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International Center for Tropical Agriculture
Since 1967 Science to cultivate change

Wild bean species regeneration: Genebank strategies and advances

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Palmira Genebank – Genetic Resources Program

Palmira, October 19th 2021

CGIAR

Genebank in Palmira

- Since 1977 conserves the genetic diversity of crops of interest, the global collections of

  Cassava (*Manihot sp*.)

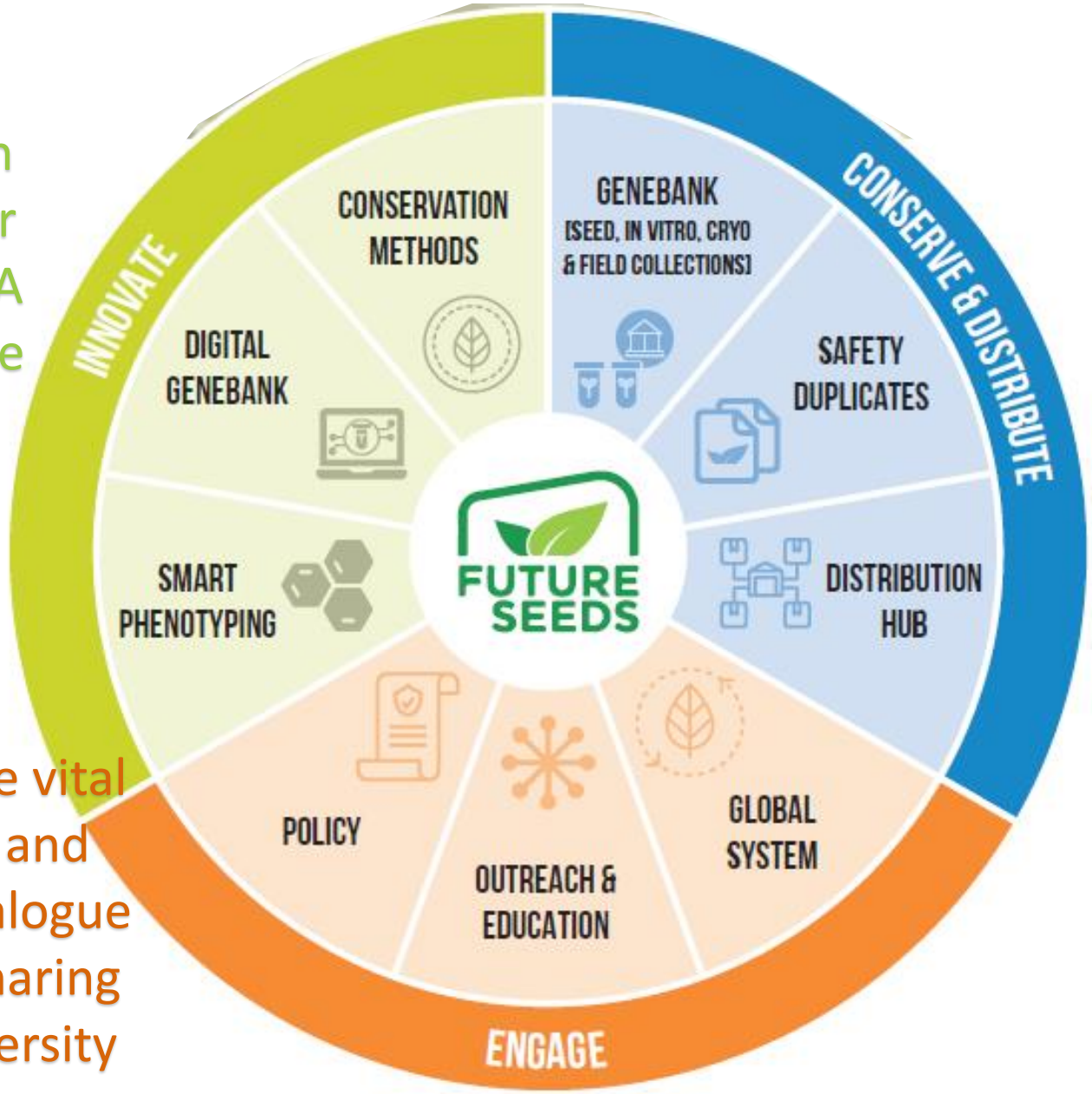
  Beans (*Phaseolus sp*.)

  Tropical Forages (>700 species)

- Future Seeds to open in 2022, a global hub for innovation in crop diversity conservation and use

Vision

Improve conservation methods and discover hidden value of PGRFA to a more targeted use of crop diversity and genetic gains



Efficiently and effectively conserve and distribute PGRFA, following the highest international standards

Raise awareness on the vital role of crop diversity and contribute to policy dialogue about the equitable sharing of benefits of crop diversity

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Genebank in Palmira

Yuca (*Manihot*)

Accesiones
+ 6.000
Especies 33 Países 28

Frijol (*Phaseolus*)

Accesiones
+37.900
Especies 46 Países 112

Forrajes Tropicales

Accesiones
+ 22.600
Especies 696 Países 75

PROTEGER

INVITRO

Conservación
mediano plazo
Control de condiciones químicas y físicas

BONSAI

Conservación
mediano plazo
Duplicado de seguridad

SEMILLAS

Conservación
largo plazo
Duplicado de seguridad

CAMPO

Conservación
mediano y largo plazo

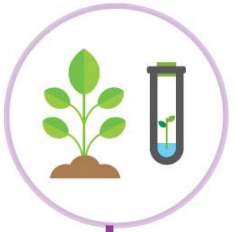
FACILITAR

Tubo *invitro*
Certificación sanitaria del material

Vaso con sustrato *
Certificación sanitaria del material

Tubo con hojas
Certificación sanitaria del material

Semillas
Certificación sanitaria del material



Material vegetal *
Certificación sanitaria del material

Tubo *invitro*
Certificación sanitaria del material

* Solo es permitido distribución nacional

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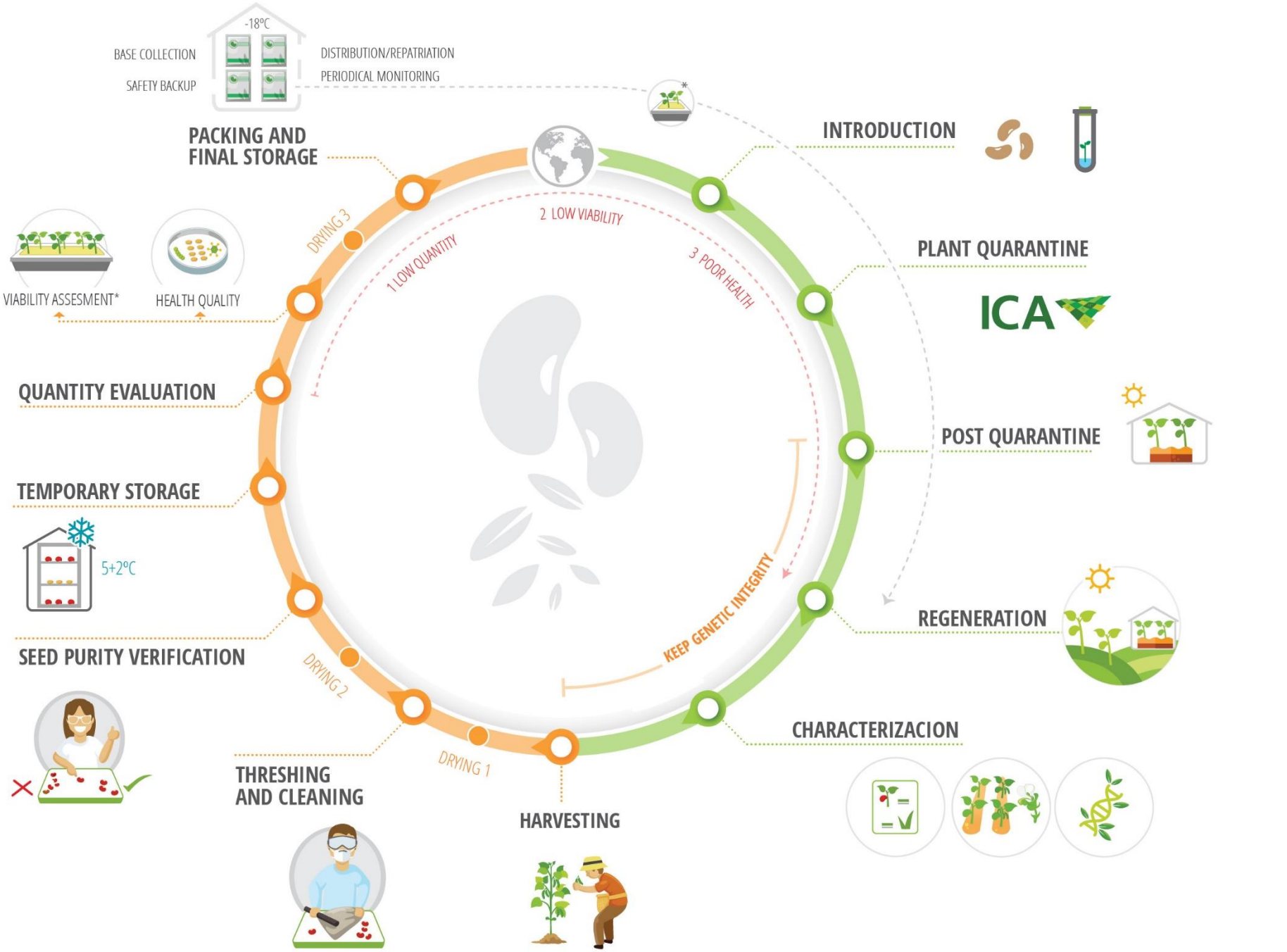
SEED CONSERVATION - **GRP**

OPERATIONS FOR BEANS AND TROPICAL FORAGES



External Stations

Rancho La Magdalena, Tenerife station

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Tenerife station: Seed production and characterisation

Mesh-houses with Aluminet and Rashel meshes, reduce radiation

(mean environmental parameters: light intensity 202 µmol photons m-2 s-1 , temperature 25.7^{o} C, humidity 60.1%)

Pluriannual and wild Phaseolus genebank regeneration site (2 Ha, 14 mesh-houses: plastic roof + irrigation system + plastic mulch)

Seed dryer in the stations area, a key facility initiate the drying process.

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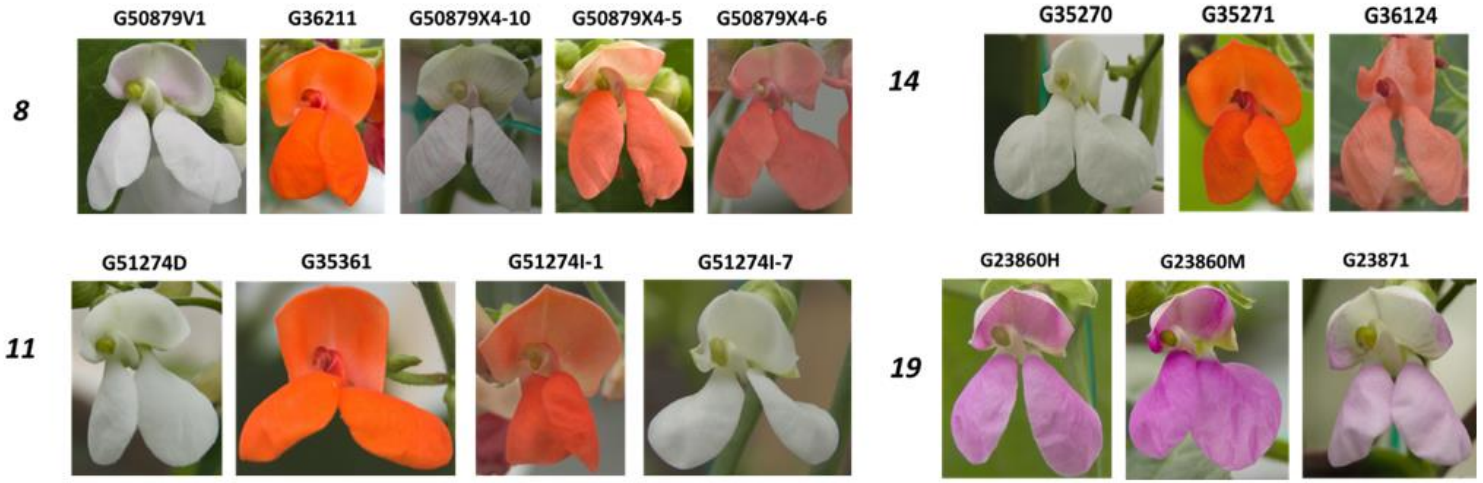
Hybrid's project (together with NIAB)

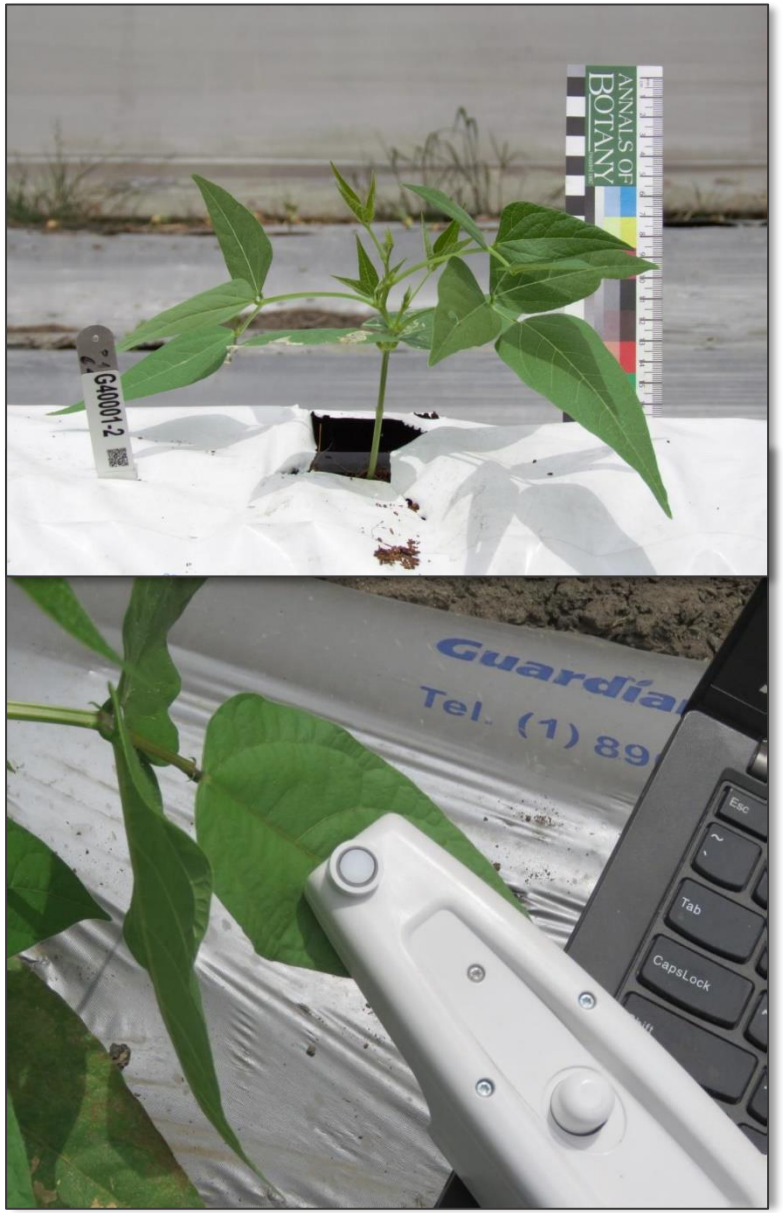
- Purpose to characterize 12 natural hybrid complexes, collected in the 80’s, in Mexico, Guatemala, Costa Rica, Colombia and Bolivia, and identify its potential for disease resistance and heat/drought tolerance
- **Characterization** - plants are grown in Tenerife, their morphological characteristics determined, when flower manual pollinize and finally the pods and seeds harvested
- **Disease screening** - material is grown under controlled conditions at NIAB in the UK and tested for responses to white mold, anthracnose and web blight
- **Crosses** with a *P. vulgaris* line to test viability of offspring and ease of use within breeding programmes
- **Genotyping** - all populations will undergo DArT genotyping to learn more about the background of these materials.

Hybrids' characterization in Tenerife

- Basic morpho-agronomical characterisation
- Detailed flower color, pod and seed morphology (Phenomics)
- Physiological measurements (Kuhlgert *et al*., 2016)

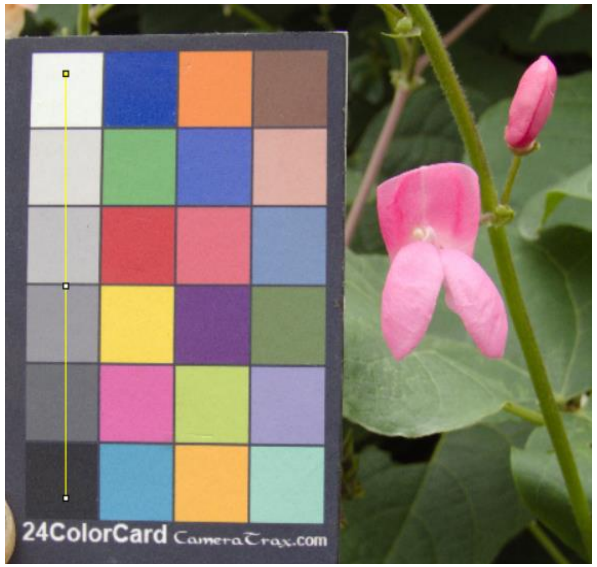


Work of Diego F. Conejo



Hybrids' characterisation: Flower color descriptors

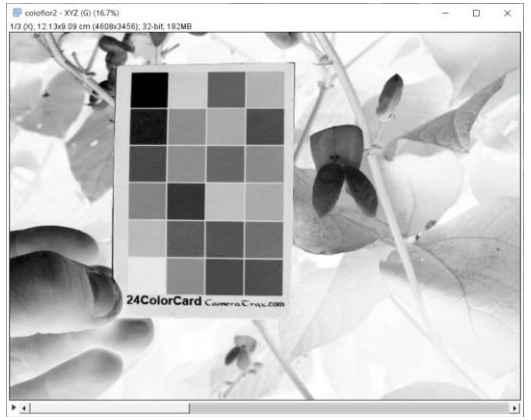
1. RAW format image capture + ColorCard



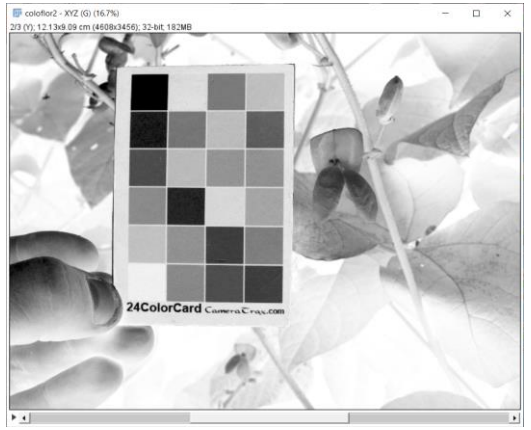
2. Image standardization with ColorCard: color linearization

3. Color Space - RGB

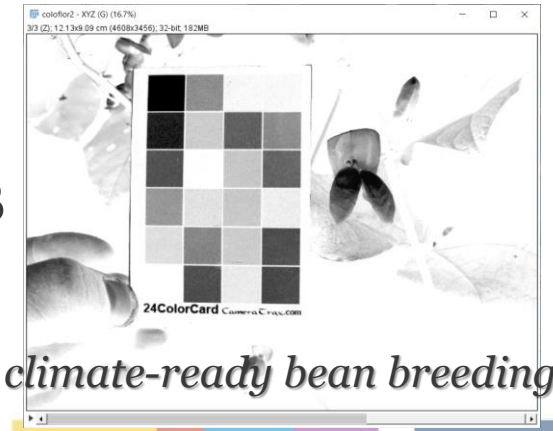
R

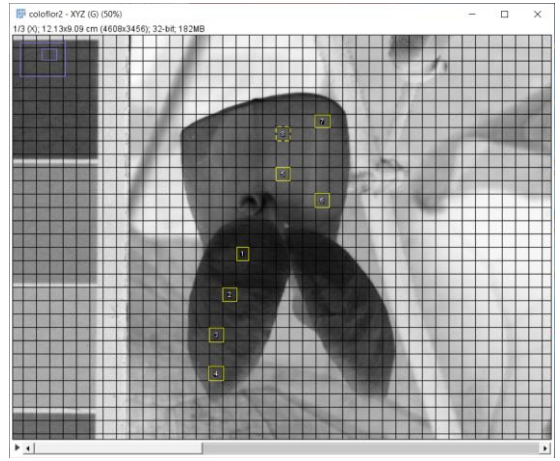


G



B





4. ROI: Wings and standard petals 0.01 cm^2 grid

Hybrids' characterization: Pod and seed morphology

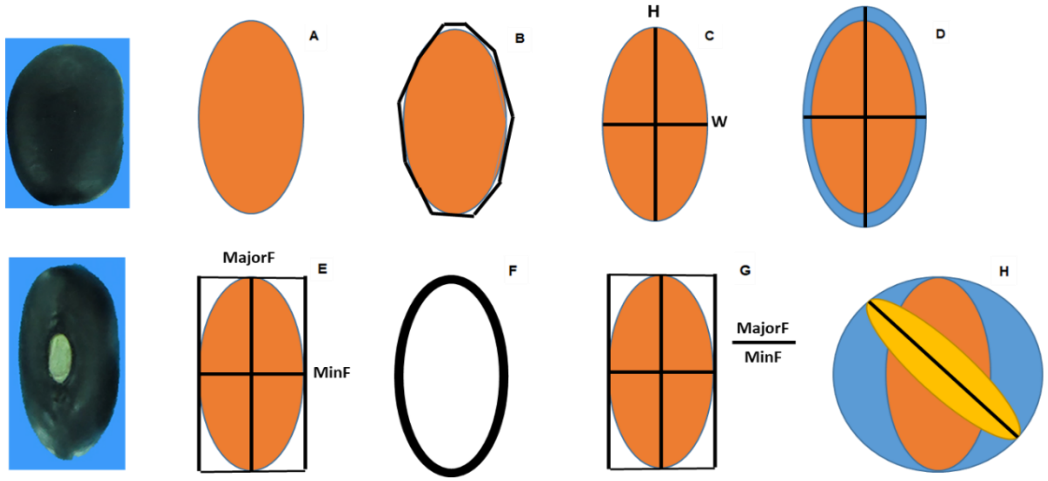
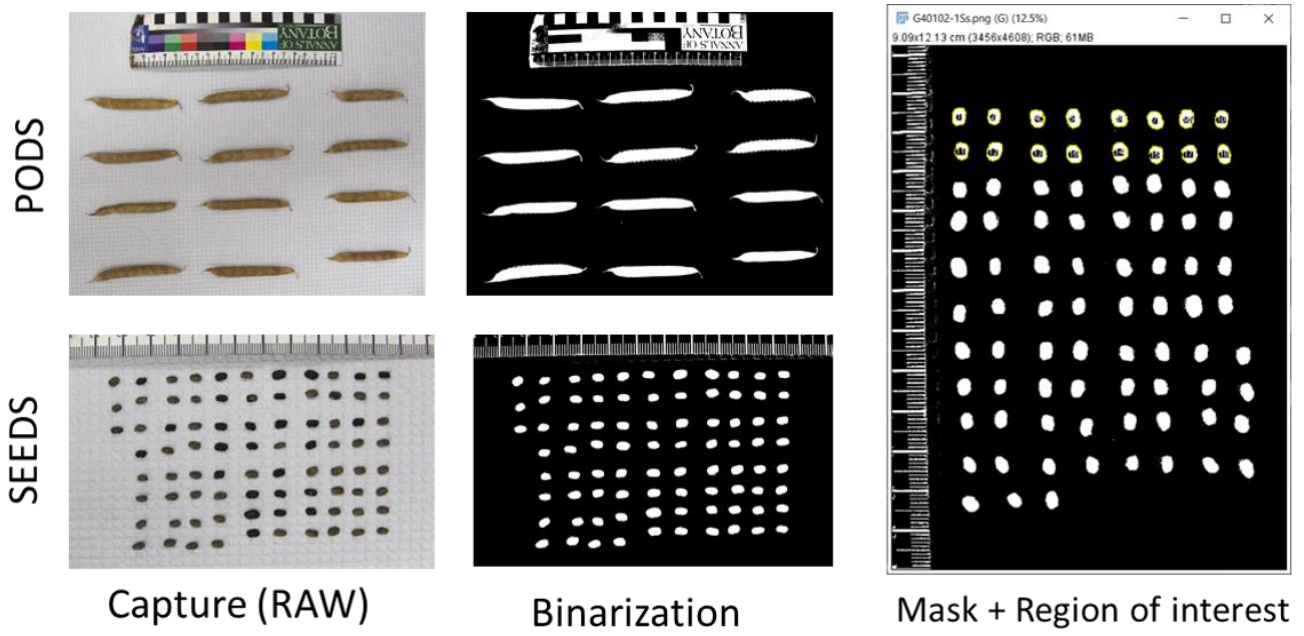
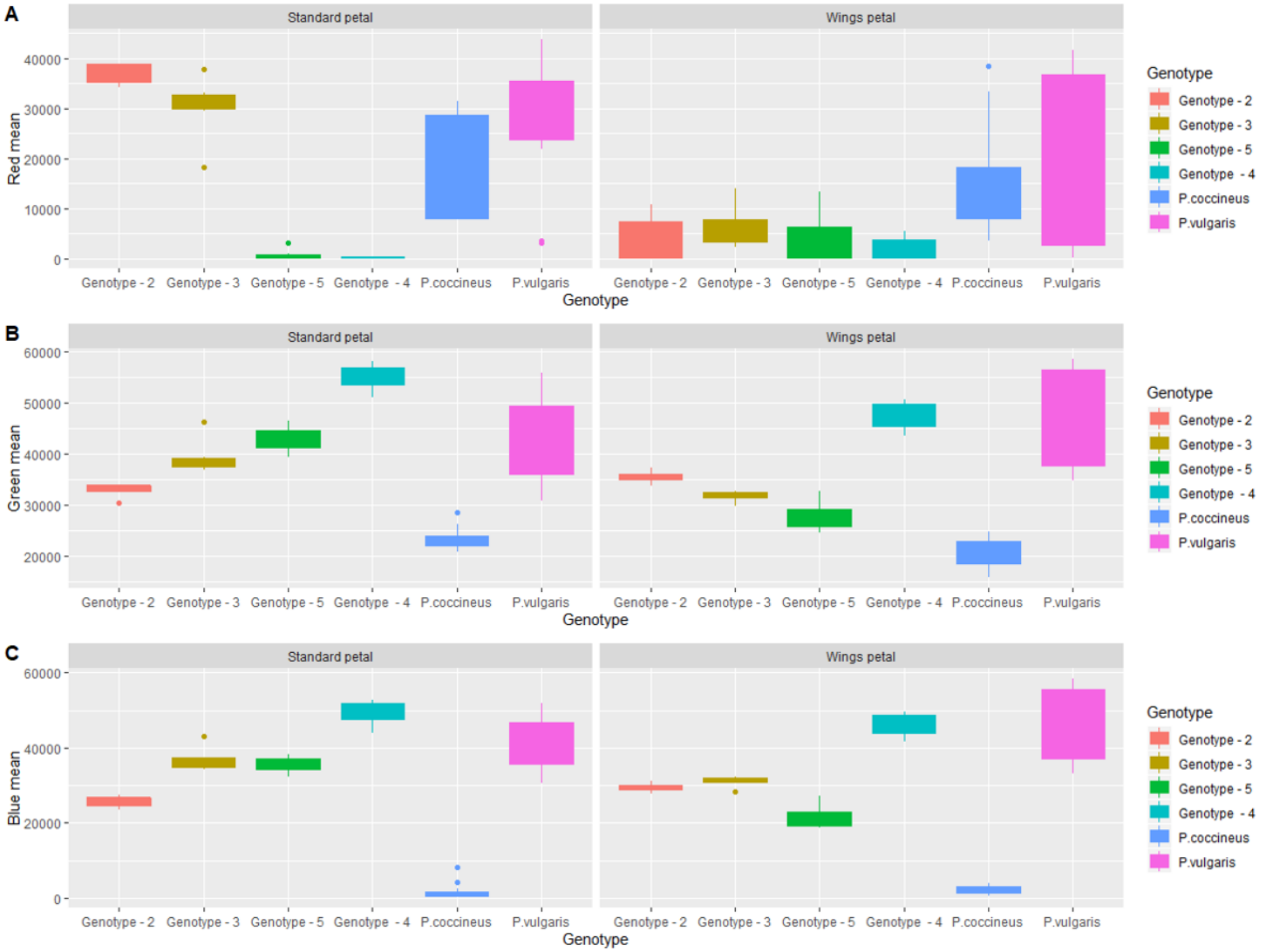


Figure 1.Morphometric descriptors used in the characterization. (A) Area, (B) Solidity, (C) Heigth and Width, (D) Minor and Major, (E) MajorFeret and Minorferet, (F) Perimeter, (G) Aspect radio (AR) and (H) Roundness.

Canon SX60 HS camera, 16.1 megapixels



Flower color descriptors – preliminar results



- Complex #8
- RGB color space
- Three images per genotype, four ROIs analysed at each wings and standard petals

Hybrid G50879-X4 shows intra-accession variation in flower color, as well as in lateral seed shape

Complex #8

Flowers and aerial parts of natural hybrids of accession G50879X4. (A) Leaf malformations accompanied by flower, (B) Stamens without stigma formation, (C) Malformation of standard and floral wings, (D) Variegation in leaves and limited growth of aerial part of the plant, (E) Limited plant height with floral formation, and (F) Aerial part in senescence.

Complex 17 *(x P. dumosus x P. costaricencis)*

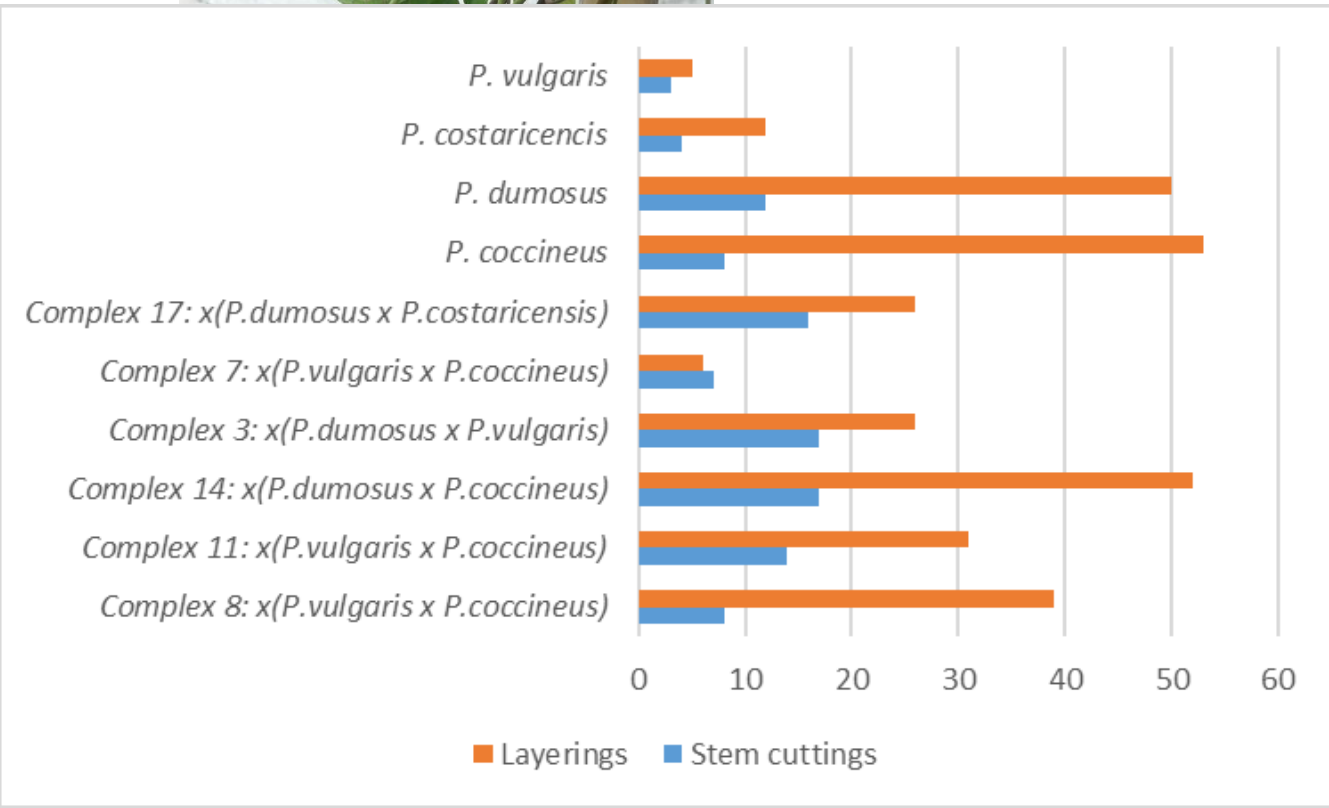
Complex 7 and Complex 11 *(x P. vulgaris x P. coccineus)*

Vegetative plant multiplication

Stem cutting

Stolon/aerial layering

Water layering



Phaseolus tuerckheimii Donnell-Smith
G40578 – origin Guatemala

Last trial for regeneration in Tenerife, using an extending pole device (engineered by D. Debouck) – permits the plant to climb up to 5-6 m and flower profusely in the upper racemes

- Started blooming 2.5 months after transplanting
- Produced more than 4,000 seeds

Phaseolus chiapasanus Piper G40794 – Oaxaca, Mexico

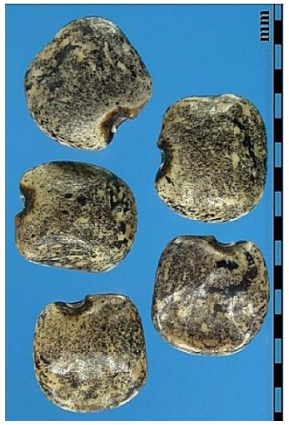
- Mean temperature 25.7 °C (15 °C- 34 °C), mean relative humidity 59.8% (36.6%- 90.9%)
- 30 plants were established in a furrow
- After 2 years (750 days) it has produced 1,640 seeds
- The root system supports establishment of the climbing aerial part, and it also helps the plant, when rains resume, to compete with other understory forest bushes and vines

Artificial Growth Chambers *Conviron* (Greenhouse IBG)

Control environmental conditions (day/night temperatures, light intensities, humidity) according to the material origin

- *Phaseolus zimapanensis*
- *Phaseolus filiformis*
- *Phaseolus albicarminus*

Phaseolus zimapanensis A. Delgado



Conditions:
16 h day/ 8 h night
1000-335 umols intensity
Temperature 18° C day/ 10° C night
Relative humidity 60% day/ 90% night

Total seeds = 1,459

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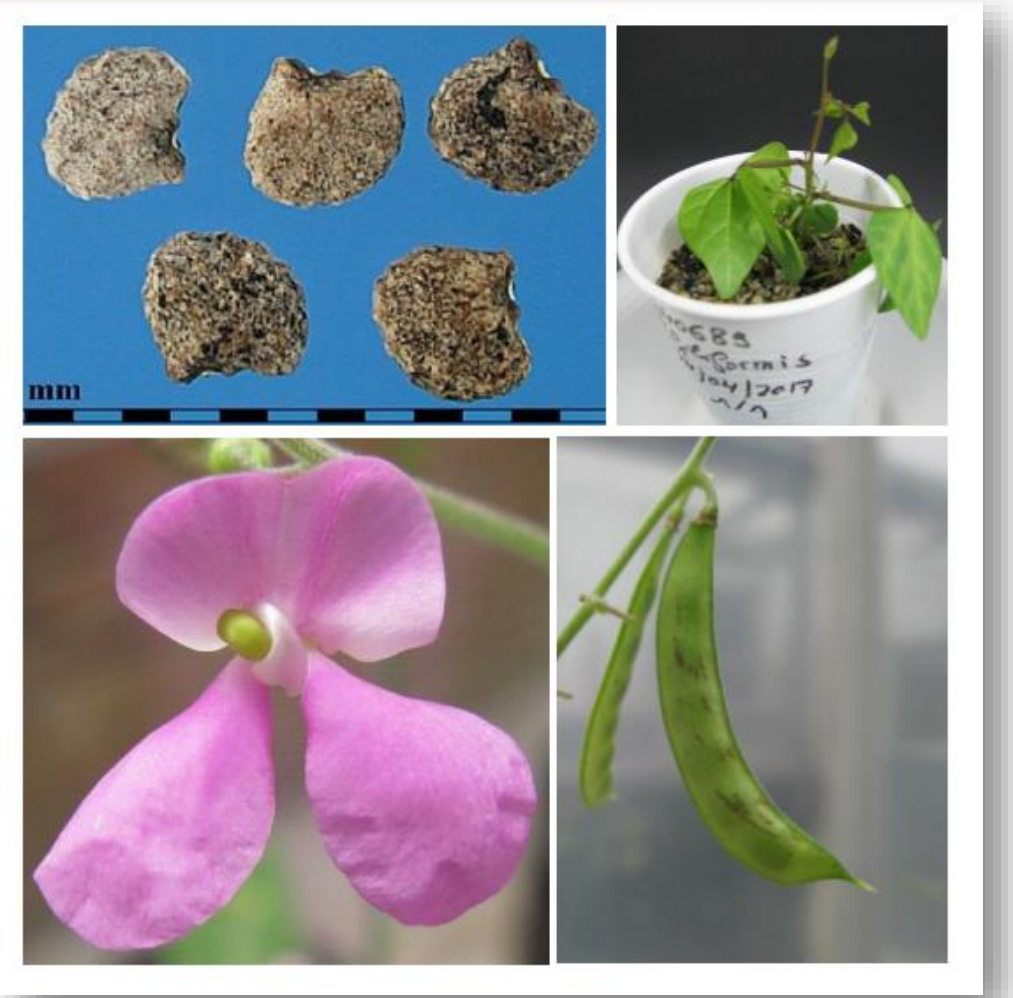
Phaseolus filiformis Bentham Accession G40689



Total seeds = 1,928

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Phaseolus albicarminus Debouck G40901 – Costa Rica

- Initially considered a *Phaseolus hygrophilus*, however due to differences observed during first regeneration cycle, it was suggested as a new specie and its taxonomy has been recently clarified (Debouck *et al*., 2020)
- Cultivated by **grafting** using as rootstock accession G35684 *Phaseolus dumosus*
- Conviron chamber conditions: 16 h day/ 8 h night, 480 µmol photons m-2 s-1, 20^{o} C day/14 ^{o} C night, humidity 80% day/90% night)
- Shoot growth after one week, transplanted to soil in Tenerife station 5 months after grafting, showing adequate adaptation

Phaseolus albicarminus Debouck

Photos by Jeison Ypiales and Ramiro Sabogal

PGRFA Regeneration in the Genebank - Palmira

- The Genebank mission is to conserve the genetic diversity of crops of interest
- Different strategies are required for regenerating/multiplying the current accessions
  - Adapting spaces/infrastructure
  - Manage nutrients and prevent pest/diseases
  - Apply artificial/manual pollination
  - Vegetative plant multiplication (layering/grafting)
- Revealing the potential of wild relatives will promote the use of interesting traits by crossings or employing editing technologies, to silence/activate specific genes in commercial varieties
- https://www.youtube.com/watch?v=E3TdPw_0NfM

A big team

- Field team in Tenerife station: Alvaro Mestizo, Jeison Ypiales, Salomon Genoy, Guillermo Rosero
- NIAB partners in the project “GCRF-BBR: Developing a hybrid-bean collection to advance climate-ready bean breeding“ Jane Thomas, Tom Wood, Sarah Dyer, Simon McAdam and Krystyna Gostkiewicz
- Palmira campus Team: Hernán Escobar, Jersaín Naranjo, Wilson Guzmán, Cesar Franco, Maria Mercedes Parra, Cenaida Perenguez, Fanny Gil, Juan Gilberto Dominguez and many more
- Research Team: Diego F. Conejo, Juan David Reyes, Ramiro Sabogal, Javier M. Gereda, Luis Guillermo Santos, Maritza Cuervo, Julio César Ramírez, Angélica Martínez, Diana Niño, Dimary Libreros, Peter Wenzl

Support

- Led by project partners NIAB and CIAT, the project “Developing a hybrid-bean collection to advance climate-ready bean breeding” is funded as part of **BBSRC’s Global Challenges Research Fund (GCRF) Bioinformatics and Biological Resource (BBR) fund** and runs from May 2018 – April 2023.
- The growth chambers were purchased thanks to a grant provided by **the *Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung* (BMZ)** of Germany.
- The work for regeneration and multiplication of germplasm is in general supported by the **Global Crop Diversity Trust.**

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Thank you!

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https://www.niab.com/research/agricultural-crop-research/research-projects/characterising-hybrid-beans

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