Crop Science ESG Investor Webinar

Sustainability Update: Biodiversity & Crop Protection

October 23, 2023

4:00 - 5:30 pm CEST
2:00 - 3:30 pm UTC
10:00 - 11:30 am EDT
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Agenda

1. Prepared Remarks
   - Welcome and Introduction
     - Dr. Klaus Kunz
     - Head of ESG External Engagement & Performance Reporting
   - Biodiversity & Regenerative Agriculture
     - Jessica Christiansen
     - Head of Sustainability & Business Stewardship, Crop Science
   - R&D and Stewardship in Crop Protection
     - Robyn Kneen
     - Head of Global Regulatory Scientific Affairs, Crop Science
   - Environmental Impact Reduction of Crop Protection ("CP EIR")
     - Daniel Glas
     - Sustainability Venture Lead, Crop Science

2. Q&A with all Speakers and additional Experts
Transparency as integral part of our sustainability efforts
Enhanced transparency efforts accompanied by engagement to regain and strengthen trust
Our Global Food Systems are Under Increasing Pressure

Demand for Sustainably Sourced Food and Renewable Fuels Never Greater

**GROWING POPULATION**

+2.2bn people on the planet by 2050¹

+50% more food and feed required to meet growing demand ²

+3bn people live in agricultural areas with high to very high water shortages³

>70% of all available freshwater is used in agriculture⁴

90% of all soils are expected to be degraded by 2050⁵

**PRESSURE ON ECOSYSTEMS**

-17% harvest losses from climate change⁷

-20% loss in arable land per capita by 2050⁶

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² FAO 2017, (FAO Global Perspective Studies)
³ FAO, 2020 (Water Scarcity | UN-Water (unwater.org))
⁴ UN-Water, 2021 (Water Scarcity | UN-Water (unwater.org))
⁵ FAO Saving our soils by all earthly ways possible | FAO Stories | Food and Agriculture Organization of the United Nations
⁷ Nelson et. al, (2014); FAO 2016 "Climate change and food security"
Our Vision
for Sustainable & Regenerative Ag Solutions

“Producing more with less and restoring more”

... based on system-based approaches, amongst others enabled by

our Biodiversity strategy,

responsible R&D and Stewardship, and

ongoing Environmental Impact Reduction
Jessica Christiansen

- Head of Sustainability & Business Stewardship, Crop Science

Biodiversity & Regenerative Agriculture
How serious is Biodiversity decline?

According to the 2019 IPBES\(^1\) Report more than 1 million species of plants and animals are facing extinction.

What does it mean for agriculture?

The average abundance of native species in most major land-based habitats has fallen by at least 20% mostly since 1900.

90% of all soils are expected to be degraded by 2050\(^2\).

Currently, land degradation has reduced productivity in 23% of the global terrestrial area.

It is estimated that about 10% of insects are being threatened.

Many countries report declines in populations of birds, bats, and insects that contribute to pest and disease regulation\(^3\).

>75% global food crop types rely on animal pollination.

Reductions in the diversity of cultivated crops, crop wild relatives, and domesticated breeds mean that agroecosystems are less resilient against future climate change, pests and pathogens.

9 out of 6,000 crop species account for 66% of total crop production\(^3\).

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\(^1\)IPBES = Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

\(^2\) FAO Saving our soils by all earthly ways possible | FAO Stories | Food and Agriculture Organization of the United Nations

\(^3\) The State of the World Biodiversity for Food and Agriculture – in Brief (fao.org)
What are the main drivers of terrestrial biodiversity decline? … and what needs to be done to bend the curve of biodiversity decline?

- **Pollution**: Crop protection application is not the major contributor to loss of biodiversity: nitrogen over fertilization (eutrophication) is likely to play a much bigger role (78% of global eutrophication).

- **The impact of climate change might increase in the future**: it can also contribute to habitat degradation

- **Land use change**: habitat loss, degradation, fragmentation and land-use intensification are the major drivers
  - Agriculture is one of the major contributors
  - Need to better balance production and conservation
  - Implement more sustainable/ **regenerative**/ biodiversity friendly, nature positive cropping systems which generate benefits for the farmer (and Bayer) while increasing yield
Bayer advocates for an outcome-based definition of Regenerative Ag to drive a solution-oriented approach

Providing a flexible framework that adapts to local field conditions, does not compromise productivity and increases yields

To achieve these **benefits**, **Bayer** supports the following **principles**:

- **Principle A**: Keep the soil covered
- **Principle B**: Diversify rotations
- **Principle C**: Minimize soil disturbance
- **Principle D**: Optimize inputs and reduce impact

**Benefit 1**: Yield increase and improved productivity
**Benefit 2**: Social and economic well-being of farmers and communities
**Benefit 3**: Improve soil health
**Benefit 4**: Mitigate climate change
**Benefit 5**: Strive to maintain, preserve, or restore biodiversity
**Benefit 6**: Conserve water resources

For more details see [https://www.bayer.com/en/agriculture/regenerativeag](https://www.bayer.com/en/agriculture/regenerativeag)
Future of Farming

Broadening our sustainability approach with a regenerative focus

Sustainability Focus

“Producing more with less”

We’re supporting food security while reducing agriculture’s impact on nature

- We’re committed to: (1) minimizing the climate footprint of farming, (2) reducing the environmental impact of crop protection, (3) enabling smallholder farmers and (4) improving water use

Reducing and mitigating: Increasing productivity while reducing the impact on nature

Regenerative Focus

“Producing more and restoring more”

We’re supporting food security and securing farm incomes while delivering net benefits to nature

- We’re committed to: (1) minimizing the climate footprint of farming, (2) reducing the environmental impact of crop protection, (3) enabling smallholder farmers and (4) improving water use

- We’re delivering nature-positive outcomes by improving soil health, restoring and protecting habitats, conserving water and sequestering carbon

- We’re helping farmers increase productivity and incomes with climate adaptation solutions and new sources of revenue

Adapting and regenerating: Increasing productivity and incomes while renewing nature

For more details see https://www.bayer.com/en/agriculture/sustainable-agriculture
Direct Seeded Rice Cropping System Approach
Providing Sustainability Benefits to Rice Production for Farmers and the Environment while Improving Farmer ROI

Bayer’s Unique System of Solutions

Core Portfolio
// non-GM herbicide tolerant hybrid rice
// Seed treatment
// Herbicides
// Nematicide
// Next Gen insecticides
// Next Gen fungicide

Digital Solution
// FarmRise

Agronomic advice
// Better Life Farming

Effect on subsequent crop in rotation

Features, Benefits, and Outcomes

ECOLOGICAL
// Reduced GHG emissions during cropping cycle & post harvest (up to 45 %) 6
// Reduced water use (up to 40 %) 5
// Carbon farming opportunities
// Optimal & responsible crop protection and fertilizer use
// Better soil health (tbc via Soil Health Index)

SOCIAL
// Improved food security and climate resilience
// Enhanced farmer health & safety
// Expanded gender-smart interventions

ECONOMICAL
// Higher yield output using less labor, inputs, and time vs transplanting (16 % lower costs) – Improved farmer incomes 4
// Additional incentives from verifiable carbon credits
// For FarmRise and Better Life Farming – access, know-how, & expertise on new technologies and practices, plus agricultural & financial service providers

Certain products and potential features, benefits, and outcomes on this slide are aspirational and may be subject to regulatory approvals and final verification

Current Needs
// Managing rice production with scarce and increasingly expensive labor
// Gaining more know-how on new & better technologies and practices
// Increasing productivity while keeping costs manageable
// Adapting to climate change with expected water scarcity

Ramesh
Location: India
Size: 3 acres
Crops: rice

Internal estimate via DirectAcre program in India 4
Carbon emission - IPCC (2006/2019) 6
Generating benefits for growers through the preservation of biodiversity and enhancement of eco-system services

We work along 3 pillars to build out the corresponding elements

SOIL HEALTH BENEFITS

// Yield stability
// Drought resilience
// Nutrient availability
// Water quality, retention & availability
// Carbon sequestration
// Disease suppression

Examples:
Long-term sustainability trials over entire crop rotation in Argentina, US, and India

HABITAT BENEFITS

// Land use optimization (e.g., enrolling unproductive land or existing farmland habitats in incentive schemes)
// Benefits from ecosystem services such as protection against run-off and erosion, pollination, natural pest control

Examples:
Latin America (ProCarbono commodities program), North America (habitat initiatives, Rol map), Bayer Forward Farming to showcasing flower strips etc.

GENETIC DIVERSITY BENEFITS

// Access to better crop genetics
// More resilient crops (climate change & resource efficiency)
// More diverse and regenerative crop systems (incl. cover cropping & intercropping)

Examples:
Collaboration with World Vegetable Center and other gene banks, CoverCress, Intercropping with Moraleda bean (India); Product concepts in biotech (e.g. breeding for cold tolerance to enable no till)

Also see
- Group positions on insect detling, deforestation and forest degradation, and protection of biodiversity
- Biodiversity website
Measurement of Biodiversity as ongoing challenge
Leverage internal and external knowhow by actively participating in diverse global associations

<table>
<thead>
<tr>
<th>Driver</th>
<th>Target</th>
<th>Measurement</th>
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<tbody>
<tr>
<td>Pollution</td>
<td>Crop Protection Environmental Impact Reduction</td>
<td>Treated area weighted environmental impact / ha</td>
</tr>
<tr>
<td>Climate change</td>
<td>GHG reduction</td>
<td>Carbon intensity (CO$_2$eq/t)</td>
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<tr>
<td>Land degradation</td>
<td>Soil Health Improvements (no target set)</td>
<td>Soil health Index etc.</td>
</tr>
<tr>
<td>Land use change</td>
<td>Habitat protected/ restored (no target set)</td>
<td>Area (e.g. via remote sensing)</td>
</tr>
<tr>
<td>Agriculture</td>
<td>Increased biodiversity (no target set)</td>
<td>Number of species (e.g. e-DNA, metabarcoding)</td>
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Challenges

// Identify scalable and affordable metrics
// Define easy to quantify output targets- taking into consideration local and regional conditions
// Biodiversity is influenced by many factors – not only agriculture
Joint efforts help us to be more impactful
Partnerships and Collaborations to effectively address biodiversity decline

**USA**
- Farmers for Monarchs
- National Fish and Wildlife Fund

**LATAM**
- Sustainability Trials
- IPAM/Woodwell
- Native Pollinators Project
- Modern Breeding Project
- TELA Maize
- Soil biodiversity monitoring BFF

**Spain/Port**
- BayDiversity

**EU**
- Biomonitor4CAP
- BIODT
- Insect Decline Group
- Pollinator Biodiversity in Agriculture
- Medical Plants Biodiversity Project

**India**
- DSR

**Africa**

**Type of partnerships**
Research and Development
Link to Commercial
Robyn Kneen

• Head of Global Regulatory Scientific Affairs, Crop Science

R&D and Stewardship in Crop Protection
Leading R&D Agriculture Platforms

Extensive Germplasm and Biotech foundation, combined with strength in Chemistry, Biologicals and Data Science Optimization, serves as Innovation Engine to discover, combine and tailor solutions for farmers.
Chemical Crop Protection – From Idea to Market

After 10 to 14 years and an average investment of about €250m, one compound reaches the market.
CropKey Approach to Open Uncharted MoA & Chemical Spaces
Serving the Needs of Farmers & Society

**Advanced Discovery Engine**

- **Computational Target Discovery**
  Discover selective and safe MoA by proprietary algorithms & omics

- **New Paradigm in Screening**
  Gain deep knowledge on biological systems by Machine learning approaches & virtual screening and docking

- **Digital Chemistry**
  Explore unlimited virtual chemical spaces by AI supported selection, design & synthesis

- **Predictive Early Safety**
  Focus on registrability & sustainability supported by early *in vitro* tests & *in silico* predictive models

**What do we plan to deliver?**

From incremental innovation on traditional chemistry to disruptive innovation towards next generation of sustainable chemistry:

- Highly effective and precise
- Breaking resistance
- Unprecedented sustainability and safety profile
Product Development is based on a holistic assessment covering efficacy, human & environmental safety, economic factors and more.

- There is no one size fits all solution.
- Each product/substance has its unique characteristics.
- Scores regularly depending on uses.
- It is key to include all relevant metric into product and substance development to enable informed decision making.
Risk Assessments as fundament of most regulations
Crop Protection Products should not pose unacceptable risk to human or animal health or the environment

What is a Risk?  \[ \text{Risk} = \text{Hazard} \times \text{Exposure} \]

E.g.: watching a shark from the beach doesn’t present a risk to your health

Swimming with it does!

We conduct extensive hazard and exposure assessments:

**Environmental Risk Assessment** incl.
- Ecological Hazard Identification
- Exposure Analysis

**Human Health Risk assessment** incl.
- Mammalian Hazard Identification
- Exposure Analysis

**Teams:**
- Ecotoxicology Team
- Environmental Sciences Team
- Toxicology Team
Hazard & Exposure Assessment

What effects are caused by the substance?

Similar studies are conducted in the areas of

- Toxicology
  - Acute “6-pack”
  - 28-day and 90-day
  - Chronic tox and/or carcinogenicity
  - Developmental toxicity
  - 2-generation reproduction
  - Genotoxicity
  - Acute & subchronic neurotoxicity
  - Endocrine disruption
  - Mode of action
  - Absorption, distribution, metabolism and excretion

- Ecotoxicology

- Environmental Fate

- Efficacy & Product Chemistry

- Metabolism & Residue

How does the exposure occur, how much is the exposure, for how long?

**Human Health**

- Exposure during application
- Residues in food and feed – establishment of MRLs
- Estimation of **dietary exposure levels** from food and drinking water

**Conduct of Exposure Studies:**

- Dermal Exposure
- Inhalation Exposure
- Dislodgable Foliar Residues (DFRs)

![Diagram](image_url)
Good Laboratory Practice (GLP)

Ensuring study data is reproducible, reliable, traceable and credible

Principles outlining how safety studies are planned, performed, monitored, recorded, reported and archived to maintain quality and integrity of study data that support regulated products:

Qualified personnel to ensure GLP compliance

Studies must be clearly planned, conducted, reported and monitored, with reviews and quality assurance checks

Documentation has to ensure each step is retraceable, reliable and transparent

Regulatory authorities conduct independent audits on companies’ processes, test facilities, and studies to confirm GLP compliance

Sponsorship is disclosed on the cover page of the study reports that are part of the regulatory dossier that is submitted to authorities.
Heterogenous Regulatory Landscape in Crop Protection

Regulatory requirements are continuously evolving and increasing

**North America: Risk-based regulation**
- High and increasing regulatory requirements
- Complex and sophisticated risk assessment
- Export orientation requires global registration strategies

**Europe 27: Hazard-based regulation**
- High and increasing regulatory requirements and new guidelines
- Green Deal and Biodiversity expected to drive future requirements
- Complex and resource demanding regulatory system

**Latin America: Very diverse requirements**
- **Brazil**: Move towards risk-based regulatory framework
- **Many countries**: Low but increasing regulatory standards driven often by export requirements
- Export orientation requires global registration strategies

**Asia Pacific: Very diverse requirements**
- **Many countries**: Standards increasing due to growing food safety and environmental concerns
- China introduced a unique barrier for acceptance GLP OECD international studies
- No or limited data protection in many countries

**Trade:**
- Global standards at risk due to national deviations (EU, China, Korea, USA, Brazil....)
Bayer Raises the Bar with our own Safety Standards

Bayer safety standards reflect those of IGOs, regulatory authorities and the latest scientific developments (example: Operator Safety Standard)

Standards and guidelines of (IGOs)
- Food and Agriculture Organization of the United Nations
- World Health Organization
- OECD guidelines

The International Code of Conduct on Pesticide Management

Latest scientific developments in Risk Assessment

Standards of reference regulatory authorities

Independent 3rd party validation

Bayer safety standards
Strong organizational Governance setup

CS R&D Governance

Overarching Product Safety Governance

License to Operate (LtO) Committee

Regulatory LtO & Product Safety Committee

Regulatory Policy & Issues Committee

Product Safety & Stewardship Committee

Incidents with implications to Regulatory LtO
At Bayer, we adhere to the FAO-WHO International Code of Conduct on Pesticide Management (accessible [here](#) on FAO’s website). Bayer’s Product Stewardship Commitment, Principles and Key Requirements covers CP and S&T (accessible [here](#) on our website). Product Stewardship is the responsible and ethical management of a product, throughout its life cycle, from invention through ultimate use, and the final disposal of any waste.
Our Crop Protection Stewardship Highlights

In the commercial phase

- SAFE USE TRAINING
- SAFE USE AMBASSADOR PROGRAM
- SUSTAINABLE PESTICIDE MGMT FRAMEWORK
- EMPTY CONTAINER MANAGEMENT
- ASSET SPECIFIC STEWARDSHIP
- INCIDENT MANAGEMENT
Daniel Glas

- Sustainability Venture Lead, Crop Science

Environmental Impact Reduction of Crop Protection ("CP EIR")
Crop Protection’s contribution in sustainable ag systems
Maintaining CP benefits while reducing its contribution to the environmental impact of agriculture

Crop protection helps farmers to secure or increase yields, thereby helping to
// feed a growing population, and
// reduce pressure to bring additional biodiverse land into production

“Land use for agriculture is inevitably related to loss of biodiversity.

Management techniques such as the use of plant protection products have by definition a negative impact on biodiversity, but this loss is by far surpassed by the higher land use in extensive production systems.”

Panel for the Future of Science and Technology (STOA): In-Depth Analysis: Farming without plant protection products (04-03-2019)

Our World in Data
Our commitment: 30% Reduction of crop protection's environmental impact

Bayer Crop Protection Environmental Impact commitment
Covering all Bayer crop protection applied on a customers’ field globally

Scope of our efforts

- All Bayer crop protection applications on field during crop production
- Reduction by CP EI per hectare (treated area weighted)²

\[
\frac{EI}{ha} = \frac{\sum (EI/k.g_i \cdot dose_i \cdot ha_i)}{\sum ha_i} = \frac{\sum EI_i}{\sum ha_i}
\]

- Even though our 30% progress is measured on our own portfolio, we will continue to track market CP EI and Bayer’s contributions to reducing that

Baseline

- All Bayer crop protection products applied globally and their respective environmental impact (average 2014-2018)³

1: Bayer CP products applied according to AgroWin data. Environmental impact calculated on product level with PestLCI/USETox® models based on their current scope.
2: Formula calculates overall CP EI/ha for the Bayer crop protection portfolio
Building on a state-of-the-art methodology combining two renown models, PestLCI and USEtox

Developed by Crop Science together with the Technical University of Denmark

Environmental Impact (EI) of crop protection

\[ \text{Environmental Impact (EI) of crop protection} = \frac{\text{Emissions into the environment (PestLCI)}}{\text{Potency of all substances applied on a field (USEtox)}} \]

- CP application data
- Substance data
- Crop & Soil
- Weather patterns

Input data processed by the models

Transparency & credibility
- All models are freely available
- Validation of approach via external panel
- Uses publicly available data for substance specific properties
- Quantifiable crop protection environmental impact assessment enabling farmers and consumers to compare different agricultural systems

State-of-the-art science
- Models are being updated on a regular basis
- Scientific consensus-based models
- Can accommodate future advancements in science

Scalability
- New technologies can be added
- Scalable to all major crops and countries
- Globally applicable crop protection impact assessment tool

Today, methodology focused on measuring EIR on freshwater. Expansion planned to also included soil and pollinators

PestLCI used by (examples)

USEtox® used by (examples)

// Crop Science ESG Webinar // Sustainability Update: Biodiversity & Crop Protection // October 23, 2023
Bayer runs a comparative environmental impact assessment of crop protection products approved by regulatory authorities

Extensive testing and risk assessments ensures that all products have no effects on human health and only acceptable environmental effects if applied according to label

Below a threshold determined by the respective regulator a substance is deemed safe

The CP EIR commitment strives for a relative improvement against the baseline

Graph only intended for demonstration purposes.
What is Bayer’s Impact?
Baseline and progress

2021 Crop Protection Industry Environmental Impact

Sales Value (EUR)

CP Environmental Impact

0% 20% 40% 60% 80% 100%

Bayer products accounted for only

2% of the environmental impact from crop protection in 2021

We reduced the global environmental impact of our crop protection products by 14%

Our goal: We will reduce the environmental impact of our global crop protection portfolio per hectare by 30% against a 2014–2018 baseline by 2030
Bayer’s major CP blockbusters with low Environmental Impact

High product development standards as key driver also for future crop protection sales

// CP EIR criteria is embedded in the development process
// Relative improvement of the portfolio
We are on the path to reduce our environmental impact

Enablers and way forward

Main contributors to the 14% reduction

- The criteria we use internally governing how we develop new crop protection products
- Which products/active ingredients we in-license or acquire through acquisitions
- Which products/active ingredients we decide to phase-out or divest
- How the products are used by the farmer and how they are embedded in a crop system approach

Innovations helping us to progress in line with our 30% commitment

Crop Protection Products:
- Xivana Fungicide
- Plenexos Insecticide
- Delaro Complete
- Iblon Fungicide
- Incelo Herbicide
- New Biological Seed treatment in Corn

Seeds & Traits:
- ThryvOn Cotton
- Bollgard 4 Cotton
- Next Generation Insect Control Traits in Corn and Soybeans
We support advancing the science behind Crop protection
Environmental Impact Assessment
Advocating for broader application

// Pollinator research partnership launched in May 2023 with The Ohio State University, Technical University of Munich and Technical University of Denmark

// 1st publication expected making the global CP application pattern data set public (submission)

2023

2024+

// Strive to include models into a Regenerative Agriculture metrics set (e.g. OP2B, WBCSD, SAI Platform)

// Contribute to public calculator intended to be developed by academic consortium

2025+

// Pollinator impact assessment methodology expected to be published

// Soil impact assessment methodology expected to be published
Recap & Preview
Crop Science ESG Investor Webinar

Sustainability Update: Biodiversity & Crop Protection

October 23, 2023

Video recording will be available soon