



# Collection, Conservation and Morpho-phenological Characterization of Avocado germplasms of Sikkim



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# 1. Introduction to project:

- 1. Project Title:** Collection, Conservation and Morpho-phenological Characterization of Avocado germplasms of Sikkim.

**Lead Institution:** College of Horticulture, Bermiok, Central Agricultural University, Imphal.

- 2. Target Area:** 6 districts of Sikkim (Namchi, Gangtok, Soreng, Pakyong, Geyzing & Mangan).

## 3. Problem Statement & Justification:

### Gaps:

- ✓ Unavailability of quality planting material and services.
- ✓ No systematic commercial orchards established so far.
- ✓ Lack of systematic conservation and documentation.
- ✓ Absence of morpho-phenological data
- ✓ Risk of genetic erosion



- **Reasons for selecting Avocado fruit tree species:**

- ✓ Agro-climatic Suitability
- ✓ High Yield and Export potential
- ✓ Nutrition and Health Benefits
- ✓ Varietal diversity ensures a 6-month availability period (July–December)
- ✓ Economic Viability and Sustainable Cultivation.



# 4. Brief evidence/field experience demonstrating the need of your proposed research and development initiatives.

## Morphological Diversity in Fruit Traits of Avocado Germplasm in Sikkim.



YMP-01



YMP-02



YMP-03



YMP-04



YMP-05



YMP-06



YMP-07



YMP-08



YMP-09



YMP-10



YMP-11



YMP-12



YMP-13



YMP-14



YMP-15



YMP-16



YMP-17



YMP-18



YMP-19



YMP-20



YMP-21

# Variability in Leaf, Seed and Tree Characteristics of Avocado Germplasm in Sikkim



# Avocado nursery at COH, Bermiok Sikkim



# Passport data of Avocado germplasms collected



COLLECTION NO	VERNACULAR NAME	STATUS	LAT	LONG	ALTITUDE	VILLAGE	DISTRICT
YMP-01	Famfal	Cultivated	27°13	88°17	1010m	Bermiok	Namchi
YMP-02	Famfal	Cultivated	27°15	88°29	1083m	Bermiok	Namchi
YMP-03	Famfal	Cultivated	27°25	88°48	933m	Bermiok	Namchi
YMP-04	Famfal	Cultivated	27°24	88°46	1032m	Bermiok	Namchi
YMP-05	Famfal	Cultivated	27°37	88°44	982m	Bermiok	Namchi
YMP-06	Famfal	Cultivated	27°13	88°28	1282m	Pabong	Namchi
YMP-07	Famfal	Cultivated	27°11	88°25	1117m	Passi	Namchi
YMP-08	Famfal	Cultivated	27°14	88°29	1235m	Pabong	Namchi
YMP-09	Famfal	Cultivated	27°28	88°45	1010m	Pabong	Namchi
YMP-10	Famfal	Cultivated	27°15	88°16	1083m	Daring	Namchi
YMP-11	Famfal	Cultivated	27°25	88°49	1033m	Daring	Namchi
YMP-12	Famfal	Cultivated	27°26	88°48	1332m	Upper Pabong	Namchi
YMP-13	Famfal	Cultivated	27°38	88°45	1382m	Upper Pabong	Namchi
YMP-14	Famfal	Cultivated	27°14	88°27	1382m	Passi	Namchi
YMP-15	Famfal	Cultivated	27°13	88°28	1117m	Thangsing	Namchi
YMP-16	Famfal	Cultivated	27°13	88°28	1235m	Passi	Namchi
YMP-17	Famfal	Cultivated	27°28	88°45	1010m	Upper Tokal	Namchi
YMP-18	Famfal	Cultivated	27°15	88°16	1083m	Bermiok	Namchi
YMP-19	Famfal	Cultivated	27°25	88°49	933m	Namphing	Namchi
YMP-20	Famfal	Cultivated	27°25	88°49	1032m	Tokal	Namchi
YMP-21	Famfal	Cultivated	27°26	88°48	982m	Tokal	Namchi

# Morphological Characterization of Avocado Based on IPGRI Descriptors



<b>COLLECTION NO</b>	<b>FRUIT SHAPE</b>	<b>FRUIT BASE SHAPE</b>	<b>FRUIT APEX SHAPE</b>	<b>FRUIT APEX POSITION</b>	<b>RIDGES ON FRUIT</b>	<b>PEDICEL SHAPE</b>	<b>NAIL HAIT PEDICEL SHAOE</b>
YMP-01	Rhomdoidal	Pointed	Pointed	Asymmetric	Absent	Cylindrical	Present
YMP-02	obovate	Inflated	Rounded	Central	Absent	Conical	Absent
YMP-03	Narrowly obovate	Depressed	Pointed	Asymmetric	Absent	Cylindrical	Absent
YMP-04	Narrowly obovate	Flattened	Rounded	Central	Present	Cylindrical	Absent
YMP-05	Narrowly obovate	Pointed	Rounded	Central	Partial	Cylindrical	Absent
YMP-06	Rhomboidal	Depressed	Rounded	Central	Present	Conical	Absent
YMP-07	Clavate	Pointed	Rounded	Central	Partial	Cylindrical	Absent
YMP-08	Ellipsoid	Inflated	Rounded	Central	Partial	Conical	Absent
YMP-09	Rhomboidal	Pointed	Rounded	Central	Absent	Conical	Absent
YMP-10	Pyriform	Pointed	Rounded	Asymmetrical	Present	Conical	Absent
YMP- 11	oblate	depressed	pointed	asymmetrical	partial	cylindrical	absent
YMP-12	pyriform	pointed	rounded	asymmetrical	entire	cylindrical	absent
YMP-13	oblate	inflated	rounded	Asymmetrical	partial	rounded	present
YMP-14	ellipsoid	flattened	rounded	central	partial	cyllindrical	absent
YMP-15	Clavate	pointed	pointed	central	partial	cylindrical	absent
YMP-16	Clavate	pointed	rounded	central	Absent	conical	present
YMP-17	rhomboidal	pointed	rounded	central	absent	conical	absent
YMP-18	pyriform	pointed	rounded	central	absent	rounded	absent
YMP-19	spheriod	inflated	rounded	central	absent	cylindrical	present
YMP-20	high spheroid	inflated	rounded	central	absent	conical	absent
YMP-21	obovate	pointed	rounded	central	absent	cylindrical	present

# Qualitative traits of different Avocado germplasms



COLLECTION NO	PEDICEL COLOUR	FRUIT SKIN SURFACE	FRUIT SKIN COLOUR	COLOUR OF THE FLESH	FLESH TEXTURE	SWEETNESS OF FLESH	BITTERNESS OF FLESH	FIBRE IN FLESH	TASTE GENERAL
YMP-01	Yellow	Smooth	Light green	Yellow	Intermediate	No	No	Low	Good
YMP-02	Yellow	Smooth	Green	Ivory	Intermediate	No	No	Low	Good
YMP-03	Green	Smooth	Dark green	Yellowish green	Intermediate	No	No	Low	Good
YMP-04	Green	Rough	Green	Green	Intermediate	No	No	Low	Good
YMP-05	Yellow	Smooth	Purple	Yellowish green	Intermediate	No	No	Low	Good
YMP-06	Yellow	Rough	Green	Ivory	Buttery	No	No	Low	Good
YMP-07	Green	Smooth	Dark green	Yellowish green	Intermediate	No	No	Low	Good
YMP-08	Green	Rough	Dark green	Cream	Buttery	No	No	Low	Good
YMP-09	Green	Smooth	Green	Ivory	Buttery	No	No	Low	Good
YMP-10	Green	Rough	green	Ivory	Buttery	No	No	Low	Good
YMP- 11	yellow	smooth	red	Yellow	Watery	No	No	Low	Poor
YMP-12	yellow	rough	dark green	Greenish yellow	Buttery	No	No	Low	Good
YMP-13	green	smooth	dark green	Ivory	Buttery	No	No	Low	Good
YMP-14	green	smooth	light green	Yellow	Buttery	No	No	Low	Good
YMP-15	green	rough	dark green	Ivory	Buttery	No	No	Low	Good
YMP-16	yellow	smooth	orange red	light yellow	Buttery	No	No	Low	Good
YMP-17	green	smooth	green	Green	Buttery	No	No	Low	Good
YMP-18	green	smooth	green	Yellow	Buttery	No	No	Low	Good
YMP-19	green	smooth	dark green	yellowish	Buttery	No	No	intermediate	Good
YMP-20	green	smooth	dark green	Yellow	Intermediate	No	No	Low	Good
YMP-21	green	smooth	orange red	light green	Watery	No	No	intermediate	Good

# Quantative traits of different Avocado germplasms



COLLECTION NO	Fruit Weight (g)	Length (mm)	Width (mm)	FRUIT PEEL THICKNESS (mm)	Peel Weight (g)	Seed Wt (g)	Pulp Weight	Fruit Volume (MI)
YMP-01	176	91	62.8	0.2	20	73	83	202
YMP-02	121	84	52.8	0.5	23	34	64	141
YMP-03	120	70	56	0.1	22	45	53	142
YMP-04	139	88	54	1.	20	29	90	174
YMP-05	142	84	55	0.2	21	40	81	170
YMP-06	225	110	65.5	0.1	35	53	137	232
YMP-07	162	121	57	0.1	26	30	106	174
YMP-08	129	79.8	56	0.15	19	29	81	132
YMP-09	154	86	60	0.1	23	34	97	146
YMP-10	182	89	63	0.2	24	30	128	214
YMP- 11	122	68	60.36	0.1	24	31	67	146
YMP-12	180	92	65	0.2	24	29	127	199
YMP-13	208	79	73	0.1	26	29	153	210
YMP-14	131	78	56	0.5	25	25	81	130
YMP-15	170	118	57	0.1	27	28	115	184
YMP-16	275	125	71	0.1	45	51	179	273
YMP-17	225	109	70	0.1	43	85	97	224
YMP-18	146	120	54	1.0	24	37	85	191
YMP-19	136	61	62	1.0	23	58	55	137
YMP-20	338	98	82	1.0	46	66	226	231
YMP-21	141	80	61	0.11	26	44	<b>71</b>	165

## 2. Project Objectives:

1. Collection and Morpho-phenological characterization of germplasms using IPGRI descriptors.
2. Identification of elite accessions for staggered harvesting (July–December).
3. Mass multiplication and distribution to the farmers.
4. Establishment of Decentralized field gene bank/orchard.

### 3. Methodology and implementation approach(1):



#### Year 1 – Exploration & Characterization

- ✓ Systematic surveys and germplasm collection will be carried out across all six districts of Sikkim (Namchi, Mangan, Gyalshing, Gangtok, Pakyong, and Soreng).
- ✓ Passport data, GPS coordinates, and farmer information will be recorded and digitized.
- ✓ Morpho-phenological characterization of all accessions will be conducted using standard IPGRI descriptors.
- ✓ Variability assessments will be performed using ANOVA, PCA, and cluster analysis.
- ✓ Elite, unique, and climate-resilient accessions will be identified for further multiplication.

## 4. Methodology and implementation approach(2):

### Year 2 - Mass Multiplication & Stakeholder Engagement

- ✓ Mass multiplication of shortlisted elite accessions through grafting on suitable rootstocks will be initiated in the College of Horticulture, Bermiok nursery.
- ✓ Meetings with FPOs, SHGs, progressive farmers, and Line Departments will be conducted to strengthen stakeholder participation.
- ✓ Farmers and community groups with suitable fallow land for accession-wise orchards will be identified, with priority given to SC/ST groups, rural youth, and SHGs/FPOs for community orchards.
- ✓ Site-specific orchard establishment plans (layout, spacing, pit preparation, soil amendments) will be prepared for each selected location.

## 5. Methodology and implementation approach(3):

### Year 3 – Orchard Establishment & Field Gene Bank Formation

- ✓ Accession-wise field gene banks and community orchards will be established at selected farmer fields.
- ✓ A target of 100–500 plants per accession will be planted.
- ✓ Planting activities will be coordinated with MGNREGA and Line Departments.
- ✓ Grafted plants will be distributed for block-wise orchard development.
- ✓ Field performance (survival) will be monitored and recorded.
- ✓ District-specific avocado development recommendations will be formulated.

# 6. Social and nutrition impact pathway – Project outcomes/Impact:



- ✓ Genetic Wealth to Community Wealth
- ✓ Improved Nutrition and livelihood Security
- ✓ Productive Use of Underutilized Land
- ✓ Support for Future Crop Improvement
- ✓ Farmer Empowerment and Capacity Building



# Slide 7. Environmental and climate advantages



- a) Efficient use of fallow land:** Converting unused lands into avocado orchards and decentralized field gene banks will restore soil fertility and reduce land degradation.
- b) Enhanced on-farm biodiversity:** Conserving multiple avocado accessions increases genetic diversity, ecological stability, and resilience within farming systems.
- c) Improved water-use efficiency:** Locally adapted and climate-resilient accessions will require fewer inputs and perform better under limited irrigation.
- d) Greater climate resilience:** Stress-tolerant accessions identified through characterization will support drought and heat resilience in future plantations.
- e) Long-term ecological benefits:** Expanding perennial fruit cultivation increases tree cover, improves microclimate, and strengthens carbon sequestration.

## 8. Scaling, sustainability and cost efficiency:

- ✓ Individual farmers will serve as long-term custodians of gene bank, ensuring continuity, income enhancement, and improved household nutrition.
- ✓ Community structures (SHGs/FPOs/Youth Clubs) will support collective orchard maintenance, monitoring, and scaling beyond the project duration.
- ✓ The accession-wise orchard model will be readily replicable across neighboring villages through standardized propagation protocols and trained local grafters.
- ✓ Cost efficiency will be achieved through convergence with MGNREGS (planting labour), MIDH (inputs), and FPO support (aggregation and marketing).
- ✓ Local contributions of land and labour will strengthen ownership and reduce operational costs.
- ✓ Continuous mass multiplication at COH will ensure an affordable and sustainable supply of high-quality planting material for future expansion.

# 9. Budget summary:



Budget Head	Year 1 (₹ lakh)	Year 2 (₹ lakh)	Year 3 (₹ lakh)	Total (₹ lakh)
<b>MANPOWER</b>				
<b>Project Associate–I</b> (₹31,000 + 10% HRA in Yr 1 & 2; ₹35,000 + 10% HRA in Yr 3)	4.09	4.09	4.62	<b>12.80</b>
<b>Skilled/Semi-skilled Field Workers</b> (2 persons @ ₹20,000/month)	4.80	4.80	4.80	<b>14.40</b>
<b>GENERAL HEADS</b>				
Consumables	1.00	1.00	1.00	<b>3.00</b>
Travel	1.50	1.50	1.50	<b>4.50</b>
Contingency	1.00	1.00	1.00	<b>3.00</b>
Overheads	0.50	0.50	0.50	<b>1.50</b>
Other Heads	1.50	1.50	1.50	<b>4.50</b>
<b>GRAND TOTAL</b>				<b>43.70</b>
<b>FORTY THREE LAKHS SEVENTY THOUSAND ONLY</b>				

# 10. Risk and mitigation strategy:



Sl. No.	Key Risk	Mitigation Strategy
1	Difficulty in accessing remote germplasm sites	Plan field visits season-wise; coordinate with local farmers, Panchayats, and line departments to ease access.
2	Low survival of collected germplasm in field gene banks/farmers' fields	Use healthy planting material, follow proper hardening, adopt irrigation, mulching, and organic nutrient support.
3	Limited farmer participation in decentralized gene bank establishment	Conduct awareness meetings, provide training, and supply quality planting material as an incentive.
4	Pest/disease incidence affecting germplasm survival	Regular monitoring and integrated pest management (IPM) practices.
5	Climate-related stresses (excess rainfall/drought)	Diversify planting sites, promote moisture conservation and climate-resilient accessions.



**Thanks**