



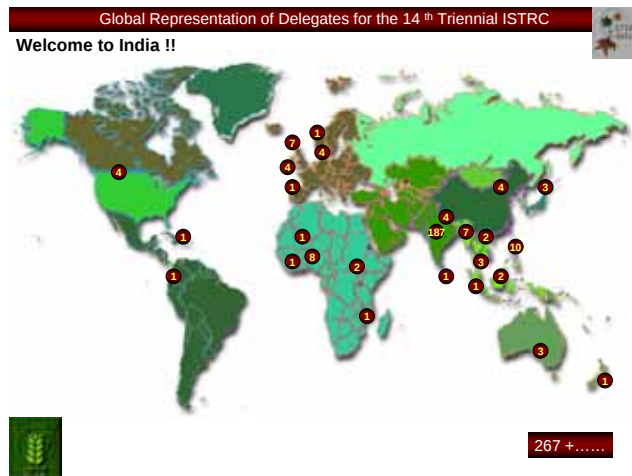
STATUS OF PRODUCTION, UTILIZATION AND MARKETING OF ROOTS AND TUBERS IN INDIA

Dr. S. Edison, Director, CTCRI, Thiruvananthapuram



Country Report delivered on the occasion of the 14th Triennial Symposium of the International Society for Tropical Root Crops at Mascot Hotel on 21st November 2006





INTRODUCTION





"Poverty is the worst form of violence" Mahatma Gandhi

"As long as hunger exists, peace cannot prevail" Willie Brandt

The Stark Realities !!!!

- From now on to 2020, India will have to gradually increase the production to around 400 m tonnes of grains
- The increase in production will have to be done under the reduced availability of land from 170 m ha to 100 m ha with reduced water availability with due attention to ecological balance

Our Challenge

"Our challenge is to attain 4% growth rate in farm sector within the shortest possible time and in a broad based manner"

Sharad Pawar



Second Green Revolution as having.....

- Farmers in focus
- Farming technology as the friend
- Food processing and marketing as partners
- Consumers as angels to be satisfied

..... Dr. A.P.J. Abdul Kalam



A Vision for the New Millennium

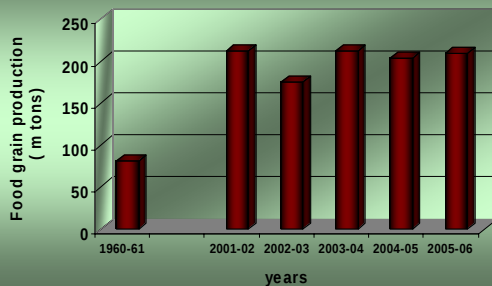
"Greater emphasis on tuberous crops such as potato, **tapioca** and **sweet potato** to make them available at cheaper rates"

Dr. A P J Abdul Kalam

Source : India 2020- A vision for the new millennium, p.71

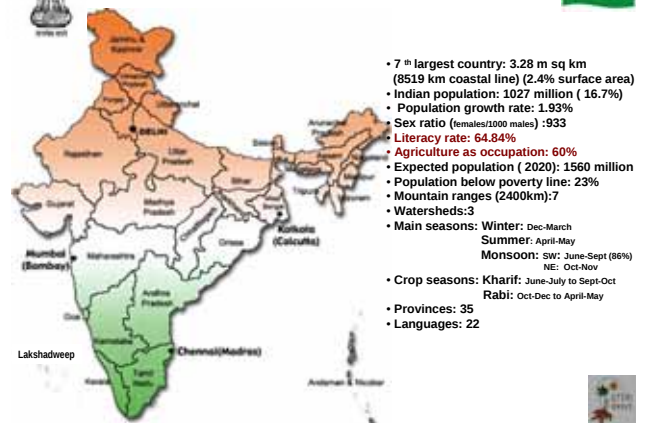


Food Grain Production Trend



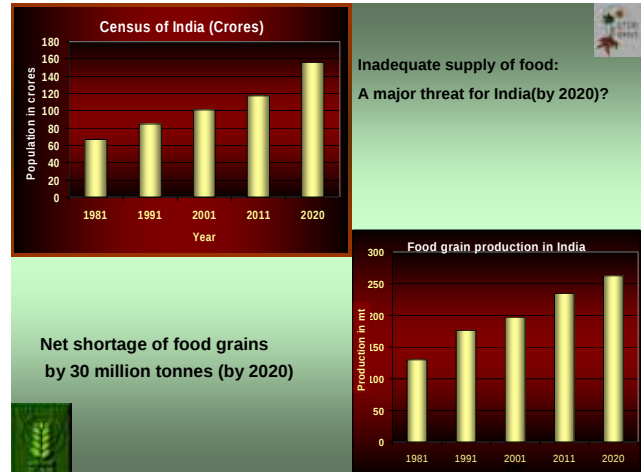
- Indian Agriculture has shored up its strengths to record a production of 212.05 m tons of food grains in 2003-04 from 82 m tons during 1960-61
- Ship to mouth existence of 1960's → Surplus (?) of 2000's
- From 2001-2004 India exported around 30 m tons of food grains

Fact file of Our Country: India





TRENDS IN AREA, PRODUCTION AND YIELD OF TROPICAL TUBERS

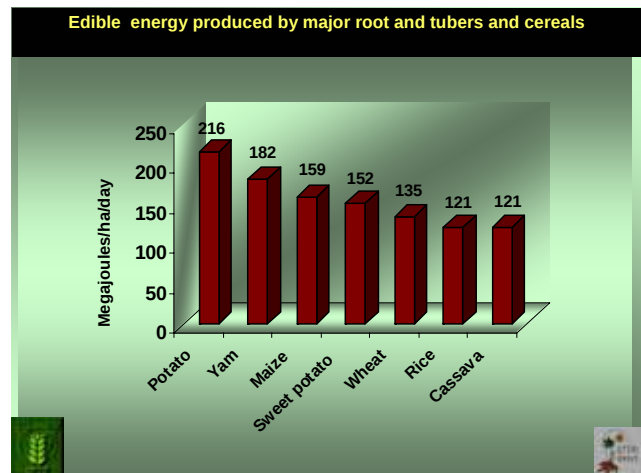


Bridging the Gap?

30 m tons of food grains~80 m tons of tubers

**Tropical tuber crops to bridge the gap
in food production (by 2020)**

**So,
Our Strategy to meet/ fill up this Gap.....**

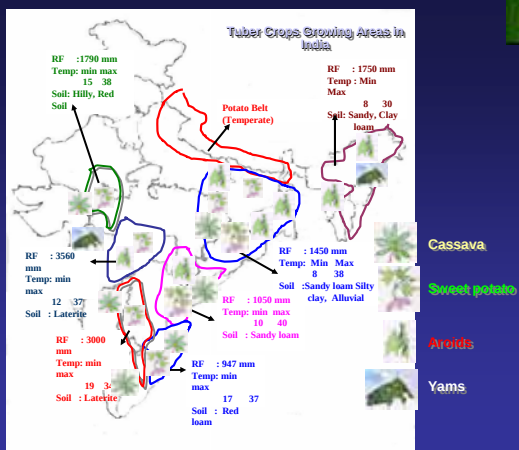


Tuber Crops Grown in India

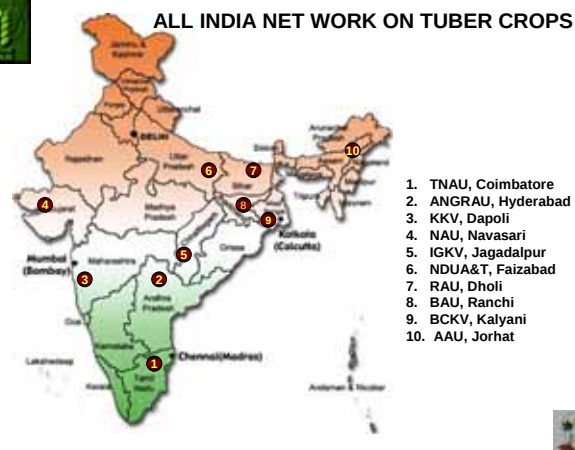
Cassava	<i>Manihot esculenta</i>
Sweet potato	<i>Ipomoea batatas</i>
Yams	<i>Dioscorea alata</i> , <i>D. esculenta</i> , <i>D. rotundata</i>
Elephant foot yam	<i>Amorphophallus paeoniifolius</i>
Taro	<i>Colocasia esculenta</i>
Tannia	<i>Xanthosoma sagittifolium</i>
Chinese potato	<i>Solenostemon rotundifolius</i>
Yam bean	<i>Pachyrrhizus erosus</i>
Arrowroot	<i>Maranta arundinacea</i>

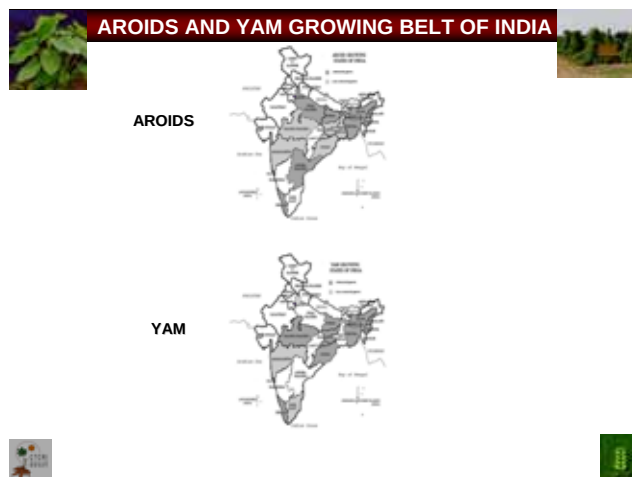
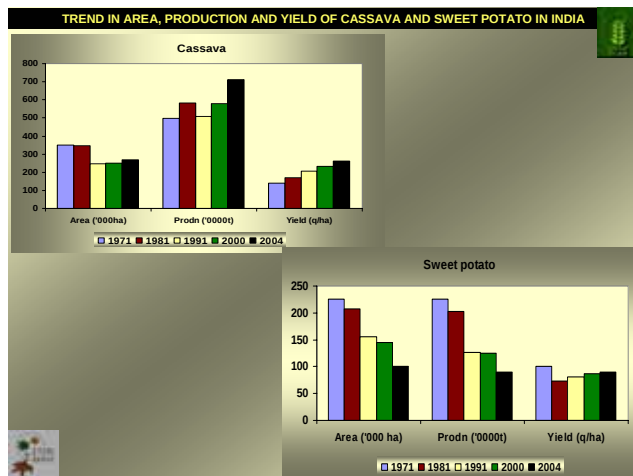
Nutritive Value of Tuber Crops

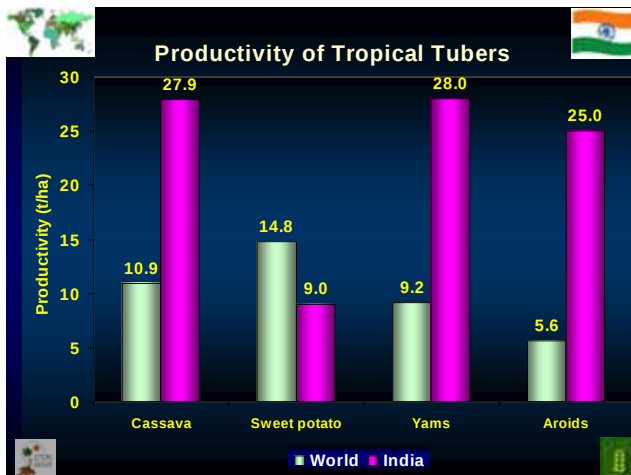
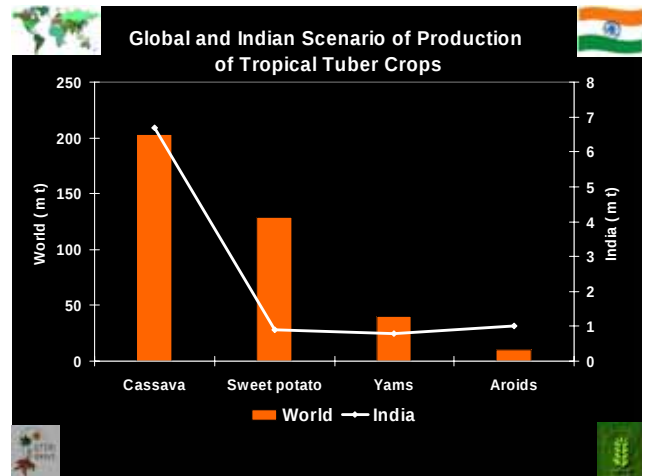
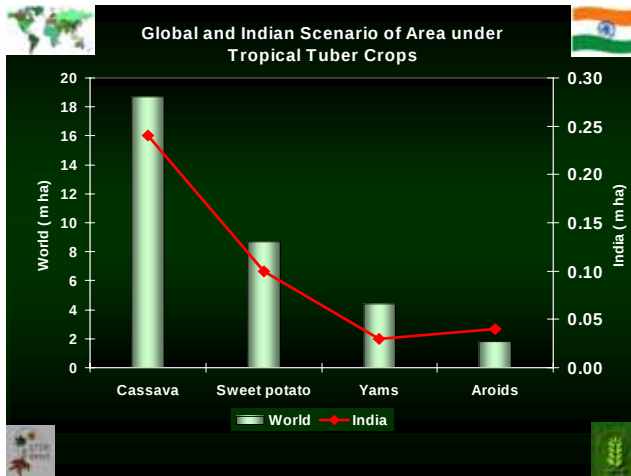
Characters	Cassava	Sweet potato	Yams	Aroids
Dry matter (%)	30-40	19-35	20-35	22-27
Starch (% FW)	27-36	18-28	18-25	19-21
Total sugars (% FW)	0.5-2.5	1.5-5.0	0.5-1.0	2.0
Protein (% FW)	0.5-2.0	1.0-2.5	2.5	1.5-3.0
Fibre (% FW)	1.0	1.0	0.6	0.5-3.0
Lipids (% FW)	0.5	0.5-6.5	0.2	0.15
Vitamin A (µg/100g)	17	900	117	0.42
Vitamin C (µg/100g)	50	35	24	9
Ash (% FW)	0.5-1.5	1.0	0.5-1.0	0.5-1.5
Energy (KJ/100g)	607	490	439	390
Anti-nutritional factors	cyanogens	trypsin inhibitors	alkaloids tannins	oxalate crystals
Starch extraction rate (%)	22-25	10-15	-	-
Starch granule size (micron)	5-50	2.42	1-70	1-12



ALL INDIA NET WORK ON TUBER CROPS







PRODUCTION

R and D on Tropical Tuber Crops is largely concentrated at CTCRI



GERMPLASM WEALTH OF CTCRI

CTCRI MAIN CENTRE, Thiruvananthapuram

Field Gene bank	: 5545 accessions
Cassava	: 1693
Sweet potato	: 927
Yams	: 859
Aroids	: 1184
Minor tubers	: 284

CTCRI RC, Bhubaneswar : 598

49 Varieties



Farmer friendly varieties of tuber crops

CASSAVA

Hybrids: H-97, H-165, H-226, Sree Visakhham and Sree sahya
Short duration: Sree Jaya, Sree Vijaya
High starch triploid: Sree Harsha
Top cross hybrids: Sree Rekha, Sree Prabha

SWEET POTATO

High yielding carotene rich lines: Sree Vardhini, Sree Rethna, Sree Bhadra, Gouri, Sree Kanaka
Short duration: Sree Arun, Sree Varun

YAMS

Sree Shilpa*, world's first greater yam hybrid
High yielding selection with good cooking quality: Sree Karthika
First dwarf bushy yam: Sree Dhanya
High yielding drought tolerant variety: Sree Priya, Sree Subhra
Lesser yam varieties with good cooking quality: Sree Latha, Sree Kala

TARO

Blight tolerant taro variety: Muktakeshi
First taro hybrid: Sree Kiran

ELEPHANT FOOT YAM

Sree Padma, Sree Athira (hybrid)
CHINESE POTATO: Sree Dhara

LATEST VARIETIES OF TUBER CROPS

SREE REKHA



SREE JAYA



SREE KANAKA



KALINGA

90/704

LATEST VARIETIES OF TUBER CROPS

SREE KARTHIKA



SREE SHILPA



SREE KIRAN



SREE ATHIRA



High starch triploid varieties Sree Apoorva (5-3) and Sree Athulya (4-2) and CMD resistant variety Sree Padmanabha (Mnga-1) will be released shortly !!!

Sree Apoorva



Sree Athulya



Sree Padmanabha

PRODUCTION TECHNOLOGIES AT A GLANCE

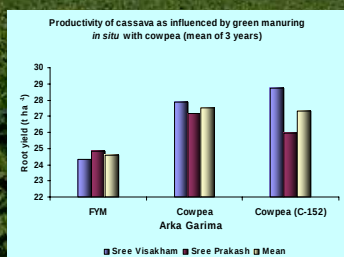
- Integrated production technologies to maximize production of tuber crops
- A simple farmer oriented technology aimed at rapid multiplication of quality planting materials
- Compatible and profitable cropping systems involving tuber crops
- Management practices for intercropping cassava with coconut, yams and edible aroids with coconut, banana and rubber
- Soil fertility management practices for continuous cassava cultivation
- Low input technology for cassava
- Fertilizer charts based on Site Specific Nutrient Management (SSNM)
- Soil test based fertilizer recommendation for various districts of Kerala, Tamil Nadu and Andhra Pradesh
- Organic farming technology for elephant foot yam
- Mycorrhizal technology for tuber crops

PRODUCTION OF QUALITY PLANTING MATERIALS



Year	Cassava	Sweet potato	Yams	EFY	Arrowroot	Taro
	stems (nos.)	cuttings (nos.)	(kg)	(kg)	(kg)	(kg)
2001-02	25845	2252620	2558	5480	44	48
2002-03	89515	1207900	3836	12610	742	2526
2003-04	30000	101200	9450	14350		220
2004-05	170975	750600	15263	8595	10	58
2005-06	5000	10000	1850	500		

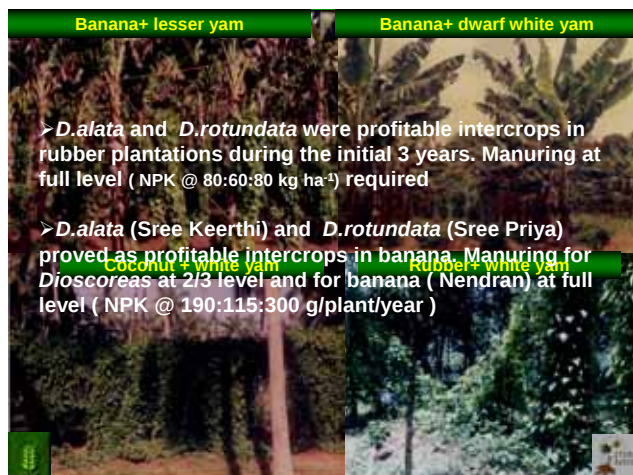
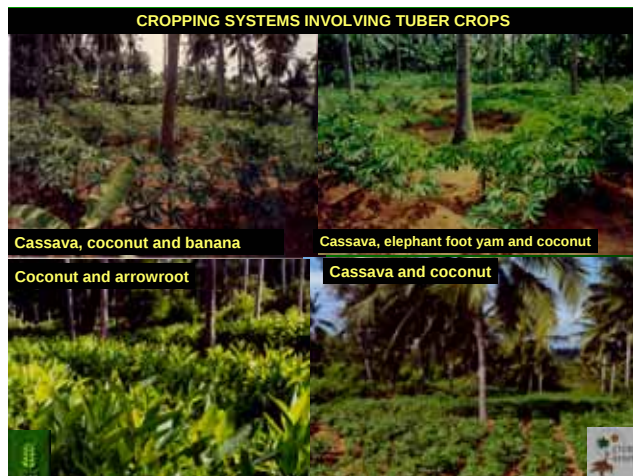
In situ incorporation of cowpea can replace FYM



Cow pea variety C-152 at 60 days
Yield: 15 t ha⁻¹

Soil Test Based Fertilizer Recommendation For Kanyakumari District Based on Soil Nutrient Survey

Location	FYM (t ha ⁻¹)	N (kg ha ⁻¹)	P (kg ha ⁻¹)	K (kg ha ⁻¹)	MgSO ₄ (kg ha ⁻¹)	ZnSO ₄ (kg ha ⁻¹)
Agastheswaram (U)	11	91	0	0	0	7
Agastheswaram (L)	11	91	41.5	0	0	5.5
Kalkulam (U)	11	91	0	94	0	9
Kalkulam (L)	11	91	0	0	0	7.7
Vilavancodu (U)	12	97	0	0	0	8.7



Management of CMD

- Use of healthy planting materials
- Use of meristem derived plants
- Growing field tolerant varieties (H 165, Sree Visakham, Sree Sahya)
- Rogueing & strict field sanitation
- Vector control - Spray 0.05% Dimethoate
- Production of virus free planting material in vector free areas
- Breeding for resistance
- Transgenic cassava resistant to CMD being developed
- Aqueous leaf and root extracts of *Boerhavia diffusa* and *Mirabilis jalapa* were found to inhibit the ICMV under glass house conditions



Integrated Pest Management (IPM) for sweet potato weevil

Pre-planting

- Disinfest the vines by dipping in monocrotophos (0.05%)
- Installation of pheromone traps, one trap per 100 m² (Rs 1000/- ha⁻¹)
- Re-ridging the crop at 30 and 60 days after planting (DAP)



CASSAVA TUBER ROT

- Major disease problem in TN
- No external symptoms in infected plants but could be identified only on the harvest of tubers. Tubers get discoloured and rot
- The causative organism was isolated and identified as *Phytophthora palmivora*
- Ridge planting, regulating irrigation, improvement of drainage condition, strict adherence to sanitation and use of *Trichoderma* sp helps in the management of the disease



BIOTECHNOLOGY IN TUBER CROPS

- TISSUE CULTURE
- MOLECULAR BREEDING
- TRANSGENICS
- INDUSTRIAL BIOTECHNOLOGY



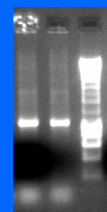
TRANSGENICS IN TUBER CROPS

- ❖ Development of transgenic cassava resistant to Indian cassava mosaic virus
- ❖ Improvement in protein content for better nutrition in cassava and sweet potato using *AmA1* gene from *Amaranthus hypochondriacus* (CTCRI-NCPGR PROJECT)

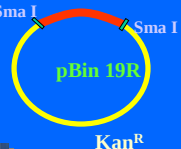
- ❖ Successful in the development of own gene constructs
- ❖ Standardised regeneration protocol (cassava)



Development of Transgenic cassava resistant to ICMD



Amplification of AC1 gene

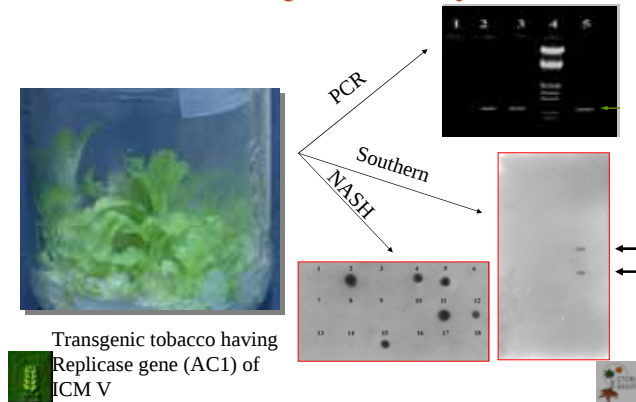


Cloning of AC1 in Ti plasmid vector



Tobacco plants transformed with ICMV AC1 gene

Analysis of AC1 gene incorporation in transgenic tobacco lines through Southern hybridization



Regeneration achieved in varieties most popular in industrial belt of Tamil Nadu viz. H 226 & H 165



UTILIZATION AND MARKETING

VALUE ADDITION TECHNOLOGIES	
Technologies	Commercialisation status
Alcohol from cassava	Patented; sold to 2 companies
Starch based biodegradable plastics	Patented; sold to 4 companies
Hand operated cassava machine	Patented; sold to 11 companies; recently 6 units were fabricated and given to individual takers; one piece exported to Nigeria (2006)
Centrifugal granulator for feed	Technology under commercialisation
Low cost waste treatment system for starch factory effluents	Technology demonstrated to 1 factory in Salem and being spread

VALUE ADDITION TECHNOLOGIES	
Technologies	Commercialisation status
Bio technique for producing fermented cassava flour	Patented; Popularisation as bakery substitute continuing
Cold water miscible starch	Patent application filed; Sold to one company; More enquiries in processing stage
Ensiling technology for cassava feed	Technology demonstrated to IVLP farmers; Popularisation efforts continuing
Value added food products from cassava and tuber crops	Technology popularisation through on campus and out reach training programmes to more than 500 SHGs, NGOs and farmers; 1500 farmers trained so far since 2003

VALUE ADDITION : CASSAVA

- Biodegradable plastics
- Ethanol
- Snack foods, fried food products
- Modified starches (cold water miscible starch, carboxy methyl starch)
- Gums & Adhesives from cassava starch
- Maltose & maltodextrins
- Citric acid from starch factory residues
- Semolina
- Extruded products (improved textural attributes)
- Silage and poultry feed



Cold water miscible starch

VALUE ADDITION: SWEET POTATO

- Sweet potato jam
- Sweet potato sauce
- Sweet potato pickles
- Sweet potato squash
- Maltose syrups and maltodextrins



Sweet potato jam

Sweet potato pickles

Maltose and maltodextrins

Sweet potato squash

VALUE ADDED FOOD PRODUCTS FROM CASSAVA AND SWEET POTATO



SNACK FOODS FROM CASSAVA



CUTLETS
Nutrition facts (per 100 g) Energy: 504 Kcal; Protein: 11.5 g; Fat: 25.2g



SAMOSAS
Nutrition facts (per 100 g) Energy: 467 Kcal; Protein: 11.9 g; Fat: 22.2g



LADDU
Nutrition facts (per 100 g) Energy: 436 Kcal; Protein: 1.0 g; Fat: 12.7g



BONDA
Nutrition facts (per 100 g) Energy: 485 Kcal; Protein: 12.8 g; Fat: 24.6g

PROCESSING EQUIPMENTS FOR TUBER CROPS



RASPER



FEED GRANULATOR



CHIPPING MACHINE



MOBILE STARCH EXTRACTION PLANT

Techno-Economic Feasibility Report

- TEFR-A tool for commercialization of technologies
- First to initiate such report making in ICAR system
- TEFR on Cassava Starch and Sago are available
- Ready reckoner to the interested entrepreneurs for starting cassava starch industry
- Price: Rs.5,510/- per copy for TEFR on Cassava starch and Rs.6,612/- per copy of TEFR on Sago
- Several interested organizations have already purchased



Production and Marketing Centres for Cassava and its Value Added Products in India

Categories	Cassava product	Major production centres	Consumer	Marketing centers
A	Raw tubers	Kerala, Tamil Nadu and Andhra Pradesh	Human consumption	Kerala, Tamil Nadu and Andhra Pradesh
B	Sago: Moti dana & Medium dana Nylon sago Sago waste	Andhra Pradesh & Tamil Nadu Tamil Nadu Andhra Pradesh & Tamil Nadu	Human consumption For sizing in textile industry	West Bengal, Maharashtra Uttar Pradesh, Andhra Pradesh, Tamil Nadu, Assam, Tripura North India Maharashtra, West Bengal
C	Starch	Tamil Nadu & Andhra Pradesh	Textile industry Adhesive manufacturers Liquid glucose, Dextrin manufacturers Confectionary Foundry Laundry Pharmaceuticals	Gujarat, Maharashtra, West Bengal
D	Chips & flour	Andhra Pradesh & Kerala	Gum manufacturers Sizing clothes Animal feed industry Snack food manufacturers	Maharashtra, Andhra Pradesh
E	Wafers, chips & pappad	Tamil Nadu	Human consumption	Gujarat, Delhi Maharashtra, Tamil Nadu, Kerala

MAJOR PRODUCTION AND MARKETING CENTRES OF CASSAVA PRODUCTS IN INDIA



TRANSFER OF TECHNOLOGY



- On farm testing of technologies
- Demonstration of technologies
- Awareness programmes, seminars, exhibitions
- Training programmes
- Mass media programme
- Video production
- Distribution of quality planting materials
- Linkage with SAUs
- Linkage with line departments
- Consultancy programmes



CTCRI LIBRARY HOLDINGS AND SERVICES



LIBRARY COLLECTION

- Books and Bound Journals :16005
- Reprints: 2625
- Current Journals: 84
- Theses: 60
- CD databases: 97 including AGRIS, CABI Crop CD, Crop Pest CDs
- Graduate Apprenticeship Offered

SERVICES PROVIDED

- Reading and reference
- CD search
- Internet search
- Photocopying
- Monthly current awareness services:
- AGRINEWS, Contents Page Service, Library News Service (on line through LAN)

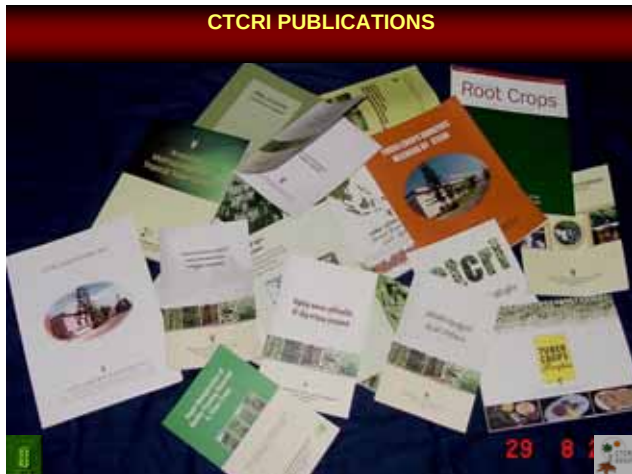


Awards and Recognitions

- J.J. Chinoy Gold Medal (1970)
- ICAR Team Research Awards (1985-86,1996-97, 1998-99)
- D.L. Plucknett Research Award (1991)
- Hari Om Trust Award (1993-94)
- Jawaharlal Nehru Award (1974, 1995,1998, 2000, 2003)
- Vasanthrao Naik Memorial Gold Medal (2002)
- Best Annual Report Award ICAR(1997-98)
- NRDC Cash Reward for Bio-degradable Plastics (2000)
- Pat Coursey Award ISTRC for Best Research in Yam (2000)
- Sardar Patel Outstanding ICAR Institution Award of ICAR (2005)
- Brazilian Award for Outstanding Research in Cassava Crop Improvement(2006)

17

CTCRI PUBLICATIONS



CTCRI MUSEUM



Automatic weather station



Modern Instruments Used for various Analysis



HPLC



Rapid Visco Analyser



Rheometer



Differential Scanning Calorimeter

Auto Analyser



Food Extruder



Atomic Absorption Spectrophotometer





Texture Analyser



Cryostat
Microtome



Image Analyser



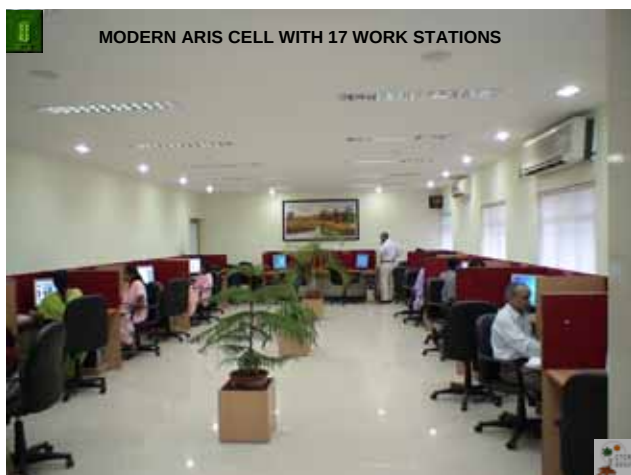
Cryo
Preservation
Unit



A VIEW OF THE TRANSGENIC LABORATORY



MODERN ARIS CELL WITH 17 WORK STATIONS



CHALLENGES AHEAD

- Breeding and development of transgenics for cassava mosaic resistance
- Developing high carotene lines of sweet potato
- Breeding taro varieties for drought and salt tolerance
- Introduction of leaf blight resistance in taro through transgenic methods
- Transgenics technology (nutritional genomics) for nutrient enhancement and value addition
- Large scale production and distribution of quality planting materials
- Low input technology for tuber crops
- Organic production of tuber crops



CHALLENGES AHEAD (contd....)

- Exploitation of biofertilizers and PGPRs for sustainable tuber crop production
- Micro nutrient management of tuber crops
- Studies on virus vector relationship
- Pest and disease resistance through biotechnology
- Development of bio pesticides from tuber crops
- Diversification for pharmaceutical sector
- Minimal processing of tuber crops for export
- Modifying starch quality through biotechnology
- Development of seed villages for tuber crops

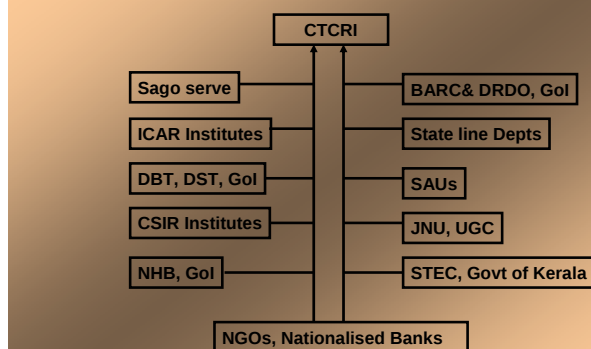
CHALLENGES AHEAD (contd...

- Farmers field schools in tuber crops
- Total factor productivity and impact assessment of research investment on tuber crop production technologies
- Commercialisation and costing of tuber crops technologies
- International trade studies
- International training facility
- Programmes for the development of North Eastern region

LINKAGES WITH INTERNATIONAL ORGANISATIONS



Linkages with National Organizations



TOP TEN TIPS ON TUBERS FROM CTCRI

- Released 46(+3) varieties of Tuber Crops from CTCRI (about 40 from AICRP centres and SAUs)
- Integrated Production Technologies
- Rapid Multiplication Techniques for QPMP
- Low Input Technology
- Integrated Pest Management Strategies
- Integrated Disease Management Strategies
- Value Addition Technologies
- Machinery for Post-harvest management
- Participatory Technology Development
- Techno-Economic Feasibility Reports

