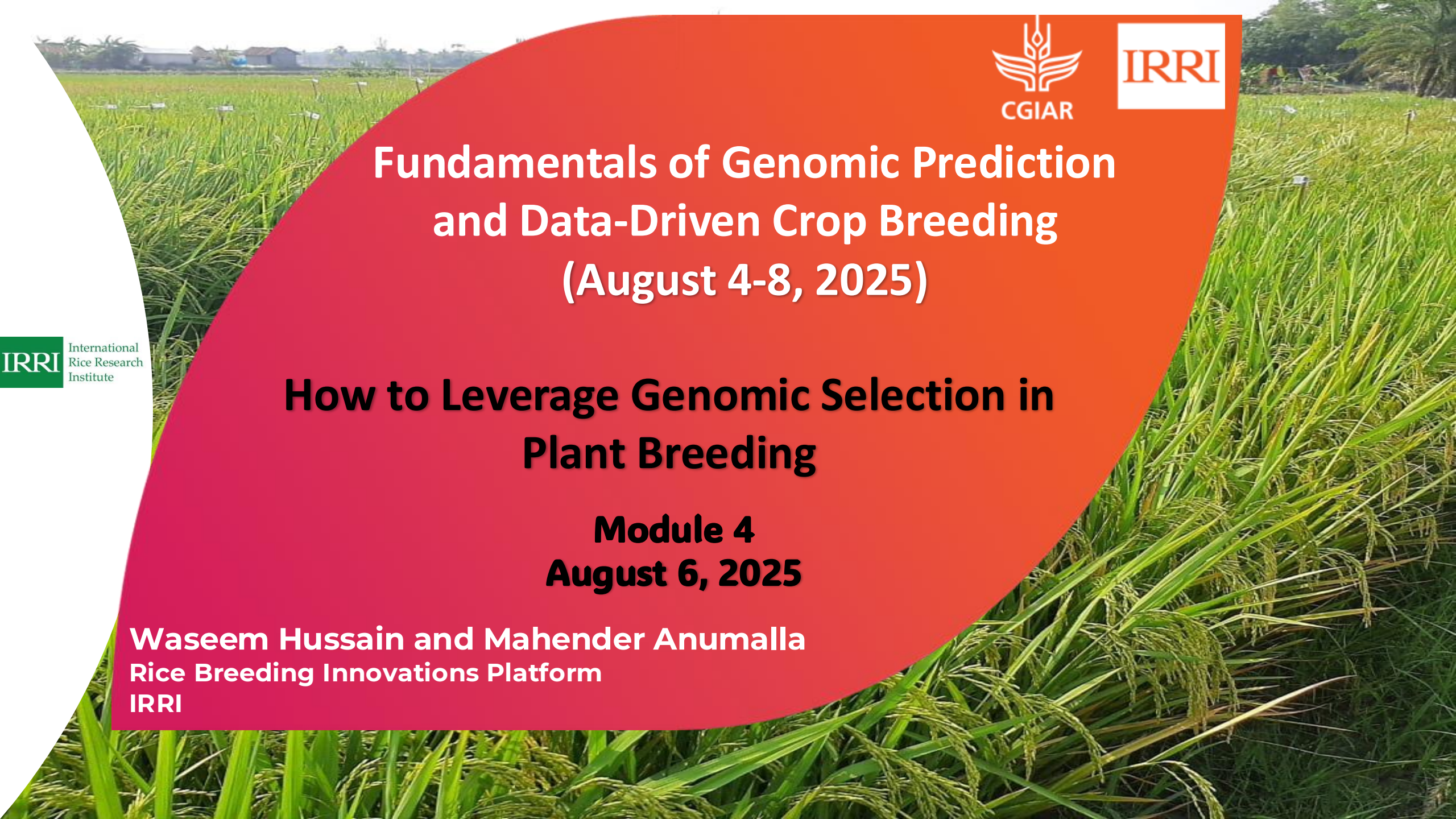


Fundamentals of Genomic Prediction and Data-Driven Crop Breeding (August 4-8, 2025)

IRRI International Rice Research Institute

How to Leverage Genomic Selection in Plant Breeding

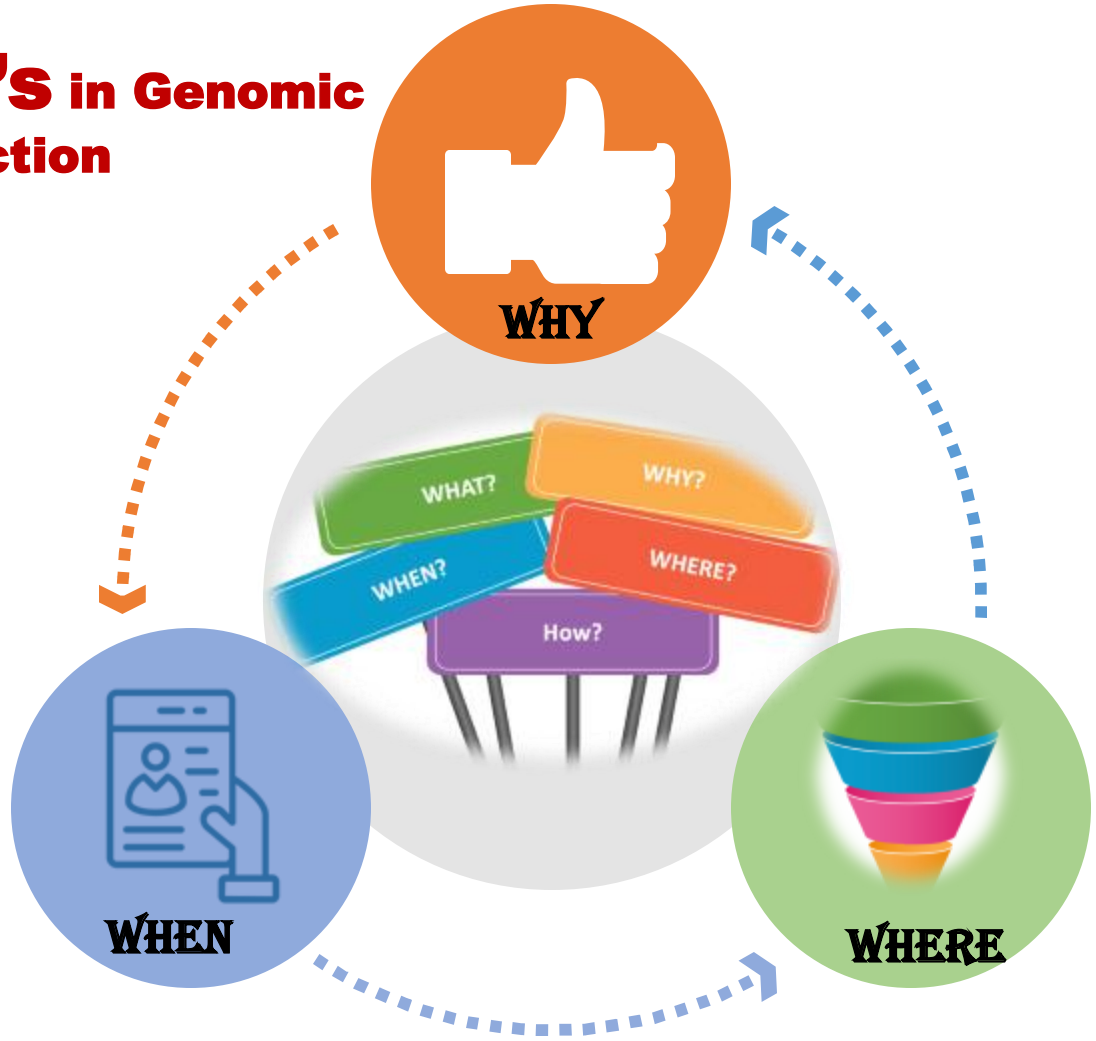
Module 4
August 6, 2025

Waseem Hussain and Mahender Anumalla
Rice Breeding Innovations Platform
IRRI

Genomic Selection in Crop Breeding

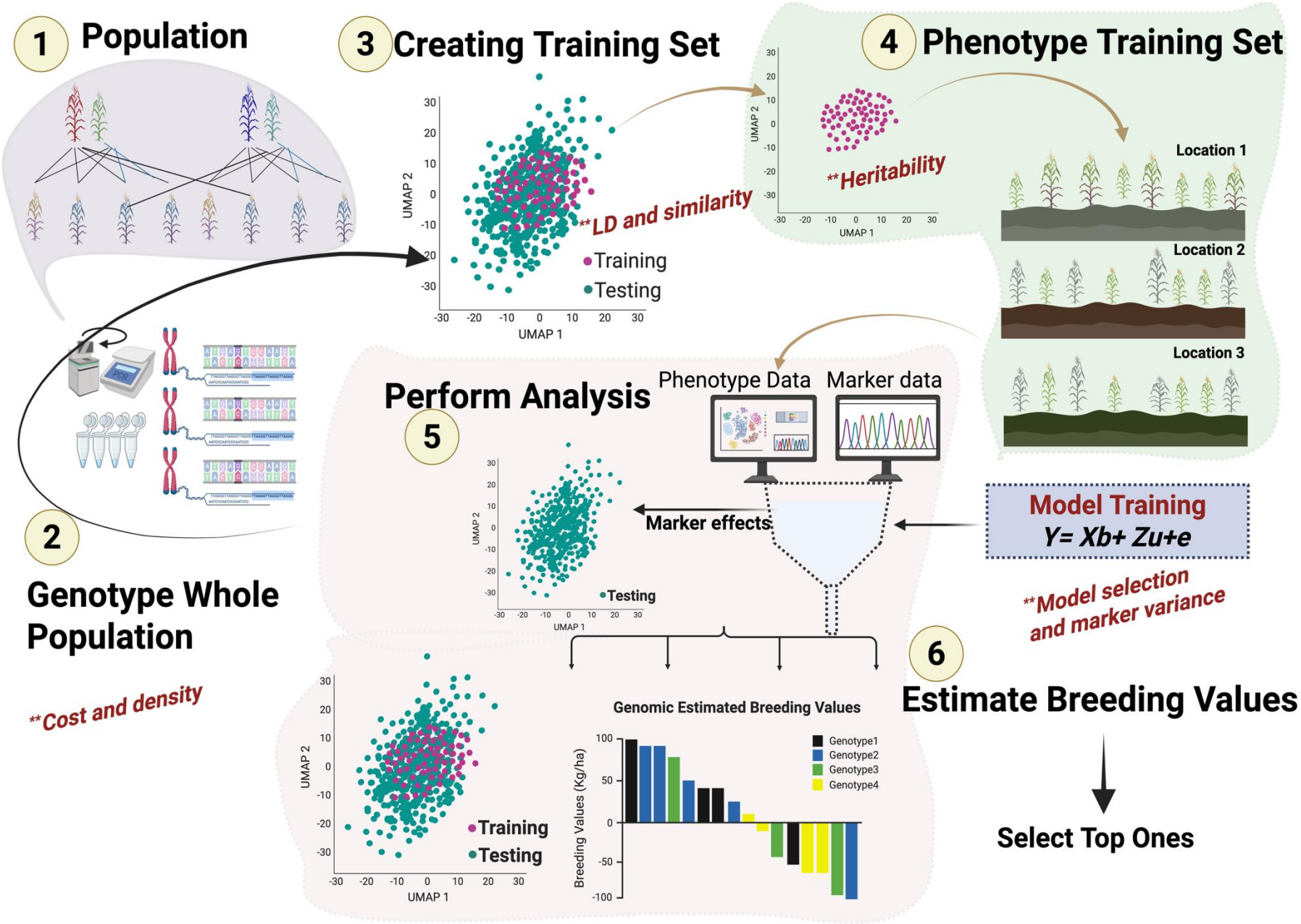
(What benefits and advantages it have over traditional phenotypic BLUP selection)

3W's in Genomic Selection

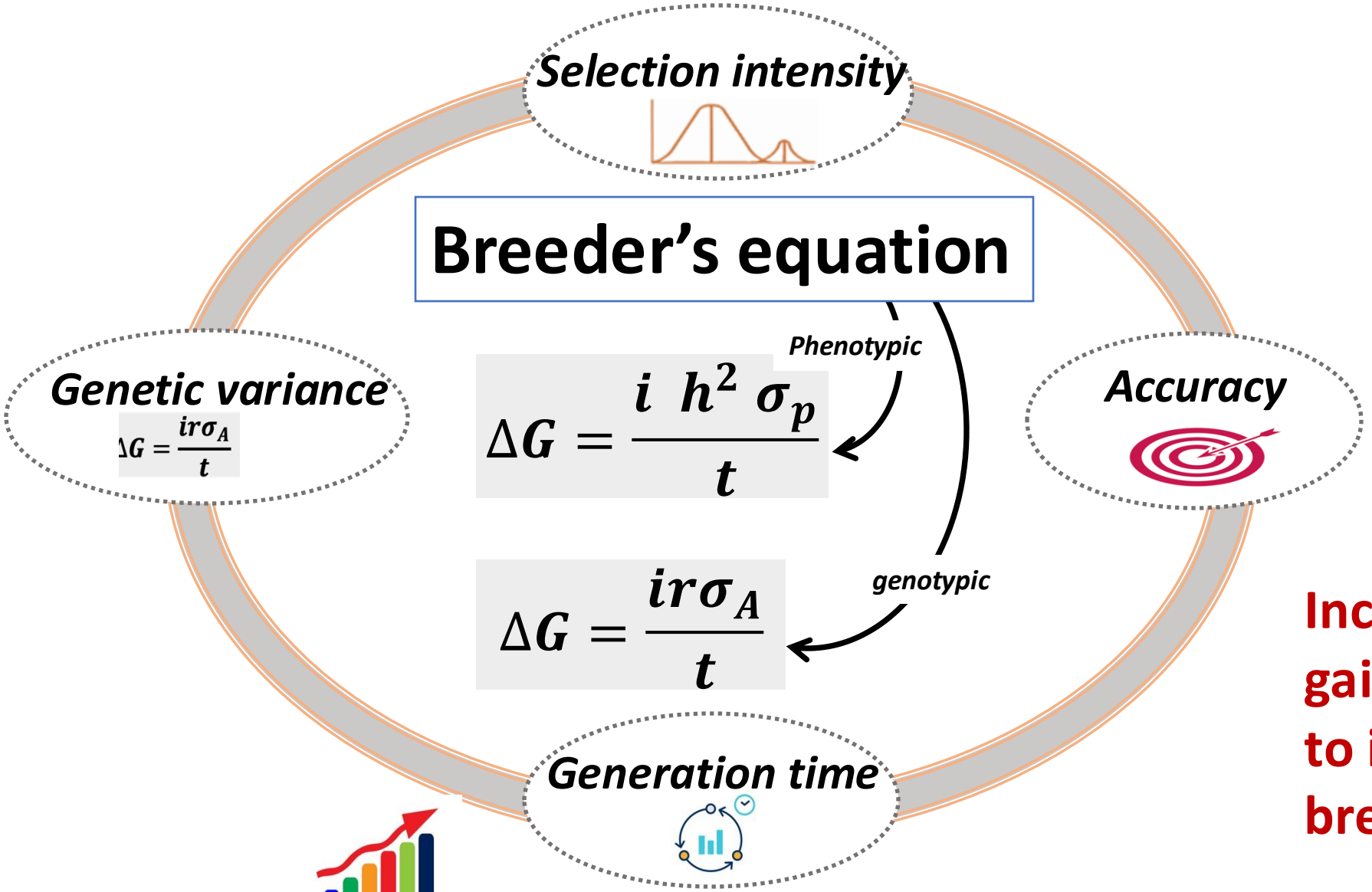


- **Why to use GS**
  - Select from more phenotypes
  - Reduce time of breeding cycle
  - Increase accuracy of selections
  - G x E and complex architecture of traits
- **When to use GS**
  - Requirements (Genotyping, reference populations etc.,
  - Resources
  - Capacity to use GS
- **Where to use GS**
  - What Stage to Apply in breeding Pipeline
  - How to implement it

How Genomic Prediction Works



The guiding principle is Breeders Equation



Increasing genetic gain is main reason to implement GS in breeding programs

$\Delta G = \frac{i\ h^2\ \sigma_p}{t}$

Why Genomic Selection

1

Phenotypes and Phenotyping

- Too many phenotypes
- Traits difficult to phenotype

2

Time and Reliable Selections

- Increased selection accuracy
- Reduction in time
- Quick re-cycling and recombination

3

Manage Resources

Effective use of resources to breed and control the selection intensity

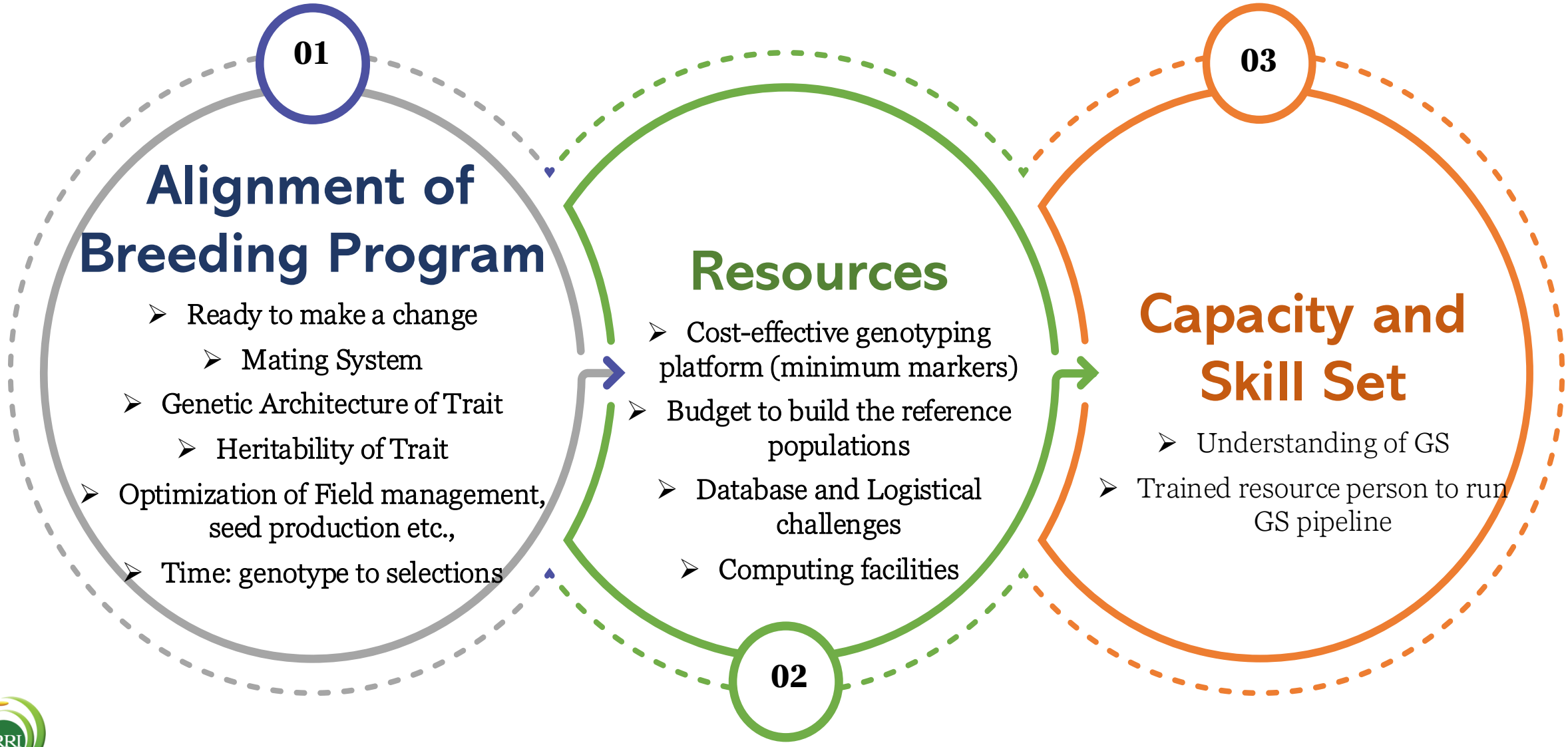
4

Dissecting G x E

G x E hinders genetic gain

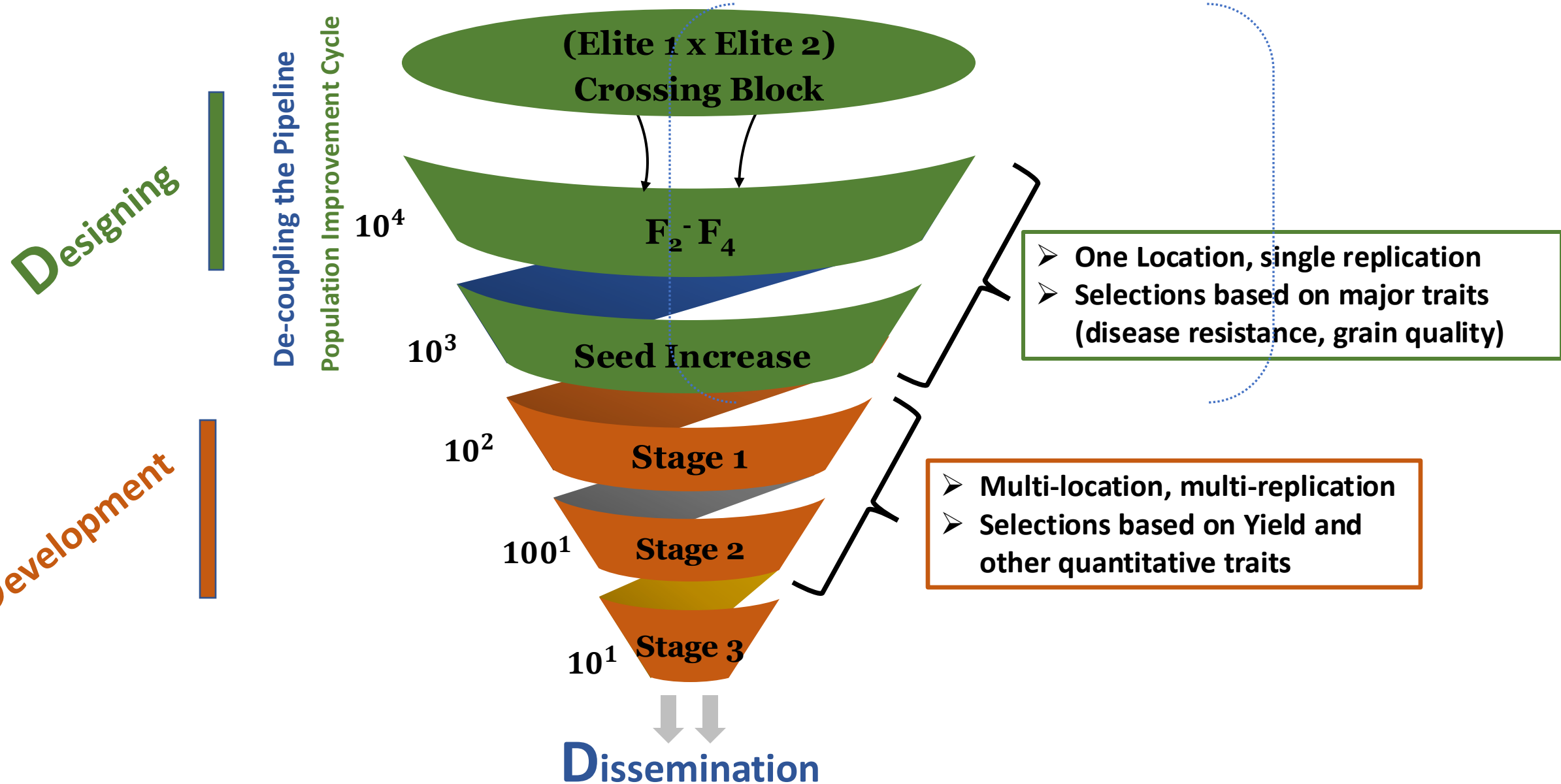
Characterization of Environments (TPE)

When to Use Genomic Selection

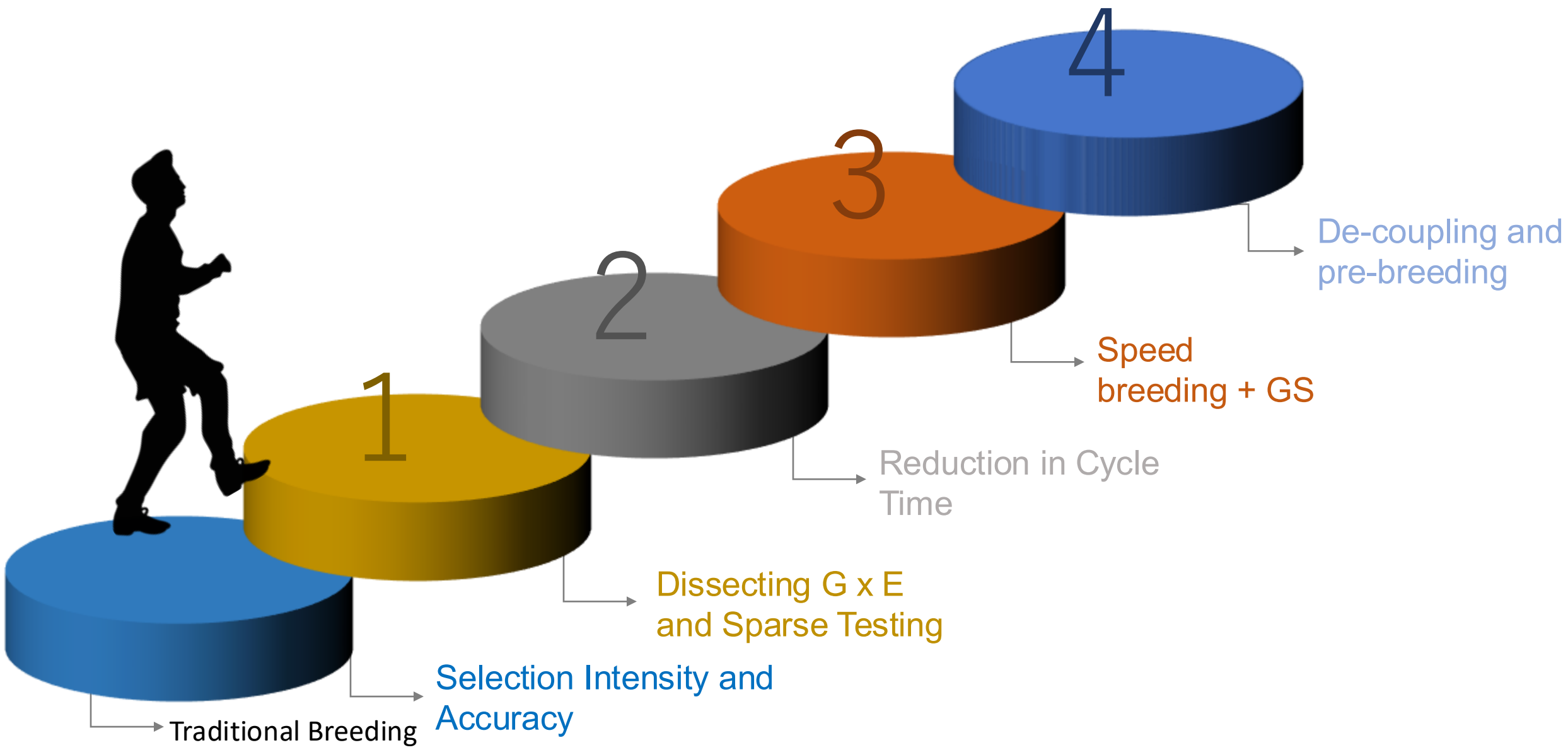


When and How to Use Genomic Selection

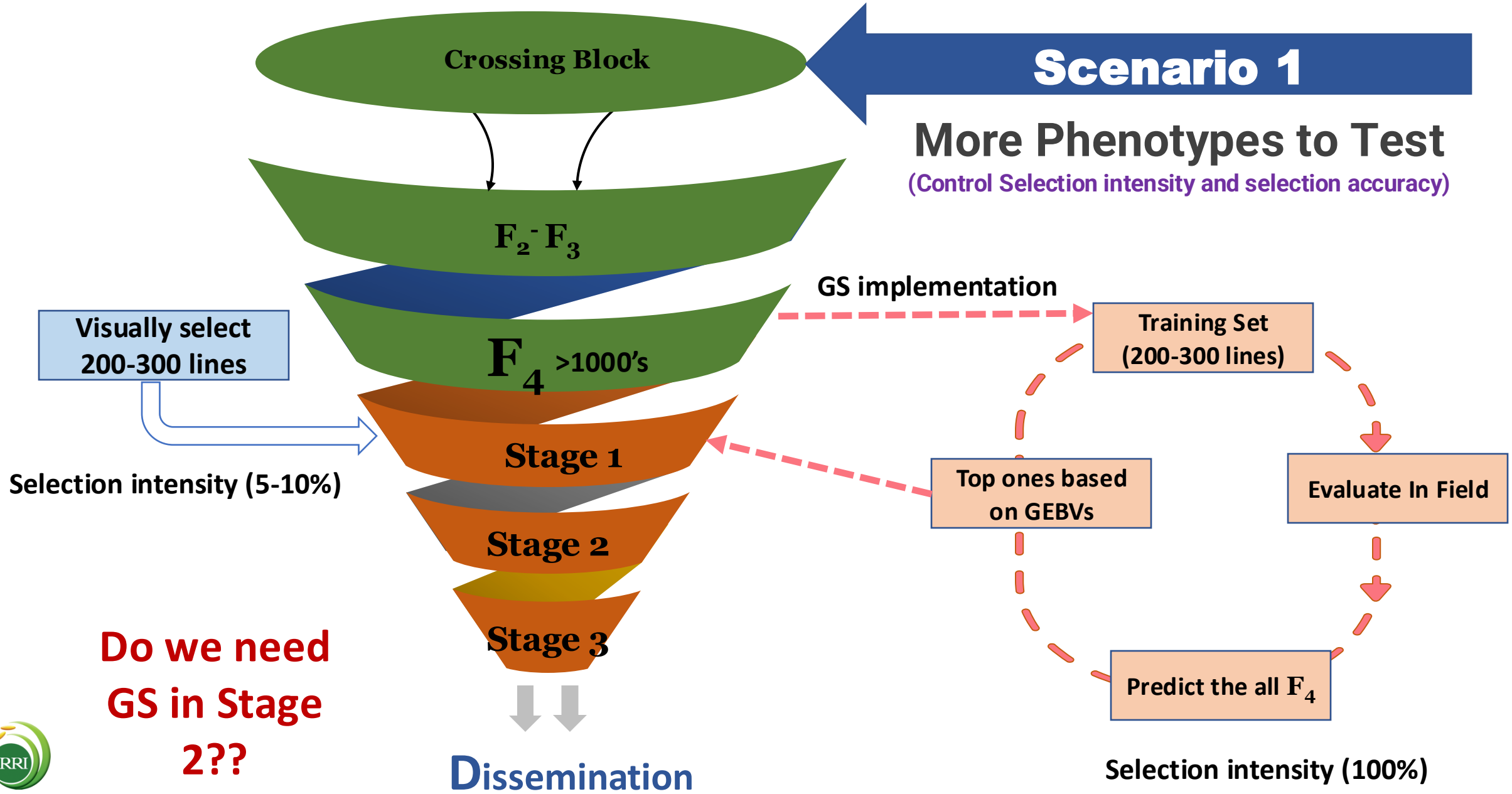
(General Breeding Program/Pipeline)



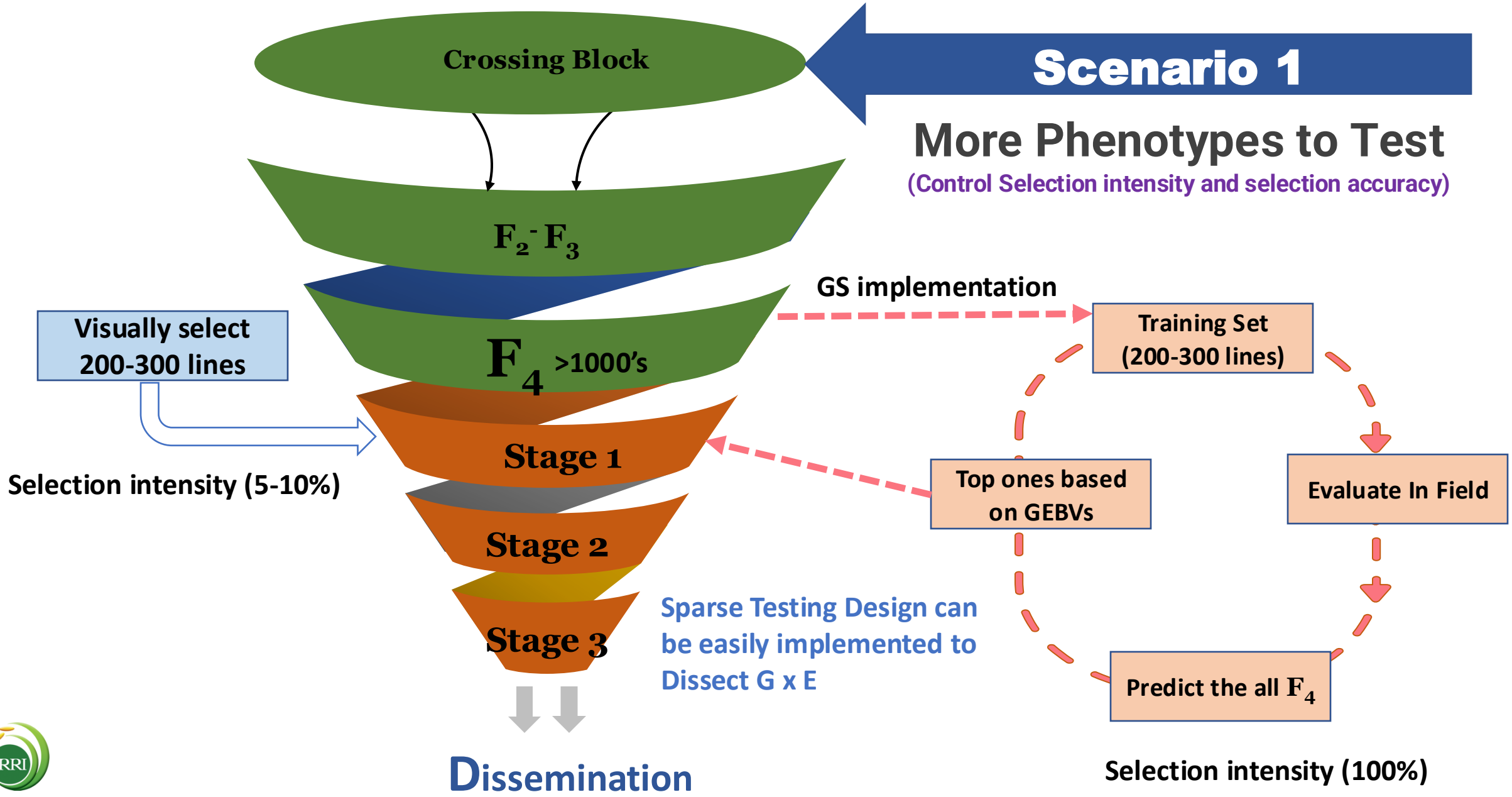
Step by step Approach for GS



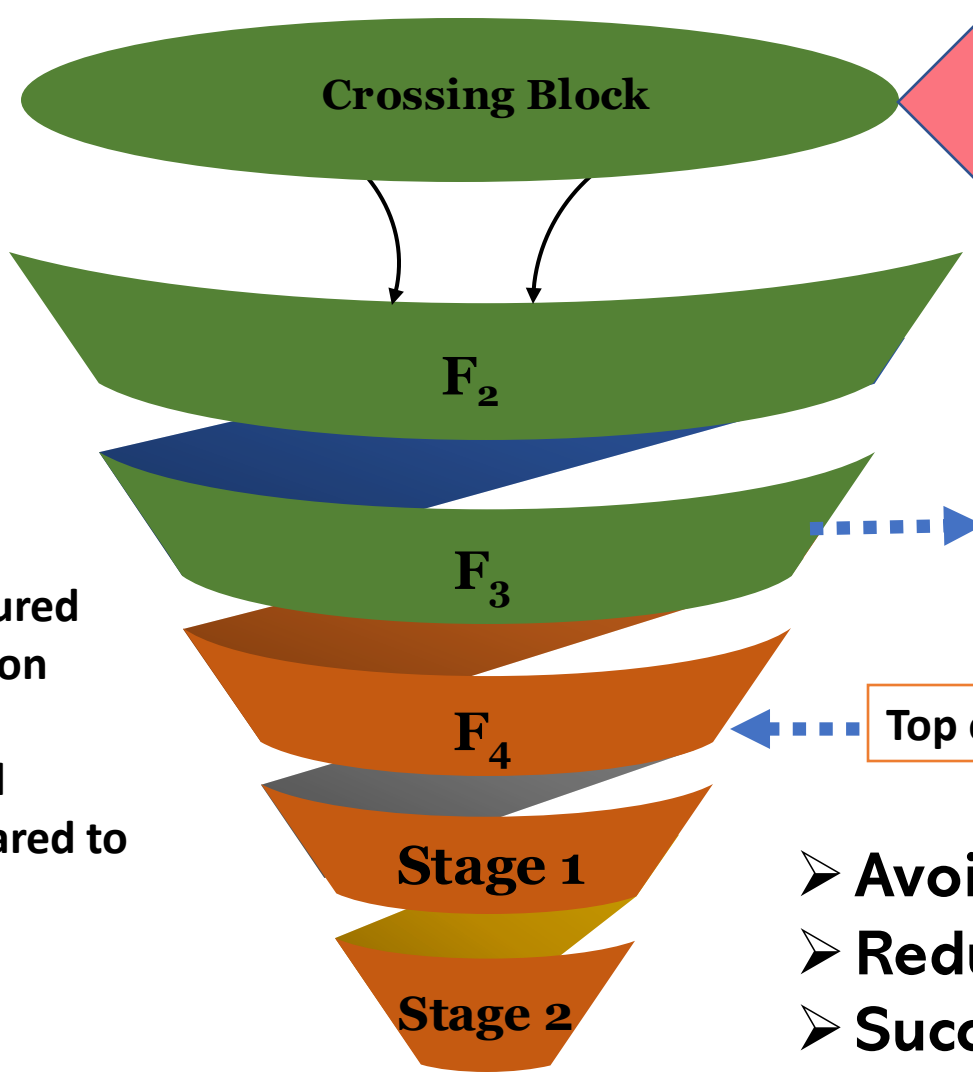
When and How to Use Genomic Selection



When and How to Use Genomic Selection



When and How to Use Genomic Selection



Scenario 2

Reducing Cycle Time

(Population Improvement and Re-cycling)

Training Population (Historical)

Genotype all F_3

Predict (GEBVs) of all F_3

Top ones planted F_4

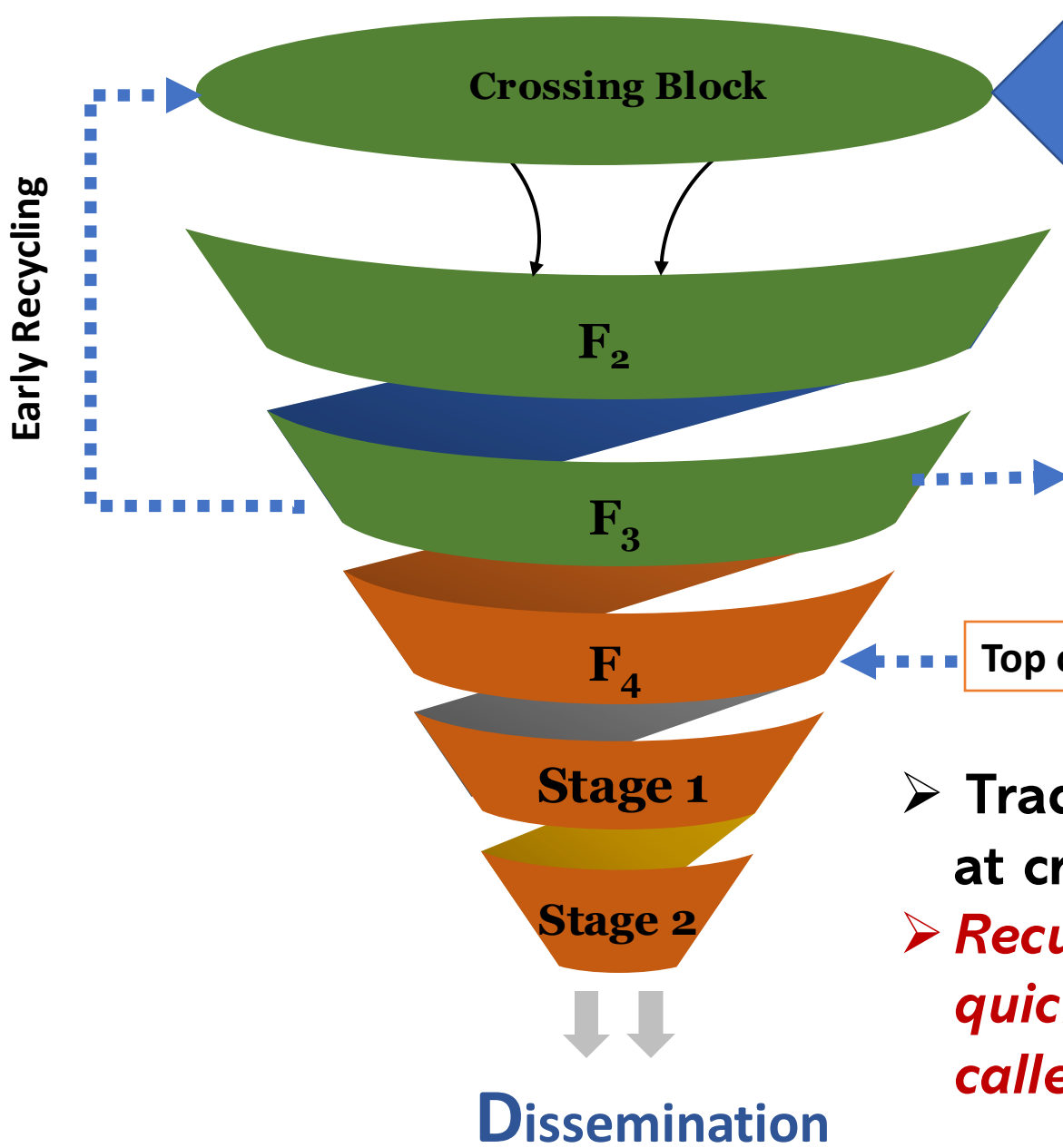
Note

- Building a Structured Training Population requires time.
- It cannot be used directly as compared to scenario 1

- Avoided growing the F_3
- Reduce the cycle time by one generation
- Success depends upon training the populati
  - High relationship with the testing set
  - LD structure should be same
  - Need to update the training population often (Why?)

Dissemination

When and How to Use Genomic Selection



Scenario 3

Reducing Cycle Time and Population Improvement

Training Population (Historical)

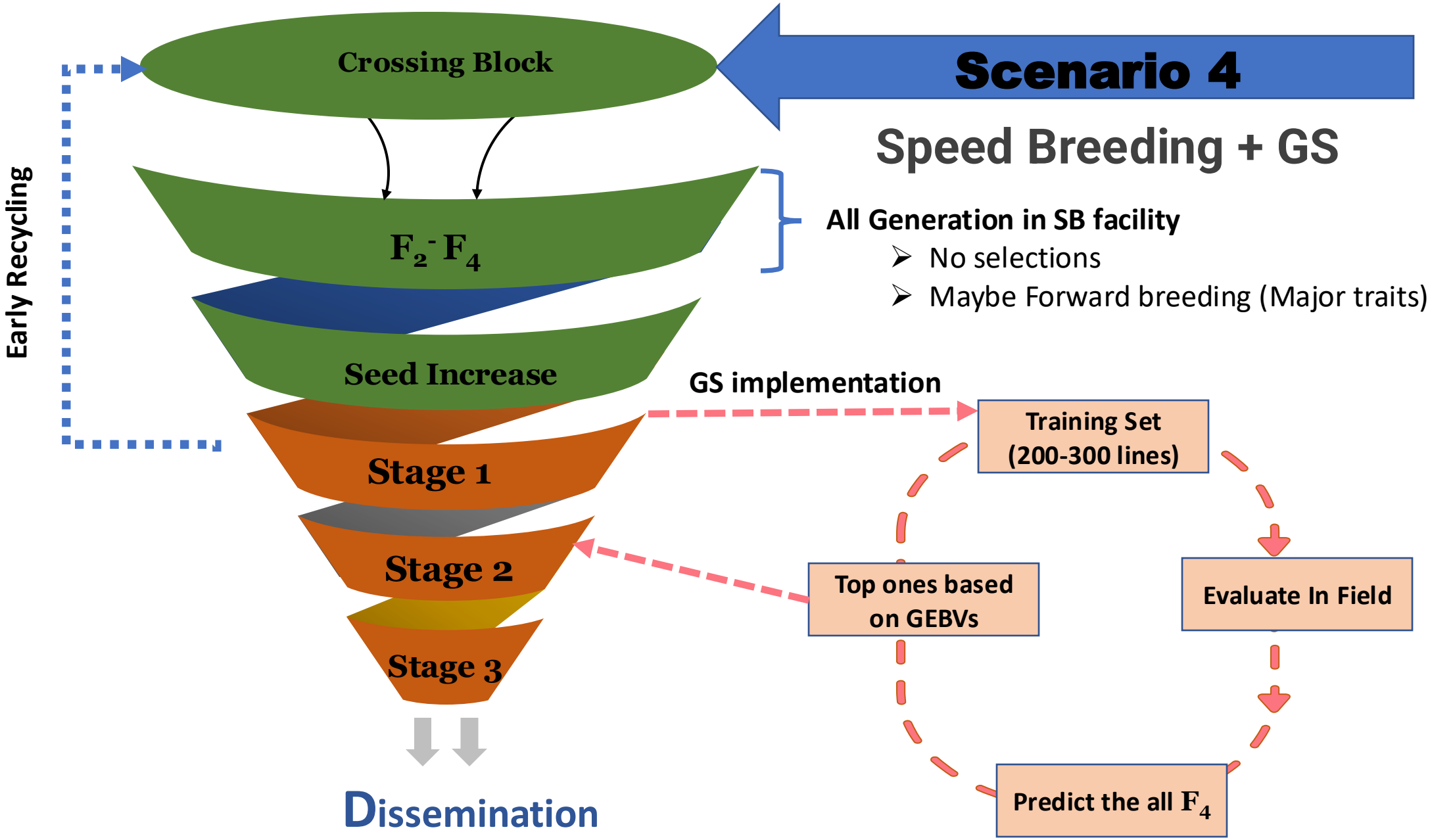
Genotype all F_3

Predict (GEBVs) of all F_3

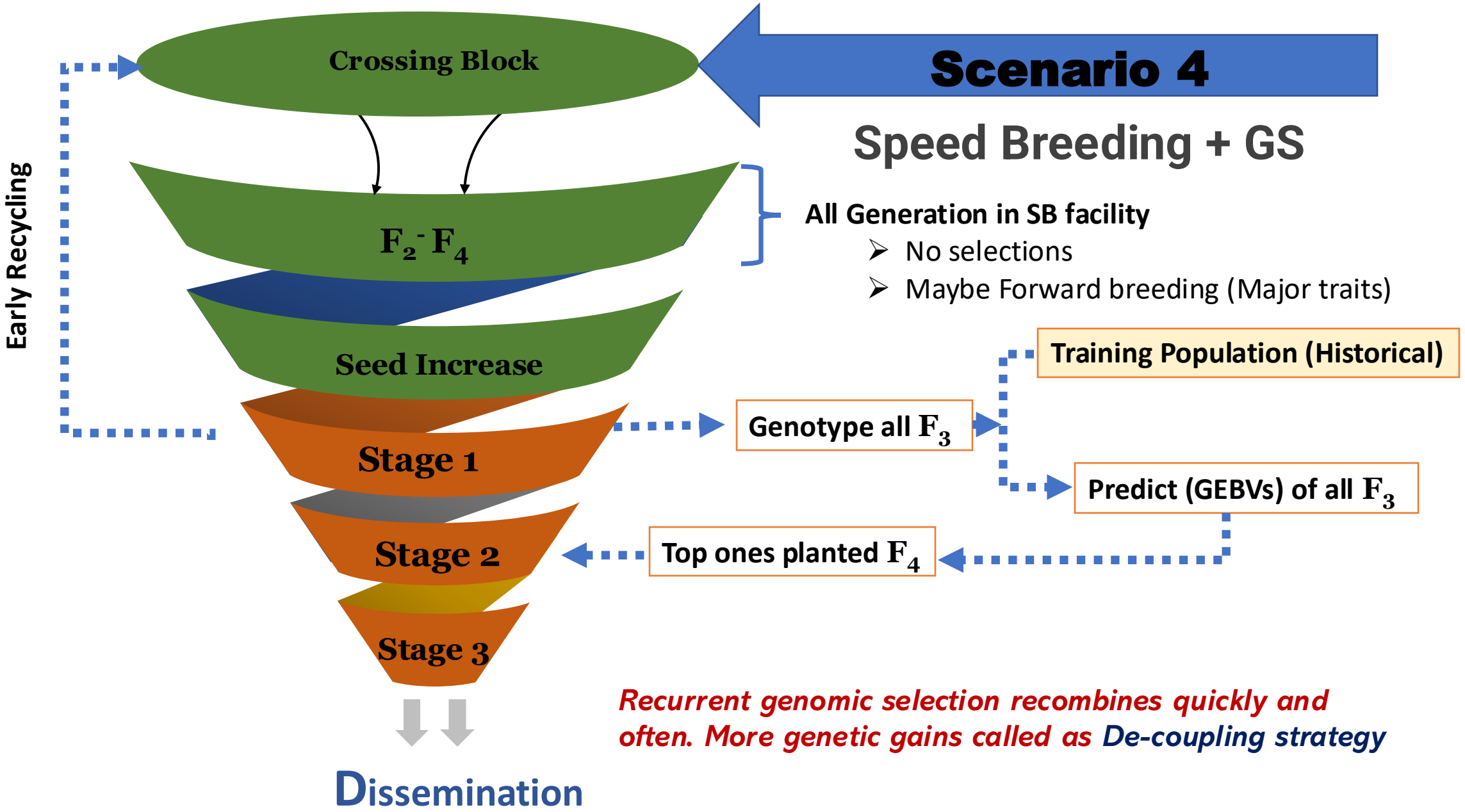
Top ones planted F_4

- Traditional approach recombines alleles at crossing only.
- *Recurrent genomic selection recombines quickly and often. More genetic gains, called as De-coupling strategy*

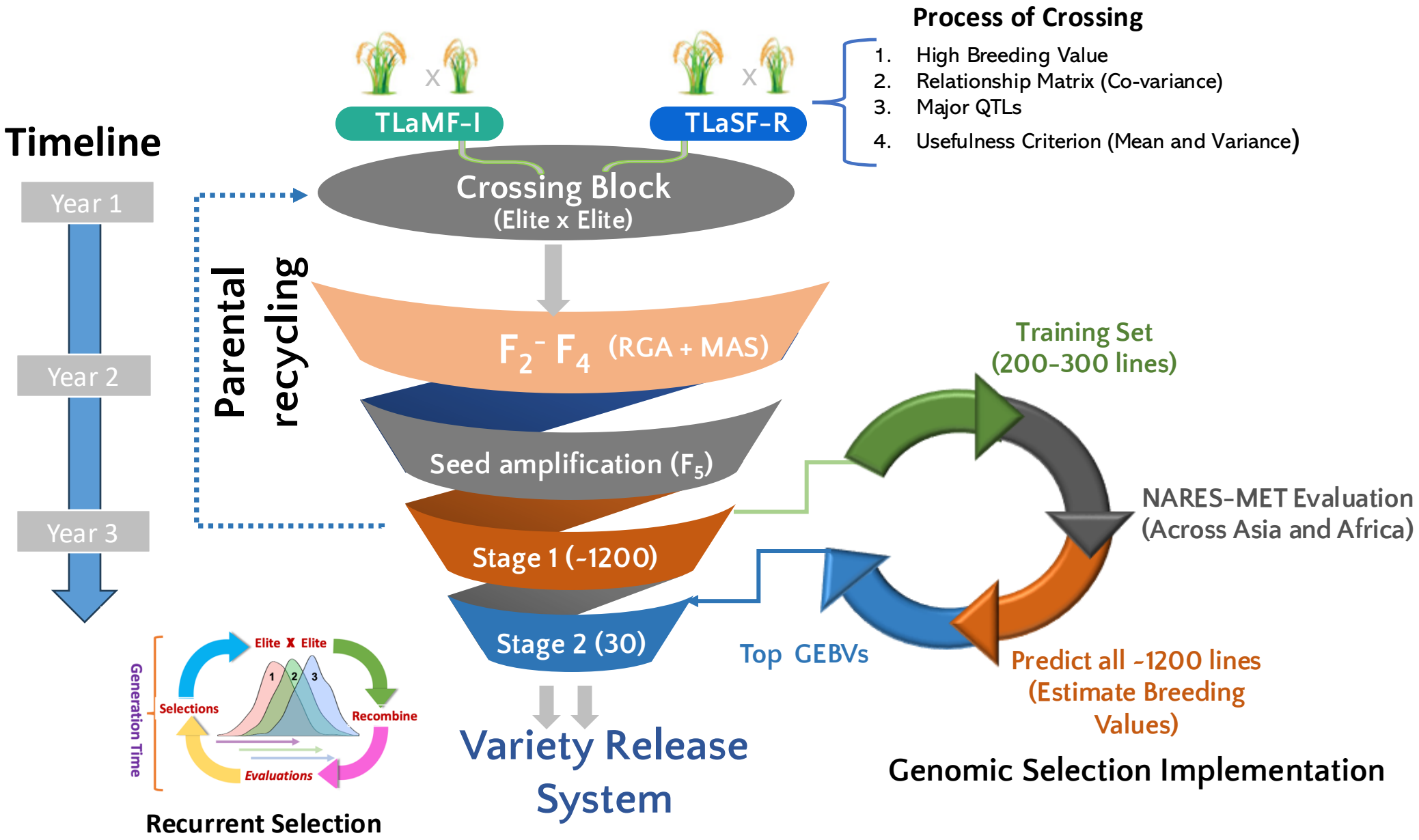
When and How to Use Genomic Selection



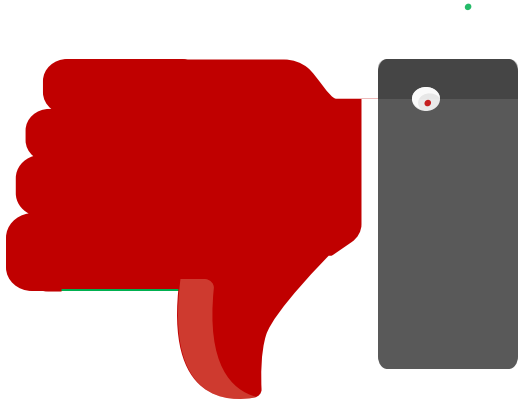
When and How to Use Genomic Selection



Genomic Selection in IRRI's Global Rice Breeding



When not to Use Genomic Selection



- Un-related populations (GS exploits relationships)
- Lack of the genotyping facility
- High cost of genotyping may halt implementation of GS
- Lack of understanding, capacity, and skill set to run GS pipeline
- Aim is not to improve only major haplotypes

How We Can Leverage Genomic Prediction in Your Breeding Program

Think in terms of:

- Connecting Genotypes
- Connecting Environments
- Saving resource
- Early Selection of Top Genotypes
- Increase Selection accuracy: More Reliable
- Dissecting G x E and Predict Stability