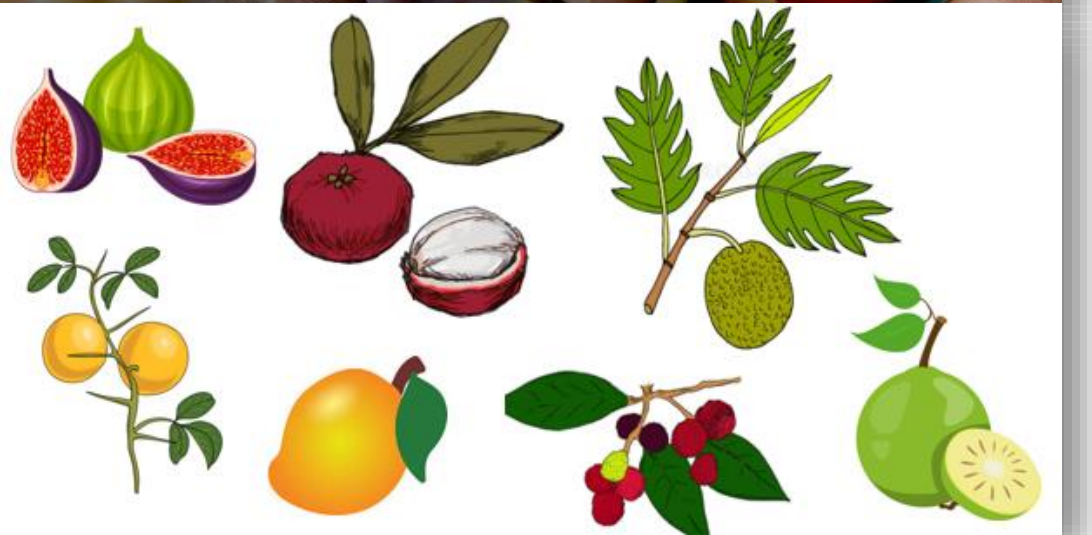


Clonal propagation, nutritional profiling and value addition of climate-resilient native fruit species for sustainable horticulture in arid region

K.L. Kumawat and P.S. Gurjar

19-11-2025

1. Introduction to project:

Lead organization :

- ICAR-Central Institute for Arid Horticulture, Beechwal, Bikaner, Rajasthan-334006

Target area:

- State: Rajasthan
- Agroecology region: Western Plain, Kuchchh and part of Kathiwara Peninsula

1. Introduction to project:

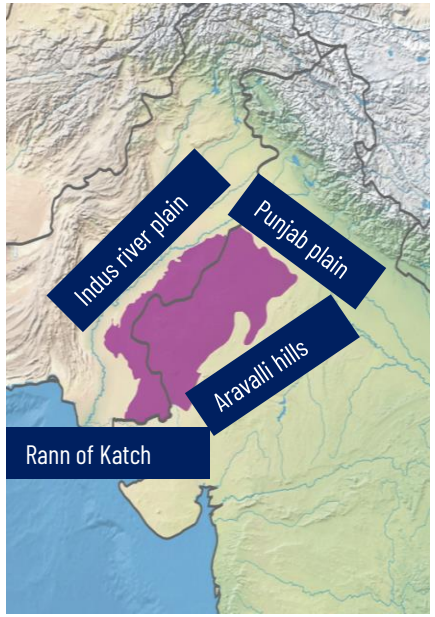
Thar Desert : Great Indian Desert

Area: 200,000 km^2

Coordinates- 27°N and 71°E

India (85%)- Raj., Pb, HR, and Guj.

Rajasthan (60%)



Rich in biodiversity

Flora: 62 families, 157 genera and 206 species

Native plants offer better resilience against climatic variability and climate change

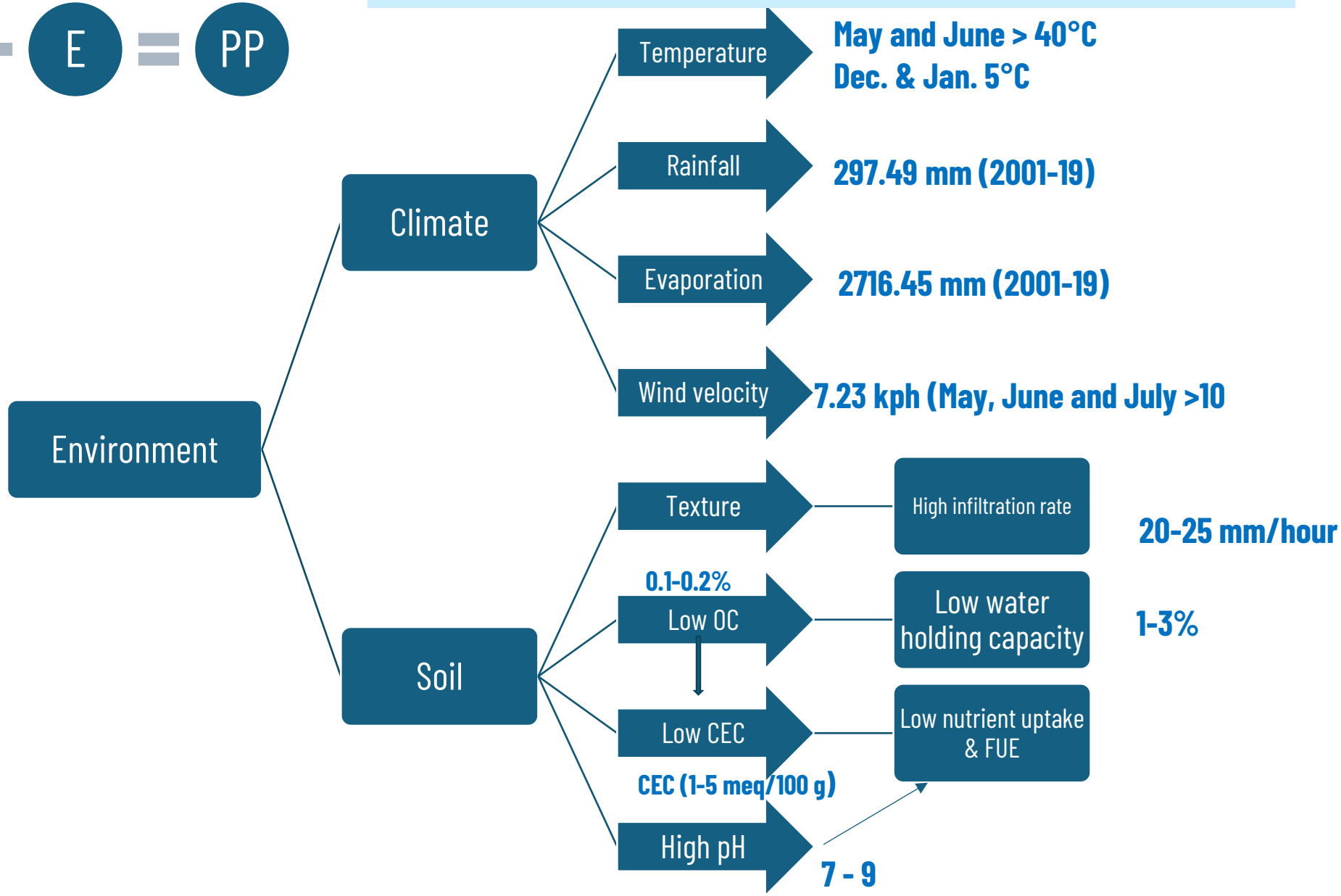
Xerophytic nature

Some spp. are at extinction stage

Conservation status – vulnerable

Challenges in arid horticulture

G + E = PP



Pilu (*Salvadora oleoides* Decne)- Protector of Thar Desert

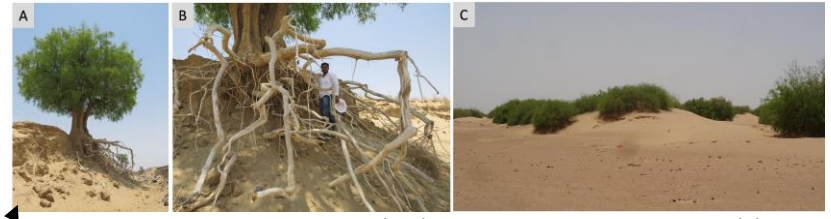
Source of fruits and part of local horticulture trade

Food source for domestic and wildlife in arid region

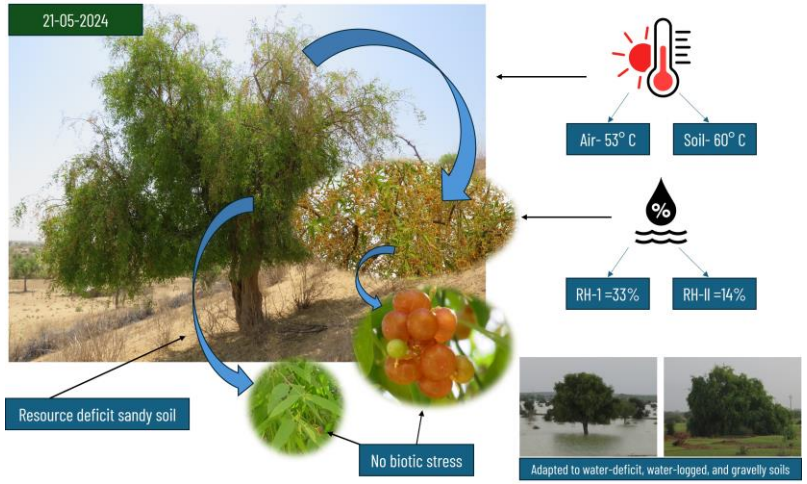
Vital refuge for birds in the desert ecology

Life-line tree for shade in the Thar desert during the hot summer months.

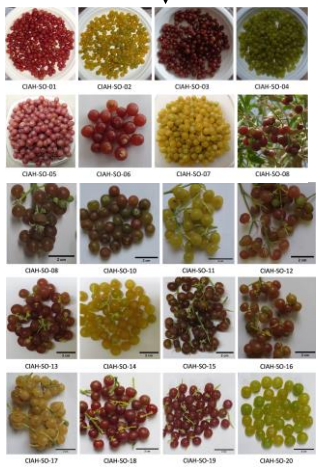
Support pollinizer

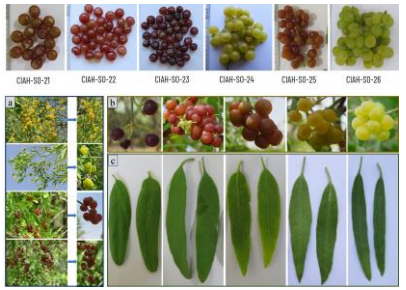


Extensive root system of pilu tree (A, B) helps in sand-dunes stabilization (C)

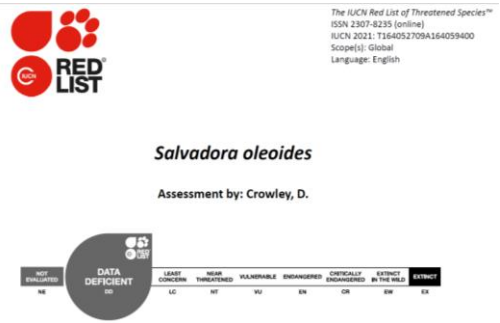


Demonstrates strong resistance to biotic and abiotic stress factors





Variability in horticultural traits



Deserts' Grapes

Ker (Capparis decidua (Forsk.) Edgew)

Capparaceae

Importance and uses

Immature fruit:
- Vegetable
- Pickle

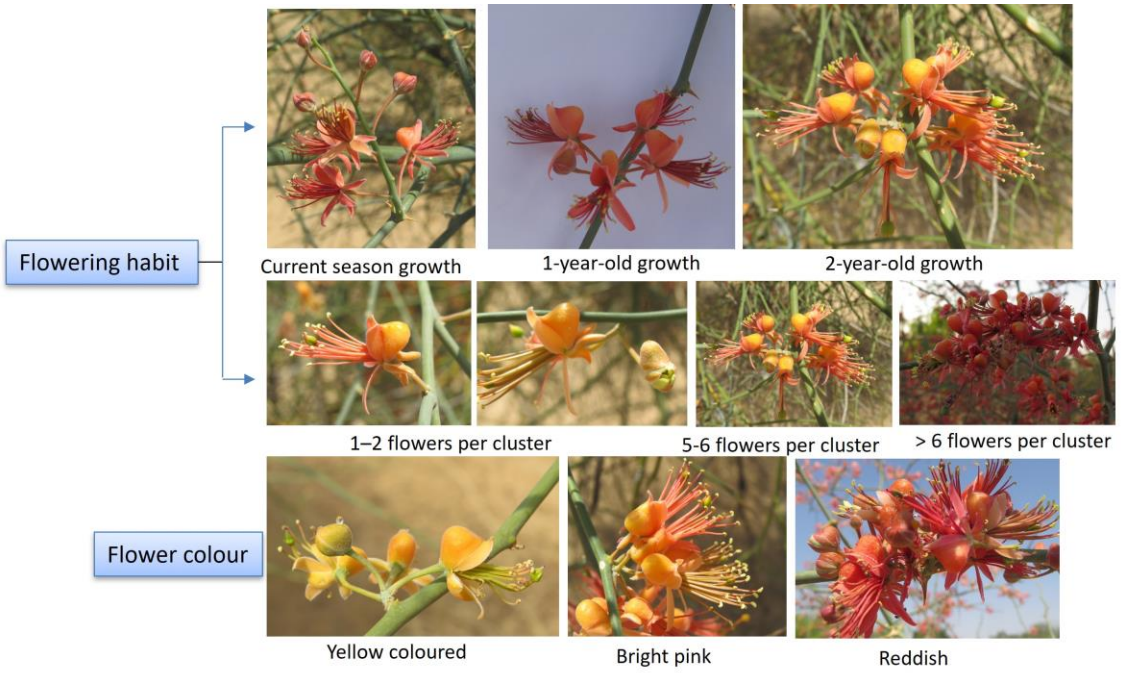
Dehydrated
- Vegetable

+ Hardy plants
+ Drought tolerant
+ Frost tolerant
+ High temperature tolerant
+ Salt tolerant

Flowering
- **February to March**
- June to July
- September to October

Variability exists in natural population of ker for growth habit, flower colour, bearing habit, fruit shape, size & colour, seed hardening timing etc.

Thornless- AHCD-1; IC-0634593



Jharber (*Ziziphus nummularia*)

Rhamnaceae

Importance and uses

Mature and Ripe fruit Suitable for fresh consumption and dehydration

+ Hardy plants
+ Drought tolerant
+ Frost tolerant
+ High temperature tolerant
+ Salt tolerant

A large variability exists in jharber particularly in relation to fruit physical traits as a result of cross pollination and seed propagation.

Fruit harvesting period - November and December

IC 657783

IC 657784

IC 657785

IC 657786

IC 657787

Ber (*Zizyphus routandifolia* Lam.)

Rhamnaceae

Bordi

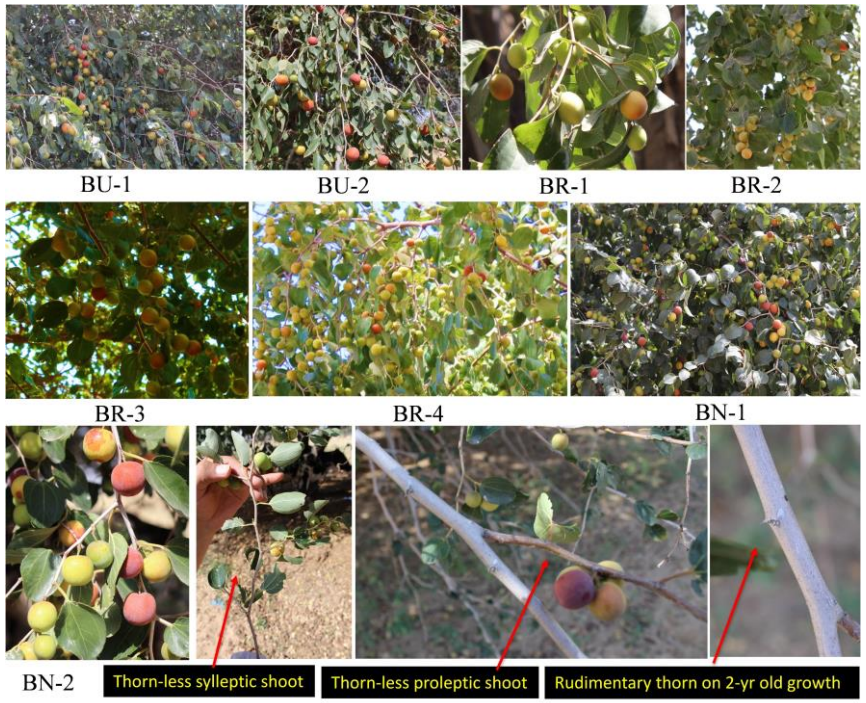
Importance and uses

Mature and Ripe fruit Suitable for fresh consumption and dehydration

+ Hardy plants
+ Drought tolerant
+ Frost tolerant
+ High temperature tolerant
+ Salt tolerant
+ Fit for boundary plantation
+ Fit for fruit based multi-storey system

A large variability exists in bordi/ber particularly in relation to growth habit, bearing habit, fruit physical traits as a result of cross pollination and seed propagation.

Fruit harvesting period: February-March



Thornless

CIAH-ZR-01

CIAH-ZR-02

CIAH-ZR-03

CIAH-ZR-04

CIAH-ZR-05

Why should we promote the cultivation of native arid fruit crops?

1. Introducing a **new crop** in hot arid regions **increases input costs** and often carries a high **risk of crop failure**.
2. Native species **offer strong resilience** to climate variability and climate change.
3. Crop **diversification** with climate-resilient native fruit species can help **ensure sustainable income** and economic security.
4. They contribute to global nutrition by **expanding the range of available food crops**.
5. Growing health awareness post-COVID-19 has driven consumers toward **natural, chemical-free foods**, making native fruits more desirable.
6. Native arid fruit crops may accumulate higher levels of essential nutrients and **health-promoting bioactive** compounds due to extreme growing conditions.
7. Promoting these crops contributes to the **conservation** of valuable plant genetic resources.

What problems are being targeted to solve:

1. Lack of propagation technology to conserve and commercialize of rare and endangered arid fruit plants (pilu and ker)
2. Lack of scientific evidence regarding nutraceutical and functional features of ker, pilu, jharber and bordi plants
3. Lack of diverse value-added products of these crops

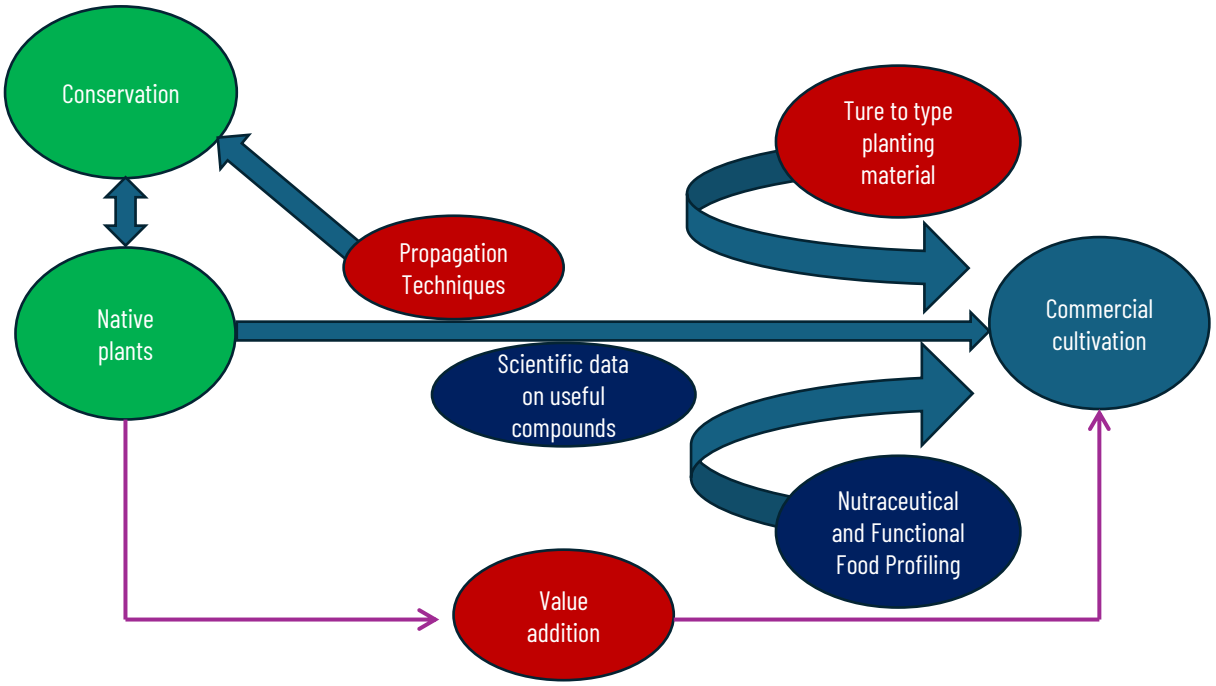
Hypothesis:

- Standardization of factors determining root formation and growth in vegetative part can enhance efficiency of propagation of *S. oleoides* and *C. decidua*.
- Being a fruit tree species of hot arid region, these crops may exhibit enhanced functional and nutraceutical compounds.

Rationality:

Importance : It is addressing commercialization of untapped and underutilized potential fruit species of hot arid region listed in IUCN Red List of Threatened Species.

Technology and knowledge gap



Actions in place to overcome gaps

26 promising genotypes of *Salvadora oleoides* were marked in Jaisalmer, Barmer, Balotra, Jalore, Sanchore and Bikaner districts of Rajasthan

Seedling progenies from 9 promising genotypes of *Capparis decidua* were collected and evaluated, leading to the identification of a high-yielding thornless genotype.

Several attempts have been made for vegetative propagation of *Capparis decidua*, but success has been limited to 6-8% and has not been consistently repeatable.

After many attempts, a breakthrough in vegetative propagation of *Salvadora oleoides* has been achieved, though further research is needed to develop a commercially viable method.

A preservation technique for ker fruit has been developed to ensure its year-round availability

2. Project Objectives:

1. To develop clonal propagation means for *Pilu* and *Ker* for collection, conservation and horticultural utilization of promising genotypes
2. To determine the nutritional profile and value addition of *Pilu*, *Ker*, *Jharber* and *Bordi* for commercial utilization and enhancing consumer acceptance
3. To establish conservation-cum-nutrition units of *Pilu Ker*, *Jharber* and *Bordi* for long-term conservation and nutritional security for landless households and schoolchildren in arid and semi-arid regions

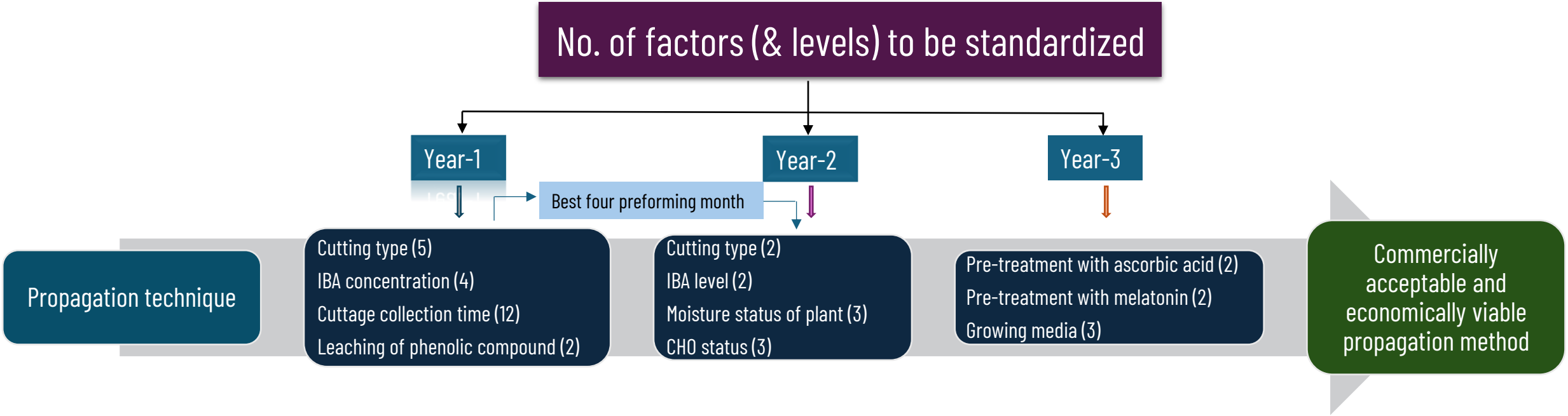
3. Methodology and implementation approach:

Objective –1 To develop clonal propagation means for *Pilu* and *Ker* for collection, conservation and horticultural utilization of promising genotypes

Particular	Details
Experimental site	ICAR-CIAH, Bikaner
Propagation environment	Mist chamber and shade net
Cuttage collection time	Morning hours (7-9 AM)
Major factors to be standardized	1. Cutting type, 2. IBA concentration, 3. Cuttage collection time, 4. Leaching of water-soluble phenolic compound in plain water 5. Moisture status of cuttage (based on watering to mother plants before collection) 6. Pre-treatment with ascorbic acid 7. Pre-treatment with melatonin 8. Carbohydrate status of branch (through gridling before collection of cuttage) 9. Growing media
Number of trials	39
Design of experiment	• Two to three-factor depending on their levels will be standardized simultaneously using a factorial completely block design. • The remaining factors will be standardized in subsequent trials. • The sequence or priority of factors will be determined by considering inter-relationship, significance and levels
Replications	3
No. of cuttage/replication	10
Observations	Observations on at least 17 parameters associated with root and shoot growth will be recorded for valid conclusion.

Product delivery pathway and time line

Objective 1



3. Methodology and implementation approach:

Objective –2 : To determine the nutritional profile and value addition of *Pilu*, *Ker*, *Jharber* and *Bordi* for commercial utilization and enhancing consumer acceptance

Activity- I

- Fruit samples of *Pilu* (26) and *Bordi* (10) will be collected from the marked elite genotypes representing diverse region.
- Fruit samples of *Ker*, and *Jharber* will be collected from germplasm block of ICAR-CIAH, experimental farm.
- Proximate analysis and basic biochemical parameters (TSS, acidity, ascorbic acid, total phenols, total flavonoids, total antioxidants, total soluble sugars, anthocyanins) analysis will be carried out in biochemistry laboratory of ICAR-CIAH, Bikaner.
- Fruit samples processing for HPLC (bioactive compounds quantification and identification) and mineral analysis will be carried out in institute laboratory.
- HPLC analysis for unique compounds and mineral analysis will be carried out through outsourcing basis from other ICAR institutes (ICAR-IARI, New Delhi).
- In-vitro antidiabetic and anticholestatic activity of fruit extract will be determined through outsourcing.

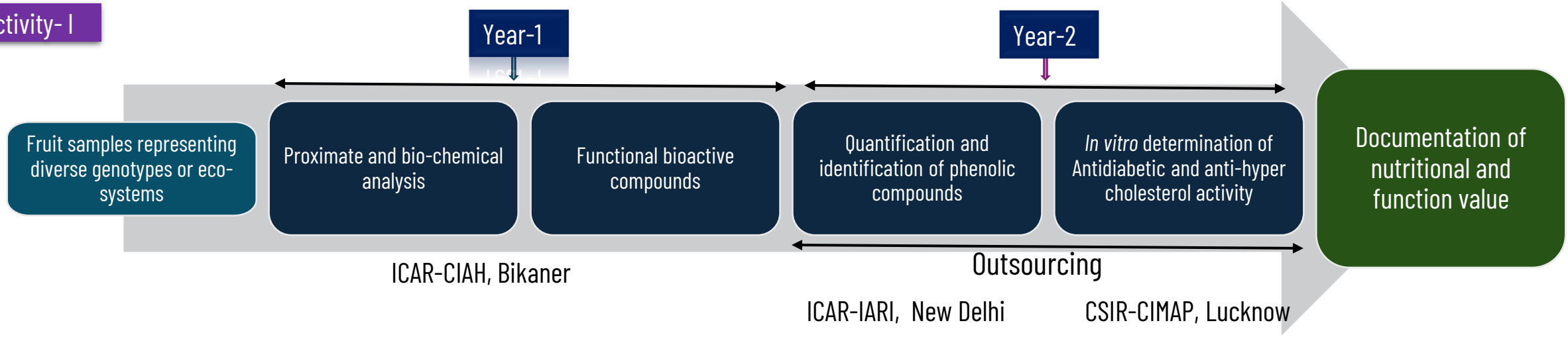
Activity- II

Value-added products of ker, pilu, jharber and bordi will be developed in the institute's post-harvest technology laboratory.

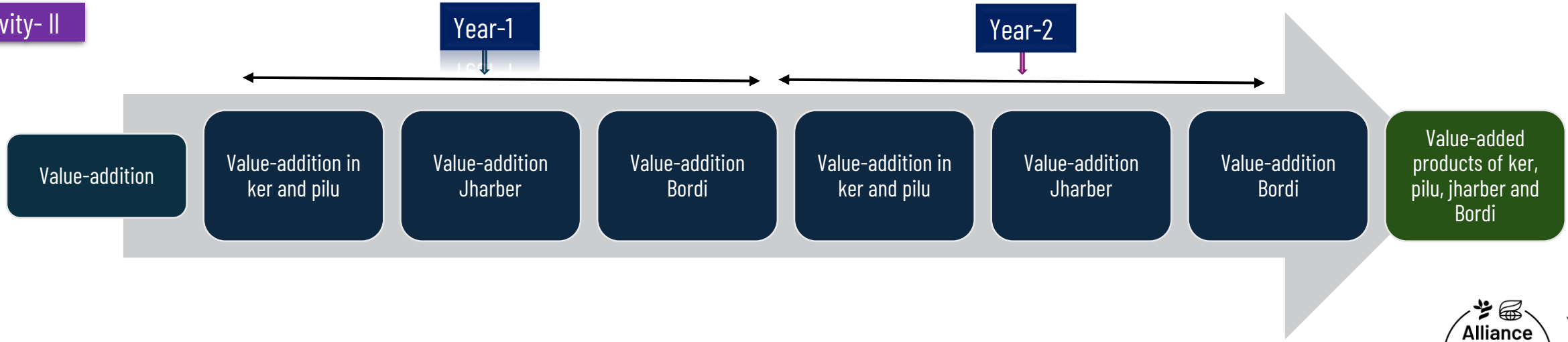
Product delivery pathway and time line

Objective 2

Activity- I

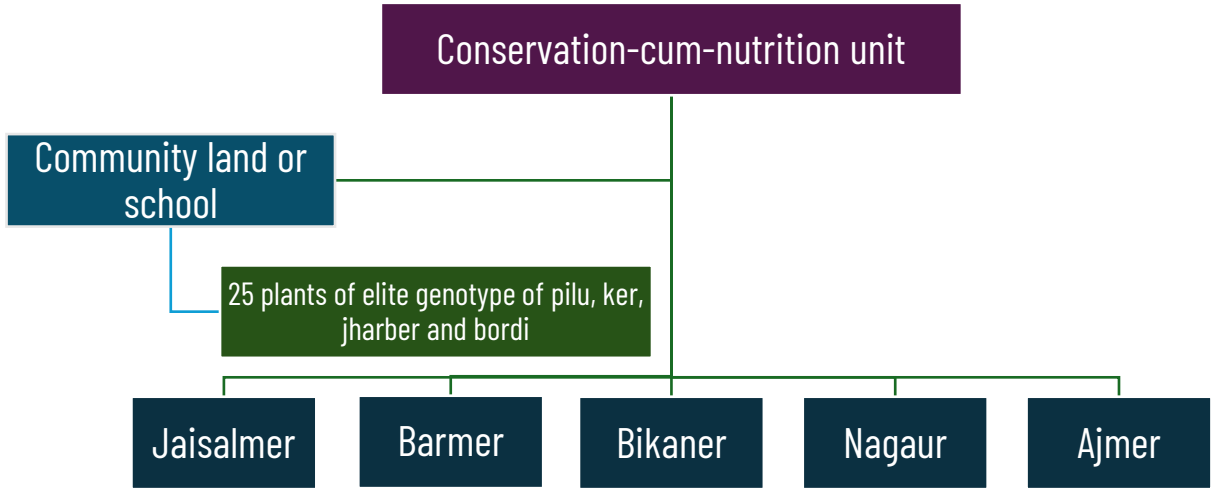


Activity- II

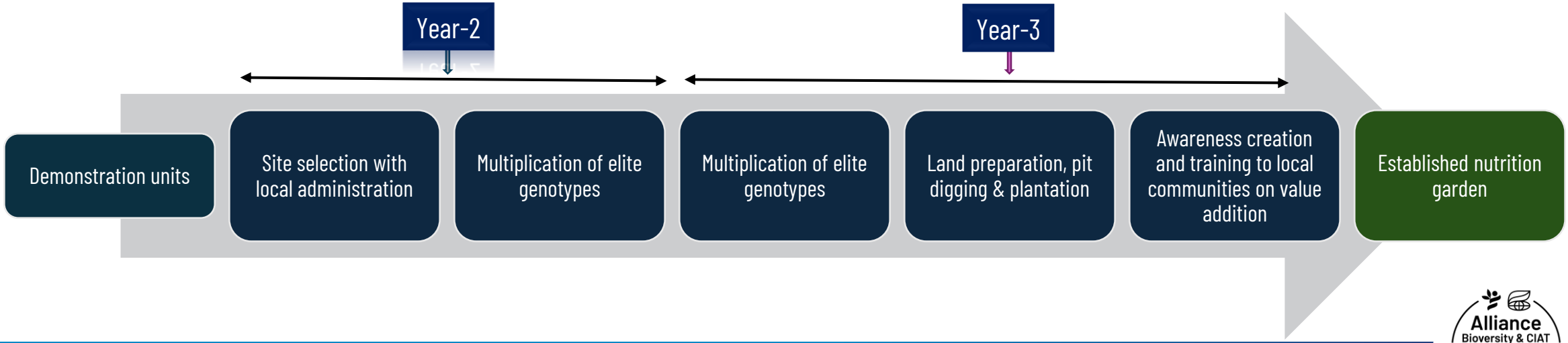


3. Methodology and implementation approach:

Objective -3 To establish conservation-cum-nutrition units of *Pilu Ker*, *Jharber* and *Bordi* for long-term conservation and nutritional security for landless households and schoolchildren in arid and semi-arid regions



Product delivery pathway and time line



Social and nutrition impact pathway – Project outcomes/Impact:

Expected Output

I. Commercially acceptable clonal propagation method for *Pilu* and *Ker*

II. Nutritional profile of four important fruit crops of arid region

III. Value-added products for income generation and round the year availability

IV. Five conservation-cum-nutrition units for community benefit

Expected Outcomes

I. The clonal propagation method will facilitate collection, conservation, characterization, evaluation, documentation, variety release, and commercialization of *Pilu* & *Ker*

II. Diversification with climate resilient crops enhance sustainability in arid horticulture

III. Commercialization of these fruit crops can lead to creation of agri-enterprises, rural employment and enhanced income for farmers

IV. Enhanced access to natural chemical free fruits for consumers and fodder for livestock

V. Expansion of green cover in the *Thar* Desert that can contribute to improved ecosystems and sand dune stabilization

Environmental and climate advantages

- Promotes large-scale cultivation of drought-, heat- and salinity-tolerant native fruit species, **enhancing resilience in arid ecosystems**.
- **Enhances carbon sequestration** and expands green cover through plantations of Pilu, Ker, Jharber, and Bordi.
- **Reduces soil erosion** and **stabilizes sand dunes**, improving long-term land and ecosystem sustainability in the Thar Desert.
- **Supports restoration of degraded landscapes** using hardy native species adapted to extreme climates.
- **Minimizes dependence on chemical inputs** due to the pest and disease resistance of these species.
- **Supports climate-smart horticulture** by conserving water and reducing environmental footprint.
- **Conserves biodiversity** by protecting and propagating rare and threatened native fruit species (ker, pilu, jharber).
- Improves microclimatic conditions through shade, windbreak effects and **increased soil organic matter**.
- Strengthens ecosystem services, including **pollination and habitat creation for native fauna**.
- Builds **climate-resilient rural livelihoods** by integrating perennial crops into farming systems.

Scaling, sustainability and cost efficiency:

- The developed clonal propagation protocols enable rapid, large-scale multiplication of elite genotypes, supporting **widespread adoption** across arid regions.
- Use of native, climate-resilient species ensures **long-term sustainability** with minimal water, fertilizer, or chemical requirements.
- Conservation-cum-nutrition units create a replicable, community-driven model that can be expanded through local institutions.
- Cost effective propagation methods and value-added processing enhance **economic viability** and reduce production risks for small farmers.
- Once protocols and products are established, public–private partnerships can scale commercialization with minimal recurring costs.
- The approach leverages existing community resources, making it both **cost-efficient** and **environmentally sustainable** over the long term.

Budget summary :

	Budget Heads	Budget (in US$*)			
		Year I	Year II	Year III	Total
A	Non-recurring				
	Small equipment's (Refractometer, digital vernier caliper, Weighing balance, etc.	2000			2000
		2000	-	-	2000
B	Recurring contingency				
	Media	1000	-	-	1000
	Root trainer	300	-	-	300
	Chemical	1000	1000	-	2000
	Tray, Crates, etc.	500	500		1000
	Research contingency	1000	5000	500	6500
	Manpower SRF @ 480 + 20% HRA Semi-skilled labour	7000 + 2300 =10300	7000 + 2300 =10300	7000 + 2300 =10300	30900
	TA, POL, office expense etc.	2000	2000	500	4500
	Miscellaneous	600	600	600	1800
	Total (B)	16700	19400	11900	48000
	Total (A+B)	**18700**	**19400**	**11900**	**50000**

Risk and mitigation strategy:

- Variability in rooting success or plant phenological event may affect propagation outcomes; this will be mitigated by conducting trials across seasons and optimizing key factors under protected conditions.
- Mortality of planted genotypes in demonstration sites will be reduced by selecting suitable protected site, ensuring proper pit preparation, and providing initial irrigation support.
- Market acceptance risks for value-added products will be mitigated through organoleptic testing with a diverse consumer group to refine product quality and preference.

Alliance Bioversity & CIAT

CGIAR

In the harshest desert, nature has already written the manual for survival; conserving and cultivating these species ensures we do not lose that wisdom.

Thanks