

# Development of a Bioprospecting Strategy for Colombian Microbial Biodiversity in Agriculture

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# Content

- What Does Agrosavia Do?
- Development of Agrosavia's Bioprospecting Strategy

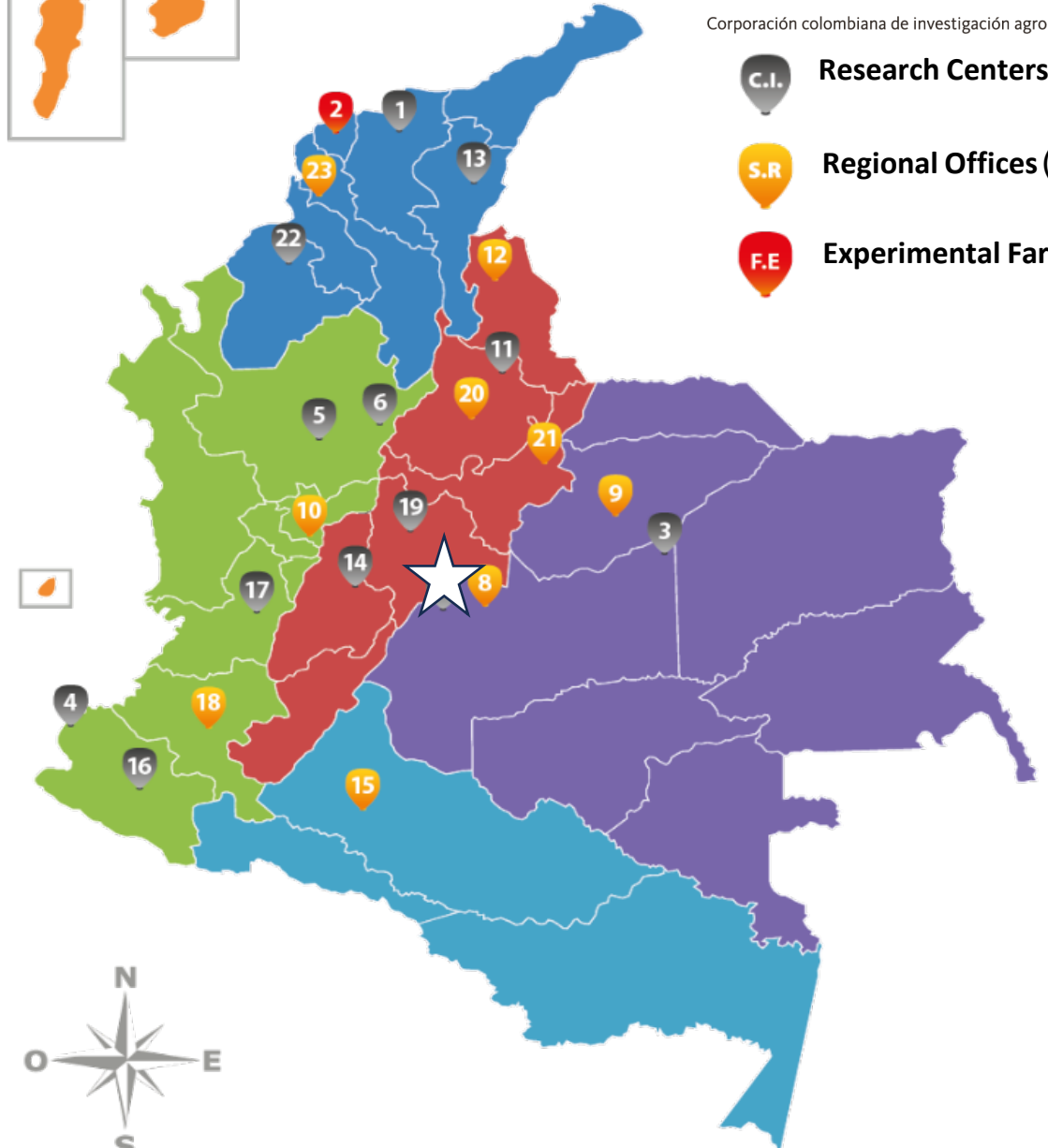
# Who are we?

AGROSAVIA is a scientific nonprofit Colombian public organization. Its focus is the development of research in the agriculture & livestock sectors.



**AGROSAVIA**  
Corporación colombiana de investigación agropecuaria

- C.I.** Research Centers (13)
- S.R.** Regional Offices (8)
- F.E.** Experimental Farms (2)



**Research Centers and Regional Offices**

# Who are we?

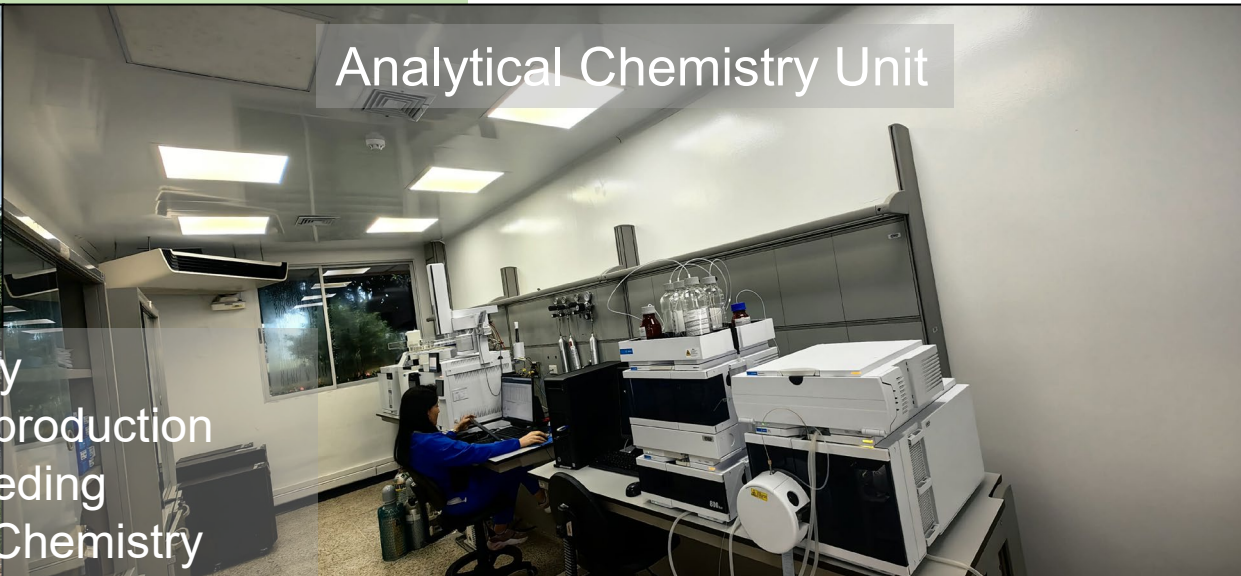
## Laboratories Network

Laboratories at La Libertad Research Center



- ✓ Entomology
- ✓ Animal Reproduction
- ✓ Plants Breeding
- ✓ Analytical Chemistry
- ✓ Molecular Biology
- ✓ Agricultural Microbiology
- ✓ Livestock Microbiology

Analytical Chemistry Unit



Livestock Microbiology



Agricultural Microbiology



## Recently renovated laboratories

Tibaitatá  
9.100 m<sup>2</sup>

La Libertad  
1.700m<sup>2</sup>

Turipaná  
710 m<sup>2</sup>

La Suiza

# Who are we?

## Department of Bioproducts

Biofertilizers

Biopesticides

Animal health and nutrition



**BACULOVIRUS®**



**Monibac®**



**TRICOTEC®**



**Erytec®**



**Rumitec®**



**Monibac®**

# Germaplasm Banks for Food and Agriculture



## Animal



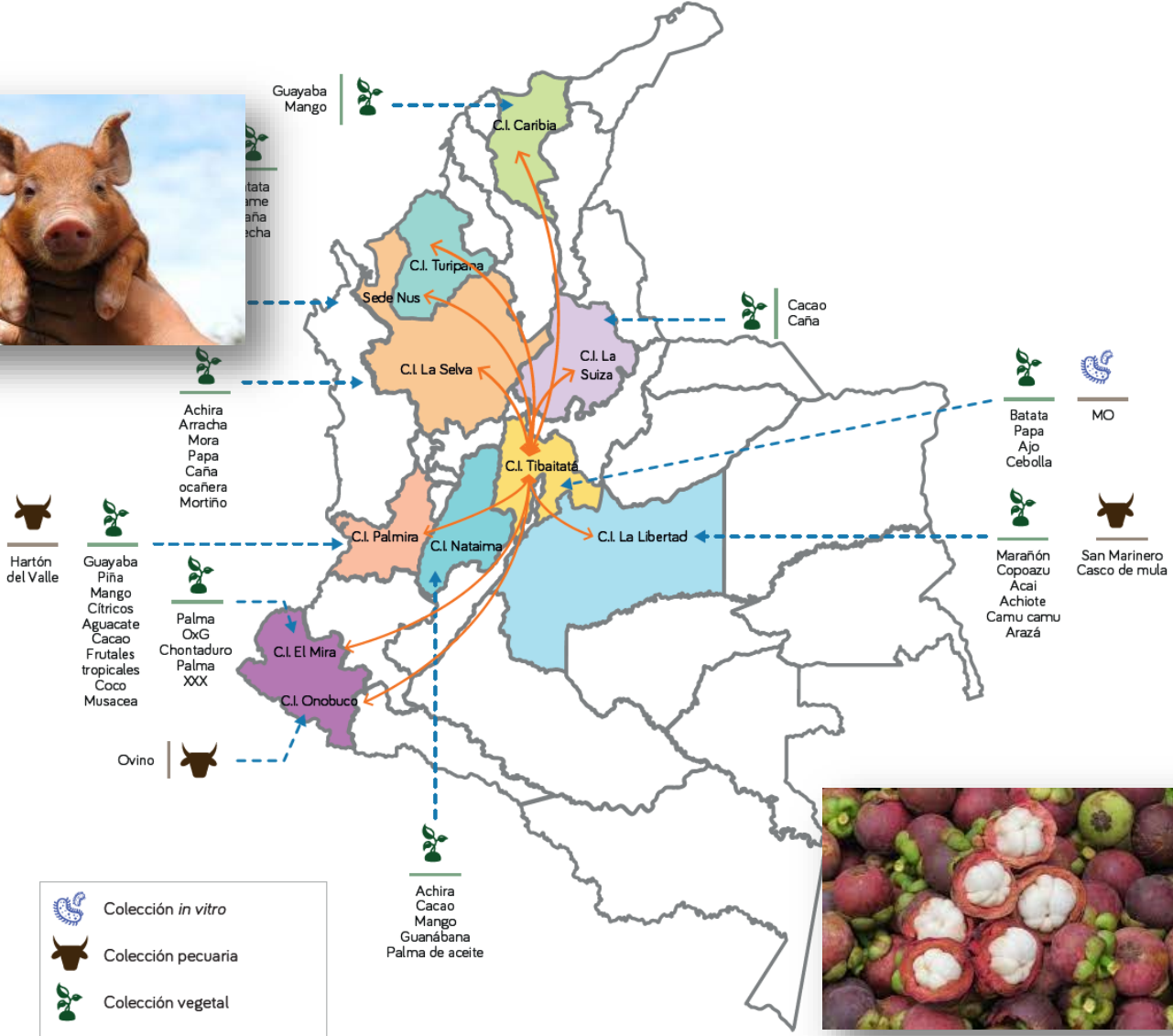
- Bovine: Blanco Oreginegro, Sanmartinero, Romosinuano, Costeño con Cuernos, Harton del Valle and Chino santandereano
- Swine (pigs): San Pedreño, Zungo and Casco de Mula
- Sheep: Criolla and Mora

### Conservation systems

- *In vivo*: 2.837
- *In vitro*: 67.256

### 3.205 genotyped animals:

- ✓ Bovine: 2.837
- ✓ Sheep: 148
- ✓ Swine: 220



## Plants

**36.313** accessions of plants with agricultural importance

### Conservation systems:

- Seeds: 29.516
- *In vitro*: 1.006
- In field: 5.791

- ✓ 4.226 accessions with morphological characterization
- ✓ 49 with ecophysiological characterization
- ✓ 1.719 with chemistry characterization
- ✓ 1.314 with molecular characterization



# Germplasm bank for food and agriculture

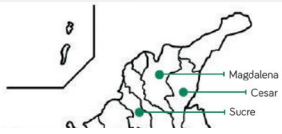
## Microbial collection

### Mycorriza

**Genera:**  
Rhizoglyphus sp.,  
Glomus sp.,  
Acaulospora sp.,  
Denticulata sp.,  
Paraglomus sp.,  
Claroideoglyphus sp.,  
Gigaspora sp.,  
Cetranspora sp.,  
Diversispora sp.,  
Denticulata sp.  
and Kuklospora sp.

*Kuklospora colan*  
*Gigaspora ros*  
*Rhizoglyphus irregularis*  
*Paraglomus occultum*

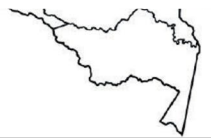
**25 accessions**



### Collection of PGPR

**Genera:**  
Brevibacterium,  
Gordonia,  
Klebsiella,  
Knoellia,  
Ochrobactrum

*Bradirhizobium diazoefficiens*  
*Bacillus megaterium*



*Arthrobacter*,  
*Stenotrophomonas*,  
*Burkholderia*,  
*Serratia*,  
*Rhizobium*  
*Acinetobacter*



### Filamentous fungus

**Genera:**  
Alternaria  
Arthrotrichytrium  
Aspergillus

*Beauveria bassiana*  
*Metarhizium robertsii*  
*Verticillium sp.*

**277 accessions**

### Collection of biological control

### Yeasts

**Genera:**  
Candida  
Debaryomyces  
Hanseniaspora  
Kodamaea  
Kurtzmanella  
Meyerozyma  
Metschnikowia  
Pichia  
Rodotorula  
Wickerhamomyces

*Kurtzmanella sp.*  
*Metschnikowia sp.*  
*Rhodotorula sp.*

**239 accessions**

### Bacteria

**Genera:**  
Bacillus  
Lysinibacillus  
Paenibacillus  
Pseudomonas

*Bacillus sp. Bs006*

**308 accessions**

*Penicillium*  
*Phomopsis*  
*Rhizopus*  
*Scopulariopsis*  
*Trichoderma*  
*Ulocladium*  
*Verticillium*

### Anaerobic bacteria from the gastrointestinal tract of bovines, chigüiro, tapir and agouti

**Genera:**  
Ruminococcus  
Fibrobacter  
Butyrivibrio

*Ruminococcus*  
*Rumen bacteria*

**164 accessions**

### Lactic acid bacteria from silage

**Genera:**  
Lactobacillus

*Lactobacillus rhamnosus*

**164 accessions**

### Collection of animal nutrition

### Bacteria

**Genera:**  
Leptospira  
Staphylococcus  
Lactobacillus  
Brucella abortus  
Escherichia coli O157-H7  
Streptococcus  
Salmonella

*Lactobacillus sp.*  
*Leptospira*  
*Escherichia coli*

**608 accessions**

### Virus

*New castle virus*

**77 accessions**

### Collection of animal health

### Ectoparasites

*Rhipicephalus microplus*

**31 accessions**

*larva*  
*Larvae eclosion*

**Endoparasites**  
**31 accessions**

*Anaplasma marginale*

**Genera:**  
Rhipicephalus  
Anaplasma  
Babesia  
Trypanosoma

BHK 21  
Vero  
HeLa  
IDE8  
ISE6

*Tick cell line*

Pictures: Conservación y manejo de la diversidad microbiana en los bancos de germoplasma para la alimentación y la agricultura. AGROSAVIA

# Publications and Bioproducts

- Romero-Perdomo, *et al.*, 2021. Phosphorus nutrition and growth of cotton plants inoculated with growth-promoting bacteria under low phosphate availability. *Front sustain food syst.*
- Mendoza-Labrador, J., *et al.*, 2021. *Bacillus* strains immobilized in alginate macrobeads enhance drought stress adaptation of Guinea grass. *Rhizosphere.*
- Zapata-Narváez, *et al.* 2021. Eficacia de antagonistas microbianos y quitina en el control de *Colletotrichum gloeosporioides* en poscosecha de mango cv. Azúcar. *Rev mex fitopatol.*
- Izquierdo-García, *et al.*, 2020. *Trichoderma virens* GI006 and *Bacillus velezensis* Bs006: a compatible interaction controlling *Fusarium* wilt of cape gooseberry. *Sci rep.*
- Melo-Bolívar, *et al.*, 2019. Establishment and characterization of a competitive exclusion bacterial culture derived from Nile tilapia (*Oreochromis niloticus*) gut microbiomes showing antibacterial activity against pathogenic *Streptococcus agalactiae*. *Plos one.*
- Betancourt, *et al.*, 2019. Effects of Colombian oregano essential oil (*Lippia origanoides* Kunth) and *Eimeria* species on broiler production and cecal microbiota. *Poult sci J.*
- Support to the National Institute of Health for the construction of an ELISA test to detect anti-SARS-CoV-2 IgG and IgM antibodies - Project Seroprevalence country emergency of COVID-19.
- Anaya, *et al.*, 2021. Inmunidad y vacunación contra la covid-19. *Medicina.*



Biofertilizer  
Nitrogen-fixing bacteria  
**Cotton and pastures**



Bio-pesticide – *Lecanicillium lecanii*  
Control of *Aleyrodidae Gossypium*  
**Cotton, Soy beans, tomato, phisalys, eggplant, pepper**



Bio-pesticide  
Control of *Erinnyis ello*  
**Rubber**

**AGROSAVIA**  
Corporación colombiana de investigación agropecuaria



Biofertilizer  
Phosphate solubilizing bacteria  
**Rice and Corn**



Bio-pesticide  
Control of *Tecia solanivora.*  
**Potatoes**



Probiotic  
Rumen bacteria  
**Calves in lactation**





**CONSERVACIÓN Y MANEJO**  
**de la diversidad microbiana en los**  
**Bancos de Germoplasma** para la  
Alimentación y la Agricultura en Colombia

**Conservation and management of  
microbial diversity in germplasm  
banks for food and agriculture in  
Colombia**

# Permit for shipment of biological material



- ✓ It is processed by National Environmental Licensing Authority (ANLA)
- ✓ Material transfer agreement between a Colombian partner\* and the international institution
- ✓ Microbial isolates are considered native biological resources
- ✓ No CITES permit is required for microbial shipment
- ✓ No CITES permit is necessary when studies that will not intervene the genetic material are going to be carried out
- ✓ It is necessary to show where the biological material is going and what are the studies that are going to be carried out
- ✓ Processing time 1 month
- ✓ Once the permit is given it lasts for 3 months
- ✓ <https://www.anla.gov.co/permiso-y-autorizacion-importacion-especimenes-convencion-cites>

# Content

- What does Agrosavia Do?
- Development of Agrosavia's Bioprospecting Strategy

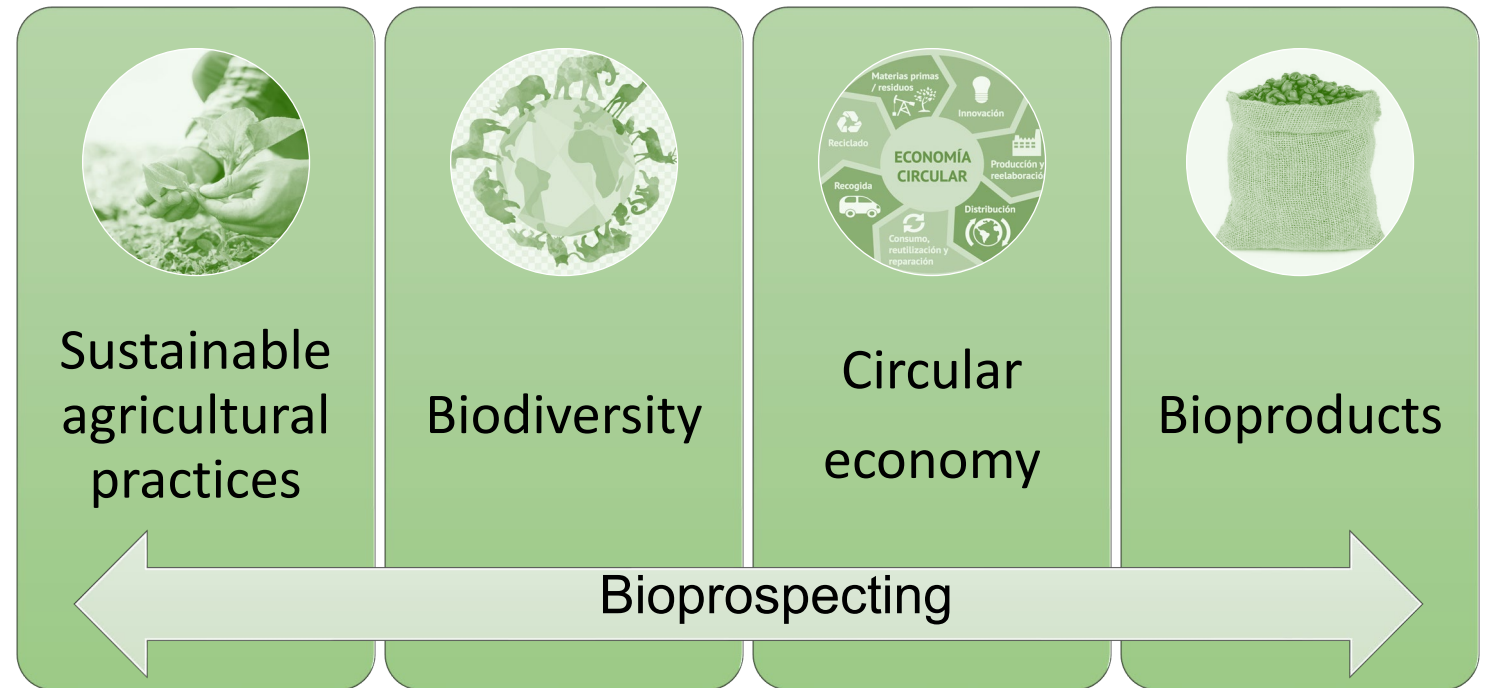
# Bioprospecting definition

Bioprospecting is defined as a systematic and organized **search for useful products** derived from **bioresources** including plants, microorganisms, animals, etc., that can be developed further for **commercialization** and overall benefits of the society (Oyemitan, 2017)



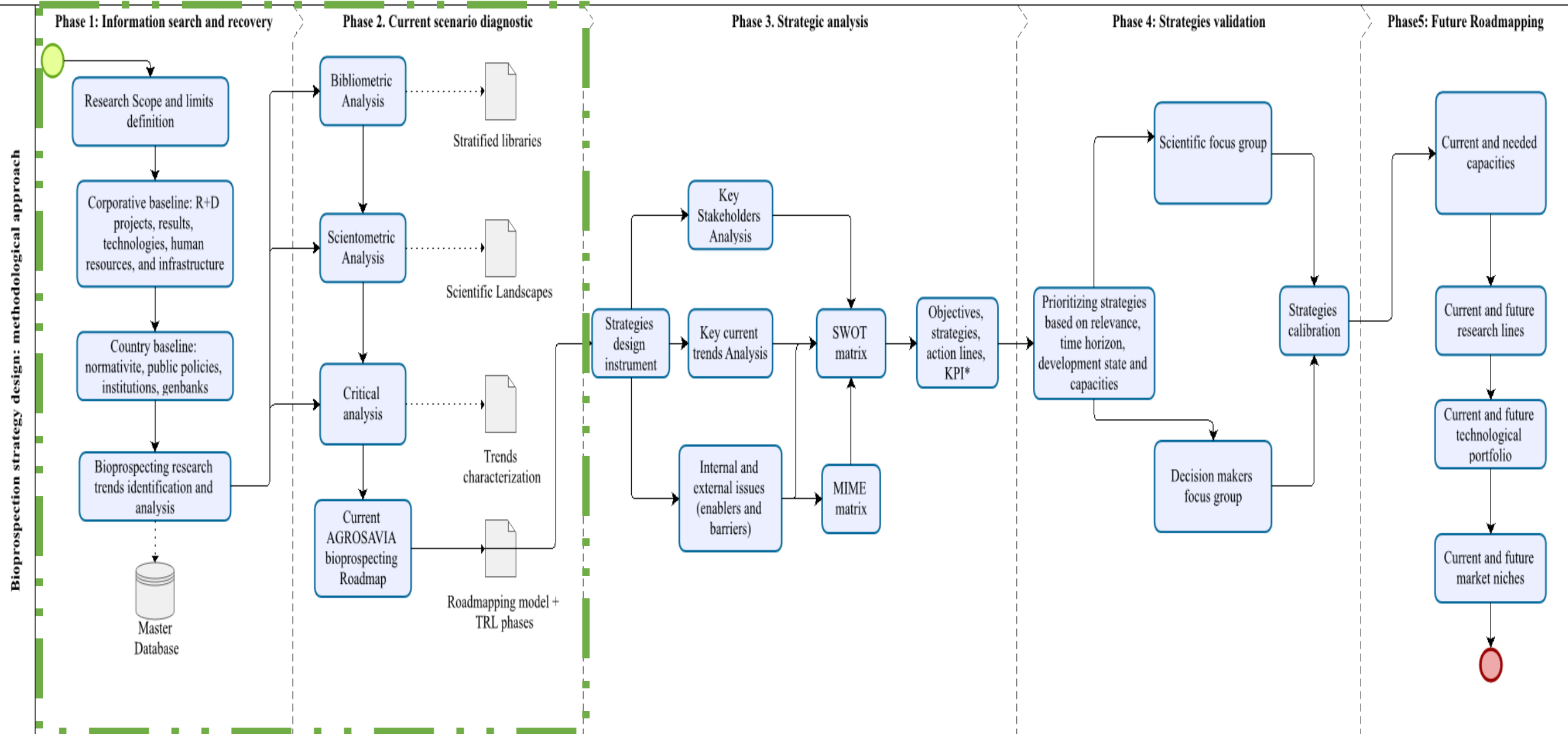
# Bioprospecting at Agrosavia

Agrosavia considers **four approaches** aimed at strengthening the **bioeconomy** in the **agricultural sector**:

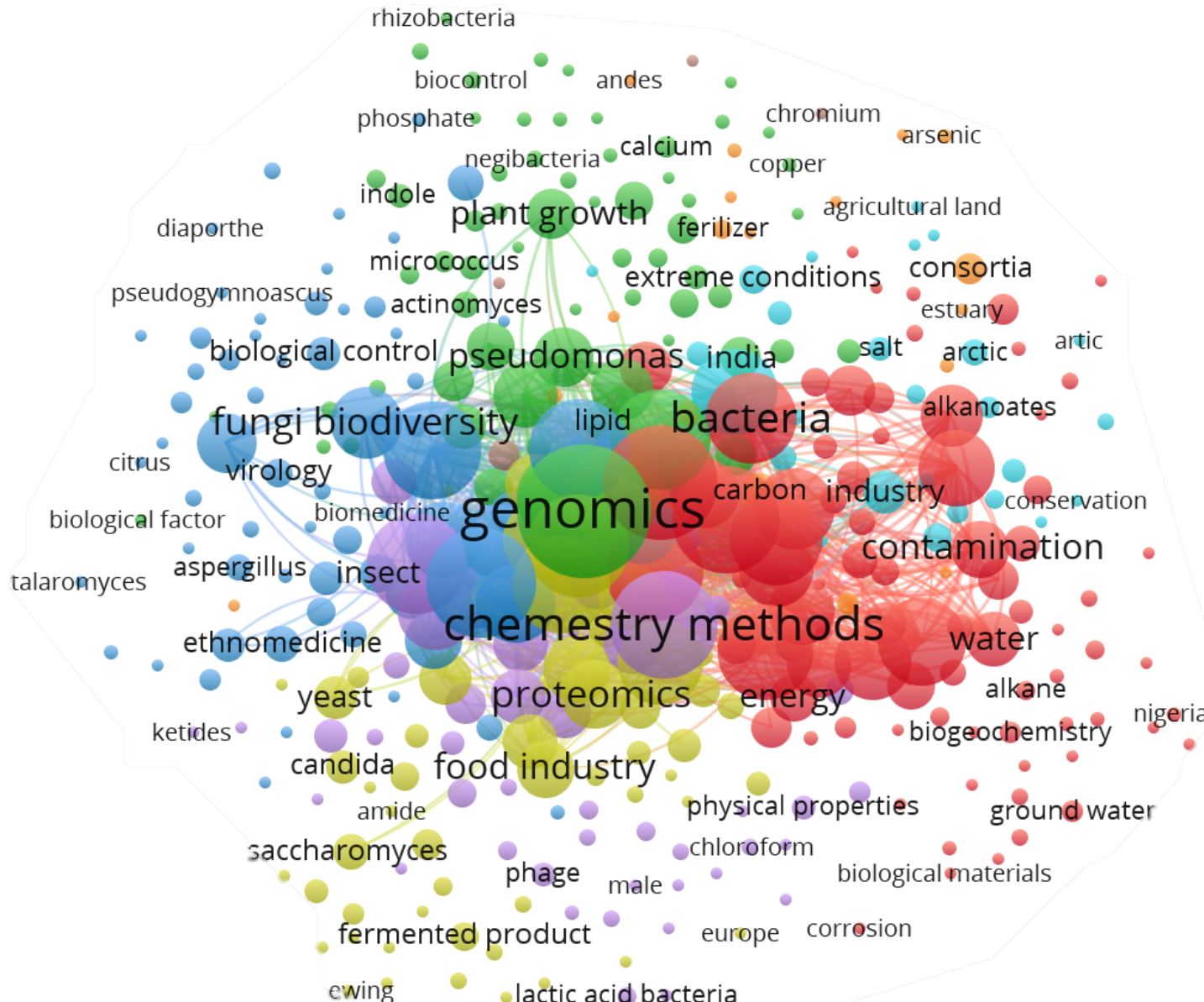


The goal to develop a bioprospecting strategy is to discern the **direction of efforts** in this field and, consequently, **define new lines of work while reinforcing existing ones** within the **institute**.

# Methodology: Flórez-Martínez et al. (2021)



# Trend topics for microbial bioprospecting

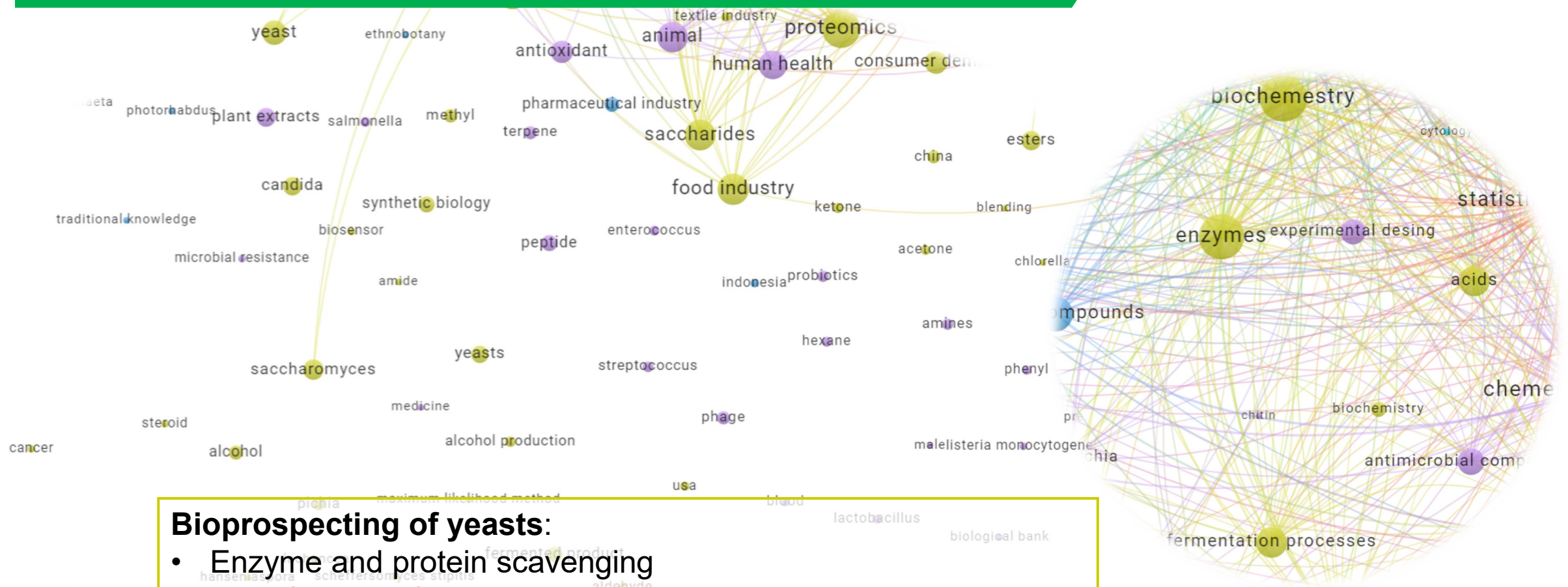


Bibliometric network of thematic clusters and key topics obtained from titles for bioprospecting of microorganisms.





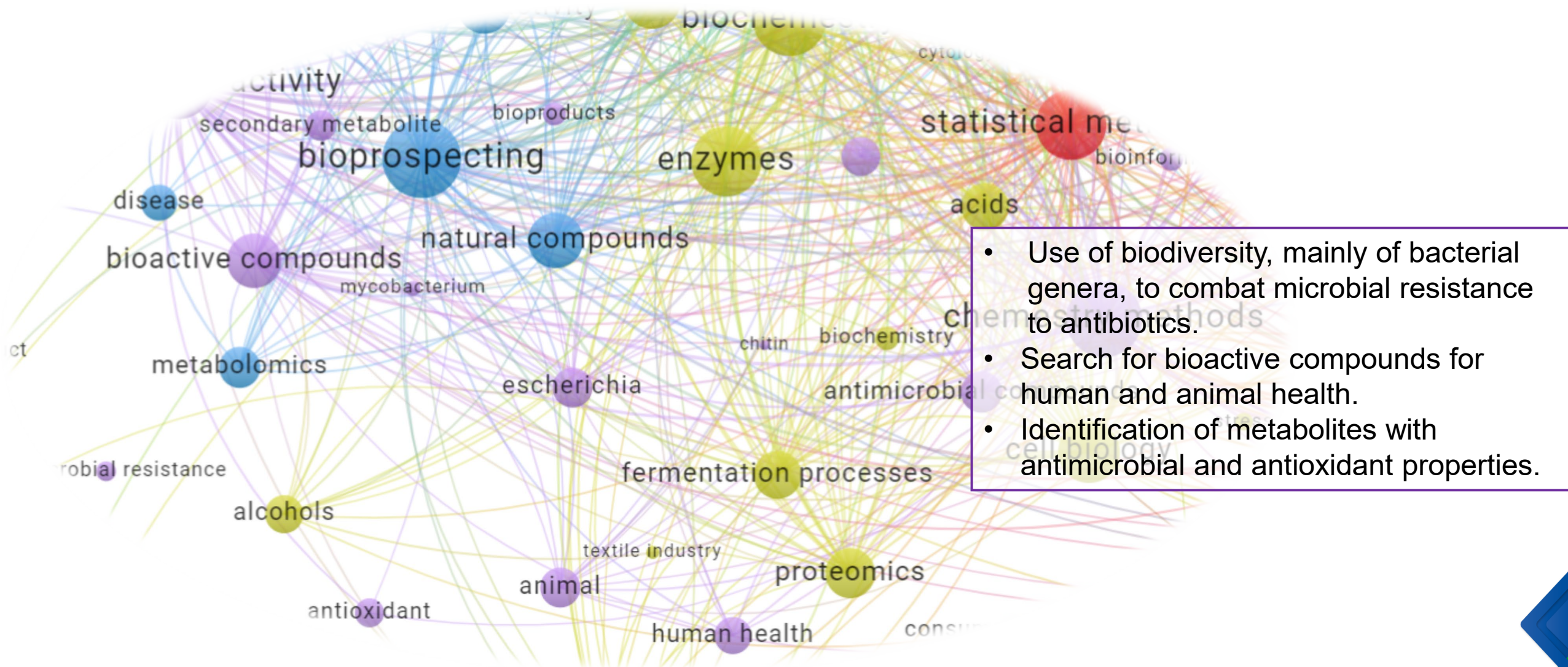
# Trend topics for microbial bioprospecting



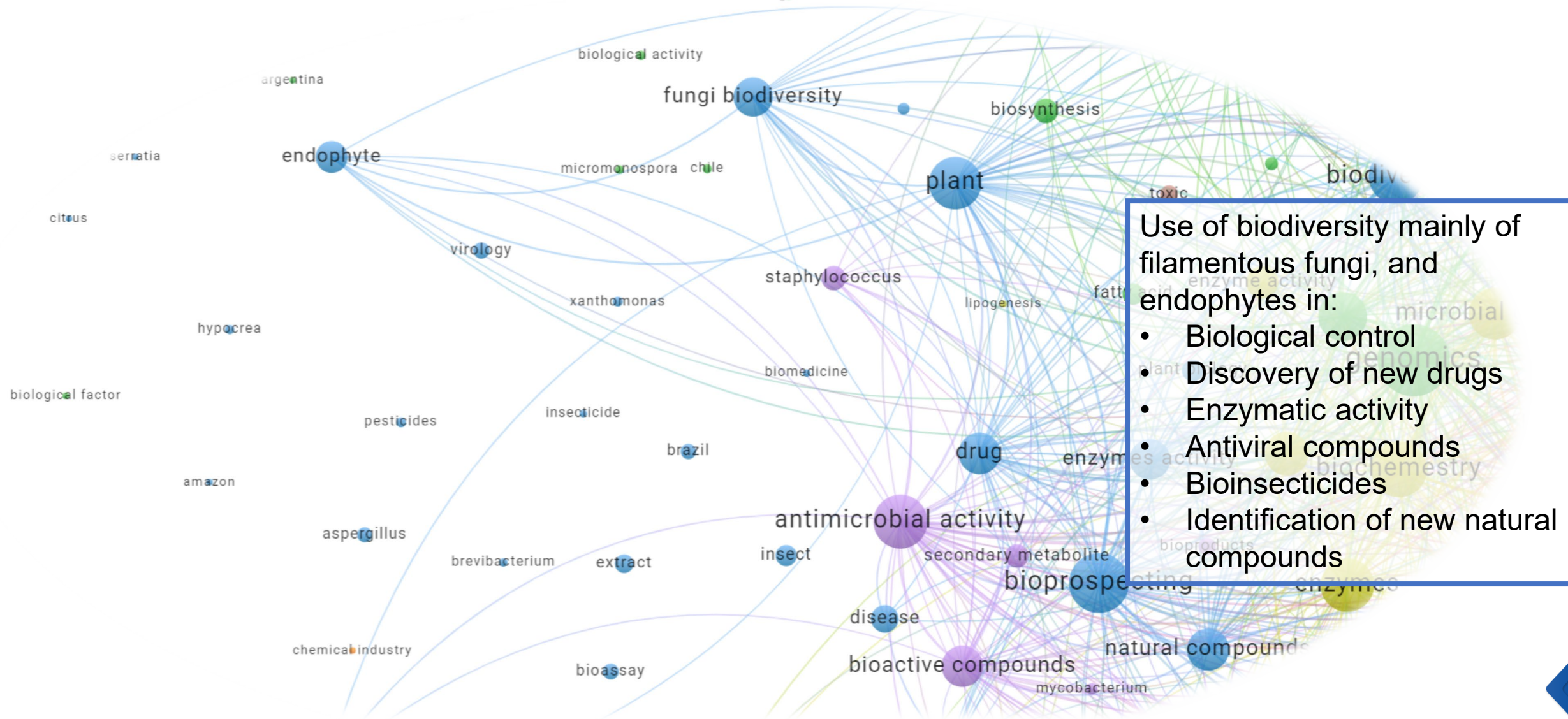
## Bioprospecting of yeasts:

- Enzyme and protein scavenging
- Identification of biochemical pathways
- Improvement of fermentation processes and conditions
- Research on fermented food products

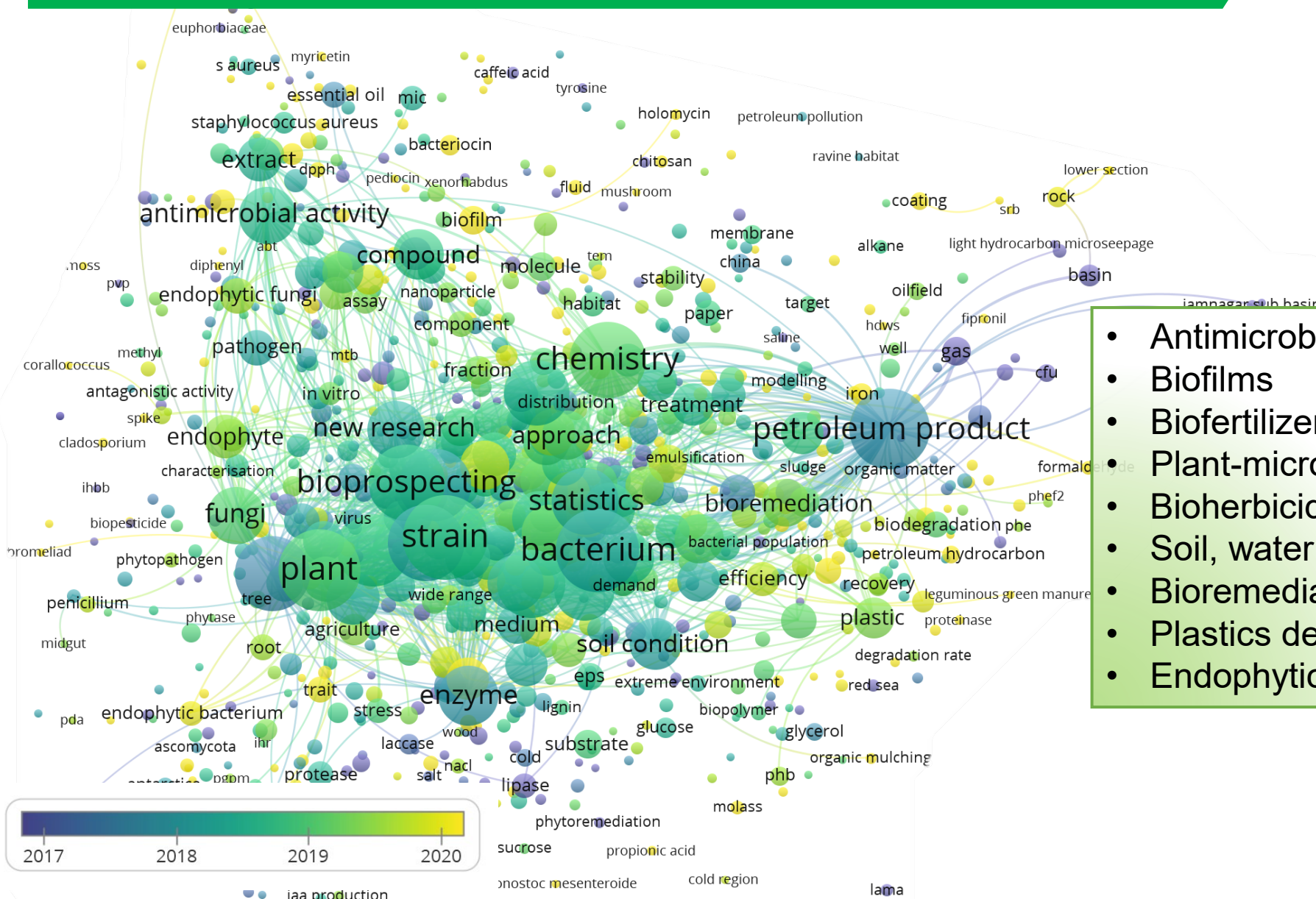
# Trend topics for microbial bioprospecting



# Trend topics for microbial bioprospecting

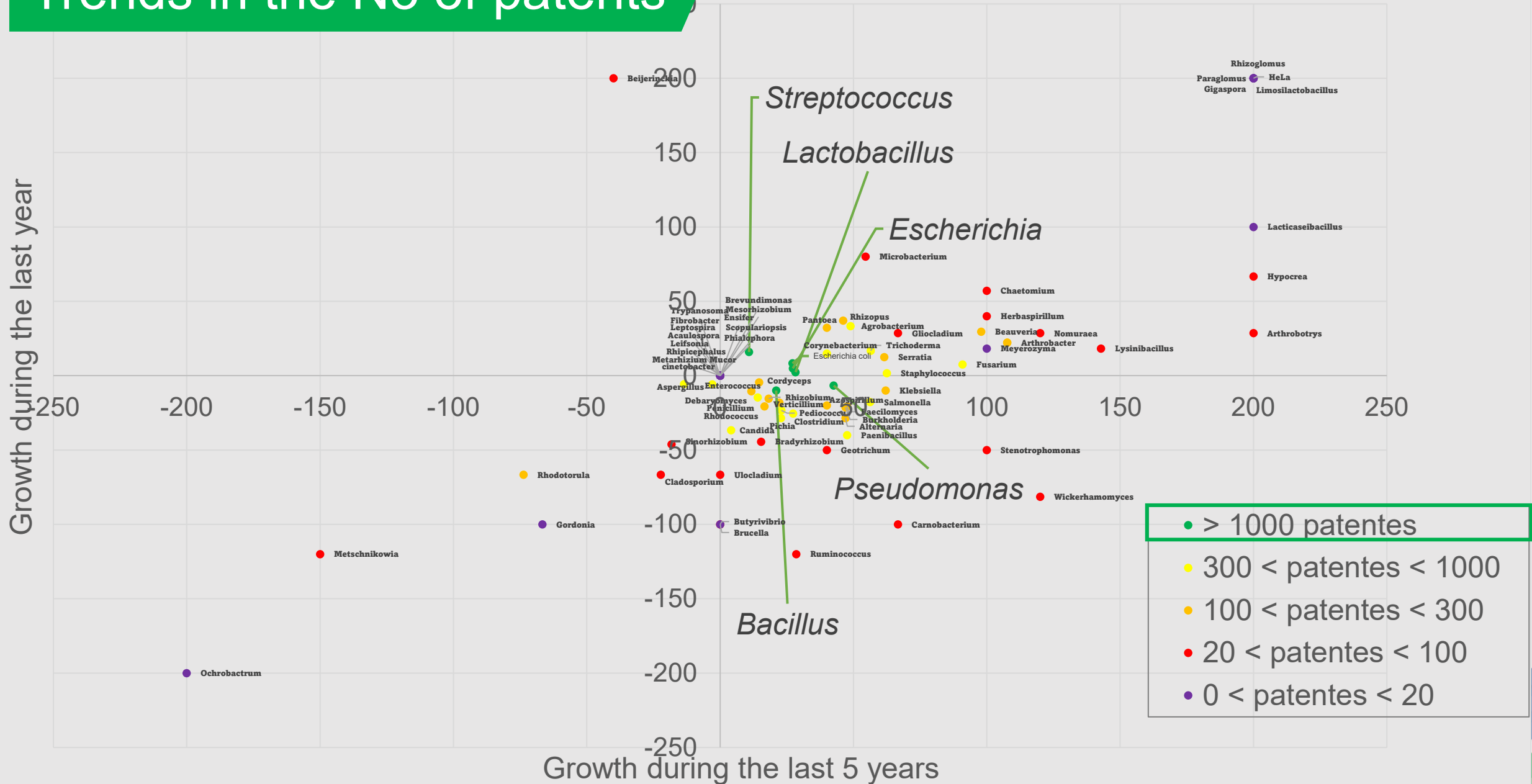


# Trend topics for microbial bioprospecting

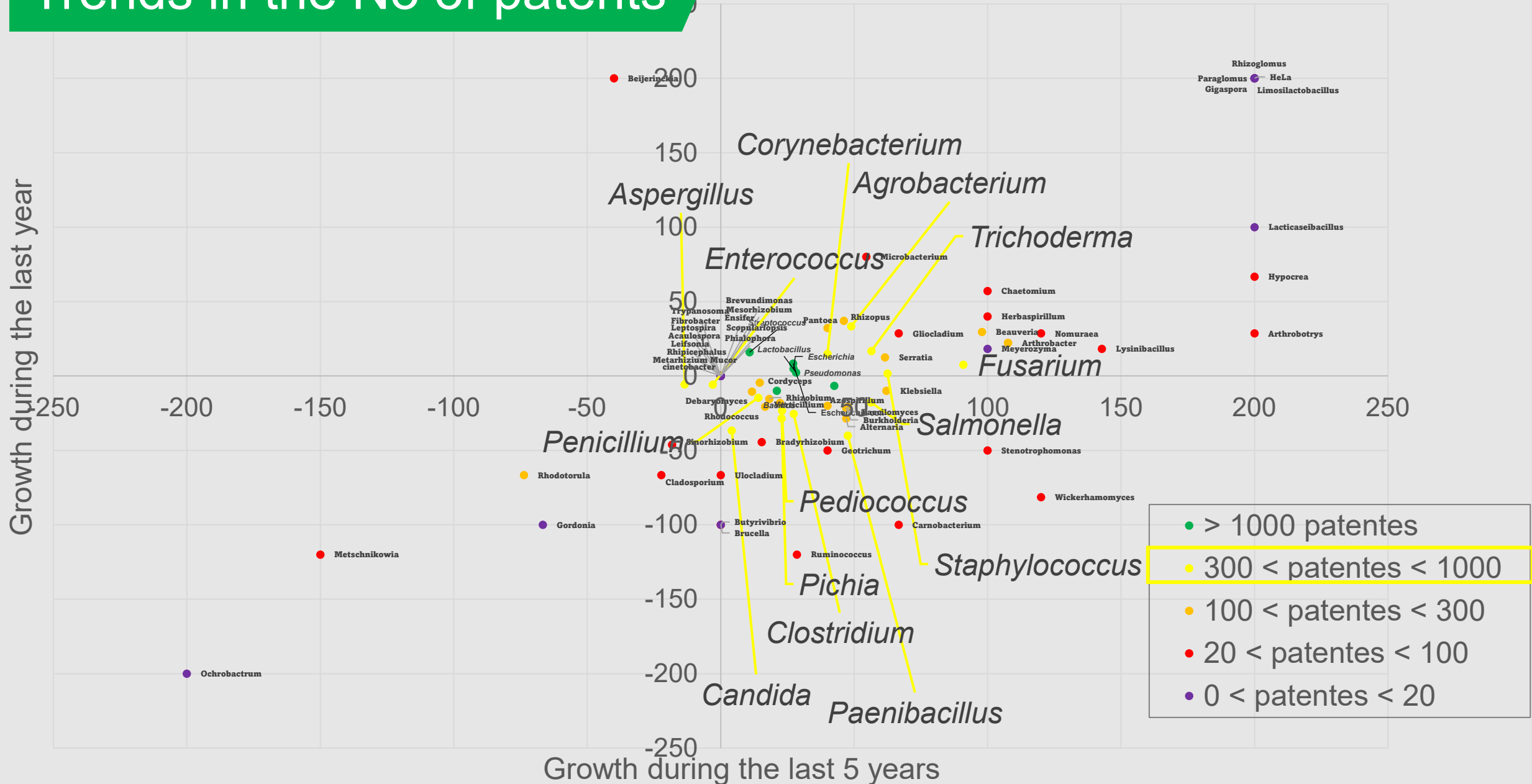


- Antimicrobial compounds
- Biofilms
- Biofertilizers
- Plant-microorganisms interaction
- Bioherbicides
- Soil, water and air pollution
- Bioremediation
- Plastics degradation and synthesis
- Endophytic microorganisms

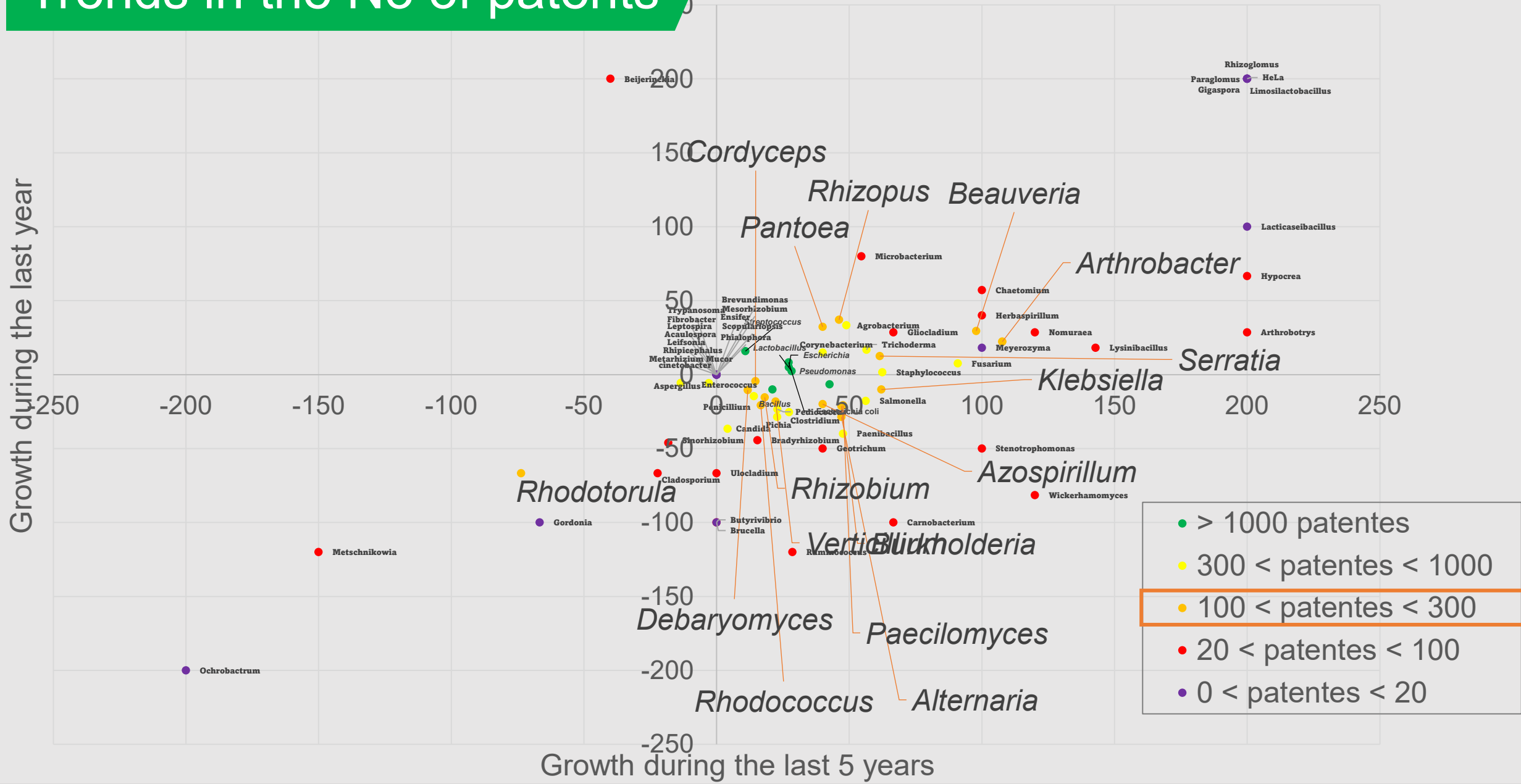
# Trends in the No of patents



# Trends in the No of patents

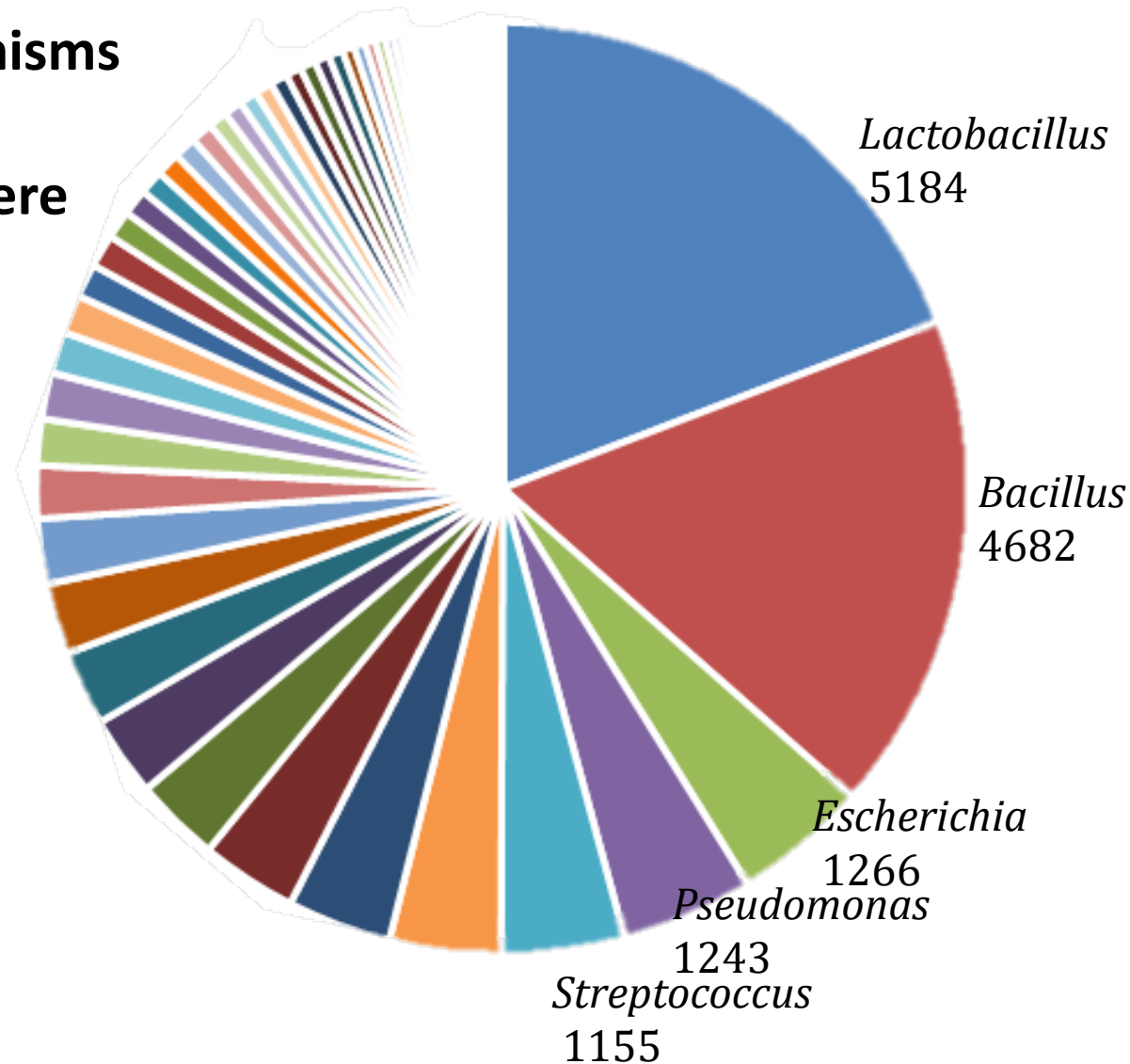


# Trends in the No of patents



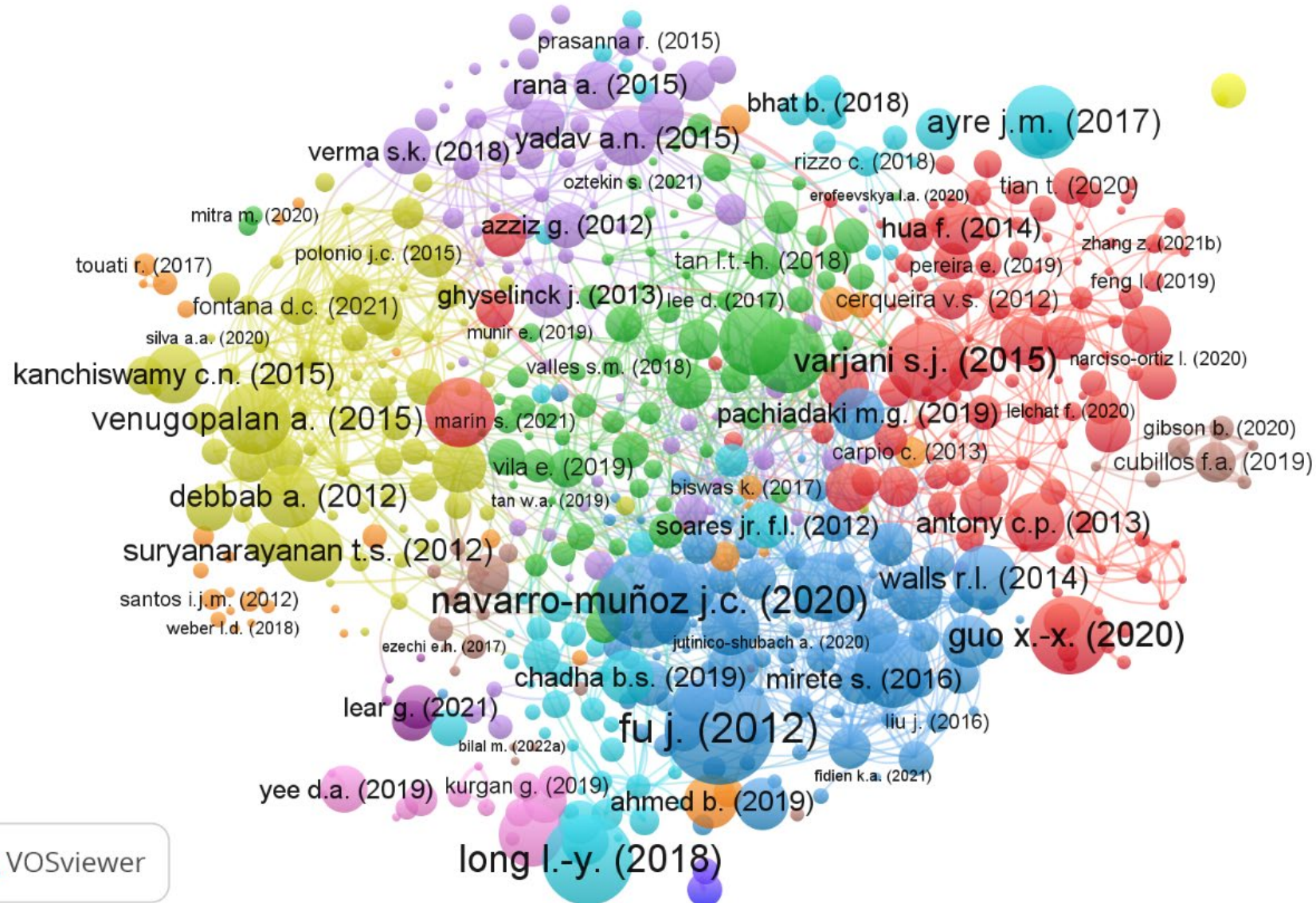
# Trends in the No of patents

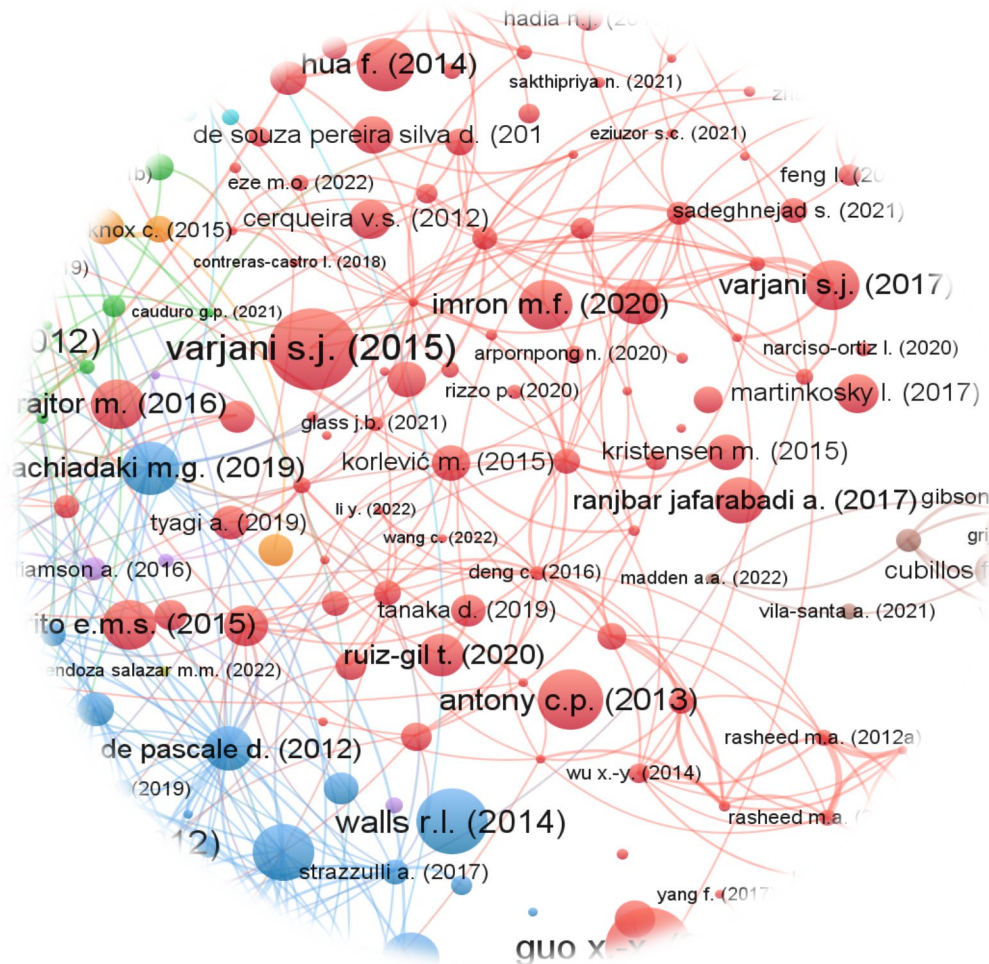
**Genera of microorganisms  
in which the largest  
number of patents were  
identified.**





# Baselines and Research Fronts





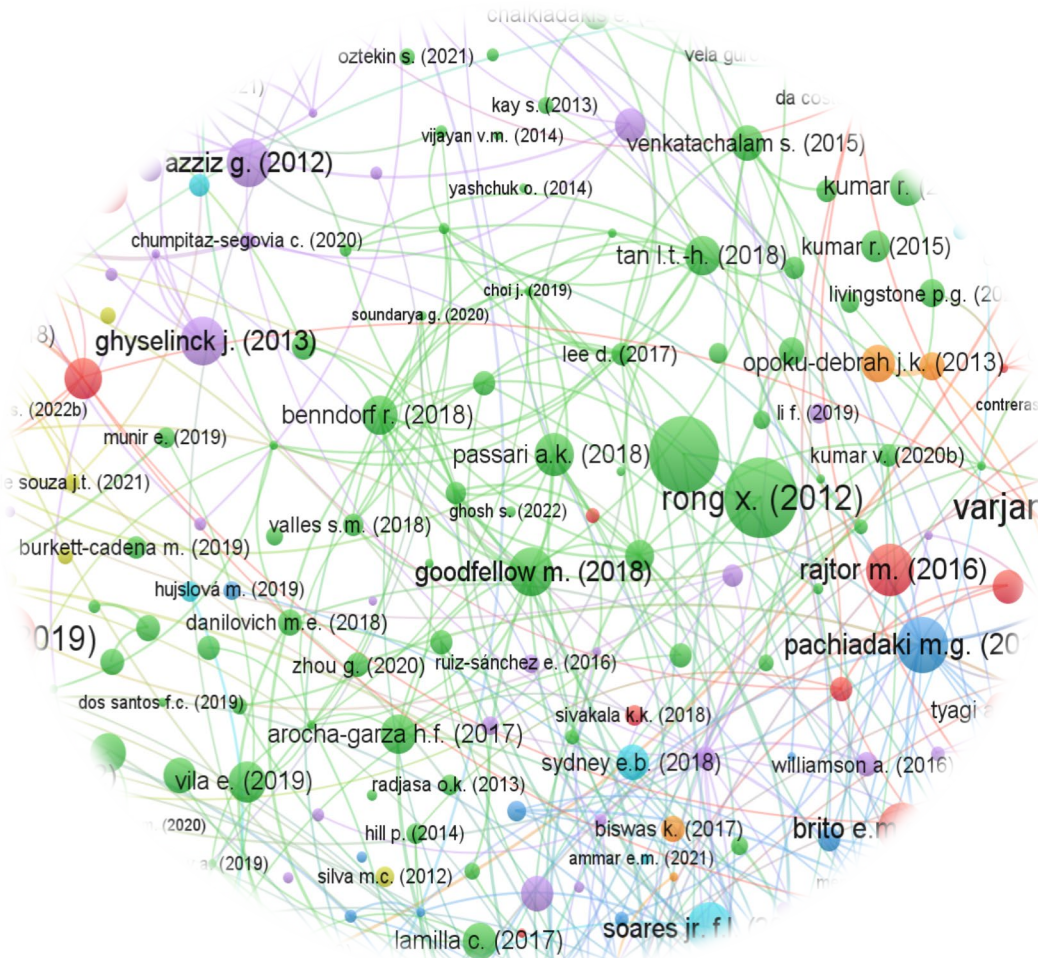
## Baselines

- Halotolerant consortia for hydrocarbon bioremediation and the effect of environmental factors.
- Bioindicators that promote hydrocarbon degradation by microbial communities.
- Study of microorganisms with antimicrobial activity that inhabit hydrocarbon-contaminated sites.

## Research fronts

- Biotransformation processes of aromatic hydrocarbons.
- Isolation of oil biodegrading microorganisms from unexplored habitats.
- Use of fungi as excellent sources of biosurfactants.

# Baselines and Research Fronts



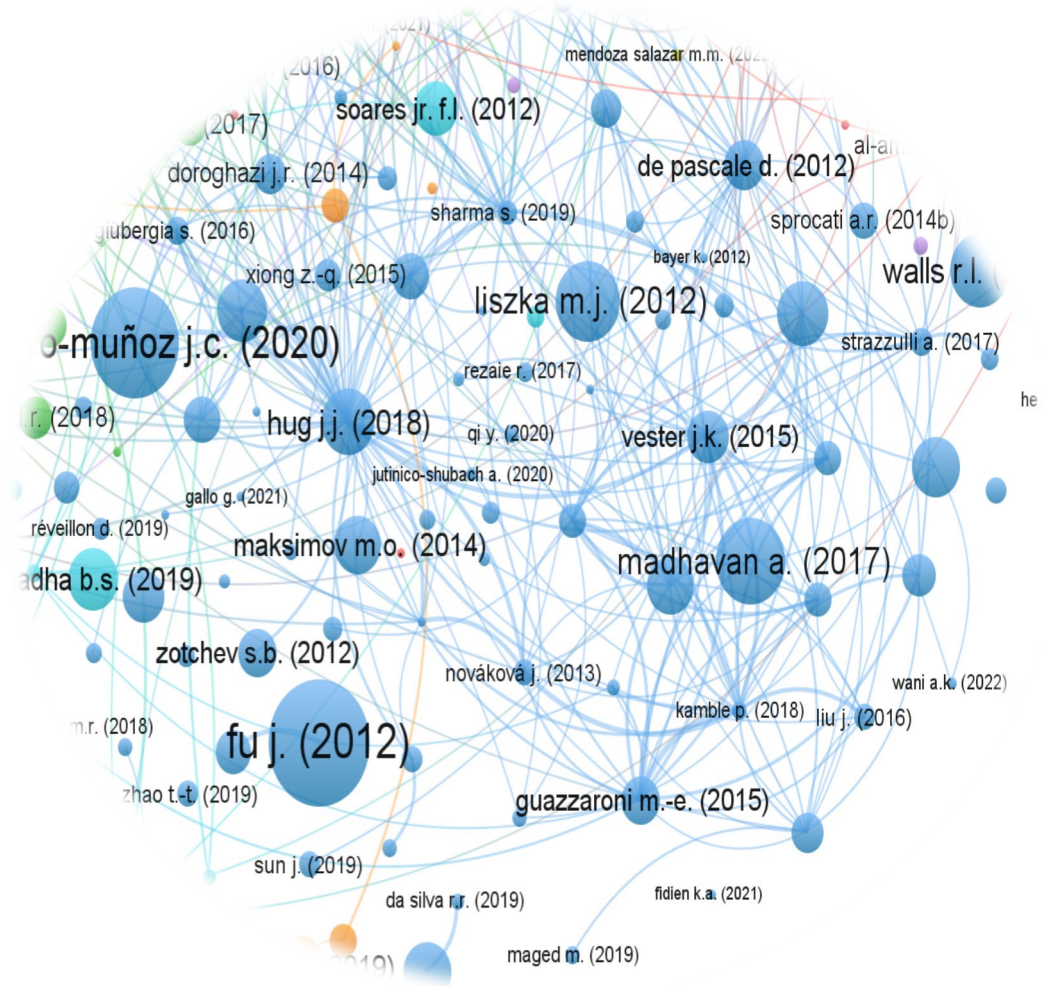
## Baselines

- Biodiversity studies of microorganisms by means of (MLST).
- Identification of new microbial taxa and metabolites, microorganisms from unexplored habitats such as Antarctica, Acatama desert, mangrove and river sediments and corals.

## Research fronts

- Research on microbial enzymes and their use for the degradation of insecticides such as fipronil, organic compounds that are difficult to degrade such as cellulose, chitin, phenols or benzopyrenes.
- Search for nanofactories for the bioremediation of environments contaminated by heavy metals.

# Baselines and Research Fronts



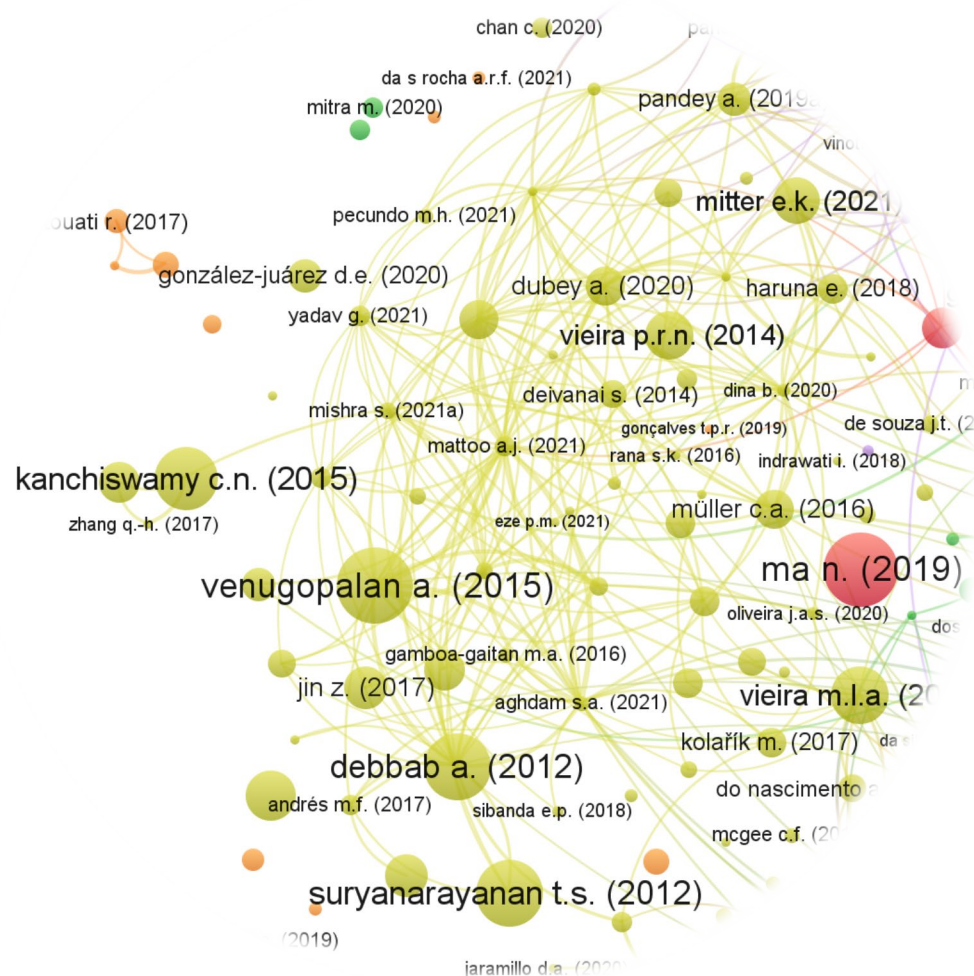
## Baseline and Research Front

- Research related to the identification of the potential of microorganisms in the production of natural compounds (antibiotics and enzymes) isolated from little-explored environments, particularly marine environments.

## Research Fronts

- Investigation of microorganisms from marine environments through metagenomics, bioinformatics, and metabolomics.

# Baselines and Research Fronts

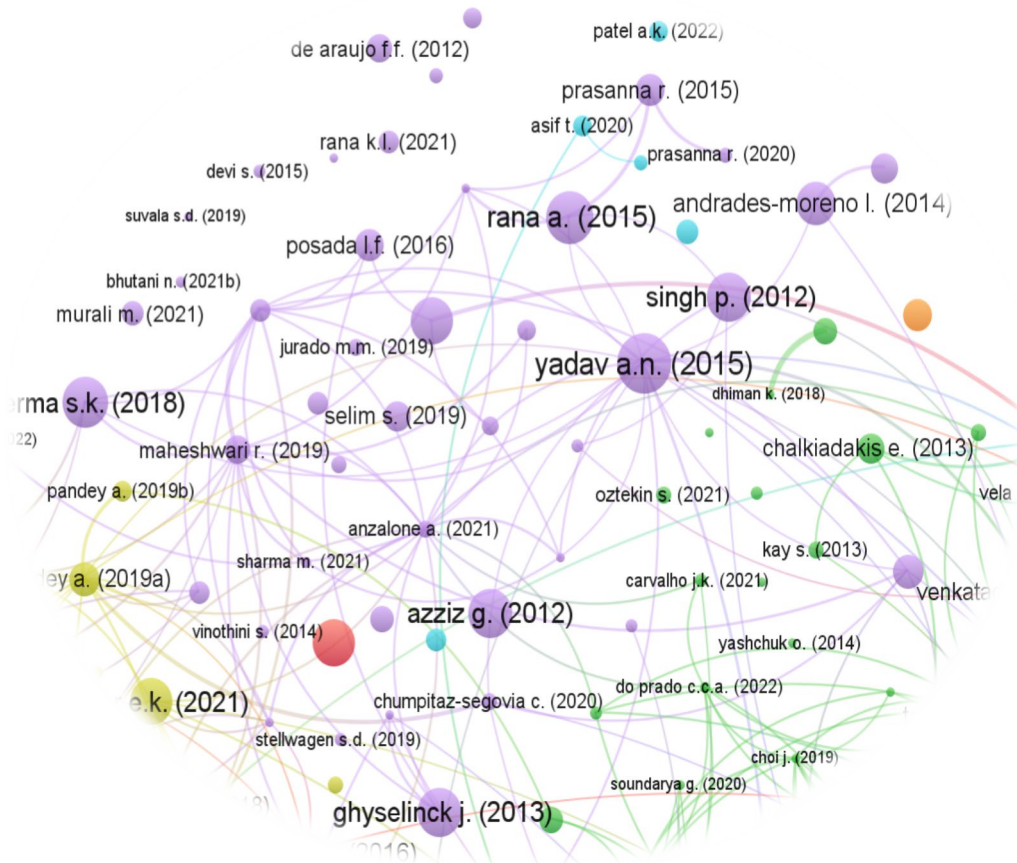


## Baseline and Research Front

- Research related to the characterization and identification of the potential of endophytic fungi that interact with plants and other eukaryotic organisms.

## Research Front

- Bioprospecting of endophytic fungi in agricultural applications, including:
  - Biocontrollers and inducers of resistance against phytopathogens and abiotic stresses
  - Biostimulants and plant growth promoters
  - Sources of new secondary metabolites



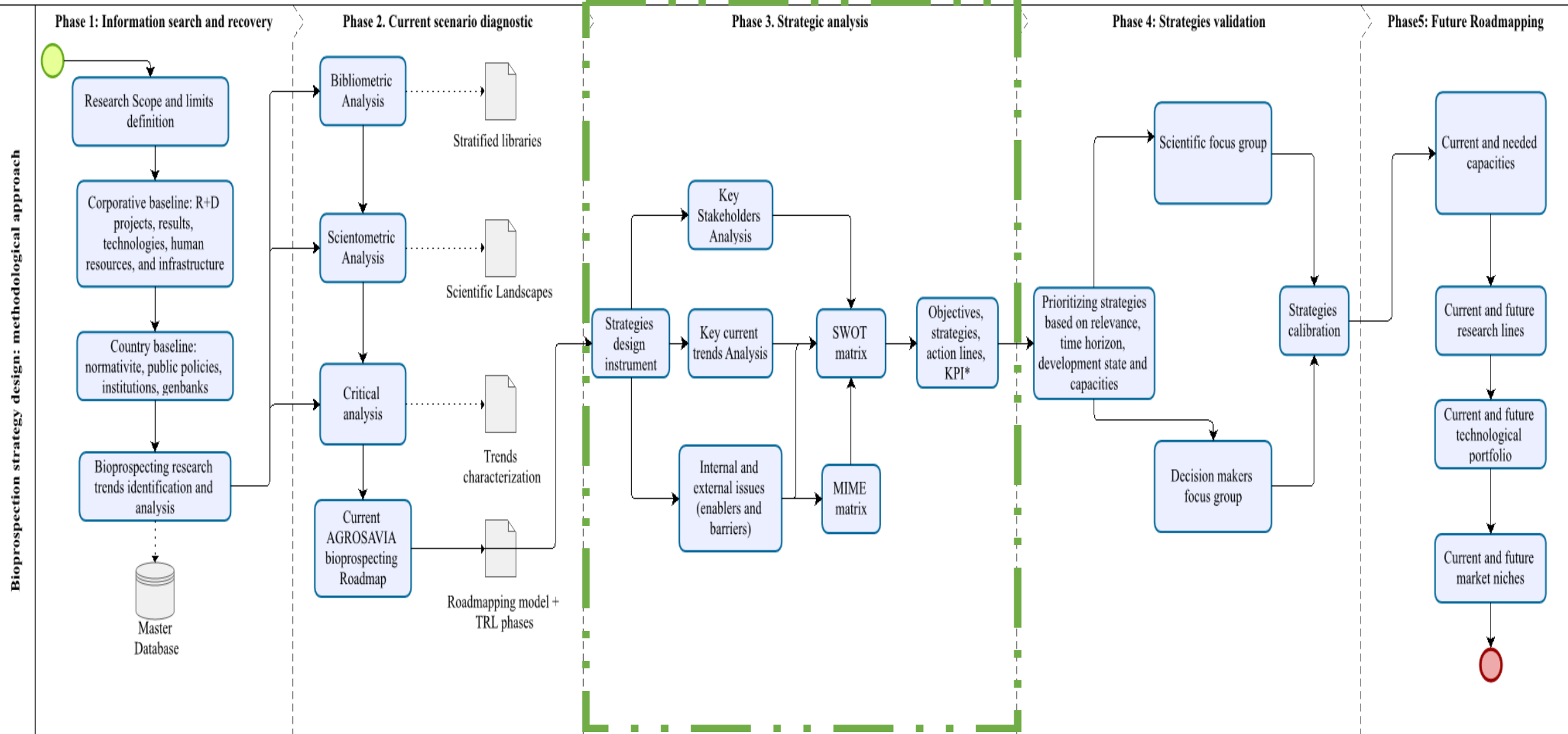
## Baseline and Research Front

- Research related to plant growth promoters.

## Research Fronts

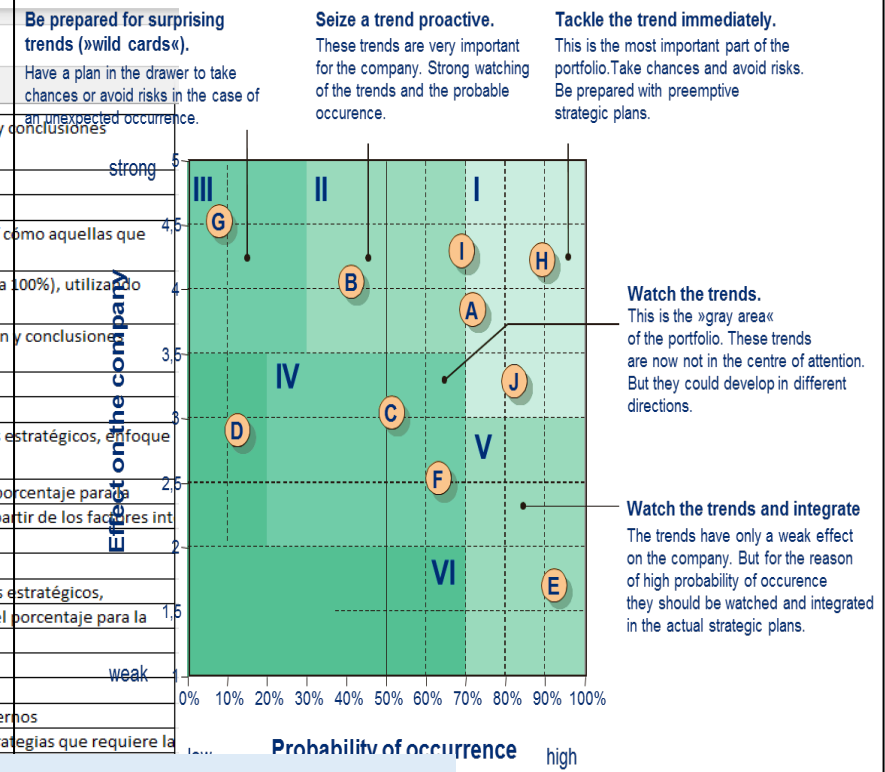
- Characterization of multiple phenotypes for plant growth promotion and other characteristics of agronomic interest, such as biological control.
- Characterization of the promoter effect and factors affecting the establishment of plant-bacteria interactions.
- Identification of microbial consortia to promote plant growth.
- Isolation and characterization of endophytic bacteria with potential as bioinoculants.

# Methodology



# Strategic analysis tool

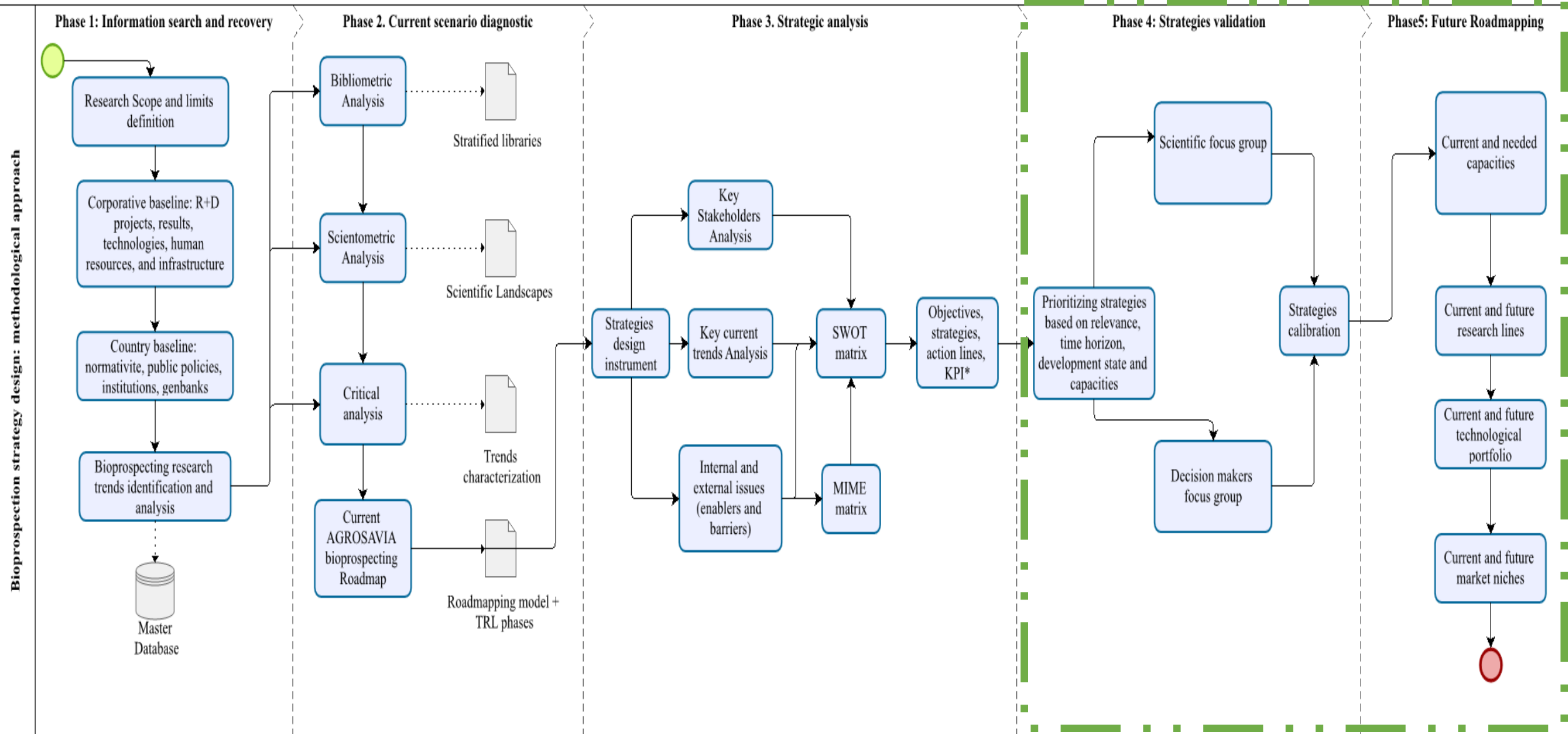
1. Identificación grupos de interés	1.3 Salidas esperadas	Clasificación de los actores generales del actor con relación a su influencia	Key stakeholders for strategy positioning	Key actors in strategy construction
	1.4 Uso en la hoja de ruta	Insumos para la formulación de la estrategia		
2. Análisis de tendencias	1.5 Usos posteriores	Identificar aliados actuales y potenciales	Actors with a neutral position	Key stakeholders in strategy development
	2.1 Objetivo	Categorizar las tendencias de acuerdo a su influencia y probabilidad de ocurrencia		
	2.2 Análisis	Para cada uno de los factores de tendencia, se debe definir su influencia (en decimales); y la probabilidad de ocurrencia (en decimales)		
	2.3 Salidas esperadas	Clasificación de los actores generales con respecto al actor		
	2.4 Uso en la hoja de ruta	Insumos para la formulación de la estrategia		
3. Factores Internos	2.5 Usos posteriores	Estudios de prospectiva territorial		
	3.1 Objetivo	Identificar los factores internos que afectan la competitividad territorial, generación de oportunidades y amenazas		
	3.2 Análisis	Identificar factores internos de fortalezas y debilidades		
	3.3 Salidas esperadas	Análisis de las fortalezas y debilidades		
	3.4 Uso en la hoja de ruta	Construcción de las Matrices MIMES y DOFAs (IE)		
4. Factores externos	3.5 Usos posteriores	Análisis de capacidades actuales y potenciales		
	4.1 Objetivo	Identificar los factores externos que afectan la competitividad territorial, generación de oportunidades y amenazas		
	4.2 Análisis	Identificar factores externos en cada una de las categorías indicadas. Para cada uno de los factores asignar el porcentaje ponderado con respecto al actor y el porcentaje para la empresa		
	4.3 Salidas esperadas	Análisis de las oportunidades y amenazas para la bioprospección en las zonas de interés a partir de los factores externos contemplados		
	4.4 Uso en la hoja de ruta	Construcción de las Matrices MIMES y DOFAs (IE)		
5. Matriz MIME	4.5 Usos posteriores	Análisis del contexto actual de la bioprospección		
	5.1 Objetivo	Identificar la tipología recomendada de estrategias acorde con el estado actual de la bioprospección corporativa frente a los factores internos y externos		
	5.2 Análisis	Ejecutar el análisis MIME en la hoja de cálculo usando el botón limpiar y luego el botón ejecutar. El resultado es una recomendación del tipo de estrategias que requiere la empresa		
	5.3 Salidas esperadas			
	5.4 Uso en la hoja de ruta			
6. Objetivos del marco de trabajo de bioprospección	5.5 Usos posteriores			
	6.1 Objetivo			
	6.2 Análisis			
	6.3 Salidas esperadas			
	6.4 Uso en la hoja de ruta			
7. Matriz DOFA (IE)	6.5 Usos posteriores			
	7.1 Objetivo			
	7.2 Análisis			
	7.3 Salidas esperadas			
	7.4 Uso en la hoja de ruta			
8. Formulación Estratégica	7.5 Usos posteriores			
	8.1 Objetivo			
	8.2 Análisis			
	8.3 Salidas esperadas			
	8.4 Uso en la hoja de ruta			



- Identification of the groups of interest.
- The trends analysis.
- Analysis of internal and external factors.
- Identifying weaknesses, opportunities, strengths, and threats.
- Defining the strategic objectives.
- Developing strategies.



# Methodology



# Acknowledgements



Head of Department of Agrobiodiversity  
Dr. Carolina González



Coordinator of Biological Resources  
Dr. Hugo R. Jiménez



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Dr. Diego H. Flórez/Leidy Cardenas



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Professional for Bioprospecting team  
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