

Breeding Operations and Phenotyping

Gustavo Teixeira
EiB Module lead



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Thinking....

How would you like to have your seed stored?



Same CGIAR station

Thinking....

How would you like to identify your plot?



Same CGIAR station

Thinking....

How would you prefer to register your data?



Same CGIAR station



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Thinking....

Which agronomic practice would you prefer?



Same CGIAR center



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Thinking....

Which is the safest workplace?



Same CGIAR station



Why am I showing these pictures ???



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↑ Staff morale



Errors ↓



Sustainability ↑



Heritability ↑



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... We will be more effective



... We will deliver better products

“... The technical aspect is not the biggest challenge....”

“The solution is known.... It is a matter of prioritization and cultural change....”

EiB – Module update Breeding Operations and Phenotyping

What has been achieved?
Challenges and next steps



Gustavo Teixeira

Breeding Operation and phenotyping Module leader at Excellence in Breeding Platform

I have over 15 years' experience in the private sector including Syngenta, John Deere and other companies.



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What do we want to achieve?



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“...breeding programs have the most effective and cost efficient phenotypic process, from field preparation to data collection. With a strong culture of delivery of quality data through continuous improvement. Providing respect and safety for all employees”.

Excellence in Breeding Program 2019

Pillars of a world-class breeding program

- Focus on developing products and adoption for impact**
 - **Double the rate of genetic gain**
 - All breeding activities are supported by clear **targeted product profiles** that outline customer and their needs
 - **Target market segments** are defined and used to define exemplar pools and breeding schemes
- Data accuracy, cost & throughput**
 - **Appropriate** use of technology to increase genetic gain and data revealed
 - Selections made on **high-quality trials**
 - Continuous and accurate **data collection**
 - Current best practice data management and quality control
 - **Breeding costs** known and readily retrieved
- Maximized evaluation accuracy**
 - **Genetic gains assessed annually**
 - Best practice implementation of **trial designs**
 - Reliable generation of data representative of **targeted population of environments** to select parents earlier
 - Latest **phenotyping and environmenting** technologies exploited
- Impactful breeding pipeline**
 - A **defined pipeline** is established to deliver high-quality germplasm from first cross to adoption to end user
 - Sufficient data is generated and available to **inform variety choices**
- Optimized breeding schemes**
 - Variety development, parent development, identification and validation of novel genetic diversity are **distinct and separate activities**
 - **Breeding cycles** are shortened (towards to the biological limit)
 - A **stage gate system** is implemented to manage breeding activities
- Crossing linked to breeding strategy**
 - Parental selections made and genetic diversity managed according to the **breeding strategy**
 - Variety development strictly based on **ultra-by-elite crosses**
 - **Genetic diversity** is measured and actively managed
- Accurate selection**
 - **Annual advancement meeting**
 - **Selection index** aligned with product profile
 - Best practice **trial analysis** to estimate breeding values and genetic merit
 - **Visualization tools** support decision-making
 - **Selection intensity and genetic diversity** considered in parent selection
- Continuous improvement culture**
 - Full use of external training and germplasm
 - **Breeding teams are the experts**
 - Clear **pathway and metrics** to deploy new and improved breeding methods
 - **Annual review** of performance metrics
 - Respect and safety for **all employees**

<https://excellenceinbreeding.org/eib-annual-meeting/day-1>



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What does it mean?



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What does it mean?

Good field
(plotmanship)



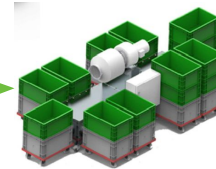
Good agronomic
practices (field prep.,
pest control, etc..)



Effective and cost efficient
process



Mechanization,
Automation,
Data collection,
Access to
service...



What does it mean?

Continuous Improvement



Everybody everyday



before



after



Health, Safety and environment



Staff morale,
Leading by example,
Sustainability

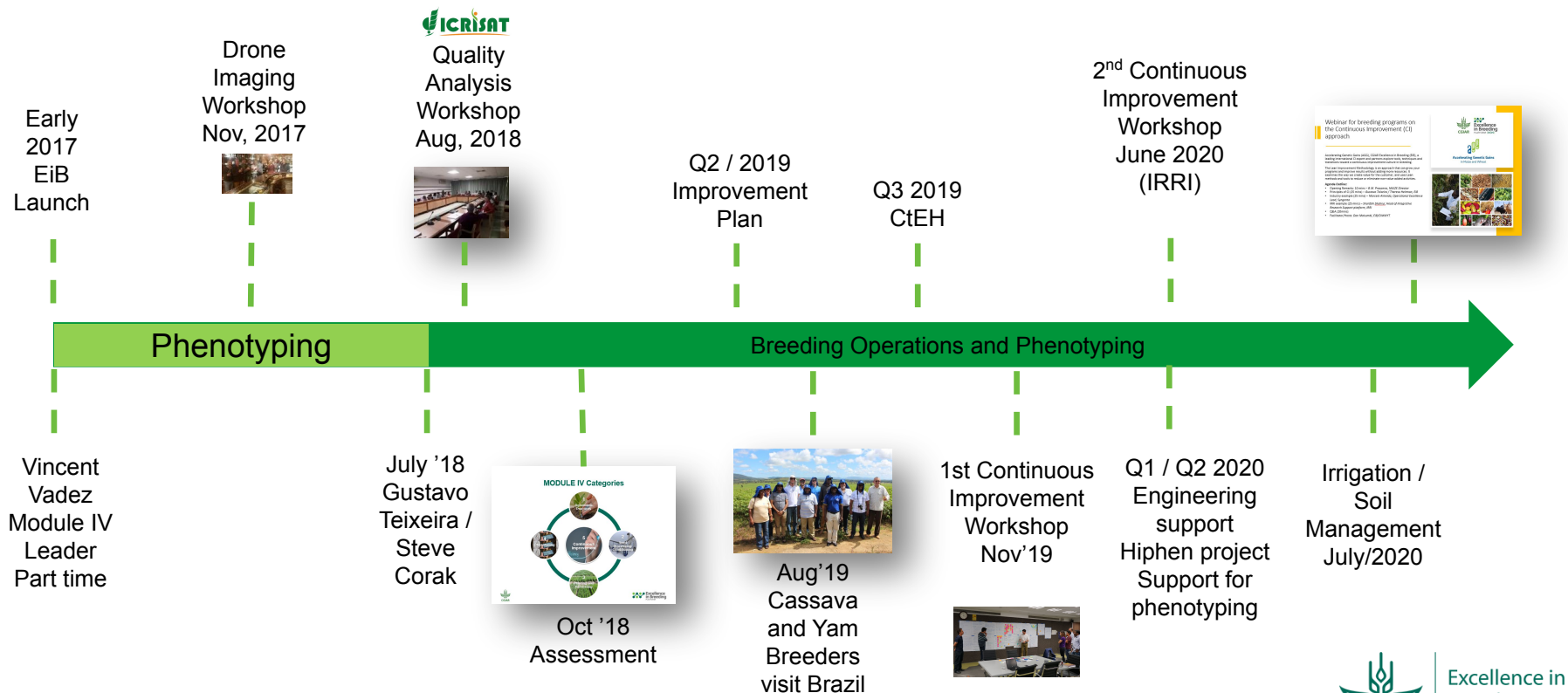


Background...



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Background



What is the current status?



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- Technical aspect
- Organizational aspect



Technical aspect
What needs to be done?



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Current status – technical aspect

- Breeding operations assessment



Breeding operations assessment



1. Agronomic practices

2. Seed processing

3. Planting and harvesting

4. Phenotyping

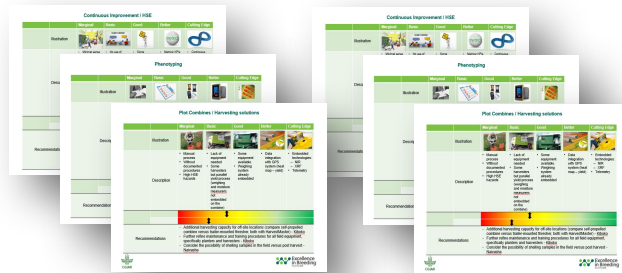
5. Continuous improvement

25 research
stations

National Programs

CGIAR

Ranking



Stations visited received a report ranking the current status of each sub-category ranging from Marginal to Cutting-edge.

The table on the right illustrates the current status of agronomic practices in Breeding Operations across CGIAR centers.

CG system

Category	Subcategory	Station / Program	Current Status			
			Marginal	Basic	Good	Cutting-edge
Agronomic Practice	Field preparation, fertility, IPM, and crop maintenance equipment	A				
		B				
		C				
		D				
		E				
		F				
		G				
		H				
		I				
		J				
		K				
		L				
Agronomic Practice	Irrigation and Weather Data	A				
		B				
		C				
		D				
		E				
		F				
		G				
		H				
		I				
		J				
		K				
		L				
Agronomic Practice	Farm Management System	A				
		B				
		C				
		D				
		E				
		F				
		G				
		H				
		I				
		J				
		K				
		L				
Agronomic Practice	Greenhouses and Controlled Environment	A				
		B				
		C				
		D				
		E				
		F				
		G				
		H				
		I				
		J				
		K				
		L				
M						

Current status of agronomic practices across CGIAR centers

Category	Subcategory	Station / Program	Current Status				
			Mileage	Cost	Revenue	Contracted	
Agronomic Practice	Field preparation, fertility, IPM, and crop maintenance equipment	A					
		B					
		C					
		D					
		E					
	F						
	G						
	H						
	I						
	J						
	K						
	L						
	M						
	B	Irrigation and Weather Data	B				
	C						
D							
E							
F							
G							
H							
I							
J							
K							
L							
M							
A	Farm Management System	A					
B							
C							
D							
E							
F							
G							
H							
I							
J							
K							
L							
M							
A	Greenhouses and Controlled Environment	A					
B							
C							
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L							
M							

Agronomic Practices

Category	Subcategory	Station / Program	Current Status				
			Mileage	Cost	Revenue	Contracted	
Seed Processing / Conditioning	Seed Process Infrastructure	A					
		B					
		C					
		D					
		E					
	F						
	G						
	H						
	I						
	J						
	K						
	L						
	M						
	B	Conditioning, Packaging and Treating	B				
	C						
D							
E							
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I							
J							
K							
L							
M							

Seed Processing

Category	Subcategory	Station / Program	Current Status				
			Mileage	Cost	Revenue	Contracted	
Planting / Harvesting	Planters / Planting Solution	A					
		B					
		C					
		D					
		E					
	F						
	G						
	H						
	I						
	J						
	K						
	L						
	M						
	A	Plot Combine / Harvesting Solution	A				
	B						
C							
D							
E							
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J							
K							
L							
M							

Planting and harvesting

Category	Subcategory	Station / Program	Current Status			
			Mileage	Cost	Revenue	Contracted
Phenotyping	Phenotyping	A				
		B				
		C				
		D				
		E				
		F				
		G				
		H				
		I				
		J				
		K				
L						
M						

Phenotyping

Category	Subcategory	Station / Program	Current Status			
			Mileage	Cost	Revenue	Contracted
Continuous Improvement	Continuous Improvements / HSE	A				
		B				
		C				
		D				
		E				
		F				
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		K				
L						
M						

Continuous Improvement



It helped us to define what needs to be done...

Our High-level Roadmap



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2020

2021

2022

2023

2024

2025

IRRIGATION
Projects – key station

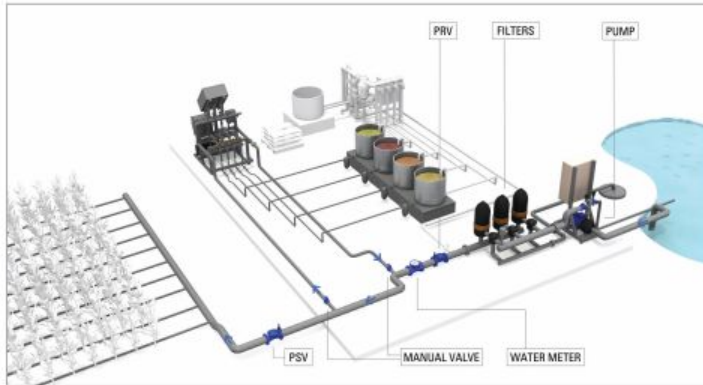
IRRIGATION
Infrast + Staff Develop.



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Irrigation project

- 7 CGIAR stations in Africa
 - Infrastructure upgrade
 - Weather station
 - Soil moisture probes



Irrigation project

- Challenges
 - Internal processes (procurement / legal)
 - Communication / scope definition
- How to mitigate
 - We'll involve procurement and legal team earlier in the process
 - We got the commitment from CIMMYT team to improve the support
 - We'll be hiring the Breeding Operation/ Mechanization specialist

Irrigation project

- Next steps
 - Implementing infrastructure (some with CtEH funds)
 - Filling additional gaps / other projects
 - Training staff
 - Breeding operation exchange program
 - Publishing material in EiB toolbox

2020

2021

2022

2023

2024

2025

IRRIGATION
Projects – key station

IRRIGATION
Infrast + Staff
Development

Soil Management
Projects – key station

Soil Management implem+
Staff Develop.



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Soil Management

- Baseline for key CGIAR stations in Africa
 - Project delayed due to COVID-19
 - Report for one station delivered



Lydiah Gatere ·



Ray R. Weil

Soil Management

- Challenges
 - Internal processes (procurement / legal)
 - Communication / scope definition
- How to mitigate
 - We'll involve procurement and legal team earlier in the process
 - We got the commitment from CIMMYT team to improve the support
 - We'll be hiring the Breeding Operation/ Mechanization specialist
- Next step
 - Finalizing pending station (visit / recommendation)
 - Implementing recommended plan
 - Training staff
 - Breeding Operation exchange program
 - Publishing material in EiB toolbox



2020

2021

2022

2023

2024

2025

IRRIGATION
Projects – key station

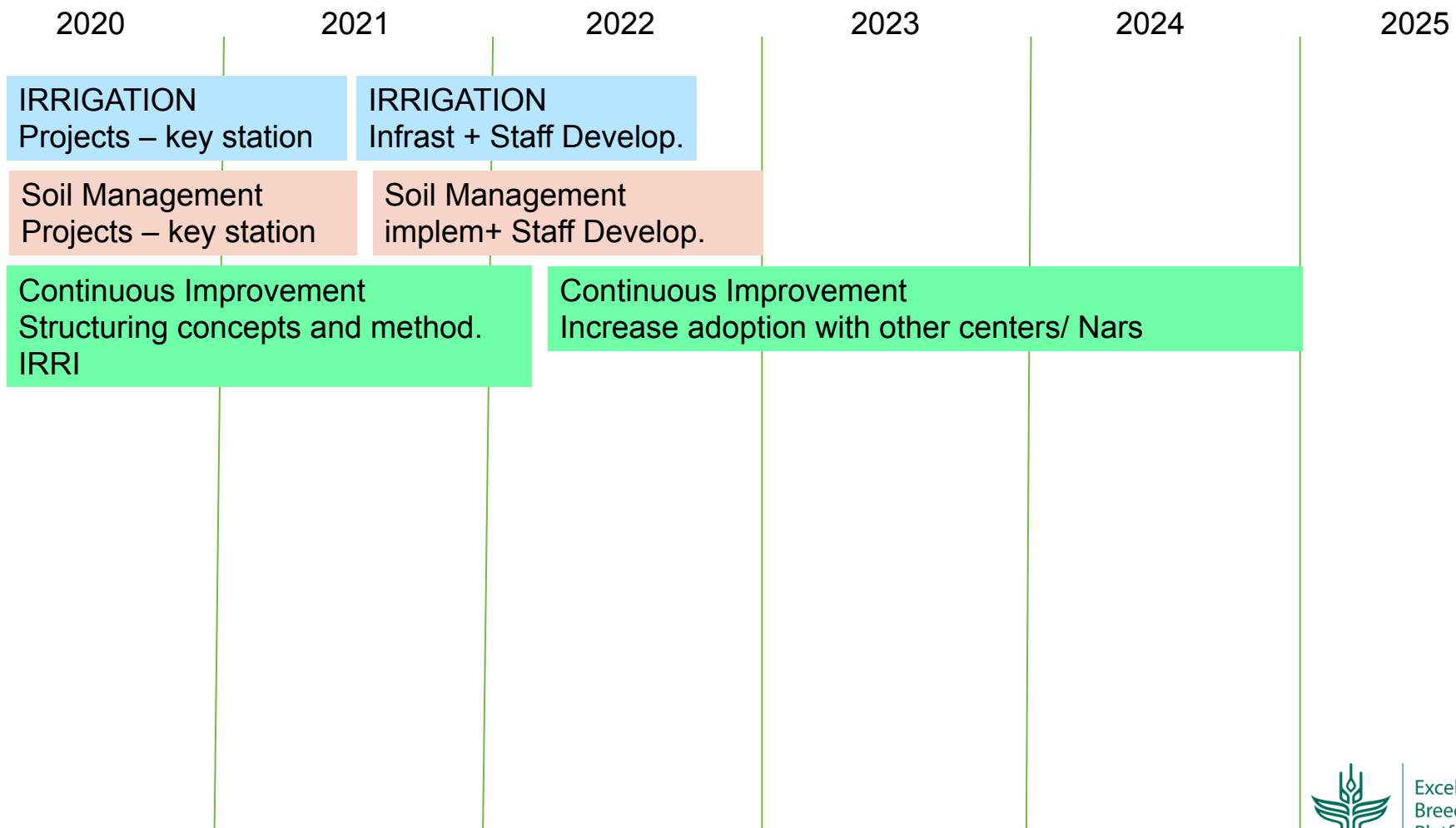
IRRIGATION
Infrast + Staff
Development

Soil Management
Projects – key station

Soil Management implem+
Staff Develop.



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Continuous Improvement

- Achievements
 - 75 CGIAR staff trained on lean methodologies (32 hour training)
 - 9 projects
 - Over 120 participants (from NARS) on CI webinar



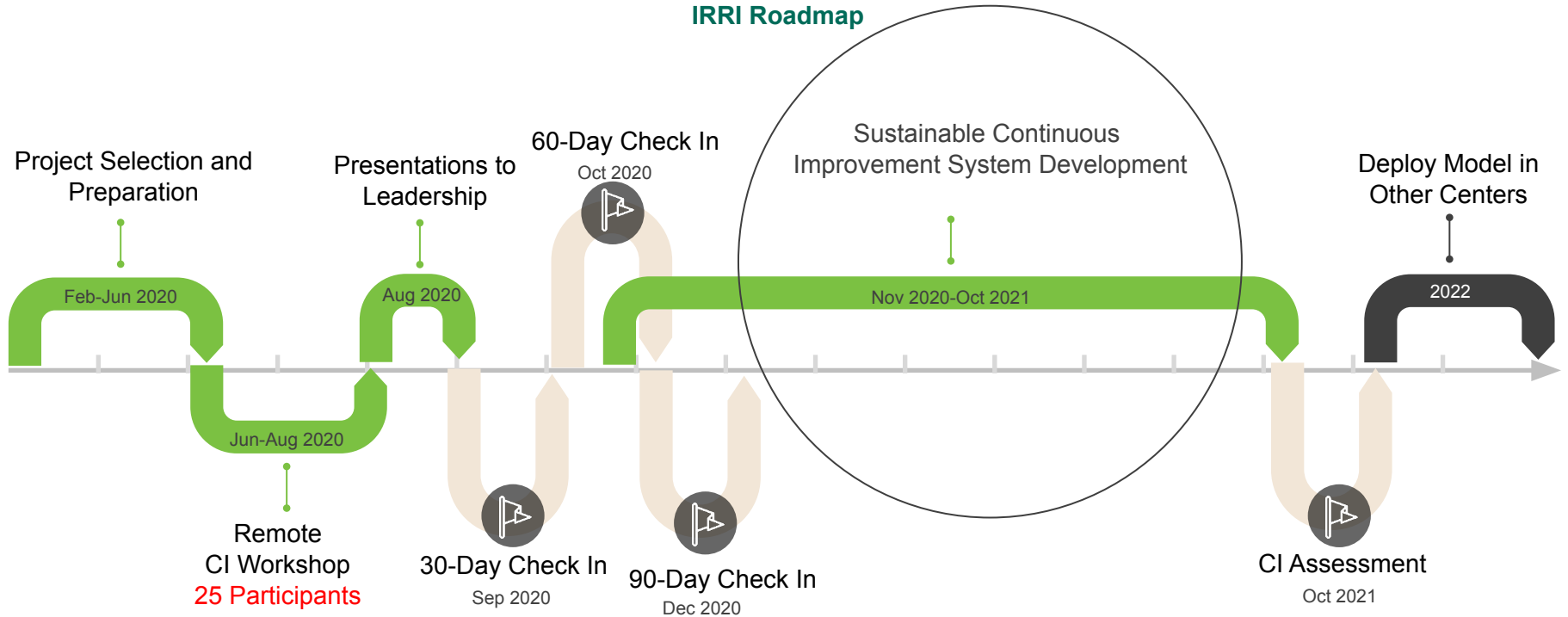
Theresa (Walker) Heitman

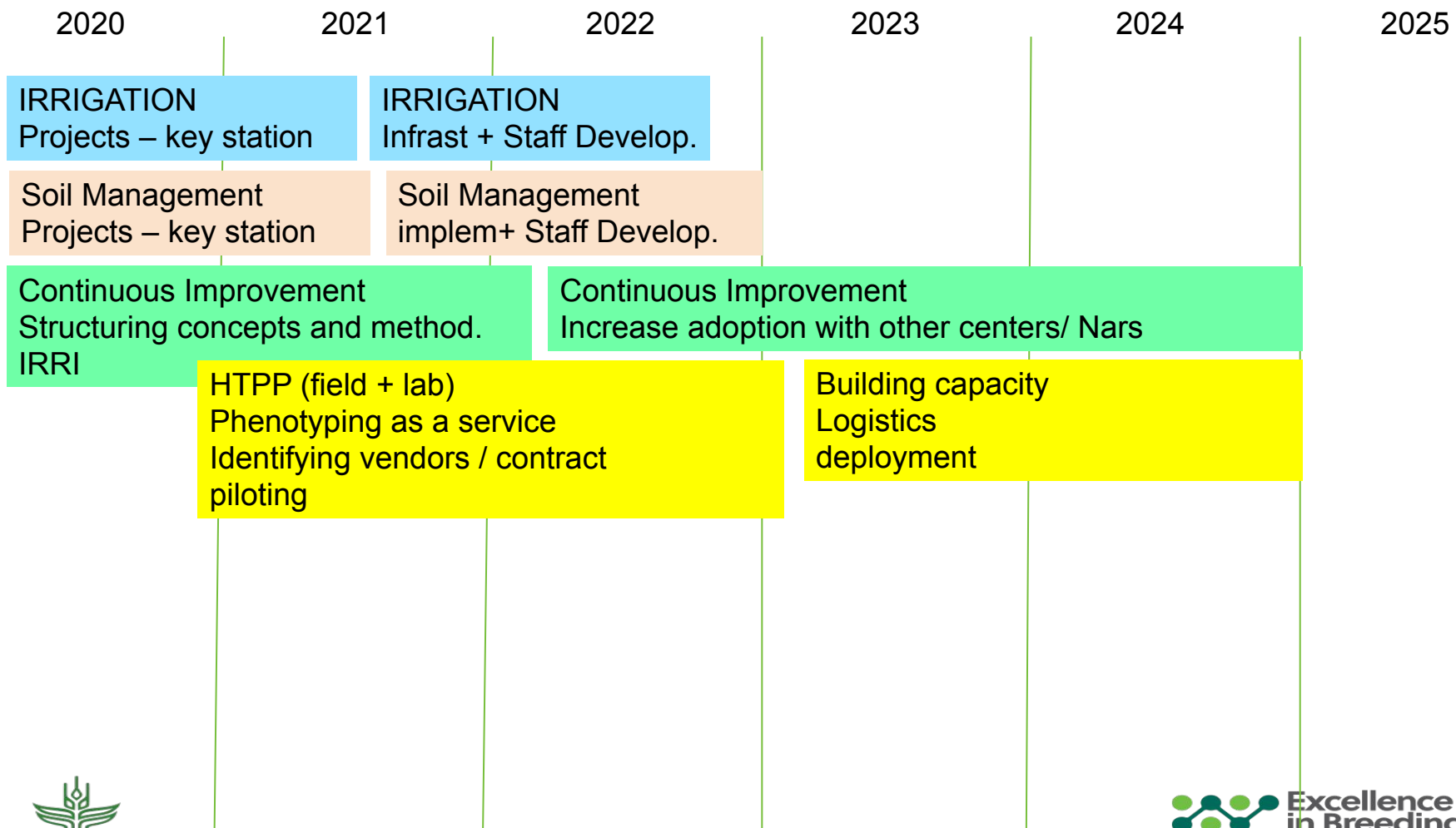
Continuous Improvement

- Challenges
 - Virtual training
 - Follow up projects (Covid-19)
- How to mitigate
 - Reduce the group size
 - Key practitioners / leaders that will help drive it
- Next step
 - Working with IRRI to create the Continuous Improvement system (including e-learning)



IRRI Roadmap





HTPP



HTPP – Quality and Nutritional trait

- Service – similar as HTPG
- Q2/Q3 identifying demand □ We are in the process of selecting vendors / contract



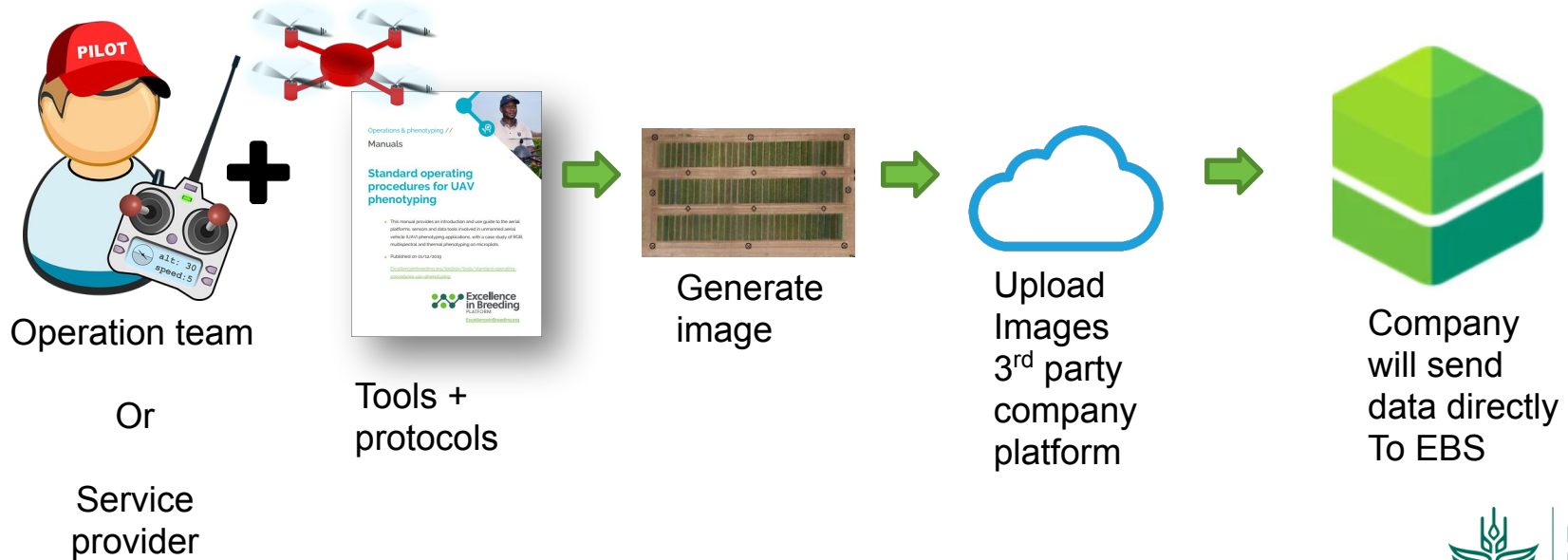
Aldo Rosales

HPPP – Quality and Nutritional trait

- Challenges
 - Understanding the demand per product profile (wish list)
 - We tried to cover too many crops
- How to mitigate
 - Reduce the scope (initiate the project with a limited scope)
- Next steps
 - Contract vendor
 - Define protocols (logistics)

HPPP – Agronomic traits / field phenotyping

- Our goal



HPPP – Agronomic traits / field phenotyping

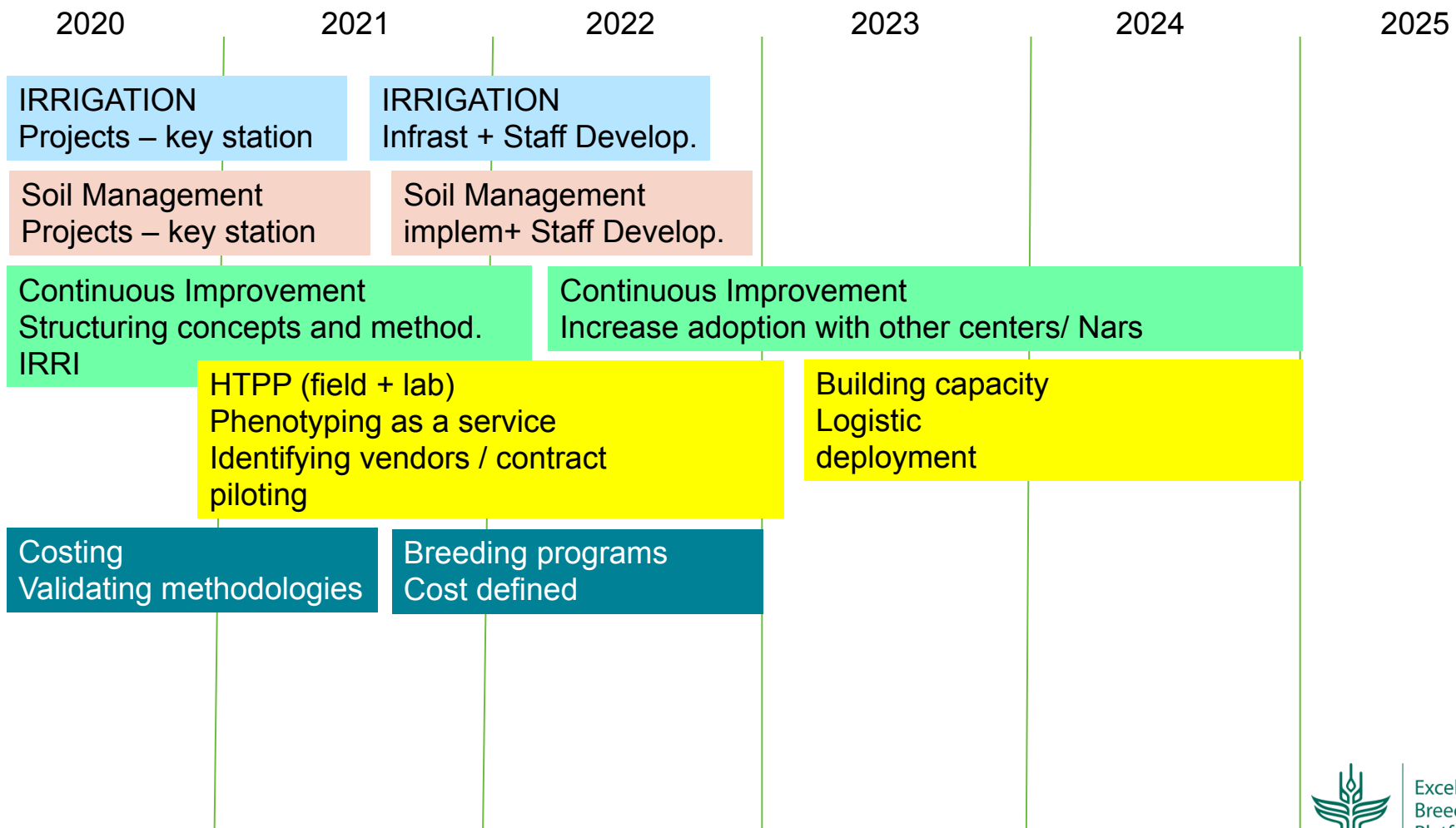
- What has been achieved?
 - Protocols are available in EiB toolbox
 - Hiphen (private company) was hired to run the first campaign (ICRISAT) – Proof of concept



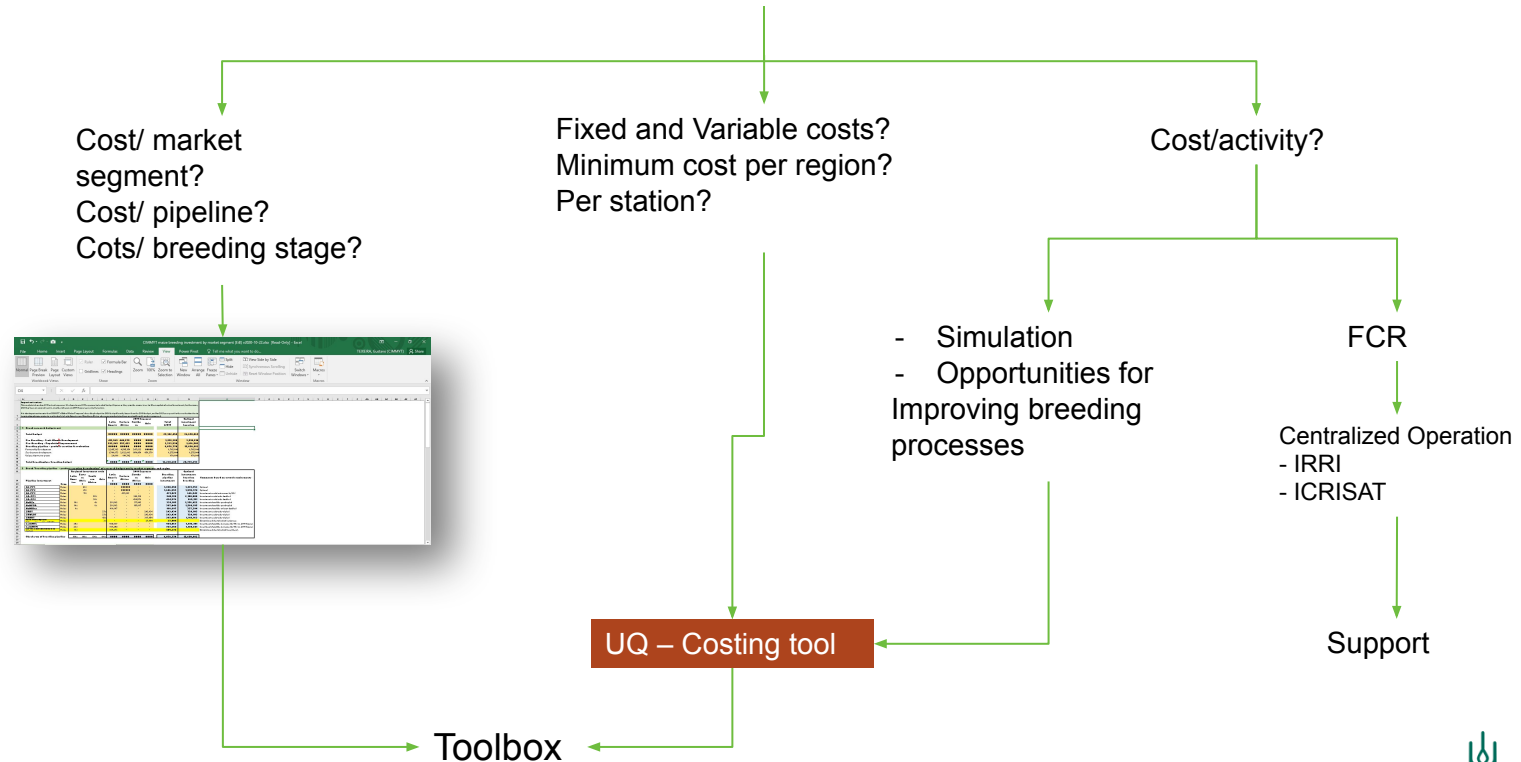
Vincent
Vadez

HPPP – Agronomic traits / field phenotyping

- Challenges
 - Internal processes
 - Regulations (drones)
- Next steps
 - Deliver the PoC
 - Develop the implementation plan (3yp) – considering other centers/ crops/ regions
 - Additional vendors / partners



Questions

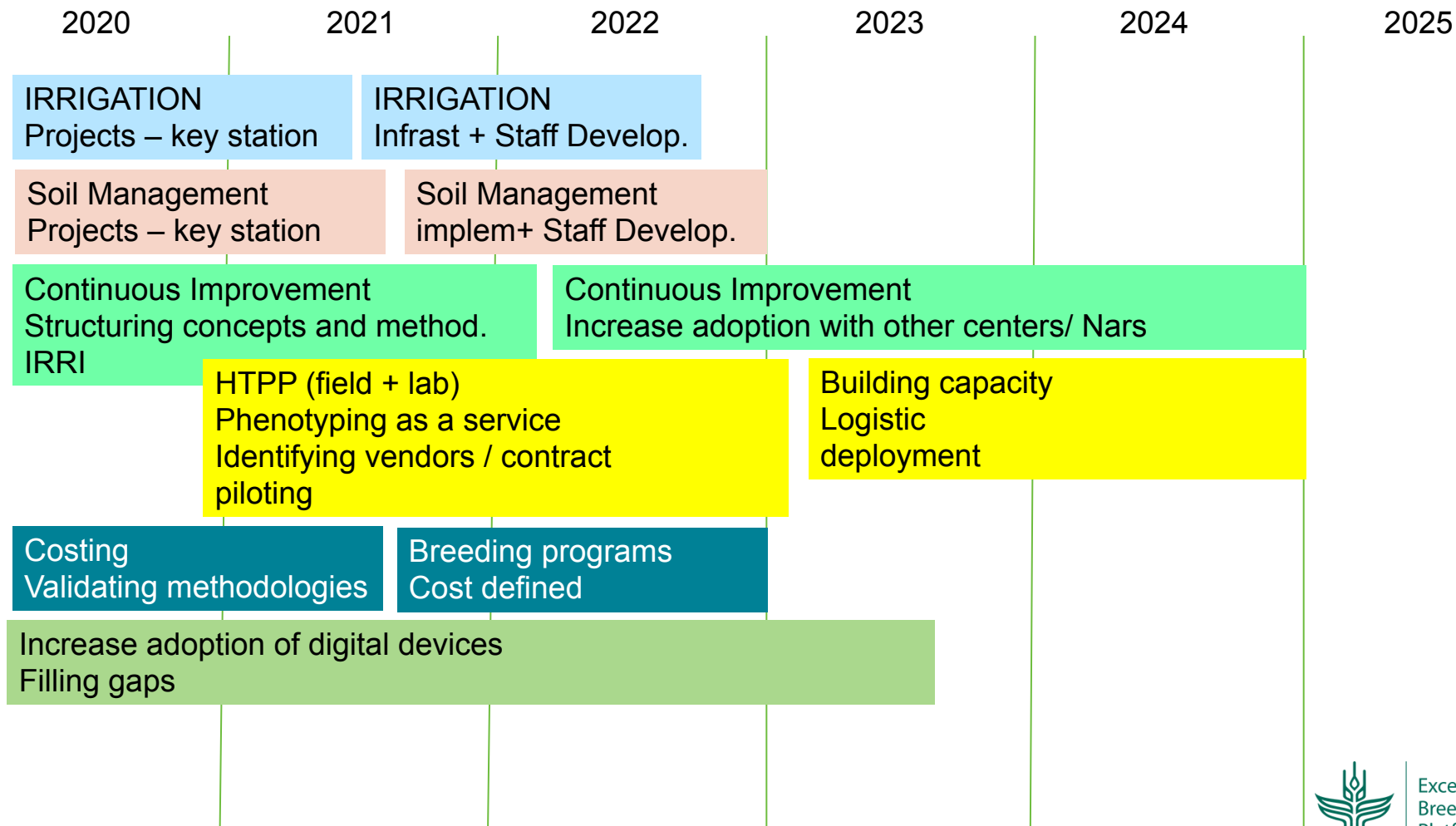


Costing

- What has been achieved?
 - Bish and Lenin supported 3 NARES to adopt UQ tool.
 - KARLO Maize
 - NARO Maize
 - CRI Rice
 - Starting now the support for Zimbabwe (Maize)
 - CIMMYT maize validated the excel template
 - CIOT (ICRISAT) and IRS (IRRI) – Sharing experience and best practices

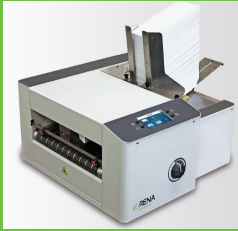
Costing

- Challenges
 - Different needs
 - Different operational modality
- Next steps
 - Promote the adoption of available tools (Template and UQ tool)
 - Supporting programs to get the cost defined



Increase adoption of digital devices

- Achievement
 - Bulk purchase



17
Packet Printers



21
Seed Counters



22
Label Printers



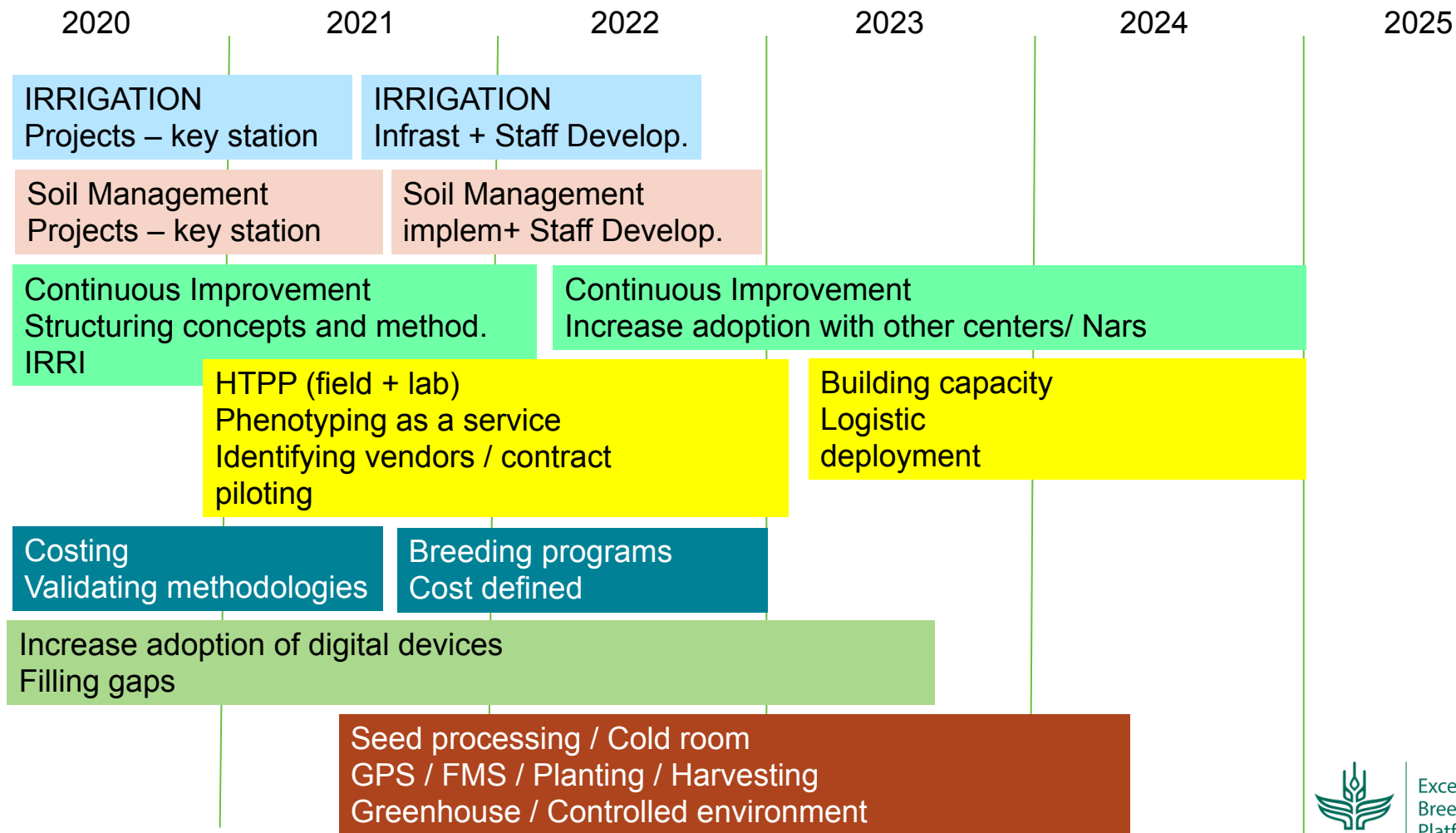
48
Laser Printers



295
Handhelds

Increase adoption of digital devices

- Challenges
 - Internal processes
- How to mitigate
 - We'll involve procurement and legal team earlier in the process
 - We got the commitment from CIMMYT team to improve the support
- Next steps
 - Deliver products
 - Train staff (Module V)
 - Start the second round of the project / considering other devices



Category	Subcategory	Station / Program	Current Status		
			Marginal	Basic	Contracted
Agronomic Practices	Field preparation, fertility, IPM, and crop maintenance equipment	A			
		B			
		C			
		D			
		E			
		F			
		G			
		H			
		I			
		J			
		K			
		L			
	M				
	Irrigation and Weather Data	B			
		C			
		D			
		E			
		F			
		G			
	Farm Management System	H			
		I			
		J			
		K			
		L			
M					
Greenhouses and Controlled Environment	A				
	B				
	C				
	D				
	E				
	F				

Agronomic Practices

Category	Subcategory	Station / Program	Current Status		
			Marginal	Basic	Contracted
Seed Processing / Conditioning	Seed Process Infrastructure	A			
		B			
		C			
		D			
		E			
		F			
	Conditioning, Packaging and Treating	G			
		H			
		I			
		J			
		K			
		L			

Seed Processing

Category	Subcategory	Station / Program	Current Status		
			Marginal	Basic	Contracted
Planting / Harvesting	Planters / Planting Solution	A			
		B			
		C			
		D			
		E			
		F			
	Plot Combine / Harvesting Solution	G			
		H			
		I			
		J			
		K			
		L			

Planting and harvesting

Category	Subcategory	Station / Program	Current Status		
			Marginal	Basic	Contracted
Phenotyping	Phenotyping	A			
		B			
		C			
		D			
		E			
		F			
		G			
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		I			
		J			
		K			
		L			

Phenotyping

Category	Subcategory	Station / Program	Current Status		
			Marginal	Basic	Contracted
Continuous Improvement	Continuous Improvements / HSE	A			
		B			
		C			
		D			
		E			
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		I			
		J			
		K			
		L			

Continuous Improvement

- Technical aspect
- Organizational aspect



Organizational aspect How to implement?



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Current scenario

Centralized Operation

- IRS – IRRI
- CIOT – ICRISAT

Operation managed by breeding team

- NARES
- Most of CGIAR programs

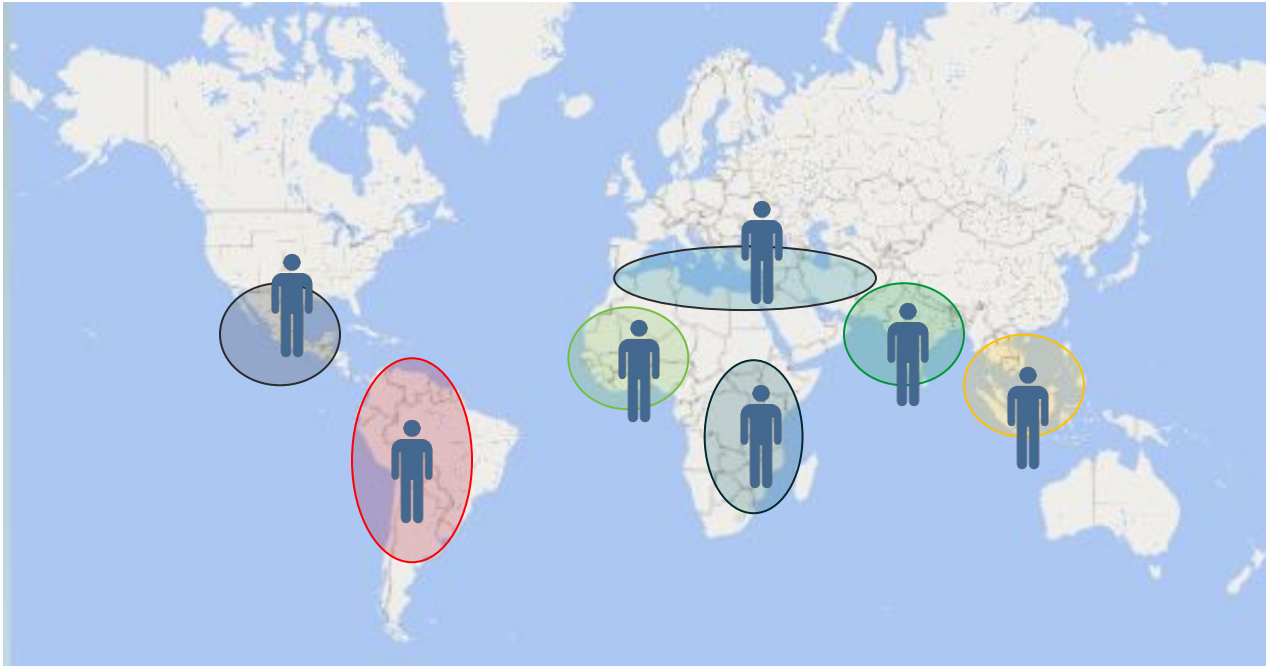
- Cost control
- Dedicated staff
- Breeders focusing on breeding
- SOPs
- Harmonized results



This is the operation mode
We believe to be the most appropriate
and the one we promote

What is our vision?

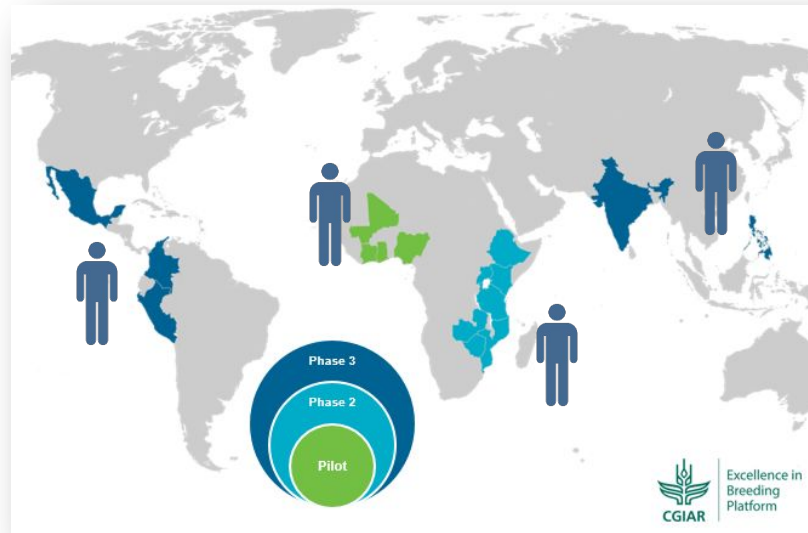
CGIAR regional operational team – heads of operation



How would EiB support that?

- From EiB annual meeting - 2019

Breeding Operation / Mechanization specialists



Continuous Improvement

Soil Management

Phenotyping

Irrigation

Quality assurance SOPs



Theresa (Walker)



Lydiah Gatere



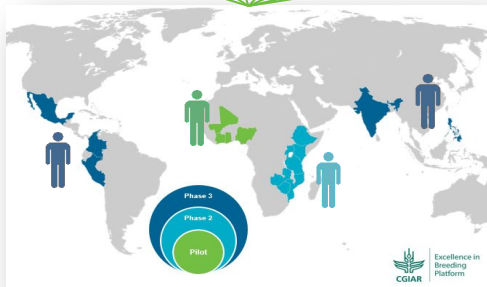
Ray R. Weil



Aldo Rosales



Vincent Vadez



Breeding Operation / Mechanization specialists



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Breeding Operation Alliance of Excellence



Breeding Operation Exchange Program





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