FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

AGRILINKS




Planting New Seeds: Innovations in Global Seed Systems

Speakers: *Robert Bertram, USAID Bureau for Resilience and Food Security*
Gary Atlin, Bill & Melinda Gates Foundation
Michael Quinn, CGIAR
Nora Lapitan, USAID Bureau for Resilience and Food Security
Simon Winter, Syngenta Foundation for Sustainable Agriculture

Moderator: *Zachary Baquet, USAID Bureau for Resilience and Food Security*

Date: September 23, 2020

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Robert Bertram, Chief Scientist, USAID Bureau for Resilience and Food Security

Rob Bertram is the Chief Scientist in USAID's Bureau for Resilience and Food Security, where he serves as a key adviser on a range of technical and program issues to advance global food security and nutrition. In this role, he leads USAID's evidence-based efforts to advance research, technology and implementation in support of the U.S. Government's global hunger and food security initiative, Feed the Future. He previously served as Director of the Office of Agricultural Research and Policy in the Bureau for Resilience and Food Security, which leads implementation of the Feed the Future research strategy and related efforts to scale innovations in global food security efforts, working with a range of partners. Prior to that, he guided USAID investments in agriculture and natural resources research for many years. Dr. Bertram's academic background in plant breeding and genetics includes degrees from University of California, Davis, the University of Minnesota and the University of Maryland. Before coming to USAID, he served with USDA's international programs as well as overseas with the Consultative Group on International Agricultural Research (CGIAR) system.

Gary Atlin, Senior Program Officer, Bill & Melinda Gates Foundation

Gary is a member of the Seed Systems and Varietal Improvement Team within the Gates Foundation Agricultural Development initiative, coordinating efforts to help increase the rates of genetic gain delivered by breeding programs serving Africa and South Asia, as well as managing the foundation’s investments in rice, wheat, and maize breeding. He joined the foundation in 2012, after a 30-year career in plant breeding and genetics in Canada, Peru, the Philippines, and Mexico, focused on developing cultivars for stressful environments. He is author or co-author of over 70 journal articles on plant breeding and quantitative genetics, and has helped develop successful cultivars in several species.

Michael Quinn, Director of Excellence in Breeding Platform, CGIAR

Michael leads EiB's overall strategy, partnerships and operations. He has extensive experience in the commercial development of germplasm through breeding and R&D management. Prior to EiB, Quinn was principal wheat breeder and R&D manager at InterGrain, Senior Wheat Breeder at LongReach Plant Breeders, principal hybrid wheat breeder at Australian Grain Technologies, and senior durum wheat breeder at the University of Adelaide – Australia

Nora Lapitan, Inputs Division Chief, USAID/RFS, Center for Ag-Led Growth

Dr. Nora Lapitan leads the Research Community of Practice in the Bureau for Resilience and Food Security at USAID. She also heads a division which supports the development of agricultural innovations and technologies and supports delivery pathways to ensure productivity and profitability. She earned her B.S. degree from the University of the Philippines and her M.S. and Ph.D. degrees from Kansas State University. Nora was a Professor at Colorado State University, where she led a research program to understand the genetics of economically important traits in cereal crops. Prior to joining USAID, she served as Program Director at the National Science Foundation. She has authored or co-authored over 80 peer-reviewed journal articles and over forty non-refereed technical articles and non-technical papers. Nora Lapitan is a Fellow of the Crop Science Society, the American Society of Agronomy, and the American Association for the Advancement of Science.

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Simon Winter, Executive Director, Syngenta Foundation for Sustainable Agriculture

Simon Winter became SFSA Executive Director in September 2017. He joined from TechnoServe, where he had most recently been Senior Vice President, Development, in Washington, D.C, and previously led operations in sub-Saharan Africa. From 2015-2017, Simon was also a Senior Fellow of the Mossavar-Rahmani Center at the Harvard Kennedy School of Government. Among Simon’s many board and advisory roles, he currently chairs the Steering Committee of the Farm to Market Alliance and the Board of ACRE Africa. Earlier career steps included management positions at McKinsey & Co, independent development consultancy, economic planning for a Ministry in Botswana, and roles on three continents at Barclay’s Bank. A UK citizen, Simon holds a PhD in Economics from the School of Oriental and African Studies, London.

Accelerating Varietal Turnover in Farmers' Fields: New Tools and Opportunities.

Gary Atlin

Gary Atlin
Bill & Melinda Gates Foundation

The Gates Foundation invests in public crop improvement to alleviate poverty by increasing the yields of smallholders

- Productivity increases leading to poverty alleviation
- A reduced environmental footprint for agriculture
- Effective and constant adaptation to a changing climate and intensifying cropping systems

(Atlin et al. 2017. Global Food Security)

- **Farmers must replace varieties regularly to benefit from breeding investment**

The "stalled" Green Revolution

- First-generation Green Revolution (GR) varieties "sold themselves" due to large, visible differences induced by major dwarfing genes
- 2nd-generation GR varieties "sold themselves" as a result of highly visible quality and disease resistance improvements
- 2nd-generation GR varieties got "stuck" in farmers' fields due to:
  - (i) Lack of yield advantage in non-stress conditions
  - (ii) Inability of public breeding systems to drive varietal turnover

Two possible reasons variety replacement has stalled:

1. **New varieties are not sufficiently superior to old ones to induce farmers to adopt them**
   - New varieties should be both higher-yielding and acceptable to the market and end-users.
   - But…there is evidence that many breeding programs are not generating yield improvements, and that some new varieties are not acceptable in the market.

2. **New varieties are superior, but state and private seed companies have no incentive to market them**
   - Replacing varieties is expensive for the small seed companies (public and private) that serve SSPs
   - In non-competitive markets, seed producers must be supported or induced to invest in varietal replacement
   - Governments need high-quality information supporting investment in varietal replacement; this must be obtained from extensive on-farm testing

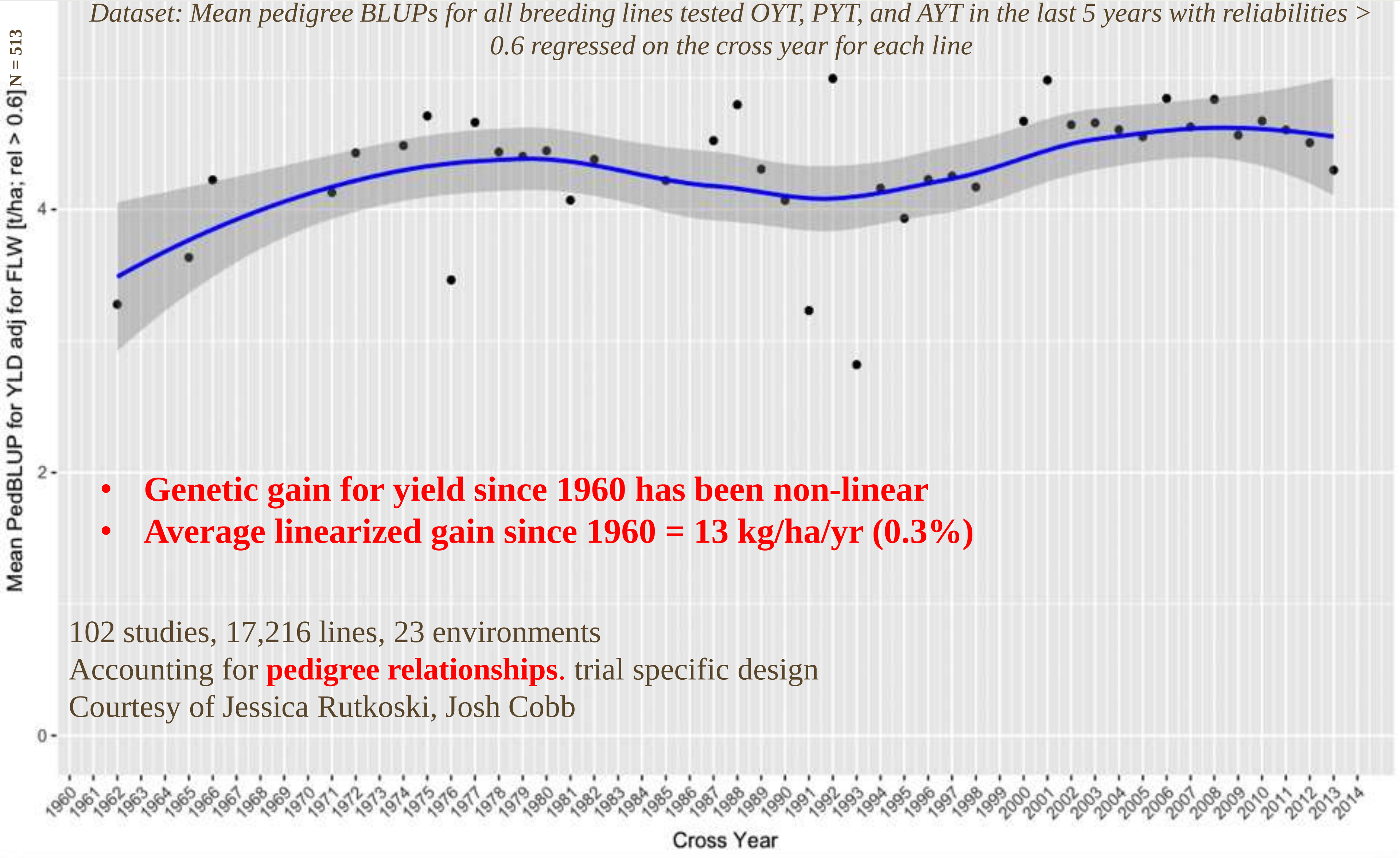
Key metrics for Gates Foundation investments in crop improvement and seed systems:

- **Rate of genetic gain** delivered in farmers' fields
  - Typically measured on research stations. Very little data exists to show rate of genetic gain on-farm, especially in Africa
  - Ranges from 0 to 1% in most CGIAR and NARES breeding programs, usually <0.5% on-station when properly measured

- **Average area-weighted age of varieties** in farmers' fields
  - Metric developed by Derek Byerlee and applied by Melinda Smale
  - Most varieties in farmers' fields in SA and SSA are over 15 years old.
  - In US, Western Europe, maize, soy, and wheat varieties are typically less than 4 years old.

Genetic trend for irrigated rice yield at IRRI 1960-2014

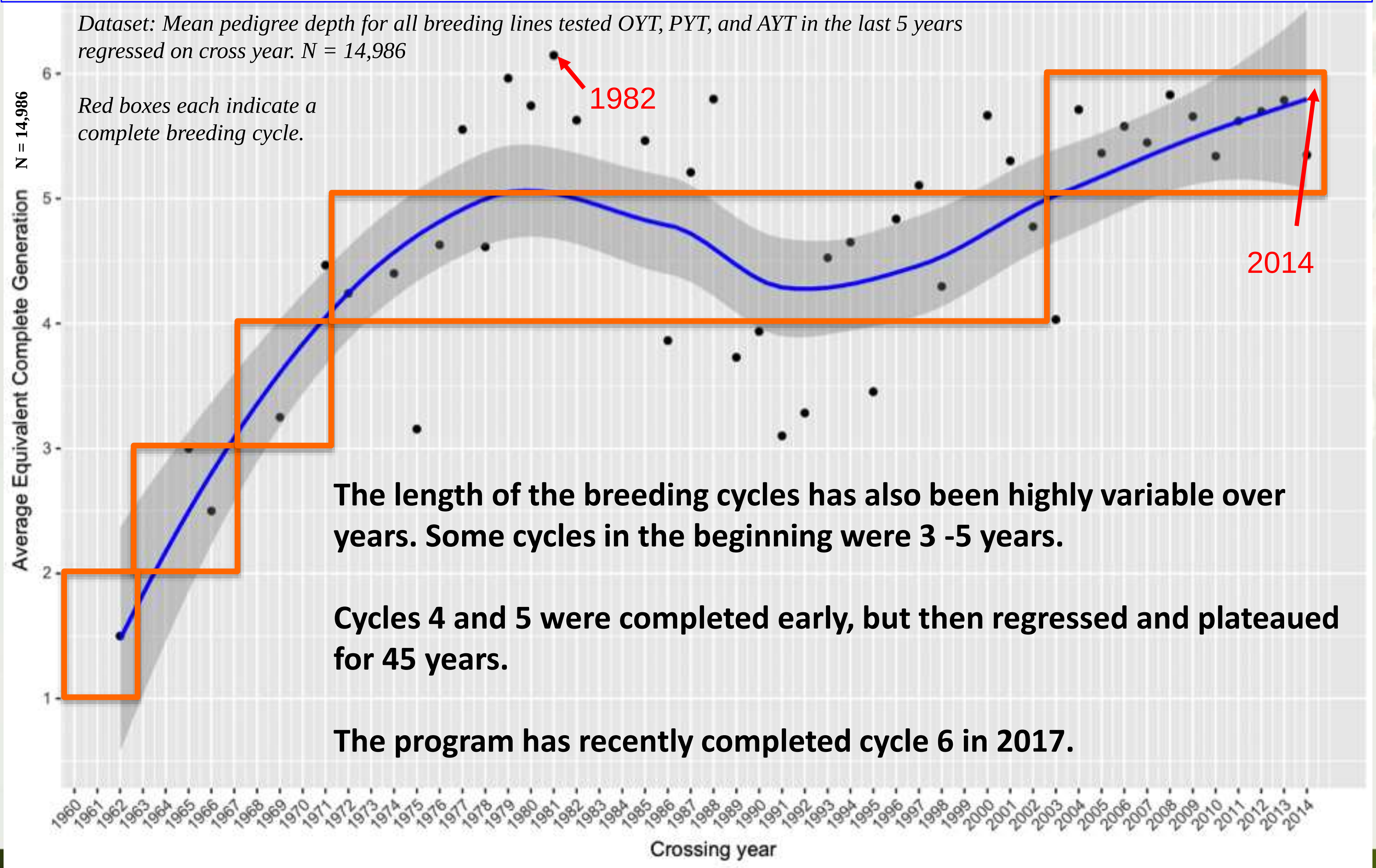
Dataset: Mean pedigree BLUPs for all breeding lines tested OYT, PYT, and AYT in the last 5 years with reliabilities > 0.6 regressed on the cross year for each line



- **Genetic gain for yield since 1960 has been non-linear**
- **Average linearized gain since 1960 = 13 kg/ha/yr (0.3%)**

102 studies, 17,216 lines, 23 environments
Accounting for **pedigree relationships**. trial specific design
Courtesy of Jessica Rutkoski, Josh Cobb

Breeding Cycles completed per year 1960 – 2014 (Irrigated Program)

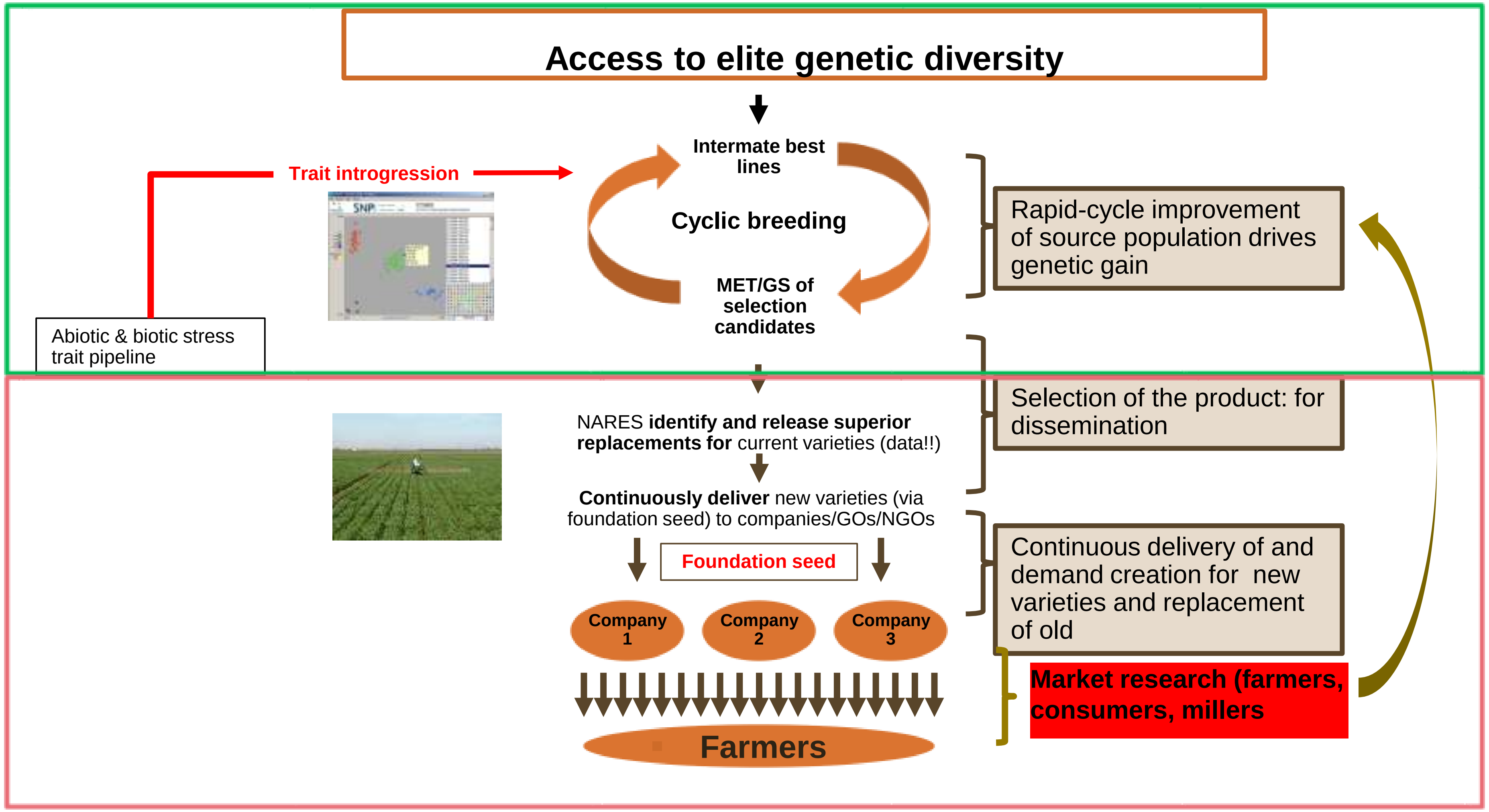


The length of the breeding cycles has also been highly variable over years. Some cycles in the beginning were 3 -5 years.

Cycles 4 and 5 were completed early, but then regressed and plateaued for 45 years.

The program has recently completed cycle 6 in 2017.

Components of a modern crop improvement system



Key changes needed in the international crop improvement system to accelerate varietal turnover

1. Use of carefully-designed product profiles

- Traditionally, breeders control the "design" of varieties in public-sector breeding
- Successful private-sector programs use *product profiles* to guide the development of varieties. Designed with support from marketing teams.
- Product profiles are being introduced into CG/NARES breeding programs. Based on market intelligence collected by social scientists from end-users, farmers, processors, seed producers, men & women.
- Market intelligence is integrated with genetic/agronomic information from breeders, pathologists, agronomists into a detailed description of trait thresholds needed for commercial success
- The job of the breeding team is to deliver varieties that conform to the product profile, and that are more productive than what farmers currently grow.
- Product profiles are used for:
  - i) Parent selection for the next breeding cycle
  - ii) Product advancement from each cycle for commercial release/ deployment

Key changes needed in the international crop improvement system to accelerate varietal turnover

2. Faster and more accurate breeding

- Typical CGIAR & NARES breeding cycles are at least 10 years, often longer.
- The “plant breeder’s error”: failing to separate out product development from population improvement processes
- Only population improvement results in genetic gain.
- The Excellence in Breeding platform is helping CGIAR programs model and simulate their pipelines, supporting quantitative optimization
- Genomic selection and “speed breeding” technology allow breeding cycles to be reduced to 2 years in many grain crops (clonal crops are slower due to low multiplication rates)
- Small, fast programs deliver higher rates of genetic gain than large, slow ones

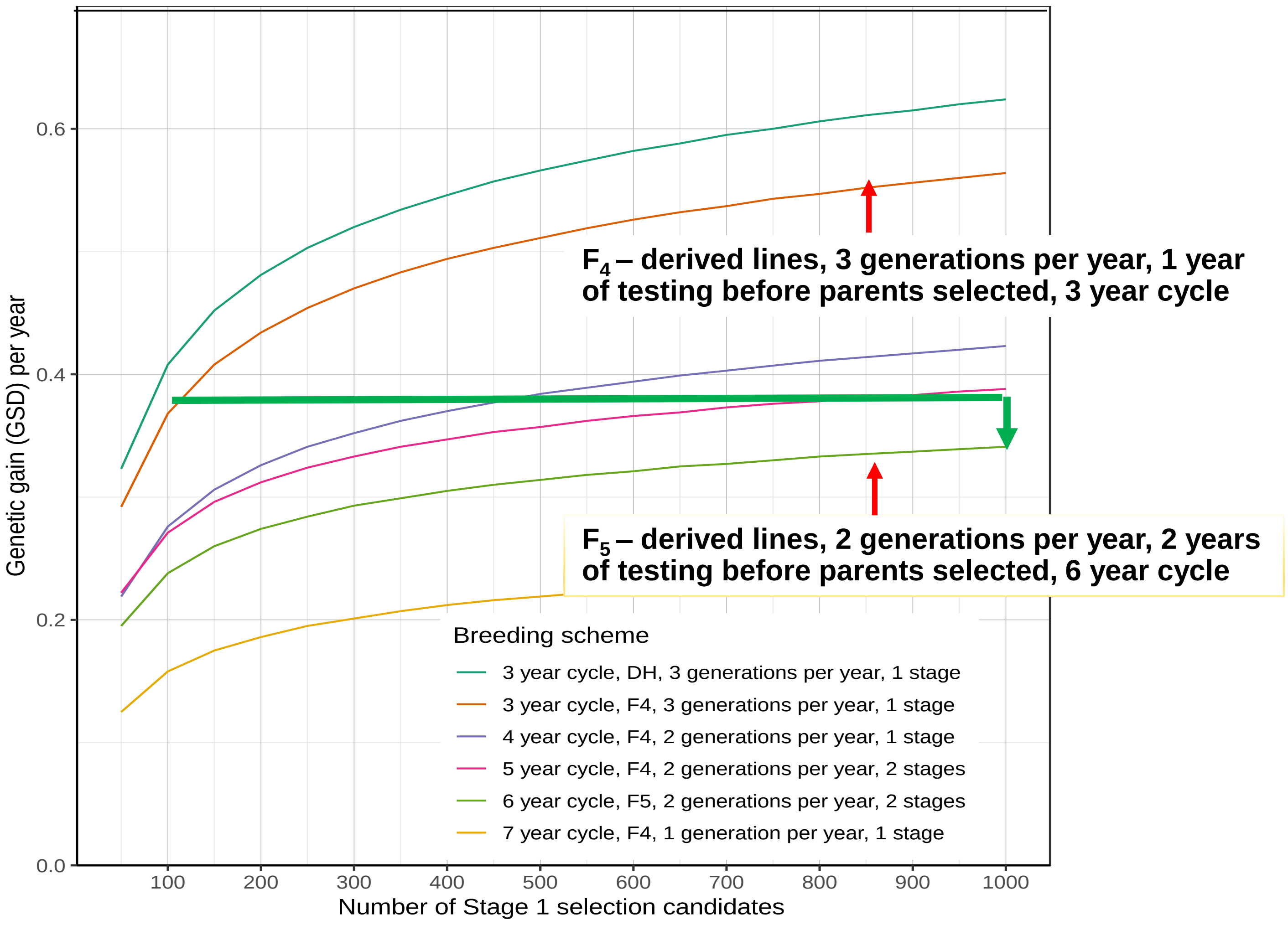
Key changes needed in the international crop improvement system to accelerate varietal turnover

3. On-farm testing at scale: the missing link in public-sector breeding

Total on-farm trials run by Pioneer in US Corn Belt vs by CIMMYT in ESA to confirm value of pre-commercial drought-tolerant maize hybrids

Program	Countries	Years	Average number of on-farm trials
CIMMYT ESA	Ethiopia, Kenya, Malawi, Zambia Mozambique, Uganda, Tanzania	2011-19	Ca. 40
Pioneer Aquamax	Western US Corn Belt	2011-13	Ca. 3,500

Expected genetic gain for breeding pipelines of different cycle length advancing 10 parents/cycle, testing 50 to 1000 selection candidates

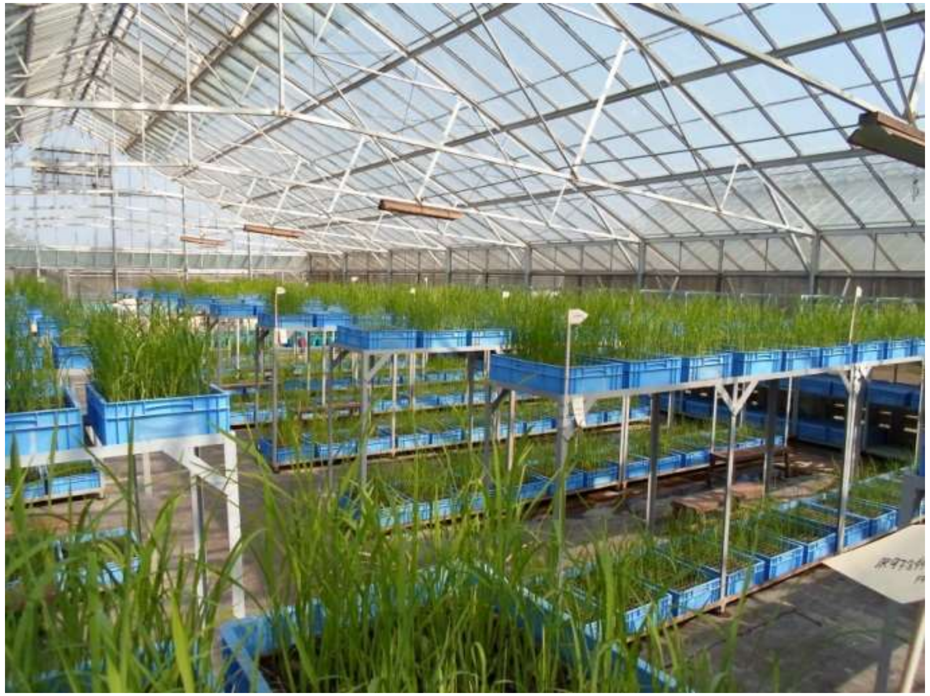


What will it take to help CGIAR-NARS networks achieve faster, more accurate breeding?

1. Adoption of a population-improvement mindset
2. Implementation of integrated breeding/genomics information management systems
3. Mechanization and digitization of population management and field testing
4. Adoption of rapid-generation advance systems permitting 3 generations to be grown annually in the field or 4 in controlled environments
5. Genotyping of all selection candidates entering replicated testing to permit genomic selection (GS)

- Capital costs of modernizing CGIAR research facilities for rapid-cycle GS will be modest- perhaps $3 M to $5 M per breeding network.
- Annual operating costs are usually reduced by shifting to RGS, mechanized field operations

Transforming Rice Breeding (TRB) at IRRI



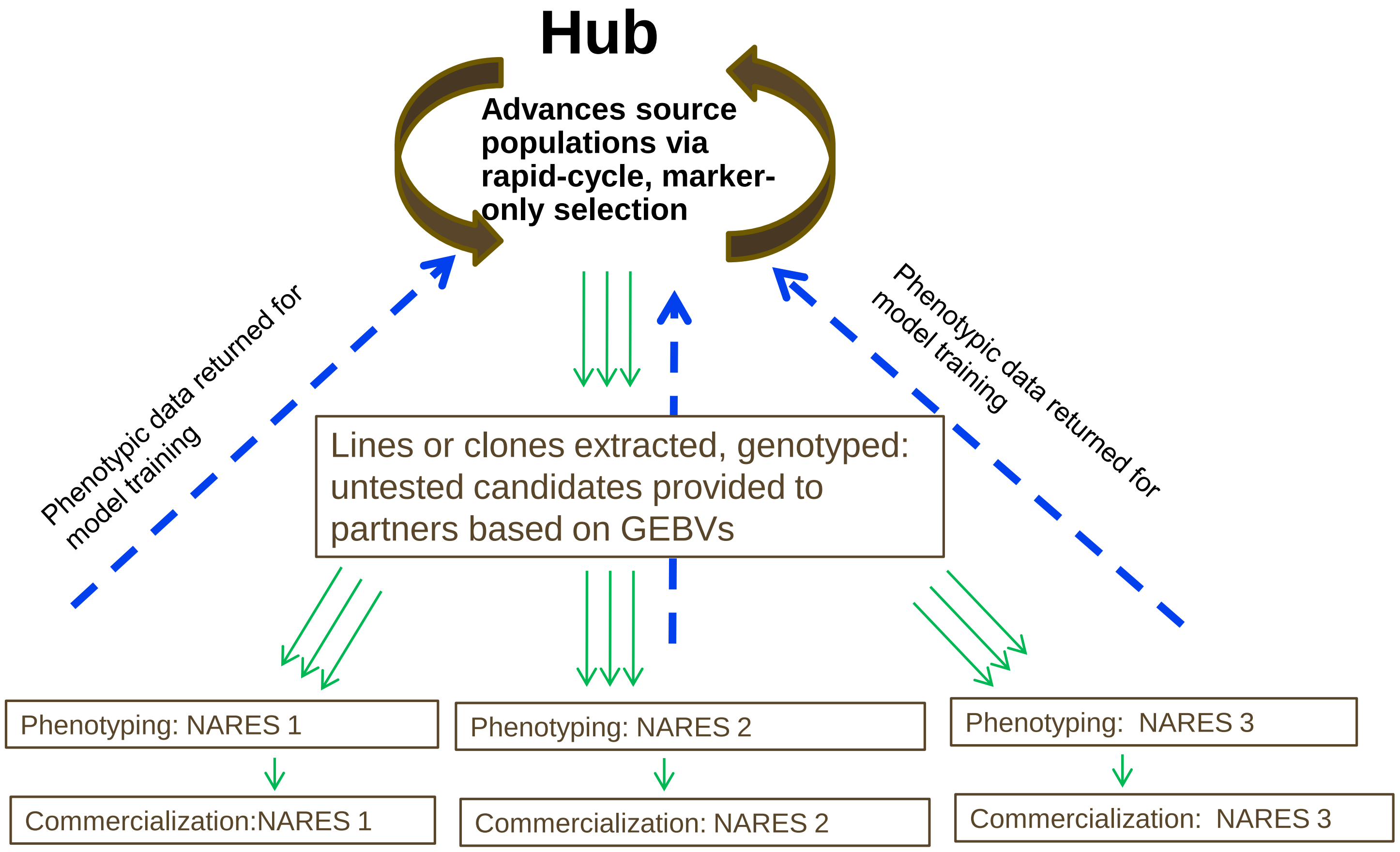
Indoor rapid generation advance (RGA) permits 4-5 generations per year

- Formal product profiles, variety replacement targets implemented
- Breeding cycle cut to 4 years
- Breeding informatics system developed and implemented
- Line development costs reduced by 90% via SSD
- Genotyping costs reduced by > 80% using external services, forward MAS implemented
- Multi-environment testing scaled up ca 10-fold
- Breeding operations centrally mechanized and digitized

Re-designing CGIAR-NARES breeding networks for rapid-cycle GS-assisted breeding

- CGIAR breeding programs typically serve regional networks of NARS, conducting joint evaluation of materials that have undergone at least 3 stages of selection at the CG center's sites.
- Some CGIAR breeding programs, e.g. PABRA, operate collaborative testing systems to which NARS breeding teams contribute materials as well, and make joint advancement decisions
- Rapid-cycle, GS-assisted population improvement opens up new possibilities for CGIAR-NARS breeding collaboration
- CGIAR can provide RGA, GS model maintenance, GEBVs
- NARES and CG jointly design product profile, select parents, make advancement decisions
- Most phenotyping done at national program sites in the TPE from Stage 1 (because parents of the next cycle are selected at Stage 1)

“Open-source” genomic selection network



Conclusions

- Varietal replacement is needed for climate change adaptation, but is happening very slowly in SSA and SA
- Low rates of varietal replacement are due to poor product design, low genetic gains, and lack of incentive for companies to replace varieties
- Genetic gains delivered by the CGIAR and NARES have slowed since the late GR, mainly due to slow breeding cycles
- Delivering higher rates of genetic gain will require CGIAR breeding programs to adopt a population improvement focus
- Breeding pipelines must be formally optimized for rate of genetic gain delivered annually
- CGIAR cereal and legume breeding programs should immediately aim for a 3-year breeding cycle, and transition to 2-year cycles within 5 years
- Modest investments in facilities needed to advance 3 generations annually in the field and 4 in controlled environments are required.
- CGIAR-NARS breeding networks need to be restructured so that product profiles are designed collaboratively, Stage 1 testing is done at NARS sites, and advancement decisions are made jointly

Improved breeding for faster variety turnover

Michael Quinn, EiB Director

23rd September 2020

Excellence in Breeding Platform

Why is variety turnover low?

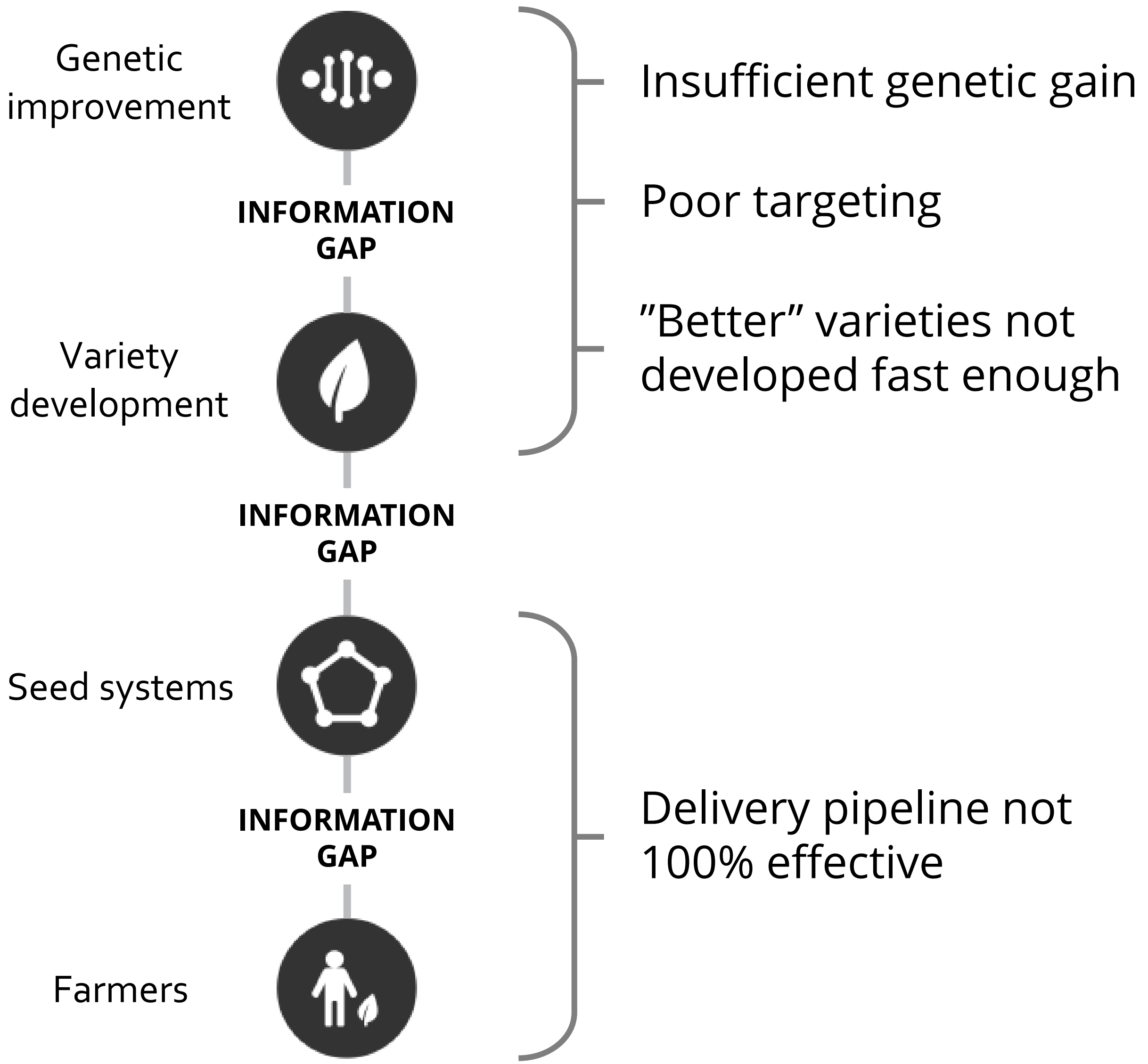
Genetic improvement

Variety development

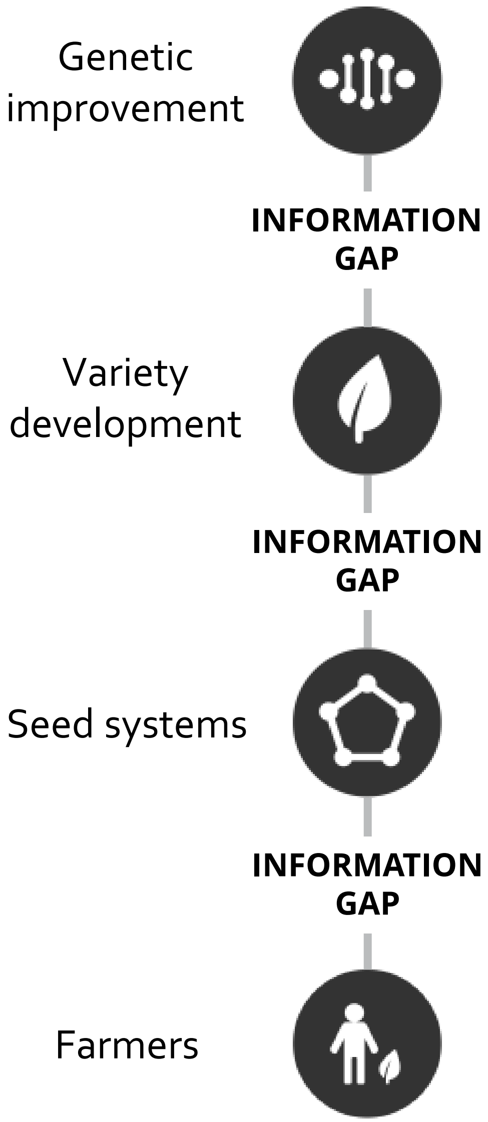
Seed systems

Farmers

Why is variety turnover low?



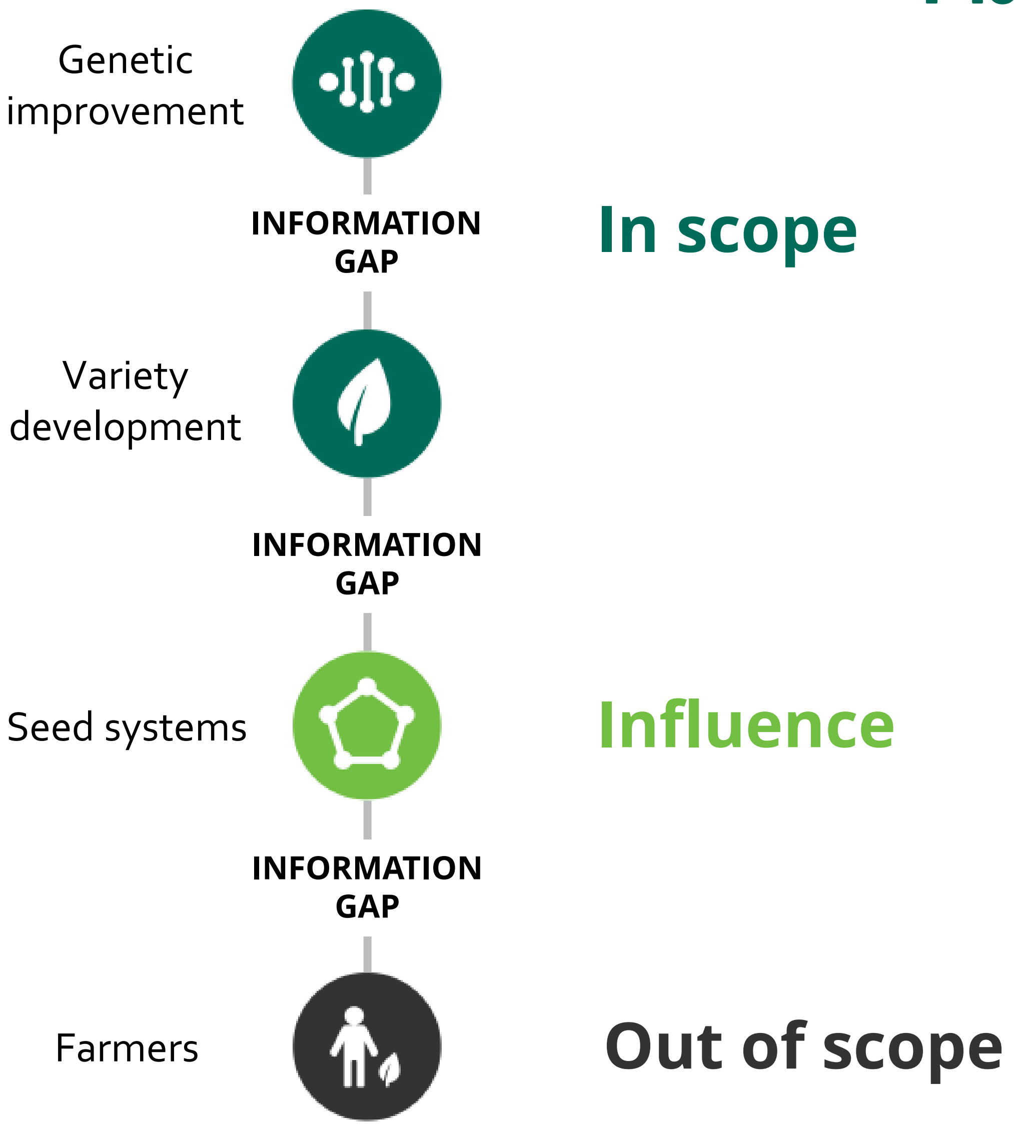
CGIAR Excellence in Breeding Platform (EiB)



- Leading and catalyzing change in CGIAR and NARS breeding programs
- Expert advice & consultancy
- Best practices and tools / technologies
- Access to shared services and training
- Targeted improvements through the Crops to End Hunger initiative

CGIAR | Excellence in Breeding Platform

CGIAR Excellence in Breeding Platform (EiB)



CGIAR Excellence in Breeding Platform

More effective seed systems

- Variety release is usually carried out by national agricultural research and extension systems (NARES)
- EiB promotes more effective CGIAR-NARES networks
  - Ownership of CGIAR germplasm by NARES
  - Definition of roles: CG drive genetic gain; NARES focus on variety turnover
  - Centralised breeding operations units for CGIAR-NARS networks

CGIAR | Excellence in Breeding Platform

Improved targeting

- Characterize the market segments targeted by CGIAR and NARES
- Consciously align breeding pipelines with the markets being targeted
- Focus on the traits and trait combinations required by end users and value chain actors in each market segment
- Business case for investment based on breeding pipelines tied to impact in market segments

CGIAR Excellence in Breeding Platform

Accelerated genetic gain

Getting the basics right with appropriate use of modern technologies and approaches

Optimized breeding schemes with applied quantitative genetics principles

Phenotyping: more accurate, lower cost and faster trials

Genotyping: greater accuracy (QC), more accurate performance prediction and efficiency gains (genomic selection / whole genome profiling

Data management: routine use of data analysis to improve decisionmaking

Biometrics: improved trial designs & analyses

CGIAR Excellence in Breeding Platform

Optimized breeding schemes

- Shortened cycle times
- Using a selection index
- Optimizing resource allocation, for example:
  - Replications within environments
  - Sampling more environments
  - Size of program
- Use of genetic resources:
  - More focused elite by elite crosses
  - Strategically and systematically bringing in new sources of high value germplasm in elite backgrounds

Eduardo Covarrubias

EiB Breeding Program Categories (Cat I to Cat III)

Donor Development (diversity/trait mining) ← information / germplasm → **Population Improvement** ← information / germplasm → **Product evaluation and release-Variety**

Donor Development (diversity/trait mining)

Identification of germplasm with novel trait variation/ diversity and development of donor germplasm from any and all high value sources 8 + year development timeframe of donor from source exploration

- Identification of high value "exotic", landrace and wild relative germplasm
- Development of well characterized, uniform donor germplasm (e.g. early generation introgressed lines;75% elite, 25% exotic)

Category I Donor Germplasm Product Profile guided

Exotic, non-elite germplasm using recurrent parents from III (*and elite un-adapted e.g Ex-PVP*)

Product: Adapted <u>well described</u> germplasm with specific trait/breeding diversity value

Population Improvement

Parental germplasm with genetic variation for priority traits 2-8 year development timeframe of parent

- Development of well characterized elite parental lines to use in variety development
- Parents to disseminate to National Partners

Category II Parent Germplasm Product Profile guided

Fast cycle pop improvement using germplasm from I, recycled from II and from III (~5% from I, 93% from II, 2% from III)

Ends at stage 1 testing or earlier if possible

Product: Adapted and competitive germplasm

Product evaluation and release-Variety

Variety development 5 year evaluation timeframe of potential varieties

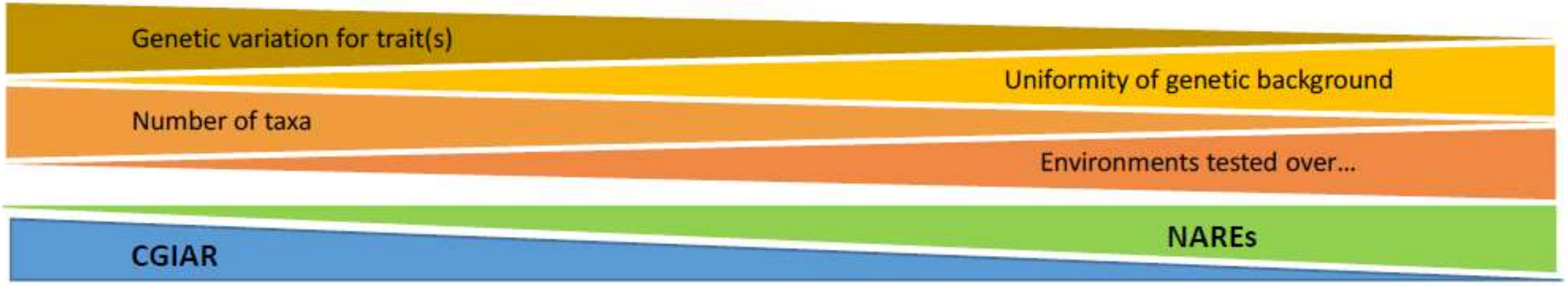
- Hybrid development
- Finished line evaluation
- Finished clone evaluation

Category III Product Profile guided

Can incorporate marker guided conversion and stacking within existing products where relevant

Evaluation of the best germplasm from II as products (incl hybrid combinations)

Product: Elite germplasm used as or in variety



Phenotyping

More accurate, efficient and rapid trials:

- More consistent irrigation.
- Better soil management.
- Better agronomic practices.
- Increased mechanization and digitization.
- A culture of continuous improvement.
- Improved health and safety for staff and care for the environment.

Gustavo Teixeira

Genotyping

Aggregated demand and training to access world-class genotyping applications at low cost for CGIAR and NARS

- QC and MAS for ~$2 per sample (marker panel of 10 markers)
- Mid density (>1000 markers) genome profiling for GS and genomics assisted breeding: ~$10 per sample

Eng Hwa Ng

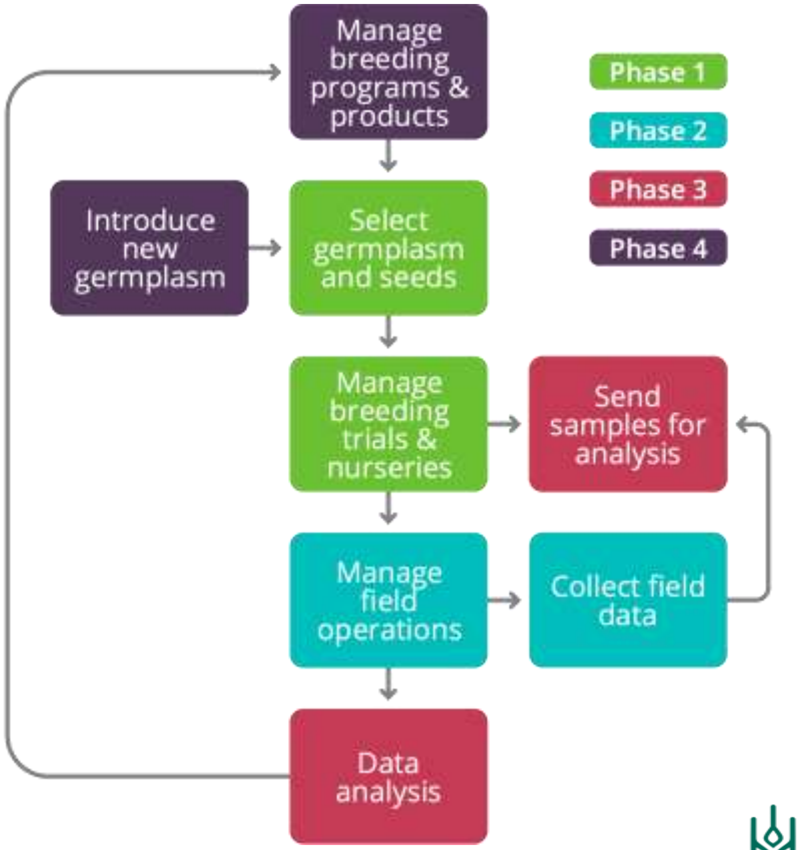
CGIAR | Excellence in Breeding Platform

Data management

Making sense of large datasets to use new breeding tools

Enterprise
Breeding
System

- In development: a full spectrum breeding data management system
- Allows breeders to go back to being breeders!



Biometrics

- One of the cheapest ways to increase accuracy and drive better decisions.
- Integrating with purpose built data management system lowering the cost of entry for current best practice trial designs and analytics

Young Wha Lee

CGIAR

Excellence in Breeding Platform

Thank you.

ExcellenceinBreeding.org
Excellence-in-breeding@cgiar.org

CGIAR | Excellence in Breeding Platform

Crops to End Hunger: Priority Crops and Target Product Profiles



Nora Lapitan
Bureau for Resilience and Food Security
USAID

Vision of Crops to End Hunger

Strengthened CGIAR crop breeding programs that develop and deliver more productive, resilient, and nutritious varieties of staple crops in demand by smallholder farmers and consumers in various geographic regions of the developing world.

USAID FROM THE AMERICAN PEOPLE

BILL & MELINDA GATES foundation

UKaid from the British people

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Australian Government
Australian Centre for International Agricultural Research

What to Invest in: Prioritization Study

IFPRI and USDA-ERS estimated impacts of faster productivity growth for selected crops on income and other indicators in developing countries in 2030.
Wiebe et al. 2020. https://osf.io/preprints/socarxiv/h2g6r/

- Parity Model
  - Allocation of research resources among multi-commodity systems based on gross value of commodity production
  - Considers how investments in crop productivity improvements can benefit smallholders farmers from higher gross sales

Parameters of Modeling Studies

- Commodity focus: 20 food crops where CGIAR does breeding
- Geographic focus: Sub-Saharan Africa, South and SE Asia, West Asia-North Africa-Central Asia (WANA-CA), Latin America (excluding China, Brazil, S. Cone)
- Approach:
  - Time frame: 2015-2030
  - Assume enhanced breeding could accelerate annual rate of yield improvement in farmers' fields by 25% over baseline yield growth (e.g., if baseline yield growth is 1%/year, enhanced yield growth is 1.25%/year)
  - IFPRI's IMPACT model used to estimate gross value production in 2030

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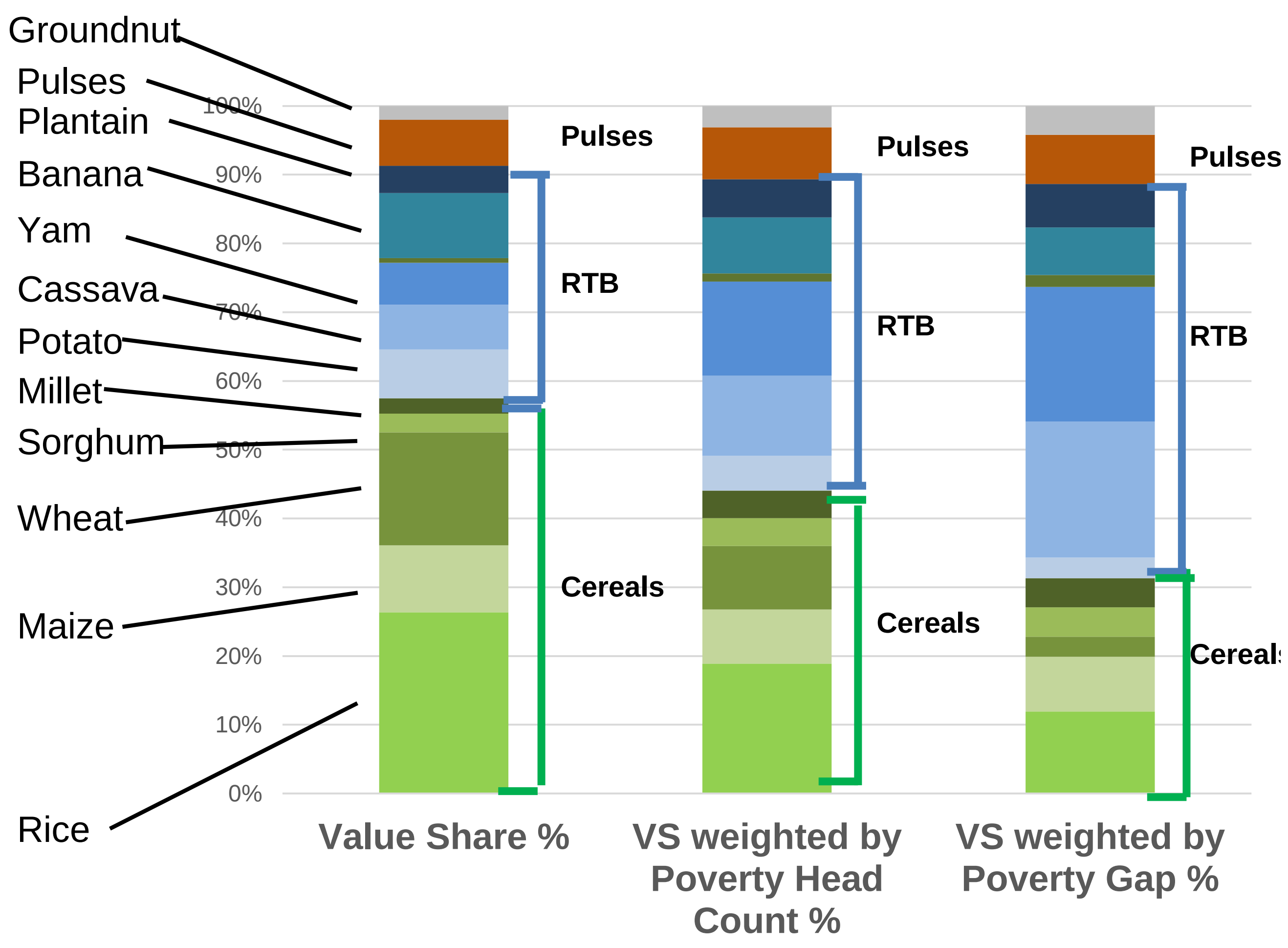
Gross Value Production using IMPACT Model (2030)



Gross Value Production in 2015, by region

	VALUE SHARE (%)				
Commodity	SSA	South Asia	SE Asia	WANA-CA	LAC
Cereal Grains					
Rice	8.4	44.7	68.6	10.0	12.7
Maize	11.1	4.3	6.9	9.5	22.3
Wheat	1.4	18.1	0.0	40.7	2.8
Sorghum	2.8	1.9	0.1	0.1	0.0
Millet	5.1	0.7	0.1	4.9	4.9
Roots, Tubers, Bananas					
Potato	2.6	8.7	0.5	19.9	8.2
Cassava	19.2	0.6	9.8	0.0	2.6
Yam	19.9	0.0	0.1	0.0	1.2
Sweet Potato	1.8	0.1	0.5	0.1	0.5
Banana	5.6	6.6	5.5	2.2	22.0
Plantain	5.8	0.1	1.2	0.0	10.4
Oilseeds & Pulses					
Pulses, Total	8.1	8.2	4.7	4.1	6.8
Groundnut	7.1	2.9	1.5	0.8	0.7
Soybean	0.8	2.7	0.5	0.4	4.2

Wiebe et al. 2020.
https://osf.io/preprints/socarxiv/h2g6r/

Target Product Profile

- A set of targeted attributes that a new plant variety is expected to meet in order to be successfully released onto a market segment. (Ragot et al. 2018)

Requirements:

- Defined market segment – geographic area or group of people having a relatively homogeneous demand for a commodity
- Market demands within a market segment- requires collecting input from all possible stakeholders
- Leading variety to be replaced
- Reviewed often to remain relevant and aligned with changes in market demand

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CTEH Unit of Investment

Crop x Region x **Product Profile**

Focus on Client needs and impact

Leading market variety is benchmark
Product profiles are based on specific market segments.
PPCs create accountability between breeders and funders around product for impact

Vehicle of improvement is the annual product advancement and review process

CGIAR Excellence in Breeding Platform

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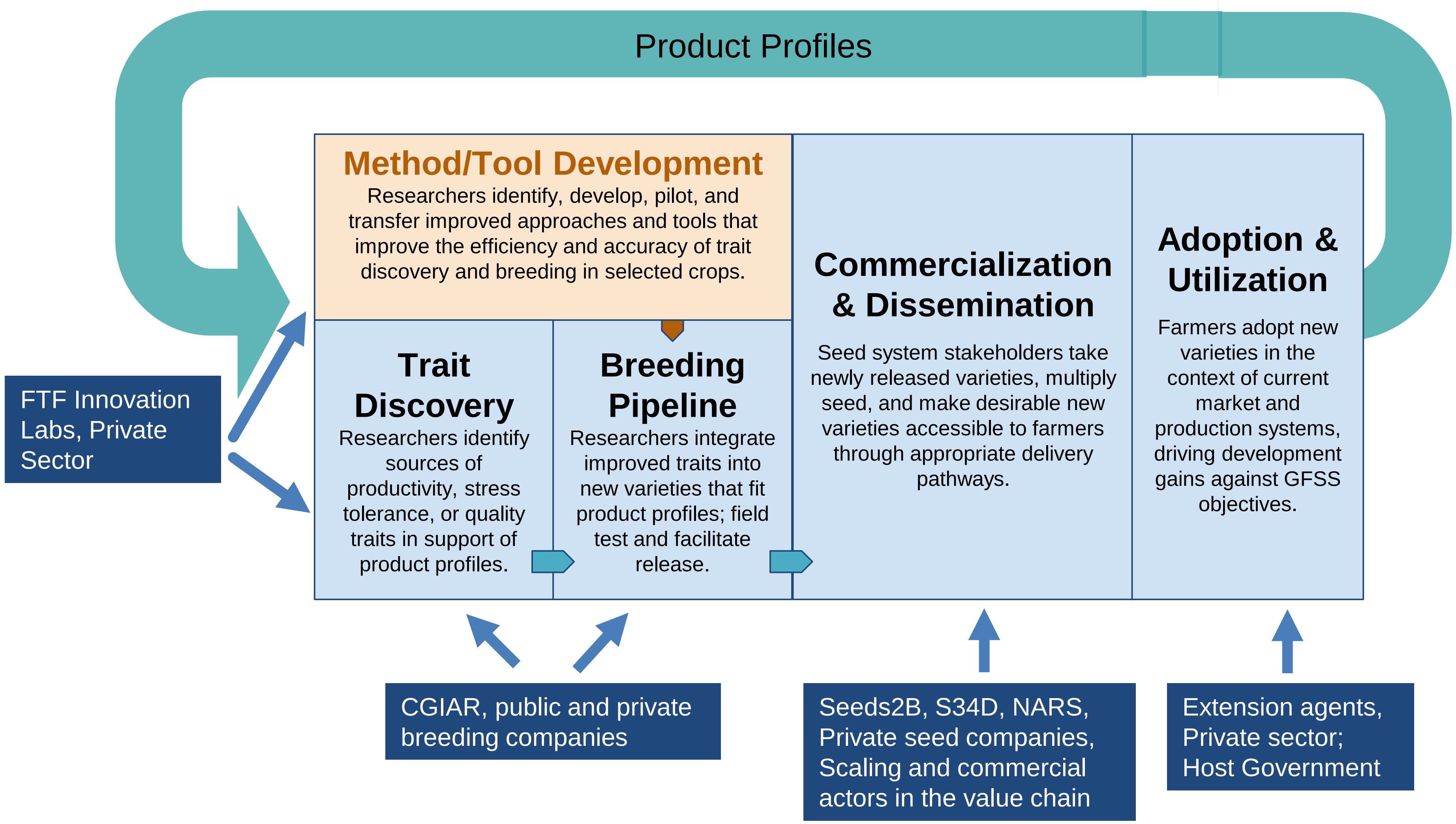
USAID/RFS Crop Improvement & Seed Delivery Framework



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USAID/RFS Product Life Cycle Decision-Making Framework

Product Profile
Target Product Profile (TPP) based on market research and segmentation

Discovery
Pre-product identification and selection based upon TPP

Proof of Concept
Development of pre-products or prototypes

Validation
Superior candidates screened through small plot trials

Selection
Final candidate selection based on value-add

Release
Regulatory Approval Variety release & registration

(Commercial) Introduction
Resources, Commitment and incentives for widespread adoption

Growth
Confirmation of widespread adoption

Maturity
Adoption has plateaued

Decline
Data demonstrates significant multi-year decline

Phase Out
Improved replacement technology exists

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www.feedthefuture.gov

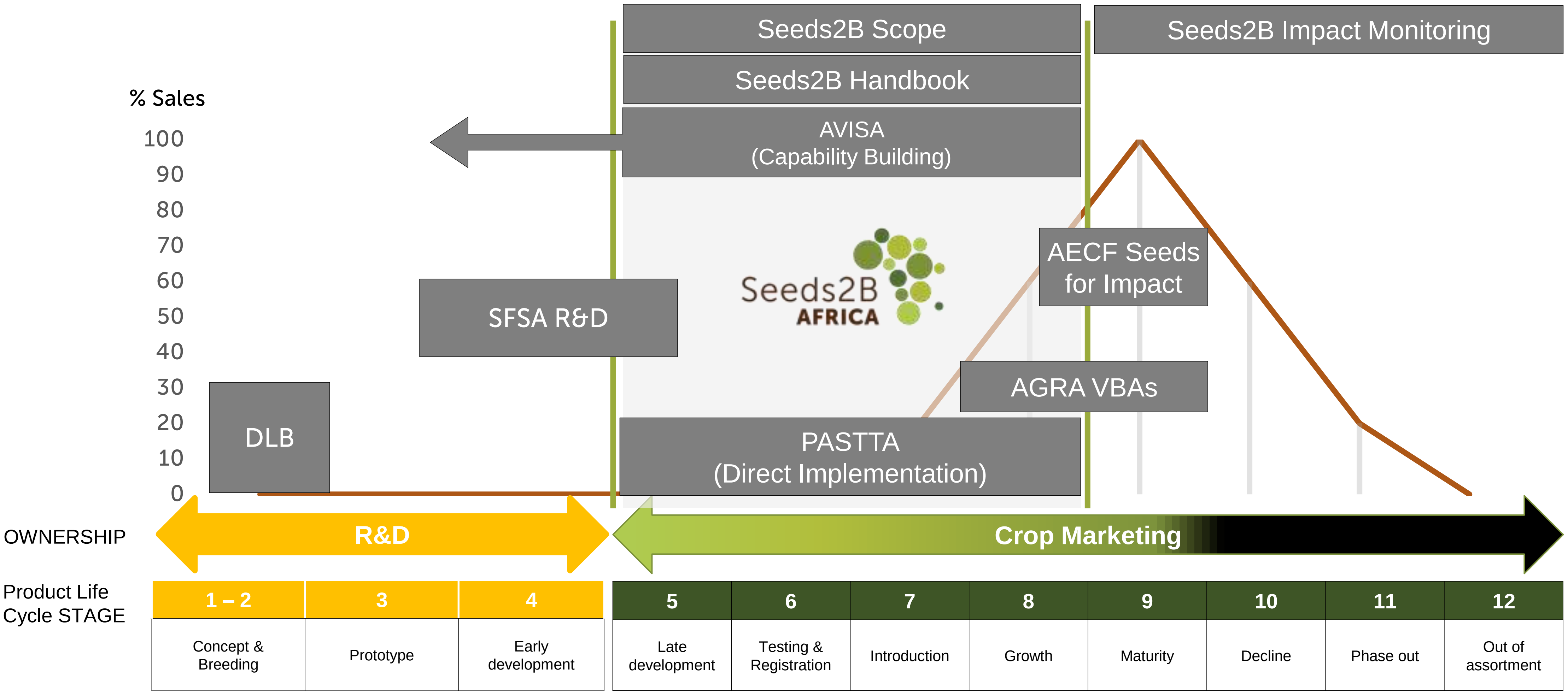
Thank You!

Seeds2B - The product “dataverse” from research to marketing

Dr. Simon Winter

Executive Director - SFSA

SFSA Seeds2B major focus and investments in seed delivery



SFSA's end to end process to commercialization

→ **Continuous** and **consistent** governance **across** the 3 key steps by the project manager is the key to success

Answering: *Who is doing what, when?*
How people/partners are working together?
Define data ownership, storage and flow, people and skill resources, decision making flow, communication flow, funding allocation and source

→ Regular monitoring and evaluation helps maintain focus on the strategy and the problem to be solved.
→ Walking through these steps is a continuous learning process which helps to progressively adjust the plan

Monitoring *progress and achievements to:*
- Track implementation, ensure targets are met, provide data to KPIs
- Update/adapt the plan as per learnings (feedback loop)

Governance at project and operational level

Monitor – Evaluate – Learn

Problem Definition

Answering the questions regarding the context, problem, needs**: <u>What, to whom, where and why.</u>**

→ Identifying and defining clearly the problem and its perimeter is more than halfway to solving it. Reliable data is critical.

"If I had an hour to solve a problem, I'd spend 55 mins thinking about the problem and 5 minutes thinking about solutions."

- Albert Einstein

Solution Design

List *the possible solutions and analyze the potential for solving the problem*
Create *hypothesis (Target PP) and articulate the value expected for the farmers*
Create the vision *of the value chain business model*
Assess *the economic, environment, social benefits*
Plan *funding, people resources*
Demonstrate *the positive ROI of the intervention*
<u>Is it feasible?</u>

→ Finding the suitable solution requires imagining different scenarios and modelling their benefits
→ The vision needs to be communicated and owned

Solution Delivery

Plan *for concrete implementation (portfolio management, marketing, production)*
Implementing *the plan to make the "solution" available at scale. Bring concepts to reality at technical, legal, and commercial levels.*

→ Extensive planning is the key to success
→ Investing in the delivery part is essential where market lacks dynamism / has failures
→ Investing according to a clear plan increases efficiency and optimization of the resources and reduces failure risks.

syngenta foundation for sustainable agriculture

SFSA's end to end process to commercialization

Set up appropriate governance

Problem statement WHAT, TO WHOM/WHERE and WHY

Targeted farmer segment

Market segmentation / TPP

Solution statement

Economic value analysis (farmer ROI), environment and social benefits

Business model

Investment case

Monitor project deliverables against the value proposition, KPIs by partners

Aligned R&D processes and stage gates

Sustainability plan of the value chain

Create Launch road map and timelines

Plan to continue feedback to breeders

Manage trials

Create portfolio

Manage portfolio/PAM

Consolidate variety profile against TPP

Update variety performance

Plan promotional activities

Execute promotional activities

Value pricing

Plan production

Execute /support partner production plan

Plan sales

Support partner sales

MTA/MTTA

Develop seed distribution / channel

Commercial and licensing agreements

Registration completion

The E2E process mindset: One vision, One team

OWNERSHIP	R&D			Crop Marketing							
PLC STAGE	1 – 2	3	4	5	6	7	8	9	10	11	12
	Concept & Breeding	Prototype	Early development	Late development	Testing & Registration	Introduction	Growth	Maturity	Decline	Phase out	Out of assortment

PLC criteria for product advancement

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Stage 5 – Late development
Test pre-selected varieties to shortlist the candidates for commercialization

Stage 6 – Pre-commercial
Test candidates to find the varieties to be launched for commercialization

Stage 7 – Commercial (Introduction)
Commercial launch of the selected variety/ies

Stage 8 – Commercial (Growth)

Stage gate 4-5 criteria:

Plan & Strategy
- Problem definition and hypothesis to design solution
- Target Product Profile (TPP) derived

Variety data review
- Variety pipeline assessment & history
- Variety performance data vs TPP and checks

Next steps
- Availing seed for testing

Stage gate 5-6 criteria:

Plan & Strategy
- Engaging key value chain partners
- Draft plan for seed production and commercialization

Variety data review
- Variety pipeline assessment & history
- Variety performance data vs TPP and checks

Implementation of next steps
- Availing seed for testing and EGS production assessment

Stage gate 6-7 criteria:

Plan & Strategy
- Key value chain partners on-boarded
- Seed production and commercialization plans ready

Variety data review
- Variety performance data vs TPP and checks
- Variety datasheet available
- Seed production recipe available

Implementation of next steps
- Availing seed for demos and seed production

Regulatory/Legal
- Variety registration completed
- Licensing agreements completed or in process
- Seed certification engagements

Stage gate 7-8 criteria:

Assessment of the solution
- Evaluation of actual seeds sales against plan and forecast
- M&E data (seed volume, area grown, number of farmers reached, etc)
- Feedback loop from farmers back to breeders on variety performance

Implementation of next steps
- Functional licensing agreements and governance
- Check continuity of seed production plan

Example of the use of a TPP to guide candidate variety selection on a joint CIP/HZPC potato breeding program in Vietnam

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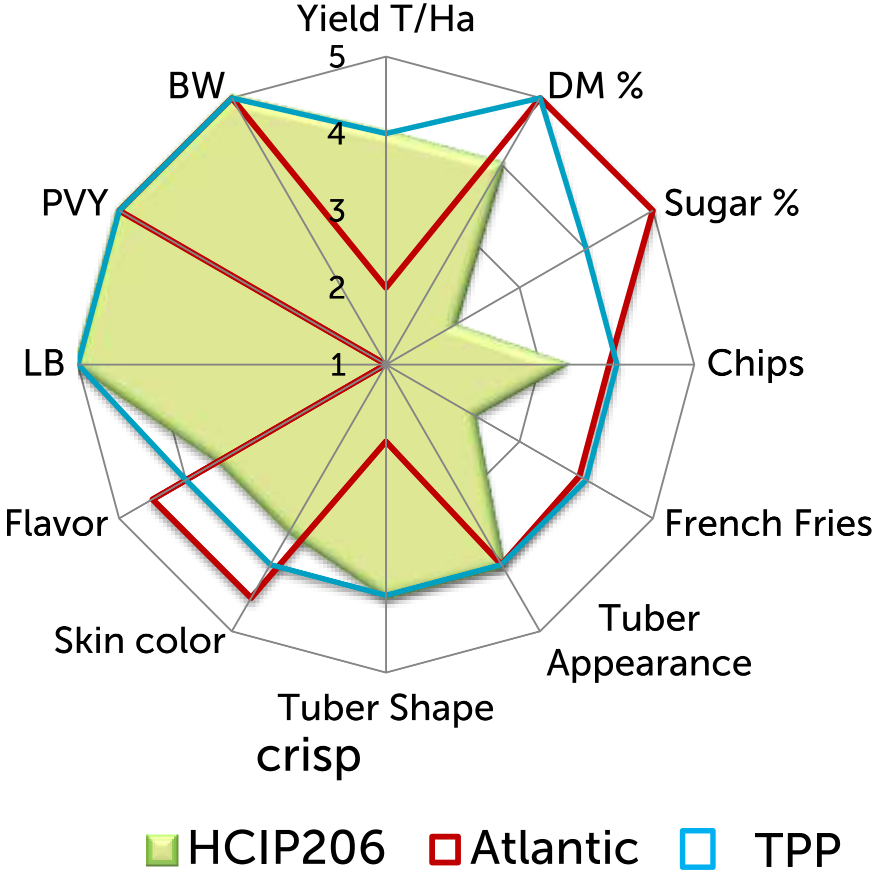

1 is poor, 5 is best

Processing / crisp segment
Data collected in Dalat, High Land in Nov18-Feb19 and Sep19-Dec19

	TPP score	HCIP206	Atlantic
Yield T/Ha	4	35.7	11.1
DM %	5	20.7	21.6
Sugar %	4	0.38	0.17
Chips	4	1.7	1.1
French Fries	4	2.7	1.1
Tuber Appearance	4	good	good
Tuber Shape	4	Uni / Large	Inter-Mid
Skin color	4	Yellow	White
Flavor	4	Inter	good
LB	5	Res	Susc
PVY	5	Res	Res
BW	5	Res	Res

TAP-5 meeting Feb 2020
Score TPP to be revised

Data flow into Dataverse

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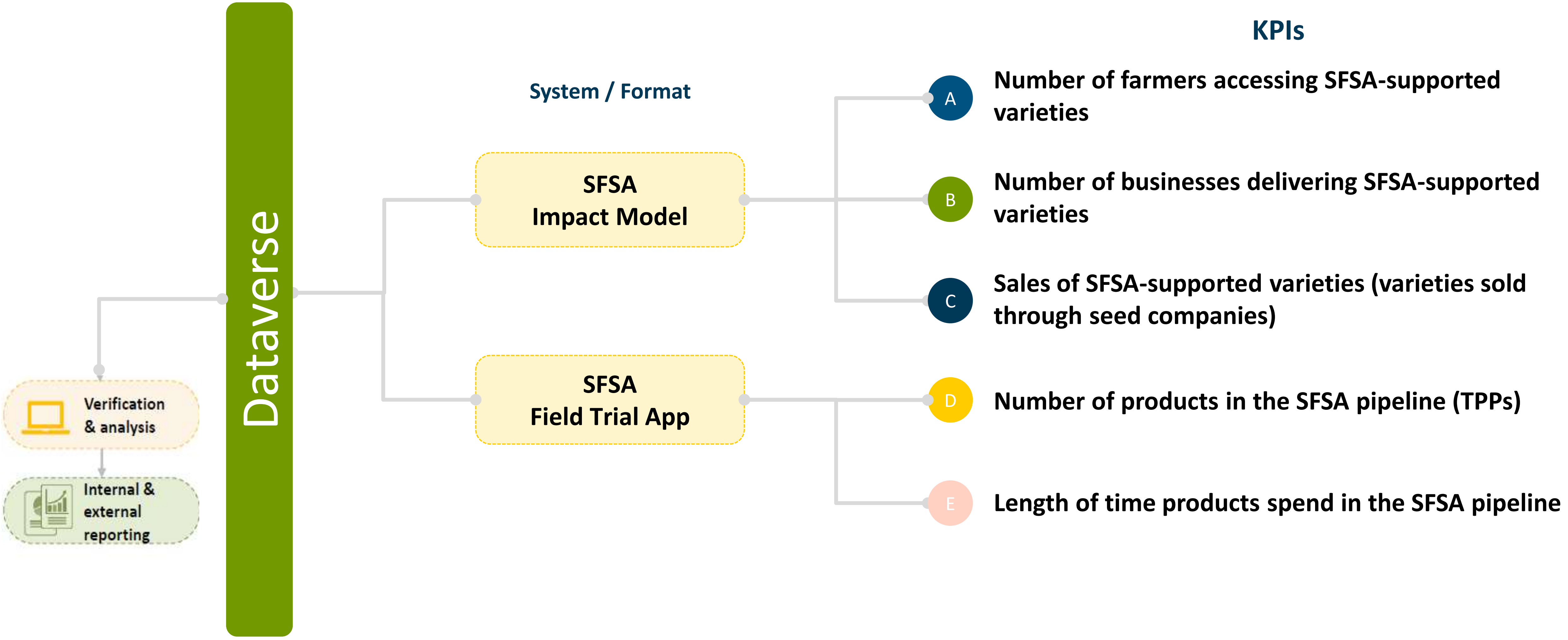

Thank you.