COCONUT RESEARCH AND BREEDING IN INDIA

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch

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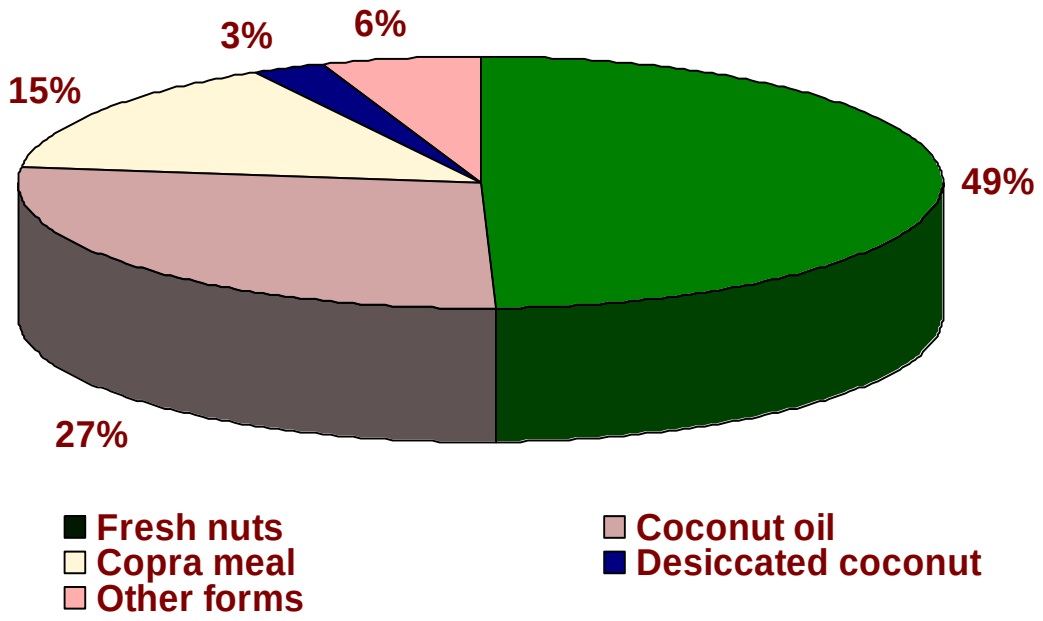
Indian Scenario

- Area - 1.89 million hectares
- Annual production - 16,942 million nuts
- Productivity - 8937 nuts/ha
- Contribution to the GDP -Rs. 8350 crores
- Export earnings - Rs. 2167 crores
- Direct and indirect employment - > 12 million people

Pattern of coconut consumption in India



Coconut Development Board, India, 2011

Coconut - National scenario

State	Area (000 ha)	Production (m. nuts)	Productivity (nuts/ha)
Andhra Pradesh	104	1042	10024
Karnataka	419	2339	5584
Kerala	788	6239	7918
Tamil Nadu	390	5770	14796
Other States	195	1553	7295
India	1896	16943	8937

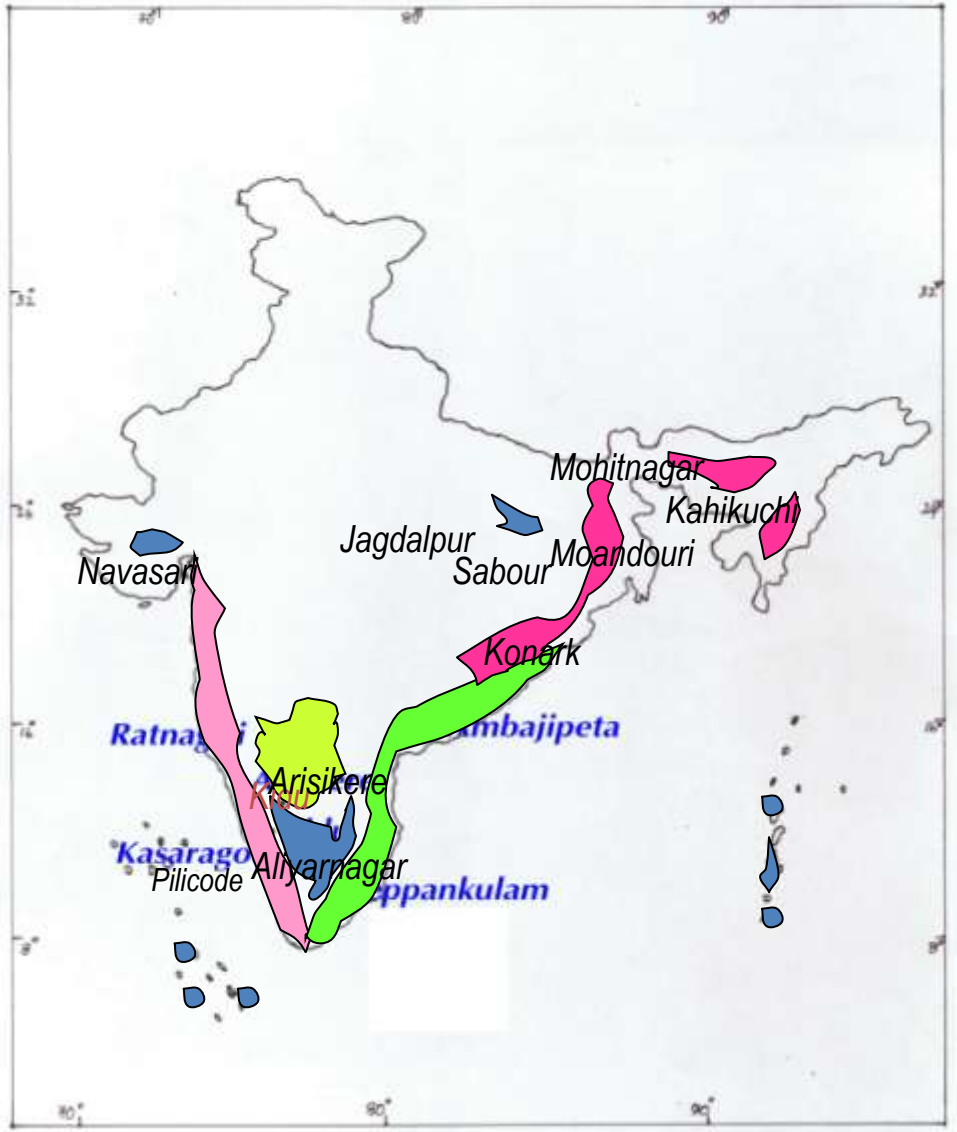
Coconut Development Board, India, 2011

- Coconut production increased from 12678 million nuts in 2001 to 16943 million nuts in 2011 with 3.56 % compound growth rate
- Productivity has shown an upward trend from 6952 nuts ha^{-1} in 2001 to 8937 nuts in 2011 with 2.76 % compound growth rate

Coconut growing areas & research set up in India

CPCRI

- HQ – Kasaragod
- Regional Stations
  - Kayamkulam, Kerala
  - Vittal, Karnataka
- Research Centres
  - Kahikuchi, Assam
  - Kidu, Karnataka
  - Mohitnagar, West Bengal
- Minicoy, Lakshadweep
- KVKs - Farm Science Centres
  - Kasaragod
  - Alappuzha
- AICRP on PALMS: 13



Coconut genetic resources

- Genetic resources form the backbone for undertaking any crop improvement programme
- Variability within the gene pool is essential for selection and hybridization for bringing about improvement in the targeted traits
- Coconut genetic resources are primarily conserved in national and international field genebanks

Coconut Genetic Resources in India

Germplasm holding at CPCRI

- CPCRI - largest collection of coconut accessions in the world

Collection	Total
Indigenous	283
Exotic	132
Total	415

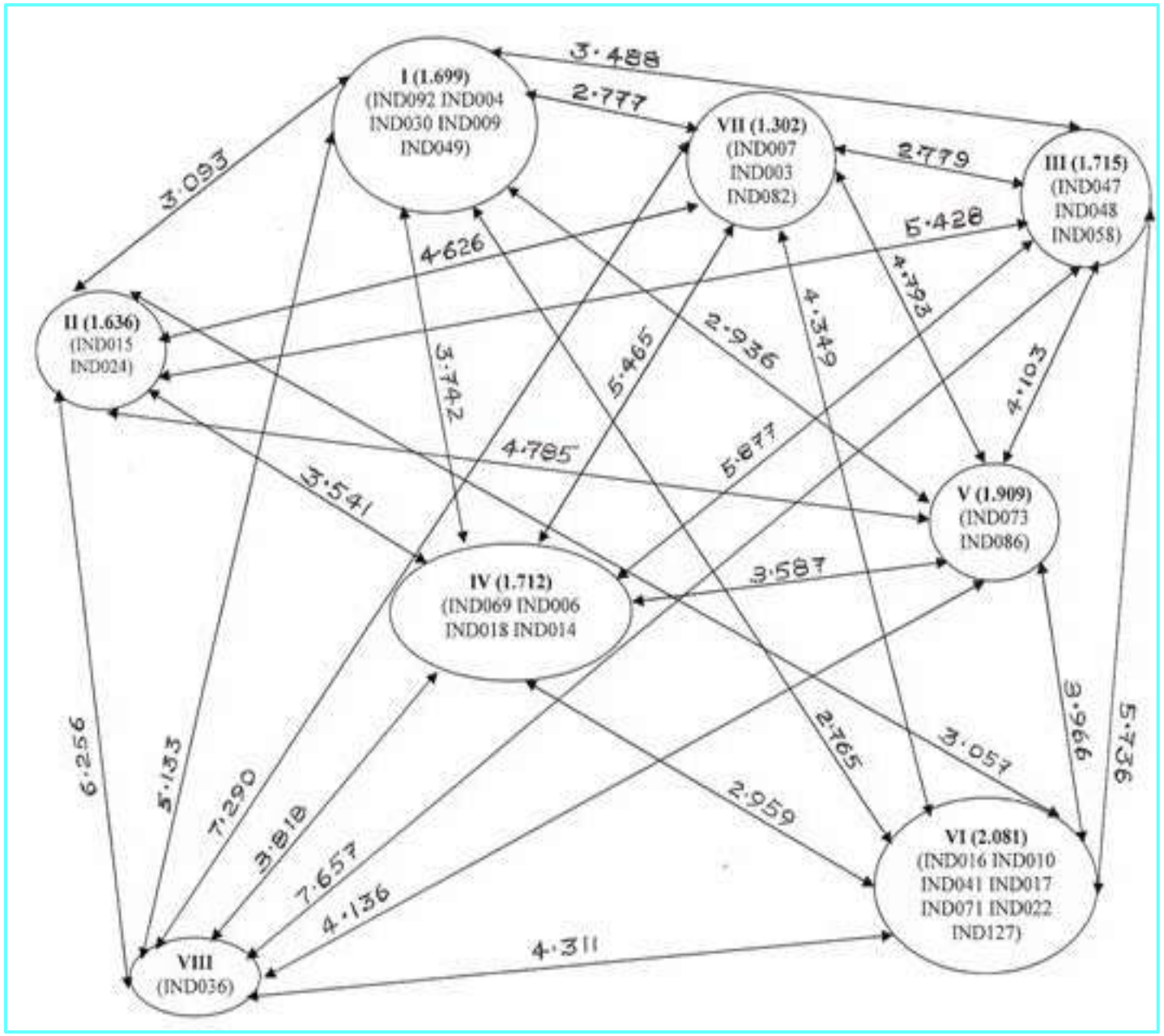
International Coconut Gene Bank for South Asia

- Established at CPCRI RC, Kidu
- 49 designated accessions from host country in RBD with 45/90 palms
- Accessions collected from member countries & Indian Ocean Islands
- 85 coconut accessions conserved

Coconut genetic resources – Characterization

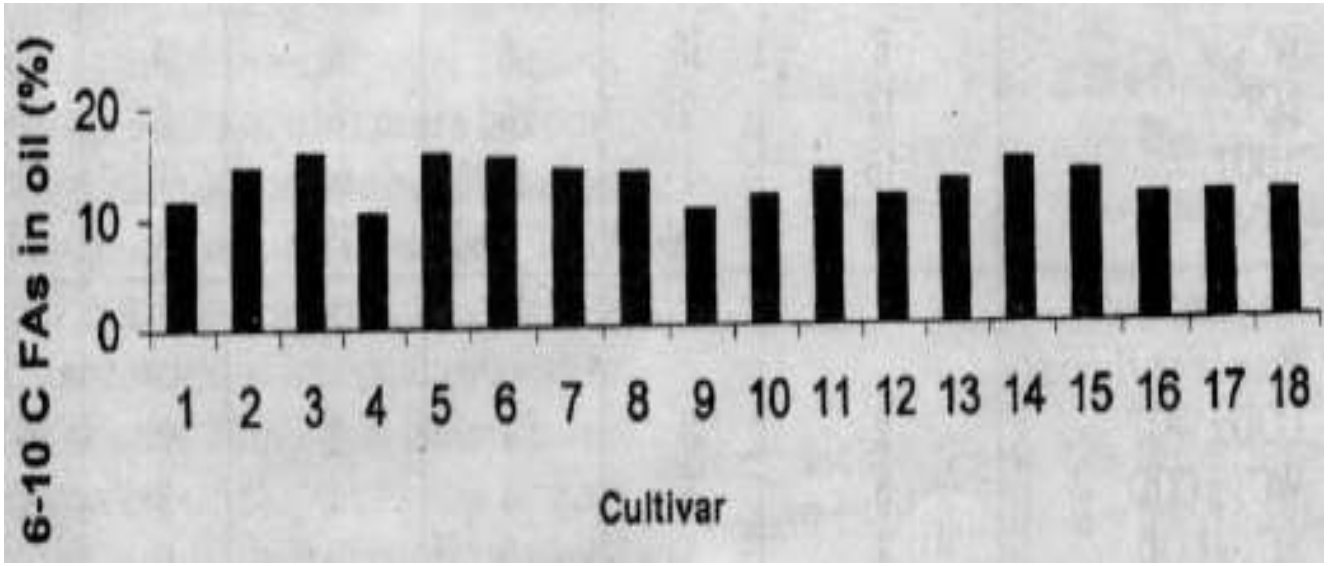
- Germplasm characterization - 70 traits
  - vegetative, reproductive, yield, tender nut and fruit component traits
  - biochemical and molecular profiles
- Trait specific accessions identified

Coconut genetic resources – Inflorescence traits



- Studies in 27 accessions, indicated floral traits contribute to diversity
- Selection of diverse accessions would help in better utilizing the diversity for crop improvement

Evaluation of coconut genetic resources – fatty acids



1-WCT; 2-LCT; 3-ADOT; 4-BENT; 5-COD x WCT; 6-WCT x COD; 7-LCT x COD; 8-LCT x GBD; 9-MYD x WCT; 10-WCT x GBD; 11-FIJT; 12-PHOT; 13-SSGT; 14-SNRT; 15-WAT; 16-ZANT; 17-JVT; 18-FMST.

Variability exists for fatty acid composition of coconut oil

Evaluation of coconut genetic resources – Oil quality

Characteristics of oil	Accession/Hybrid
Low saturated/unsaturated FAs	Hybrids
High lauric acid content, low saturated/unsaturated FA ratio	LCT x GBGD, LCT x COD, COD x WCT
High saturated FA	ADOT, LCT, SSGT
High MCFAs	LCT, ADOT, COD x WCT
High myristic acid concentration	BENT, WAT, FMST, MYD x WCT, WCT x GBGD
High lauric acid concentration	ADOT, LCT, LCT x GBGD, LCT x COD
Low saturated/unsaturated fatty acids and high medium chain fatty acids	LCT x GBGD, COD x WCT, LCT x COD, WCT x COD

Evaluation of coconut genetic resources – fatty acids

- High lauric acid concentration and low ratio of saturated to unsaturated fatty acids - suitable for edible and industrial purposes (soap industry)
- High saturated fatty acid concentration and high lauric acid concentration suitable for pharmacological uses - manufacture of Trilaurin
- High concentrations of medium chain fatty acids more suitable for curing diet absorption disorders in humans
- High concentration of myristic acid suitable for manufacturing binder and emollient used in cosmetics
- These findings indicate possibility of using germplasm in breeding for oil quality

Evaluation of coconut genetic resources - fibre

- Identification of coconut accessions with greater quantity and quality of fibres (long, stiff fibers/soft fibres), would benefit the coir industry
- Physio-chemical and structural characteristics of coconut fibres undertaken in 9 indigenous coconut cultivars, 2 hybrids and 3 ecotypes of WCT

Evaluation of coconut genetic resources - fibre

Variety	Dry husk weight (g)	Dry fibre weight (g)	Long fibre weight (g)	Medium fibre weight (g)	Short fibre weight (g)	Bit weight (g)	% of Long Fibre	% of Medium Fibre	% of Short Fibre	% of bit
BENT	106	42	18	13	11	64	17	12.26	10.38	60.38
LMT	126	39	16	14	9	87	13	11.11	7.14	69.05
COD	198	42	15	16	11	156	7.6	8.08	5.56	78.79
AO	382	52	21	19	12	330	5.5	4.97	3.14	86.39
D X T	150	36	17	7	12	114	11.3	4.67	8.00	76.00
ECT	202	64	18	24	22	138	8.9	11.88	10.89	68.32
LO	459	133	106	15	12	326	23	3.27	2.61	71.02
T X D	133	33	13	11	9	100	9.8	8.27	6.77	75.19
GBGD	222	62	28	17	17	160	12.6	7.66	7.66	72.07
TPT	308	75	31	21	23	233	10	6.82	7.47	75.65
WCT	300	73	27	23	23	227	9	7.67	7.67	75.67

Long fibre : Length >20 cm,
Short fibre : Length between 5- 15 cm
Medium fibre : Length between 15-20 cm
Bit : Length <5 cm

Trait-specific coconut accessions

Trait	Accession
High female flower production	Spicata, Laccadive Micro Tall, Ayiramkachi Tall
Large inflorescence	Borneo Tall
High copra content (>300 g)	San Ramon Tall, Malayan Tall, Markham Tall
Low copra content (<125 g)	Surinam Brown Dwarf, CGD, MYD, Laccadive Micro Tall, Ayiramkachi Tall
High Oil content (>72%)	Laccadive Micro Tall
Dwarf - high copra content (>200 g)	CRD, NLGD
High copra/oil output (>4 t copra/ ha & >2.5 t oil/ha)	Fiji Longtowan Tall, Adirampatnam Tall, CCNT, JVT, PHOT
Ball copra production	LMT, TPT, WCT, AYKT, JVT
Good quality tender nut water	COD, MOD, PHOT, MGD, GBGD, CCNT
Drought tolerance	AGT, WCT, JVT, FMST
Root (wilt) disease resistance	CGD, MGD
Leaf spot resistance	TPT
Eriophyid mite resistance	COD
Sweet endosperm	*Mohacho Narel*
Pink husk (tender fruits)	Guelle Rose Tall, West Coast Pink Tall

Coconut genetic resources – Cataloguing

- Coconut descriptors developed for 74 conserved germplasm accessions
- Descriptors and photo plates prepared for COGENT World Catalogue of conserved germplasm and Catalogue of farmers varieties

Coconut genetic resources - Descriptor plates

Cataloguing of farmers varieties

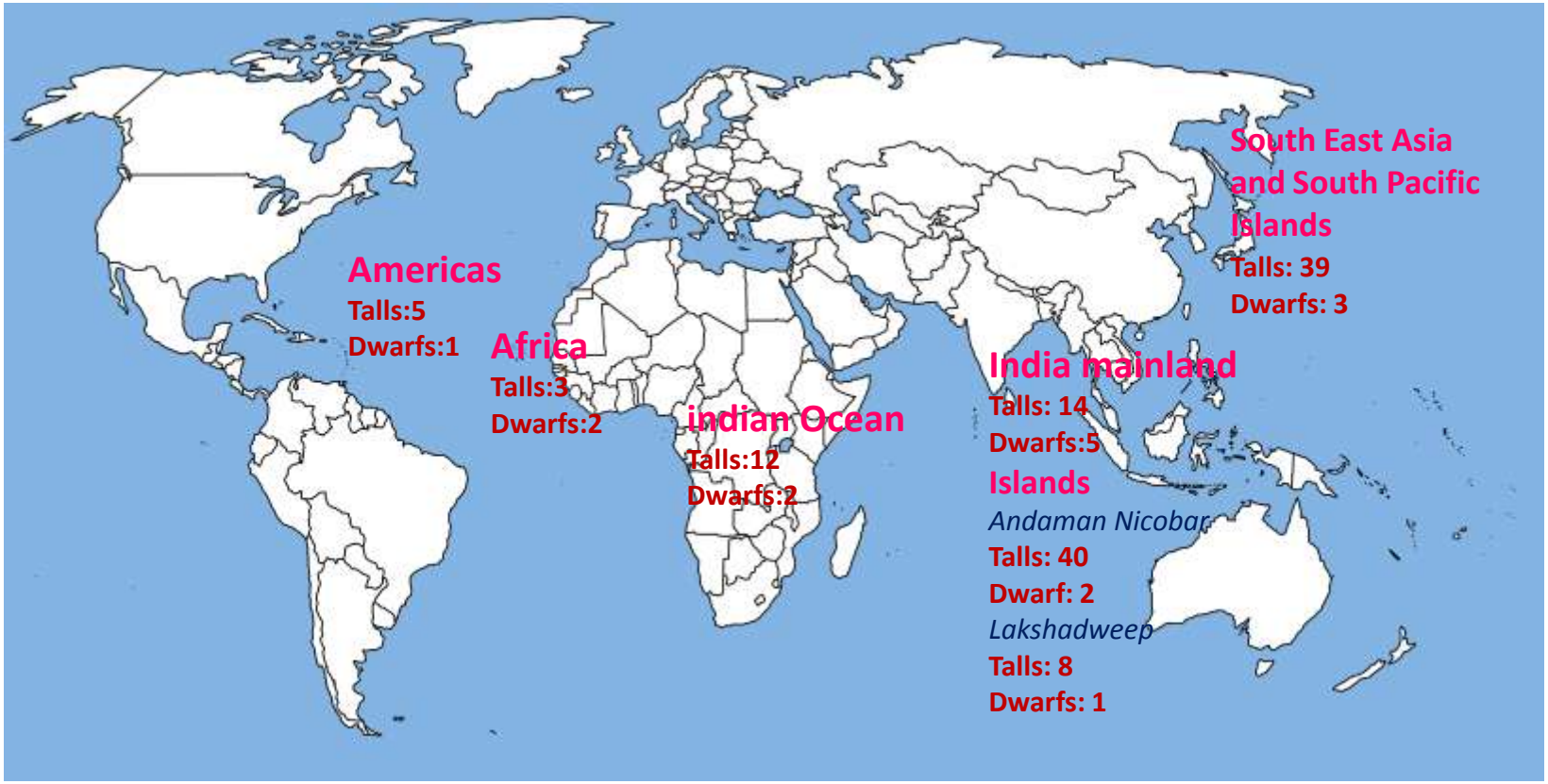
In situ characterization of local coconut ecotypes

- Bedakam from Kasaragod & Kuttiadi from Kozhikode in Kerala
- Copra recovery greater in Bedakam
- Adaptive traits

	Bdk	Ktd	LSD0.05	LSD0.01
Cop rec**%	65.93	59.69	1.25	1.64
Cav vol**ml	123.79	115.54	5.09	6.68
End th.**cm	1.24	1.33	0.02	0.03
End wt**gm	234.86	256.71	9.22	12.12
Fe eq lt**cm	47.08	44.21	0.82	1.08
Fr bdt**cm	14.41	12.34	0.29	0.38
Husk th*cm	2.60	2.75	0.07	NS
Nut wt**gm	349.01	374.85	11.93	15.67
Sh th.**cm	0.48	0.45	0.011	0.014
Sh wt.*gm	114.15	118.01	3.20	NS
Husk%**	47.05	45.51	1.04	1.37

DNA fingerprinting of coconut accessions

- Molecular characterization, with SSR markers, of 138 diverse accessions, covering major & minor coconut growing regions of the world, including Africa and America completed



Molecular Diversity – Indigenous talls

Accession/Location	Genetic diversity	Heterozygosity Index
Andaman Ordinary Tall	0.33	0.19
Assam Green Tall (Assam)	0.36	0.30
Ayiramkachi Tall (Tamil Nadu)	0.33	0.31
Benalium Tall (Goa)	0.33	0.15
Calangute Tall (Goa)	0.36	0.35
East Coast Tall (Tamil Nadu)	0.49	0.50
Gangapani Tall (Andhra Prades	0.34	0.42
Kappadam Tall (Kerala)	0.42	0.51
Laccadive Ordinary Tall	0.59	0.62
Laccadive Micro Tall	0.30	0.23
Orissa Giant Tall (Orissa)	0.30	0.20
Orissa Tall (Orissa)	0.40	0.50
Tiptur Tall (Karnataka)	0.40	0.24
West Coast Tall (Kerala)	0.35	0.43
Spicata (Kerala)	0.39	0.47

- Overall Talls showed high level of genetic diversity.
- Among indigenous Talls, LCT showed higher level of diversity

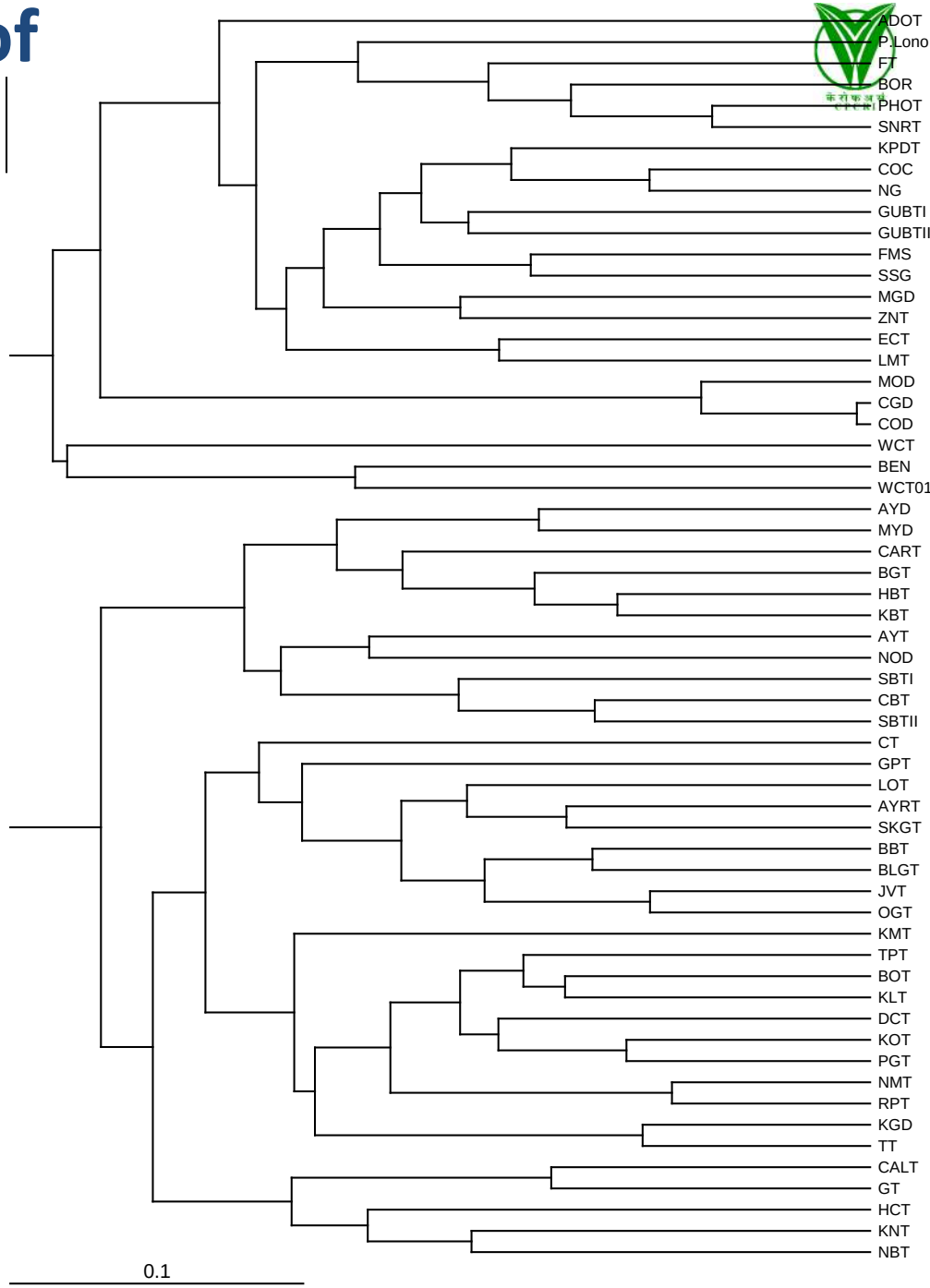
Molecular Diversity – Indigenous dwarfs

Accession/Location	Genetic diversity	Heterozygosity Index
Andaman Yellow Dwarf	0.06	0.13
Chowghat Green Dwarf (Kerala)	0.00	0.00
Chowghat Orange Dwarf (Kerala)	0.07	0.03
Gangabondam Green Dwarf (Andhra Pradesh)	0.17	0.06
Kulasekharam Orange Dwarf (Tamil Nadu)	0.58	0.78
Kenthali Orange Dwarf (Karnataka)	0.06	0.13

- Overall Dwarfs showed low level of genetic diversity, except for KOD
- Among indigenous dwarfs, CGD found to be highly homozygous

Genetic relationship of coconut accessions

- Dendrogram based on SSR data identified two major groups corresponding to the two centres of domestication – primary centre (South East Asia) and secondary centre (Indian Ocean region)
- A database “COCOGEN” developed for microsatellite data
- This excel based database has provisions to analyse 11 microsatellite parameters



An excel based macro for fingerprinting data management and analysis was developed.

Bioinformatics - Database and web tools

- Coconut microsatellite database
- Coconut Germplasm Database
- Plant disease resistant gene database
- Protein kinase database
- Phytoplasma database
- Stress gene database
- Palms database
- Coconut disease Database
- EST-SSRs database
- Pest Management
- Microbial Information system
- PGPRs
- Shannon Diversity tool
- Coconut and oil palm EST annotated database
- Phytoplasma server
- Coconut cultivar identification

- Computation and Molecular modeling
- Analysis of genome sequence data of oil palm, date palm & coconut

Applications of biotechnology for cryopreservation, embryo & plumule culture

- Embryo culture for field collection of germplasm from distant places
- Plumule culture technique
  - for production of homozygous lines & homogeneous breeding materials
  - Enhancing multiplication rate of hybrids & resistant lines
- Cryopreservation of pollen & embryos for *in vitro* germplasm conservation







Utilization of coconut genetic resources

- Genetic resources utilized for development of improved varieties and high yielding hybrids
- In India, 24 varieties and 15 hybrids released for cultivation in different agro-climatic zones of the country

Improved coconut varieties developed in India

Higher copra yield

Variety	Important traits	Nut yield (ha^{-1} $year^{-1}$)	Copra yield (t ha^{-1} $year^{-1}$)
Chandra Kalpa	Drought tolerant, high oil - 72%	17266	3.4
Kalpa Mitra	High nut, oil yield, Drought tolerant	15308	3.7
Kalpa Dhenu	High nut, oil yield, Drought tolerant	14240	3.4
Kalpatharu	Drought tolerant, ball copra, high yield	21004	3.7
Pratap	High yield	20826	3.6
Kamarupa	High yield	26878	4.0
Aliyarnagar Tall 1	High yield	17978	2.9
Kera Bastar	High yield	19580	3.2
Kera Keralam	High yield	26166	3.5
Aliyarnagar Tall 2	High yield	21360	2.9
VPM-3	High yield, drought tolerant	14952	3.4

Improved coconut varieties developed in India

Dual purpose

Variety	Important traits	Nut yield (ha^{-1} $year^{-1}$)	Copra yield (t ha^{-1} $year^{-1}$)
Kera Chandra	High yield	19580	3.9
Kalpa Pratibha	High nut, oil yield, tender nut, Drought tolerant	16198	4.1
Kalparaksha	High nut, oil yield in RWD prevalent areas	17748	3.3
Kalpa Haritha	Dual purpose for copra and tender nut	21004	3.7
Gautami Ganga	Dual purpose for copra and tender nut, Andhra Pradesh	13260	3.6
Kera Madhura	Dual purpose for copra and tender nut, Kerala	23140	4.8
Kalyani Coconut	High yield, West Bengal	14240	3.9

Improved coconut varieties developed in India

Tender nut

Variety	Important traits	Nut yield (ha^{-1} $year^{-1}$)	Copra yield (t ha^{-1} $year^{-1}$)
Chowghat Orange Dwarf	Dwarf, orange colour fruit	12852	Chowghat Orange Dwarf
Kalpa Jyothi	Dwarf, yellow colour fruit	19935	Kalpa Jyothi
Kalpa Surya	Dwarf, orange colour fruit	21593	Kalpa Surya

Root (wilt) disease tracts

Variety	Important traits	Nut yield (ha^{-1} $year^{-1}$)	Copra yield (t ha^{-1} $year^{-1}$)
Kalparaksha	High nut, oil yield in RWD prevalent areas	13260	2.9
Kalpasree	Dwarf, superior oil, high yield in RWD areas	18360	1.8

Superior coconut hybrids released in India

#- Yield under rainfed conditio

Hybrid	Parentage	Nut yield (palm year^{-1})	Copra yield (kg palm^{-1} year^{-1})
Chandra Sankara#	COD x WCT	110	25
Kera Sankara#	LCT x GBGD	106	21
Chandra Laksha#	LCT x COD	109	21
Kalpa Samrudhi#	MYD x WCT	117	25
Kalpa Sankara	WCT x CGD	84	18
Laksha Ganga	LCT x GBGD	108	21
Ananda Ganga	ADOT x GBGD	95	21
Kera Ganga	WCT x GBGD	100	21
Kera Sree	WCT x MYD	112	24
Kera Sowbagya	WCT x SSAT	130	25
VHC-1	ECT x MGD	98	13
VHC-2	ECT x MYD	107	16
VHC-3	ECT x MOD	156	25
Godhavari Ganga	ECT x GBGD	140	21
Konkan Bhatye coconut hybrid 1	GBGD x ECT	116	22

Drip Fertigation in coconut

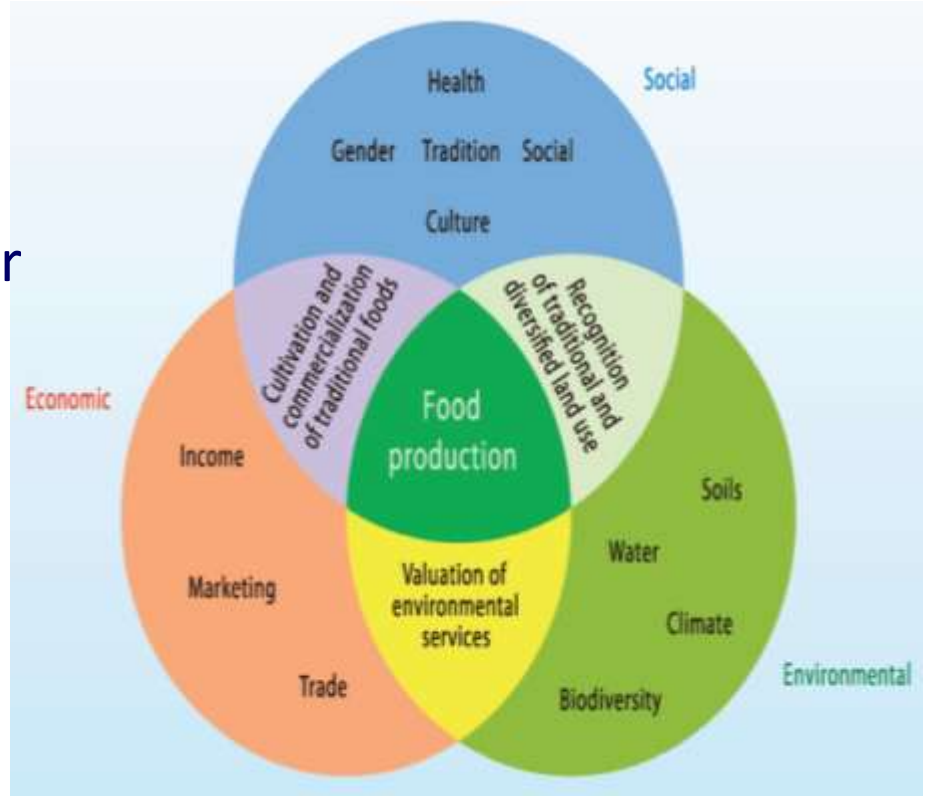
- Drip irrigation 66% Eo @ 30-32 l palm^{-1} day^{-1}
  - from December to May
  - can save 34% of water
  - cost of installation : Rs 50,000/ha
- Fertilizer application through drip irrigation
  - 50% reduction in quantity of fertilizers
  - Six splits from December to May
- Urea 91 g; Phosphoric acid 33 ml; & MOP 167 g per palm per split dose

Effect of fertigation on coconut yield in red sandy loam soil

Treatments	I Year	II Year	III Year	IV Year
25% N:P:K (Drip)	93	88	95	102
50% N:P:K (Drip)	112	102	106	126
75% N:P:K (Drip)	111	99	103	128
100% N:P:K (Drip)	120	97	110	117
100% N:P:K (Soil)	123	101	109	113
C D(5%)	13.7	6.8	7.0	13.2

Eco-friendly technologies & bioresource management

- Sustainable, ecological production management system
- Promotes and enhances biodiversity, biological cycles, water use efficiency and soil biological activity
- Positive impact on environment and socio-economic status of farmers.



Holistic approach in Eco-friendly Agri.

Bioresource Management

- Crop Residue Management
- Exploitation of Microbial Resources
- Utilization of Legume-Rhizobium symbiotic systems
- Systems approach in bioresource management

Recycling plantation wastes to produce vermicompost

Coconut leaf + cow dung (10:1)

40- 50% moisture

Coconut leaf vermicompost

Eudrilus sp.

Large scale vermicompost production unit

Properties of coconut leaf vermicompost

Parameter	Values	Parameter	Values
C:N ratio	9.95 – 17.0	Total N (%)	1.8 – 2.1
Total C (%)	35-37	Ca (ppm)	19,500-20,413
Organic C (%)	17- 20	K (ppm)	1600-4013
Humic acid (%)	10-13	Mg (ppm)	4290-4679
IAA (ppm)	0.52-1.15	P (ppm)	2100-3043
GA (ppm)	0.23-1.61	Na (ppm)	1411-1525
Phenols (ppm)	10-14	S (ppm)	2915-3041
WHC %	116-150	pH	6.2-7.9

Coir pith: valuable organic input in coconut cultivation

- By-product of coir processing industry is available at 8.1 mt year^{-1}

Coir pith

Marasmiellus troyanus

Lentinus squarrosulus

Lepista sp

urea @ 0.5%

Trichoderma sp.

Pleurotus sajor caju

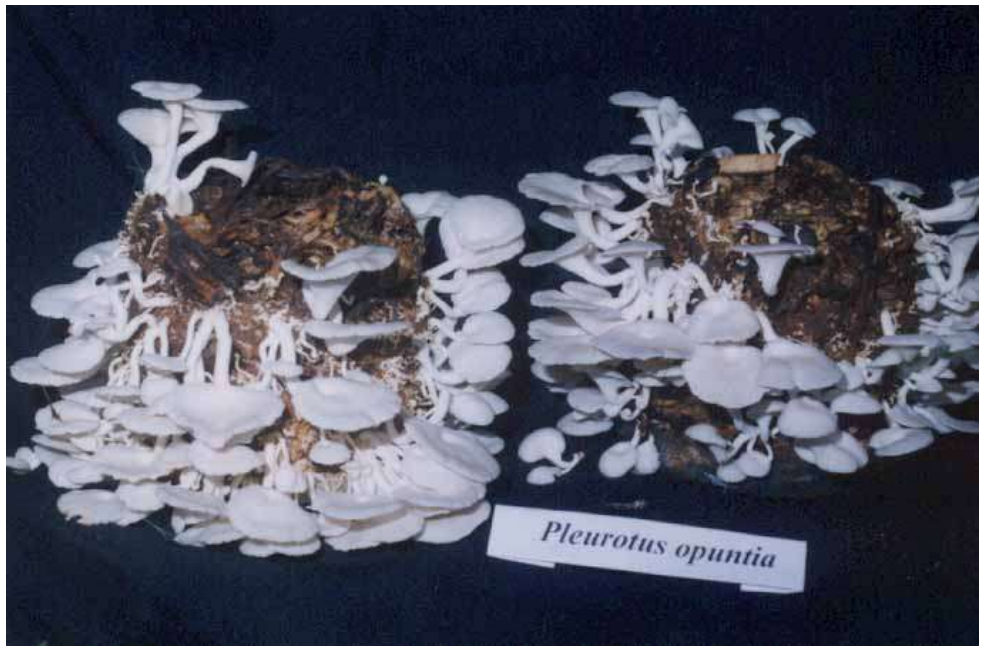
Coir-pith compost

Composting of coir pith by poultry manure amendment

Treatment	OC (%)	N (%)	C:N	P(%)	K(%)
CP+ PM (10%)	30.15	1.41	21.42	0.88	1.33
CP+ PM (10)+ RP + L	28.95	1.30	22.34	1.21	1.66
CP (Control)	35.25	0.61	58.80	0.05	0.63

Mushroom cultivation on plantation waste

- Coconut leaf stalk and bunch wastes are suitable substrates for oyster mushroom cultivation
- Fermented coir pith is a suitable substrate for milky white mushroom production
- Biological efficiency of mushroom production is 55 to 70%



Growth promotion effects - *Pseudomonas putida* KnSF208 &*Bacillus coagulans* RSB 14

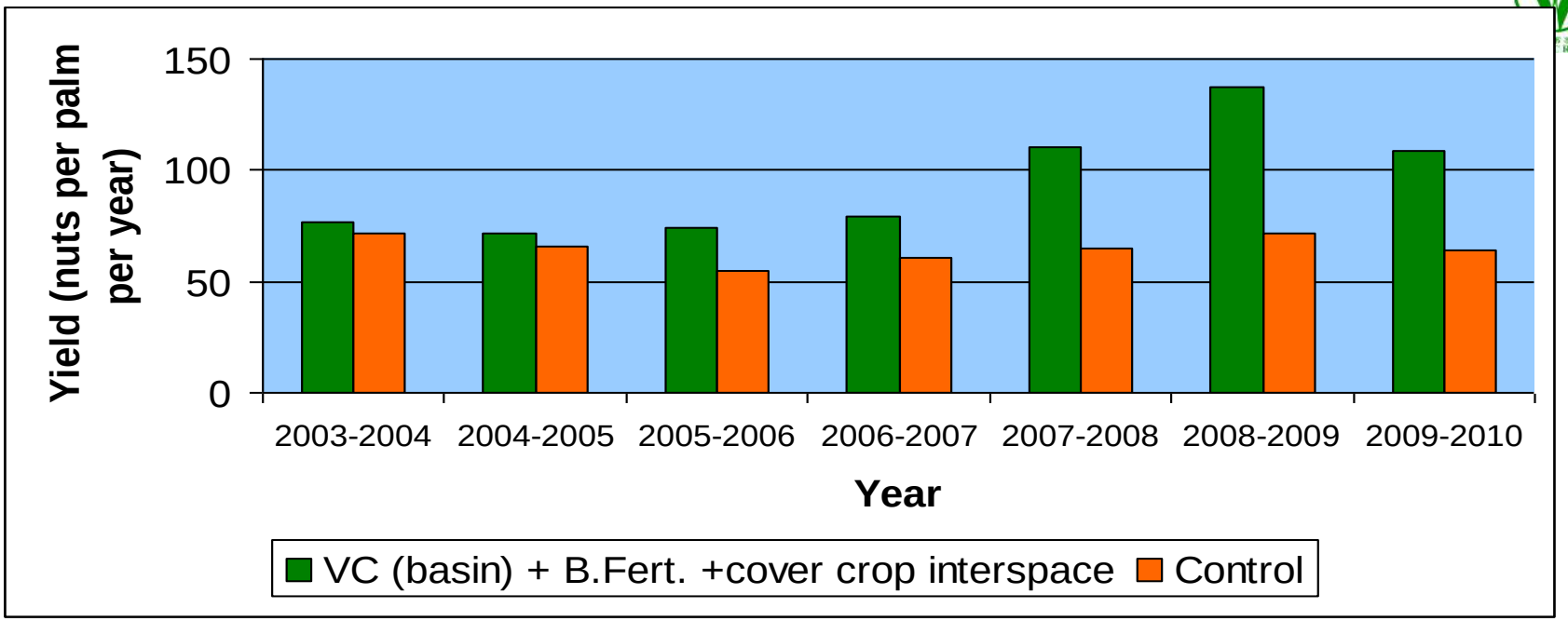
Control PGPR treated

KnSF 208 Control

RSB 14 Control

Isolate No.	Collar Girth (% ↑)	root no. (% ↑)	Length (% ↑)			Fresh wt. (% ↑)			Dry wt. (% ↑)		
			shoot	root	total	shoot	root	total	shoot	root	total
KnSF208	7	1	16	55	25	27	47	29	24	41	27
RSB14	12	29	11	33	16	27	29	27	31	37	32

Organic farming technology for coconut



Treatments	03-04	04-05	05-06	06-07	07-08	08-09	09-10
VC (basin) + B.Fert. +cover crop interspace	77	72	74	79	110	137	109
Control	72	66	55	61	65	72	64

Coconut based Cropping System for higher productivity and profitability

- Coconut interspaces provide ample scope for mixed & intercropping
- **Inter or mixed crops in coconut & arecanut gardens**
  - **Fruits** - mango, sapota, orange, banana, papaya, pineapple, noni
  - **Vegetables** - vegetable cow pea, coccinia, bhendi, chillies, brinjal, cucurbitaceous vegetables
  - **Tuber crops** – elephant foot yam, colocasia, cassava, yams
  - **Spices and condiments** - pepper, clove, nutmeg, allspice, cinnamon, ginger & turmeric
  - **Cocoa**
  - **Medicinal plants -** Orila - *Desmodium gangeticum* DC, Moovila - *Pseudarthria Viscida L.,* Chittadalodakam – *Adhatoda beddomei C.B. Clarke,* Karimkurinji - *Nilgiranthus ciliatus (Neees),* Nagadanthi – *Baliospermum montanum (Willd)*

Coconut based high density multispecies cropping system

Yield of different crops

Crops	Plants/ ha (No)	Yield (kg)	
		Per plant	Per ha
Coconut (nuts no.)	156	165	25740
Clove	110	0.85	93.5
Black pepper	156	0.75	117.0
Banana	264	6.30	1663.2
Pineapple	3014	0.90	2497.5

Coconut-Pepper-Banana-Pineapple-Clove (Kasaragod)

New dimensions in nutrient management

- Organic recycling enables reduction of fertilizers to two third dose
- Contribution of beneficial microbes & synergistic interactions recognized
- PGPRs, arbuscular mycorrhizae with high growth promotion isolated

Economics (Rs./ha)

Cost of production	71420
Gross income	186750
Net income	115330

Coconut based mixed farming system

Mixed farming : coconut+cows+quail+fish+banana+biogas+pepper

- Viability of the system under organic farming worked out
- Organic recycling meets 100 % N, P & 85 % K requirement

Comparative economics of coconut based cropping systems (Rs/ha)

Cropping system	Total expenditure	Total return	Net return
Coconut monocrop (rainfed)	42400	52500	10100
Coconut monocrop (irrigd)	53300	77000	23700
Coconut+ Cocoa	74000	119000	45000
HDMSCS*	71420	186750	115330
Coconut Based mixed farming*	253025	390189	137164

Nutrient flow in coconut based farming system

Items	Quantity	N (kg)	P (kg)	K (kg)
A) Nutrient contribution by the components of the system				
Cow dung	14 tonnes	98.00	70.00	105.00
Poultry	295 kg	1.92	2.36	2.08
Silk worm	12 kg	0.11	0.05	0.09
Cows urine and cowshed washings	50000 litres	30.00	-	28.00
Total		**130.03**	**72.41**	**135.17**
B) Nutrient substitution through recycling of the coconut fronds (minus petiole)				
Coconut Leaves (vermicompost)	1.45 tonnes	26.14	4.36	6.94
Total (A+B)		**156.17**	**76.77**	**142.11**
C) Inorganic addition to the system				
Coconut palms	0.5:0.32: 1.2*	79.00	22.12	157.37
Grass**	160 : 20 : 20	131.2	16.4	16.4
Total		**210.2**	**38.52**	**173.77**
Percent supplementation of inorganics through waste recycling				
% supplementation		**74.29**	**Entire**	**81.78**

* palm/year;

**Entire P (80 kg) & K (80 kg) dose is applied at the time of planting. Fresh grass is planted every four years. Hence shown as split for each year.

Product Development - Value Added Products, Functional Foods, Functional Drinks & Organic Products

Development of value added products

- Virgin Coconut Oil
- coconut water squash,
- marmalade, jam
- Vinegar
- chips
- snowball tender nut
- neera, sugar, jaggery
- extruded products
- haustorium products
- fortified products
- Activated Carbon

Technology for fortifying wheat flour with dried defatted coconut and the combination optimised to prepare functional foods

Development of labour saving machineries

- Shell fired copra drier
- Ultra light weight coconut harvester
- Power operated sprayer
- Coconut chips slicer
- Power operated coconut splitting device
- Coconut chips dryer
- Coconut testa remover
- Coconut grating machine
- Coconut milk expeller
- Coconut oil separator
- Modified snowball tender nut machine
- VCO cooker
- Coconut palm climbing device

Coconut Grating Machine
Capacity:200 nuts/minute

Coconut Testa Remover
Capacity:45 nuts/hr

Machineries developed & patented

Tender nut Punching Machine

- To pierce the tender nut
- Capacity: 30 nuts/minute
- Patent No. 233744

Tender nut Cutter

- Used to cut open the tender nut after consuming the tender nut water
- Capacity: 15 nuts/minute
- Patent No. 233744

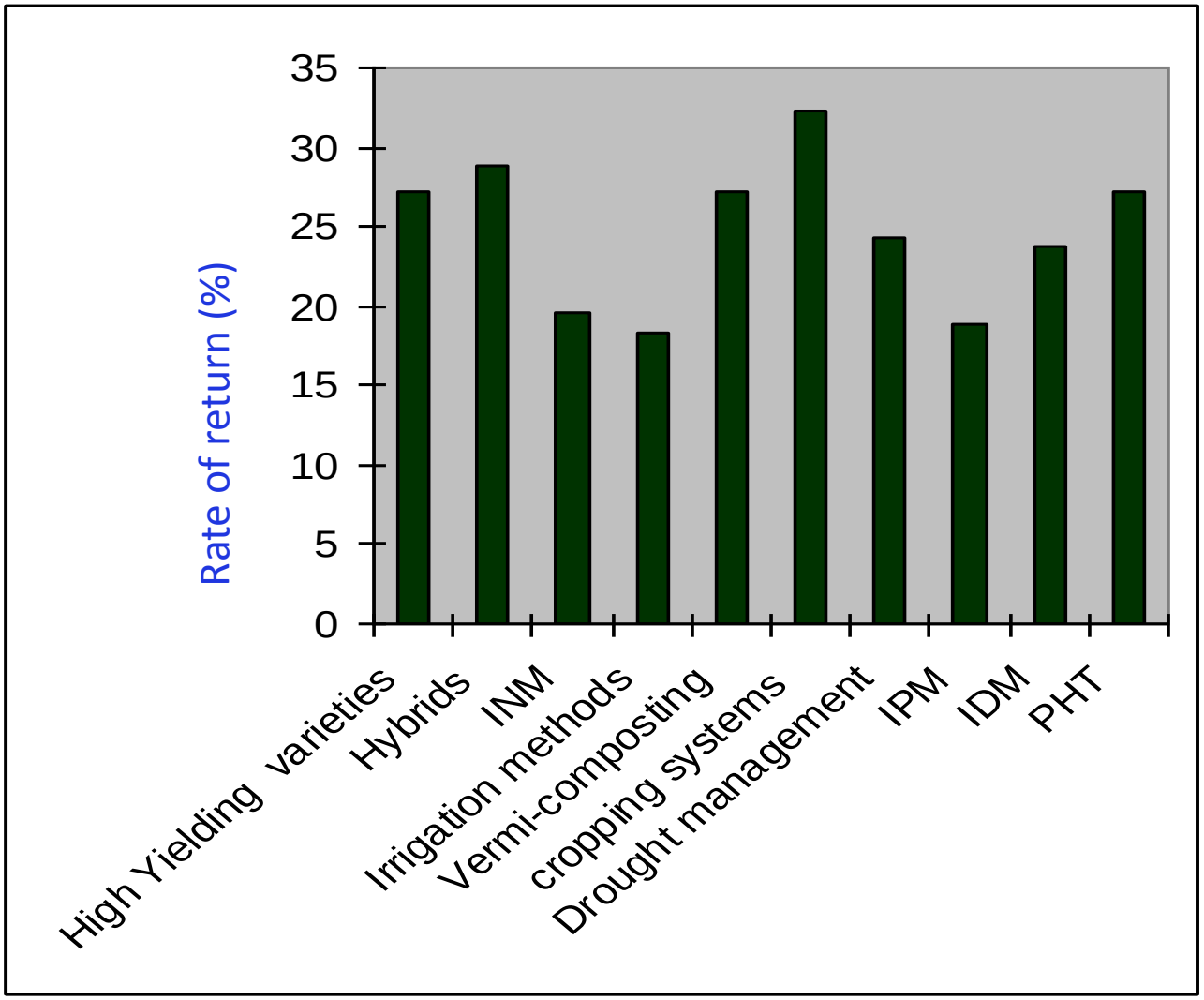
Coconut Deshelling Machine

- A cage wheel with horizontal stopper bars. Used to remove shell of partially dried coconut kernel
- Capacity – 200 nuts/batch, Time 4 min/batch
- Patent No. 233742

Coconut Climbing Device

- ‘ U ’ clamp fit with rubber grip.
- Time taken to climb 15 m tree - 7.5 minutes
- Patent filed

Technologies developed and Rate of Return in coconut



Issues in the research front

Tackling devastating diseases

Root (wilt) disease in coconut

- Affecting coconut cultivation in 0.4 million hectares
- Annual loss of 968 million nuts
- Phytoplasma disease
- No definite control measure
- Disease spreading to newer areas
- Similar to Welligama Disease reported from Sri Lanka

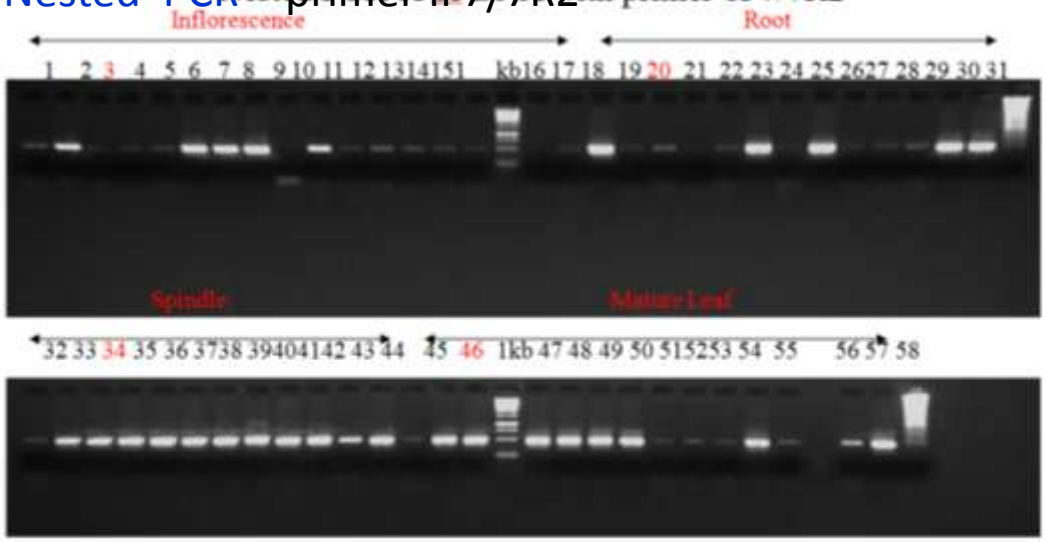
Root (wilt) disease in coconut

Achievements made in India

- Electron microscopy observations
- Molecular and serological detection tests
- Kalparaksha, Kalpasree - varieties having relative resistance
- Kalpa Sankara - tolerant hybrid with higher nut yield
- Package of technologies for management of diseased palms and achieve increase in yield

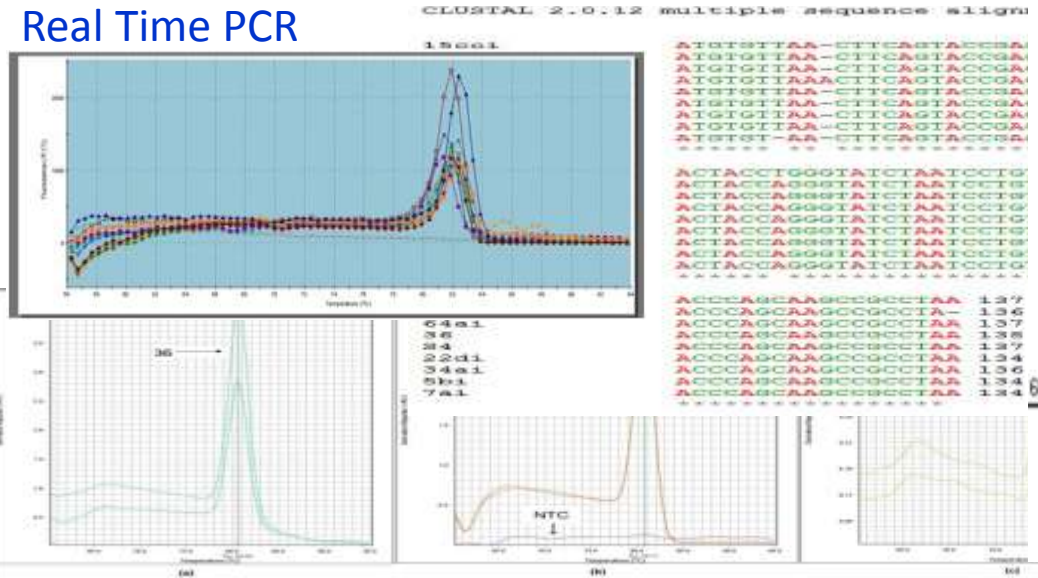
Root (wilt) disease diagnostics - molecular approaches

Nested PCR – primer IF7/7R2

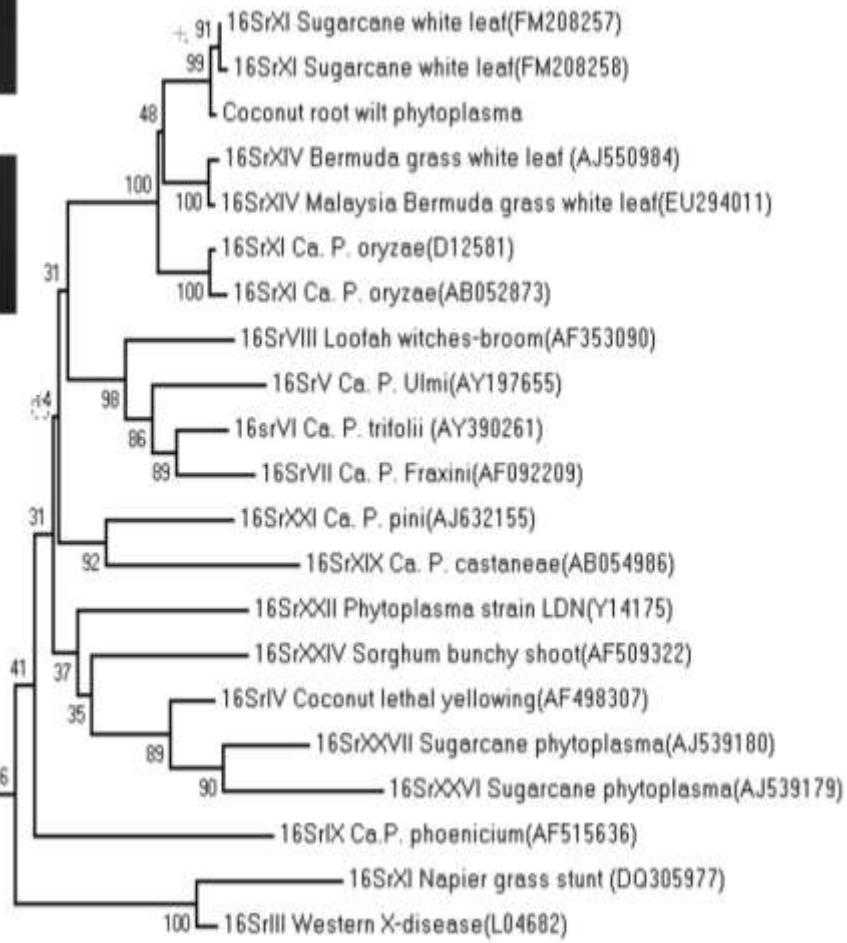


Band shows the presence of phytoplasma in samples

Real Time PCR



16S rDNA XI group phytoplasma - root (wilt) disease of coconut



Root (wilt) disease in coconut

Need for international collaboration

Issues

- Development of molecular diagnostic kit
- More studies on identification of vectors and transmission tests
- Development of molecular markers for resistance
- No method for multiplication of resistant material

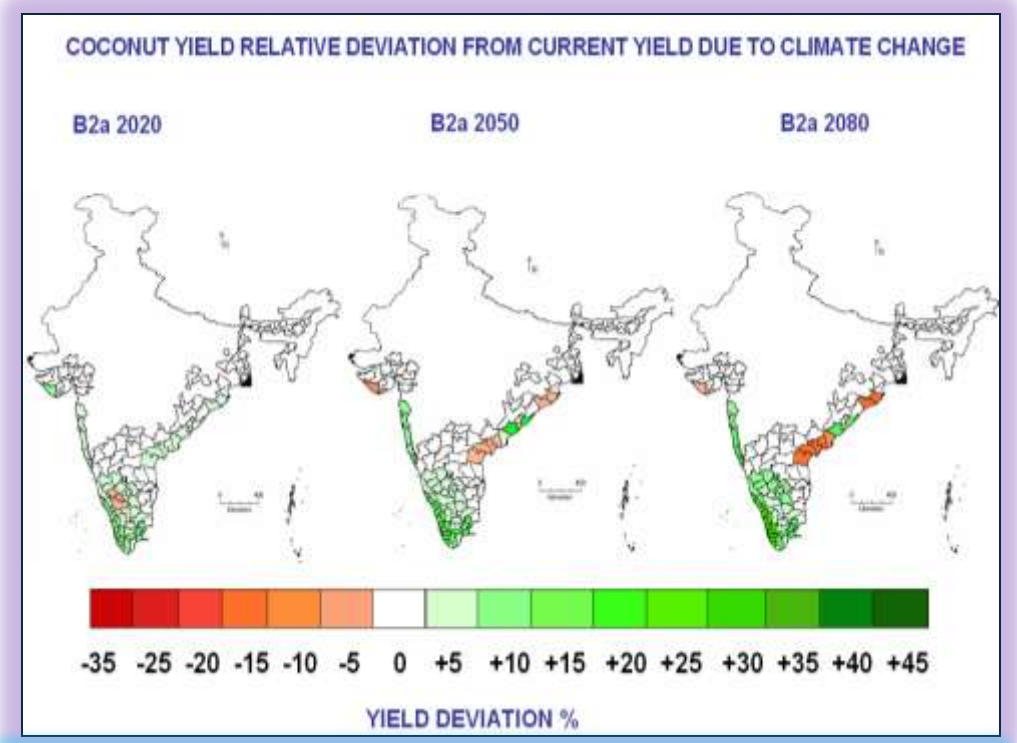
Issues in the research front

Climate change impacting coconut production

- Extreme drought in Tiptur, Mysore areas of Karnataka devastated lakhs of palms
- Intensive rain after drought – more incidence of bud rot disease
- Climate resilient agriculture – strategies & programme to address issues

Development of mitigation technologies for climate change

- Info-Crop coconut model developed & validated to quantify potential yields in different agro climatic zones
- Analysis of major coconut growing zones in India indicated general warming trends
- Potential yields in different agro-climatic zones simulated and model validated for 11 different zones



Coconut simulation model derived relative deviations in nut yields due to climate change in B2a scenario of HadCM3 model

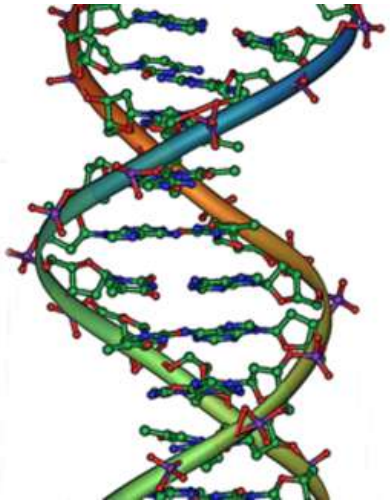
Issues in the research front
Exchange of germplasm among the countries

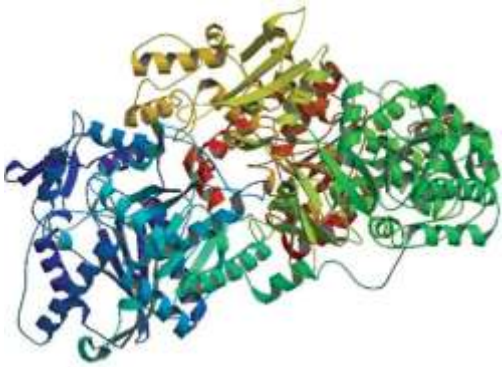
- No exchange of germplasm taking place among countries
- Implementation of ITPGRFA
- Global strategy for germplasm exchange
- Consultations with Governments

Issues in the research front

Coconut genomics

- Genomes of other palms *viz.* date palm, oil palm sequenced
- No progress in sequencing of coconut genome
- International thematic groups formed under COGENT
- No collaborative action plans
- Reports on sequencing coconut genome from China, but not available in public domain





Issues in the research front

Coconut tissue culture

- Lack of viable tissue culture protocol for mass multiplication of elite and resistant material

Thank You