Our world faces enormous challenges including a changing climate, limited natural resources and a growing population. And we believe agriculture is part of the solution. At Bayer, we’re a responsible, global team working to shape agriculture through breakthrough innovation for the benefit of farmers, consumers and our planet.

More than a century of agricultural expertise

~8,000 R&D employees, more than 35 R&D sites and 175 breeding sites worldwide*

€2.4 billion annual investment to bring novel solutions to market*

Unmatched product portfolio – from seeds and traits to biological and chemical crop protection

Cutting-edge digital tools and information, enabling farmer decision-making

Customers spanning the globe, representing farms of all types and sizes

Established network of 240 partners devoted to innovation in agriculture

*Numbers based on company information and internal calculations | Bayer + Monsanto pro forma figures considering divestments | Monsanto calendarized to twelve-month period ended November 30, 2017
Agriculture worldwide is facing new threats due to invasive agricultural pests

// Pest invasions favored by:
// Globalized agricultural markets, with the same or similar crops and vegetables on every continent
// Global warming, with most serious pests native in tropical or warm regions
// Cultural factors, including limited pest management tools, level of education and poverty

// Potential consequences
// Reduced yields
// Reduced quality
// Post harvest selection of ruined charges
// Increased control costs (e.g. monitoring, insecticides, …)
// Disruption of pest and resistance management strategies

Characterizing invasive pests: Helicoverpa armigera

o Native in the Palearctic, invasive in the Americas (Brazil 2013)
o Highly polyphagous, e.g. cotton, soybean, vegetables, corn
o Feeds on leaves, flowers, buds and fruits
o Most reported cases of insecticide resistance
o Fast lifecycle, high migration potential
o Annual crop losses in the billions
o Big threat to farmers, irrespective of farm size
Understanding the changing importance of different pest species over time

Source: Legacy Monsanto Brazil (results not published).
Identifying management tools: *Spodoptera frugiperda*

- Native to North and South America
- Invaded Africa 2016 (or earlier!) and spread east and south
- Over 100 host plants e.g. corn, rice, cotton, soybean, …
- Smallholder farmers in Africa have no experience with this pest
- Over 75% yield loss in Africa due to *S. frugiperda* is quite common without IPM, with the potential of 3 billion dollar loss Africa especially in smallholder farms
- Why is *S. frugiperda* a more severe pest than African *Spodoptera* species? (Goergen 2016)
  - Prefer corn vs. grasses in oviposition
  - Stronger mandibles (silica content of the leaves)
  - Larvae can be predatory on lepidopteran larvae

Use experience with *Spodoptera frugiperda* in corn in Americas

Helpful experience:
- Effective control tools and their relevance
- Selection criteria

Different:
- Use of corn* 8% vs. 55%  
  * FAOSTAT 2013 data
- Application technique
Options for integrated management programs


High infestation pressure early

- chemical product
- biological product

High infestation pressure later

- ?
- S-TR
- biological product
- chemical product

Further product(s)

Selection of control tools in corn

Efficacy vs. Costs and Risk

<table>
<thead>
<tr>
<th>Chemical Class</th>
<th>Efficacy S. frugiperda</th>
<th>Costs</th>
<th>additional Stewardship requirements</th>
<th>user</th>
<th>environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbamates</td>
<td>+++</td>
<td>low</td>
<td>high</td>
<td>very high</td>
<td></td>
</tr>
<tr>
<td>Organophosphates</td>
<td>++</td>
<td>moderate</td>
<td>high - moderate</td>
<td>high</td>
<td></td>
</tr>
<tr>
<td>Pyrethroids</td>
<td>++</td>
<td>very low</td>
<td>moderate</td>
<td>high</td>
<td></td>
</tr>
<tr>
<td>Benzoylureas</td>
<td>++</td>
<td>low</td>
<td>low</td>
<td>moderate</td>
<td></td>
</tr>
<tr>
<td>Biologicals (B.t. foliar)</td>
<td>+</td>
<td>low</td>
<td>low</td>
<td>low</td>
<td></td>
</tr>
<tr>
<td>Spinosyns</td>
<td>+++</td>
<td>high</td>
<td>low</td>
<td>moderate</td>
<td></td>
</tr>
<tr>
<td>Diamides</td>
<td>+++</td>
<td>high</td>
<td>low</td>
<td>moderate</td>
<td></td>
</tr>
</tbody>
</table>

Source: Sales panel data 2016 / MSDS a.o. publicly available information
Support of responsible use of chemical products

Effectiveness, Safety and Environmental protection

- Make products available (registrations and sales)
- Compliance with stringent registration requirements (intensive studies)
- Compound information, safety instructions and clear recommendations for use (technical info, package leaflet label)
- Education on pest knowledge (identification, life cycle)
- Demonstrations for optimum product use (Scouting, trial demos, field days)
- Training on safe use of chemical products (handling, user protection equipment, application techniques, REI)
- Instructions on good agricultural practice (environment protection, residues, resistance management)
- Education on beneficials (identification, life cycle)
- Programs to establish refuge areas (beneficial protection, biodiversity)

Cooperation of industry, governments, non-governmental organizations, institutes, universities, advisers, farmer associations and lead farmers

Smallholder farming initiative for advanced/emerging farmers

The Smallholder Pyramid (<2ha)

- Professional
- Advanced
- Emerging
- Subsistence

Future potential: 60% of smallholder acreage

1. Adapted from C.K. Prahalad
2. Estimated based on FAO data
Together with our partners we aim to offer solutions for the entire value chain

**Business model**

**Business Alliances**
Shared values, agreed goals and KPIs, clear governance

- Credit/Insurance
- Seeds
- Water & Energy
- Soil Nutrition
- Pest, Disease, Weed Control
- Harvest, Equipment
- Storing, Access to Market
- Mechanization provider
- Storage provider
- Processor Trader
- Cooperatives, Farmers Groups, Farmers

**“Better Life Farming” Alliance**
Global partnership to drive local success

- Livelihood measurement / progress monitoring
- Training programs
- Know-how / best practice exchange platform
- Machinery, Access to market, Certifications
- Network of farming services
- Customized business models
- Digital solutions

Global Level

Country / Crop Level
Pilots in different countries to validate the approach

Better Life Farming Alliance

Local crop-based models

• Shared values
• Agreed goals
• Auditable KPIs
• Clear governance

Philippines

Vietnam

Thailand

Zambia

Kenya

Ghana

Côte d’Ivoire

India

2015 2016 2017 2018 2030

Ideation
Strategy

Implementation of Pilots KN, IN

Onboarding of next 6 countries

Platforms activated in 18 countries

Development Digital Solution
Digital Upgrading/Upscaling

2016

2017

2018

2019

2020

2021

2022

2023

2024

2025

2026

2027

2028

2029

2030

Thank you

for telling our story