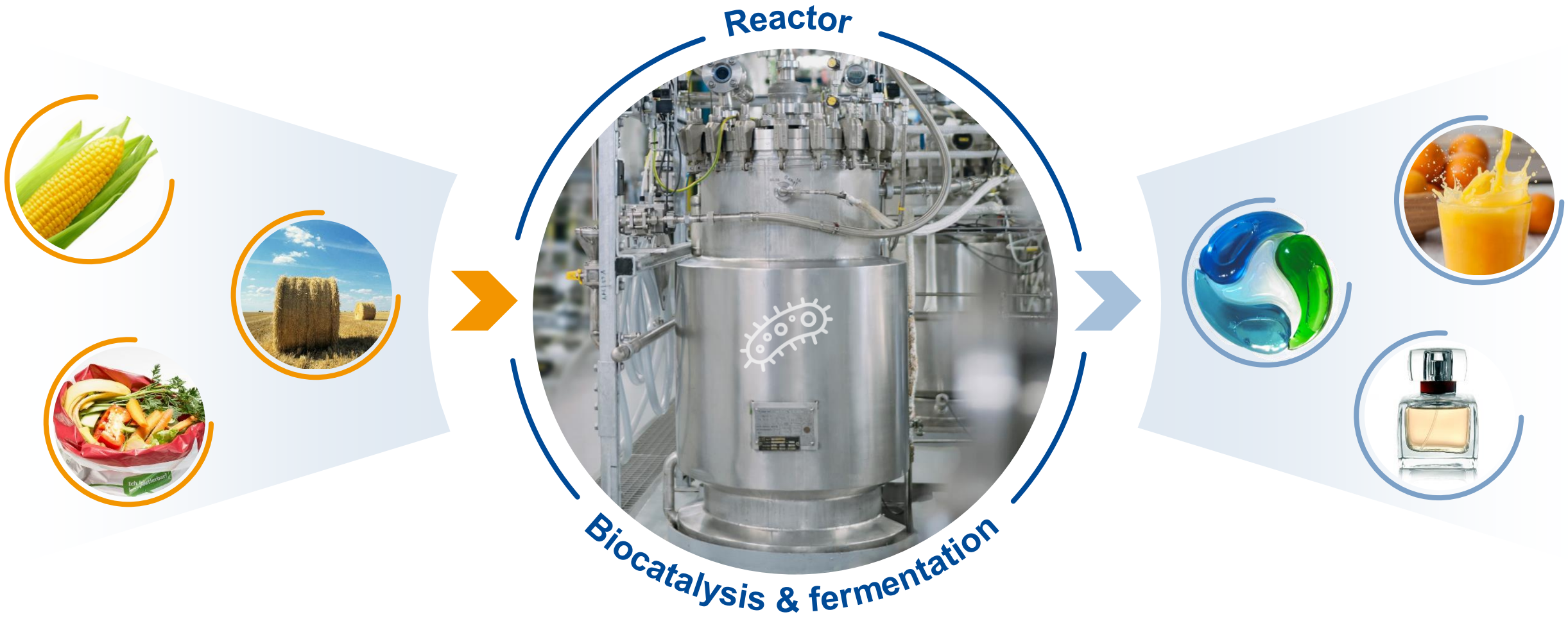
BASF
We create chemistry

White biotechnology as one key element of BASF's toolbox

Dr. Doreen Schachtschabel
Vice President, White Biotechnology Research

BASF Research Press Conference, November 17, 2022

Microbial cell factory



BASF
We create chemistry

White biotech enables a plethora of different products

Examples of launches and production startups

Schizophyllan
Biopolymer for enhanced oil recovery

Succinic acid
Solvent, e.g., for compostable plastics

Acrylamide
Diverse applications, e.g., in mining

Inscalis®
Specialty and row crops insecticide

Bacillus
Active ingredient for seed treatment in agriculture

Lavergy® Pro 106 LS
Lavergy® Pro 114 LS
Lavergy® C Bright 100L
Enzymes for laundry detergents

2012 — 2015 — 2018 — 2020

Before 2012

- >10 optically active intermediates and actives via biocatalysis
- Vitamin B_2 by fermentation

Natuphos E®
Enzyme for animal feed

Bacillus
Fungicide active ingredient for agriculture

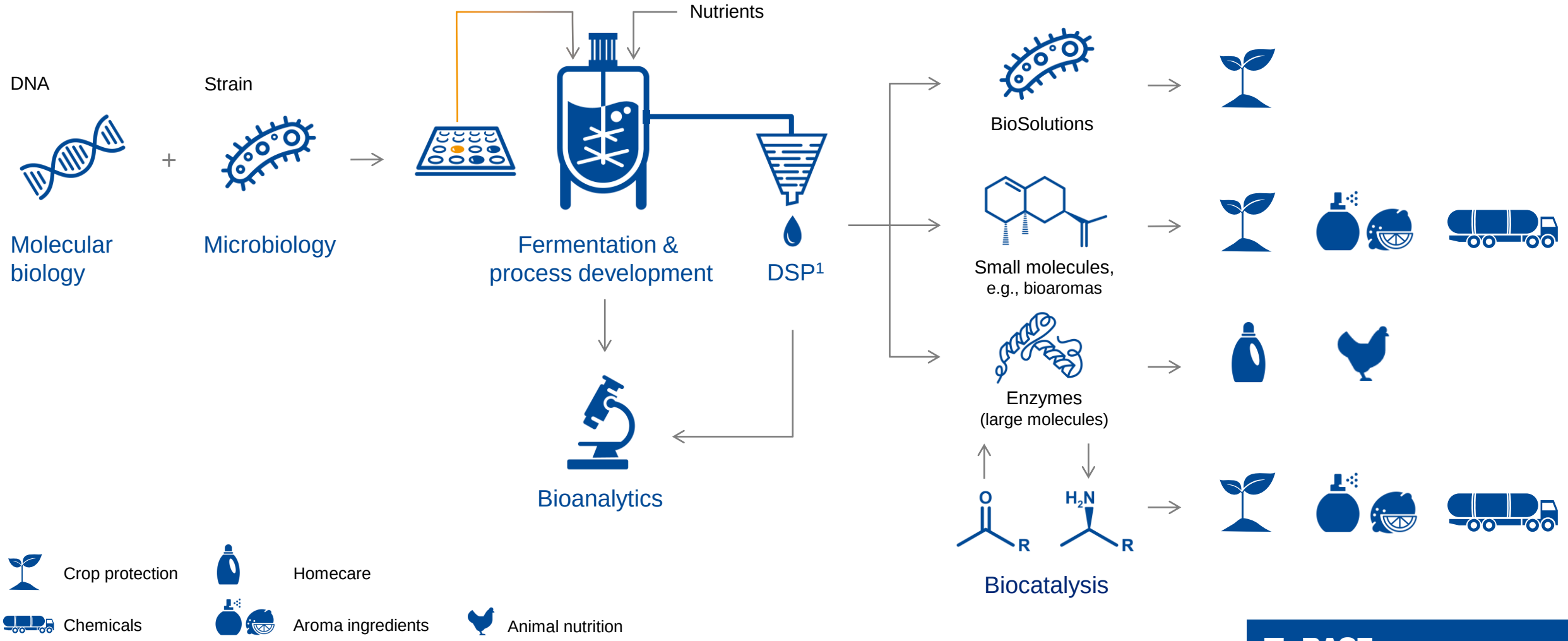
New vitamin B_2
production strain (2nd generation)

Santalol
Fragrance ingredient

Natupulse®TS
Enzyme for animal feed

BASF
We create chemistry

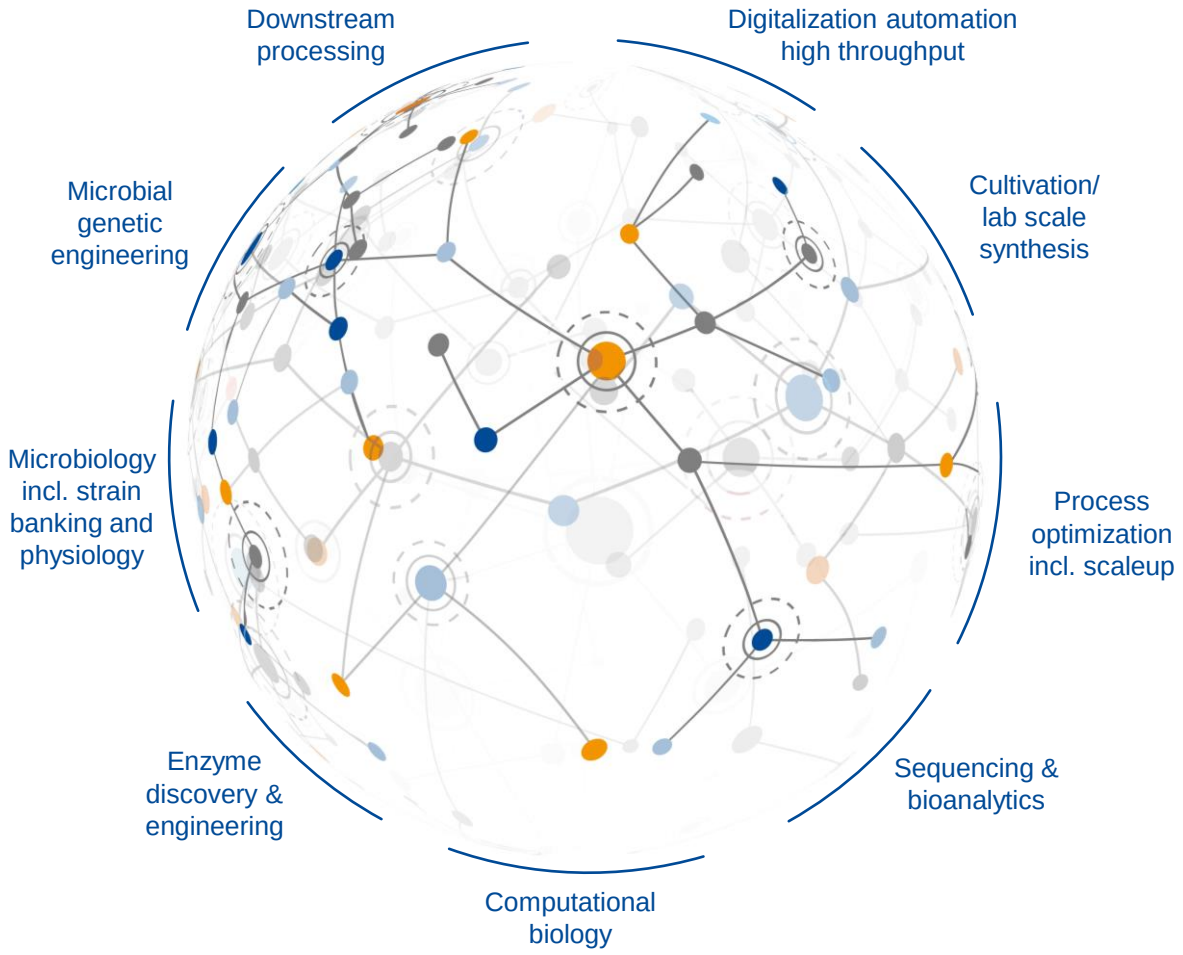
White biotechnology at BASF – covering the whole development chain



 [1] DSP = Downstream processing

BASF
We create chemistry

White biotechnology research competencies are offered in early collaboration with other units and professions[1]



~10 External service providers (e.g., gene synthesis, sequencing)

~10 Scientific collaborations worldwide (companies)

>30 Scientific collaborations worldwide (academic)

[1] Only examples for technologies and collaborating units shown.

BASF
We create chemistry

Digitalization: A prerequisite for our work

Data management
- Enhance data quality and FAIR[1] data
- Ensure legal and regulatory compliance (incl. Nagoya protocol)

Systems biology
- Targeted strain design
- Metabolic engineering
- Pathway optimization

Computational protein engineering
- Targeted optimization of proteins
- Protein structure predictions
- Molecular simulations

Bioinformatics
- Identification of genes and enzymes
- Searching in metagenome libraries
- Check sequence integrity

[1] FAIR = findable, accessible, interoperable and reusable

BASF
We create chemistry

BioSolutions by BASF: A complement to conventional crop protection

Bio fungicides
Serifel®

beneficial bacterium *Bacillus amyloliquefaciens* forms a strong shield of protection around plants

Bio insecticides
Velifer®

works by releasing the spores of the beneficial fungus *Beauveria bassiana,* controlling various pests

Bio seed treatment
Nodulator®

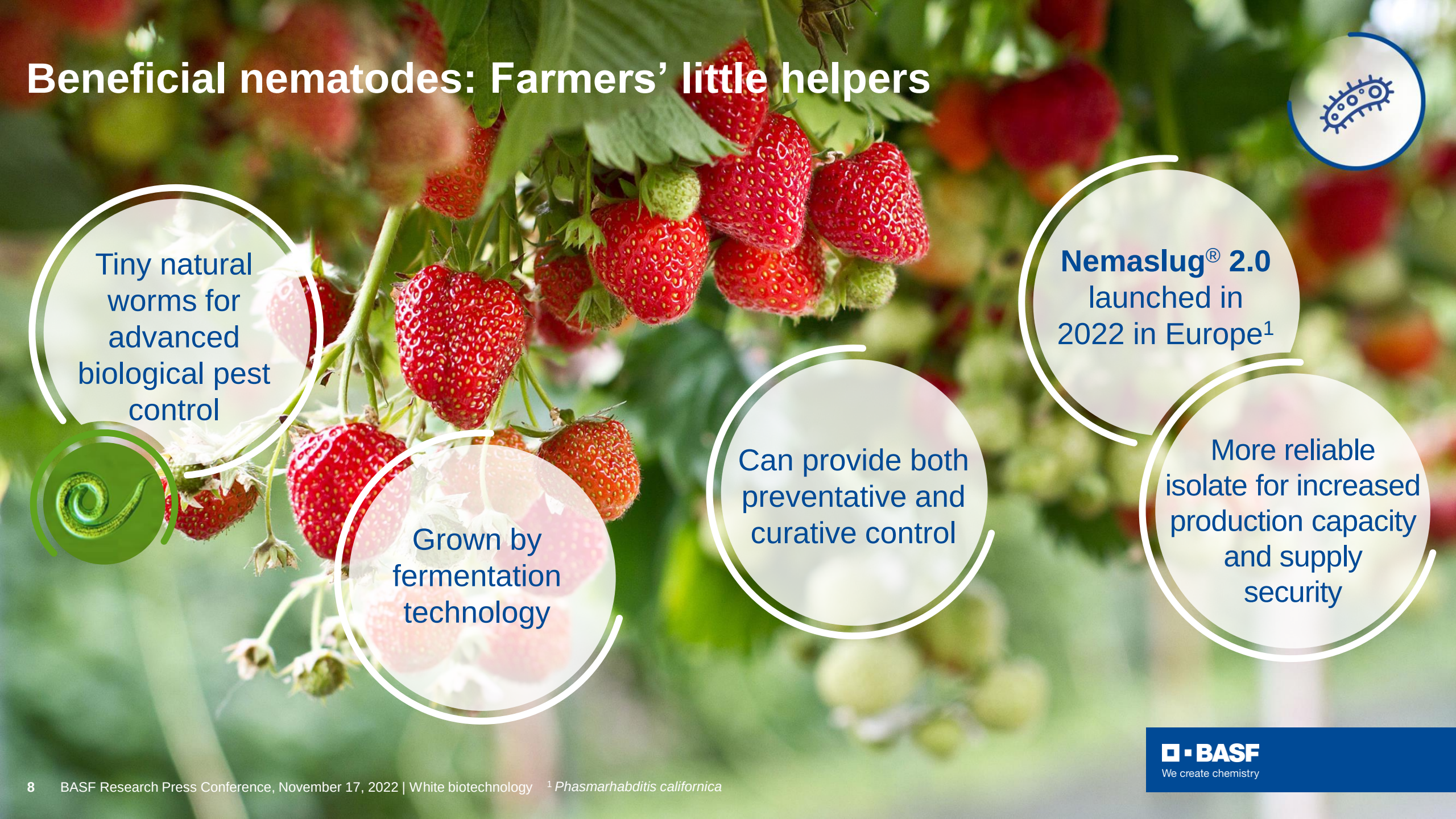
seed-applied inoculants help legumes fix more nitrogen

Beneficial nematodes
Nemaslug® 2.0, Nemasys®

microscopic worms which control a wide range of pests

BASF
We create chemistry

Beneficial nematodes: Farmers' little helpers



Tiny natural worms for advanced biological pest control

Grown by fermentation technology

Can provide both preventative and curative control

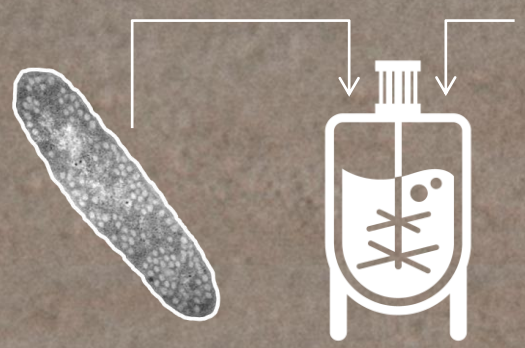
Nemaslug® 2.0 launched in 2022 in Europe[1]

More reliable isolate for increased production capacity and supply security

BASF
We create chemistry

[1] *Phasmarhabditis californica*

Fermentative production of flavors and fragrances



Intermediate →

Valencene → Santalol → Nootkatone → Bergamotene

Isobionics®

Rhodobacter

- Natural isoprenoid producer
- High product tolerance
- Scalable and robust
- No off-odors

Sustainability facts Santalol

- 100% free of endangered sandalwood trees
- Based on renewable resources
- Starting material is corn grown in Europe

BASF
We create chemistry

Inscalis® – a new insecticide based on fermentation

- **Inscalis®** for the control of piercing and sucking insects
- **Targets high-value crops:** fruits and vegetables, soybeans, cotton

- Co-developed with Meiji[1], Japan
  - First and only product in the pyropene class
  - Favorable regulatory profile
  - First regulatory approval in Australia in April 2018

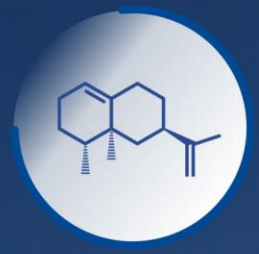
Untreated

Treated with Inscalis®

[1] Meiji Seika Pharma Co. Ltd; acquired in 2022 by Mitsui Chemicals Agro, Inc.

BASF
We create chemistry

Inscalis® – chemistry and biotechnology joining forces

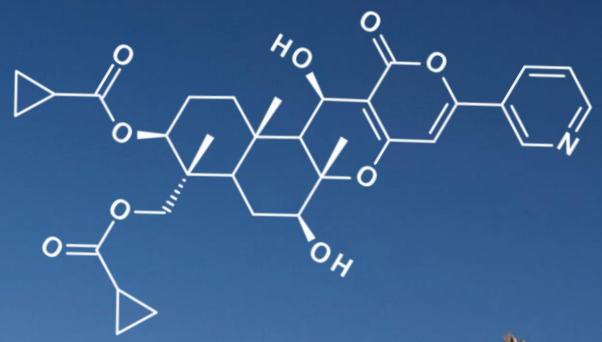


Step 1:
Fermentation

⊕

Step 2:
Chemical synthesis

⊖



Inscalis®

- **Production strain:** *Penicillium coprobium*
- **Fermentation optimized:** High productivity, low by-products
- Penicillium strain improved by metabolic engineering
- Chemical modification boosts activity

BASF
We create chemistry

Detergent enzymes: Excellent washing performers, even at low temperatures

- **Detergent enzymes:** e.g., protease, amylase, cellulase, mannanase, lipase
- **Production process:** based on bacterial and fungal hosts

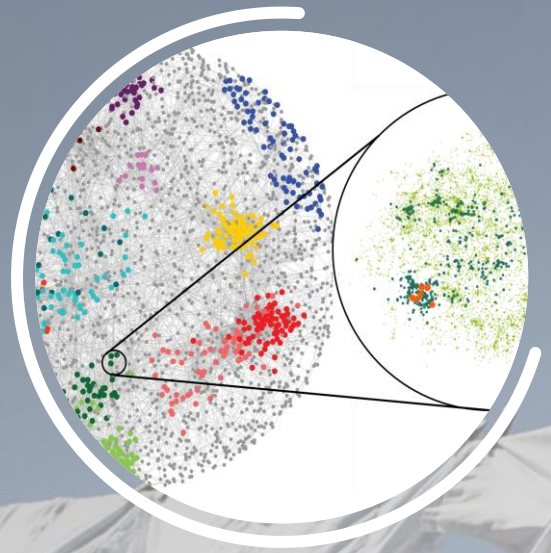
Benefits

- Lavergy® Pro series engineered and formulated proteases that remove tough stains at ambient temperatures
- Energy savings with lower wash temperatures
- Garment protection via Lavergy® C Bright (anti-greying protection)
- Bio-based and readily biodegradable

BASF
We create chemistry

Detergent enzymes: Stages of development

Discovery, screening and directed evolution of enzymes



Strain design by selection, genome editing and metabolic engineering

Process development and scaleup of fermentation and DSP[1]

[1] DSP = Downstream processing

BASF
We create chemistry

White biotechnology: One key element of BASF's toolbox

1 White biotechnology is gaining impact in the chemical industry as an **alternative/ complementing technology.**

2 **Speed and power** offered by genetic engineering, directed evolution and computational biology **enable competitive production processes.**

3 **From lab to market**: BASF has **successfully launched** numerous products based on white biotechnology in recent years.

4 **Increased market demand** for "green" and biodegradable products and the trend towards sustainability are **opportunities** for the field.

BASF
We create chemistry

BASF

We create chemistry