



अनुसंधान की मुख्य विशेषताएं Research Highlights 2012 - 2013



केन्द्रीय कन्द फसल अनुसंधान संस्थान

(भारतीय कृषि असुसंधान परिषद्)

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Research Highlights 2012-13

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Front cover : Leaf blight resistant taro var. Muktakeshi
Back cover : Elephant foot yam tissue culture, High carotene orange fleshed sweet potato,
Carotene rich cassava



Contents

Preface	5
<hr/>	
Research Achievements	
<hr/>	
Crop Improvement	7
Crop Production	9
Crop Protection	12
Crop Utilization	15
Extension & Social Sciences	19
AICRPTC	22
<hr/>	
General	24
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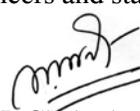
PREFACE

The Central Tuber Crops Research Institute established in 1963 with its headquarters at Thiruvananthapuram commemorates its golden jubilee during 2012- 2013. CTCRI along with its Regional Centre in Bhubaneswar is the only Institute in the world conducting exclusive research on tropical tuber crops. The Institute with the support of ICAR and other Indian and foreign funding agencies in collaboration with the sister Institutions of ICAR, SAUs, NGOs etc. accomplished significant achievements in the development and dissemination of tropical tuber crop technologies during 2012-13. It is our bounden duty to apprise our clientele including farmers; small, medium and large entrepreneurs; industrialists, extension personnel, policy makers, etc. about the salient achievements made by the institute during 2012-13. In that context, the highlights of the work done during the year 2012- 2013 are compiled and presented in this booklet.

The high yielding cassava clone Ce-185 has been identified and recommended for state release in Kerala by AICRP (TC) in its XIIth AGM. Number of promising clones (CR20A-2, 8W5, CR21-10, 9S127, CR43-11, CMR-100) with good tuber shape and fried chip quality were identified and are being evaluated under Preliminary Yield Trial and/or Advanced Yield Trial at CTCRI farm as well as in farmers' field. Current and future suitability maps of elephant foot yam cultivation in India and site specific nutrient management (SSNM) recommendations of elephant foot yam have been developed. Green manuring *in situ* as alternate source to FYM for cassava and organic production technology of taro have been standardized and most promising lines of sweet potato for saline soil have been identified. A Pilot Plant was commissioned to scale up the production of bio-fumigant from the rinds and leaves of cassava which is effective against stored product pests. *Trichoderma* and biofertilizers for disease management and sustainable production of *Amorphophallus* and greater yam, lateral flow device and reverse transcriptase – LAMP techniques for easy detection of DMV in *Amorphophallus*, coccinellid *Cryptolaemus montrouzeri* for bio-control of elephant foot yam mealybug are some of the salient achievements in the area of crop protection. Technology for low glycaemic and gluten-free pasta from cassava, process for the production of maltoligosaccharides debranched starch with high resistant starch content, biodegradable packaging films, extruded snacks etc. have been developed. Development of techno-economic feasibility reports (TEFR) for value added products, impact assessment of production technologies, interactive information management for tuber crops user system, bioinformatics tools for genomic data analysis are some of the other important contributions during the year. Outreach programmes for popularization of improved tuber crops technologies in NEH and tribal areas were undertaken during the year.

Let me place on record my sincere gratitude to Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR for his continuous guidance. I would also like to thank Dr. N.K. Krishnakumar, DDG (Horticulture) for his suggestions and encouragement. I congratulate the team who have brought out this compilation. I thank all the scientists, officers and staff members for their active participation in the advancement of our Institute.

Thiruvananthapuram
26.06.2013


Dr. S. K. Chakrabarti
Director

RESEARCH ACHIEVEMENTS

CROP IMPROVEMENT

- A large collection of 1923 cassava, 1472 sweet potato, 1151 yams, 921 taro, 277 elephant foot yam, 28 tannia, 212 yam bean, 130 chinese potato and 37 other minor tuber crops accessions are being conserved as field gene bank.
- Three hundred and fifty landraces of cassava were characterized and documented based on 12 key traits and 24 morphological duplicates were identified. Elite accessions were evaluated and the clones CI-898 and CI-75 were identified for higher yield and lower cyanogens (<30 ppm); CI-60 for early bulking, drought tolerance and higher yield; CR43-11 and CR43-7 for drought tolerance; CI-800, CI-802 and CI-859 for better cooking quality.
- The sweet potato genotypes ST-10 with high extractable starch (20.8 - 21.2%), ST-14 with high carotene (13.2 - 14.4mg 100g⁻¹) and ST - 13 with high anthocyanin (85 - 90 mg 100g⁻¹) were registered at NBPGR, New Delhi.



ST-10

ST-14

ST-13

- Identified 18 sweet potato accessions with high starch (22.2 - 24.8%) and minimum weevil damage (5 - 10%), five with low sugar content (< 3%), 13 with early maturity (75 - 90 days) and four with K and P efficiency.
- Fourteen wild species of sweet potato including *Ipomoea aquatica*, *I. carnea*, *I. trifida*, *I. coccinea*, *I. palmata* & *I. nil* were collected and maintained in the field as possible donors of resistance to sweet potato weevil in pre-breeding programme.
- Database of taro germplasm with passport data of 122 accessions, tuber photographs of 161 and disease scoring data of 342 was updated.



Variability in taro tubers

- Two genotypes of cassava (CR21-10 and CR20-A2) suitable for processing into fried chips have been identified through on-farm trial. A new promising clone (CMR-100) suitable for chips was identified along with CMD resistance, middle branching habit, uniform tuber shape (cylindrical), light yellow flesh, non-bitterness and high dry matter (43%).



Cassava tubers and chips of CMR100

- Promising cassava hybrids (9S-127 and CR35-18) with CMD resistance and high dry matter content ($> 40\%$), early maturity (CR43-11), and tolerance to post-harvest physiological deterioration (CI-800 and CR20-A2) have been identified.
- Promising greater yam accession (Da-331) with purple flesh and higher yield (28.0 t ha^{-1}); tall white yam hybrids (Dr-657) with higher yield (35.0 t ha^{-1}), good tuber shape and better cooking quality; dwarf white yam hybrids (Drd-1068, Drd-1157) with higher yield (25 t ha^{-1}) and good culinary quality have been identified through on-farm trial.
- Molecular markers RME-1 and SSR44/NS136 were confirmed and validated which could differentiate CMD resistant and susceptible lines of cassava.

- Draft DUS testing guidelines have been prepared for cassava with 53 traits including 9 grouping traits and for sweet potato with 34 traits including 7 grouping traits. Thirty three characters of 37 released sweet potato varieties and 26 characters of 14 released cassava varieties have been recorded. Seventeen pre-harvest characters of sweet potato and 11 characters of cassava have been validated for uniformity and stability.
- Thirty two pre harvest morphological characters of elephant foot yam and 31 characters of taro have been recorded for developing DUS testing guidelines.
- Six taro accessions were identified as early maturing type while 64% of the populations were tolerant to taro leaf blight in a European Union funded participatory trial.



Early maturing taro line

CROP PRODUCTION

- Rice-pulse-short-duration cassava cropping system was proved to be feasible at Thiruvananthapuram, Kerala. Green gram, black gram and soybean were equally compatible in rice based cropping systems involving short-duration cassava. There was a possibility to save half FYM and N and full P for cassava especially when black gram and green gram preceded cassava. Continuous cultivation of cassava for 8 years without any manures and fertilizers (absolute control) could sustain yield to the tune of 14.71 t ha⁻¹.



First crop of rice



*Second crop of pulse
Green gram Co Gg-7*



*Third crop of short- duration
cassava*

- The low input integrated practice of cultivating NPK-efficient cassava genotype (Ac. No.130) along with the nutrient management practice of application of organic manures, and chemical fertilizers including secondary and micronutrients based on soil test was found effective in sequestering atmospheric CO₂ to soil organic carbon. Organic farming proved to be equally productive as that of conventional practice in taro and dwarf white yam.
- Soil test based application of NPK @ 84:0:106 kg ha⁻¹ along with FYM @ 5 t ha⁻¹ produced yield in cassava (21.32 t ha⁻¹) on par with recommended POP (NPK @ 100:50:100 kg ha⁻¹+ FYM @ 12.5 t ha⁻¹) (24.70 t ha⁻¹).
- Integrated application of organic manures, secondary and micronutrients along with half of the recommended doses of NPK, significantly enhanced the cormel yield as well as quality of taro. Soil amendment with lime @ 0.5 t ha⁻¹ not only enhanced productivity and quality of the produce but also improved soil fertility.
- Drip irrigation in cassava at 100% CPE along with NK fertigation @ 50% during 1- 40 days, 30% during 41-80 days and 20% during 81-120 days gave significantly superior tuber yield. Significant yield could be obtained when 50% fertigation was applied during the first 40 days after transplanting.
- The recommended doses of fertilizer applied through fertigation in more number of splits resulted in higher corm yield of elephant foot yam while the corm yield with 40 numbers of split of recommended fertilizer was on par with 50 numbers of splits (32.5 and 33.5 t ha⁻¹ respectively). Maximum corm yield of 37.3 t ha⁻¹ was observed with fertigation at 4 days interval and 40 numbers of split application of recommended dose of fertilizer.
- Mulching with porous, black coloured plastic sheets resulted in complete suppression of weeds of all kinds with 60% additional tuber yield of cassava.



Mulching with porous black coloured plastic sheets

- Water deficit stress (WDS) during 4 and 5 or 5 and 6 months crop growth period significantly affected growth and productivity of *Amorphophallus* variety Gajendra. WDS during growth stages A to F i.e. from the time of sprouting (stage A) to development of full leaf (stage F) suppressed the development of leaf indicating that the initial establishment is a critical period of crop sensitivity to WDS and this crop growth period requires adequate soil moisture. Similarly, crop growth period between 4 and 6 months is also a critical period which requires adequate soil moisture for crop productivity.
- Analysis of gene expression profile of adventitious and tuber forming roots of sweet potato revealed differential gene expression under ambient temperature and heat stress condition.
- In sandy clay loam soils, moisture level at 50% water holding capacity (WHC) was on par with moisture at 100% of WHC level on the rate of P mineralized but significantly different and higher as compared to air dry conditions (2.83 against 3.54 kg P ha⁻¹ per season). Higher level of P had a significantly higher mineralization rate of 4.53 kg P ha⁻¹ per season as compared to control (2.61 kg ha⁻¹ per season) in sandy loam soils.
- The three years field experimentation with 6 selected K efficient genotypes of cassava at four different levels of K indicated the efficacy of these genotypes to perform equally well without K as well as at higher levels of K with Aniyoor and 7 III E3-5 superior for edible and industrial purposes respectively.



K efficient genotypes

- Developed nutrient management plan for Pathanamthitta district of Kerala giving emphasis to tropical tuber crops after analyzing 10,348 soil samples for pH, organic carbon, major, secondary and micronutrients. In six major hill cassava production systems of Eastern and Western Ghats in Tamil Nadu with different elevations, soil type, soil fertility management levels etc. were characterized for major soil physical properties and nutrient contents.

- Prepared a nutrient rich organic manure through composting of cassava starch factory solid waste (thippi) having mean N, P, K, Ca, Mg, Fe, Cu and Mn content of 1.32, 3.82, 0.4, 2.18, 0.96, 1.11, 0.08%, 11.23 and 89.93 ppm respectively, which is 3.5, 49, 7, 3.25, 8.1, 185, 100, 2.5 and 12 times than that in thippi with reduced starch, cellulose, cyanide and fibre and enhanced protein content.
- Zeolite materials with high cation exchange capacity were synthesized from fly ash for enhanced soil nutrient retention. Dose of zeolites for soil application was standardized. Evaluation of its suitability as soil amendment in sweet potato (variety ST-14) indicated 57% tuber yield over control (no zeolite).
- Identified salt tolerant sweet potato varieties CIP-440127, Samrat and Pusa Safed suitable for cultivation in salt affected areas.



Sweet potato tubers obtained in soils treated with 1% Fly ash zeolite

CROP PROTECTION

- Malathion, chlorpyrifos and methyl parathion at 0.5% concentration completely controlled adult yam mealy bug (*Rhizoeus amorphophalli*) two days after treatment. Elephant foot yam mealybug (*Rhizoeus amorphophalli*) was successfully controlled in storage by releasing coccinellid (*Cryptolaemus montrouzieri*) @ 2 beetles per kg tuber at a temperature of 25 to 30°C. The parasite *Anomalicornia tenuicornis* Mercet (Encyrtidae) controlled 15-20% of *R. amorphophalli* in storage.
- A Pilot Plant was installed to scale up the production of bio-fumigant from the rinds and leaves of cassava. Two bio-formulations from the bioactive principles of cassava seed, one effective in controlling pseudostem weevil in banana and the other for management of aphids, were developed.
- Two repellents for female sweet potato weevil *Cylas formicarius* were identified as α -Humulene and α -Gurjunene. Feeding deterrents for *C. formicarius* were identified as 2-(2-butylcyclopropyl)-cyclopropanonanoic acid methyl ester and 9,12 - (Z,Z)-octadecadienoic acid released from flowers and storage roots, respectively.

- Dasheen mosaic virus (DsMV) in *Amorphophallus* was detected through Lateral flow device and Reverse transcriptase – LAMP techniques. DsMV, *Broad bean mottle virus* and *Hibiscus singapore virus* were detected through deep sequencing of virus infected *Amorphophallus* samples. Transcriptome analysis of elephant foot yam revealed differential gene expression in infected and healthy samples. An efficient callus multiplication and regeneration procedure has been developed for the production of virus free plants.



Shoot regeneration in *A. paeoniifolius*

- Yam Maclura virus was detected from leaves and tubers of greater yam using virus specific primers and antibody and diagnosed through NASH technique. The partial genome of the virus was amplified with specific primers. Sequence analysis showed 69% similarity to *Chinese yam necrotic virus*.
- Specific primers were designed using RAS-like, TRP1, GPA1 and ASF-like regions for accurate detection of *P. colocasiae*. Simple and rapid *in vitro* methods were developed for zoospore generation in *P. colocasiae* and screening taro accessions against leaf blight.
- Correlation between virus titre and CMD symptom severity like susceptible, recovery and resistant, was established using quantitative PCR. A qPCR protocol was standardized for detection and quantification of *P. colocasiae* inoculum load in infected taro leaves.



Taro blight lesions

- Soil and tuber treatment with *Trichoderma* @ 50 g of 10^7 cfu g^{-1} and 5 g in fresh cow dung slurry per kg of tuber respectively, along with foliar application of Carbendazim @ 0.05% three times at 15 days interval after initiation of the symptom was most effective for the management of greater yam anthracnose caused by *Colletotrichum gloeosporioides*. Toxin produced by the pathogen has been purified and partially characterized using TLC and column chromatography. Lesion produced on leaves *in vitro* using crude toxin was positively correlated with field symptoms.



Trichoderma tuber treatment

Inoculum for soil treatment

Spraying fungicides

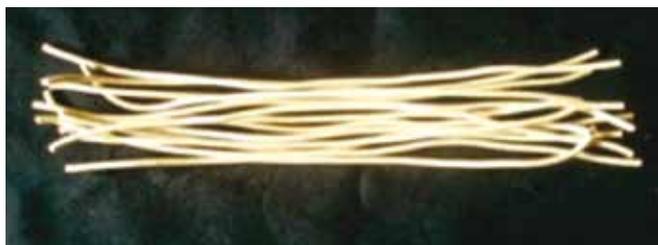
- Planting material treatment with cow dung mixed with *Trichoderma* (@ 5g per kg), use of *Trichoderma*-enriched compost and application of 200 g neem cake per plant resulted into 22% higher corm yield and 80% reduction in collar rot incidence, 15% reduction in leaf blight and 10% reduction in mosaic incidence over control in the farmer's field. ITS and tef characterization of 10 isolates of bio-control agents (BCA) against *Sclerotium rolfsii* identified three different species, viz., *Trichoderma asperellum*, *T. harzianum*, and *T. longibranchiatum*. RAPD analysis revealed high polymorphism among isolates, even within the same species.
- Potent bio-control agents of vermi-compost origin against taro leaf blight and elephant foot yam (EFY) collar rot were identified as *Bacillus subtilis*, *B. cereus*, *Providencia rettgeri* and *T. asperellum*. The bacterial isolates expressed N_2 fixing, P and K solubilizing and growth promotion properties. Disease suppression varied with the origin of vermi-compost. Minimum concentration of 10% was required for pathogen suppression. Application of vermi-compost reduced the taro leaf blight incidence (PDI of <5) and collar rot in elephant foot yam (10-30%) in pot culture. Vermi-wash reduced the lesion development by *P. colocasiae* on detached taro leaves *in vitro*. Production of defense enzymes; chitinase, glucanase and total phenols increased with application of vermi-compost in taro plants.



Suppression of taro blight and collar rot of EFY by vermiwash

CROP UTILIZATION

- Technology standardized for the production of sweet potato spaghetti with low starch digestibility and low estimated glycaemic index (EGI) using legume flour sources and low glycaemic pasta from cassava using commercial resistant starch source, NUTRIOSE®.



Sweet potato spaghetti

- Low calorie sago with higher resistant starch content (35%) compared to control sago (23%) in was developed.
- Low cost simplified technique developed for the purification of linamarin (toxic glucoside of cassava) from cassava leaves and rind. Linamarin nanoparticle may find use in targeted drug delivery.
- Cassava leaf protein concentrate was prepared using cheap methods and its efficiency as fish meal substitute was tested in ornamental fish in collaboration with CMFRI, Kochi. Twenty percent LPC incorporation resulted in maximum gain in weight of Black Molly fish.
- Dehydrated cassava leaf meal was tested as an animal protein supplement in collaboration

with the Kerala Veterinary and Animal Sciences University (KVASU). Replacement of concentrated feed with 30% leaf meal gave the largest weight gain in goats.

- Technology for value added fried snack food from cassava was commercialized to five entrepreneurs. Setting up of a Techno Incubation Centre for the commercialization of value added products from tuber crops was approved by the Department of Agriculture, Govt. of Kerala, under the 'Value Addition Scheme' of Small Farmers' Agribusiness Consortium.
- Extruded products were developed from blends of cassava with cardamom, black pepper, turmeric, rice-banana, rice-wheat etc. The best fermented cassava-wheat-rice blended extrudate was obtained at 200°C die temperature and 80 rpm of extruder speed. A highly expanded product was obtained from sweet potato turmeric blend at 180°C and 92 rpm of extruder screw speed.



Fermented cassava, wheat and rice flour extrudates

- Lacto pickle of orange fleshed sweet potato with carrot and beet root (1: 1: 1 ratio) was developed by lactic fermentation with a probiotic strain of *Lactobacillus plantarum* (MTCC 1477).
- Alpha amylase enzyme from *Bacillus subtilis* strain CM 3 earlier isolated from cow dung microflora was purified and used in amendment with the commercial saccharifying enzyme (Palkodex, 10 ml, v/v, M/S Maps Enzyme Ltd, India) for hydrolysis of sweet potato flour and subsequently to ethanol. After 120 h of fermentation, the maximum yield of ethanol was 380 ml per kg flour.

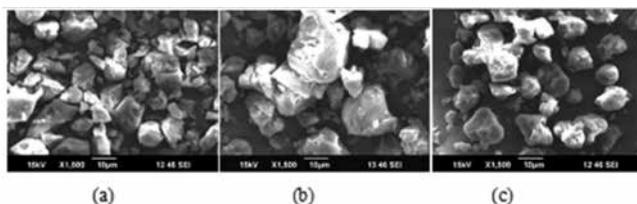
- A vibro sieving system for sieving wet starch slurry was developed. Industrial evaluation of vibro sieving system was carried out at three deck slopes and two sieve sizes (250 & 400 mesh) and the results showed that the concentration of the feed and output were 8.2% and 9.3%, respectively. The whiteness of starch in feed and output were 93.0 and 97.05%, respectively.



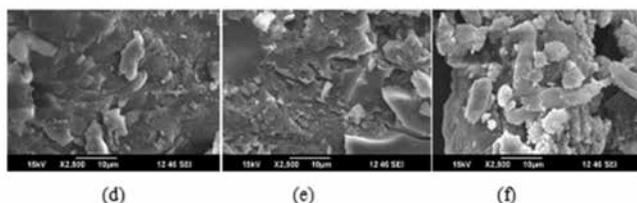
Industrial evaluation of starch vibro sieving system at M/S T.A.Perumal Starch Industries, Salem

- Recovery of starch could be enhanced through ultrasound sonication at 450 W energy level and 50% pulsation rate for 10 minutes. The whiteness of the recovered starch ranged from 88.50 to 96.22% and maximum whiteness was obtained at 600 W energy level and 70% pulsation rate when treated for 10 min.
- Developed modified cassava starch (hydroxypropylated and cross linked)-nano clay (nanocalibre 100A-Amino silane modified nanokaoline clay) and nanocalibre 100 SD (nanokaoline clay in spray dried form) composite biodegradable films. Hydroxypropylated / crosslinked starch-nanocalibre 100 A film had maximum whiteness index and tensile force with minimum total colour change and solubility. Hygroscopicity of crosslinked starch-nanocalibre 100 A film was minimum with 0.09 g g⁻¹ for 4% starch-0.3% clay and 20% glycerol composites. Among the cassava starch-wax composite films, maximum thickness, whiteness index, tensile force and elongation at break with minimum total colour change, swelling power and solubility obtained for starch-bee wax films. Minimum hygroscopicity was obtained for the films with 0.108 g g⁻¹ and 0.102 g g⁻¹ for 3% starch-10% bee wax / parafin wax and 15% glycerol composites.

- The oligosaccharide profile of the maltooligosaccharides synthesized by the dual enzymatic process of cassava, maize and potato starches using a commercial starch debranching enzyme, pullulanase and a thermostable alpha-amylase, Spezyme (Genencor), was determined by HPLC analysis. The product contained maltotriose, maltopentaose, maltohexaose and maltoheptaose as major oligosaccharides.
- The morphology and crystallinity of the enzymatically debranched cassava and potato starches were determined. All debranched products showed higher percentage crystallinity than the corresponding native starches. After debranching, cassava starch showed a transition from A-type to B-type pattern via type-C. Loss of granular structure was observed in the debranched starches.
- A comparative study of the structure and properties of the naegeli dextrans and lintnerized starches of cassava (a tropical tuber starch), potato (a temperate tuber starch) and maize (cereal starch) was performed. The dextrans of all the three starches showed complete erosion of amylose fraction. The morphology, crystallinity, aqueous solubility, thermal properties and *in vitro* digestibility of the dextrans were determined and compared.



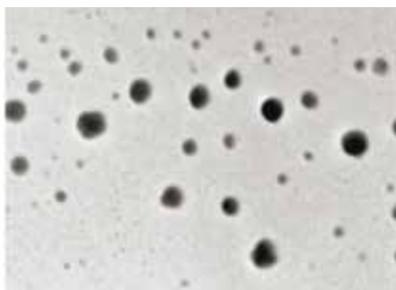
Lintnerized starch after 6 days of acid hydrolysis (a) cassava, (b) potato and (c) maize



Lintnerized starch after 35 days of acid hydrolysis (d) cassava, (e) potato and (f) maize

- The residual acrylamide content in the porous sample of superabsorbent polymeric gel was determined and no detectable monomer was observed. The cassava starch based semi-synthetic superabsorbent hydrogel was evaluated under field conditions, as a soil additive for moisture retention and its effect on physical, chemical and biological properties of the soil as well as on plant growth parameters was studied. The sample with higher percentage of starch showed 78% degradation after 5 months of disposal in soil. The product was tested for its efficiency to remove heavy metal ions from aqueous solutions and the adsorption was maximum for Pb^{2+} ions (about 66%), whereas it was minimum for Zn^{2+} (2%).

- Cassava starch-g-poly (methacrylamide) having good flocculation efficiency was synthesized and characterized. These grafted starches exhibited good textile sizing properties.
- Nanostarch was synthesized from cassava starch, characterized and incorporated in composites for evaluation as matrix for incorporation of curcumin.



Nanostarch particles under TEM

EXTENSION AND SOCIAL SCIENCES

- Non-monetary practices, viz., land preparation, selection of seed material, seed size, depth of planting, spacing, method and time of fertilizer application and inter-culture operations were adopted by the farmers as per the recommendations in West Bengal for taro and yams and in Odisha for elephant foot yam. Farmers of Andhra Pradesh growing elephant foot yam and yams were also adopting fertilizer as per the recommendation. Some farmers indiscriminately used fertilizers, pesticides and fungicides in all the surveyed villages. Average adoption index with regard to the selected sweet potato production technologies in Odisha was estimated as 55.61.



Taro field in West Bengal

- Under the rain-fed conditions of Andhra Pradesh, the short duration triploid cassava line 3-4 performed well and preferred by the farmers with an average tuber yield of 19 t ha⁻¹ and extractable starch content of 27%.
- Tapioca starch demand in textile sector was 85 lakh tonnes for 2011 and the projected demand for 2016, 2021 and 2026 is 0.9; 1.01 and 1.15 lakh tonnes respectively. Tapioca starch demand in corrugation adhesive sector was 1.15 lakh tonnes for 2011 while the projected demand for 2016, 2021 and 2026 at current growth rate of 10% in the industry is 1.85; 2.98 and 4.36 lakh tonnes, respectively.
- Techno-Economic Feasibility Report (TEFR) was prepared on Pasta from sweet potato and gluten free pasta from cassava. Total capital investment for each unit with a working capacity of 38.4 tonnes sweet potato pasta and gluten free pasta from cassava was at Rs. 44 and 45 lakh respectively.
- An EST analysis pipeline developed for the analysis of EST from tuber crops and distribution studies of SSR in EST data of cassava, sweet potato and yams were carried out; 5489, 3373 and 2267 SSR containing sequences were identified for cassava, yams and sweet potato respectively.
- An R function developed for SSR prediction, which identifies the location of the SSR in the sequence and the number of repeats. With a view to develop tools for miRNA analysis, an miRNA target prediction tool for the given mRNA sequence and miRNA sequence has been developed in R package incorporating sequence similarity score and energy prediction.
- Developed a disease diagnostic system of cassava (An expert pathologist) on the web. This helps the users to clear their doubts regarding various cassava diseases and potential yield of cassava in all the 15 agro climatic zones of India. Tuber information café (TIC) was modified by including more user friendly features. On-line facility for early warning about mealy bug was developed using PHP/MySQL and launched. A simulation model about the dynamics of mealy bug has been developed.



- About 20 tuber crops dishes from Nagaland (Konyak tribe – 17 and Aao tribe – 3) were documented. Semi-processed taro products like Teangyakwan (processed taro leaf), Teangwan (dried taro tubers), Fluo (dried taro leaves), (processed taro petioles) and Tungan (dried taro tubers) were documented. Several home-based recipes like Teangyakhoi, Teanghoi, Teang, Fluo Curry, Tung Rahak Sui, Tungkungsui, Tungrhak, Tunkhon, and Tung Pai were also documented.



Tungrhak



Shouhwan



Fluo Curry

CTCRI - NEH PROGRAMME

For Enhancing food security and sustainable livelihoods in the North-Eastern India through tuber crops technologies, a baseline survey was conducted in Manipur, Meghalaya, Nagaland and Tripura to identify the present livelihood status of the tuber crops farmers in the project villages. Besides the livelihood status, the major tuber crops production systems, the farmers' food insecurity status, proneness to shocks and disasters and their

coping strategies were also studied. The project partners were equipped in the knowledge and skills necessary for conducting the livelihood survey through training programmes in Manipur, Meghalaya, Tripura and Nagaland.



CTCRI - TSP PROGRAMME

Under Tribal Sub Plan (TSP), systematic effort was undertaken to improve the productivity of root and tuber crops by careful application of improved technologies. Thus the focus more on outreach programmes complemented with need based research modules which would be done through support of seed materials development and distribution, knowledge dissemination, production processing linkage, capacity building and entrepreneurship building. During the year 2012-13, 465 tribal farmers were identified as beneficiaries from Chhatisgarh (Narayanpur district), Jharkhand (Deogarh) and Odisha (Kandhamal and Koraput districts) state and laid out 665 demonstrations on tuber crops technologies. Planting materials of different tuber crops were distributed to them. Capacity building training programmes were organized for the tribal farmers one each in Narayanpur, Deogarh, Kandhamal and Koraput districts on root and tuber crops

ALL INDIA COORDINATED RESEARCH PROJECT ON TUBER CROPS (AICRPTC)

A total of 175 new accessions on various tuber crops were added to the field gene bank, thus maintaining a total of 4666 accessions in various AICRP Tuber Crops centres. Molecular characterization of genotypes of taro (20), EFY (18), Sweetpotato (45), Swamp taro (15) and yam bean (11) have been done using RAPD, SSR markers at BCKV, Kalyani. The elite germplasm accession (Me 833) has been released as TNAU Tapioca Yethapur 1 during 2012 – 2013. Green manure @ 50 kg along with 5 kg each of N- fixing and P- solubilizing biofertilizers could reduce the nitrogen and phosphorus requirement of cassava to 50%.

Integrated weed management in cassava indicated that four hand weedings was equivalent to black polythene mulching for weed control giving maximum tuber yield and weed control efficiency. Intercropping elephant foot yam with turmeric/ ginger in 1:2 proportion appeared to be the best combination for maximum yield equivalents and land equivalent ratio. Yam bean seed extract@ 5% was found very promising against yam bean pod borer. On the basis of pooled mean of three years data amongst 140 yam bean genotypes, only six genotypes viz; DL-1, DPH-11, DPH-33,DPH-45, DPH-82 and DPH-70 exhibited relatively high level of field tolerance to yam bean pod borer.

E-networking of centres of AICRP on tuber crops became functional and all the centres started using the network effectively for uploading the information.



GENERAL

TRAINING AND OTHER RELATED PROGRAMME

The following training and related programmes have been conducted by CTCRI

- Two training programmes, one on “Value addition of tuber crops and use of bio-pesticides from cassava” was organized for the officials of Krishi Vigyan Kendras (KVKs) in Mizoram on 1st July 2012 and the second one for farmers on 2nd July 2013 at ICARNEH Mizoram Centre, Kolasib.
- A technology intervention programme was launched on “Enhancing food security and sustainable livelihoods in the North-Eastern India through tuber crops technologies” in the form of a planning and inception workshop conducted at ICARRCNEH, Meghalaya during 24-25, July 2012.



- A “Seminar-cum-training on improved tuber crops technologies” was organized on 21st September 2012 at ICARRCNEH Nagaland Centre, Jharnapani, Nagaland along with ICARRCNE, Barapani, Meghalaya.
- National training programme by AICRP on “Tuber crops germplasm conservation, climate change mitigation & e-networking” was inaugurated by Dr. Shashi Tharoor, M.P. at CTCRI on 24th September, 2012.
- “Training workshop on sustainable livelihood assessment and value chain analysis” was organized during 24-26 September, 2012 at ICARRCNEH Nagaland Centre, Jharnapani, Nagaland along with ICARRCNEH, Barapani, Meghalaya.
- The All India level “Model training course on sustainable management strategies of tuber crops based cropping systems” sponsored by the Directorate of Extension, Ministry of Agriculture, Govt. of India was organized at CTCRI during 5-12 October, 2012.

- A “Seminar-cum-training programme on tuber crops technologies” was organized on 16th October, 2012, at ICAR Tripura Centre, Lembucherra, Tripura.
- A training programme on “Improved tuber crops production technologies for NEH Region” under CTCRI-NEH programme was organized at CTCRI during 3-7 December, 2012.

IMPORTANT EVENTS

- All India PG Entrance examination of ICAR for Admission to PG programme and the award of ICAR Junior Research Fellowships (JRF) : 17th April, 2012
- 38th Institute Research Council Meeting : 24 - 26 April, 2012
- HH Sree Visakhram Tirunal Endowment lecture was delivered by Prof. V.N. Rajasekharan Pillai, Executive Vice-President, Kerala State Council for Science, Technology and Environment (KSCSTE) and Ex-officio Principal Secretary, Department of Science and Technology, Government of Kerala : 18th May, 2012
- XII Annual Group Meeting of AICRP on Tuber Crops : 18 - 20 June, 2012
- Foundation day and launching of cassava biofumigant pilot plant : 10th July, 2012
- Vigilance Awareness Week : 29th October to 3rd November, 2012
- TUBER FEST 2012 : 29 - 30 November, 2012
- Golden Jubilee celebrations of CTCRI Curtain raiser by HH Dr. A.P.J. Abdul Kalam, Ex- President of India : 28th January, 2013
- Research Advisory committee meeting : 14 - 15 February, 2013
- National Science day : 28th February 2013
- Institute Management Committee meeting : 15th March, 2013
- Field Experience Training (FET) to six ARS probationers of 97th FOCARS : 23rd February to 15th March, 2013.



PARTICIPATION IN EXHIBITIONS

Participated in 12 exhibitions in different places of Kerala and Odisha.

VISITS ABROAD

Thirteen scientists visited abroad to impart training, attend training, as a consultant, invited speakers, to attend international symposium, workshops and conferences.

PUBLICATIONS

Papers in research journals	: 64
Book chapters	: 20
Popular articles	: 3
Folders/leaflets/pamphlets	: 3
Papers in conferences/proceedings/seminars	: 63
Chapters in training manual/news etc	: 6
Books /Technical reports	: 7
Technical bulletin	: 4
Annual reports (CTCRI and AICRPTC)	: 2
CTCRI News	: 4

AWARDS/ RECOGNITION

- Regional Centre was awarded as second best Centre in Horticulture at exhibition of Global Conference on Horticulture for food, nutrition and livelihood options held during 28th - 31st May, 2012 at OUAT, Bhubaneswar.
- Dr. G. Byju, Principal Scientist, Division of Crop Production was awarded Dhiru Morarji Memorial Award for the best research paper published in Indian Journal of Fertilizers during 2011. The award was presented by Sri Srikanth Jena, Union Minister of State for Fertilizers during FAI Annual Seminar 2012 in Agra on 10 December 2012.
- Dr. Rajasekhara Rao Korada, Senior Scientist was conferred Norman Borlaug Science and Technology Fellowship to conduct research on “Insect-plant chemical interactions in sweet potato” with Prof. Micheal Stout and Dr. Jeff Davis, Dept. of Entomology, Louisiana State University, Baton Rouge, USA during 24th September to 14th December, 2012 by United States Department of Agriculture-Foreign Agricultural Service (USDA-FAS).
- Dr. C. A. Jayaprakas, Principal Scientist & Head, Division of Crop Protection was presented the “Swadeshi Innovation Award 2012” by Sri. Sri. Ravisankar, instituted by Swadeshi Science Movement for the contribution on the “isolation of bioactive

principles from cassava and formulation of biopesticide against the pest of field crops and stored products

- The Sardar Patel Outstanding Agricultural Institute Award for 2005 was won by this Institute. The cash award of ` 5 lakhs was received in 2006. The interest from the money was utilized to award the following best administrative staff, technical, skilled and support staff of CTCRI for 2007 to 2012. The award was presented by Dr.APJ Abdul Kalam on 28th January 2013 during golden jubilee celebrations curtain raiser.

	Administrative	Technical	Skilled Supporting Staff
2007	Smt. K.V. P.Sarada	Sri. M. Manikantan Nair	Sri. K. Saratchandra kumar
2008	Smt. R. Bhagavathy	Sri. V.R. Sasankan	Sri. A. Chandran
2009	Sri. T. Vijayakumara Kurup	Sri. N.C. Jena	Smt. P. Sarojini
2010	Sri. T. Jayakumar	Sri. A. Madhu	Sri. S. Radhakrishnan Nair
2011	Smt. C.K. Syamalakumari Amma	Sri. C.S. Salimon	Sri. K.C. Jena
2012	Sri. S. Sasikumar	Sri. B. Renjith Kishore	Sri. Samsuddin Khan

DISTINGUISHED VISITORS

More than fifty distinguished personalities visited CTCRI including Dr. A. P. J. Abdul Kalam, Ex-President of India , Shri. K.P. Mohanan, Minister for Agriculture, Govt. of Kerala, Dr. Shashi Taroor, M.P., N.K. Krishna Kumar, DDG (Hort.), ICAR, New Delhi ,Dr. Umesh Srivastava, Assistant, Director General (Hort. II), ICAR, Dr .V.L. Chopra, Former DG, ICAR, Dr. Kirti Singh, Ex- Chairman, ASRB.

LIBRARY SERVICES IN BRIEF

During the period, 73 books, 20 journals, and current protocols in Molecular Biology (six volumes) and RHS Colour Chart were added to the stock. Services include CD-Searches , Ready-reference service, AGRINEWS, circulation of books and photocopying. Developed two softwares for photocopying and book loan register to help the users and to assist the routine library activities in asp.net application.

INSTITUTE TECHNOLOGY MANAGEMENT UNIT

Institute Technology Management Unit (ITMU) of the Institute has been active in carrying out following IP activities during the period 2012-13.

The unit had engaged with public / private parties for the commercialization of technologies. Technology of value added fried products and fried chips from cassava have been tranferred to five parties on a consultancy mode. An assignment deed has been made with National

Research Development Corporation (NRDC), New Delhi-110048 for the commercialization of CTCRI developed machineries. MOU has been made with Small Farmers Agri Business Consortium, SFAC (Society under the Department of Agriculture, Govt. of Kerala), Thampanoor, Thiruvananthapuram for setting Techno Incubation Centre (TIC) for Agro-processing of tuber crops. Agreement was made with M/s. Matha Engineering Works Thumba, Thiruvananthapuram for licensing of knowhow of cassava chipping machine and mobile starch extraction unit. The ITMU has taken initiative in filing one provisional and two complete patent application.



NEW JOINING

Dr. S.K. Chakrabarti, Principal Scientist, CPRI, Shimla joined as the Director of CTCRI on 2nd April 2012.

Dr. M.N. Sheela, Principal Scientist, Division of Crop Improvement, CTCRI joined as Head of that Division on 6th September 2012.

Dr. Kalidas Pati, joined as scientist at Regional centre of CTCRI, Bhubaneswar on 16th May 2012.

Sri. Harish, E.R. joined as scientist in the Division of Crop Protection on transfer from Sunnhemp Research Station, Pratapgarh, Uttar Pradesh, Regional Station of Central Research Institute for Jute and Allied Fibres on 4th June 2012.

Dr. Asha, K. I. joined as Principal Scientist in the Division of Crop Improvement on transfer from NBPGR Regional station, Thrissur on 11th March 2013.