NEW VISTAS IN CASHEW BREEDING

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Eat cashew without fear of cholesterol !!

- Delicious snack food. Free from cholesterol. Fat rich in unsaturated fatty acid - helps in reducing the blood cholesterol.
- Proteins (21%), carbohydrates (22%), fat (47%), minerals and vitamins. All the essential amino acids
- The cashew apple - sugars, amino acids, tannin, ascorbic acid (Vitamin C) and crude fibre. Very rich in ascorbic acid (240 mg/100g). Phenols, tannin and flavonols present could serve as natural antioxidants.

ICAR -Directorate of cashew Research, Puttur, Karnataka, India

Mandate

- To conduct mission oriented research for improving productivity and quality with special reference to export.
- To serve as National repository for cashew germplasm and a clearing house for research information on cashew.
- To act as a centre for training on research methodologies and technology updating of cashew and to coordinate national research projects.
- To provide consultancy on CPT.
- To generate quality planting material.
- To collaborate with national and international agencies.

About Cashew

- Brazil is the native of cashew.
- Introduced into India during 16th century.
- India made cashew a commodity of International trade and acclaim.
- Cultivated in east coast, west coast regions and also to some extent in plains region and NEH region.
- Export earnings by export of cashew kernels: Rs. 2906 Crores (2009-10), Rs. 2598 Crores (2010-11) and Rs. 4390 Crores (2011-12) and 4067 crores (2012-13) .

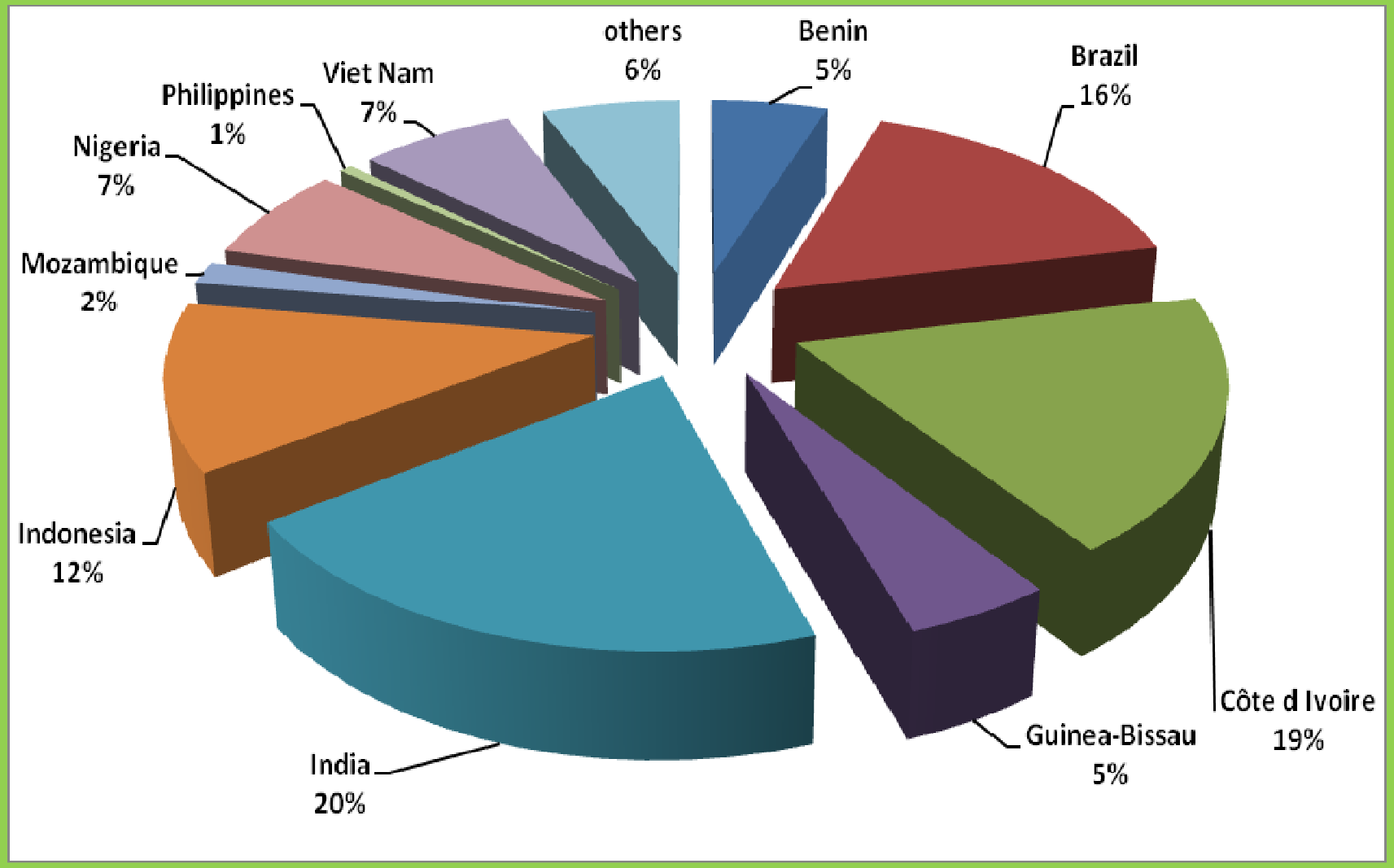
About Cashew (contd.)

- **Processing capacity in India : 13-14 lakh tonnes.**
- **Import of RCN : 6-7 lakh tonnes.**
- **India exports over 1.0 lakh cashew kernels to over 65 countries of the world.**
- **The major countries that import Indian cashew are United States of America, Netherlands, United Kingdom, United Arab Emirates, Japan, France, Saudi Arabia, Spain, Russia, Germany, Canada and Greece.**

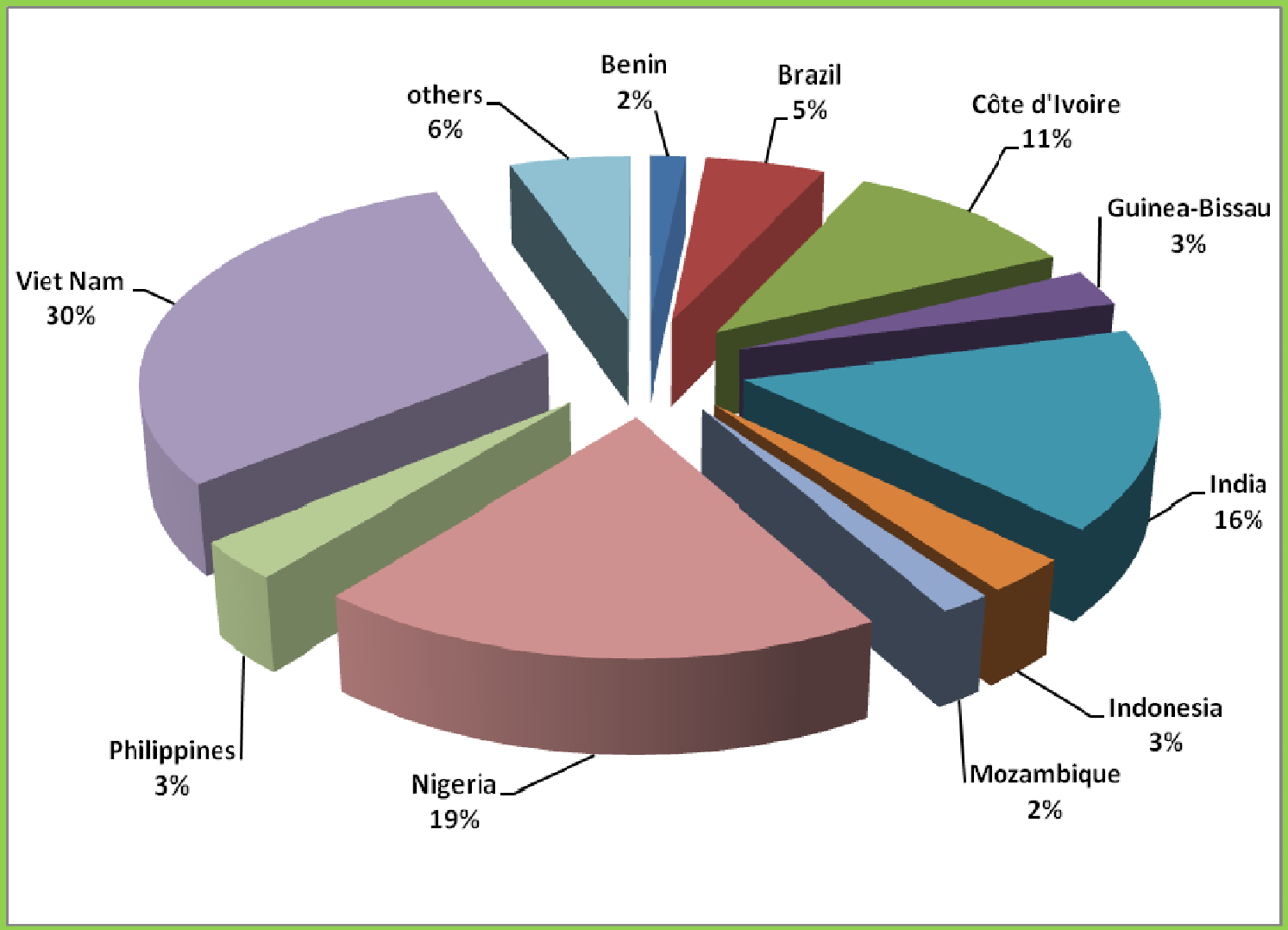
Journey of Cashew Research

- **Research on cashew was first initiated in the early 1950s.**
- **In 1971, ICAR also sanctioned All India Coordinated Spices and Cashew Improvement Project (AICS and CIP) with its Headquarters located at CPCRI, Kasaragod, India**
- **NRCC- Established in 1986**
- **National Research Centre was upgraded and renamed by ICAR in 2009 under XI Plan as Directorate of Cashew Research (DCR).**

Per cent distribution of cashew area in different countries



Per cent distribution of cashew production in different countries

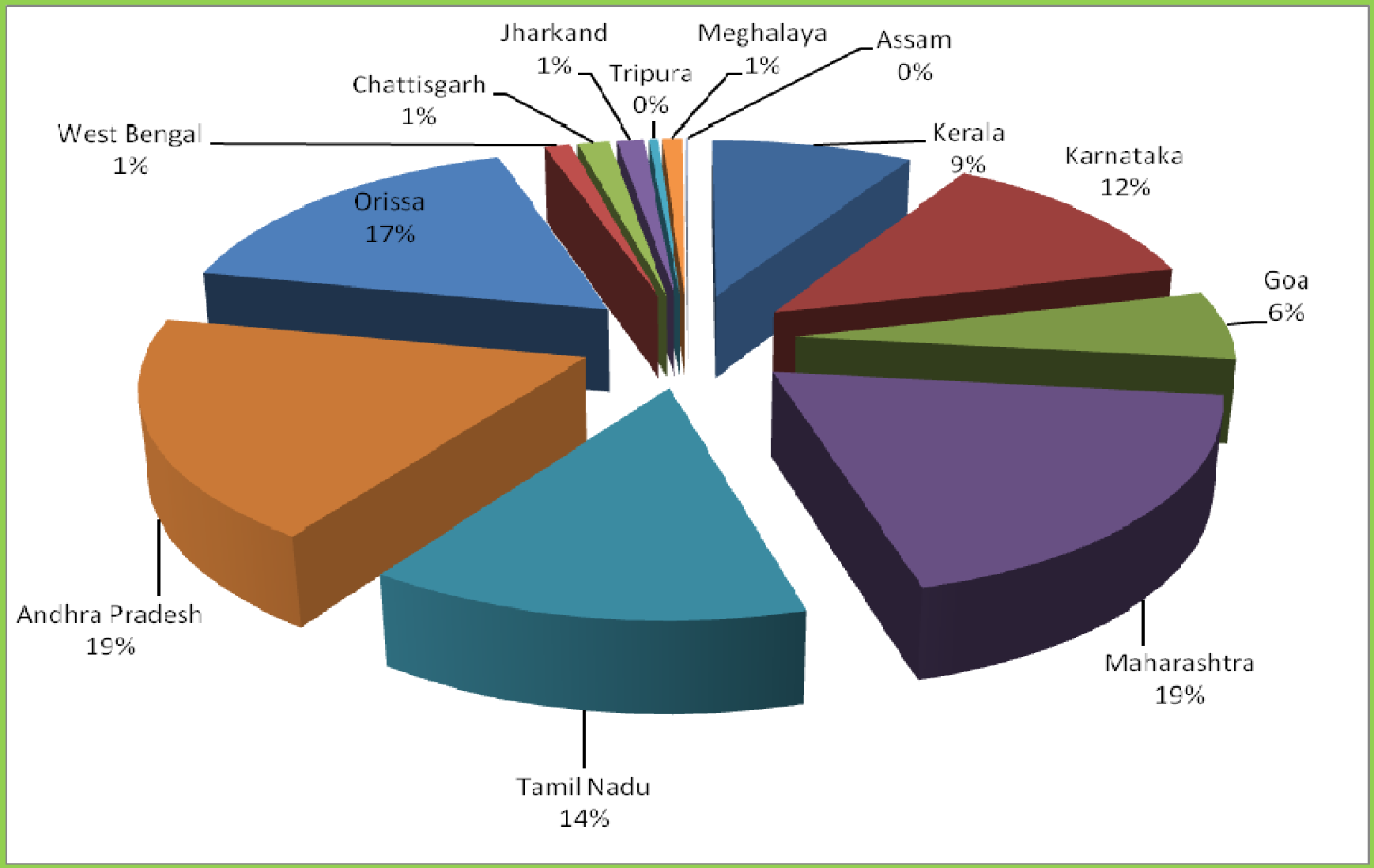


Cashew statistics in India during 2012-13

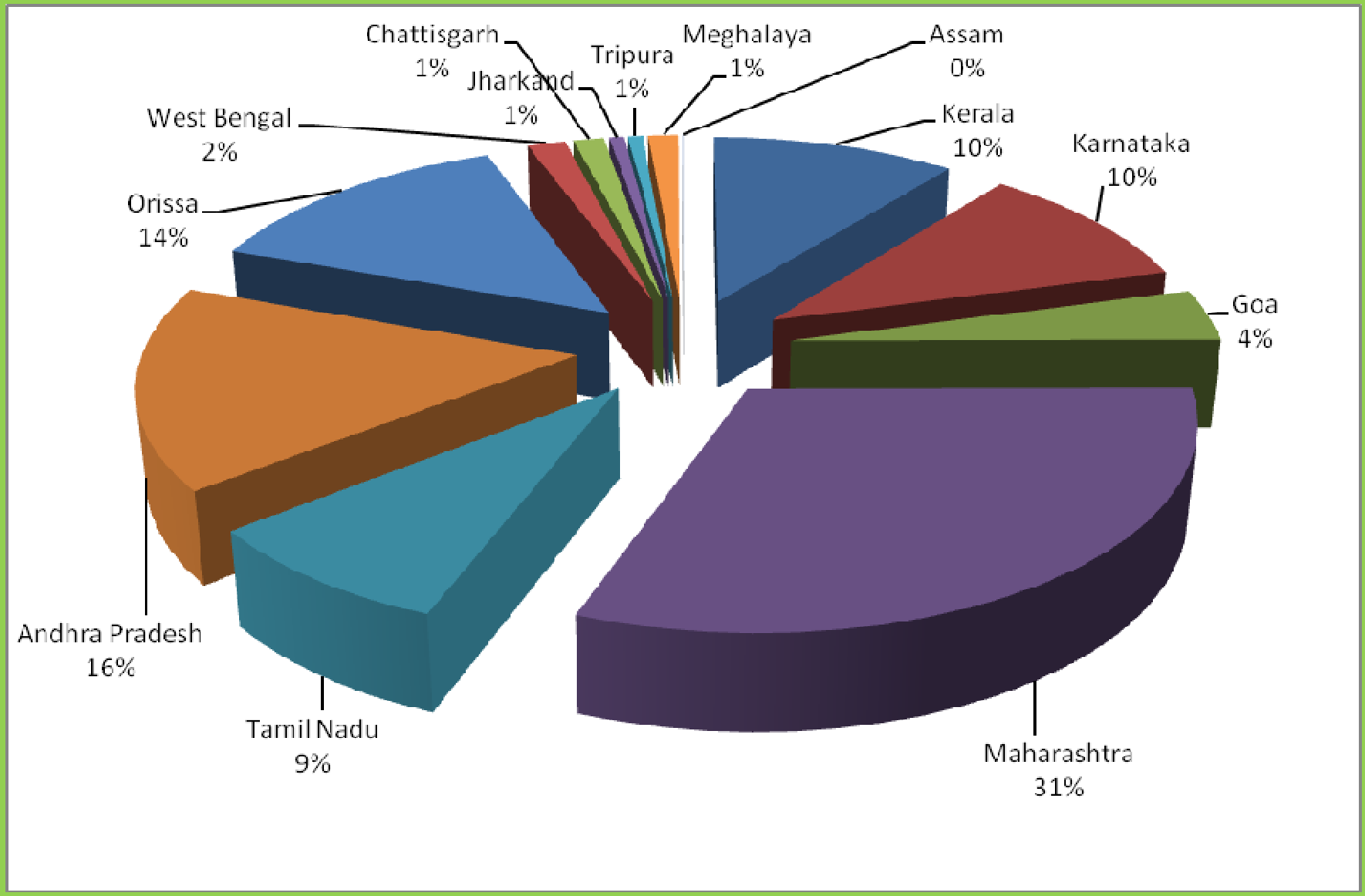
State	Area (000 ha)	Production (000 MT)	Productivity (kg/ha)
Kerala	84.88	76.96	898
Karnataka	121.88	68.64	588
Goa	57.47	29.95	540
Maharashtra	184.20	224.64	1040
Tamil Nadu	136.42	62.40	469
Andhra Pradesh	183.95	118.14	646
Odisha	163.91	99.84	679
West Bengal	11.00	12.06	1096
Chhattisgarh	13.50	15.60	1560
Jharkhand	11.50	4.64	336
Tripura	4.10	5.72	1427
Meghalaya	8.50	9.36	1001
Assam	0.90	0.52	505
TOTAL	982.21	728.47	772

Source : DCCD, Kochi

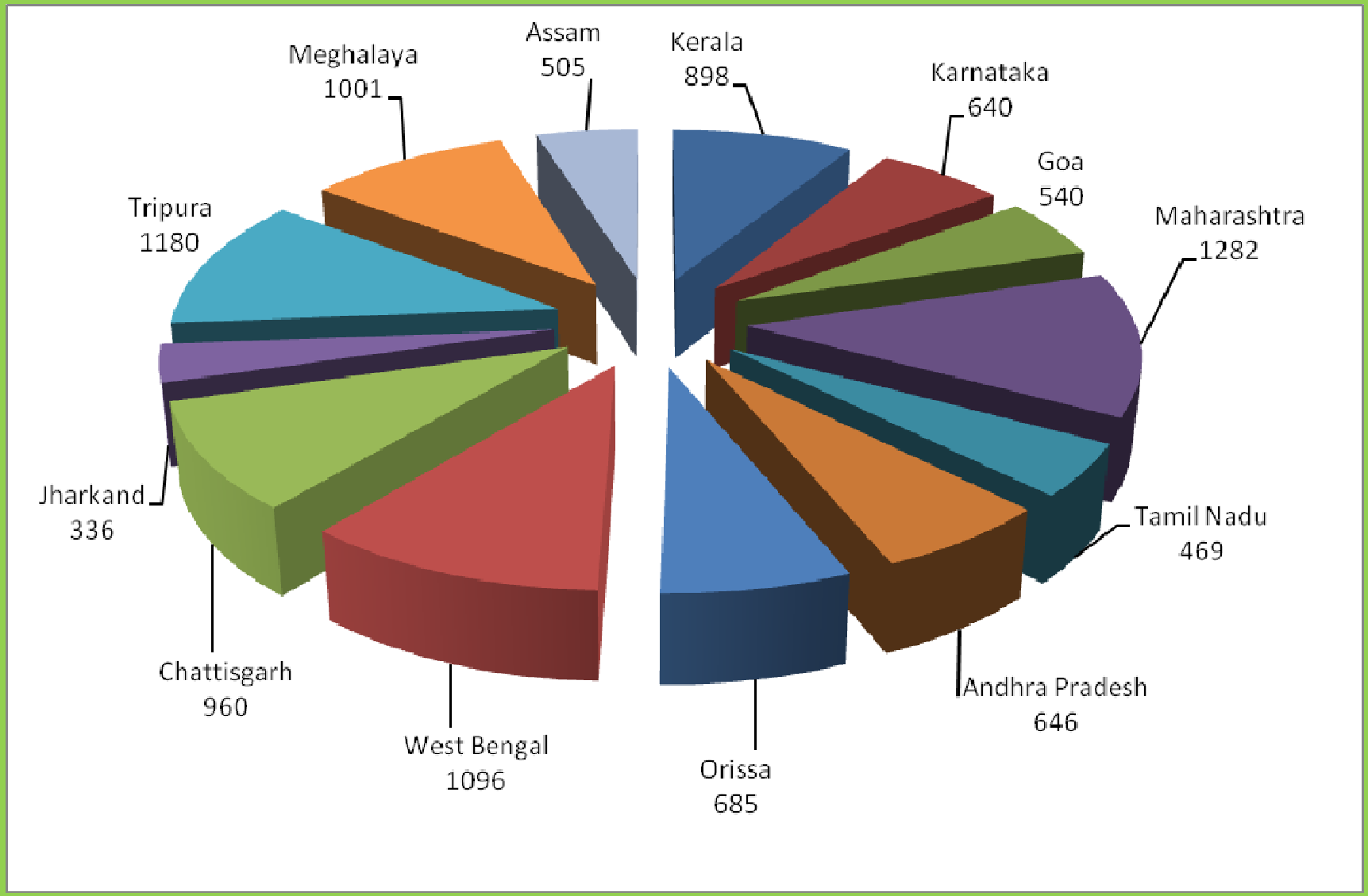
Per cent distribution of cashew area in different states (2012-13)



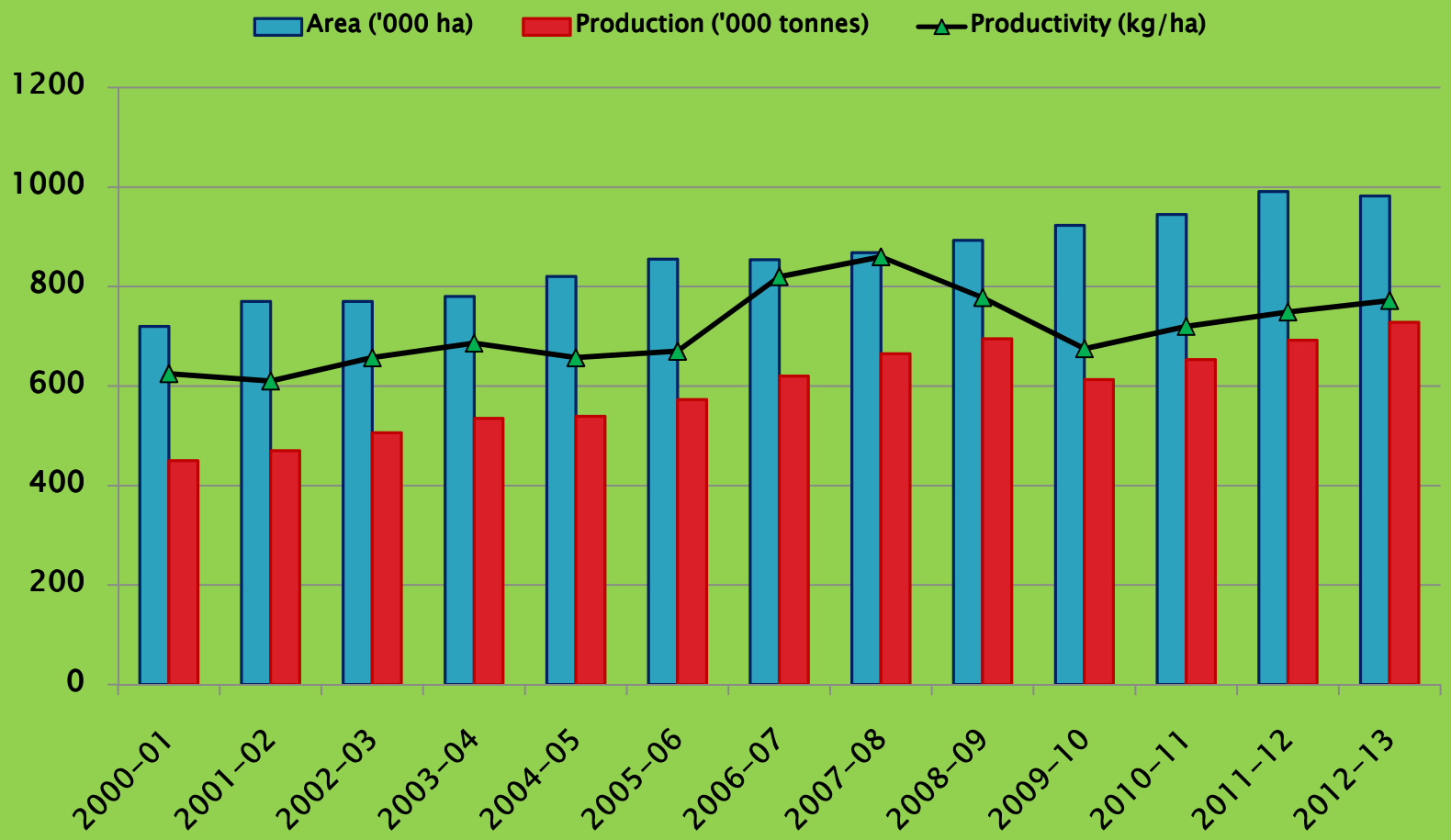
Per cent distribution of cashew production in different states during 2012-13



Productivity of cashew (kg/ha) in different states in India (2012-13)



Trend in Area, Production and Productivity of Cashew



Cashew varieties released in India

Centre	No. of varieties released	Variety
East Coast		
Bapatla	7	BPP-1 to BPP-6 and BPP-8
Vridhachalam	4	VRI-1, VRI-2, VRI-3 and VRI (Cw) 5
Bhubaneswar	1	Bhubaneswar-1
Jhargram	2	Jhargram-1, Jhargram-2
West Coast		
Vengurla	7	Vengurla-1 to Vengurla-7
Goa	2	Goa-1 and Goa-2
Madakkathara	8	Anakkayam-1, Madak-1 (BLA-39-4), Madak-2 (NDR-2-1), K-22-1, Kanaka, Dhana, Priyanka and Amrutha
Ullal	5	Ullal-1, Ullal-2, Ullal-3, Ullal-4, UN-50
DCR Puttur	3	NRCC Selection-1, NRCC Selection-2 and Bhaskara
Chattisgarh	1	Indira Kaju
Chintamani	2	Chintamani-1 and Chintamani-2
Total	42	

Bhaskara

Madakkatara-2

Vengurla-4

Kanaka

Ullal-3

Varieties developed by DCR, Puttur

Parameters		NRCC Selection-1	NRCC Selection-2	Bhaskara
Year of release		1998	1998	2006
Yield (t/ha)	:	1.5	1.5	1.6
Nut size	:	Medium (7.6 g)	Medium to bold (9.2 g)	Medium (7.4 g)
Cashew apple	:	Big (70-80 g)	Medium (50-60 g)	Medium (50-60 g)
Season of flowering	:	Mid – Late season	Early season	Mid season
Shelling %	:	High (28.8%)	High (28.6%)	High (30.6%)
Kernel protein (%)	:	24.20	25.60	29.91
Kernel weight (g)	:	2.20 g	2.63 g	2.2 g
Kernel grade		W-210	W-210	W-240

Varieties developed by DCR, Puttur

NRCC Sel-1

Varieties developed by DCR, Puttur

NRCC Sel-2

Varieties developed by DCR, Puttur

Bhaskara

Cashew germplasm in India

State	At NCFGB	At AICRP centers	Total
Andaman & Nicobar Islands	10	--	10
Andhra Pradesh	103	48	151
Arunachal Pradesh	2	--	2
Assam	3	--	3
Chattisgarh	1	61	62
Goa	45	--	45
Karnataka	128	128	256
Kerala	72	181	253
Maharashtra	45	297	342
Manipur	1	--	1
Meghalaya	11	--	11
Mizoram	1	--	1
Orissa	21	97	118
Tamil Nadu	46	200	246
Tripura	3	--	3
West Bengal	14	92	106
Exotic	22	--	22
Total	528	1104	1632

Variability in Cashew Apple

Reasons for low productivity in cashew

Old and senile plantations
Non descript genotypes
Marginal lands
Priority for cashew
Fluctuating market prices

Breeding Objectives

High yield
Dwarf and semi compact types
Short flowering duration
High sex ratio
Bold/Medium nut size
High shelling percentage
Resistance to TMB and CSRB
Cashew apple
CNSL content

Current Cashew Breeding Strategies

- Development of dwarf and semi-compact hybrids for high density planting system
- Development of hybrids with high yield and bold/medium nut size
- Introgression of characters from wild species for pest resistance breeding
- Marker Assisted Selection for economic traits
- Breeding for cashew apple

High Density Planting in Cashew

High Density Planting

- Closer planting at 4m x 4m (625 plants/ha) or 5m x 4m (500 plants/ha) or 5m x 5m (400 plants/ha) increases yield 2-3 fold that normal spacing 8m x 8m (156 plants/ha).
- Regular pruning every year/ thinning tree population after 11 years is required .
- This method is more suitable for soils with low fertility.

Development of dwarf and compact hybrids

1. A total of 253 hybrids obtained from crossing NRCC Sel-2, Bhaskara and Ullal-3 as female parents and Taliparamba-1, Brazil dwarf and Kodippady-2 as male parents are under evaluation.

2. Some of the hybrids are showing the signs of reduced vigour , semi compact canopy and precocious bearing.

Brazil dwarf (NRC-492)

Taliparamba

Kodippady

A hybrid plant; Cross combination Bhaskara x brazil Dwarf

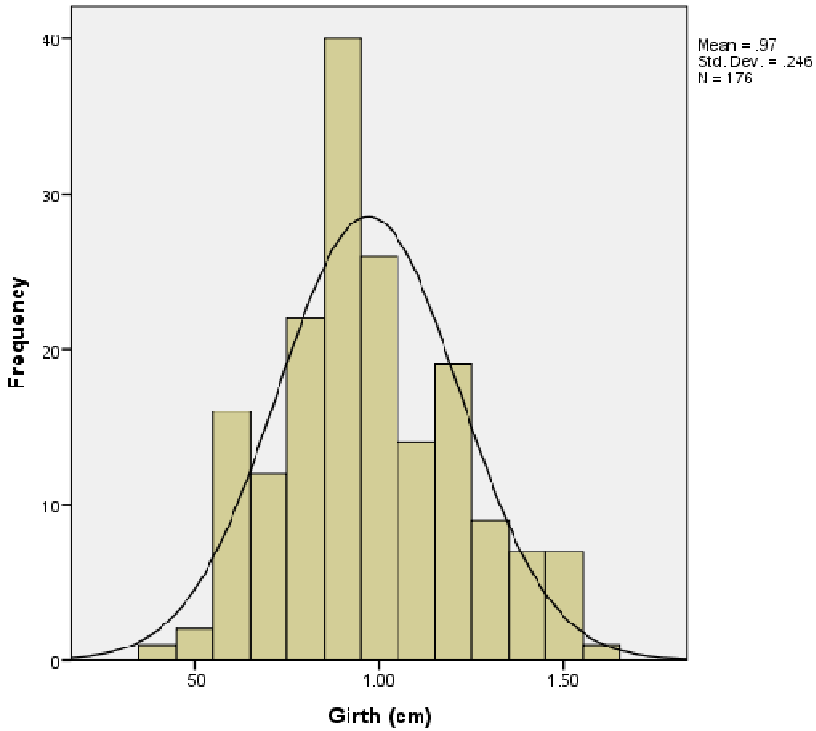
Hybridization 2013-14

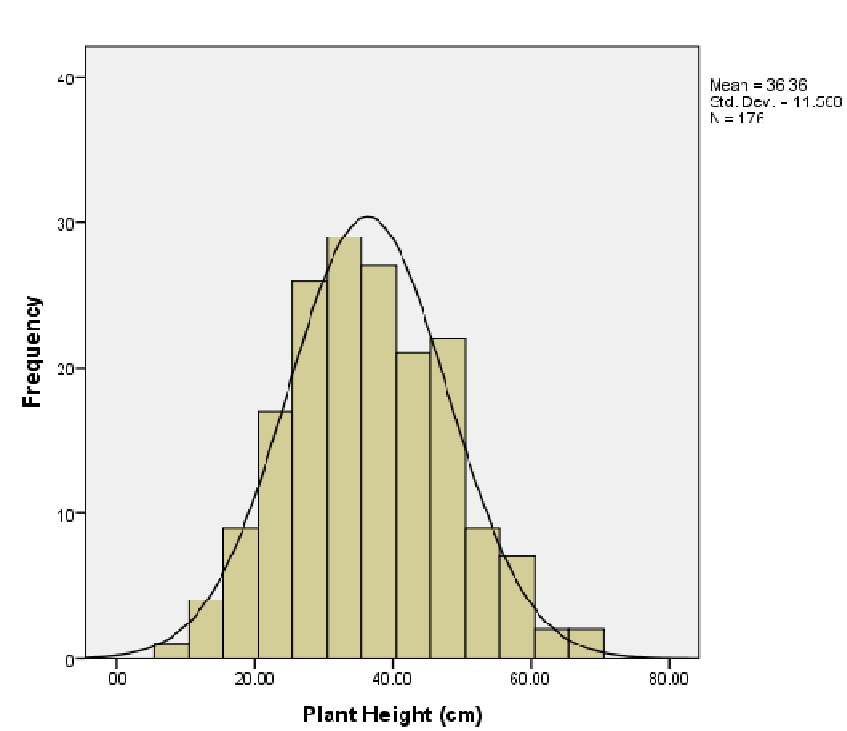
S.No.	Cross			No. of nuts sown	No. of seedlings germinated	No. of seedlings planted	% Germination	% Mortality (Numbers)
1	Vengurle-4	x	NRC-492	204	177	177	86.76	2.26 (4)
2	Vengurle-4	x	Taliparamba-1	150	134	134	89.33	1.49 (2)
3	Priyanka	x	NRC-492	90	70	70	77.78	2.86 (2)
4	Priyanka	x	Taliparamba-1	22	10	10	45.45	0
5	Dhana	x	NRC-492	62	61	61	98.39	0
6	Dhana	x	Taliparamba-1	78	75	75	96.15	0
7	Madakkathara-2	x	NRC-492	170	151	150	88.82	0.67 (1)
8	Madakkathara-2	x	Taliparamba-1	129	62	62	48.06	0
9	NRC-492	x	Vengurle-4	16	10	10	62.50	0
10	Taliparamba-1	x	Vengurle-4	7	7	7	100.00	0
11	NRC-492	x	Priyanka	30	13	13	43.33	0
12	Taliparamba-1	x	Priyanka	11	8	8	72.73	0
13	NRC-492	x	Dhana	16	12	12	75.00	0
14	Taliparamba-1	x	Dhana	8	4	4	50.00	0
15	NRC-492	x	Madakkathara-2	15	10	10	66.67	0
16	Taliparamba-1	x	Madakkathara-2	2	0	0	0	0
			Total	1010	804	803		
						Range	0-100	0-2.86
						Mean	68.81	0.36
						SE	6.65	0.18
						CV	38.69	195.8

Variability for seedling parameters in direct and reciprocal crosses observed at 80 days

S.No	Cross	Girth (cm)				Plant height (cm)			
		Range	M	SE	CV	Range	M	SE	CV
1	Vengurle-4 x NRC-492	0.3-1.1	0.77	0.01	20.1	9.0-37.0	24.72	0.40	21.4
2	Vengurle-4 x Taliparamba-1	0.4-0.9	0.68	0.01	17.1	14.0-38.5	27.75	0.45	18.1
3	Priyanka x NRC-492	0.4-1.1	0.86	0.01	13.9	11.0-52.0	39.24	0.85	18.8
4	Priyanka x Taliparamba-1	0.4-1.1	0.77	0.08	32.4	15.0-40.0	29.15	2.38	25.8
5	Dhana x NRC-492	0.5-1.0	0.74	0.04	15.3	23.5-39.5	32.11	0.45	11.0
6	Dhana xTaliparamba-1	0.5-1.0	0.74	0.13	15.7	17.0-43.0	31.74	0.57	15.6
7	Madakkathara-2 x NRC-492	0.2-1.1	0.70	0.01	24.8	8.5-38	25.80	0.48	22.8
8	Madakkathara-2 x Taliparamba-1	0.3-1.0	0.73	0.02	18.7	9.0-37.5	27.09	0.80	23.3
9	NRC-492 x Vengurle-4	0.4-0.8	0.62	0.04	21.2	13.0-33.0	25.70	1.70	20.9
10	Taliparamba-1 x Vengurle-4	0.6-1.0	0.76	0.06	19.9	21.0-31.0	27.71	1.30	12.4
11	NRC-492 x Priyanka	0.5-0.8	0.59	0.03	16.2	21.5-33.0	26.77	0.92	12.4
12	Taliparamba-1 x Priyanka	0.7-0.9	0.77	0.04	13.4	28.0-43.5	33.50	2.07	17.5
13	NRC-492 x Dhana	0.5-0.8	0.61	0.03	16.3	14.0-37.0	26.67	1.71	22.2
14	Taliparamba-1 x Dhana	0.7-0.9	0.75	0.05	13.3	20.0-30.0	24.25	2.17	17.9
15	NRC-492 x Madakkathara-2	0.4-0.8	0.63	0.05	23.7	10.5-29.0	21.65	2.46	36.0

Vengurle-4 x NRC-492





Skewness:0.33, appx.sym
Kurtosis: -0.30, platykurtic

Skewness:0.23, appx.sym
Kurtosis: -0.30, platykurtic

Hybrid seedlings planted in the field at Shantigodu

Hybrid seedlings

Characteristics of promising hybrids

Hybrid	Cross combination	Annual yield in 7th harvest(kg/tree)	Cumulative yield for 7 harvests(kg/tree)	Av. Yield of seven harvests (kg/tree)	Mean nut weight (g)	Mean kernel weight (g)	Shelling (%)
H-43	NRCC Sel-2 x Bhuthnath-II	5.20	35.33	5.04	12.33	3.33	27.00
H-66	NRCC Sel-2 x Bhuthnath-II	6.25	34.61	4.94	10.30	2.90	28.15
H-68	NRCC Sel-2 x Bhuthnath-II	6.55	35.55	5.07	11.42	3.28	28.75
H-125	NRCC Sel-2 x Bhedasi	5.95	37.60	5.37	12.75	3.40	26.66
H-126	NRCC Sel-2 x Bhedasi	5.70	34.39	4.91	10.83	3.33	30.76
NRCC Sel-2 (check)	-	1.78	23.17	3.31	9.2	2.63	28.60
Bhuthnath-II(parent)	-	-	6.1(over six harvests)	1.02	9.2	2.80	30.43
Bhedasi (parent)	-	-	5.21(over six harvests)	0.87	10.00	3.0	30.00

Apple characteristics of promising hybrids

Sl. No	Tree No.	Apple colour	Apple weight(g)	TSS (Brix)	Juice (%)
1.	43	Orange Red (33B)	100	13.00	81
2.	66	Orange Red (33B)	110	13.00	80
3.	68	Orange Red (33B)	108	12.50	70
4.	125	Orange Red (33B)	105	14.00	70
5.	126	Orange Red (33B)	102	13.00	72
6.	NRCC Sel-2(check)	Orange Red (33B)	95	14.00	60
7.	Bhuthnath-2(parent)	Yellow Orange(23A)	55	12.00	65
8.	Bhedasi(parent)	Yellow(13A)	90	13.00	75

PROMISING HYBRIDS UNDER EVALUATION

Cross combinations of NRCC Selection-2, Bhuthnath and Bhedasi

H-66

H-68

H-125

H-126

H-68

H-125

Sel-2

Bhaskara

Promising germplasm under evaluation

Hybridization with wild species

Sl.No.	Female parent	Male parent
1.	Ullal-1	*A. microcarpum*
2.	Ullal-3	*A. microcarpum*
3.	V-4	*A. microcarpum*
4.	Bhaskara	*A. microcarpum*
5.	Ullal-1	*A. othonianum*
6.	*A. microcarpum*	Bhaskara
7.	*A.microcarpum*	V-4
8.	*A.microcarpum*	Ullal-3

Wild / Weedy Species

Jungly caju (Semecarpus pranaui)

Fruit bunch of jungly caju

Seedling Selection in Cashew

- Cross pollinated crop- offers ample scope for exploring diversity among seedling progenies.
- An attempt - identify ideal plant from seedling progenies of popular cultivars.
- Seedling progenies of NRCC Sel-2, Vengurla-4, VRI-3, Bhaskara, VTH-174, and VTH-30/4.
- Some of the progenies - precocity , boldnut and higher yield. (VTH-30/4- 6.9 kg)

Variability for growth parameters and yield in seedling progenies of varieties (16 seedlings /variety)

Trait	Statistic	NRCC Sel-2	Vengurle-4	VRI-3	Bhaskara	VTH-174	VTH-30/4
Height (m)	Range	3.25-6.45	4.00-7.45	3.50-7.10	3.75-8.90	5.10-7.25	4.10-7.25
	Mean	4.80	5.21	4.76	5.80	6.05	5.43
	SEm ±	0.21	0.30	0.21	0.39	0.15	0.24
	CV %	17.71	23.03	17.44	26.72	10.25	18.05
Tree spread (m)	Range	3.50-7.62	3.25-9.72	3.22-7.80	3.87-8.95	4.62-8.9	3.62-9.25
	Mean	5.04	5.89	5.33	5.81	6.67	6.23
	SEm ±	0.26	0.41	0.25	0.33	0.26	0.37
	CV %	20.83	27.84	18.57	23.06	15.44	23.43
Yield (kg)	Range	1.45-2.54	1.20-2.98	0.94-4.41	0.56-3.38	0.50-3.05	1.02-6.90
	Mean	1.85	1.82	2.46	1.95	1.75	2.04
	SEm ±	0.08	0.12	0.21	0.11	0.13	0.34
	CV %	17.84	25.27	34.15	23.08	29.14	66.18

Tree-480(VTH30/4)-
6.9 kg yield

Backcross breeding

Material	Details
Hybrid (F1)	Ullal- 3 x Brazil Dwarf Bhaskara x Brazil Dwarf
Backcrosses (2)	(Ullal- 3 x Brazil Dwarf) x Ullal-3 (Bhaskara x Brazil Dwarf) x Bhaskara

Back crossed hybrid seedlings in nursery

SOWING

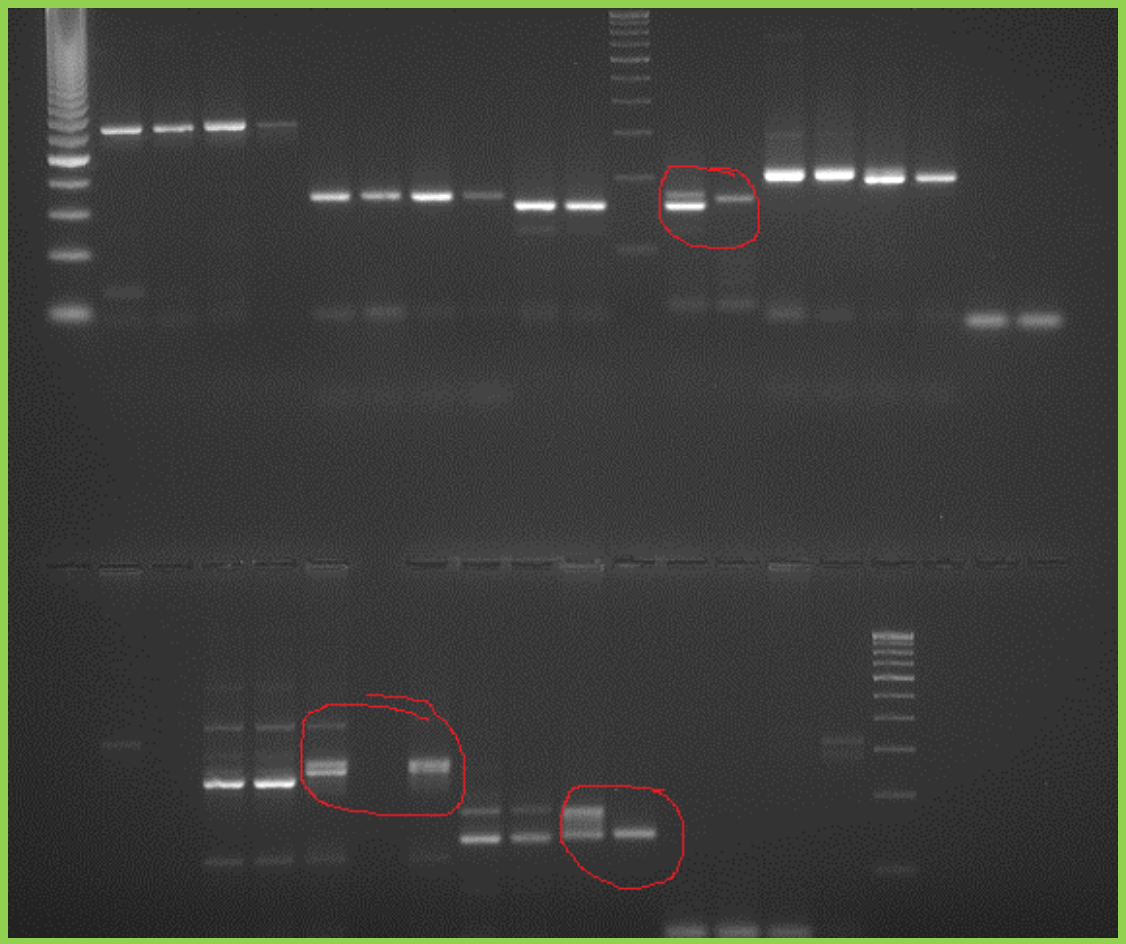
1.5 MONTHS OLD

3 MONTHS OLD

Backcross breeding

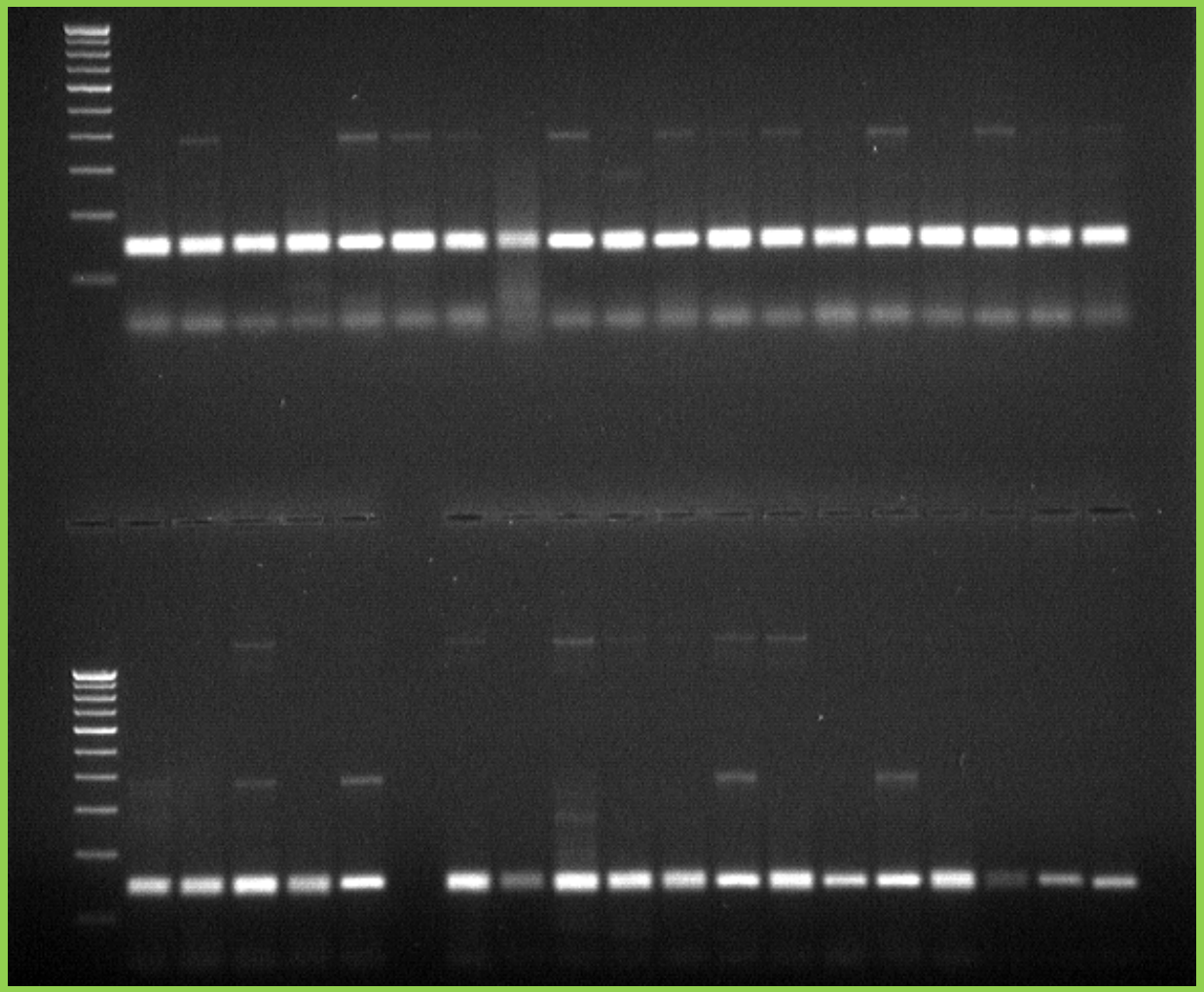
Material	Details
Hybrid (F1)	Ullal- 3 x Brazil Dwarf Bhaskara x Brazil Dwarf
Backcrosses (2)	(Ullal- 3 x Brazil Dwarf) x Ullal-3 (Bhaskara x Brazil Dwarf) x Bhaskara

Marker Assisted Selection for Economic Traits

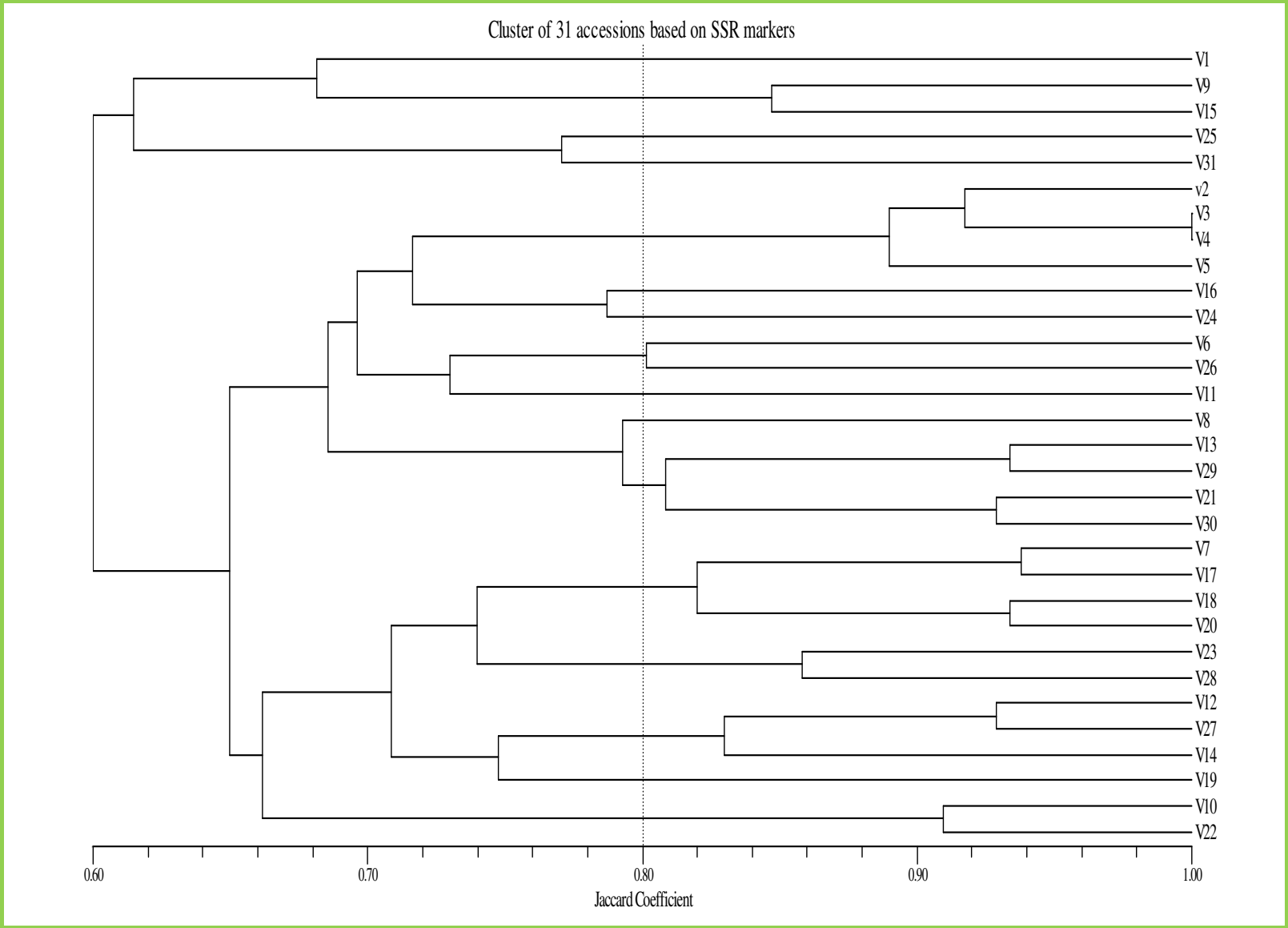


SSR polymorphism in parents (SSR-8)

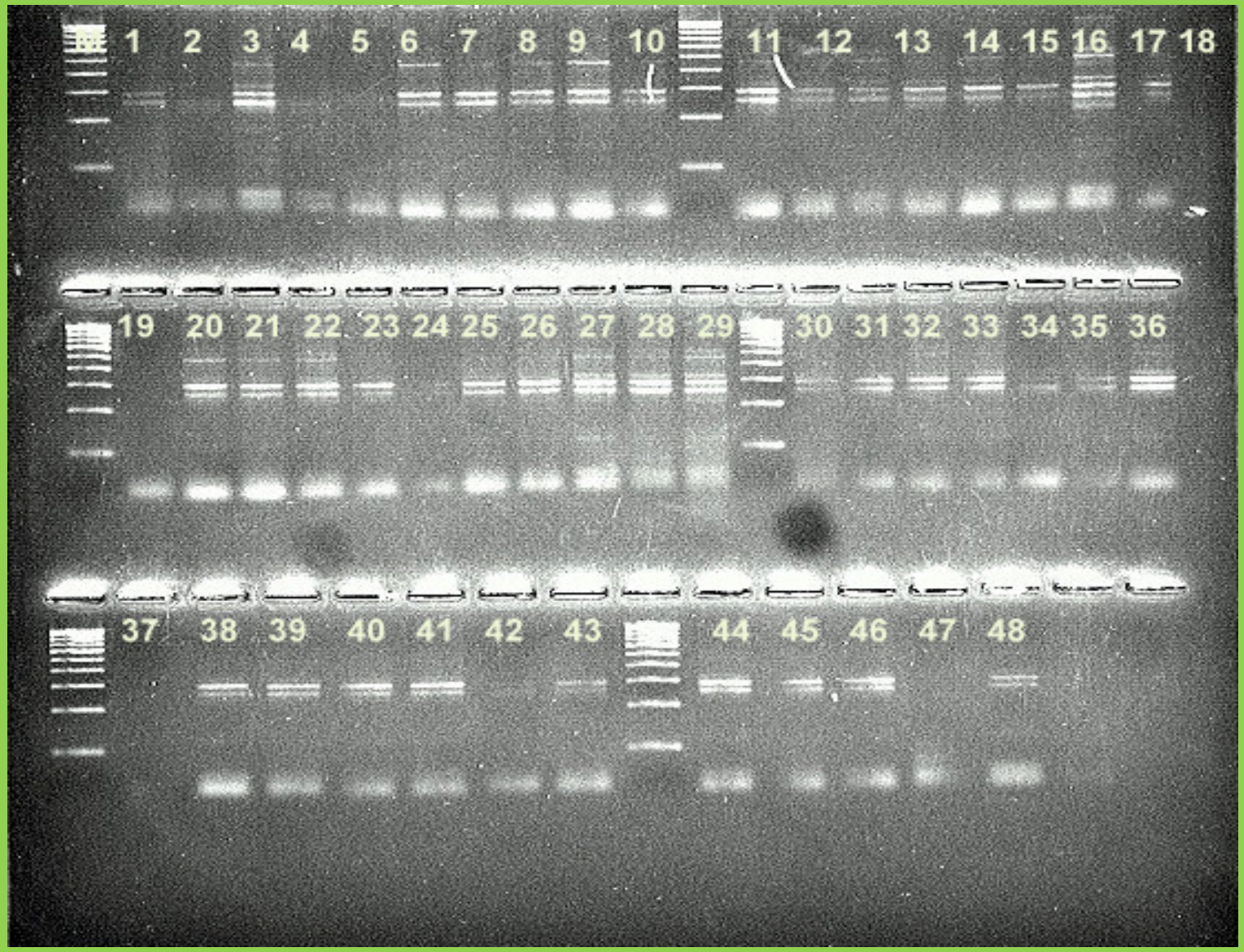
SSR profile in F1 population- CS-3



Cluster of 31 accessions Based on SSR markers of cashew



SSR amplification with pistachio primer (Ps23)



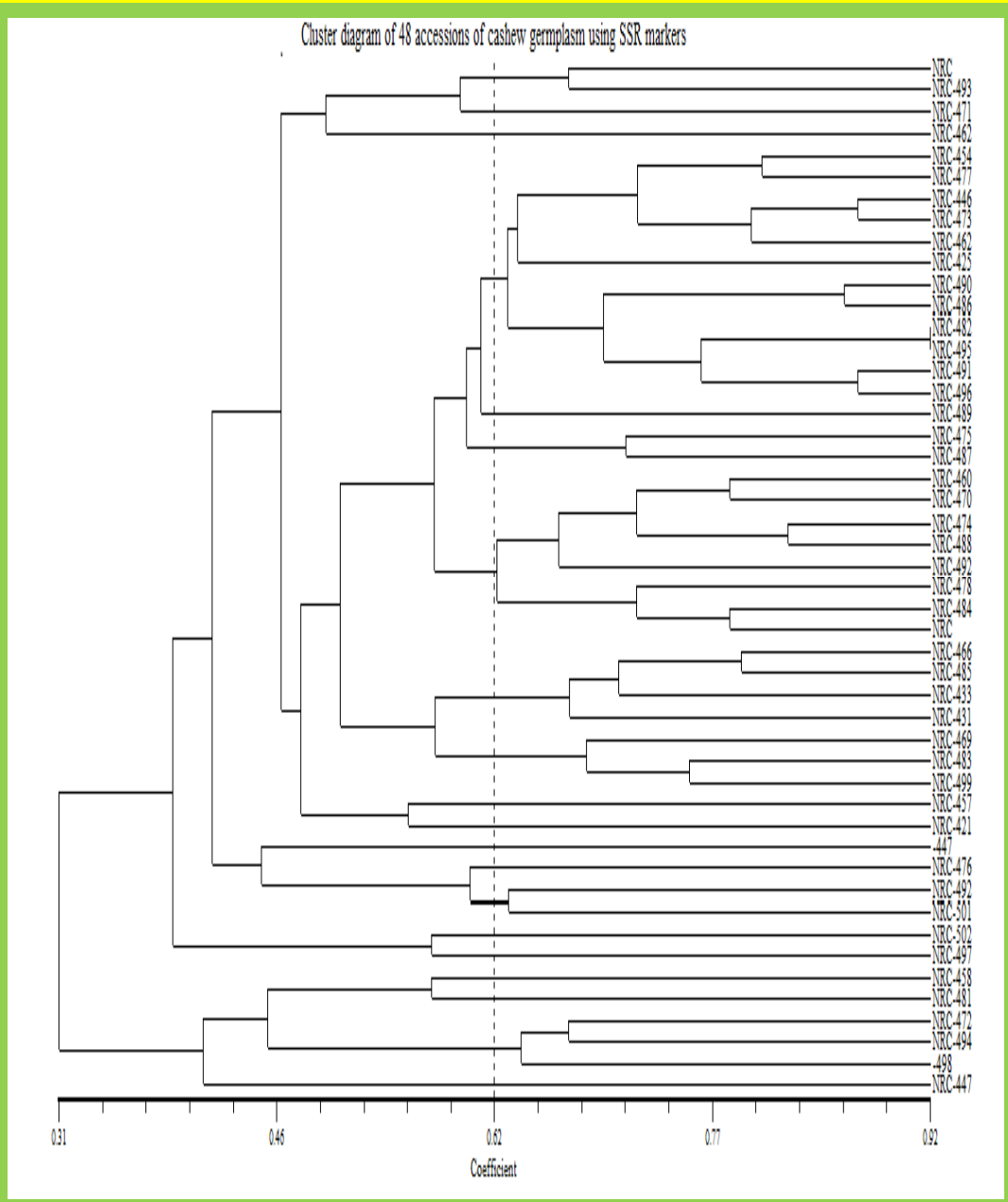
Cluster ing 48 accessions. based on SSR markers from other species

NRC 447 and 493 are highly divergent

NRC 482 and NRC 495- Highly similar

Average similarity = 0.52

Modertate diversity among accessions



Breeding for cashew apple

13 accessions have been planted in 2014

Challenges

- Development of varieties resistant to CSRB and TMB
- Varieties suitable for moderate cold climate
- Breaking the yield barrier

THANK YOU