Log Frame for the Sustainable use of potato crop wild relatives (CWR) and development of a pre-breeding core collection with key climate change-related traits project

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| 1. Genetic base of breeding populations broadened with selected CWR donor materials | a. Novel genetic variation for traits in CWR-derived pre-breeding material of INIA Uruguay and CIP’s Potato Breeding Programs deployed in elite tetraploid genetic background from both programs (Y1) | Database in CIP’s Global Trial Data Management System (GTDMS) and project reports | • Rapid multiplication, health testing and germplasm distribution occurs within normal timeframe  
• Lack of flowering  
• Pre-zygotic barrier.  
• Requirement of mentor pollination  
• Requirement of embryo rescue  
• Usable levels of 2n gamete production are identified on the CWR |
| 2. Evaluate and seek to complement new pre-breeding pools for key pathogen resistances, traits relative to climate change, end-user and market preferences | a. 20 4x pre-breeding hybrid lines with key reproductive attributes, documented for disease resistance, heat tolerance and market traits under in-vitro cleaning (Y3) | Database in GTDMS and project reports | |
| 3. A CWR derived pre-breeding core collection for traits related to climate change adaptation, i.e, heat and drought tolerance and key pathogen resistances i.e, to Late blight (LB) and Bacterial wilt (BW) of potato developed | a. Validation of target traits by means of standardized protocols of 20 exotic accessions historically evaluated yet not well-documented (Y2)  
b. Hybrid families with at least 300 TS each generated from introgression of target traits from the 20 exotic accessions into 2n-gamete producing landraces (Y3) | Database in Global Trial Data Management System (GTDMS) of CIP and Project reports | |
| 4. Abiotic factors stimulating 2n-gamete production identified and applied in pre-breeding | a. 15 2n-gamete producing CWR and landraces with valuable traits selected for trait transfer (Y2)  
b. Abiotic stress conditions inducing diploid gamete production in diploid CWR and landraces tested (Y2) | Database on GTDMS, project reports, Public Newsletter | |
| 5. A pre-breeding strategy to facilitate the characterization and incorporation of genes controlling target traits, and exploitation of transgressive segregation or heterosis outlined | a. Self-compatible 2n-gamete producing plants generated from self-incompatible 2x CWR- and 2x landrace derived hybrids (Y2-Y3)  
b. Nested matting design proposed for development of nested association mapping for GWAS (Y3) | GTDMS and project reports | |
| 6. Capacities for pre-breeding developed and new plant genetic resources available in public domain | a. An undergraduate student from the Faculty of Agronomy of a Peruvian Public University with capacity in crossing procedures, improved understanding of reproductive barriers (methods for examining pollen-pistil interactions in Solanum), methods and techniques for detecting and circumventing them (Y2)  
b. Database with new pre-breeding material and selected 2n-gamete producing CWR and landraces documented (Y3)  
c. Electronic protocols for protocol for generation of tuber families from TS and target trait assessment i.e, BW resistance assessment and drought tolerance assessment in public domain  
### Activities (as per specific objective)

| 1.1 Generation of BC3 true seed from BC2 selected *S. commersonii* and *S. chacoense* derived 4x hybrids with resistance to bacterial wilt (BW), heat tolerance (HT) and long photoperiod (LD) adaptation. | At least 1000 TS per successful cross produced (Y1)  
200 TS from 20 CWR derived 4x hybrid families dispatched to partners in Africa (Y1-Y2)  
Data of family response to BW, heat, and drought stress in Y3 | Database on GTDMS and project reports  
Environmental conditions affect plant growth  
Lack of flowering, pollen infertily |
| 1.2 Generation of TS from intercrossing of selected F1 Piurana derived *S. tuberosum* hybrids with late blight resistance (LB) and heat tolerance (HT)  
1.3 Tuber family generation and family testing of 4x TS generated (TS with BW resistance, HT and LD; TS with LB and HT) by CIP Regional Program in Ethiopia | • 20 hybrids lines documented for performance and attributes.  
• 20 hybrids lines evaluated through participatory selection for preference traits. | Database on GTDMS and project reports  
Environmental conditions affect plant growth |
| 2.1 Greenhouse screening for BW resistance of BC3 4x progenies derived from *S. commersonii* and *S. chacoense*.  
2.2 Field assessment of selected BW resistant BC3 genotypes for agronomical attributes, heat tolerance and long photoperiod adaptation  
2.3 Field assessment of selected LB resistant 4x Piurana derived hybrid lines for agronomical attributes and heat tolerance.  
2.4 Total glycoalkaloid content analysis of tubers from selected CWR derived 4x selected clones  
2.5 On farm trials to assess farmer’s preference of selected hybrid clones | • Database/literature review.  
• Tuber seed or mother plants of > 50 accessions from compiled list available in Y1  
• Phenotypic data on drought and heat tolerance, BW and late blight resistance for 50 CWR documented in on-line database by Y2.  
• At least 300 TS from 30 interspecific crosses generated in Y3. | Database on GTDMS and project reports  
Environmental conditions affect plant growth  
Lack of flowering  
Pre-zygotic barrier.  
Requirement of mentor pollination  
Requirement of embryo rescue |
| 3.1 Compile information of CWR accessions documented with resistance to BW, LB and/or tolerance to heat and drought  
3.2 Vegetative propagation of accessions from in-vitro plants  
3.3 Greenhouse trials for resistance or tolerance assessments, as appropriate  
3.4 Assessment of pollen fertility, 2n gamete production and self-compatibility of selected CWR accessions  
3.5 Crossing Block for trait introgression to 2n-gamete producing landraces or directly to 4x breeding lines for 2n-gamete producing CWR |  |  |
4.1 Compile phenotypic data for disease resistances, stress tolerance, post-harvest and nutritional traits of 2n-gamete producing CWR and landraces
4.2 Semi-controlled greenhouse trials to test temperature effect on 2n-gamete production
4.3 Mapping of QTL for 2n gamete production in the DMDD map derived from the doubled monoploid DM 1-3 used to develop the Potato Genome Sequence

- 1 panel of at least 20 2n-gamete producing 2x genotypes identified and documented for adaptation, post-harvest and nutritional traits.
- Incidence, variation and GXE effect on the frequency of 2n pollen production determined in 2x panel.
- Putative candidate genes for 2n-gamete production identified.

Database on GTDMS, project report, Public Newsletter

5.1 Introgression of Sl gene originating from S. chacoense into 2n-gamete producing diploid landraces and selected self-incompatible CWR derived diploid hybrids
5.2 Tuber generation from self-compatible plants of CWR- and landrace- diploid derived F1 hybrid progenies
5.3 Outline a nested mating design and propose a pre-breeding strategy

- At least 800 CWR and landrace derived lines containing Sl gene
- A pre-breeding strategy for characterization and speed up incorporation of genes controlling target traits, and exploitation of transgressive segregation or heterosis.

Database on GTDMS, project report and Concept Note

- Environmental conditions affect plant growth
- Lack of flowering
- Pre-zygotic barrier.
- Requirement of mentor pollination

6.1 Capacity in pre-breeding techniques
6.2 Develop an updated protocol for generation of tuber families from TS
6.3 Develop an updated protocol for drought tolerance assessment.
6.4 Develop a protocol for bacterial wilt resistance, implementing a test sensitive method for detection of *R. solanacearum* (e.g. RT-PCR) in latently-infected tubers
6.5 Manual of crossing procedures updated with mentor pollination and embryo rescue methodology, flow cytometry analysis, procedures for EBN determination and methods for determining pollination behaviour through examination of pollen-pistil interactions

- 1 undergraduate student trained in pre-breeding techniques through a thesis research
- 3 updated protocols.
- 1 Manual.

Thesis research and training documents available online in GTDMS’s breeding tools