Designer Seeds: Next-Generation Breeding Technology

Crop Science Innovation Summit

June 20, 2023

Mike Graham // Head of Plant Breeding, Bayer Crop Science
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This presentation may contain forward-looking statements based on current assumptions and forecasts made by Bayer management.

Various known and unknown risks, uncertainties and other factors could lead to material differences between the actual future results, financial situation, development or performance of the company and the estimates given here. These factors include those discussed in Bayer’s public reports which are available on the Bayer website.

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Bayer Plant Breeding Unmatched Scale Maximizes Farm Productivity

Bayer Plant Breeding products reach ~160m acres globally

Six main row crops:

- Corn
- Soybean
- Cotton
- OSR/ Canola
- Wheat
- Rice

Elite germplasm with integrated biotech and native traits deliver €10.5bn annual seed & trait sales

Delivering World-Class Genetics and Product Offerings

1. Developing and deploying >500 unique products every year across large and small holder customers
2. Enabling increased yield potential across crops
3. Managing ~65 active biotech and native traits and 138 trait packages across crops within the breeding pipeline
4. Native traits like Short Corn (SD) and disease resistance provide additional value
5. Building Next Generation Innovations
6. Each product advanced through the breeding pipeline goes through ~140 data science models until commercialized
7. New protected culture facilities in Marana, AZ and Petrolina, Brazil, expected to accelerate breeding generations by up to 6X
Leading Positions in Global Seed & Traits Fueled by Innovation

\[ \text{2022 Global S&T Sales}^1 \]

<table>
<thead>
<tr>
<th>In €bn</th>
<th>Bayer</th>
<th>Corteva</th>
<th>Syngenta AG</th>
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<td>8.5</td>
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\[ \text{2022 Corn S&T Sales}^1 \]

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<td>6.1</td>
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\[ \text{2022 Soy S&T Sales}^1 \]

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<td></td>
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<td>0.6</td>
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1 Source: As reported in FY 2022, exchange rate FY2022: ~1.05 USD/EUR. 2 Market Position determined annually, as of Q1-2022. 3 Internal estimate including sum of branded plus licensed seed (germplasm) share measured as of 2022 for U.S. and Europe and as of 21/22 season for Brazil, Argentina and South Africa.
Data Connected Plant Breeding Advantage

Breeding Product Development Process (8-10 years)

Data & analytics driving decisions & AI connected pipeline - enabling a dynamic breeding pipeline

Fieldview Field Health Imagery Data Collection
Seed Chipping Technology for accelerated discovery
Marana, AZ Protected Culture Design Center
Cassette Planter delivers large scale field testing
Drone Sensors; globally connected data ecosystem
Seed Bulk-Up for Pre-Launch testing

Customer Insights

Discovery
Population Selection
Population simulation and human supervised, model driven selection for desired characteristics
Early Design
Advanced genomic selection including future environmental challenges
Intermediate Development
Large-Scale Field Testing, Trait Integration and prescriptive data collection to inform models and feed pipeline
Advanced Product Understanding
Traited Testing, Early Tailored Solutions data generation, and preparation of digital data package for Climate models
Pre-Launch
Broad product testing by R&D and Market Development, Seed Bulk-Up, System Testing and Pre-Marketing

Competitive Advantages

Customer driven quantitative economic indices
Extensive environmental and on-farm data driving targeted discovery
Unique data-driven bio-economic models that allow precise fitting of product concepts
Industry-leading global germplasm libraries across crops and markets - 100X larger
Decades of field and genomic data combined with industries leading data science platform
Ability to rapidly sample and genetically evaluate millions of seeds - 15X faster
Advanced Product Design facilities that enable multiple cycles of planting per year
Industry leading Trait Integration programs stack traits into elite germplasm
Largest global field-testing footprint & digital field-testing twin capabilities diversifies geographic data insights
Fully automated seed distribution centers prescriptively sample diverse growing environment
Traited-Testing evaluates products as they would be experienced by the growers
Most advanced and distributed network of field testing in the industry
Evaluation of agronomic systems for product deployment & customer recommendations

Data & analytics driving decisions & AI connected pipeline - enabling a dynamic breeding pipeline

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Deploying >250 Corn Hybrids in 2022 to Expand Leading Position

Foundational to Expected Growth in Our >€6bn Global Annual Corn Seed & Trait Sales

- >100m acres of Bayer Corn Germplasm grown in 2022
- Deployed >250 new hybrids globally in 2022; offer >1,500 hybrids globally
- >7 bu/acre U.S. yield advantage with leading hybrids in like-for-like trait package hybrid comparisons
- Best NCGA Yield Performer in 2022, winning >70% of the ~National Spots, with 20 of the 27 spots from Bayer germplasm

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1 Annual yield advantage calculated each year by comparing 3 leading DEKALB products within each state having a minimum of 100 comparisons to national competitor products containing similar crop protection traits as of 2022. All comparisons are head-to-head using +/- 2RMs and weighted average calculated using 15% moisture; 2 NCGA = National Corn Growers Association – National Corn Yield Contest.
Soybeans, Cotton and Vegetable Seed Businesses Benefit from Annual Germplasm Refresh to Drive Sales Growth

Deployed ~150 new varieties in 2022; offer >850 varieties in North America

Over last 4 years, RR2Xtend & Xtend Flex Soybeans saw a 2.9 bu/acre advantage\(^1\) over Enlist™ E3 Soybeans

Deployed >10 varieties in 2022; offer >30 Deltapine varieties in the U.S.

U.S. lint/acre yield advantage with leading varieties; 2022 was ~70 lbs/ac advantage for Deltapine\(^2\) vs. top-planted competitor varieties

Deployed >90 varieties in 2022; sell ~2,000 vegetable hybrids and varieties in 22 crops across 110 countries

Innovative varieties of fruits and vegetables can help develop more sustainable and regenerative food systems and increase access to essential nutrients

\(^1\) Soy Trials: (184 locations with 20 in 2019 (Roundup Ready® 2 Xtend), 57 in 2020 (Roundup Ready® 2 Xtend), 67 in 2021 (XtendFlex® Soybeans) and 40 in 2022 (XtendFlex® Soybeans) reporting data located with 22-IA, 24-IL, 23-IN, 11-KS, 1-KY, 7-MI, 30-MN, 10-MO, 1-MS, 5-ND, 17-NE, 15-OH, 1-OK, 11-SD, 4-PA and 2-WI.). Significant at \(P \leq 0.10\) LSD at 0.6 Bu/A as of 12/13/2022. Roundup Ready® 2 Xtend or XtendFlex® soybeans planted with a farmer-selected (or in case of Bayer Trials, Bayer-selected) weed control program that may include dicamba, glyphosate, glufosinate and various residual herbicides. Enlist E3® soybeans planted with a farmer-selected (or in case of Bayer Trials, Bayer-selected) weed control program that may include glyphosate, Enlist One® herbicide, Liberty® 280 SL herbicide and various residual herbicides; \(^2\) Cotton 3-year average: 2600 trials comparing top DP varieties within a region vs. the top 3 planted competitors based on market survey data (Kynetec).
Breeding Pipeline to Deliver €11bn in Peak Sales Potential

Thousands of New Varieties and Hybrids in Development to Fuel Growth in €10.5bn S&T Sales

- **Corn:** €7bn
  - Thousands of new corn hybrids in development for annual refresh across each global market; ~250/ year
  - Corn Disease Shield- NA

- **Soybeans:** ~€1bn
  - Thousands of new soy varieties in development for annual refresh across Americas ~150/ year
  - Soybean Native Resistance

- **Cereals:** ~€1bn
  - Hybrid Wheat
  - Wheat Germplasm and Disease Pkg.

- **Vegetable Seed:** ~€1bn
  - Thousands of new varieties in over 22 different crops; ~90/year

- **Other:** ~€1bn
  - Rice hybrids for APAC
  - Hundreds of Cotton varieties to support annual refresh in U.S.; ~10/year
  - Canola germplasm for EMEA and Canada

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1 Represents non-risk adjusted estimated peak sales for the breeding pipeline; ~50% incremental sales value. Note: Projects listed per crop are subset of the pipeline; selected top contributors to peak sale potential.
Accelerating Genetic Gain with Precision Breeding

ACCELERATING OUR ABILITY to bring innovative solutions to our customer around the world

Data & analytics driving decisions & AI connected pipeline - enabling a dynamic breeding pipeline

Fieldview Field Health Imagery

Customer Insights

Customer Driven quantitative economic indices

Fieldview Field Health Imagery Data Collection

Seed Chipping Technology for Accelerated Discovery

Advanced Genomic Capabilities

Genomic Insights & AI driving new breeding starts

Marana, AZ Protected Culture Design Center

Accelerated Breeding Methods

Genomic Insights & AI driving new breeding starts

Cassette Planter delivers large scale field testing

Digital Field-Testing Twin

Mix of simulated and actual field testing

Doubling Genetic Gain by 2030

Accelerating Breeding Cycle from 5-6 years to ~4 months

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Data Driven Solutions and Simulation Key to Acceleration

- **Starts with a Customer Driven Pipeline**
  - Every plant designed is aligned with customer-preference quantification.
  - Novel translation of customer insights into a number allowing for accurate data driven decisions through product development.
  - Selection indices combine economic and agronomic data with customer survey preferences and insights to determine desired characteristics for next-gen. hybrids.

- **Accelerated Breeding Methods**
  - Continuous Breeding Cycle accelerating from 5-6 years to ~4 months.
  - New protected culture facilities in Marana, AZ and Petrolina, Brazil.

- **Leads to Digital Field-Testing Twin**
  - Simulations use our extensive data assets to predict performance across millions of scenarios and environments.
  - Simulations assist with crop placement and product advancement.

**Example:** PRECEON Hybrid Ear Height Simulation

**Short-Stature Hybrid 1 -** Ear height too low in simulation

**Short-Stature Hybrid 2 -** shows favorable ear height in simulation

Simulated ear height for >130k farmer fields across 10 environmental years.
Potential to Shape Transformation of Wheat Production by End of the Decade

Hybrid Wheat: New Production System for the World’s Largest Crop

Resilient Hybrid Wheat System

- Hybrid wheat expected to provide higher yield and yield stability, with potential fit on a significant portion of the ~555m acres of wheat grown globally and ~€700m PSP
- Envision a more sustainable and resilient system with better nitrogen use efficiency, disease, drought and heat tolerance
- Advancements in genomic tools and the cytoplasmic male sterility system are enabling the development of hybrid wheat at competitive cost
- ‘Blue ocean’ market potential to drive value of market for Wheat seed and technologies, which has already happened in crops like corn

Market Leaders in Hybrid Wheat

Different climatic zones in key regions Europe and North America require distinct approaches:

Europe

- In 2021, we launched a strategic R&D partnership with RAGT, the European market leader in varietal wheat, leveraging strong complementarity of partners:
  - RAGT: Best-in-class germplasm and rich portfolio of native traits
  - Bayer: Wide array of R&D assets, seed production know-how; leader in CP

US

- Hybrid wheat program based on our leading U.S. WestBred germplasm position

Our Vision: A digitally enabled sustainable hybrid wheat system offering
Direct Seeded Rice: More Sustainable & Profitable Solution

Rice Production Systems Today Water & Labor Intensive

- 3RD LARGEST GLOBAL CROP WITH 165M HA¹
- USES UP TO 43% WORLD’S IRRIGATION²
- ~80% TRANSPLANTED PRODUCTION³

³ Our World in Data: Land area per crop type, World, 1961 to 2021 (ourworldindata.org)
² International Rice Research Institute: Water management - IRRI Rice Knowledge Bank
¹ Scientific Reports: A global analysis of alternative tillage and crop establishment practices for economically and environmentally efficient rice production | Scientific Reports (nature.com)

Farmer Economics Show 16% Lower Costs with DSR⁴

- Reduces Water Usage by up to 40%⁵
- Up to 45% reduction in CO2 emissions⁶
- Manual labor reduced by up to 50% or 150 labor hours per 1 Ha DSR⁷
- Methane reduction up to 85%⁸

⁴ Internal estimate via DirectAcre program in India
⁶ Carbon emission - IPCC (2006/2019) |
⁷ Labor: Sidana et al. (2020)
⁸ CH4 Reduction: Science Direct - Direct-seeded rice reduces methane emissions - ScienceDirect

Today: Resource Intensive Transplanted Rice (TPR) practices

- Puddling & Leveling
- Nursery Beds
- Manual transplanting
- Manual reaping

Future: Mechanized and Technology driven Direct Seeded Rice (DSR) cultivation

- Laser land levelling
- Direct seeding with machinery
- Precision Application
- Mechanical harvesting

Our Target: Improve water use per kg of crop by 25% in 2030 by transforming rice cropping system

Our World in Data: Land area per crop type, World, 1961 to 2021 (ourworldindata.org)
International Rice Research Institute: Water management - IRRI Rice Knowledge Bank
Scientific Reports: A global analysis of alternative tillage and crop establishment practices for economically and environmentally efficient rice production | Scientific Reports (nature.com)
Carbon emission - IPCC (2006/2019) |
Labor: Sidana et al. (2020)
CH4 Reduction: Science Direct - Direct-seeded rice reduces methane emissions - ScienceDirect
Bayer Direct Acres: DSR Crop System Featuring Hybrid Rice
Elite Rice Germplasm, Effective Weed Mgmt. and Digital Tools to Drive Sustainable, Operational Efficiency

Seeds & Seed Growth
- Arize
- Gaucho

~40% Seed Share in DSR Market in India (7% of Acres)

Herbicides
- Council
- Cailor
- Nadora

Post-Emergent single shot application
Need Based LPO

Fungicides
- Antracol
- Nativo

Insecticide
- Ambition

Crop Performance Enhancer

DIGITAL TOOLS & PLATFORMS

CARBON & SUSTAINABILITY

Opportunity for 75% DSR HA in India by 2040

DIRECT SEEDED RICE SYSTEM
- Elite Designed Hybrid Rice
- Integrated & Effective Weed Mgmt System
- Digital Insights & Agronomic Support

HYBRID RICE TRIALS

1 internal estimate based on socio economic, climate effects and policy environment
Key Takeaways – Designer Seeds

01 Foundational germplasm platform delivers ~500 new products annually on >160m acres

02 Delivers ~€11bn in peak sales potential with expansion and upside potential

03 Widening our leadership position through AI connected pipeline and key investments to improve genetic gain and acceleration to market

04 Enabling opportunities in underserved market, like hybrid wheat and direct seeded rice

05 Driving regenerative ag with higher farm productivity, as well as resource and water utilization
Designer Seeds: Next-Generation Breeding Technology

Crop Science Innovation Summit

June 20, 2023

Mike Graham // Head of Plant Breeding, Bayer Crop Science
## Crop Science: Seed & Traits and Digital R&D Pipeline
(Annual Update Feb 2023)

<table>
<thead>
<tr>
<th>Phase I</th>
<th>Phase II</th>
<th>Phase III</th>
<th>Phase IV</th>
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<tbody>
<tr>
<td><strong>CORN SEED &amp; TRAIT</strong></td>
<td><strong>Digital Disease Mgmt. - NA</strong></td>
<td><strong>Seed Placement Digital Tool – NA</strong></td>
<td><strong>Annual Germplasm Upgrades</strong></td>
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<td>2nd Generation Seed Density Digital Tool - NA</td>
<td>5th Generation Lepidoptera Protection</td>
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<td>Short Stature Corn – Breeding Approach</td>
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<td><strong>Annual Germplasm Upgrades</strong></td>
<td>5th Generation Herbicide Tolerance w/ (RHS2)</td>
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<td><strong>Soybean Native Resistance</strong></td>
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<td><strong>4th Generation Herbicide Tolerance (HT4)</strong></td>
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<td><strong>Corn Disease Shield - NA</strong></td>
<td><strong>Annual Germplasm Upgrades</strong></td>
<td>(3 Tolerances – Adds 2, 4-D and HPPD)</td>
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**Note:** Products are highlighted in parentheses and expected to reach the 50% incremental sales milestone in the year following launch.

Projects listed here and included in the peak sales potential by segment do not include projects funded by our LEAPS investments; includes all advancements made in FY’22, updated Feb’23.

PSP = Peak Sales Potential; 50% incremental; Expected to reach 30% of PSP by 2023, 80% of PSP by 2037 and remainder in 2038. **Note that products are excluded from the pipeline PSP typically the year following launch.**

2 In collaboration with KWS; 3 In collaboration with BASF; 4 “Other” category includes seeds and traits, such as cotton, canola, wheat, OSR, rice, vegetable seeds and sugarbeets, plus carbon and digital Models.

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