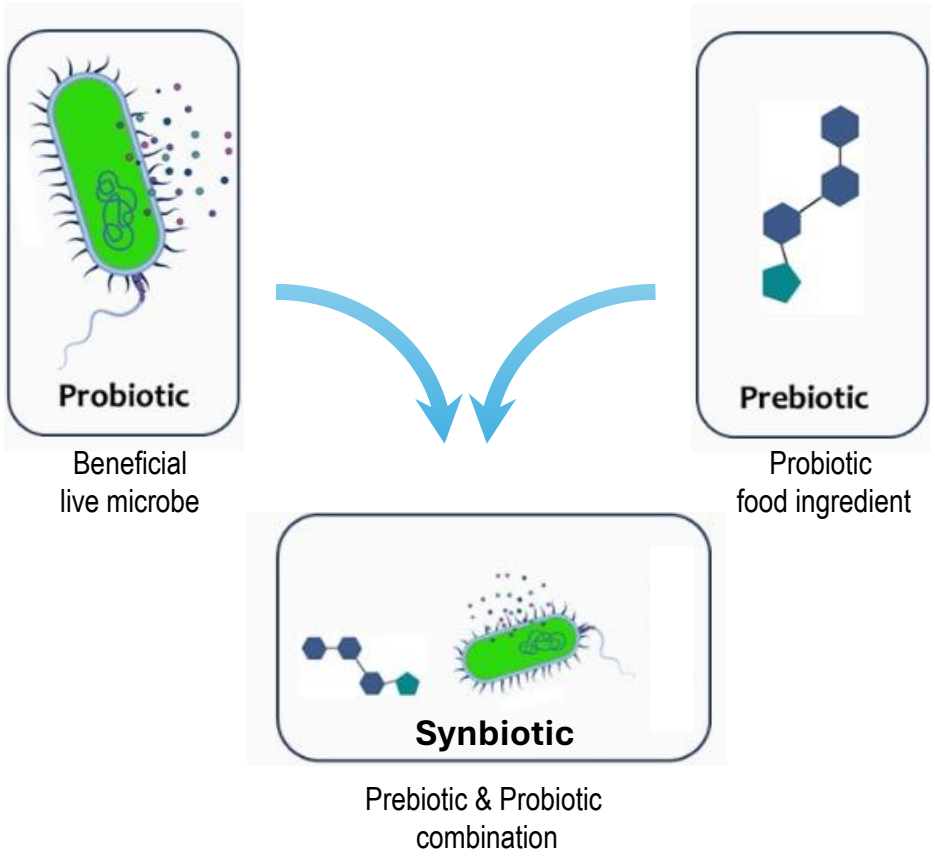


BIO-BASED MULTICOMPONENTS
(e.g., *Biosupplements, Biopesticides, Biofertilizers*)

What are **SYNBIOTICS**?

- **Definition** (SYN = together – BIOTIC = life)
  - Probiotics + Prebiotics [1]
  - Complementary & Synergistic [2]
  - Live microbes + substrates [3]
  - Synbiotic ≠ Symbiotic
- **Applications**
  - Human & Animal Health
  - Plant & Environment Protection
- **Statistical data**

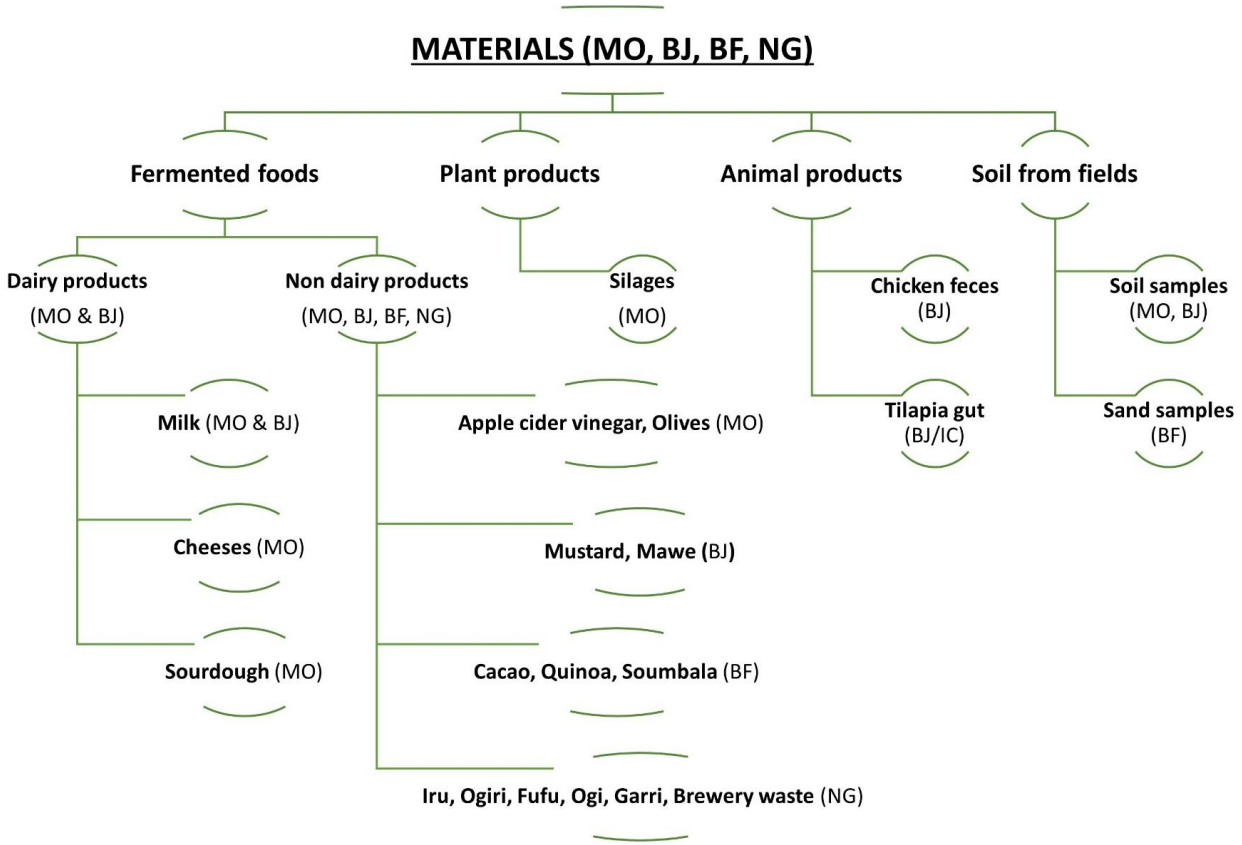




[1] Gibson & Roberfroid . *The Journal of Nutrition*. **1995**, *125:1401–1412*
[2] Kolida & Gibson. *Annual Review of Food Science and Technology*. **2011**, *2*:373–393
[3] Swanson et al. *Nature Reviews Gastroenterology & Hepatology*. **2020**, *17*:687–701

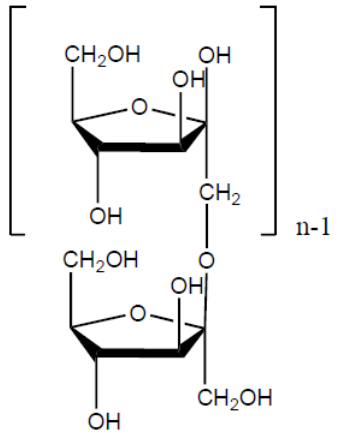
Synbiotic Components for Sustainable African Farms

Sources of Native Probiotic Strains

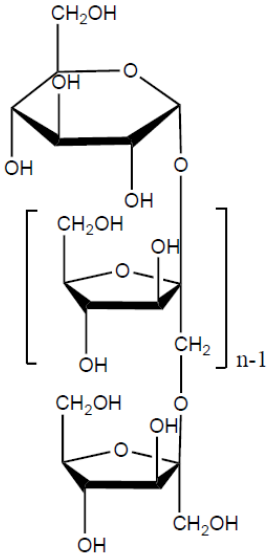


Standard prebiotics

- Fructo-oligosaccharide FOS & Inulin (DP 2 to 60)
- Source: chicory
- Purity > 99.5% (w/w)
- Physical state: powder



FOS

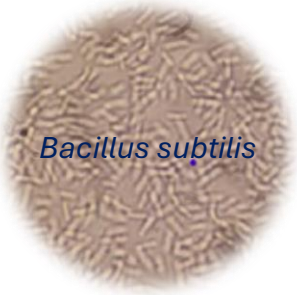


Inulin

Native probiotic strains

Isolation & Identification methods

- Selective media (MRS, LB, YPD,...)
- Isolation & purification (colonies)
- Phenotype analyses
  - Colonies
  - Microscopic images
  - ...

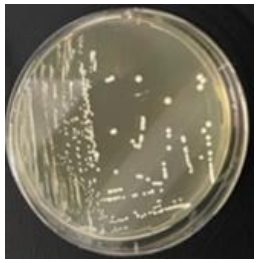


- Sequencing 16s rRNA (% ID)

- Specific proteins by MALDI-TOF MS (score)

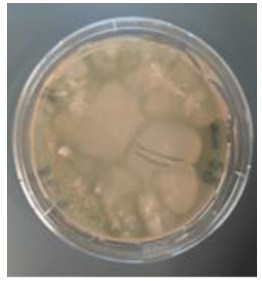
Genera, species, strains (~ 180)

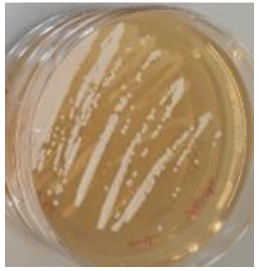
- Lactic Acid bacteria
  - ☞ *Lactobacillus*
  - ☞ *Leuconostoc*
  - ☞ ...
- Soil Bacteria
  - ☞ *Bacillus* sp.
  - ☞ *Pseudomonas* sp.
  - ☞ ..
- Fungi
  - ☞ *Saccharomyces* sp.
  - ☞ *Yarrowia* sp.
  - ☞ ...



◄ ***L. plantarum***

B. Subtilis ►





◄ ***S. cerevisiae***

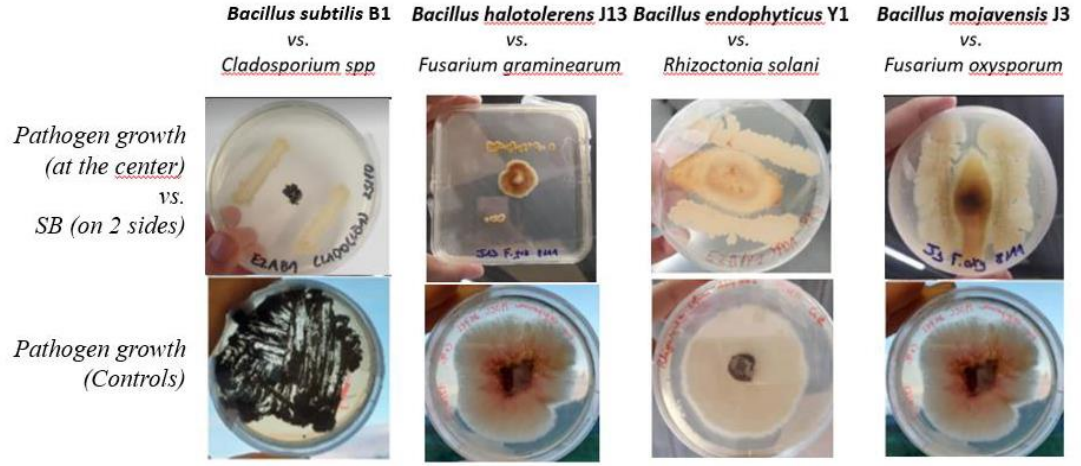
Bacillus : Screening & Selection criteria

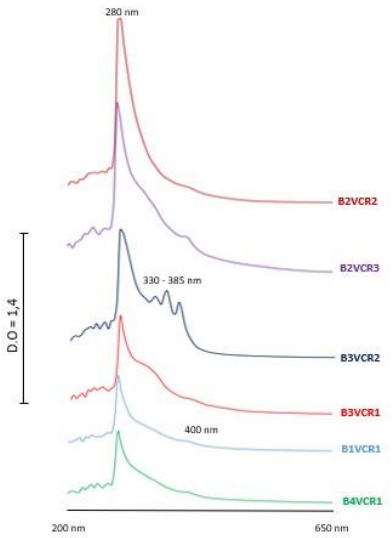
1. Microbial profiling

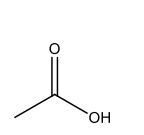
- Growth rate & biomass yield
- Antagonism to pathogens
- …

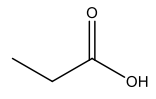
2. Metabolite production

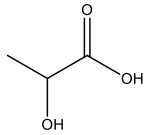
- Supernatant UV-Visible spectrum
- Organic acids
- Lipopeptides (surfactin, fengycin, …)
- Bioemulsifiers (EI_{24})
- Antioxidants (DPPH, …)
- ….

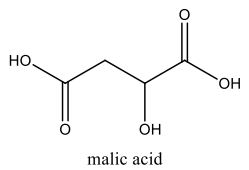


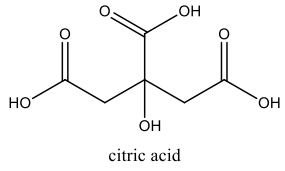


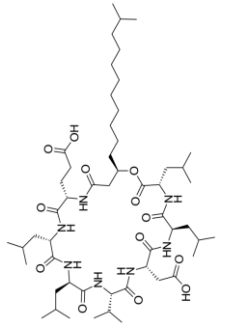


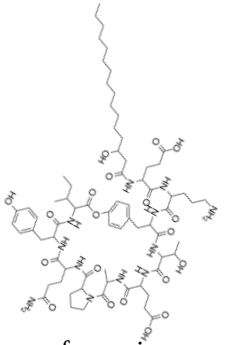












Synbiotic design, formulation & assessment

METHODOLOGY

- **Combination of selected ingredients**
  - Probiotic strain
  - Oligosaccharide prebiotic (FOS, Inulin)
- **Optimization**
  - Ratio (%)
  - Doses (CFU/g, % w/w)
- **Formulation**
  - Pellets (without drying)
  - Powder (with drying + thermoprotectors)
- **Assessment**
  - QC (powder)
  - Performance (activity)
  - Stability (powder + activity)

ASSESSMENT CRITERIA

- OD_{600} vs. time
  - Culture media
  - Prebiotic
  - Probiotic
  - Prebiotic + Probiotic
- Cell viability (CFU/g)
- Thermophysical fingerprints (powder) [4]
- Probiotic survival rate (%)
- Relative humidity (Aw)
- Colour (BI)

[4] Razafindralambo et al. **2019**. *Scientific Reports*, 9:1–8

Synbiotic activities on tomato culture for trials in Benin (Aug-Nov 2023)

Material

- Tomato variety: Cobra 26 F1
- *B. subtilis* (probiotic); FOS (prebiotic)
- *B. subtilis* + FOS (synbiotic)

Methodology

- Field experiment on pilot sites in farms
- Fisher blocks design (triplicate)
- Seed germination & transplanting [5]
- Treatments [6]
  - seed incubation
  - soil surface application
- Agro-morphological assessment [7]
  - plants (height, leaf area)
  - fruits (weight, size, firmness)

Biofertilizer effect of biotic species on tomato

Treatment	Tomato		
	weight	size	firmness
Control	-	-	-
Prebiotic	--	-	--
Probiotic	++	-	++
Synbiotic	--	-	--

Results

- Tomato firmness increases with probiotic & decreases with prebiotic and synbiotic vs. Control
- Less soft fruit (more resistant to spoilage microorganisms attack)
- Better quality (longer shelf-life)

[5] Nihorimbere et al. 2010; [6] Sirajuddin et al. 2016; [7] Abobi et al. 2021

Conclusion

- **Isolation** of native strains from African (> 180)
- Double **identification** (genomic & proteomic)
- Microbial & metabolic **profiles**
- **Selection** of potential strain
- Synbiotic **design**, **formulation** & **controls**
- Lab **production** for case studies in Africa
- **Preliminary results** of performance on tomato growth

Acknowledgment, team & collaborators

Co-funded by the European Union

Researchers involved

- Hary Razafindralambo – WP/TS leader (BE)
- Philippe Jacques – TS leader (BE)
- Majid Mounir – CS leader (MO)
- Kouhounde Sonagnon – CS leader (BF)
- Kifouli Adeoti – CS leader(BJ)
- PhD students (IC, MO, BF, BJ)

Collaborators

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CHU de Liège Clinical Microbiology

LIÈGE université LSAF

LIÈGE université Gembloux Agro-Bio Tech | BEAGx

Thank you for your attention!