



Creating Wealth from Agricultural Waste

Indian Council of Agricultural Research
New Delhi

Creating Wealth

From

Agricultural Waste



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नरेन्द्र सिंह तोमर
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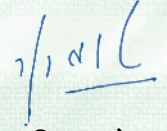
कृषि एवं किसान कल्याण,
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संदेश

मुझे यह जानकर खुशी है कि भारतीय कृषि अनुसंधान परिषद, कृषि उपशिष्ट से सम्पदा सृजन के संबंध में प्रौद्योगिकियों पर एक सार-संग्रह प्रकाशित कर रहा है जो पर्यावरण के लिए चुनौती उत्पन्न कर रहे, बड़ी मात्रा में उत्पन्न कृषि उपशिष्ट के प्रबंधन हेतु व्यवहार्य समाधान देने वाली प्रौद्योगिकियों का संकलन है। इसमें विशिष्ट प्रौद्योगिकियों का वर्णन किया गया है जिनका विभिन्न स्तरों पर विस्तार एवं वाणिज्यीकरण किया जा सकता है और ये कृषि-अपशिष्ट के प्रबंधन में सहायता के अतिरिक्त ग्रामीण क्षेत्रों में रोजगार के अवसरों का सृजन कर आत्मनिर्भर भारत के निर्माण में योगदान कर सकती है।

साठ के दशक में हरित क्रांति आरंभ होने से लेकर अब तक भारत में अपनाई गई कृषि-क्रियाओं से देश में खाद्य सुरक्षा की स्थिति सुनिश्चित हुई है किन्तु फसल उत्पादन में बढ़ोतरी के साथ-साथ, उपशिष्ट की उत्पत्ति में भी बढ़ोतरी है। यह चिंता का विषय बनता जा रहा है क्योंकि यह वायु, मृदा या जल के प्रदूषण में योगदान करने वाले महत्वपूर्ण कारकों में से एक है। जब हम किसानों की आय बढ़ाने की बात करते हैं तो यह भी हमारी जिम्मेदारी बन जाती है कि हम उन्हें ऐसी प्रौद्योगिकियां उपलब्ध कराएं जो उनकी आय में वृद्धि करने के साथ-साथ कृषि-क्रियाओं से उत्पन्न अपशिष्ट का प्रभावी रूप से प्रबंधन कर सके। इस पृष्ठभूमि के मद्देनजर यह सार-संग्रह बहुत महत्वपूर्ण है क्योंकि यह उन प्रौद्योगिकीय विकल्पों के बारे में बताता है जिनसे कृषि-आधारित अपशिष्ट को सम्पदा में बदला जा सकता है और फार्म, कृषि-आधारित प्रसंस्करण उद्योगों, मात्स्यिकी, पशुपालन आदि से उत्पन्न अपशिष्ट को कम किया जा सकता है।

यह दस्तावेज कृषि-अपशिष्ट से सम्पदा-सृजन के लक्ष्य की प्राप्ति में महत्वपूर्ण भूमिका निभा सकता है और इस क्षेत्र के सभी हितधारकों के लिए मार्गदर्शक की भूमिका निभा सकता है। यह दर्शाता है कि किस प्रकार से कृषि-अपशिष्ट के प्रबंधन में विभिन्न अंतरालों एवं बाधाओं का समाधान किया जा सकता है और यह मानव-उपयोग, फसलोत्पादन, पशुपालन एवं मात्स्यिकी में लाभप्रद हो सकता है। मुझे आशा है कि यह दस्तावेज सभी हितधारकों के लिए बहुत महत्वपूर्ण होगा और कृषि-अपशिष्ट संबंधी समस्याओं के समाधान हेतु नए रास्तों को खोजने के लिए रोडमैप का कार्य करेगा, अंततः एक स्वच्छ एवं हरे-भरे भारत के निर्माण की दिशा में अपना योगदान करेगा। भारतीय कृषि अनुसंधान परिषद द्वारा किए गए इस प्रयास के लिए मैं बधाई देता हूँ शुभकामनाओं सहित।



(नरेन्द्र सिंह तोमर)

परशोत्तम रूपाला
PARSHOTTAM RUPALA



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संदेश

यह असीम हर्ष का विषय है, कि भारतीय कृषि अनुसंधान परिषद कृषि अपशिष्ट में कमी लाने तथा इसे विभिन्न उपयोगी उत्पादों में बदलने के लक्ष्य की प्राप्ति के लिए "टेक्नोलॉजिज ऑन क्रिएटिंग वैल्यू फ्रॉम एगिकल्चरल वेस्ट" शीर्षक से एक सार-संग्रह प्रकाशित करने जा रही है। चूंकि देश इस महती लक्ष्य को प्राप्त करने की दिशा में धीरे-धीरे आगे बढ़ रहा है। यह हमारा उत्तरदायित्व हो जाता है कि हम उन कारकों की जांच करें जो इस यात्रा के दौरान हमारे पर्यावरण के उपकर्ष के लिए जिम्मेदार हैं।

यह दस्तावेज़ में कृषि परिचालनों के दौरान उत्पन्न अपशिष्टों की समस्या से निबटने के लिए भारतीय कृषि अनुसंधान परिषद के अनुसंधान संस्थानों द्वारा विकसित की गई सभी महत्वपूर्ण प्रौद्योगिकियों की चर्चा करता है तथा इसके बदले में मानव, पशु, मत्स्य अथवा कृषि क्षेत्र के लिए कृषि उपयोगी उत्पाद भी तैयार करता है। ये प्रौद्योगिकियों फील्ड स्तर पर कृषि अपशिष्टों का प्रबंधन करने के लिए नवोन्मेषी समाधान सुझाएंगी और साथ ही न्यूनतम निवेश के साथ अतिरिक्त आय और रोजगार सृजन के अवसर प्रदान करने का कार्य भी करेंगी।

मुझे पूर्ण विश्वास है कि यह सार-संग्रह प्रगतिशील हितधारकों के लिए सहायता के उपयोगी संसाधन की भूमिका निभाएगा तथा कृषि-अपशिष्ट के प्रबंधन से पर्यावरण की सुरक्षा में भी योगदान करेगा तथा ग्रामीण क्षेत्रों में रोजगार के अवसर सृजित करने तथा हमारे कृषक समुदाय की आय में वृद्धि करने के साथ-साथ एक समृद्ध तथा मजबूत, स्वच्छ तथा हरित भारत का निर्माण करने का मार्ग प्रशस्त करेगा।

(परशोत्तम रूपाला)

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संदेश

भारत ने खाद्य सुरक्षा को सुनिश्चित करने के लिए बहुत ही महत्वपूर्ण कार्य किये हैं। नवीनतम प्रौद्योगिकीय अन्वेषणों में सफलता पाई है और कृषि-क्षेत्र में दक्षता लाने के लिए नवोन्मेषण किए हैं। इन सफलताओं के साथ-साथ, कृषि क्षेत्र टूट जलाने, खराब गंध, कृषि उद्योग अपशिष्टों आदि के माध्यम से वायु प्रदूषण जैसे पर्यावरणीय प्रदूषण के रोकथाम में बहुत बड़ी हिस्सेदारी निभा रहा है। हमारे लिए यह सोचना आवश्यक हो गया है कि कृषि या अन्य क्षेत्रों से उत्पन्न अपशिष्ट का कहां उपचार किया जाए और इसे मानव या पशु या कृषि के लिए किसी उपयोगी उत्पाद में कैसे बदला जाए।

किसानों और कृषि आधारित उद्योगों के समक्ष आ रही कृषि-अपशिष्ट प्रबंधन की समस्या की चुनौतियों का सामना करने के लिए, भारतीय कृषि अनुसंधान परिषद के संस्थानों ने कृषि-अपशिष्ट के प्रबंधन को सुनिश्चित करने के लिए प्राथमिकता के आधार पर कार्रवाई की है और इसे उस रूप में परिवर्तित किया है जिससे उसका कुछ मूल्य प्राप्त हो, जिसका अर्थ है, अपशिष्ट सामग्री से सम्पत्ति का सृजन करना। मुझे यह जानकर खुशी है कि कृषि अनुसंधान एवं शिक्षा विभाग, भारतीय कृषि अनुसंधान परिषद के सहयोग से संसाधन के रूप में कृषि अपशिष्ट को केन्द्र में रखते हुए लक्ष्य-प्राप्ति हेतु कृषि अपशिष्ट से सम्पत्ति सृजन संबंधी प्रौद्योगिकियों पर एक सार-संग्रह प्रकाशित कर रहा है।

मुझे विश्वास कि यह विशेष प्रकाशन, किसानों को अतिरिक्त आय के साथ-साथ, शून्य अपशिष्ट-आधारित कृषि क्षेत्र के लक्ष्य की प्राप्ति का एक रोडमैप विकसित करने में मदद करेगा। मैं विश्वास करता हूं कि यह सार-संग्रह कुछ थोड़ी सी या

निवेश-रहित अपशिष्ट प्रबंधन की साधारण तकनीक से कुछ बहुत ही उपयोगी अन्तर्दृष्टियां प्रदान करेगा जिनको सरल वैज्ञानिक मार्गदर्शन के साथ आसानी से व्यवहार में लाया जा सकता है। मैं एक बार फिर से इस प्रकाशन को प्रकाशित करने के लिए कृषि अनुसंधान और शिक्षा विभाग तथा भारतीय कृषि अनुसंधान परिषद को बधाई देता हूं।

शुभकामनाओं सहित।



(कैलाश चौधरी)



त्रिलोचन महापात्र, पीएच.डी.

सचिव एवं महानिदेशक

TRILOCHAN MOHAPATRA, Ph.D.
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FOREWORD

Agriculture is the back bone of our country. Gross fixed capital formation in agriculture is recorded as 16.5% of Gross Value Added (GVA) in 2019-20. Right from the Kashmir to the coast of Kanya Kumari and from North eastern states to the desserts of Rajasthan the country is involved in a number of agricultural activities. The most commonly followed cropping system in the country is rice – wheat based but horticulture, fisheries and animal husbandry also plays very important role in the country's economy. We have been witnessing that, while agriculture is contributing towards the food & nutritional security of our people, and economic growth of the country, improper management of agricultural waste generated in the process has been contributing towards mounting air, soil and water pollution. India generates about 350 million tonnes of agricultural waste every year. As per the estimates given by the ministry of new and renewable energy, this waste can generate more than 18,000 MW of power every year apart from generating green fertilizer for use in agriculture. Globally about 1.3 billion tonnes of food products for human consumption gets wasted or lost every year and about one-third of biodegradable municipal solid waste mainly comprise of domestic kitchen waste generated from households. This intern generates obnoxious gases and GHGs besides foul odour, around the landfill sites. Taking a single crop of potato for example, a total world potato waste is estimated to be 12 million tonnes per annum out of which 2 million tonnes of potato waste is generated in India alone.

With the launching of the flagship scheme “Swachh Bharat Mission” by Government of India in 2014, Indian Council of Agricultural Research took a clarion call to work importantly on the waste generated from agricultural practices and convert it into products that are useful either for humans, animals or for farm land. All the ICAR Institutes together with KVKs under ATARIs acted on these issues giving due priority and have come out with number of

technologies in the form of value-added products, processes or processing equipment that can be successfully used to convert agricultural waste into wealth.

This book on Technologies of Creating Wealth from Agricultural Waste includes 140 technologies which have explored different arena of wealth creation utilizing various waste material generated during agricultural activities whether it be the waste generated during crop harvesting, crop processing, product synthesis etc. Some of these technologies have been transferred or commercialized, several of these are presently at various stages of commercialization. Documentation of these technologies in form of a compendium will attract different stakeholder and will be a stepping stone for creating business ventures around them to create employment opportunities in the rural areas which will in turn contribute towards a strong and Atmanirbhar Bharat.



(Trilochan Mohapatra)

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With the initiation of Swachh Bharat Abhiyan in 2014 throughout the country, the massive problem of management of collected waste emerged. Indian Council of Agricultural Research being an integral part of Indian agriculture research realized the importance of management of waste generated during agricultural practices. The Council moved towards initiating research which focused on the management of agricultural waste together with converting it into some useful products, thereby generating wealth from waste. Consequently, all the ICAR institutes intensified efforts towards developing targeted technologies that are helpful in converting the agro-waste into some income generating product with minimal inputs. This compendium is all about these technologies and gives us a birds-eye-view to novel technologies giving us opportunity to convert waste into wealth. The compendium includes technologies converting agricultural crop waste, horticultural waste, animal or fisheries waste management which are either commercialized or are in advanced stage of commercialization. This book is intended to be a reference material for the related stakeholders including individuals, cooperatives or such other institutions who intend to venture into this area for livelihood options.

I put on record my immense gratefulness to our Hon'ble Agriculture & Farmers Welfare Minister Shri Narendra Singh Tomar ji and the Hon'ble Ministers of State for Agriculture & Farmers Welfare Shri Parshottam Rupala ji and Shri Kailash Chaudhary ji for their visionary leadership and the micro vision for agriculture sector and interest to work dedicatedly for the cause of the farmers and farming community. I am also grateful to the former Minister of Agriculture & Farmers Welfare Hon'ble Shri Radha Mohan Singh ji and former Minister of State for Agriculture & Farmers Welfare Shri Gajendra Singh Shekhawat ji for their motivation and keen interest in these efforts.

A lot of efforts from many persons have gone into developing and refining these technologies. I place on record my deep sense of gratitude to Dr. T. Mohapatra, Secretary, DARE & DG, ICAR

for spearheading the efforts at all levels beginning from conceptualizing the idea of developing technologies for agricultural waste management to bringing out a compendium on Wealth from agricultural waste.

The motivational guidance received from the Former and present secretaries of ICAR namely, Shri Chhabilendra Raul ji, Shri Sushil Kumar ji and Shri Sanjay Singh Ji and the Financial Advisor DARE/ICAR Shri B. Pradhan ji are gratefully acknowledged. The inputs and the suggestions provided by DDGs and concerned ADGs are also gratefully acknowledged.

The enormous efforts put in by the Directors of ICAR Research Institutes and ATARIs for coming up with such technologies and providing the details are gratefully acknowledged. Support received from the Scientists and staff of the Technical Coordination Division is thankfully acknowledged.



(S.P. Kimothi)

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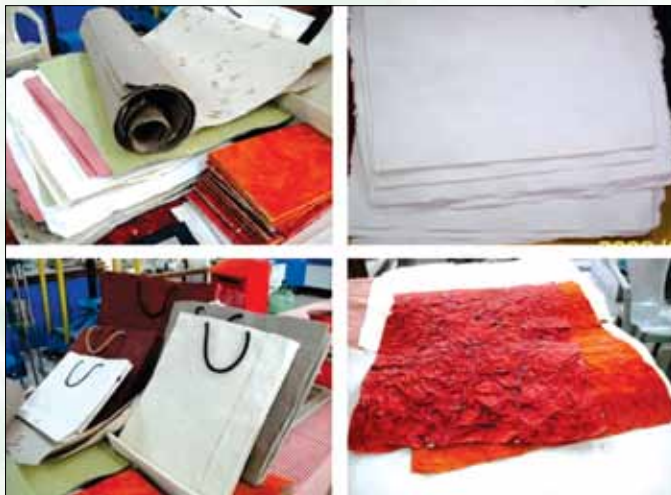
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भक्तानुष
ICAR

TECHNOLOGIES FOR CONVERTING WASTES FROM CROPS/ CROP BY-PRODUCTS INTO HIGH VALUE PRODUCTS

Preparation of Handmade Paper from Jute Waste



Development of a technology of making handmade paper from jute fibre especially jute residue will open up a new area where substantial quantity of thrown away jute waste can be used for making handmade paper of good commercial value. A new avenue of utilization of jute wastes is opened up, which would otherwise be burnt by farmers or thrown away creating disposal problem.

Salient Features:

The handmade paper/paper board is made from low grade jute fibre and can be suitably blended with other lignocellulosic fibres by adopting an inexpensive pulping process with minimum use of cooking chemicals like caustic soda, sodium carbonate, lime etc. Most of the properties are same as normal handmade paper and even better in some of the cases. There are diversified uses of it such as in Files, Folders, Greetings Card, Shopping bags, Visiting Card, Posters, writing grade paper, paper boards, file covers, greeting card etc.

Benefit:

- Handmade paper products conserve resources and generate less pollution
- Producing handmade paper uses much less total energy than producing virgin paper
- Reduces total number of trees cut down to make paper
- Cost involved: Cost of Machine and Equipment: Rs. 70 lakhs (Approx.)

Developer: S N Chattopadhyay, ICAR-NINFET, Kolkata

Contact Details: Director, (email: director.ninfet@icar.gov.in), ICAR-National Institute of Natural Fibre Engineering & Technology, Kolkata-700 040 West Bengal (www.nirjaft.res.in)

Lac Dye from Effluent of Stick Lac Washing

Lac dye, a by-product of lac industry, is lost in the effluent during washing of sticklac in primary processing of lac in which the basic raw material sticklac is converted into a semi-refined product: seedlac. The sticklac, apart from lac resin, also contains water-soluble lac dye (laccaic acid).



Recovery of by product lac dye can be done from effluent of lac washing upto extent of 50% of dye present in sticklac. India, at present, produces about 17,000 tons of lac annually. Considering this annual production, nearly 100 tons lac dye is lost in effluents during washing. Thus, an enormous potential exists for recovery of the dye as by-product of lac industry.

Status of Commercialisation

The technology is already commercialized

Salient Features:

- Lac dye is mixture of at least five closely related compounds all being anthraquinone derivatives which has been assigned the names as laccaic acid A, B, C, D & E.
- A process has been developed for recovery of lac dye from effluent wash water of primary processing for its commercial production.
- Lac dye can be recovered from wash water with average yield of 0.25% by wt. of sticklac.
- Bright colour lac dye with higher dye content can be prepared.
- Lac dye is used in textile as mordant dye for dyeing animal fibres like wool and silk.
- The lac dye has price of Rs.3,000-4,000/kg in domestic market.

Benefits:

- Recovery from effluent of lac washing and hygienic disposal of effluent.
- Lac dye is natural and non-toxic, so it is also being used outside as food colouring material.
- It has good demand in domestic market and also has export potential as Japan, China and Thailand are using lac dye for colouring beverages and products like ham, sausages, bean.

Training:

Training is given by ICAR-Indian Institute of Natural Resins and gums, Ranchi, Jharkhand.

Developed by: S. K. Pandey, ICAR-IINRG Ranchi

Contact Details: Director, (director.iinrg@icar.gov.in), ICAR-Indian Institute of Natural Resins and Gums, Namkum, Ranchi-834 010 Jharkhand (<https://iinrg.icar.gov.in/>)

Lac Mud as Organic Manure

Lac mud is the waste product of lac processing industries which is obtained to a tune of about 2.5 to 4.5% on dry and wet weight basis, respectively, of the raw material (sticklac) processed in primary processing of lac. Lac mud produced is mostly dumped due to lack of proper method of disposal which may create pollution hazards.



Status of commercialization

The technology is ready for commercialization

Salient Features

- Application of decomposed enriched lac mud in vegetables have recorded 22.0, 22.5 and 18.3 percent higher yield of brinjal, tomato and spinach, respectively, over 100% N through inorganic source (farmers' practice). This technology ensures saving of 48 percent of N and P fertilizers, and 65 per cent of K fertilizer in brinjal and tomato. In spinach, similar saving in N and P fertilizers along with 36.6 percent saving of K fertilizers was recorded.
- Application of fortified lac mud in floriculture have recorded 31.7 and 38.5 per cent higher flower yield of rose and chrysanthemum, respectively, over conventional method of manuring. This technology ensures saving of 5kg and 700 g of manure per plant in rose and chrysanthemum, respectively. It may also improve the soil fertility status as well as decrease dependency on other manure.
- The technology developed ensures quality vegetable production, saving of inorganic fertilizers, improvement in soil fertility status and more over it may give another diversified dimension to lac industry which may be helpful to sustain the lac production system.
- Technology developed has been tested and demonstrated under farmers' field condition.

Benefits

- The technology developed ensures quality flower production, improvement in soil fertility status and more over it may give another diversified dimension to lac industry which may be helpful to sustain the lac production system.
- It will address both social and environmental issues

Training

No specific training required

Developer: A.K. Singh & S.Ghosal, ICAR-IINRG, Ranchi

Contact Details: Director, (director.iinrg@icar.gov.in), ICAR-Indian Institute of Natural Resins and Gums, Namkum, Ranchi-834 010 Jharkhand (<https://iinrg.icar.gov.in/>)

Preparation of Value-Added Products from Gummy Mass (GM) – A Problem Industrial Effluent of Lac Industry



Gummy mass



Gasket cement compound



Biocomposite boards

Gummy mass is a by-product of lac industry involved in making of Aleuritic acid. Effluent, which comes out during the manufacture of Aleuritic acid, is often a problem for its manufacturers for its proper disposal, as it is sticky material and does not dry at ambient temperature. There is a long-time demand from lac industry for its proper utilization. Gummy mass can be used in coating materials (varnish and paint), gasket cement compound and bio-composite board.

Status of commercialization

The technology is ready for commercialization

Salient Features

- GM generated from effluent of Aleuritic acid utilized in development of coating materials (varnish and paint), adhesive/ binder and preparation of bio-composite boards. It can also be used in preparation of cementing composition for automobiles to provide sealing of joints against leakage of oil.

Benefits

- Gummy mass prepared from effluent of Aleuritic acid manufacturing units can be used as a source material for industrial applications.
- Adoption of the technology will not only solve the problem of Aleuritic acid industry but better utilization of the gummy mass.
- This can ultimately serve as a source of secondary income to Aleuritic acid manufacturers and others.

Training

Training is given by ICAR-Indian Institute of Natural Resins and Gums, Ranchi, Jharkhand.

Developer: M.F. Ansari, ICAR-IINRG, Ranchi

Contact Details: Director, (director.iinrg@icar.gov.in), ICAR-Indian Institute of Natural Resins and Gums, Namkum, Ranchi-834 010 Jharkhand (<https://iinrg.icar.gov.in/>)

Fortified Rice Analogues from Broken Rice and Dal

The development process for production of fortified rice analogues consist of composite flour, containing the milling by-products viz., broken rice and broken dal using extrusion technology. A die containing holes with dimensions of 6.0×1.5 mm was designed and fabricated to produce rice analogues which resembles raw rice in size and shape. The composite flour with base material as rice flour was optimised for different levels of

moisture content and pigeonpea dhal flour based on the proximate composition, colour, texture and pasting properties as responses. The optimized composite flour was further added with fortified nutrient ready mixes and extruded to produce fortified rice analogues. The type and levels of nutrient ready mix was optimized based on the retention after cooking.



Status of commercialization

MoU Entered with M/s. Radhey Agro Industries, Raichur for transfer of technology and commercialization.

Salient Features

- Value addition to broken rice and dhal.
- Availability of fortified rice enriched with protein, iron zinc and vitamins.
- Fulfils micronutrient deficiency as per FSSAI recommendations.

Benefit

- Utilization of milling by-products of low economic value.
- Reducing the risk of micronutrient deficiencies.
- Fortification with additional protein, iron, zinc and vitamins.
- Improving micronutrient status in daily diet of people at low cost.
- Additional monitory benefits to the rice miller.

Training

Training is imparted by University of Agricultural Science (UAS), Raichur.

Developer: Udaykumar Nidoni, Ambrish G, P F. Mathad and Sudha Devi G, University of Agricultural Science (UAS), Raichur (AICRP on PHET)

Contact Details: Director, (director.ciphet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana-141004 Punjab (www.ciphet.in)

Protein Isolates/Concentrates from De-Oiled Cakes/Meals using Novel Process

This is a novel process to produce protein isolates/concentrates from oilseed cakes/meals (example soy meal, groundnut cake) without addition of strong or diluted acid. The protein yield from this process is about 35-36% of the total weight of soymeal and 25% of total weight of groundnut cake used, whereas, in the existing process, maximum 30% protein yield from soymeal can be obtained. The developed method comprises novel bacterial strains isolated from a food sample for producing protein from de-oiled meal/flour. The obtained supernatant after precipitation of protein from a particular batch may be used for precipitation of another batch and so on.



Soya protein isolated through novel method

Groundnut protein isolated through novel method

Status of commercialization

Not Commercialized

Salient Features

- This process is an acid free process and yields higher protein about 5% over conventional process.
- Superior protein quality in terms of solubility, wettability, water absorption capacity and degree of hydrolysis and digestibility.
- The plant protein is used in protein supplements, texturized vegetable proteins, imitation dairy products, sea food products, beverage industry, infant food formulations, bakery products etc.
- Benefit Cost Ratio: 2.5:1.

Benefit

- Value addition to indigenous de-oiled cakes/meals instead of export.
- Availability of superior protein with lower cost.
- May help to combat protein malnutrition in the country.
- The technology has potential for import substitution worth Rs. 600 crore.

Training

Training is imparted by ICAR-Central Institute of Post-Harvest Engineering and Technology (CIPHET), Ludhiana.

Developer: D. N. Yadav, Sangita Bansal, Swati Sethi, Surya Tushir, R. K. Singh, S. N. Jha, ICAR-CIPHET, Ludhiana

Contact Details: Director, (director.ciphnet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana-141004 Punjab (www.ciphnet.in)

Microbial Protein using Corn Cob

- Microbial protein is the dried cells of microorganism which can be used as a dietary protein supplement. This is a non-conventional and alternative source of plant and animal protein produced by bacteria, fungi, yeast, and algae. The advantages include its high protein content and short growth times, leading to rapid biomass production, which can be continuous and is independent of the environmental conditions.
- The process could be made economical by using lignocellulosic waste, such as corn cob, generated from agricultural and industrial activities, which serve as an inexpensive carbon source for microbial protein production. This fulfils a dual purpose of effective handling of agro-residues and its adequate bioconversion for the development of microbial protein. This protein is suitable for human consumption and thus can be used as an ingredient or a substitute for fortification.

Status of commercialization

Awaiting to be Commercialized

Salient Features:

- Pre-treated corn cob can work as a cheaper source of carbon during fermentation along with added nutrients.
- Yeast particularly *Saccharomyces cerevisiae* was added to this corn cob medium for production of protein. The microbial protein so obtained contains 45.5% crude protein.
- Amino acid profiling of this protein showed that it is rich in Sulphur containing amino acids like Cysteine (5.22mg per 100mg) and Methionine (5.65mg per 100mg), whereas most of the cereal protein lacks in these two amino acids.

Benefit

- The technology enables utilization of low value corn cob as a substrate for production of protein.
- This protein can be utilized for fortification of cereal based products to maintain balanced amino acid profile.

Training

Training is imparted by ICAR-Central Institute of Post-Harvest Engineering and Technology (CIPHET), Ludhiana.

Developer: Surya Tushir, S.K. Tyagi, V. Chanasekar, A.K. Jaiswal, ICAR-CIPHET, Ludhiana

Contact Details: Director, (director.ciphnet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana-141004 Punjab (www.ciphnet.in)

Utilization of Corn Cob Powder for Kulhad Making

Traditionally mud cups (*kulhad*) are prepared using red mud. Continuous depletion of source has affected the availability of this mud and consequently there is need to develop alternatives to fully or partially replace red soil in Kulhad making. Corn cobs, otherwise a waste product, are utilized for making mud cup to convert this waste into value added product.



Corn cob incorporated earthen cup

Status of commercialization

Technology awaiting commercialisation.

Salient Features

- The corn cob powder is mixed in different ratios with mud and cups are prepared by baking the molded cups in a direct fire.
- Physical properties thermal properties and Newton's cooling constant of corn cob powder blended mud cups are measured for assessing the feasibility of partial replacement of mud by corn cob powder as an agro biomass utilization process.
- The corn cob powder can be added up to 15% (w/w) and further addition reduced the physical and thermal properties of the cup.

Benefit

- The agricultural biomass residues can partially be used for making cups along with mud.
- This type of biomass utilization provides an alternate solution for disposal of corn cob residues.

Training

Training is imparted by ICAR-Central Institute of Post-Harvest Engineering and Technology (CIPHET), Ludhiana.

Developer: Surya Tushir, S.K. Tyagi, V.Chanasekar, A.K.Jaiswal, ICAR-CIPHET, Ludhiana

Contact Details: Director, (director.ciphnet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana-141004 Punjab (www.ciphnet.in)

Biochar From Agricultural Waste Material

Biochar is a carbon rich material produced by incomplete combustion of biological materials in the absence of oxygen or with limited amount of oxygen. Agricultural waste and weed biomass can also be used to produce biochar. It is reported by the research scholar that biochar stores carbon in the soil for hundreds to thousands of years and thus, the level of greenhouse gases like CO₂ and CH₄ can be reduced significantly from the atmosphere. In order to make biochar from biomass (*Ageratum conyzoides*, *Lantana camera*, *Gynurasp.*, *Setaria sp.*, *Avenafatua*, Maize stalk and Pine needle) material continuous biochar production machine or modified portable metallic kiln was used.



Status of commercialization

Technology awaiting commercialisation.

Salient Feature

- Biochar are produced from the agricultural waste and weed by using pyrolysis method.
- Agricultural biomass can be converted into biochar within two hours with a conversion efficiency of 25-35% depending on the type of biomass by using modified portable metallic kiln.

Benefit

- Improve soil fertility and crop yield.
- Increased fertilizer use efficiency.
- Improve water retention, aeration and soil tilth.
- Higher cation exchange capacity and less nutrient runoff.
- Application of biochar improved soil pH by 0.26 to 0.30 units within two months. So, biochar has positive and significant effect on soil pH.
- Biochar improved the available soil nitrogen ranging from 4.5 to 21.3 mg kg⁻¹.
- Potassium availability increased by application of biochar.

Developer: Division of Agricultural Engineering

Contact Details: Director, (director.icar-neh@icar.gov.in), ICAR-ICAR Res. Complex for NEH Region, Umiam, Meghalaya (www.icarneh.ernet.in)

Soil less Planting Media using Sugar Industry Residue

The press mud, a residual product in Sugar Industry that is available abundantly at the rate of 2 percent of the cane crushed, has physical properties similar to soil and provides good anchorage to plant roots. The press mud once composted provides essential nutrients to plants.



Hence a soil less planting

media is formulated using composted and powdered press mud. This soil less planting media comprises of 50 per cent composted press mud, 25 per cent coir pith and 25 percent powdered dry cow dung. Acidity of the mixture is neutralized by adding dolomite and further enriched with Neem cake and biocontrol agents. The soil less planting media is regularly produced by the ICAR ICAR-Krishi Vigyan Kendra (Ernakulam), packed, branded and marketed in 10 kg bags at ICAR-CMFRI sales counter.

Salient Features

- Better moisture retention and less frequent irrigation requirement.
- Better root anchorage and reduced plant lodging.
- Enhanced nutrient value and no need of basal manure dose.
- Can be re-used for more than 3 plantings.

Benefits

- Commercial scale planting media production from press mud is a promising enterprise for youngsters while ensuring nutritionally rich planting solution to urban farmers. As this technology eliminates use of soil, the environmental degradation on account of soil mining can also be prevented.

Training

Entrepreneurship development programme on *Soilless planting media production* is offered by ICAR-KVK (Ernakulam) of CMFRI.

Developer: F. Pushparaj Anjelo and Shinoj Subramannian, KVK, Ernakulam

Contact Details: Director, (director.cmfri@icar.gov.in), ICAR-Central Marine Fisheries Research Institute, Kochi, Kerala (www.cmfri.org.in)

Production of Enzymes Cellulases at Industrial Scale by Microbial Fermentation Utilizing Groundnut Shell as Substrate

Groundnut shell, one of the richest source of cellulose (upto 70%), is difficult to decompose. In India, about 2 MT of groundnut shells available annually at nominal cost, are used in poultry feeds, for production of briquettes, etc. At present about 10% of domestic need of cellulase is met from local production and 90% being imported and therefore a part of the available groundnut shell can be utilized for production of cellulase at industrial scale by microbial fermentation. The cellulase enzyme is used in industries engaged in bio-polishing fabrics/garments, bio-stone washing, animal feed, textile, food industry, enzymatic saccharification of agro-waste, etc.



Processing of groundnut shell for production of cellulases by microbial fermentation (L-R: Groundnut shell, powdered groundnut shell; solid substrate fermentation by *Phanerochaete* sp. (whitish) and *Trichoderma* sp. (greenish))

Salient Features:

- A process includes producing cellulase enzyme by utilizing groundnut shell as a substrate employing microbes like *Trichoderma* sp. and *Phanerochaete* sp. by fermentation (both solid substrate and liquid).
- In solid substrate fermentation, 25-40 IU of cellulase can be produced per gram of groundnut shell by both the organism. By liquid fermentation, 150-200 IU of cellulase can be produced /gram of groundnut shell which are nearly 10 times better in enzyme yield as compared to traditional use of paddy/wheat straw used as substrate.

Benefits:

- Cellulase produced are tolerant to high temperature.
- From processing of 100 kg of groundnut shell an amount of Rs. 20,000/ can be earned as net income.
- It needs minimum facilities to produce crude cellulase.
- As raw material is very cheap, the cost per unit is also very nominal.

Transfer of technology:

Already transferred to M/s Paccar Biotech Pvt. Ltd., Ahmedabad on non-exclusive basis on payment of one time license fees for commercial production. The technology is available for further licensing.

Developer: ICAR-Directorate of Groundnut Research, Junagadh

Contact Details: Director, (director.dgr@icar.gov.in) ICAR-Directorate of Groundnut Research, Junagadh, Gujarat (www.dgr.org.in)

Phospho-Sulpho-Nitro (PSN) Compost for Improving Nutrient Enrichment, Productivity and Soil Health

Bioconversion of bio-waste namely crop residues, city waste and horticultural wastes with low nutrient contents to nutrient enriched phospho-sulpho-nitro (PSN) compost is a boon for sustainable crop production. Avoiding direct use of chemical fertilizers with supplemental use of natural and low-cost mineral resources such as rock phosphate, pyrites, micas, phospho-gypsum etc., along with fresh cow dung and selective microbial consortia could further enhance the manurial value to a great extent.

Salient Features

- To prepare one tonne of PSN compost about 1000 kg of above wastes is taken (Dimension, LxWXH::12 ft x 7.5 ftx3.5 ft) by heap method.
- In the first layer spread 30kg wastes then 30 kg cow dung spray urea solution (660g in 20 L water) then spread 17 kg rock phosphate (5% P₂O₅ basis) and 6 kg pyrites @ 10% on material (DWB) and maintain moisture of 60-70%.
- The above process with all the steps is repeated till the heap attain of about 3-4 feet.
- Microbial consortia of fungi (*Paecilomyces fuisporus*, *Aspergillus awamori*, *Trichoderma viride*) and bacteria (*Bacillus polymixa*, *Pseudomonas striata*, *Azotobacter chroococcum*) is used as bioinoculum.
- Finally, the upper side and all peripheries of the heap are covered with cow dung slurry to maintain optimum moisture content inside the heap and covered with polythene sheets to protect from adverse climatic condition.
- After 15 days of composition, the first turning must be advocated and maintained the moisture at 60-70 % throughout composting process.
- Compost will be ready at 1.5-2.5 month of decomposition and one can get about 950-1000 kg of enriched PSN compost.



Benefits

- Mature PSN compost has better nutritional value in improving crop production.
- PSN compost can be used as partial substitution of chemical fertilizers.
- PSN Compost has potential for enhancing soil biological activities and overall soil health.

Training

Training is imparted by ICAR-Indian Institute of Soil Science, Bhopal.

Developer: M. C. Manna, J. K. Thakur, A. B. Singh, A. Sahu, S. Bhattacharjya, Asit Mandal, A. K. Tripathi and Ashok K. Patra, ICAR-IISS, Bhopal

Contact Details: Director, (director.iiss@icar.gov.in) ICAR-Indian Institute of Soil Science, Bhopal, Madhya Pradesh (www.iiss.nic.in)

Bioreactor with Microbial Consortium to Recycle Food Waste using Rapid Composting Technique

Globally 1.3 billion tonnes of food products for human consumption gets wasted or lost every year. Waste dumping and burning emits various types of toxic gases including green house gases (GHGs). This causes significant impact on air pollution, aesthetic problems, unknown diseases, pathogens and heavy metals contamination in ground water through leaching. The technology is being demonstrated on a pilot scale.

For this Power operated shredder machine and Power operated semi-automated composter has been developed.

Salient Features

- The shredder machine consists of a shredder blade, feed housing, holder channel, reversible rotating system and power (5 HP) transmission with motor.
- The bioreactor unit consists of a compact vessel, double helical sliding blade, feed housing, thermo sensor, heating mantle, rotating system and power (5 HP) transmission with motor.
- All the ingredients and microbial consortium are mixed and fed together with required amount of water.
- The mesophilic microbial consortium added at initial stage and thermophilic bio-inoculum is used after 15 days of decomposition.
- The compost is ready within 25-30 days of decomposition. These composts are sun dried, bagged and stored for using as organic fertilizer in the farmers field.
- It is also used for making compost from temple waste, kitchen waste and segregated biowaste from cities.
- Cost of the machine is approximately Rs. 2.0 Lakhs per unit.

Benefits

- It is a rapid decomposition technique.
- It provides complete recycle of city waste and food waste and their value addition.

Training

Training is imparted by ICAR-Indian Institute of Soil Science, Bhopal.

Developer: M. C. Manna, J.K. Thakur, A. B. Singh, Asha Sahu, S. Bhattacharya, Asit Mandal, A. K. Tripathi, D. Amat and Ashok K. Patra, ICAR-IISS, Bhopal

Contact Details: Director, (director.iiss@icar.gov.in) ICAR-Indian Institute of Soil Science, Bhopal, Madhya Pradesh (www.iiss.nic.in)



Family Net Vessel Compost (FNVC) Technology for Recycling of Kitchen Waste



About one-third of biodegradable municipal solid waste mainly comprise of domestic kitchen waste generate from households that creates odour problem, obnoxious gases and GHGs in the landfill sites. Recycling of kitchen waste into valuable compost has developed the concept of Family Net Vessel Compost (FNVC) technology using three epigeic earthworm species viz., *Eisenia fetida*, *Eudrilus eugeniae* and *Perionyx excavates*.

Status of Technology Transfer

Technology is ready for transfer

Salient Features

- In this technology, the vessel is made of a nylon net (Length x Diameter:90cm x 35cm) and a plastic basket placed inside the vessel.
- In the basket, about 100-150 numbers of adult epigeic earthworms of three species in equal combinations is kept along with small pieces (3-5 cm length) of waste (2kg) and a layer of well decomposed cattle dung spread over the waste(2kg).
- Whole material is covered with piece of jute bag and keep moist by adding water regularly to maintain the optimum moisture.
- The capacity of the FNVC is about 10-15 kg. It can be hung in the available space of the house or on the branches of the tree planted around the house with the help of nylon rope
- Domestic waste generated by a family (4 members) each day, is added to the vessel for about 10 days till 10-15 kg mass is attained and left for decomposition for another 20 days. After 30 days the vermicompost gets ready for use.

Benefits

- FNVC is an efficient technology and can be easily adopted to convert kitchen waste into valuable compost.
- This technology improved the nutrient levels of the compost with carbon and plants primary nutrients.

Training

The training is imparted by ICAR-Indian Institute of Soil Science, Bhopal.

Developer: M. C. Manna, Asha Sahu, J. K. Thakur, Asit Mandal, A.B. Singh, A. K. Tripathi, S. Bhattacharjya, D. Amat and Ashok K. Patra, ICAR-IISS, Bhopal

Contact Details: Director, (director.iiss@icar.gov.in) ICAR-Indian Institute of Soil Science, Bhopal, Madhya Pradesh (www.iiss.nic.in)

Utilisation of Okara for Development of Soy based Food Product



Okara is a food by-product from tofu and soy milk production. Okara consists of 3.5 to 4.0% protein, 76 to 80% moisture and 20 to 24% of solids. On moisture free basis okara contains 12 to 14.5% crude fiber and 24% protein. Due to its high moisture and nutrient content, okara is highly prone to putrefaction and this has limited its commercial use. However, okara can be used to prepare bakery-based soy products and fermented products that are rich in protein.

Status of Technology Transfer

Technology is ready for transfer & popularisation.

Salient Features

- Use of okara in preparation of food products will help in eco-friendly disposal of soy processing unit waste by making soy-based food products like biscuits, cakes, muffins, *Gulabjamun*, idli, dosa etc. rich in high quality protein.
- Okara can be used as animal feed, especially for farms in vicinity of soy milk or tofu factories. Okara is sometimes spread on fields as a natural nitrogen fertilizer.
- It can be added to compost to add organic nutrients and nitrogen.
- Use of okara can provide regular income to rural population/ farmers/women folk associated in soy milk and tofu production thus improving their economic status.

Developer: LK Sinha and Sumedha Deshpande, ICAR-CIAE, Bhopal

Contact Details: Director, (director.ciae@icar.gov.in), ICAR-Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh (www.ciae.nic.in)

Cotton Stalks Put to Good use for Oyster Mushroom Cultivation



Cotton stalk, a lignocellulosic biomass, consists of approximately 50-60% holocellulose and 25-28% lignin, 6-8 percent ash content and rich in minerals especially potassium. This makes them a potential substrate for production of mushrooms which could fetch additional income to the farming community.

Status of Technology Transfer

Technology is ready for transfer & popularisation.

Salient features

- ICAR-CIRCOT developed a technology for oyster mushroom (*Pleurotus florida* and *P. ostreatus*) cultivation in cotton stalks.
- About 300 g of fresh oyster mushroom can be obtained from one kg of dry cotton stalks in thirty days. Generally, two to three harvesting of mushrooms takes place.
- The cost of production of one kg of mushroom is Rs. 50 including spawn cost.
- The market value of oyster mushroom ranges between Rs. 80 to 150/-.

Benefits:

- Important protein source for rural mass.
- As an entrepreneurial activity, a cotton farmer can earn minimum of Rs. 10,000/- by cultivation of oyster mushroom using cotton stalks.

Training:

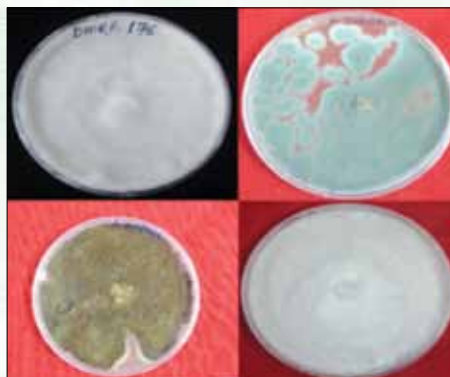
Training is being imparted at Ginning Training Centre of ICAR-CIRCOT, Nagpur.

Developer: ICAR-CIRCOT, Mumbai

Contact Details: Director, (director.circot@icar.gov.in) ICAR-Central Institute for Research on Cotton Technology, Mumbai, Maharashtra (www.circot.res.in)

BioCompost Technology

BioCompost is a carrier based formulation of consortium of four lignocellulolytic fungi namely *Phanerochaete chrysosporium*, *Trichoderma viride*, *Aspergillus awamori* and *Pleurotus florida*. The consortium can be used to convert diverse agricultural residues of almost all field crops like wheat, rice, mustard, maize, and soybean into mature compost within 65- 70 days by pit or windrow methods.



Salient features

- Compost pit with the dimension of 3 x 2 x 1 meter or alternatively windrows can be prepared. The windrows are kept in trapezoidal shape with bottom width of 2 m and top width of 1.5 m and a height of 1 to 1.2 m.
- The windrow method of composting involves layering the material in the form of piles and subsequent mixing together with the application of culture. Each windrow is prepared using straw mix (substrates for composting) + Cow dung + good quality soil + old compost in the ratio of 8: 1: 0.5: 0.5.
- To enhance the process of composting, BioCompost is added at a rate of 5000 ml per tonne of the material. All the constituents are mixed thoroughly.
- In case, P enriched compost is to be prepared, Rock phosphate@1% is also added as a source of insoluble P. At all times, 65 -70 % moisture is maintained in the biomass.
- The piles containing raw material should to be turned after every 15 days.
- The mature compost needs to be sieved so as to have uniform size particles and to get rid of any undecomposed material.

Benefits

By this process N (1-1.5%) and P (0.3-0.5%) enriched compost can be prepared from diverse crop residues within 65-70 days.

Training

Specific training modules can be prepared and trainings can be held at ICAR-NBAIM, itself for a short period of 1 or 2 days.

Developer: K. Pandiyan, Arjun Singh, A.K. Saxena, ICAR-NBAIM, Mau, Uttar Pradesh

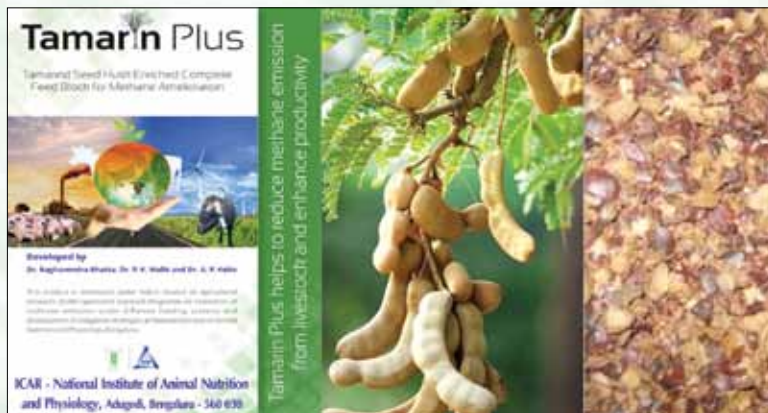
Contact Details: Director (director.nbaim@icar.gov.in), ICAR- National Bureau of Agriculturally Important Microorganisms, Mau, Uttar Pradesh 275103 (www.nbaim.org.in)



भारत
ICAR

**TECHNOLOGIES FOR CONVERTING WASTES FROM
HORTICULTURAL CROPS/ CROP BY-PRODUCTS INTO
HIGH VALUE PRODUCTS**

Tamarind Seed Husk Reduces Enteric Methane Emission



Tamarind (*Tamarindus indica*, common name Imli) is grown in more than 50 countries. India alone annually produces more than 98 thousands metric tons of tamarind. Tamarind seed husk, an agricultural waste constitute about 35% of the decorticated roasted seed. Tamarind seed husk contains 13-15% tannins and very effective in the modulation of rumen fermentation.

The technology has recently been patented (Patent no. 338616).

Salient features

The use of tamarind seed husk at 5% level in the diet can reduce the enteric methane emission by 17-20%. Tamarin Plus, a product developed using tamarind seed husk can be fed to the growing (>4 months old), lactating and adult animals *ad libitum*. Tamarind seed husk is an inexpensive material and cost only 3-4 rupees per kilogram and therefore can be used as an ingredient of total mixed ration along with straw and concentrate items at the above specified level.

Impact

Annually, 38×10^8 Giga calorie energy is wasted from livestock due to methane emission in India. About 26.28×10^6 giga calorie energy can be saved annually with 20% confirmed methane reduction by the adoption of product. The saved energy would lead to additional production of 10-12 MMT from the livestock in the country.

Training

Training is needed for the processing and formulating the tamarind seed husk based product Tamarin Plus

Developer: Raghavendra Bhatta, P. K. Malik and A. P. Kolte, ICAR-NIANP, Bengaluru

Contact details: Director (directornianp@gmail.com), ICAR-National Institute of Animal Nutrition and Physiology, Bengaluru (www.nianp.res.in)

Pineapple Fruit Residue Silage as Fodder Source for Livestock

In India more than 1.3 million ton of non-edible pineapple fruit residue is available annually and is being wasted. The pineapple fruit residue (PFR) contains high moisture (65-70%) and total sugar (>50%) making it susceptible for fungal growth and spoilage within 2 days. This fruit residue has been converted into animal feeds by improving the keeping quality of PFR through silage technology. The PFR was chaffed into pieces of 1-2 inches and compacted in drums / bags at a moisture content of



about 65% with 4:1 ratio (w/w) of pineapple leafy crown and fruit peels and kept under air-tight condition. With a period of 20 days, good quality PFR silage was prepared and nutritive value was better than maize green fodder. Feeding of PFR silage based total mixed ration to sheep did not show any adverse effects and supported desired growth. Study in dairy cows fed PFR silage based diet showed an improvement of daily milk yield by about 20% and fat content by 0.6 units. **This technology has been licensed to M/s. Fresh Fruits Processing Pvt. Ltd. to prepare silage from pineapple fruit residue in drums and bags and market as fodder for livestock. This technology will help in mitigating the green fodder shortage in the area of pineapple cultivation.**

Salient Features

- Technology for preparing silage from pineapple fruit residue.
- It is a process of using pineapple fruit residue silage as fodder along with concentrate mixture in the form of total mixed ration.
- Pineapple fruit residue silage can be used as green fodder.
- Nutritive value of pineapple fruit residue silage is better than maize green fodder.
- Feeding pineapple fruit residue silage improved milk yield and milk fat content.

Benefits

Cost: Benefit

Cost of pineapple fruit residue	: Rs 1 per kg
Cost of maize green fodder	: Rs 3 per kg
Cost of silage making from pineapple fruit residue	: Rs 1 per kg
Net saving	: Rs 1 per kg by feeding pineapple fruit residue silage replacing maize green fodder

Training

Training is required for preparing silage from pineapple fruit residue and preparation of total mixed ration. Training available at ICAR-NIANP, Bangalore

Developer: NKS Gowda, DT Pal, S Anandan and CS Prasad, ICAR-NIANP, Bangalore

Contact Details: Director (directornianp@gmail.com) ICAR-National Institute of Animal Nutrition and Physiology, Bangalore, Karnataka (www.nianp.res.in)

Alcoholic Beverage with Nutraceutical Properties from Kinnow peels

The available kinnow peel in the country is about 4.0 lakh tonne. Kinnow peel beverage with nutraceutical properties has been developed using a simple low-cost indigenous technology, comprising of use of crude enzyme consortium, addition of natural extracts/ ingredients, fermentation with a naturally occurring yeast and clarification using simple filtration technique.

Status of Technology Transfer

Technology is ready for transfer.

Salient Feature

- Kinnow peel alcoholic beverage is prepared from the fresh Kinnow peels which are subjected to size reduction followed by enzymatic hydrolysis. The beverage prepared is clarified regularly for a period of two months to impart a characteristic flavour to it. Kinnow peel beverage has an acceptable colour, odour and taste and possesses typical flavour of beverage.
- Crude enzyme consortium was produced by a strain of *Aspergillus niger* isolated.
- Kinnow peel alcoholic beverage contains about 5-6% (v/v) and has some important characteristics which included total phenolic content (TPC), scavenging ability (SA) and acidity of Kinnow peel beverage ranged from 15-18 mg/ GAE, 65-80% and 0.40-0.42%, respectively. These features indicate the nutraceutical potential of the Kinnow peel beverage. No methanol was found in the beverage prepared from Kinnow peels.
- Benefit Cost Ratio 1.5: 1.



Alcoholic beverage from Kinnow peel

Benefits

- Alcoholic beverage with higher Nutraceutical properties.
- Proper waste utilization.

Training

Training is imparted by ICAR-Central Institute for Post-Harvest Engineering & Technology (CIPHET), Ludhiana.

Developer: H.S.Oberoi, ICAR-CIPHET, Ludhiana

Contact Details: Director, (director.ciphnet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana-141004 Punjab (www.ciphnet.in)

Oil Palm Factory Waste for Mushroom Production



Pleurotus

Agaricus

Volvariella

Calocybe

During the process of oil extraction from oil palm fresh fruit bunches (FFB), oil palm bunch refuse and oil palm mesocarp waste are available in sterilized form.

These waste materials have been proved to be ideal substrates for growing edible mushrooms like Paddy straw mushroom (on EFB), Oyster mushrooms, Summer white milky mushroom and Summer white button mushroom (on mesocarp waste) either directly or after developing compost.

Status of Technology Transfer

Technology is ready for transfer

Salient Features

- Farmers near the factory zone can take up cultivation of mushrooms as a small-scale industry within the premises of oil palm factory or in fields.
- It can provide regular income to rural population/farmers/women folk involved in mushroom production thus improving their economic status.
- It also helps in eco-friendly disposal of oil palm factory wastes by utilizing for edible mushroom production and bioconversion of waste material into edible food rich in high quality protein.

Training

Training can be provided on mushroom production technology to the persons near factory zone and other persons associated with palm oil industry by ICAR-Indian Institute of Oil Palm Research, Pedavegi, Andhra Pradesh.

Developer: M. Kochu Babu (Rtd. Director, ICAR-IIOPR, Pedavegi)

Contact Details: Director (director.iopr@icar.gov.in) ICAR-Indian Institute of Oil Palm Research, Pedavegi, Andhra Pradesh (<http://dopr.gov.in>)

Use of Palm Oil Mill Effluent in Animal and Fish Feeds Formulation

Crude palm oil industries generate an overwhelming amount of palm oil mill effluent (POME). Environmental issues associated with POME disposal have challenged the palm oil-producing nations.

POME is a high organic content containing liquid, released during palm oil milling process, with a brownish colour and stinky odour. POME, a major source of inland water pollution is highly acidic in nature and has a high biological oxygen demand (BOD), 30,000mg/L, chemical oxygen demand (COD), 50,000 mg/L, along with unsafe levels of oil and grease, suspended solids, and total nitrogen content.

In this technology different feeds, containing palm oil sludge as chief source, can be formulated based on the crude protein content of dehydrated palm oil mill effluent (POME).

Staius of Commercialisation

Proven and awaiting commercialization

Salient Feature

- The leftover of palm oil mill can be utilized in the formulation of animal feeds without any depression in either growth rate or milk production with marked economic advantage over other costly feeding systems or ingredients.
- Dehydrated POME could be incorporated in the diets of buffalo calves and buffaloes up to 40% level; in the diets of lambs up to 60 % level; in the diets of kids (goats) up to 50 % level and; up to 20 % level in the diets of piglets.
- Dried palm oil sludge (POS) can be included in the fish feed up to 60% for fresh water fish *Rohu* as well as ornamental fish *Koi- Carp* and 40 % for fresh water fish *Catla catla*.
- Palm kernel cake (PKC) can be included in the diets of fresh water fish variety *Rohu* up to 10 %.
- Machineries are required for manufacture of feed formulations.

Benefit

- A marked economic advantage can be obtained by utilizing the POS/POME as an ingredient in animal feed formulations in comparison to that of control concentrate mixtures. Unit cost of production of milk/meat etc., gets reduced which will be advantageous to producer as well as consumer. Costly ingredients can be diverted for other purposes.
- This also leads to environmentally friendly disposal of the factory wastes.

Training

Training required on manufacturing the feed formulations and is imparted by ICAR-Indian Institute of Oil Palm Research, Pedavegi, Andhra Pradesh.

Developer: M. Kochu Babu, (Rtd. Director, ICAR-IIOPR, Pedavegi); M. Vijayalakshmi, ANU, Guntur; P. Kumaraiah, P. V. Rangacharyulu, ICAR- CIFA, Odisha; E. Raghava Rao, NTR College of Veterinary Science, Gannavaram; Shinoj Subramannian, ICAR-IIOPR, Pedavegi

Contact Details: Director (director.iopr@icar.gov.in) ICAR-Indian Institute of Oil Palm Research, Pedavegi, Andhra Pradesh (<http://dopr.gov.in>)

Animal Feed from Potato Waste

Potato pulp, peels, culls, chips and fragments etc. are produced during processing. Approximately 35% of the total processed potato crop is discarded as waste during processing. Total world potato waste is estimated to 12 million tonnes per year. About 2 Million tonnes of potato waste produced in India.



Potato waste causes disposal problem but if properly processed, it can be suitably incorporated into animal feed. A complete animal feed can be easily and economically prepared with potato waste by replacing about 25 to 30% grain component.

No such technology is available in the market at present. The technology has the potential to convert waste of potato processing industry and wasted potatoes into value added products i.e. animal feed, thus reducing the disposal problem of waste. This method can be easily adopted by industry and small/large scale farmers.

Status of Commercialization

The technology is ready for commercialization.

Salient Feature

- Raw ingredients (Potato component, maize, mustard oilcake, de-oiled rice polish, rice polish mineral mixture, salt, urea) – Cleaning weighing –Grinding (Hammer mill)-Mixing of feed ingredients (Blender, 30 Min.) Pellet making/extrusion (Horizontal/vertical pelletiser or single screw extruder) – Drying (Trey drier/sun drying)-Packaging-Storage.
- The technology has the potential to convert waste of potato processing industry and wasted potatoes into value added products i.e. animal feed, thus reducing the disposal problem of waste.
- A commercial feed plant can be established and run (on annual basis) at a total capital investment of Rs. 27 lakhs; which will give a profit of approximately 4.0-4.5 lakhs/annum.

Benefit

- A complete animal feed can be easily and economically prepared with potato waste by replacing about 25 to 30% grain component.

Developer: Sangeeta Chopra, ICAR-CIPHET, Ludhiana

Contact Details: Director, (director.ciphnet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana, Punjab (www.ciphnet.in),
Director, (director.cpri@icar.gov.in) ICAR-Central Potato Research Institute, Shimla, Himachal Pradesh (http://cpri.icar.gov.in)

Preparation of Cashew Apple powder (CAP) and Product Diversification

Cashew is cultivated in 10.62 lakh ha and about 70 lakh MT of cashew apples are produced in India (Cashew apple is the Pseudo fruit i.e. adhered swollen peduncle of cashew nut). Only 5-7% of the total production is currently utilized.

Status of Commercialization

The technology is ready for commercialization.

Salient Features

- Due to short shelf life and the presence of astringency, cashew farmers are unable to get additional revenue through cashew apple.
- Converting the perishable fruit into stable cashew apple powder will provide an additional income to the farmer and will generate employment in rural sector.
- Presence of high ascorbic acid and dietary fiber with proanthocyanin, can explore the possibility in nutritive mix, infant food and pharmaceuticals.

Procedure

- Production of Cashew Apple Powder (CAP) involves picking, cleaning, slicing of cashew apple and chemical treatment for tannin reduction. Treated cashew apples are dried using either Convection drying (CD) or Poly house solar tunnel dryer (PHSTD) and ground to fine powder.
- It is a simple technique of drying, pulverizing and packaging.
- Cost of production is approximately Rs 20 per kg.

Benefit:

- Technology developed for drying cashew apples harnessing solar energy is a low cost one and it can be followed in cashew growing regions. As such cashew apples are not utilized by growers; this technology aid to convert bulk cashew apple in to powder form having long shelf life.
- Either food products like Ready to Serve (RTS) beverage, jam, Jelly, laddu, Burfi, cookies and bio fuel could be prepared by them or CAP prepared can be supplied to food processing industries for large scale production of diversified products.
- As farmers are unable to get any benefit from cashew apple which is considered as waste at present, this will help them to get additional revenue and motivate to continue in cashew supply chain.
- BCR: 1.23:1.

Training

Two days training for preparation of cashew apple powder and diversified products is given by Directorate.

Developer: D Balasubramanian, ICAR-DCR, Karnataka

Contact Details: Director, (director.dcr@icar.gov.in) ICAR-Directorate of Cashew Research, Puttur, Karnataka (www.cashew.res.in)

Arka Fermented Cocopeat

Coirpith, a by-product of the coir industry is obtained during the extraction of coir fibre from the coconut husks. India annually produces about 21288 million coconuts. Around 35 percent of the total biomass of these nuts is comprised of the husk, from which coir fibre and coirpith are extracted. Currently around 45 % of these husks are utilized by the coir industry. The annual production of coir pith is estimated at 7.5 million tonnes per annum. Kerala stands first in country in coir production. Traditional methods of cocopeat production are time taking and water intensive. The Arka Fermented Cocopeat technology provides an alternate method which can be adopted by both nurserymen and cocopeat manufacturers.



Status of Commercialization

*The technology and the associated products are already commercialized with private entrepreneurs viz., M/s Bloom Biotech, Chikkamagalur and M/s Natura Crop Care, Bengaluru.

Salient Features

- In this method solid state fermentation of coirpith (raw material) is done by a consortium of the tannase producing fungal species *Aspergillus heteromorphus*, for a period of thirty days followed by the enrichment of the fermented substrate with the Arka Microbial Consortium a carrier based formulation of beneficial microbes.
- This technology has simplified the entire process in an environment friendly manner with minimal water usage and environmental pollution.
- For nursery entrepreneur an investment of Rs.50,000 is required to set up a production facility of approximately 30 t/month and the cultures used in the bio-conversion can be purchased from the institute or its licensees.
- A cocopeat manufacturer needs to invest around 10 lakhs (exclusive of land and building), in order to set up a Biosafety Level - 1 microbiological laboratory for the mass production of the cultures used in the bioconversion and enrichment.

Benefit

- Reduced cost of production compared to the traditional methods.
- The soil gets enriched with beneficial microorganisms, viz., N fixers, P solubilizers and plant growth promoters; shows better seed germination, vigorous and uniform seedlings and early transplantation maturity.
- It is self-employment generating technology in coconut growing belts of South and East India.

Training

Hands on training on the production of AFC is imparted by by ICAR- IIHR, Bengaluru.

Developer: G.Selvakumar, P.Panneerselvam, A.N. Ganeshamurthy and V.K.Rao, ICAR-IIHR, Bangalore

Contact Details: Director, (director.iihr@icar.gov.in) ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka (www.iihr.res.in)

Technology for the Isolation of Antioxidants, Pectin and Dietary Fibre from Mango Peel

During processing of mango, peel and kernels are left out as waste by-products. Mango peel accounts for 15 to 20 % of whole fruit weight. The peels and kernels of the fruit are found to possess 20 to 30 times more antioxidants than the pulp.

Dietary fibre is a nutraceutical food supplement used for gastro-intestinal tract health. The yield of dietary fibre from mango peels is 40 %. So, the peels can be exploited as a new source for dietary fibres.

This technology enables laboratory scale isolation of natural antioxidants, pectin and dietary fibre from mango peel, a processing waste material.



Status of Commercialisation

Upscaling and commercialization awaited.

Salient Feature

- In this technology, mango peels are used to isolate natural antioxidants, pectin and dietary fibre. Unlike other natural antioxidants like tocopherols and ascorbates, the mango peel antioxidants possess heat stability and can be used in the preparation of foods which require heating operations. The yield of pectin, which is an industrial food additive for gelling, is to the tune of 9 – 11 % from peels.
- Equipments required are a Sample mill, a Solvent extractor, a Solvent evaporator and Industrial drier. An industrial shed of 30 x 40 meters square with facilities like power and water are also needed. This includes a capital requirement of Rs.45 lakhs (excluding shed)
- The yield of antioxidants is 16-20% and fortification of mango concentrate (65% solids) with peel antioxidants (0.08%) doubled the antioxidant activity of mango concentrate.
- The yield of pectin, which is an industrial food additive for gelling, is to the tune of 9–11% from peels.
- The yield of dietary fibre from mango peels is 40 %.
- Benefit Cost Ratio is 1.11.

Training

Laboratory scale training will be given at Indian Institute of Horticultural Research, Bangalore for interested people.

Developer: V. K. Rao, C. K. Narayana, I. N. Doreyappa Gowda, D. V. S. Rao, ICAR-IIHR, Bangalore

Contact Details: Director, (director.iibr@icar.gov.in) ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka (www.iibr.res.in)

Fortified Baked Products from Cabbage waste (Biscuits, Bread & Rusk)

About 4.0 million tonnes of cabbage leaf is wasted as field residue in India. These wastes have large amounts of nutrients beneficial for health like, 390 mg/100g vitamin C, 2.633% protein and 6537 µg /100 g total carotenoids. These waste leaves have great potential for use in food fortification.

A process has been standardized for its utilization in daily food like bread, biscuits and rusk having higher nutritional value than the normal.



Status of Commercialization

Awaiting Commercialization.

Salient Features

- Cabbage leaves peeled-off during preparation for market are washed and blanched to inhibit the enzymatic activity and remove strong smell and then dried and powdered. The powder is mixed with refined wheat flour upto a maximum of 7% (w/w) and dough kneaded as required for baked products (Bread, Rusk and Biscuits/Cookies).
- The process involves two stages; first sanitization, stabilization and pre-processing of cabbage leaf waste into shelf stable intermediary and second incorporation of an optimized intermediary product and baking at a standardized temperature to retain its nutritional value.
- Three baked products (Bread, Rusk and biscuits/cookies) developed by supplementing the wheat dough with cabbage leaf powder resulted in enhancement of nutrition of these commonly used daily foods.
- The products developed from cabbage leaf waste are 3-5 times high in total carotenoids, 2-10 folds high in crude fibre and 80-100% high in total antioxidants.
- As cabbage is sprayed heavily with pesticides, it is emphasized that those with residues of chemicals may be avoided. However, the damaged inner leaves discarded during trimming could be made use of.

Benefit

Replacement of refined wheat flour with 5-7% of powdered cabbage leaf enhanced its protein content by 22-44%, crude fibre content by 118-188% and total carotenoids by 54-138%. The total antioxidant activity increased from 98.65 to 151.22 mg/100g due to fortification.

Training

ICAR-Indian Institute of Horticultural Research, Bangalore.

Developer: C.K.Narayana & D.V.Sudhakar Rao, ICAR-IIHR, Bangalore

Contact Details: Director, (director.iihr@icar.gov.in) ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka (www.iihr.res.in)

Banana Central Core Stem Candy and Cookies



About 25 – 30 tonnes of pseudostem waste is produced after harvest of the crop, of which about 5-7 tonnes of central core can be extracted from one hectare.

Central core (true stem), a component of pseudostem is commonly used in kitchen for culinary preparations. Karpuravalli & Poovan varieties are best suited for central stem.

The core stem part is used for preparing candy, which is sweet in taste and rich is fiber and potassium.

Status of Commercialisation

Awaiting Commercialization.

Salient Feature

- Central stem can be converted into a candy by slicing and steeping in sugar syrup, to make a central stem preserve or candy which is sweet in taste and rich is fibre.
- Banana central core stem based ginger candy can be prepared by mixing syrup and ginger in the ratio of 8:2. Central core stem slices/pieces are soaked in the syrup-ginger extract mixture and dried in the hot air oven overnight after draining the excess syrup.
- It can be fortified with other juices like carrot, beetroot, curcumin, etc.
- It can be stored safely up to three months without any spoilage.

Benefit

- The part is rich in dietary fibre and believed to have the properties to dissolve the kidney stones.
- Rich in fiber and potassium.
- Can generate rural employment, particularly for women sector.

Developer: C.K. Narayana, K.N. Shiva, P. Suresh Kumar, Amelia Keran D, K. Kamaraju and S. Uma, ICAR-NRCB, Tamil Nadu

Contact Details: Director, (directornrcb@gmail.com), ICAR-National Research Centre for Banana, Tiruchirapalli, Tamil Nadu (www.nrcb.res.in)

Banana Central Core Stem Pickle

Banana stem is a waste material produced during crop production with less economic value. About 25 – 30 tonnes of pseudostem waste per hectare is produced after harvest of the banana crop, of which about 5-7 tonnes of central core can be extracted from one hectare. Varieties such as Karpuravalli, Poovan, are best suited for central stem. It is converted into a high value-added product by making central core stem pickle.



Status of Commercialisation

Technology already commercialized.

Salient Features

- This is a product developed by using the waste material, i.e., Central core stem. Central core stem is a waste material, after harvest of bunches. The process involves extraction of central core from pseudo-stem, slicing and cutting into small pieces, removal of fiber, blanching, and addition of spices and oil.
- Equipment required are Steam Boiler, Mixer cum Grinder, frying pans, Pickle filling and packing machine/ pouch sealing machine and blancher.
- A capital investment of Rs 44, 71,500 is required.
- Benefit Cost Ratio is 1.61.
- This product is highly suitable for Self-help group for women (SHGs).
- Being rich in fibre and potassium, the product is suitable for consumption to all age groups.
- The product is tasty and stable for one-year at room temperature.

Benefit

- The waste material will provide additional revenue to the farmers.
- It is useful for small and medium scale industries.
- This technology can create rural employment based on wealth generation from waste.
- The product is tasty and stable for one-year at room temperature.

Training

The training and transfer of technology for the product is available at ICAR – National Research Centre for Banana, Thogamalai Road, Thayanur Post, Tiruchirappalli – 620 102, Tamil Nadu.

Developer: C.K. Narayana and K.N. Shiva, P. Suresh Kumar, Amelia Keran D, K. Kamaraju, S. Uma, ICAR-NRCB, Tamil Nadu

Contact Details: Director, (directornrcb@gmail.com), ICAR-National Research Centre for Banana, Tiruchirappalli, Tamil Nadu (www.nrcb.res.in)

Banana Central Core Stem Juice a Ready to Serve Beverage



About 25 – 30 tonnes of pseudo-stem waste is produced after harvest of the crop, of which about 5-7 tonnes of central cores can be extracted from one hectare depending upon the variety. The core stem part is generally used for culinary preparations. Juice is extracted from the central core stem either manually or mechanically. The stem is rich in fibre and potassium. About 80-95% juice could be recovered from central core stem of commercial banana varieties.

Status of Commercialisation:

Technology already commercialized.

Salient Feature

- The process involves extraction of central core from pseudo-stem, slicing and cutting into small pieces, removal of fibre, crushing and extraction of juice, pasteurization, packing, sterilization and storage. It should be served chilled. The protocol and recipe have been standardized.
- It requires a total capital investment of Rs 1,39,02,350; manpower of 7 persons; space of 3000 Sq Ft. covered plinth area; working tables and equipment like Stem Slicer, cleaner and Juicer, Pasteurization unit and Filling and Sealing Unit together with power supply of 5HP and Banana Central core stem as raw material.

Benefit

- It has the property of dissolving kidney stone.
- It can be enriched with ginger and nannari flavour.
- Adopted to Micro, small and medium enterprise levels.

Training

Technology transfer and trainings are available in the Institute on payment basis.

Developer: K.N. Shiva, P. Suresh Kumar, K. Kamaraju and S. Uma ICAR-NRCB, Tamil Nadu

Contact Details: Director, (directornrcb@gmail.com), ICAR-National Research Centre for Banana, Tiruchirapalli, Tamil Nadu (www.nrcb.res.in)

Banana Flower Pickle (Thokku)

The banana male bud is a waste material produced during crop production with less economic value. It is converted into a high value-added product by making pickle (Thokku). The product is tasty and stable for a year at room temperature. The technology can be adopted in all banana growing regions of the country. The product is suitable for all age groups.



Status of Commercialisation:

Technology already commercialized.

Salient Feature:

- This is a product developed by using the waste material, i.e., flower bud. Flower bud is a waste material, after last hand developed in the bunch.
- The process involves removal of pistil, blanching, grinding and addition of spices and oil. The protocol and recipe have been standardized.
- A working capital of Rs 44,71,500 is required. It includes 1060 Sq.Ft. covered plinth area; Working Tables; equipment like Steam Boiler, Mixer cum Grinder, frying pans, Pickle filling and packing machine/ pouch sealing machine and blancher with power supply of 5HP and manpower of 7 persons. The raw material required is Banana male flower bud.
- Benefit Cost Ratio is 1.66.

Benefits:

- The product is rich in dietary fiber.
- Can be ideal choice with *idly*, *dosa*, *chappathi* and even with rice items.
- Employment generation to rural enterprise, particularly to women.

Training

Technology transfer and trainings are available in the Institute on payment basis.

Developer: C.K. Narayana and K.N. Shiva, ICAR-NRCB, Tamil Nadu

Contact Details: Director, (directornrcb@gmail.com), ICAR-National Research Centre for Banana, Tiruchirapalli, Tamil Nadu (www.nrcb.res.in)

Banana Peel Based Muffin, Pizza base & Pickle

Nearly 25-35% of the green fruit is constituted by peel which is packed with nutrients and anti-oxidants.

It can be utilized as source of raw materials for producing peel pickle by adding spices and preservatives. The peel of culinary purpose varieties [like Nendran, Monthan, Saba] can be utilized for making this product.

Status of Commercialisation:

Awaiting Commercialisation.

Salient Features

- This is a product developed by using the green peel.
- The process involves peeling, cutting into pieces, blanching, grinding and addition of spices and oil.
- Being rich in dietary fibre, aids in digestion and forms very good taste with idly, dosa, chapati and bread, etc.
- A working capital of Rs 44,71,500 is required. It includes 1060 Sq.Ft. covered plinth area; Working Tables; equipment like Steam Boiler, Mixer cum Grinder, frying pans, Pickle filling and packing machine/ pouch sealing machine and blancher with power supply of 5HP and manpower of 7 persons.
- Replacement of semolina flour with upto 10% with banana peel flour, resulted in fibre rich pizza base.
- Peel Flour (15%) incorporated muffin had more gas bubble formation in batter and resulted in springier muffins with greater aerated structure and volume. The incorporation of peel flour also improved the colour of the muffin crust.
- Benefit Cost Ratio is 2.0.



Benefit

- The product is different from normally available pickles in the markets.
- It gives good taste and stable for one year at room temperature.
- Peel has anticancer properties.
- It can be produced at cheaper cost and raw materials are available throughout the year.
- It creates rural employment and revenue generation to rural population. Particularly to women sector.
- The costs of the pickles are cheaper than the pickles that are available in the markets.

Training

ICAR–National Research Centre for Banana, Tiruchirappalli, Tamil Nadu.

Developer: P. Suresh Kumar, K.N. Shiva, Amelia Keran D, K. Kamaraju, S. Uma, ICAR-NRCB, Tamil Nadu

Contact Details: Director, (directornrcb@gmail.com), ICAR-National Research Centre for Banana, Tiruchirapalli, Tamil Nadu (www.nrcb.res.in)

Starch and Modified Starch from Banana

India, the largest producer, produces 30.0 million tons of banana from 0.8 million ha, sharing one-fourth of world production. Multibillion loss of banana (both at farm and marketing channels) occurs due to huge wastage (25-30%) in on-farm and transportation. Isolation of starch and using it for the development of new products will pave the way to recover this waste partially.



Status of Commercialisation:

Proven and awaiting commercialization

Salient Features

- Banana, with its higher quantity of starch and resistant starch offers a greater extraction of starch other than conventional sources.
- Banana starch could be a supplement to meet the starch demand and could be used in food and non-food applications.
- Starch could be used as supplementary in low glycemic products – making of bread, bun, cookies, cake, pasta and noodles.
- Modified starch could be used as supplementary in low glycemic products. Due to adding new functional groups to starch, it makes difference in structural and functional properties.
- Starch modification by enzymatic and chemical methods are done and it require minimum processing infrastructure like peelers, cabinet drier, pulverizer, hammer mills, sieves, packaging and storage units are required.

Benefit:

With the varying functional and structural characteristics of different varieties, (e.g. amylose, resistant starch, thermal properties) and functional (e.g. cooking characteristics, swelling power, water holding capacity, freeze-thaw stability and rheological behaviour) features of starches makes banana starch comprehensively useful for different food and other industrial application.

Developer: P. Suresh Kumar, K.N. Shiva, Mr. A. Saravanan, S. Uma, ICAR-NRCB, Tamil Nadu

Contact Details: Director, (directornrcb@gmail.com), ICAR-National Research Centre for Banana, Tiruchirapalli, Tamil Nadu (www.nrcb.res.in)

Low Glycemic Products using Banana Flour and Powder



With the production of 30.0 million tons from an area of 0.8 million ha, India is the largest producer, contributing one fourth of world banana production. Utilization of green banana and plantain for its flour is of interest as a possible resource to make healthy functional products. One fifth of world bananas amounting 4-5 million tons are getting rejected in the export process due to quality issues. These bananas are mostly thrown, which cause environmental pollution and incur huge loss to the farmers as well as processors. In addition, plantain varieties, grown in 30% area are underutilized for their nutritive uses.

Staius of Commercialisation:

Proven and awaiting commercialization.

Salient Features:

- Due to higher resistant starch content in banana it could be used for making different functional and designer products.
- Banana flour used as a gluten-free replacement to refine flour, wheat flour etc., for making varieties of baked goods like pizza, extruded snacks like pasta, noodles and vermicelli products.
- Banana flour incorporated bread, bun and cake can be prepared by partial replacement of traditional *maida* and thus make the product with low gluten content.
- It requires Bakery equipment, Homogenizer, extruders, boilers, packaging unit.
- Cost Benefit Ratio varies from 1.28 to 1.71 depending on the type of product.

Benefit:

- It is a food with good prebiotic characteristics which could be consumed even by diabetic patients.
- Low Glycemic products aids in lower absorption of carbohydrates and releases low sugar in blood and also enhances the activity of gut microflora and probiotics.

Developer: P. Suresh Kumar, K.N. Shiva, D. Amelia Kiran, A. Saravanan and S. Uma, ICAR-NRCB, Tamil Nadu

Contact Details: Director, (directorncrb@gmail.com), ICAR-National Research Centre for Banana, Tiruchirapalli, Tamil Nadu (www.ncrb.res.in)

Basil Seed Suspended Banana Ready to Drink Beverage



The banana is not being utilized properly. The available products in the market are using the artificial banana essence and costlier hydrocolloids to make the suspended juices. The real benefit of banana juices for its coolant effect, rich potassium and magnesium is not fully exploited.

Status of Commercialisation:

Proven and awaiting commercialization.

Salient Features

- Over ripen banana was peeled and extracted juice.
- Banana juice can be prepared from **over-ripen** fruit added with basil seeds which provides high nutrient energy drink.
- **Basil seeds** are good source of omega 3 and 6 fatty acids. Basil seed drink helps in weight loss, reduce body heat, prevent constipation, treats acidity and control blood sugar levels.
- Addition of desire suspending agents for basil seed suspension, homogenization, pasteurization, cooling, KMS added as a preservative and bottling.
- Juice unit including steam kettle, pasteurizer, sealer, bottling unit, homogenizer.

Benefit

- Combating malnutrition and providing balanced nutrition.

Developer: P. Suresh Kumar, K.N. Shiva, D. Amelia Kiran and S. Uma, ICAR-NRCB, Tamil Nadu

Contact Details: Director, (directorncrb@gmail.com), ICAR-National Research Centre for Banana, Tiruchirapalli, Tamil Nadu (www.ncrb.res.in)

Biscuits/ Cookies/ Muffins from Centre Core Stem & Peel of Banana

After harvesting the fruit bunch of banana, huge plant bio-waste is generated, out of which pseudostem (30-34%), flower & bracts (5%) and rhizome (12-14%) together they contribute 50 per cent of the banana plant biomass. Burning of pseudostem after harvest of the bunches leads to CO₂ emission. Little quantity is being utilized in raw form for culinary purposes. Banana peel and central stem is rich in dietary fiber, protein, essential amino acids such as leucine, valine, phenyl alanine and theonine the micronutrients like K, P, Ca, Mg, Fe and Zn, polyunsaturated fatty acids. They possess good antioxidant compounds like polyphenols, and catecholamines. It is used in food, pharmaceutical and medical drugs. Banana peel powder could be used as a functional replacement in the variety of bakery products like cookies, biscuits, muffin, health foods etc.



Status of Commercialisation:

The technology is Commercialized

Salient Feature

- Good quality powder is produced from the bananas of right variety and degree of ripeness.
- The process involves removal of outer sheath, using the central stem, slicing, drying, pulverising, addition of sugar, fat and baking powder.
- Muffins are prepared by initially blending all wet ingredients together to form cream, and finally all dry ingredients were added to get batter consistency. Batter placed in greased muffin mould when baked at 180°C for 25 minutes yield banana peel incorporated muffin with acceptable textural and sensory properties.
- By replacing 10-20% of all purpose white flour (*Maidha*) with banana peel flour, the overall nutritious composition of muffin will be increased, without compromising any sensory appeal.
- Converting central stem into a value added product will boost the income of the farmers by incorporated various flavors and multigrain biscuits.
- Cost Benefit Ratio: 1.69.

Benefit:

- The product is delicious, crisp and stable for 3 months at room temperature. It is highly appreciated by consumers especially by children because of their soft texture and characteristic delicious taste.

Training:

Training is required on the minimal processing of central stem, drying and using it in bakery and confectionary products.

Developer: P. Suresh Kumar, K.N. Shiva, K. Kamaraju and S. Uma, ICAR-NRCB, Tamil Nadu

Contact Details: Director, (directornrcb@gmail.com), ICAR-National Research Centre for Banana, Tiruchirapalli, Tamil Nadu (www.nrcb.res.in)

Cellulose & Micro-Crystalline Cellulose from Banana Sheath Fibres



- After bunch harvest more than 50t/ha of pseudo-stem is left unutilized. This stem and peduncle could be used to produce cellulose. With the 8-lakh area under cultivation, minimum of 40 Million tons of waste is generated. Banana fiber mainly composed of cellulose component, which is a complex carbohydrate.
- In addition to cellulose, fibers were also composed of hemicelluloses, lignin, wax and pectin, which will differ based on the chemical composition of variety of that fibres.
- The highest cellulose content in banana fibre was found to be in Nendran of about 60.72%.

Status of Commercialisation:

Proven and awaiting commercialization.

Salient Features

- Layers of sheath was used (11-13 layers) and shade drying of obtained sheath is done.
- Mechanical extraction is done using Raspador machine/Improved fiber extractor.
- Fibre was waxed for removal of pectin and gummy material, alkali treated to remove hemicelluloses and lignin content and acid hydrolysis followed by bleaching done to obtain pure cellulose.
- Benefit Cost Ratio 2.27.

Benefit

- Ferulic acid is produced from banana fibres as a source by fermentation method. Inoculum of co-cultures yields good recovery.
- Cellulose fibers were applied in the field of textile industry, as an adsorbent, chemical filters, as reinforcement biocomposites which shows similar objective of engineered fibres and acid hydrolysed fibres produces nano cellulose.

Developer: K.J. Jeyabaskaran, M.M.Mustaffa, R.Pitchaimuthu, T.Sekar, ICAR-NRCB, Tamil Nadu

Contact Details: Director, (directornrcb@gmail.com), ICAR-National Research Centre for Banana, Tiruchirapalli, Tamil Nadu (www.nrcb.res.in)

Banana Fiber from Pseudostem Sheath

Banana pseudo-stem is a waste material after the harvest. Annually 30 million tonnes of biomass is produced through banana cultivation from which 1.5 million tonnes of fibre could be extracted. The biomass production varies from 54.60 t/ha (Poovan) to 94.10 t/ha (Saba). In pseudo-stem, only 9-10 layers of sheath of the plant yield fibre. The quantity of biomass produced depends on the variety. The natural fiber has multifaceted uses in preparing many value added products such as handicraft items (table-mat, bag, wall hangings and other fancy articles, etc.), ropes, craft paper, etc. This may lead to rural employment and thereby, generation of additional income to the farming community.

Status of Commercialisation:

The technology has been commercialized.

Salient Feature

- This is a process developed for using pseudo-stem many value-added products. Banana fibre is extracted from the sheath of banana pseudo-stem by hand or machine. The fresh pseudo-stem yields about 1-1.5% of fibre.
- Two types of fibers can be obtained; **Coarse fiber**, from the outer sheath of banana pseudostem used for making garlands and **Fine fiber**, from middle layer sheaths of seven to eight, used for making handicraft items, shirts and sarees by blending with cotton or silk, after extracting thread manually.
- A capital investment of Rs 22,09,625 is needed. A space of 1060 Sq.Ft. (500 Sq.Ft. Covered plinth area) is required along with working tables, Improved banana Fibre Extractor with power supply of 5 HP. Banana Pseudostem is required as raw material with manpower of 5.
- Benefit Cost Ratio is 1.76.

Benefit

- This may lead to rural employment to the farming community, particularly women.
- It is natural fibre and eco-friendly in nature made from cheaply available waste as raw material.
- It has wide range of applications (textile, handicraft, absorbent, automobiles, etc.).

Training:

The training is available at ICAR – National Research Centre for Banana, Tamil Nadu.

Developer: P. Suresh Kumar, K.N. Shiva, C.K. Narayana, P.Divya, K. Kamaraju, S. Uma, ICAR-NRCB, Tamil Nadu

Contact Details: Director, (directornrcb@gmail.com), ICAR-National Research Centre for Banana, Tiruchirapalli, Tamil Nadu (www.nrcb.res.in)



Decorative Wall Panels Using Banana Pseudostem Fibres and Natural Binders



ICAR-CIRCOT has developed innovative decorative wall panels using banana fibres. These panels provide an eco-friendly alternative for the conventional interior panel boards.

Salient Features

- This technology is suitable in the location where the banana pseudo-stem fibres are available. The production process is very simple and follows the compression molding technique. Novel colouring technology is used to colour the banana fibres for aesthetic look. The potential stake holders are banana farmers, interior decorators and architects.
- Cost of the unit (as per 2019 costs or later): Rs. 20.00 lakhs for molding equipment and other accessories for starting one industry with a capacity of around 100 panels of size 2' x 2' per day.
- Cost of operation per unit size (as per 2019 costs or later) Rs. 2000 per batch of 100 panels.

Benefits

Eco-friendly binder is used in the production process, making the entire product completely eco-friendly. It has very good acoustic property and aesthetic look. Has very good workability hence easy to cut in any shapes and sizes.

Developer: ICAR-CIRCOT, Mumbai

Contact Details: Director, (director.circot@icar.gov.in) ICAR-Central Institute for Research on Cotton Technology, Mumbai, Maharashtra (www.circot.res.in)

Paper Plates from Natural Fibre Biomass



ICAR-CIRCOT has developed a technology for production of disposable paper plates from the banana pseudo-stem fibres and sugarcane bagasse. The conventional plastic coating of paper plate is replaced by a novel bee wax or sugarcane wax-based coating process.

Salient Features

- The production process is by pulping the raw materials followed by compression molding process. No binders/additives are used during processing; lignin present in the fibres act as the binder. This technology could be easily adopted in a place where the water source and the raw materials – banana pseudo-stem and sugarcane bagasse are available in plenty.
- Cost of the unit (as per 2019 costs or later): Rs. 40.00 lakhs for pulping and molding equipment for starting one industry which can produce 10,000 to 30,000 paper plates per day (depending on its size).
- Cost of operation per unit size (as per 2019 costs or later): Rs. 8,000 per batch of 20,000 paper plates.

Benefits

The prepared paper plates had sufficient strength for holding the food items and acceptable aesthetic look. The potential stake holders are banana farmers, banana fibre extractors, sugarcane industries, Incubators / start-ups.

Developer: ICAR-CIRCOT, Mumbai

Contact Details: Director, (director.circot@icar.gov.in) ICAR-Central Institute for Research on Cotton Technology, Mumbai, Maharashtra (www.circot.res.in)

Yoghurt with Antioxidant from Wine Lees

As per an estimate, Indian wine industry is producing 20 million litre wines and generating about 1.2 thousand tons of red wine lees which is a waste product collected after 2nd racking. Its disposal is a major environmental problem. Presently, waste material is disposed by burning in open fields or flowed in water bodies without attempting environmental issues which results in loss of potential source of organic matter and valuable plant nutrients.



A technology has been developed in which yoghurt is enriched with wine lees and it can attract the consumers very fast when it will enter in the market with tag of antioxidants.

Status of Commercialisation:

Ready for commercialization.

Salient Feature

- Wine lees shows significant antibacterial properties as well as antioxidant properties and includes as spreads, none caloric thickeners, flavour enhancers, and functional food additive, such as β -glucans. The fine wine lees from fermentation of red grapes is source of natural colour also.
- Wine lees obtained from red wine of Cabernet Sauvignon has numerous properties like antioxidant activities, rheological properties beside natural colour and aroma.
- The raw material i.e. fine wine lees from red wines may be acquired from any winery on prior booking of the material.
- For processing of fine wine lees, equipment for freeze drying is required which will dry the lees at -65°C , 0.12 mBar pressure for 3–4 h to remove ethanol content and preserve maximum amount of phenolics content and anthocyanins.

Benefit

- Enriched yoghurt with wine lees is beneficial to health,
- It increased sensory acceptance.
- It acts as source of natural colour.
- It can be used as spreads, none caloric thickeners, flavour enhancers, and functional food additive, such as β -glucans.
- It will help in proper disposal of winery wastes.
- 1.5:1 (Benefit Cost ratio).

Training

Training on processing of wine lees by ICAR-NRCG while general training on yoghurt making by ICAR-NDRI, Karnal.

Developer: Ajay Kumar Sharma, ICAR-NRCG, Pune

Contact Details: Director, (director.nrcg@icar.gov.in) ICAR-National Research Centre for Grapes, PB No.3, Manjri Farm Post, Solapur Road, Pune-412307, Maharashtra (<http://nrcgrapes.icar.gov.in>)

Enrichment of Cookies by Using Grape Pomace Powder

At present, 93 registered wineries exist in India. These wineries are generating about 3 lakh tones of grape waste. Its disposal is a major environmental problem. Presently, waste material is disposed by burning in open fields, which results in loss of potential source of organic matter and valuable plant nutrients.

Wastes generated during wine and grape juice preparation have huge quantity of phenolic compounds. The grape pomace from red wine and juice (Manjari Medika) contain viable functional ingredients and can be added in cookies to increase total phenolic content, radical scavenging activity and dietary fibers.



High value cookies prepared through replacing of maida by grape pomace powder

Status of Commercialisation:

Ready for commercialization

Salient Features:

- The raw material i.e. wine grape pomace from red wines and Manjari Medika, may be acquired from any winery or grape juice industry on prior booking.
- The cookies are developed by processing of wine grape pomace powder, alteration in normal process of cookies making and product is also very specific.
- The addition of grape pomace powder obtained from red wines, increased antioxidant properties comprising ferric reducing antioxidant power, total phenol content, flavonoid and anthocyanin.
- Wine grape pomace powder imparts brown colour to cookies as compared to control. Improved sensory properties were recorded in cookies enriched by addition of wine grape pomace powder.
- The developed technology can be adopted without investing more money for creating extra facilities.

Benefit

- Increase nutritive value of the product.
- The technology will also encourage proper disposal of winery and juice wastes which will reduce impact on environment and additional return.
- Benefit in monetary terms.

Training

General training of cookies making from any ICAR institute having bakery facilities while training on grape pomace powder processing from ICAR-NRCG.

Developer: Ajay Kumar Sharma, ICAR-NRCG. Pune

Contact Details: Director, (director.nrcg@icar.gov.in) ICAR-National Research Centre for Grapes, PB No.3, Manjri Farm Post, Solapur Road, Pune-412307, Maharashtra (<http://nrcgrapes.icar.gov.in>)

Fine wine Lees Enriched Ice Cream with Health Benefits

As per an estimate, Indian wine industry is producing 20 million liter wines and generating about 1.2 thousand tons of red wine lees. Its disposal is a major environmental problem. Presently, waste material is disposed by burning in open fields or flowed in water bodies without attempting environmental issues which results in loss of potential source of organic matter and valuable plant nutrients.

The fine wine lees are a waste product collected after 2nd racking in process of red wine making, and is having significant antibacterial and antioxidant properties which is found suitable as spreads, none caloric thickeners, flavour enhancers, and functional food additive, such as β -glucans.

Addition of processed fine wine lees can significantly affect physico-chemical parameters of ice cream. This is a technology of preparation of ice cream with higher nutraceutical properties by utilization of wastes from wine industry.



Status of Commercialisation:

Ready for commercialization

Salient Features

- The raw material i.e. fine wine lees from red wines may be acquired from any winery on prior booking of the material.
- For processing of fine wine lees, equipment for freeze drying is required which will dry the lees at -65°C , 0.12 mBar pressure for 3–4 h to remove ethanol content and preserve maximum amount of phenolics content and anthocyanins.
- It has high level of antioxidants and with this low sugar ice-cream can be produced.

Benefit

- Enriched ice cream will be helpful in improving the functional properties of product and intake of this specific product will certainly have health benefits. Which can't quantify in terms of rupees.
- The technology will encourage proper disposal of winery wastes which will reduce impact on environment.
- Enriched ice-cream have health benefits including nutritional, functional properties, delayed melting and attractive natural colour with excellent aroma.

Training

Training on ice cream making can be acquired from any NDRI, Karnal.

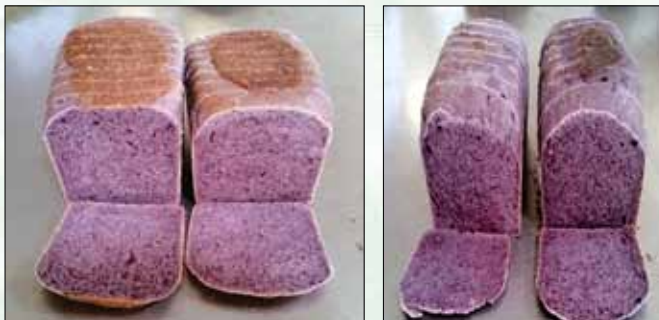
Developer: Ajay Kumar Sharma, ICAR-NRCG. Pune

Contact Details: Director, (director.nrcg@icar.gov.in) ICAR-National Research Centre for Grapes, PB No.3, Manjri Farm Post, Solapur Road, Pune-412307, Maharashtra
(<http://nrcgrapes.icar.gov.in>)

Enriched Breads by Addition of Grape Pomace Powder

Winery and grape juice industry by-products grape pomace is a viable functional ingredient which can be used in bakery products to increase total phenolic content, radical scavenging activity and dietary fibers.

This technology has potential to utilize waste generated from wine or grape juice industry.



Prepared breads having antioxidant properties, attractive colour with fibres

Status of Commercialisation:

Technology transferred to a bakery at Pune.

Salient Feature:

- Grape pomace powder imparts dark brown to light red colour to breads, while pomace powder of Manjari Medika impart very attractive red colour to breads.
- Attractive natural colour contains anthocyanins, phenols, fibres, etc.
- The raw material i.e. grape pomace from red and white wines or Manjari Medika grapes, may be acquired from any winery or juice industry.
- The replacement of maida through addition of pomace powder from different sources like red and white wine grape varieties and Manjari Medika (grape juice variety) increased antioxidant properties.
- Processing and proper storage of skin powder is needed to avoid presence of microbes.

Benefit

- The developed technology can be adopted without investing much capital for creating extra facilities.
- Enriched breads have improved functional properties and intake of enriched and attractive breads will have health benefits.
- Proper disposal of winery and juice industry wastes.

Training

General training of bread making can be acquired from any ICAR institute having bakery facilities and training on pomace powder processing will be provided by ICAR-NRCG.

Developer: Ajay Kumar Sharma, ICAR-NRCG. Pune

Contact Details: Director, (director.nrcg@icar.gov.in) ICAR-National Research Centre for Grapes, PB No.3, Manjri Farm Post, Solapur Road, Pune-412307, Maharashtra (<http://nrcgrapes.icar.gov.in>)

Use of Cymbidium Orchids Leaves for Weaving Baskets



A woman making Baskets from Cymbidium orchids leaves



Basket made from Cymbidium orchid leaves at Stake holders' Meet at NRCO, Sikkim

The leaves of Cymbidium orchids are up to 1 meter long and old pseudo bulbs shed their leaves every year due to their sympodial growth habit. One full grown plant shed on average 10-12 leaves per year and these leaves go waste. These dried leaves are very strong and can be utilized for weaving baskets.

The baskets made from these leaves are durable and give an aesthetic look and are degradable. It is useful in reducing farm waste.

Status of Commercialisation:

Technology already transferred

Salient Features:

- It is a eco-friendly product which is made from dried leaves of Cymbidium orchids and found good for women empowerment. The women farmers can weave easily by coiling and tying the leaves.
- These baskets can be useful for multiple purposes. Farmers will earn rupees 150-200/- per baskets will improve the livelihood of women farmers. Baskets being made are organic and can be used for decorative purpose in domestic market. This technology is recommended for adoption in any hilly state especially for city dwellers.

Training

ICAR-National Research Centre on Orchids, Pakyong, Sikkim.

Developer: D. R. Singh, Raj Kumar, D. Barman, P. Ravi Kishore, ICAR-NRCO, Sikkim

Contact Details: Director, (director.nrco@icar.gov.in), ICAR-National Research Centre for Orchids, Sikkim (www.nrcorchids.nic.in)

Technology for Essential Oil Extraction from Crop Residues of Seed Spices

Steam distillation is a common technique being used for essential oil extraction from medicinal and herbal plants. Value added form of spices has become the thrust area with tremendous potential. The global market is increasingly shifting from commodity to value added products. India exports raw seed spices as well as their value-added items to around 70 countries. Apart from spices oil, oleoresins, curry powder, ground spices and organic spices, more value-added products from seed spices, needed to be developed and marketed globally. In most of the seed spices after harvesting of economic product i.e. seeds considerable crop residues remain unutilized. These residues contain significant essential oil and need to be extracted for substantiating the farm income.

Residues from cumin crop containing 82% biological waste and 18% broken seeds resulted in 1% recovery of essential oil. Intact seeds of cumin contained 3-4% essential oil. Similarly, ajwain crop residues containing 84% biological waste and 16% broken seeds resulted in 2% essential oil extraction. Intact ajwain seeds are having 4-5% essential oil.

Status of Commercialisation:

Technology is ready for commercialization.

Salient Feature

- Steam distillation technique can be used for essential oil extraction from seed spices which is economically viable and enhance the income of seed spice stakeholders.
- By using this technology, essential oil from crop residues of seed spices under extreme hot climate can be extracted.
- Modification in existing technology utilize 10% of required water for condensation.
- Residues can be utilized which, otherwise of no use besides providing additional source of income to seed spices growers.
- Installation of steam distillation unit with the capacity of 40-50 Kg per batch cost less than Rs. 2.0 lakh and initial investment and operating cost in Rs1.5 lakh.

Benefit

- Residues may be utilized which, otherwise of no use. Provide additional source of income to seed spices growers.

Training

Only normal skills are required, and the training can be imparted by NRCSS, Ajmer.

Developer: S. N. Saxena, R. K. Kakani, R. K. Solanki, ICAR-NRCSS, Ajmer

Contact Details: Director, (nrcss.director@gmail.com) ICAR- National Research Centre on Seed Spices, Ajmer, Rajasthan (www.nrcss.res.in)

Use of Pomegranate Peel Waste Extract as Low-Cost Feed Supplement in Poultry



Fruit juice processing workshops produce large quanta of pomegranate peels which is considered as processing wastes. Chromatographic analysis revealed that these waste materials contain valuable polyphenols, known to have antimicrobial, antioxidant and hepato-protective activities in animals.

These golden wastes could strategically be used as source material for low cost extraction of polyphenols in water solvent using hot infusion method. Pomegranate peel infusion improves performance in broiler and layer birds when supplemented daily.

Status of Commercialisation:

Technology is proven and awaiting commercialization.

Salient feature of the technology:

- Pomegranate peel wastes are shade dried for 4 days and then ground into coarse powder. This powder is the raw material and used for pomegranate peel infusion.
- The powder is extracted with warm water in a glass container and crude extract is filtered twice using muslin cloths. The pomegranate peel infusion, thus prepared, are kept in dark coloured containers away from sunlight. The infusion should be used within 48 hours of preparation.
- Broilers or layer birds show better performance in terms of liveability, body weight gain and feed conversion ratio when supplemented with this infusion in drinking water at low dose levels.
- It is estimated that cost for production of 100 litres of peel infusion is only Rs.110.00.

Benefits:

- The method of green extraction of pomegranate peel wastes is simple and does not require any sophisticated instrument. This extraction can well be accomplished in food processing workshop itself as additional income generation avenue.
- When peel infusion is supplemented in poultry birds, Benefit Cost Ratio from the flock becomes 2.13 which is 3% more than un-supplemented group of birds.

Developer: Sarbaswarup Ghosh, Sasya Shyamala KVK, W.B.; Paresh Nath Chatterjee, WBUAFS, Kolkata

Contact Details: Director Research (arunasisvet@gmail.com), West Bengal University of Animal & Fishery Sciences, Kolkata, West Bengal (<http://wbuaafscl.ac.in>)

Technology of Extraction of High Value Polysaccharide from Ripened Lasora- An Underutilized Fruit

Lasora (*Cordia myxa*) is potential underutilized fruit plant in arid and semi-arid regions of India. It finds uses in health, nutrition and curing certain human ailments in traditional medicine systems. Unripe fresh fruits are widely used for vegetable and pickle at a time when availability of conventional vegetables is scarce. However, the ripened fruit pulp has transparent and very sticky mucilage surrounding the stone which makes



it unsuitable for consumption. On average 10% w/w mucilage can be obtained from ripened fruits. Polysaccharide has been extracted and purified from fruit mucilage.

Status of Technology Transfer:

Technology is ready for transfer.

Salient features

- Process for polysaccharide extraction has been optimized. It involves heating and mechanical stirring of mucilage, precipitation with solvent and dilute acid followed by purification and drying by lyophilisation.
- Fine off-white powder of polysaccharide is obtained.
- The powder on reconstitution can be used as emulsifying and thickening agent in foods.
- It also showed good film forming properties and thus can be used in coating applications.

Benefit

- A large quantity of ripened fruit which goes waste due to lack of utility can be exploited for polysaccharide extraction.

Training

Laboratory scale training is imparted by ICAR - Central Arid Zone Research Institute, Jodhpur.

Developer: Saurabh Swami, P.R. Meghwal, Akath Singh, Om Prakash, ICAR- CAZRI, Jodhpur

Contact Details: Director, (director.cazri@icar.gov.in), ICAR-Central Arid Zone Research Institute (CAZRI), Jodhpur, Rajasthan (www.cazri.res.in)

Tutti Frutti from Watermelon Rinds



Processing of fruits and vegetable result in different kinds of waste, such as citrus peel, Banana peel, watermelon peel etc. i.e. non-edible portion of fruit. After processing, it accounts for about 10-60% of the total weight of the fresh produce. Such waste poses increasing disposal & potentially severe pollution problems & represents a loss of valuable biomass and nutrients.

Status of Technology Transfer:

Technology is ready for transfer

Salient Features

- This is product developed by using the white portion of watermelon.
- The process involved chopping, boiling, straining, boiling in sugar syrup for 10 minutes, mixing with three different colours and resting for half an hour, drain it, dry under sunlight
- Being rich in Vitamin A, C, Potassium and magnesium.
- A very good test with cakes, cookies, ice cream and sweets

Benefit:

- The product is different from normally available cherries in the markets.
- It gives good taste & stable for 6 months at room temperature.
- It can be produced at cheaper cost & raw materials are available throughout the year.
- It creates rural employment & revenue generated to rural population. It provides employment generation to rural enterprises especially women.
- The cost of cherries is cheaper than the cherries available in the market.

Training

The training is imparted by KVK, ICAR-CAZRI, Jodhpur.

Developer: Savita Singhal, Poonam Kalash & B.S.Rathore, KVK, ICAR-CAZRI, Jodhpur

Contact Details: Director, (director.cazri@icar.gov.in), ICAR-Central Arid Zone Research Institute (CAZRI), Jodhpur, Rajasthan (www.cazri.res.in)

Technology for Growing Oyster Mushrooms on Coconut Waste

A low cost technology has been developed for cultivation of oyster mushroom utilizing coconut wastes such as leafstalk, bunch waste, leaflets, etc. Coconut wastes are chopped to 5-7 cm long pieces and soaked in water overnight. Excess water is drained off and substrates are sterilized by steam pasteurization in an autoclave at 1.02 kg cm² pressure for 1½ h. The substrate is then filled in polybags and inoculated



with spawn @ 100 g per bag containing 3-3.5 kg substrate. Sterilized rice bran is added @ 5% as an organic supplement. The bags are incubated for spawn run in a mushroom house for 15-20 days. After the spawn run, the polythene cover is ripped open and the compact cylindrical bed is sprayed with water two or three times daily. The first flush of mushroom fruiting bodies is ready in 5-10 days after opening of the bag. Three to four crops can be harvested from each bed. The technology is a source of employment and income for many women self-help groups, unemployed youth and rural folk and is a right step in direction of 'Atmanirbhar Bharat'.

Status of Technology Transfer

*The technology is already commercialized.

Salient Feature

- Mushroom produced on coconut wastes is nutritionally rich and medicinally important food item.
- It contains 20-30% protein on dry weight basis and a rich source of minerals, vitamin C, and vitamin B complex.
- The technology does not need any additional land requirement and utilizes the waste materials available in farmers' coconut gardens.
- The spent mushroom substrate obtained after harvesting of mushrooms can be used for compost/ vermicompost production.

Benefit

- Through this technology, the lignin rich coconut wastes are easily converted to useful edible protein source.
- This technology can not only be the source of income but also provide nutritional security to the impoverished farm families.

Training

Three-days training for production of mushrooms from coconut wastes is given at ICAR-CPCRI, Kasaragod, Kerala.

Developer: George V Thomas, Alka Gupta, Murali Gopal, ICAR-CPCRI, Kerala

Contact Details: Director, (anithakarun2008@gmail.com) ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala (www.cpcri.gov.in)

Technology for Production of Biochar from Coconut Wastes

Coconut plantations and coconut-based cottage industries generate close to 25 million MT of biomass wastes annually in India. They are an ideal feed-stock for producing biochar owing to high lignin content. Biochar is a solid, carbon rich, value-added product obtained by pyrolysis of residues from agriculture, forestry, animals etc. under limited or nil oxygen environments. Hence, a technology was developed at ICAR-CPCRI to convert coconut wastes such as tender coconut husks, mature coconut husks, coconut petioles, etc. into biochar by their pyrolysis under oxygen-limiting conditions using a simple charring kiln. The coconut wastes are suitable for biochar conversion with a turnover of 40-50% on weight-by-weight basis.



Status of Technology Transfer

*The technology is proven, yet to be commercialized.

Salient Feature

- The biochar produced from coconut wastes is sustainable and excellent soil amendment.
- It is carbon-rich, black, light weight and porous.
- High alkalinity and good ash content make it fit for remediating acid soils.
- High potassium content in these biochars could help reduce the use of inorganic K.
- It can be produced easily at farmers' level.

Benefit

- Coconut waste biochars are highly suitable as organic input for improving soil health and fertility of poor degraded soils.
- They enhance the crop production capacities of soils by improving the physical properties, increasing the soil pH, and adding valuable organic carbon and potassium.
- Combination of coconut biochars with coconut leaf vermicompost or coir-pith compost is an excellent soil amendment for humid tropical soils.
- The technology helps in converting environmentally hazardous wastes such as tender nut husks to useful agro-product.

Training

One-day training for production of biochar is given at ICAR-CPCRI, Kasaragod, Kerala.

Developer: Murali Gopal, Alka Gupta, S. Neenu, George V Thomas, ICAR-CPCRI, Kerala

Contact Details: Director, (anithakarun2008@gmail.com) ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala (www.cpcri.gov.in)

Farm-Level Production of Bioinoculants using Waste Mature Coconut Water



Luxuriant growth of bioinoculant *Bacillus megaterium* in coconut water +rice gruel medium indicated by the turbidity (right)



Bioinoculant multiplied in coconut water+rice gruel medium in a pressure cooker



Bioinoculant *Bacillus licheniformis* multiplied by this method without any external contamination

A simple and economically viable method for mass-multiplication of plant-beneficial bacterial and fungal inoculants (bioinoculants) is developed for the benefit of the farmers. This decentralized on-farm bioinoculant production by farmers paves way for enhanced adoption of bioinoculant technology by farmers, helping them to improve their farm soil health and fertility and ultimately crop production capacity.

Status of Technology Transfer

*The technology is yet to be commercialized.

Salient Feature

- The method utilizes locally available wastes such as mature coconut water and rice gruel (1:1 ratio) synergistically blended with biochar, as a medium for on-farm production of contaminant-free bioinoculants. The method produces aqueous bioinoculant formulation that can be easily applied as seed treatment, seedling dip, soil drenching and foliar spray and is suitable for immediate field application.
- Contamination-free bioinoculants containing BIS stipulated population of bacteria or fungi can be obtained.

Benefit

- The method also circumvents the necessity for storage of the bioinoculants as they can be produced and used immediately.
- The method, if practised by individual farmers or group of farmers, can greatly reduce the carbon-foot print for bioinoculant mass-multiplication because of the decentralized approach.

Training

Three-days training for farm level production of bioinoculants is given at ICAR-CPCRI, Kasaragod, Kerala.

Developer: Murali Gopal, Alka Gupta, George V Thomas, ICAR-CPCRI, Kerala

Contact Details: Director, (anithakarun2008@gmail.com) ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala (www.cpcri.gov.in)

Coconut Wastes Composts as Soilless Medium



The technology of raising crops in soilless medium as an alternative to arable land agriculture is getting prominence in the current climate change scenario. Recycled coconut biomass residues such as coconut leaf vermicompost and urea-free coir-pith compost are used as inputs in appropriate ratio to prepare soilless medium because they are environmental friendly and sustainable. The soilless medium mixture is added with plant-beneficial bioinoculants {both bacterial and fungal plant growth promoting rhizobacteria (PGPR)} which further helps in production of healthy and robust seedlings. It was successfully used for raising healthy seedlings of vegetables such as tomato and chilli, fruits such as papaya, spices such as black pepper and plantation crops such as arecanut and cocoa. The coconut composts-based soilless medium prepared this way is a boon for agri-horti nurseries and tissue culture units and urban-farming.

Status of Technology Transfer:

Technology is ready for transfer

Salient Features

- Soilless medium is entirely coconut wastes-based recycled product; is fully organic and of sustainable nature.
- It aids in quick germination of seeds and production of disease-free, organically-raised seedlings.
- The seedlings raised in soilless medium develop robust root system.
- It can be used for production of seedlings of high value vegetable, flower, spice and even plantation crops.

Benefit

- It is important for healthy and organic vegetable production in urban scenario and in nursery management of agri-horti-forestry crops.
- It is an excellent potting mixture for all types of polybags/ grow bags or pot cultivation in peri-urban farming.

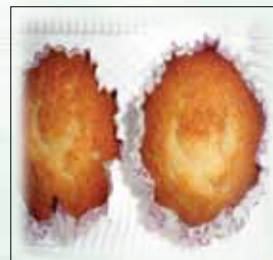
Training

One day training for preparation of soilless medium is given at ICAR-CPCRI, Kasaragod, Kerala.

Developer: Murali Gopal, Alka Gupta, P. Chowdappa, ICAR-CPCRI, Kerala

Contact Details: Director, (anithakarun2008@gmail.com) ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala (www.cpcri.gov.in)

Kalpa Krunch – W(H) Ealthy Product from Coconut Wastes



Coconut milk residue (CMR), virgin coconut oil (VCO) cake and coconut testa (CT) are the co-products of coconut processing industries which are either under or not utilized. These are rich in dietary fibres, protein, fat and anti-oxidant activity. The inclusion of these waste products in extrusion, bakery and confectionery production lines resulted in a fibres, minerals and nutrient rich food products at affordable cost.

Status of Technology Transfer: Commercialized and transferred to

1. Smt Raksha. Dayanand, # 50 C S Mansion, Church Street, Bangalore, Pin – 560001, Karnataka, India, Mob – 9448487635/ 7760111477.
2. M/s Perambra Coconut Producer Company, 2nd floor, Alankar Arcade, Perambra P.O, Kozhikode, Kerala-673525 India Mob - 9895105622.

Salient Features

- It comprises multiple principles such as extrusion, baking, caramelization and moulding.
- Mixing the ingredients (CMR flour / VCO cake flour / CT flour 15%) with 85% Broken rice flour / Maize flour / Millets flour) → Extrusion → Drying → Packaging OR with bakery raw materials (Maida, Ghee, sugar powder etc.) → Moulding → Baking → Packaging OR with cocoa powder → Conching → Tempering → Mixing with flavors and other ingredients → Molding → Packaging.
- Integrated processing unit for value addition of coconut processing industries-based waste products into extrudate, bakery and confectionery products.

Benefit

- Nutritional benefit,
- Employment generation,

Training

Training is imparted by ICAR-Central Plantation Crops Research Institute (CPCRI), Kasargod.

Developer: M.R.Manikantan, R.Pandiselvam and Shameena Beegum

Contact Details: Director, (anithakarun2008@gmail.com) ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala (www.cpcri.gov.in),

Director, (director.ciphet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana, Punjab (www.ciphet.in)

Pectin from Citrus Fruit Residue

The process involved use of organic acid while aqueous extraction from citrus peel powder. The process comprises of peel drying, grinding, aqueous extraction, straining, drying of pectin clump, lifting dried flake, powdering, and purification. The yield of 10-15% purified pectin (on dry weight basis) can be obtained depending upon the citrus variety chosen for pectin extraction. The process can be applied to any citrus peel with slight variation in processing time. Extracted pectin can be used in the food industry as a thickener, emulsifier, texturizer and stabilizer. It can also be added in jams and jellies as a gelling agent. It has also been used as a fat substitute in spreads, ice-cream and salad dressings and is a part of soluble dietary fibre.



It can also be added in jams and jellies as a gelling agent. It has also been used as a fat substitute in spreads, ice-cream and salad dressings and is a part of soluble dietary fibre.

Status of Technology Transfer:

Technology is ready for transfer

Salient Features

- The peel of pre-mature dropped fruits and waste originated of citrus processing industries can be utilized for pectin extraction.
- The system consists double jacketed kettle with stirrer, Hydraulic press/ screw press, Holding tank, Tray dryer, Solvent extractor/ rotary evaporator, pumps, industrial grade citric acid and ethanol, Grinder/hammer mill.

Benefit

- Less environmental pollution.
- Utilization of waste material.
- More revenue generation of otherwise waste material.
- The technology has potential for import substitution worth Rs. 70 crore .

Training

Training and licensing of the technology is imparted by ICAR-Central Institute of Post-Harvest Engineering and Technology (CIPHET), Ludhiana.

Developer: Sunil Kumar, ICAR-CIPHET, Ludhiana

Contact Details: Director, (director.ciphnet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana, Punjab (www.ciphnet.in)

CIPHET GLOW U: Face Care system



CIPHET GLOW U: FACE PACK



CIPHET GLOW U: FACE TONER

Face pack and face toner were prepared from Kinnow peel and its extracts. Face pack was made from dried Kinnow peels. The face pack prepared from kinnow peel is a rich blend of major concentrate of Kinnow peel powder and its extracts, and other minor components as thickener, adherent and preservative. Kinnow peel pack has all the properties of a standard face pack i.e. it is a smooth paste and has natural pleasant odour. It also has cleansing, tightening and refreshing effects on skin and is non-toxic.

Status of Technology Transfer:

Technology is ready for transfer

Salient Features

- This product has been developed using a natural extract from Kinnow peel using safe, cheap and readily available solvents or through aqueous extraction procedures.
- The face care systems possess disinfectant and antiseptic properties which help in protecting facial skin from general pathogens. Kinnow peel is a rich source of vitamin C, carotenoids, limonene, antioxidants, micronutrients and antibacterial limonoids.
- The products developed are low cost products prepared using a very simple indigenous technology which can be easily taken up by an entrepreneur and promoted in the market.

Benefit

- Kinnow peel Face care system has nourishing, healing, cleansing and astringent effects. CIPHET GLOW U Face Care System improves the condition of the skin & keeps it soft, more supple and free from other skin disorders upon regular use.

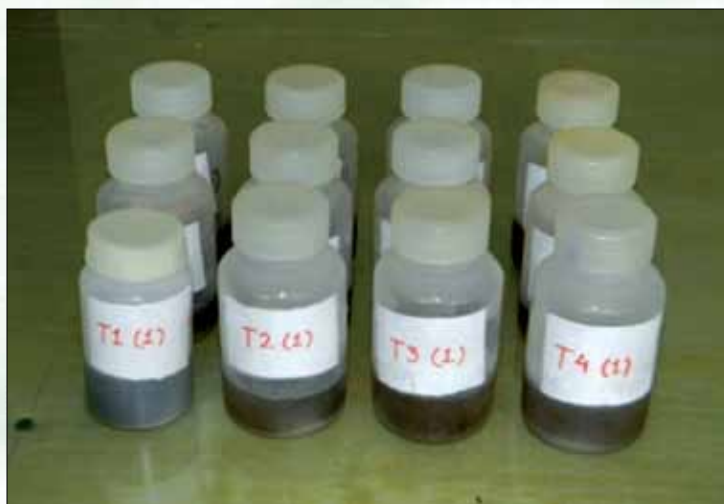
Training

Training and licensing of the technology is imparted by ICAR-Central Institute of Post-Harvest Engineering and Technology (CIPHET), Ludhiana.

Developer: D.S. Uppal, H.S. Oberoi, R.T.Patil, ICAR-CIPHET, Ludhiana

Contact Details: Director, (director.ciphet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana, Punjab (www.ciphet.in)

Enzymes from Potato Peels



Potato processing industries produce peel as waste every day. They have to get rid of this waste. This is an environmental problem also. Amylase and protease enzymes are very much useful for various industries. Use of Bacillus group of bacteria produces amylase and protease enzymes from potato peel waste.

Status of Technology Transfer:

Technology is ready for transfer.

Salient Feature

- For production of amylase and protease enzymes from potato processing industrial waste.
- Amylase - 4665/50 hr batch; Protease - 14.76 gm/50 hr batch.

Benefit

- Add value to waste from potato processing industry which is otherwise poses disposal issues.

Training

Training is imparted by Junagadh Agriculture University (JAU), Junagadh (Gujarat).

Developer: A M Joshi and M. N. Dabhi, JAU, Junagadh (AICRP on PHET)

Contact Details: Director, (director.ciphnet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana, Punjab (www.ciphnet.in)

Cashew Apple Beverages



In India about 70 lakh MT of cashew apples are produced and only 5-7% of it is currently utilized. Due to short shelf life and the presence of astringency cashew are not utilized properly. After removal of astringency i.e., tannin the decanted juice is used to prepare different beverages. Inputs used: Cashew apple, sugar, KMS, citric acid, polyvinyl pyrrolidone.

Status of commercialization:

Technology transferred to NGOs, SHGs at production catchments.

Salient Features

- 100 kg of cashew apple and 30 kg sugar produces 400 bottle of RTS with 200 ml capacity.
- 100 kg. Cashew apple and 26 kg sugar gives 75 bottles of squash with 750 ml capacity.

Benefit

- Add value to waste from cashew plantation.

Training

Training and licensing of the technology is imparted by OUAT Bhubneshwar.

Developer: N. R. Sahoo, OUAT, Bhubneshwar (AICRP on PHET)

Contact Details: Director, (director.ciphet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana, Punjab (www.ciphet.in)

Utilization of 'Patchouli Spent Charge' After Distillation of Essential Oil for the Manufacture of Agarbatti

Patchouli spent charge, the by-product (waste) obtained after extracting essential oil from patchouli herbage was sun dried and ground to 20-40 mesh powder using a shredder and a grinder. This powder can be substituted (up to 10%) for the wood powder normally used at about 15% level in the manufacture of agarbatti base sticks which are subsequently dipped in fragrance solutions to get commercial agarbattis. Since, the 'spent charge' powder also contains about 0.1-0.5% aromatic essential oil, the agarbattis can have added patchouli smell. Wherever patchouli oil is used in the agarbatti dip (fragrance) solution, in such cases, the costly essential oil usage is either reduced / replaced by using the above agarbatti base sticks prepared using the 'spent charge' powder.



Status of commercialization:

Ready for commercialization

Salient Features

- Wood powder, one of the raw materials used in the manufacture of agarbatti @15% level, can be replaced advantageously up to 10% with the powdered by-product namely, 'patchouli spent charge' with improved quality characteristics.
- Up to 2/3 of wood powder requirement in agarbattis is substituted with 'patchouli spent charge' powder (waste material).

Benefit

- This powder can be substituted (up to 10%) for the wood powder normally used at about 15% level in the manufacture of agarbatti base sticks.

Training

Training is imparted by Junagadh Agricultural University, Junagadh.

Developer: H. G. Ramya, V. Palanimuthu, Vasundhra and Dayanand Kumar, JAU, Junagadh (AICRP on PHET)

Contact Details: Director, (director.ciphnet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana, Punjab (www.ciphnet.in)

Green Particle Board from Cassava Stems using Bioadhesives

Cassava (*Manihot esculenta* Crantz) is mainly cultivated for its root starch. The non-root biomass of cassava includes stem and leaves. The stem to root ratio varied between 0.19 to 0.85 with an average value of 0.50, which depends on the growing location, variety, and maturity of the crops while harvest. Cassava is propagated through stem cuttings and only 15% is required for the planting, and only a small proportion for domestic fuel and the rest is reincorporated into the soil or burned off in the field itself. Hence, by considering the stem to root ratio of 0.50, in India the total quantity of cassava stem comes about 2.33 million tonnes.



The cassava stem contains, about 15-39% starch, 22.80-40% cellulose, 10-28.8% hemicellulose, and 11.8-22.10% lignin on dry wt. basis. These data showed that cassava stem has enormous potential to be the raw material for particle board manufacturing because it has the lignocellulosic fibre.

Status of Technology Transfer:

Technology is ready for transfer

Salient Features

- Based on the physico- mechanical properties of the board, among the different synthetic resins, urea formaldehyde was found to be the best resin for the production of particle board.
- Among the different modified starches viz., starch succinate, oxidized starch and cross linked starches used as binders, the starch succinate was found to be better to improve the mechanical and hydrophobic properties of the board. Also properties can be improved by blending with fibres and wax.
- Technology developed will help us to produce environment friendly “green” particle board utilising native/modified starch as bioadhesive from cassava stem alone or blended with other lingo-cellulosic agro-residues.

Benefit

- Synthetic polymers used in particle board preparation causes formaldehyde emission creating adverse health and environmental issues. Hence cassava starch was used as bioadhesive and optimum conditions for the environment friendly “green” board preparation was pressure 60 bar, time 15min and starch 15% with 10% plasticiser.

Training

Training is imparted by ICAR-Central Tuber Crops Research Institute (CTCRI), Thiruvananthapuram.

Developer: Sajeew M.S. Krishnakumar T and Jyothi A. N., ICAR-CTCRI, Kerala (AICRP on PHET)

Contact Details: Director, (director.ciphet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana, Punjab (www.ciphet.in)

Cashew Apple Crunch



Cashew being a major fruit crop of the region and considering the surplus availability of cashew apples, its nutritional value, there exists huge scope for preparation of value-added food products.

Status of Technology Transfer:

Technology is ready for transfer

Salient features

- The crunch is sugar treated chewing crunchy bites.
- It is prepared by utilizing the cashew apples and then treating the same in a various sugar concentration and then made in the form of chewing bites.
- Technology does not require costly equipment's, easy and simple.
- The products stores well at room temperature for 12 months with simple packing without any synthetic preservatives.

Benefits

- The potential beneficiaries are cashew farmers, agri- entrepreneurs, self-help groups, small and medium scale food processing industries.
- The technology ensures additional return through apple utilization and generation of employment opportunities.

Training

ICAR – Central Coastal Agricultural Research Institute, Old Goa, Goa.

Developer: A. R Desai, ICAR-CCARI, Goa

Contact Details: Director, (director.ccari@icar.gov.in) ICAR-Central Coastal Agricultural Research Institute, Goa (www.ccari.res.in)

Nutmeg Pericarp Taffy



Nutmeg fruit has about 80-85 % of pericarp and trees of high yielding nutmeg varieties produce about 75- 100 kg of fresh pericarp per tree, besides the economic yield of spice products, nutmeg seed and mace. The biomass of nutmeg pericarp is left behind in the garden for rotting after collecting the seeds and mace. Therefore, the pericarp is worth processing into a number of value-added food products.

Status of Commercialisation:

The technology has been commercialized with a small scale agri entrepreneur through a non-exclusive licensing agreement.

Salient features

- The nutmeg taffy is a product prepared by using nutmeg pericarp or rind.
- The product stores well at room temperature for 12 months with simple packing and without any synthetic preservatives.

Benefits

- The potential beneficiaries are cashew farmers, agri- entrepreneurs, self-help groups, small and medium scale food processing industries, agro-eco tourism projects.
- The product is commercially acceptable, and process is commercially feasible.
- Nutmeg pericarp taffy is one such potential technology to earn additional income from the same nutmeg tree besides income from yield of spice products.

Training

Training imparted by ICAR – Central Coastal Agricultural Research Institute, Old Goa, Goa.

Developer: A. R Desai, ICAR-CCARI, Goa

Contact Details: Director, (director.ccari@icar.gov.in) ICAR-Central Coastal Agricultural Research Institute, Goa (www.ccari.res.in)

Jackfruit Seed Powder and Mushroom Powder-based Chocolate Wrap (Arka Jackolate)

About 1.74 million tonnes of jackfruits are produced annually in the country, from which more than 2.00 Lakh tonnes of seed are obtainable. Presently 99% of these seeds go as waste. Less than 1% may be utilized as a vegetable or animal feed. The seeds in the jackfruit constitutes about 10-15% of the whole weight and the seed powder has several beneficial properties due presence of several phytochemicals.

Status of Commercialisation:

The technology ready for commercialization.



Salient Features:

- The seed powder of jackfruit seeds besides having good antioxidant property was also found to have anti-microbial activity against pathogenic bacteria. The starch in jackfruit seed powder is reported to be RS type-2 resistant starch. As the jackfruit seed powder is bland without any taste, its consumption can be promoted only when it is converted into more palatable and enjoyable food product.
- A product was developed using chocolate as a wrap for enrobing jackfruit pulp & seed powder, where the product is very highly liked by all the consumers.
- The de-bittered jackfruit seed powder of different particle sizes were blended with mushroom powder and other additives and then enrobed with chocolate and shaped.
- Equipment Required: Solar or hot air driers, Powder mill or pulveriser, Sievers of different mesh sizes, steam jacketed kettle, Steam generator, Weighing Machine & Balances, Freezer, Chocolate melting machine, Nut Roaster, Chocolate enrober, Accessories, Packaging machines.
- Apart from this 3 HP Power supply, Potable water is needed. It requires a space of 1000 square feet covered area (owned or rented) and manpower: 5 persons. Capital Requirement is Rs. 34.50 Lakhs (Approx) Rs.25.00 Lakhs (Fixed Capitasl) + Rs.9.50 Lakhs (1 month working capital).

Training:

Specific training is required which will be provided to the licensee as part of Transfer of technology. The licencing fee is Rs.30,000/-.

Developer: C. K. Narayana, ICAR-IIHR, Bangalore

Contact Details: Director, (director.iihr@icar.gov.in) ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka (www.iihr.res.in)

Jackfruit Seed Powder and Mushroom Powder-based Biscuits / Cookies (Arka Jackies)

- The seeds in the jackfruit constitute about 10-15% of the whole weight and the seed powder has 60.62% starch, 0.366% proteins, 2.05% crude fibre, 0.86 mg/100g phenols, 1.57 mg/100g flavonoids, 6.17 µg/g anthocyanins, 21.46 µg/g FRAP and 29.63 µg/g DPPH.
- The seed powder besides having good antioxidant property was also found to have anti-microbial activity against even pathogenic bacteria.
- The seed is a waste material usually thrown away or a little used as animal feed. To a limited extent it is also used as a vegetable. The starch in jackfruit seed powder is reported to be RS type-2 and can be used in development of specialties products like diabetic foods. Looking at its nutritional and therapeutic properties, it has enormous potential for using in food fortification.



Status of Commercialisation:

The technology is already commercialized.

Salient Features:

- In this technology a process was developed to make fortified biscuits / cookies using jackfruit seed powder and mushroom powder. Mushroom is high in selenium and jackfruit seed is rich in leucine, an essential amino acid. The bitter principle in jackfruit seed is removed and seed is made into powder. Further a process for making jackfruit seed & pulp powder and mushroom powder fortified biscuits / cookies was standardized.
- Equipment required are Solar or hot air driers, Powder mill or pulveriser, Sievers of different mesh sizes, Dough kneading machine, weighing machine & balances, baking equipment for making baked products, Steam jacketed kettle, Steam generator, packaging machines.
- Other Infrastructure required 3 HP Power supply, Potable water and space of 1000 square feet covered area (owned or rented); manpower: 5 persons. Capital Requirement: Rs. 19.50 Lakhs (Approx) (Rs.16.00 Lakhs (Fixed Capital) + Rs.3.50 Lakhs (1 month working capital).

Training:

Training is required on baking technology.

Developer: C. K. Narayana, ICAR-IIHR, Bangalore

Contact Details: Director, (director.iihr@icar.gov.in) ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka (www.iihr.res.in)

Natural Fibre from Pineapple Leaf

India is one of the major producers of pineapple and its cultivation is spread across various States particularly North-eastern States. After harvest of the mature fruits, the leaves are thrown away as an agro-waste. These leaves contain 2.5- 3.5% good fibre which has a high demand in textile and industrial applications.



Status of Commercialisation:

Ready for commercialisation.

Salient Feature

- Extraction of fibre from the entire length of pineapple leaves.
- Eliminates the drudgery involved in the manual extraction process.
- The extractor runs through a 1 H.P. single phase electric motor.
- The output capacity of extractor is 30 kg green leaves per hour.

Benefit

- As a sustainable resource, it will play a pivotal role in the continuous supply of natural fibre to textile industries.
- Diversified value-added products can be developed from pineapple fibre alone or its blends with other natural fibres.
- Creation of rural employment with additional income for farmers.
- The availability of pineapple fibre will benefit the stake holders across the value chain viz. *farmers; processing industries; exporters, consumers.*

Training:

The training is available at ICAR-National Institute of Natural Fibre Engineering & Technology, Kolkata, West Bengal.

Developer: Laxmikanta Nayak, ICAR- NINFET Kolkata

Contact Details: Director, (director.ninfet@icar.gov.in) ICAR-National Institute of Natural Fibre Engineering & Technology, Kolkata, West Bengal (www.nirjaft.res.in)

Natural Fibre from Banana Pseudo-Stem

There is a vast area under banana cultivation across India. After harvest of banana fruit, the pseudo stem is thrown away as an agro-waste. This pseudo-stem contains around 1% good quality natural fibre having high demand in textile and non-textile sector.



Status of commercialisation

The technology is proven and transferred for field adoption.

Salient Feature

- Extraction of fibre from the entire length of pseudo-stem.
- Human drudgery eliminated with the elimination of backward dragging action.
- The extractor runs through a 3 H.P. three phase electric motor.
- The output capacity of extractor is 150 kg pseudo-stem per hour.

Benefit

- As a sustainable resource, it will play a pivotal role in the continuous supply of natural fibre to textile industries.
- Diversified value-added products can be developed from banana pseudo-stem fibre alone or its blends with other natural fibres.
- Creation of rural employment with additional income for farmers.
- The availability of banana pseudo-stem fibre will benefit the stake holders across the value chain viz. *farmers; processing industries; exporters, consumers.*

Training:

The training is available at ICAR-National Institute of Natural Fibre Engineering & Technology, Kolkata, West Bengal.

Developer: Laxmikanta Nayak, ICAR- NINFET Kolkata

Contact Details: Director, (director.ninfet@icar.gov.in) ICAR-National Institute of Natural Fibre Engineering & Technology, Kolkata, West Bengal (www.nirjaft.res.in)

Use of Areca Sheath as Dry Fodder for Livestock

In coastal region of Karnataka, the paddy straw availability as dry fodder for livestock has been low and is imported from neighboring regions at higher price. Areca plantation as a commercial crop is extensive in this area and the fallen areca sheath is used as fuel-wood and plate making. The residue after plate making is wasted and the potential availability of areca sheath in India is about 500 thousand tons per year. This residue was evaluated as an alternative dry fodder and found that the nutritive value of areca sheath is superior to paddy



straw. Shredded areca sheath to pieces of 2 x 10 mm size when used as dry fodder replacing paddy straw along with concentrate mixture in the form of total mixed ration of dairy cattle, the average milk yield increased by 7-10% and milk fat by 0.2-0.3 units and cost of dry fodder reduced by 50%. The problem of dry fodder shortage in coastal region of Karnataka has been addressed with this innovation. In Andaman & Nicobar Island also two areca sheath processing units have been established by a farmer producer company and areca sheath is being used as dry fodder.

Status of Technology transfer

The technology is proven and transferred for field adoption. The Karnataka Milk Federation has adopted this technology and has established more than 70 areca sheath processing units in their milk unions.

Salient Features:

- It is a technology for using areca sheath as dry fodder for livestock.
- It is a process of shredding the dried areca sheath and using along with concentrate mixture as total mixed ration.
- Shredded areca sheath can completely replace paddy straw.
- Nutritive value of areca sheath is better than paddy straw.
- Feeding of areca sheath improved milk yield and milk quality.

Benefits:

Cost of paddy straw	: Rs 8 per kg
Cost of areca sheath	: Rs 3 per kg
Cost of processing areca sheath	: Rs 1 per kg
Net saving	: Rs 4 per kg of dry fodder

Training:

No specific training is required. Technology is simple to adopt.

Developer: NKS Gowda, DT Pal, S Anandan and KT Sampath, ICAR-NIANP, Bangalore

Contact Details: Director, (directornianp@gmail.com) ICAR-National Institute of Animal Nutrition & Physiology, Bengaluru, Karnataka (www.nianp.res.in)

Pineapple Fruit Residue Silage as Fodder Source for Livestock

In India more than 1.3 million ton of non-edible pineapple fruit residue is available annually and is being wasted. The pineapple fruit residue (PFR) contains high moisture (65-70%) and total sugar (>50%) making it susceptible for fungal growth and spoilage within 2 days. This fruit residue has been converted into animal feeds by improving the keeping quality of PFR through silage technology. The PFR was chaffed into pieces of 1-2 inches and compacted in drums / bags at a moisture content of about 65% with 4:1 ratio (w/w) of pineapple leafy crown and fruit peels and kept under air-tight condition. With a period of 20 days, good quality PFR silage prepared and nutritive value was better than maize green fodder. Feeding of PFR silage based total mixed ration to sheep did not show any adverse effects and supported desired growth. This technology will help in mitigating the green fodder shortage in pineapple cultivation.



Status of Commercialisation:

This technology has been licensed to M/s. Fresh Fruits Processing Pvt. Ltd. to prepare silage from pineapple fruit residue in drums and bags and market as fodder for livestock.

Salient Features

- Technology for preparing silage from pineapple fruit residue.
- It is a process of using pineapple fruit residue silage as fodder along with concentrate mixture in the form of total mixed ration.
- Pineapple fruit residue silage can be used as green fodder.
- Nutritive value of pineapple fruit residue silage is better than maize green fodder.
- Feeding pineapple fruit residue silage improved milk yield (about 20%) and milk fat content (by 0.6units).

Benefits

Cost: Benefit

Cost of pineapple fruit residue	: Rs 1 per kg
Cost of maize green fodder	: Rs 3 per kg
Cost of silage making from pineapple fruit residue	: Rs 1 per kg
Net saving	: Rs 1 per kg by feeding pineapple fruit residue silage replacing maize green fodder

Training

Training is required for preparing silage from pineapple fruit residue and preparation of total mixed ration. Training available at ICAR-NIANP, Bangalore.

Developer: NKS Gowda, DT Pal, S Anandan and CS Prasad, ICAR-NIANP, Bangalore

Contact Details: Director, (directornianp@gmail.com) ICAR-National Institute of Animal Nutrition & Physiology, Bengaluru, Karnataka (www.nianp.res.in)

Production of Silage for Pig From Vegetable/Banana Stem Waste



Silage with banana stem plus vegetable waste (60:40)



Silage with banana stem plus colocasia (60:40)



Silage prepared using vegetable waste

Vegetable wastes are produced in large quantities across India especially in market areas and causes environmental pollution from the production of obnoxious odour. These materials can be well utilized as pig feed after processing such as making silage. This will not only reduce the environmental pollution but also reduced the cost of production in pig. Vegetable waste are rich in energy and many micronutrients.

Status of commercialisation/ transfer:

The technology is proven and transferred for field adoption.

Salient Features:

- The process includes collection of vegetable waste from market, washing the waste followed by sun drying for 3-4 hours, cutting into small pieces, mixing the materials with molasses or jaggery @ 3-4 % and salt 0.25 %, it is then mixed properly and packed in silage bag or thick polythene in airtight condition and kept for 21 days. Then materials become ready for feeding. After opening the silage bag, the materials should be finished within 2-3 days.
- The production requirement of pig can be met by 3 kg vegetable waste silage with 0.5-1.0 kg rice polish/rice bran plus 100 g oil cakes/fish meal along with 2 tea spoonful mineral mixture per day per adult pig. The advantage of this technology is that the materials can be kept for one year also if bags are not open. This can be fed during scarcity period.

Benefit:

- It reduces environmental pollution.
- Increase profit of the farmers by reducing the feed cost.
- The cost of production was reduced by Rs.13.77 and Rs. 10.52 per kg gain at 10 % and 15 % level of inclusion in grower ration of pig.

Developer: Keshab Barman, Swaraj Rajkhowa, R. Thomas and S.R. Pegu, ICAR-NRCP, Assam

Contact Details: Director, (nrconpig@rediffmail.com), ICAR-National Research Centre on Pig, Rani, Guwahati Assam (www.nrcp.in)

Utilisation of Pruned Woods for Healthy Pomegranate Sapling Production



Pruning is a regular practice in pomegranate. Generally, the pruned woods are thrown away. Pruning of one hectare of fully-grown pomegranate orchard, planted at a density of 740 plants/ha. produces hard/semi-hardwood stem cuttings suitable for propagation of about 10000-12000 healthy planting material.

Salient Features

- Pruned wood of disease free plants under stress or semi-dormant stage or just before actively growing period can be used for making cuttings. Note cuttings from actively growing plants or lateral wood which flowers profusely do not give satisfactory cutting success.
- The hard/semi hardwood stem of about one year old branch and 8.0-12.0 mm diameter is cut into stem cuttings of 20-25 cm length with 4 nodes. The cuttings is arranged into bundles of 50-100 cuttings and treated for 15 minutes with luke warm solution (45-50°C) of 0.1% Carbendazim (50 % WP) + 0.05% 2-Bromo-2-nitro-1,3-propanediol along with any surfactant, this is followed by surface sterilization with 2.0% solution of NaOCl (4 % w/v) for 10 minutes. The basal 2-3 cm portion of cutting is then given 2000 ppm IBA treatment for about 1 minute before planting on microbe fortified cocopeat medium in nursery bags under shade.
- The treated hardwood cuttings from waste wood can also be used for *in situ* direct field planting(if climate is not too harsh). Four cuttings are planted/pit using half kg plant beneficial microbe fortified cocopeat, each pit should be supplied with two drippers for optimum moisture maintenance and covered with old shade net after planting of cuttings. The healthy bio-hardened saplings produced can be used for expansion of own orchard

Benefits

- Technology of sanitation protocol for hardwood pomegranate cuttings has already been commercialized.
- Pruned wood of healthy plants which is generally thrown away can generate resource worth of Rs. 2,00,000/- per hectare.

Training

Training is imparted by ICAR- National Research Centre on Pomegranate, Solapur.

Developer: N.V. Singh, ICAR-NRC on Pomegranate, Solapur

Contact Details: Director, (nrcpomegranate@gmail.com), ICAR-National Research Centre on Pomegranate, Solapur, Maharashtra (nrcpomegranate.icar.gov.in)

Extraction of Virgin Pomegranate Seed Oil

Pomegranate seeds are the by-product of juice processing industry. Pomegranate seeds can also be extracted from unmarketable fruits (affected by abiotic cracking, borer, bacterial blight and other fungal spots etc.). The seeds are around 10 % of fruit weight. The technology has been developed for extraction of virgin pomegranate seed oil (PSO) rich in conjugated linolenic acid.



Status of Commercialisation:

Technology is ready for commercialization.

Salient Features

- The technology involves extraction process for optimum yield and quality of PSO. The seeds of commercial Indian cultivars *Bhagawa* and *Ganesh* contains 28% and 26.43 % oil.
- Technology involves cleaning of the marc (leftover portion of arils after juice extraction), drying of seeds, size reduction, and oil extraction using hydraulic cold press.
- Recovery of high-quality virgin PSO up to 18.8 and 19.20 % for *Bhagawa* and *Ganesh* cultivars respectively can be achieved.
- Approximately 60 kg of unmarketable pomegranate fruits can yield around 1 lit. of PSO.

Benefits

- PSO a unique natural product, is exceptionally potent antioxidant, significant natural anti-inflammatory agents, improves heart health, protects against cancer, atherosclerosis, and improves skin health. It has high demand in international market for food, pharmaceutical and cosmetic industry.
- Technology has potential for employment generation and waste fruit utilization.

Training

Training can be arranged by ITMU, ICAR-NRCP, Solapur.

Developer: Nilesh N. Gaikwad and R. K. Pal, ICAR-NRC on Pomegranate, Solapur

Contact Details: Director, (nrcpomegranate@gmail.com), ICAR-National Research Centre on Pomegranate, Solapur, Maharashtra (nrcpomegranate.icar.gov.in)

Coco peat based Coco Husk for Soilless Cultivation

Cocopeat is prepared from the coconut husk which is abundantly available in coastal plains of the region. It is the waste product of coconut plantation in nearby area and generated in large volume. Cocopeat is a multi purpose growing medium made out of coconut husk. The fibrous coconut husk is pre washed, machine dried, sieved and made free from sand and other contaminations such as animal and plant residue. Cocopeat is a very good alternative to traditional peat moss and Rock wool. Its air filled porosity and high water holding capacity makes it, an ideal growing medium for the plant crops. It is 100% organic and eco friendly, free from soil borne pathogen and weed. It has a pH of 5.7 – 6.5 ,EC level <1 mS/cm is ideal for plant growth.



Status of Commercialisation:

Not commercialized

Salient Features

- It can maintain EC and pH, it holds water in good amount
- The good cocopeat media, which helps to better management of water and fertilizers in soilless vegetable cultivation under protected structures.

Benefits

Helps to control of soil-borne diseases.	:	Efficient use of irrigation water and fertilizers.
Cost of Technology	:	Rs. 20 kg/bag (1.5 kg dry cocopeat per bag)
		The filler trial on use of cocopeat for soilless capsicum cultivation was conducted in 2020.
		The further trial is in progress.

Training

Demonstrated to the farmers under outreach activities through KVK etc

Developer: Dr. H.T. Jadhav, Cooperating Centre, BSKKV Dapoli, AICRP on PET

Contact Details: Director (director.ciphet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana-141004 Punjab (www.ciphet.in)

Development of Fiber Rich Cookies from De-oiled Pomegranate Seed Cake

Pomegranate seeds are juice processing industry by-product and can also be extracted from unmarketable fruits. Pomegranate seed cake (PSC) is the by-product of the pomegranate seed oil extraction process. PSC is a good source of proteins, fats and fiber. The pomegranate seed cake recovery in seed oil production is around 80%. The technology has been standardized for development of pomegranate de-oiled seed cake-based cookies.



Status of Commercialisation:

Technology is ready for commercialization

Salient Features

- PSC extracted from cold press is safer for consumption as compared to solvent extraction method and is utilized for development of cookies.
- The optimized conditions for development of cookies were 23.92% PSC, 45.27 g fat and 26 minutes of baking time.
- The PSC cookies have fiber (8.47 %), protein (5.57 %), hardness (155.81 N) and high overall sensory acceptability.

Benefits

- The wheat flour has been replaced to the tune of 23.92% by pomegranate seed cake in cookies.
- Technology is capable of employment generation as well as waste utilization.

Training

Training is imparted by ICAR-NRC on Pomegranate, Solapur.

Developer: Nilesh N. Gaikwad, ICAR-NRC on Pomegranate, Solapur

Contact Details: Director, (nrcpomegranate@gmail.com) ICAR-National Research Centre on Pomegranate, Solapur, Maharashtra (nrcpomegranate.icar.gov.in)

Pomegranate Seed based Mouth Freshener

Pomegranate seeds are by-product of juice processing industry and can also be extracted from unmarketable fruits. Pomegranate seeds are rich in conjugated linolenic acid, protein, fiber etc. A crunchy mouth freshener has been developed from the pomegranate seeds.

Status of Commercialisation:

Technology is ready for commercialization.

Salient Features

- For the preparation of mouth freshener, Pomegranate seeds extracted by cleaning marc (leftover portion of arils after juice extraction) are dried, blended with mix of sugar syrup and spices followed by heat treatment in microwave oven, cooling and vacuum packaging.
- The mouth freshener has crude fiber (3.89%), total phenols (158.24 mg/L GAE).
- It is also rich in micronutrients Calcium (2.4 g/kg), Magnesium (1.92 g/kg), Ferrous (222 mg/kg), Manganese (14 mg/kg), Zinc (47 mg/kg) and Copper (57 mg/kg).

Benefits

- The high value mouth freshener can be replacement for *Gutkha, tobacco, panmasala etc.* owing to good chewability and high sensory acceptability.
- The pomegranate seed-based mouth freshener development can utilize the seed waste and has considerable employment generation potential as required for building an Atmanirbhar Bharat.

Training

Training can be arranged at ICAR-NRC on Pomegranate, Solapur.

Developer: Nilesh N. Gaikwad, and Ashis Maity, ICAR-NRC on Pomegranate, Solapur

Contact Details: Director, (nrcpomegranate@gmail.com) ICAR-National Research Centre on Pomegranate, Solapur, Maharashtra (nrcpomegranate.icar.gov.in)





भारत
ICAR

TECHNOLOGIES FOR CONVERTING FISHERIES & ANIMAL WASTES INTO HIGH VALUE PRODUCTS

Chitin and Chitosan from Prawn Shell Waste

Chitin is the second most abundant biopolymer which is the major structural component of the exoskeleton of arthropods. Prawn shell is a commercial source for this product. From chitin, chitosan glucosamine and many other derivatives are manufactured.



Chitin and its allied products have versatile applications in medical, industrial, agricultural and biotechnological and nutraceutical fields. The shrimp processing industry in India turns out more than 1.25 lakh tones of head and shell waste per annum. Shellfish processing creates an environmental problem in the form of shells and head waste. About 50% of the raw material is discarded as waste after processing. The prawn shell wastes thrown at present can produce about 7,000 tonnes of chitin. ICAR-CIFT has optimized technologies for several applications in the food and medical fields.

Status of Commercialisation:

Technology transferred and adopted by many industries and entrepreneurs.

Salient features

- Prawn shell waste can be effectively converted into chitin and chitosan.
- Chitin is produced by demineralization and deproteinization of crustacean shell using acid and alkali respectively. Deacetylation of chitin yields chitosan.
- Chitosan can be used for developing several products like; biodegradable & antimicrobial packaging films for food applications; freshness & time-temperature indicators; beads for removal of lead & fluoride from water; membranes for periodontal applications & Plastic Surgery, as an edible coat to improve keeping quality of fish, etc.

Benefits

- The fishers/aqua farmers can supplement the income by supplying shrimp shell as raw material for chitin /chitosan production.
- Chitin and chitosan are having high demand in the both domestic and export market, as they offer great scope for conversion of processing waste into many high-value products of industrial, pharma and nutraceutical importance.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: P. Madhavan, K.G. Ramachanan Nair, P.T Mathew and A.A. Zynudheen, ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Glucosamine Hydrochloride from Shrimp, Lobster and Crab Shells

Glucosamine is a nutraceutical recommended for arthritis that can fight joint inflammation and inhibit the production of enzymes that destroy cartilage. Commercial production of glucosamine hydrochloride is carried out from chitin.

Status of Commercialisation:

ICAR-CIFT has successfully transferred this to many industries and entrepreneurs.

Salient features

- Chitin can be hydrolysed to glucosamine hydrochloride by adding concentrated hydrochloric acid. The crude glucosamine hydrochloride is diluted with water and clarified with activated charcoal.
- The solution is filtered and evaporated under vacuum. The crude glucosamine hydrochloride coming as the residue can be separated from the mother liquor by adding alcohol.
- Glucosamine hydrochloride can be produced using the same facilities outlined for chitin and chitosan production. Only an additional line is required with a glass-lined reaction vessel as the main equipment.

Benefits

- Glucosamine hydrochloride is a high-end nutraceutical product by virtue of its properties.
- It plays a major role in lubricating joints, increasing their mobility and strengthening of cartilage.
- Glucosamine is commonly used in the treatment of osteoarthritis.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

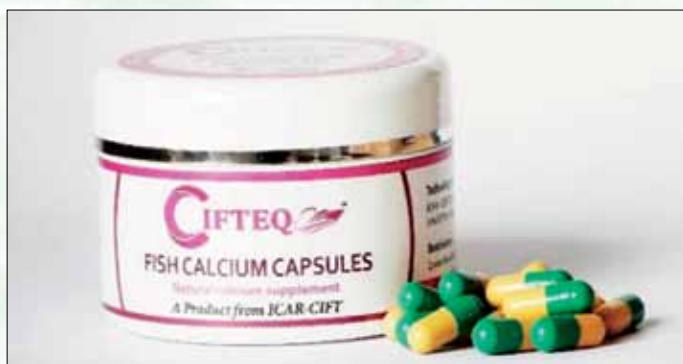
Developer: K.G. Ramachanan Nair, P.T Mathew and A.A. Zynudheen, ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)



Calcium from Fish Bones

Fish bone, which is otherwise wasted during processing, is an important source of calcium in the form of dicalcium phosphate with high bio-availability. When compared to commercial calcium capsules which are essentially calcium carbonate, the calcium from fish source is nutritionally better since it contains phosphorus also.



Status of Commercialisation:

ICAR-CIFT has successfully transferred this to a few entrepreneurs.

Salient features

- Product from the fish bone which is a processing discard during the preparation of fish fillets and mince can be utilized.
- Calcium is extracted by removing the protein content by enzyme treatment and fat content is removed by treatment with alcohol. The treated bone is washed free of alcohol, dried powdered and encapsulated to form fish calcium capsule.
- This technology provides a solution for the utilisation of fish bone which forms a significant portion of fish processing waste.

Benefits

- The calcium from the fish source is a cheaper and better alternative for commercially available calcium supplements.
- It is biocompatible and exhibits good bio-availability.
- The process for production is simple with minimum capital investment.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: A.A. Zynudheen and George Ninan, ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Chitosan-based Hand Sanitizer

Proper hygiene is of utmost importance in fish processing industries where bacteria are particularly problematic. Fish processing industry workers wash their hands several times in a day which leaves their hands dry and soar. Hydro-alcoholic hand sanitizers available in the market contain synthetic antibacterial compounds (mostly containing Triclosan) that cannot be used by workers in fish processing plants due to regulatory reasons. These commercial hand sanitizers mostly contain synthetic acrylogel polymers and quick evaporating alcohol leaves our hands dry. A hydro-alcoholic antibacterial hand rub gel incorporating succinyl chitosan has been developed which leaves a moisturising effect.



Status of Commercialisation/transfer:

ICAR-CIFT has successfully transferred this to two entrepreneurs.

Salient Features

- A novel amphiphilic derivative of chitosan used as viscosifying come moisturizing agent in hydro-alcoholic hand sanitizer.
- Succinyl chitosan gives the formulation required spreadability and leaves a moisturizing effect on hands. The hand gel contains 67% ethanol and 0.05% Coumaric acid. Fragrance and vitamin E can be easily incorporated in the formulation for use in personal care.
- Having excellent hyaluronic acid like moisturising properties.

Benefits

- The developed hand rub gel has the desired spreadability and leaves a moisturizing effect on hands.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: Nilai Sekhar Chatterjee and Suseela Mathew, ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Feed from Fish and Shellfish Processing Discards

Processing of fish and shellfish for human consumption results in a considerable quantity of waste to the tune of nearly 50% of the raw materials. But it is highly nutritious and contains highly digestible protein, fat and minerals. Additionally, many other bioactive compounds are also present in these discards which enhance the growth. It is an ideal source for making feed for various farmed animals viz., cattle, poultry, pigs, other pets and fishes. Feed developed from fishery discards is found to have high nutritional value and acceptability among the farmed species. The waste can be converted into silage by adding acid or can be dried and used in the feed formulations. ICAR-CIFT has optimised technologies for pig, poultry and fish.



Status of Technology Adoption/ transfer:

Technology has been adopted by many industries and entrepreneurs.

Salient features

- Converting fish waste into fish meal can be practised in the normal fish meal unit.
- To convert the waste into silage pH of waste is lowered by the addition of formic acid and liquefaction, it is mixed with de-oiled rice bran or wheat bran and compounded into the feed.
- Fish waste-derived fish meal is used as the replacement of normal fish meal which is an essential ingredient in the formulation of livestock feed.
- Automated process line developed by ICAR-CIFT.

Benefits

- Simplified process for highly cost-effective feed.
- Highly acceptable feed with a better growth rate for premium farm-reared animals and fish.
- Alternate use and recovery of cheap protein source and employment generation with less investment.

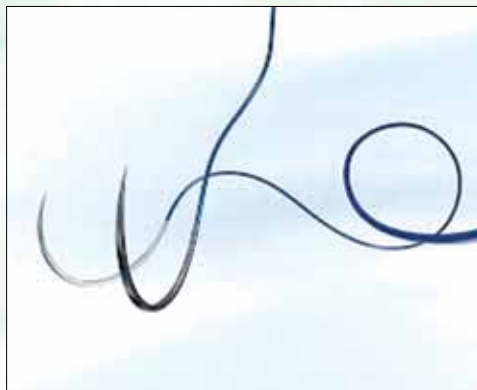
Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: Zynudheen A.A. Bindu J., Binsi. P.K., Sreejith S, T.K.S. Gopal and K.G.R Nair, ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Absorbable Surgical Suture from Fish Guts



A low-cost method for the preparation of absorbable surgical sutures from the fish gut has been developed, which involves the extraction of collagen from the gut of live fish. The collagen fibres are twisted, cross-linked and bodied to give fine threads of absorbable collagen sutures. They are surface smoothed, cut to size and packed in isopropanol.

Status of Commercialisation/transfer:

ICAR-CIFT has successfully transferred this technology.

Salient features

- From a fish weighing up to 1 kg, 4-5 sutures can be made, which is valued at Rs. 2500-3000.
- The protocol is approved for human trials by the Drug Controller of India.
- The sutures produced by this method are evaluated for tenacity, absorbability and shelf-life and is free from abnormal tissue reactions.

Benefits

- Fish gut sutures perform as good as commercial sutures of similar grade.
- Absorbable fine grade sutures from fish gut can find applications in microsurgeries and ophthalmic surgeries.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: M.K. Mukundan, T.V. Sankar, Suseela Mathew and K. Devadasan, ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Astaxanthin Capsules from Shrimp Processing Waste

Astaxanthin is a naturally occurring carotenoid pigment found in certain animals and plants. The main sources of astaxanthin are krill, algae, red trout, shrimp, crab and lobster. Shrimp processing discards is one among the cheapest raw material for recovery of this natural carotenoid. Astaxanthin possesses various health benefits and is an important candidate for nutraceutical applications.



Status of Commercialisation/transfer:

ICAR-CIFT has successfully transferred this technology.

Salient features

- The astaxanthin capsules have been developed from shrimp processing wastes. Each capsule contains 6 mg of astaxanthin dispersed in 250 mg virgin coconut oil. Vitamin E is added as a stabilizer.
- The process line is simple and economical and can be easily integrated into the chitin production line.
- Currently, astaxanthin soft capsules are priced at around Rs. 2,000 for 100 capsules.

Benefits

- Powerful free radical scavenger, which further offers extraordinary protection against hypertension, inflammation, cancer and age-related degenerative changes.
- Reduces oxidative stress on kidneys and thereby beneficial in preventing renal cell damage.
- Protects skin against UV light-mediated photo-oxidation.
- Protects the liver by detoxification mechanism.
- Crosses blood-brain barrier, and hence is available to eye, brain and central nervous system to alleviate oxidative stress that contributes to Glaucoma and Alzheimer's disease.
- Benefits heart health by modifying LDL and HDL cholesterol levels.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: Binsi P.K. and A.A. Zynudheen, ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Bio-ceramic Hydroxyapatite from Fish Scale and Bone

Hydroxyapatite is one of the few materials, classified as a bioactive natural material that supports bone in-growth and osseointegration. Hydroxyapatite in different forms, including scaffold, is currently used clinically as bone void fillers. The process to extract hydroxyapatite from fish bone and scale has been optimised.



Status of Commercialisation/transfer:

ICAR-CIFT has successfully transferred this technology.

Salient features

- The fish derived hydroxyapatite exhibits superior reabsorption rate and bone-forming ability, and hence can be considered as an effective substitute for synthetic hydroxyapatite.
- The process line for extracting biological hydroxyapatite from fish processing discards such as fish scale and bone is economic and environmental-friendly.
- Possess superior biocompatibility, physiological stability, and osteoconductivity compared to commercially available synthetic hydroxyapatite.

Benefits

- Hydroxyapatite derived from the fish bone and scale has demonstrated the ability to act as bone graft materials.
- In *vivo* studies conducted at CIFT in wistar rats indicated higher radiographically detectable calcification compared to that of commercially available osseografts.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: Binsi P.K., A.A. Zynudheen and Ravishankar C.N., ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Carboxymethyl Chitosan from Prawn Shell Waste

There is a growing interest in water-soluble chitosan derivatives such as carboxymethyl chitosan in all areas, especially in biomedical and pharmaceutical fields. Besides the superior solubility in water, it also possesses good biocompatibility and the ability to form fibers and hydrogels.

Status of Commercialisation/transfer:

ICAR-CIFT has successfully transferred this technology.



Salient Features

- Normally, the native pH of Carboxymethyl chitosan lies at the alkaline range; whereas this product is soluble over a wide pH range of 6-9.
- The product is biocompatible and devoid of any cellular toxicity, as indicated by *in vivo* experiments in animal models.

Benefits

- Active ingredient in feed, foliar spray and insecticide formulations, as it is soluble at neutral pH.
- It is a dietary fibre which increases faecal mass, reduces the glycemic response of the food, and lower the cholesterol level.
- Excellent heavy metal adsorption characteristics, making it a promising option for water treatment.
- The excellent moisture-holding characteristics along with the similarities with the extracellular matrix polysaccharides makes it ideal for cosmetic applications.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: Binsi P.K. and A.A. Zynudheen, ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Chito-Oligosaccharides from Shrimp Shell Waste

Processing of shrimps generates large quantities of solid wastes, especially the head and body shell which accounts approximately



to 40-50% of whole shrimp weight. The waste produced each year by the shellfish processing industries represents a practical challenge to developing countries like India. Chitoooligosaccharides (COS) or chitosan oligomer is the derivative of chitosan produced from the shrimp shell waste. It is the depolymerized form of chitosan. Chitoooligosaccharide is a nitrogenous polysaccharide, which has low molecular weight and high solubility.

Status of Commercialisation/transfer:

The technology is ready for commercialisation.

Salient features

- Chitoooligosaccharide is produced by partial hydrolysis of chitosan using enzyme. The production process is environmentally friendly.
- One ton of shrimp shell waste can produce 13 kg of enzyme hydrolysed chitoooligosaccharides.
- COS has a low molecular weight, low viscosity, high solubility, good absorption capacity, biodegradability and biocompatibility.
- COS possesses bioactivities such as anti-oxidative, anti-bacterial, anti-fungal, anti-tumour and anti-inflammatory activity.

Benefits

- COS can be used in the field of medical, pharmaceutical, food preservation and packaging, agriculture and the cosmetic industry.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: Renuka V., Elavarasan K., A.A. Zynudeen and Ravishankar C.N., ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Chitooligosaccharides-based Film from Shrimp Waste

Biopolymer-based packaging materials are considered as 'Socially responsible products' for its environment-friendly approach. Bioplastics from seafood-based films have gained importance owing to the large quantity of waste generation (40-60%). The waste contains protein, carbohydrates and minerals.



Chitosan and gelatin-based biopolymers film is considered as an alternative to mammalian gelatin since it doesn't have any safety issue. Chitooligosaccharides (COS) is the cationic polysaccharide produced from the shrimp shell waste. COS-based biodegradable film prepared using chitosan and fish gelatin.

Status of Commercialisation/transfer:

The technology is ready for commercialisation.

Salient features

- COS-based bio-composite film is prepared using chitosan from shrimp shell waste and gelatin from the fish skin waste.
- It has excellent antioxidant and antimicrobial properties compared to chitosan and chitosan fish gelatin films.
- It has good mechanical, physical, structural and thermal properties, and has 40% solubility with very high transparency.
- It is tough, long-lasting, flexible, and very difficult to tear.

Benefits

- COS-based bio-composite film can be used in the field of medical, pharmaceutical and food preservation & packaging.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: Renuka V., Bindu J. and Ravishankar C.N., ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

ChitoPro - A Bone Health Supplement from Fish and Shellfish Waste



Bone health is reported to be affected adversely with the complex and multifactorial process of aging. The dietary consumption of certain marine biomolecules such as glucosamine and collagen are proven to improve bone health, especially the joints.

Status of Commercialisation/transfer:

The technology is ready for commercialisation.

Salient features

- The product has been developed using chitin and collagen derivatives which are the natural biological molecules.
- ChitoPro contains derivatives of chitin derivative from shrimp shell waste and collagen derivatives from fish scale waste.
- Chitosan and collagen derivatives are generally recognized as safe.
- The product 100% of biological origin and has no added flavors, additives and synthetic substances.

Benefits

- Studies in animal models have proven the restoration of bone and cartilaginous tissues against induced arthritis.
- Chitosan derivatives help to fight inflammation and to fight arthritis.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: Elavarasan K., Tejpal C.S and A.A. Zynudheen, ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Collagen Peptide from Fish Processing Waste

Collagen peptide is obtained by the controlled hydrolysis of collagen extracted from fish scale, bone, skin etc. These peptides exhibit various biological activities such as antioxidant, anti-hypertensive, anti-proliferative, anticoagulant, calcium-binding, anti-obesity, anti-diabetic activities and postponement of age-related diseases. Their application possibilities range from the general 'functional' to specific target-oriented requirements like treatment of skin, bone and hair ailments.



Status of Commercialisation/transfer:

ICAR-CIFT has successfully transferred this technology.

Salient features

- Unlike collagen, collagen peptides are water-soluble, and their bioavailability is relatively higher than native collagen.
- They have wide application possibilities in pharmaceutical, health foods, nutraceutical and cosmetic industries.
- Collagen peptide production offers scope for the production of high demand value-added products in domestic and export markets.

Benefits

- An ideal alternative to mammalian sources of collagen which has a negative demand on account of health issues as well as religious sentiments.
- Improves in increasing bone mineral density and supports healthy joints. It has high potential in the cosmetic industry *viz.*, prevent skin aging by improving skin hydration and elasticity and reducing deep wrinkle formation.
- Fortification of foods with collagen peptide is highly recommended for middle-aged and geriatric population, for patients suffering from osteoporosis and sports nutrition.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: Suseela Mathew, Binsi P.K. Parvathy U., George Ninan and A.A. Zynudheen, ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Gelatin from Fish Skin

Gelatin is a soluble polypeptide derived by the denaturation of collagen which is primarily the major structural protein in the skin and bones. Gelatin is primarily used as a gelling agent that finds a variety of applications in the food and pharmaceutical industries. About 30% of the solid waste generated in Fish processing comprises of skin and bone with high collagen content which can be utilised for the commercial extraction of gelatin. Gelatin from marine sources is a possible alternative to bovine gelatin. The utilization of fish skin for the extraction gelatin can significantly address the problem of waste disposal in the Fish Processing Industry.



Status of Commercialisation/transfer:

ICAR-CIFT has successfully transferred this technology.

Salient features

- Prepared from fish skin using acid extraction process.
- The yield of gelatin from fish skin is approximately 8-12% which depends on the species and extraction process.
- Gelatin from the skin of tropical fish species viz., Indian Major Carps, Tuna, and Perches have comparable gel strengths with bovine and porcine gelatins ranging from 200 Bloom to 420 Bloom.

Benefits

- Fish skin gelatin is not associated with the risk of Bovine Spongiform Encephalopathy and acceptable to many religious groups.
- It has a lower gel melting temperature and unique property of better release of the product's aroma and flavor when compared to gelatins of mammalian origin.
- Fish gelatin can become a niche product offering unique and competitive properties to other biopolymers, as well as meeting the demand of the global halal/kosher market.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: George Ninan, ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Enzymes for Protein Hydrolysate Production from Fish Viscera



Increasing environmental pollution and limited biological resources has emphasized the need for better utilization of fish processing waste. Crude enzymes can be extracted from fish visceral and those enzymes can be further applied in the preparation of bioactive protein hydrolysates. Fish waste generated from the processing of fish accounts for 35% or more. Visceral waste comprises 3-5% of the total weight of fish which is considered as waste.

Status of Commercialisation/transfer:

The technology is ready for commercialisation.

Salient features

- Use of crude visceral enzymes in the replacement of costly enzymes for bioactive protein hydrolysate preparation.

Benefits

- Visceral waste of fish could be utilized as a source of enzymes and these enzymes can be further utilized in the production of highly valued products like fish protein hydrolysates.
- Better utilization of seafood processing waste and decreased environmental pollution caused due to the disposal of waste.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: L. Narasimha Murthy, Girija G. Phadke, Parvathy U., A. Jeyakumari, C.G. Joshy and A.A. Zynudheen, ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Foliar Spray from Fish Waste



Foliar spray is a fish waste-derived liquid product that contains peptides and amino acids. The product is prepared by hydrolysing the protein in fish waste utilizing acid or enzyme. An alternate method is by fermentation using bacteria.

Status of Commercialisation/transfer:

ICAR-CIFT has successfully transferred this technology to many industries and entrepreneurs.

Salient features

- Process is simple.
- Stable product under room temperature.
- Can be directly applied after dilution on a wide variety of plants.
- It can be fortified with the deficient components if required.

Benefits

- Enhances the productivity of the plants immediately and possess pest repellent properties.
- Product can be manufactured without much investment.
- High demand for the product and is gainful employment with a high return of margin.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: A.A. Zynudheen and Binsi Pillai, ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Marine Melanin from Cephalopod Ink

Natural antioxidants and immunity boosters have attracted a great treaty of attention in recent times. The natural pigment 'Melanin' has been found to have beneficial effects in this direction. Cephalopod ink is identified as the most useful source for the commercial production of melanin. Considering the present average annual production of cephalopods in the country, a minimum of 2000 tons of cephalopod ink is being generated every year, which can yield about 600 tons of melanin.



Status of Commercialisation/transfer:

The technology is ready for commercialisation.

Salient features

- The extraction process is technically simple and environment friendly, economically feasible with a greater margin of return.
- Currently, melanin is priced at \$ 100-350/g in the International market, projecting the huge opportunities in utilising cephalopod ink in the country.

Benefits

- Powerful antioxidant.
- Improves Immune responses of the body.
- Potent anti-inflammatory agent.
- Strong Photoprotective agent.
- Skin and hair nourishing agent.
- Potent Anti-ageing agent.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: Binsi P.K., Zynudheen A.A. and Ashok Kumar K., ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Multipurpose Protein Ingredient from Cuttlefish Skin



Cuttlefish processing results in the generation of skin waste which accounts for 8-9% of the total weight. Considering 70% of the total frozen cuttlefish export in the processed form, it yields approximately 6000 tonnes of cuttlefish skin waste generated annually. Cuttlefish skin waste contains 81.43% moisture, 17.4% crude protein, 0.34% crud fat and 1.28% ash. Approximately, around 1044 tonnes of crude protein can be recovered from 6000 tonnes of cuttlefish skin waste. Presently, cuttlefish skin waste remains unutilized and is being disposed of. Cuttlefish skin waste can be effectively converted into protein derivatives using enzymes. Cuttlefish skin waste is also rich in collagen.

Status of Commercialisation/transfer:

ICAR-CIFT has successfully transferred this technology to many industries and entrepreneurs.

Salient features

- Customized protein hydrolysis technology for utilizing cuttlefish skin for multipurpose protein-rich ingredients.
- The process is enzyme based and hence, environmentally friendly.
- The product packed in aluminum laminate in the powder form is stable at room temperature for one year.
- The product can be stored in liquid form for the same period without appreciable deterioration in product quality at room temperature.

Benefits

- Bio-functional feed ingredient.
- Plankton production enhancer in the aquaculture system.
- Bio-fertilizer for crops.
- Ingredient in algal culture media.
- Ingredient for microbiological media.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: Elavarasan K., Tejpal, C.S. and Hanjabam M.D., ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

PUFA Rich Oil from Tuna Eye Balls



With growing health awareness, people have become very selective about their diet. The health benefits of PUFA are well known and there exists a huge potential for such products. Fish oils possess many protective properties against cardiovascular diseases, rheumatoid arthritis, depression and neurological disorders.

Status of Commercialisation/transfer:

The technology is ready for commercialisation.

Salient features

- This technology utilizes urea crystallization method for extracting polyunsaturated fatty acid-rich oil for edible purposes.
- Extraction of PUFA rich oil from tuna eye gave a yield of 12 %. The tuna eye oil is rich in PUFA and has many health benefits.
- Tuna eye oil was found to contain a higher concentration of Docosahexaenoic acid (35% of total fatty acid), Eicosapentaenoic acid (7% of total fatty acid), Arachidonic acid (3.6% of total fatty acid) and Linoleic acid (1.3% of total fatty acid).

Benefits

- This technology represents cost savings because the raw materials are tuna eye which is generally discarded during tuna processing.

Training

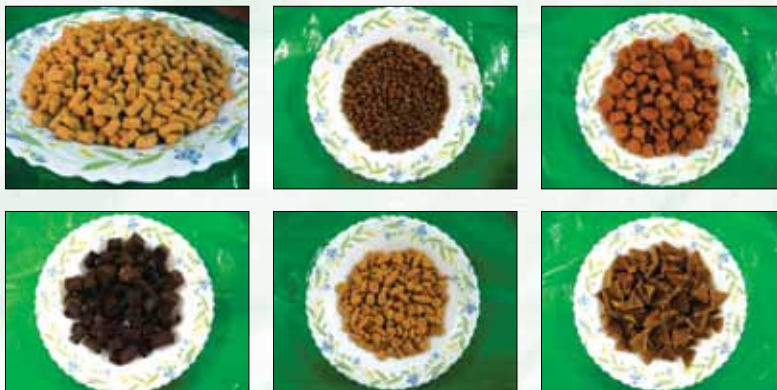
Institute offers hands-on training programmes as part of technology licensing and business incubation.

Developer: T.K. S. Gopal, Suseela Mathew, R. Anandan, Bindu J. and Ravishankar C.N., ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Alignment Pet Food from Tuna Cannery Waste

Tuna canning industries generate a lot of waste since only the meat portions are utilised for canning. The frames, bones, belly meat etc. can be pulverised and pet feed can be developed from such waste. This technology combines the solution for environmental pollution as well as considers the increasing market demand for an indigenous feed for Pets of pet lovers.



Status of Commercialisation/transfer:

- ICAR-CIFT has successfully transferred this technology to many industries and entrepreneurs.
- Salient features
- Tuna waste from the thermal processing plant is utilised to develop pet feed by extrusion processing.
- The feed can be developed into different shapes and sizes using different ingredients
- The nutritional content and combinations can be varied as per the pet requirement.
- Our trials indicated that this feed can supplement or partly replace the existing feed given to the pets.

Benefits

- The pet feed is comparable with commercially available feeds and is cost-effective.
- Feeding trials in canines have found good acceptance and can supplement or partly replace the existing feed of dogs.
- Utilisation of canning waste which is otherwise discarded or used as fertilisers.

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation.

Developer: T.K.S. Gopal, Bindu J., C.O. Mohan and Ravishankar C.N., ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Silage from Fish Processing Discards

Fish silage is a liquid product developed from trash fish or fish processing discards. It is prepared by adding a sufficient quantity of acid, {generally formic acid} to the macerated fish waste and mixed intermittently. On liquefying after few days, it is mixed with a binder and co dried for use as a feed protein ingredient.

Status of Commercialisation/transfer:

ICAR-CIFT has successfully transferred this technology to many industries and entrepreneurs.



Salient features

- The product is partially hydrolysed protein with all other nutrients preserved
- It is used as a substitute for fish meal in preparing feed for animals, birds and fish.
- Since it contains hydrolysed protein it is found to have a high level of absorption and comparable growth rate in the test animals.

Benefits

- Very simple process can be adapted anywhere with any quantity of fish discards
- Low investment requirement and does not require sophisticated machines
- Product with high nutritive value with long storage life under room temperature

Training

ICAR-CIFT offers hands-on training programmes as part of technology licensing and business incubation

Developer: Zynudheen. A.A, Mathew, P.T and K.G. R. Nair, ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Protein-Based Bioactive Edible Films from Fish and Shellfish Head Waste

Shrimp head waste is highly abundant in India owing to the factor that an enormous amount of shrimp is being processed for export every year. Shrimp head waste contains more than 12% as protein on a wet weight basis. Similarly, the fish head is most commonly wasted during processing accounts nearly 35-40 % (w/w) of solid waste which contains proteins, lipids and other minor nutrients. Obtaining the proteins from fish and shrimp head is highly complicated due to its structural complications and higher enzyme degradation (in shrimp head). ICAR-CIFT has developed pH and enzyme assisted extraction process to recover the protein in the form of biologically active peptides. These protein derivatives found to offer advantages in the development of bioactive edible coatings or films.



Status of Commercialisation/transfer:

The technology is ready for commercialisation.

Salient feature

- The protein recovery from head waste is 16% to the whole shrimp head waste.
- The Tilapia fish head contains 18% protein and the recovery rate by enzyme process developed was 12-13% on a wet weight basis.
- The spray dried product contained 85-91% protein. The protein derivatives are biologically active (antioxidants in nature) and functional.
- The film developed from recovered proteins had better transparency and mechanical properties.

Benefits

- The process developed for the extraction of protein from fish head and shrimp head waste is more economical and enhances the additional revenues while reducing the environmental stress from the fish/shellfish processing industry.
- Proteins and derivatives developed are found useful in the edible coating, wrappings and functionally active films.

Training

ICAR-CIFT offers training through the Agribusiness Incubation Centre of the Institute.

Developer: Sathish Kumar K., Elavarasan, A.A. Zynudheen and Bindu J., ICAR-CIFT, Kochi

Contact Details: Director, (director.cift@icar.gov.in), ICAR-Central Institute of Fisheries Technology, Cochin, Kerala (www.cift.res.in)

Plankton Booster from Fish Waste



Plankton is the primary and essential food for the initial stages of fish and shrimp. Plankton crash is a very common problem in semi-intensive or intensive aquafarming. A quality cost-effective indigenous eco-friendly product has been developed from fish-waste to boost the plankton production and to maintain healthy plankton bloom in aquaculture systems. The product named as Plankton^{plus} is a promising technology to enhance aquaculture production. The product has proven its efficiency in various aquaculture systems for fish and shrimps.

Salient features

- Unique liquid product developed from marine fish trimmings/waste.
- Nutrient-rich soup, high protein (45-55%), lipid (15-20%), amino acids (Histidine, Cysteine, Lysine and glutamic acid), essential fatty acids (EPA & DHA) and minerals.
- Effective under a wide range of salinity (0 to 47 ppt).
- Enhances the abundance and diversity of phytoplankton for aquaculture.
- Increases zooplankton density (Ciliates, rotifers and copepods) significantly in ponds.
- Customizable technology for small, medium and large-scale operations.

Benefits

- Improves survival of shrimp and fish to the tune of 10.00 -15.00%.
- Enhances average body weight of shrimp and fish to the tune of 9.00-19.00 %.
- Increases shrimp/fish productivity to the tune of 0.6 -1.71 t/ha.
- Reduces the requirement of formulated feed for shrimp and fish without affecting growth and production performance.

Training

ICAR-CIBA offers hands-on training programmes at the Pilot Plant facility of CIBA.

Developer: Debasis De, Sandeep, K.P., P. Mahalakshmi and K. K. Vijayan, ICAR-CIBA, Chennai

Contact Details: Director, (director.ciba@icar.gov.in) ICAR-Central Institute of Brackishwater Aquaculture, Chennai, Tamil Nadu (www.ciba.res.in)

Organic Manure from Fish Waste



On average 30-35% of fish goes as waste. Fish waste is available centrally in fish markets as consumers prefer cleaned fish to whole fish. As there is no mechanism to dispose of it, the fish vendors used to dispose of waste in nearby water bodies that pollute the environment. On the other hand, fish is a rich source of nutrients for plants if suitably processed and applied as manure. The technology of aerobic composting of fish waste using microbial inoculum was standardized by the ICAR-Krishi Vigyan Kendra (Ernakulam). The product is sold under the commercial name *Fishlizer*.

Status of Commercialisation/transfer:

Technology is transferred for upscaling/commercialisation.

Salient features

- *Fishlizer* contains Nitrogen (1.44%), Phosphorous (0.45%), Potassium (0.46%), Calcium (1.28%), Magnesium (0.5%), Sulphur (0.15%) and Boron (11.3 mg/kg).
- The amino acids present in fish would enhance flowering and fruit setting in plants, favouring enhanced production.
- The standard recommendation is 200gm *Fishlizer* per grow bag as basal dose and subsequent 50 gram in every 15 days interval.

Benefits

- Commercial-scale manure production from fish waste is a promising enterprise for youngsters while ensuring nutritionally rich organic manure for farmers.

Training

ICAR-KVK (Ernakulam) of CMFRI offers entrepreneurship development programmes on *Organic manure production from fish waste* that covers production, packing, storage, marketing and backstopping the business for the initial two years.

Developer: P. Sreeletha and Shinoj Subramannian, KVK, Ernakulam

Contact Detail: Director (director.cmfri@icar.gov.in) ICAR-Central Marine Fisheries Research Institute, Ernakulam, Cochin, Kerala (<http://www.cmfri.org.in>)

Pet Food/Product From Slaughter House Waste/ by-Products



Offals/waste of slaughter houses is cheaper as compared to lean meat. Products based on slaughter house meat by-products viz hide, skin & their trimmings, head shanks and tail hides, and bones etc. are used for Pet food. The offals/by-products (including organs, fat or lard, skin, feet, abdominal and intestinal contents, bone and blood) represents 52.0 - 68.0% of the live weight of animals and thus a valuable source of potential revenue may be put to use.

Status of commercialization:

Technology is ready for transfer.

Salient Feature

- This technology has been developed for manufacturing of pet food by using selected meat offals mixed in 40-50% ratio by weight, residues of potatoes and cereals.
- The developed product is 45 to 50 percent cheaper than the products manufactured.

Benefit

- Cheaper pet food at micro/small level.
- Cost of disposing slaughter-house waste is reduced.
- Minimizes waste disposal problem.

Training

Training is imparted by Department of Post-Harvest Engineering and Technology Aligarh Muslim University, Aligarh- 202002 (UP).

Developer: Wazid Ali Khan, Saghir Ahmad and P.K.Srivastava, AMU, Aligarh, (AICRP on PHET)

Contact Details: Director, (director.ciphet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana,Punjab (www.ciphet.in)

Integrated Nutrient (IN) Mixture from Animal Waste (Manure)

Salient features

- An integrated nutrient mixture was prepared by fortifying animal waste (manure) with inorganic fertilizers and beneficial microorganisms. The base material for this mixture is a combination of finely powdered and sieved cow manure, goat manure, poultry manure, ash and rock phosphate containing 80 % organic constituents. Secondary nutrient and micronutrient fertilizers were used to fortify the mixture. Besides, the mixture contains locally isolated plant growth-promoting bacterial consortium (*Bacillus methylotrophicus* strain STC-4) which is compatible with the nutrient concentration of the mixture. The color of the mixture is greyish brown and more than 90 % material passes through 2 mm sieve. The pH of the mixture is 7.78 and EC was 0.006 dS/ m (non-saline). The mixture contains 0.81 % nitrogen, 0.16 % phosphorus and 1.09 % potassium. The cost of production of the mixture is Rs. 25.48/ kg only.



Integrated Nutrient (IN) mixture

Status of Commercialisation/transfer:

Technology is transferred for upscaling/commercialisation.

Benefit

- The effect of this mixture was tested and verified in short duration horticulture crops. Banana variety Grand Naine treated with a recommended dose of fertilizers along with integrated nutrient mixture @ 1 kg/plant during 3 months after planting had the highest number of leaves (14.80), highest leaf length (114.75 cm) and highest leaf width (43.41 cm) during the vegetative stage. It also recorded the least number of days taken for harvest (337.73 days), highest bunch weight (26.52 kg), highest fruit weight (131.85 g), fruit length (19.9 cm) and fruit circumference (13.13 cm). The integrated nutrient mixture improved the growth of the selected and tested crops.

Training

Training imparted by ICAR–Central Coastal Agricultural Research Institute, Old Goa, Goa.

Developer: Maneesha S.R., G. R. Mahajan and R. Ramesh, ICAR-CCARI, Goa

Contact Details: Director, (director.ccari@icar.gov.in) ICAR-Central Coastal Agricultural Research Institute, Goa (www.ccari.res.in)

Anti-Methanogenic Product '*Harit Dhara*' for Reducing Methane Emission



Methane, a potent greenhouse gas which contribute approximately 30% of the global anthropogenic greenhouse gas emission. A recent estimate of ICAR-NIANP confirmed that cattle, buffalo, sheep and goats contribute 56, 29, 5 and 10% to the annual enteric methane emission, respectively. In addition to global warming, methane emission from the livestock also held accountable for a substantial energy loss (6-12% of the energy intake). Annually, 38×10^8 Giga calorie energy is wasted from livestock due to methane emission in India.

Status of Commercialisation/transfer:

Technology is transferred for upscaling/commercialisation.

Salient features

- '*Harit Dhara*' is an anti-methanogenic product produced by using condensed and hydrolysable tannins containing phyto-sources.
- The product can be fed to growing (>4 months old), lactating and adult animals. Daily supplementation of *Harit Dhara* @ 150 g per day to growing cattle and buffaloes and @ 500 g per day to adult cattle and buffaloes lead to a reduction of about 20% in daily enteric methane emission.
- The daily dosage for sheep is about 50 g per day. The product is cheap and cost only 3-4 rupees per kg.
- A patent has been filed for the product (Temp/E-1/5396/2019-CHE dated 8th Feb 2019).

Benefit

- With the usage of *Harit Dhara*, the enteric methane emission can be reduced by 20-22%.

Training

Training is imparted by National Institute of Animal Nutrition and Physiology, Bengaluru.

Developer: Raghavena Bhatta, P. K. Malik and A. P. Kolte, ICAR-NIANP, Bangalore

Contact Details: Director, (directornianp@gmail.com) ICAR-National Institute of Animal Nutrition & Physiology, Bengaluru, Karnataka (www.nianp.res.in)

Fermented Fish Silage from Visceral Waste of Freshwater Carps

- A huge amount of processing waste is generated in India from fish markets, fishing harbours, fish landing centres, seafood processing factories. Annually around 5 lakh tonnes of dressing waste is being generated from carps alone.
- These discarded fish wastes are rich in proteins, fats and minerals and are converted to valuable by-products like fermented fish silage. The organic components of the waste have a high biological oxygen demand and if not managed properly, can pose serious environmental pollution.
- Fish silage could be put to use as a feed ingredient in poultry, livestock and fish feed and also could be used as organic manure in crops.
- The technology is Under advanced stage of research and development.



Salient Features:

- Fermented Fish silage is a liquid product made from dressing waste of fish or whole fish that are liquefied by the action of natural enzymes present in the fish. The enzymes are activated by the addition of carbohydrate sources like jaggery (20% w/w), molasses etc. The production of acid by fermentation and the subsequent reduction in pH helps in the liquefaction of protein.
- Significant increase in egg production with 3% silage incorporation in feed of Japanese Quail has been observed. Cost of feed/kg egg mass reduced by 4.17% with 12% silage incorporation in its diet.
- Supplementation of fish silage upto 10% in broiler diet reduced the feed cost by Rs 5/kg weight gain.
- When applied to Okra as liquid manure a 31.85% increase in yield was obtained. Vermicompost was mixed with fish silage to enhance its micronutrient content.
- Cost of production of wet silage is Rs 12/kg

Benefit

- It is an income generating activity for coastal women and will also help in alleviating environmental pollution caused by the piling up of fish processing wastes.

Training

Skill training can be given to the potential technology adopters by the institute.

Developer: Tanua S, ICAR-CIWA, Bhubaneswar

Contact Details: Director, (director.ciwa@icar.gov.in) ICAR-Central Institute for Women in Agriculture, Bhubaneswar, Odisha (www.icar-ciwa.org.in)

Low-Fat, High-Fibre Meat Products Using Food Industry By-Products



Dietary fibres extracted from pea pod



Health meat products with pea pod dietary fibres

About 38% of food wastes or by-products occur during food processing. These food industry by-products are good source of nutraceuticals, bioactives, inherently functional and possess many components that are good for human health. In this invention, dietary fibres have been extracted from pea-pods and developed as fat replacer for development of low-fat, high-fibre processed meat products. The final processed meat product is having low fat and high fibre contents with excellent water binding properties, textural properties and sensory properties.

Status of Transfer:

Technology is ready for transfer and upscaling/commercialisation.

Salient Features

- Dietary fibres from pea pods have been extracted.
- Fat replacers have been developed from the pea pod dietary fibres.
- Developed health meat products have excellent water binding properties, textural properties and sensory properties.

Benefit

- Utilization of food industry by-product for development of health food products.

Training

Training and licensing of the technology is imparted by ICAR-Central Institute of Post-Harvest Engineering and Technology (CIPHET), Ludhiana.

Developer: Yogesh Kumar, K. Narsaiah, R.K. Singh, Sandeep Mann, R.K. Vishwakarma

Contact Details: Director, (director.ciphnet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana-141004 Punjab (www.ciphnet.in)

Aquaponics System for Production of Plant Biomass

In traditional aquaculture practices, the nutrients provided by the fish in the form of fecal matter and feed waste are normally discharged to the environment. The developed system (Aquaponics) is innovative agricultural technique that allows to grow crops



with help of waste created by fishes efficiently. System utilizes waste as the nutrient component for the plants. One Aquaponics Unit comprises of fish culture tank of 2800 L capacity, biofilter with 95 L filtration material volume and hydroponics tank with total waterbed surface area of 3.6 m². Pangas fish and marigold plant also tried in the system. The total production of pangas and marigold in each replicate were 2143.33 g and 384 ± 21 number of flowers (79.80 ± 3.36 mm diameter and 16.67 ± 0.93 g weight), respectively. The efficiency of the whole system is mainly focused on the effectiveness of the biofilter in the chemical conversion of Total ammonia nitrogen (TAN) which shows 61.97 % reduction in Total ammonia nitrogen (TAN) with the current hydraulic loading of 3.68 Litre per minute (LPM) of filter media. One farmer can operate 10-20 units simultaneously with different level of operations and accordingly the profit can be increased.

Status of Transfer:

Technology is ready for transfer and upscaling/commercialisation.

Salient Features

- The use of lightweight Fibre-reinforced plastic (FRP) material made the system much more convenient for transportation to various remote locations and considered eco-friendly.
- The developed system can be a useful tool for hobbyists and also can add recreation to common users.
- Indian socio-economic condition would be greatly benefited by the new design which is aiming for the livelihood improvement of small and medium-scale farmers as well as the people in remote areas by the production of healthy food for the local market.

Benefit

- One unit of the developed experimental Nutrient film technique (NFT) aquaponic system produced the net profit of INR 714 (≈ \$9.8) in 90 days of operation from the 8 m² installation area.
- Cost of one unit of Aquaponic System : INR 70,000/-.

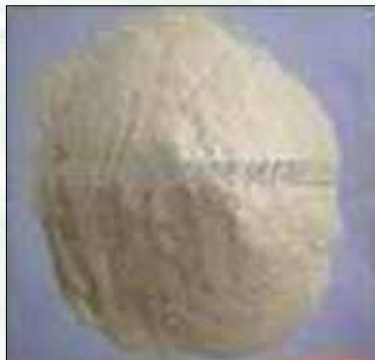
Training

3 days training is sufficient to impart knowhow of the technology which is available at PAU, Ludhiana under AICRP on PET centre.

Developer: B. C. Mohapatra, ICAR-CIFA, Bhubaneshwar (AICRP on PET)

Contact Details: Director, (director.ciphet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana-141004 Punjab (www.ciphet.in)

Process for Extraction of Flavour from Shrimp Waste



During shrimp processing nearly 80% waste is generated in the form of shrimp head, exoskeleton, hepatopancreas, eye stalk, residual meat which can be utilized for extracting flavor active compounds useful marketable products.

Utilization of this waste for extracting flavor active compounds will put this waste into useful marketable products. This minimizes the pollution problem and at the same time maximizes the profits of the processors.

Status of Transfer:

Technology is ready for transfer and upscaling/commercialisation.

Salient Feature

- The flavour of seafood like shrimp flavour is hard to synthesize and it is almost necessary to produce from natural products.
- The flavour of seafood like shrimp flavour almost necessary to produce from natural products. The procedure for extraction of shrimp flavour was standardized using shrimp head.

Benefit

- Efficient utilization of shrimp waste by conversion into value-added and marketable product.
- Minimizes pollution and cost of disposal.

Training

Training is imparted by Faculty of Fishery Sciences, 5 Budherhat Road, PO: Panchasayar, Kolkata-700094. Tel & Fax: 033-24328763.

Developer: S Sarkar, Cooperating Centre Kolkata (AICRP on PHET)

Contact Details: Director, (director.ciphnet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana-141004 Punjab (www.ciphnet.in)

Fish Bone Hydroxy-Apatite from Fish Filleting Wastes

The hydroxyapatite (HyAp) was isolated from fish bone by thermal calcination method. The characterization of HyAp was done using TGA, SEM, EDX, XRD and FT-IR to investigate the thermal stability, morphology, calcium to phosphorous weight ratio, crystallinity and purity of thermal calcinized HyAp. The isolated HyAp expressed pure HyAp characteristics.

Status of Transfer:

Technology is ready for transfer and upscaling/commercialisation.

Salient Features

- Thermal calcination method is best method for isolation of fish bone HyAp with almost no organic portion, high purity, stability, crystallinity, nanostructure and no cytotoxicity making it appropriate for use in biomedical applications.

Benefit

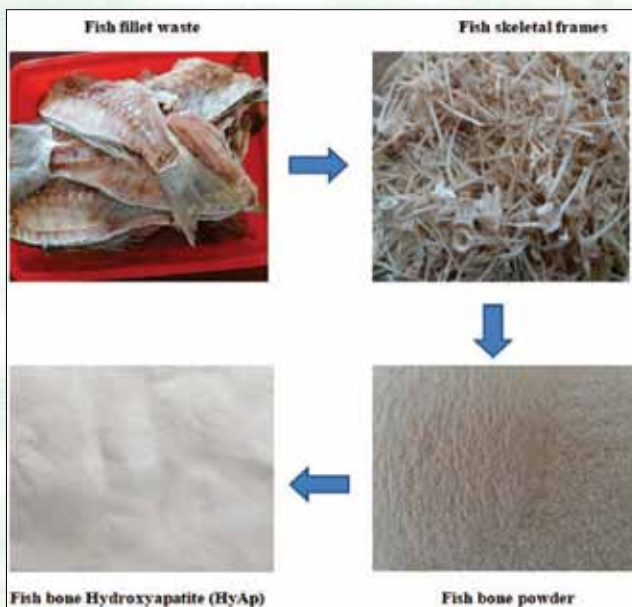
- The fish bone Hydroxy Appetite from the fish bone powder could be fortified in food products, helps consumers in meeting the calcium requirements.
- Thermal calcinations method is best method to isolate Hydroxy Appetite from fish bone powder.
- The isolated Hydroxy Appetite possess almost no organic portion, high purity, stability, crystallinity, nanostructure and no cytotoxicity making it appropriate for use in biomedical applications.

Training

Department of Fish Processing Technology, College of Fisheries, Karnataka Veterinary Animals and Fisheries Sciences University, Mangalore, Karnataka.

Developer: C. V. Raju, Lakshmisha, Amitha Salian and Arunkumar P, KVAFSU, Mangalore (AICRP on PHET)

Contact Details: Director, (director.ciphet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana-141004 Punjab (www.ciphet.in)



Sausage from Low Value Marine and Freshwater Fish

The developed indigenous technology provides hygienically processed value-added fish products for the domestic and export markets using under-utilized and low value fish harvested from marine and fresh water sources. Low value marine fish namely Bulls eye fish (*Priacanthus hamurur*) was used for creating value added product.



Status of Transfer:

Technology is ready for transfer and upscaling/commercialisation.

Salient Feature

- These are Fish Sausage made from low value or underutilized fishes.
- Fresh Bull's eye fish (*Priacanthus hamurur*) are dressed to remove scales, head and viscera and then wash in clean chilled water. The meat is separated from the bones using meat picking machine and then minced. Spices are added to minced meat as per the standard recipe and mixture is ground in a silent cutter for 10-15 min.
- Subsequently, fine paste is transferred to sausage filler and stuff it into synthetic casing. The outer surface of the casing is washed in soap water and then in clean water. The sausages are thermally processed at 80-90°C for 45 min. and allowed to get cooled to the room temperature. The sausages are re-boiled at 100°C for one minute to remove the wrinkles and to get smooth appearance. The sausages can be wiped and stored in refrigerated condition ($5 \pm 2^\circ\text{C}$) or in a deep freezer (-20°C) for a period of 28 days and 6 months respectively.
- The sausages can be wiped and stored in refrigerated condition ($5 \pm 2^\circ\text{C}$) or in a deep freezer (-20°C) for a period of 28 days and 6 months respectively. The value of final product is Rs. 200/- per kg, whereas estimated unit cost of operation is Rs. 76-85/kg.

Benefit

- Provides hygienically processed value-added fish products for the domestic and export markets.

Training:

Training is imparted by AICRP on PHET Centre; College of Agricultural Engineering, UAS, Raichur.

Developer: Udaykumar Nidoni and A. A Fazal, UAS, Raichur (AICRP on PHET)

Contact Details: Director, (director.ciphet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana-141004 Punjab (www.ciphet.in)

Sampurnatm Foliar Spray for The Promotion of Growth and Increased Water Retention Capacity of Crops



Sampurna™ is fish hydrolysate (FAA) made from trash fish and/or fish wastes through microbial processing. It is enriched with organic substrates like Humate and Fulvate. FAA is of immense value to crop plants in stimulating foliage and promoting growth by making available nutrients and amino acids. It contains humate and fulvate which are organic chelators. They combine minerals to convert them into organic compounds that can be absorbed by plants more easily. They enhance root growth and increase water retention capacity. FAA present in Sampurna provides essential element nutrition to plants.

Salient features

- Fish hydrolysate (FAA) developed from trash fish and/or fish wastes.
- Contains Fish hydrolysate (15%), Potassium Humate (6%) and Potassium Fulvate (3%)
- Contains organic chelates that ligand nutrient molecules.
- Suitable for drip irrigation and fertigation.
- Helps in correcting soil salinity when used in drench.
- Rural technology that can be easily adopted and scaled-up.

Benefits

- The application of FAA optimizes physiological parameters in crops.
- Enhances the availability of primary nutrients
- Efficiently works in Paddy, Cotton, Chili, Turmeric, Maize, Onion and leafy vegetables.
- Helps in environment conservation through recycling of trash fish and fish wastage
- Micronutrient deficiency in various crops is overcome

Training

ICAR-CIFA offers hand-holding training and follow-up.

Developer: B. Seshagiri, ICAR-CIFA, Odisha

Contact Details: Director, (director.cifa@icar.gov.in) ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, Odisha (www.cifa.in)



भातुअनुषु
ICAR

PROCESSES/ TECHNOLOGIES FOR CONVERTING AGRICULTURAL WASTES INTO WEALTH

Pilot Plant for Production of Protein Isolates from De-Oiled Cakes(DOC)

The de-oiled cake (DOC) left after oil extraction from major oilseeds is about 10 million tonnes (soy meal: 4 MT, groundnut cake: 3 MT, mustard: 2 MT, sunflower cake: 1 MT). At present, these cakes are either utilized as animal feed or being exported to other countries like China and Malasiya.

For the commercial production of protein isolates from de-oiled cakes an indigenous machinery has been developed, designed and commissioned for the first time (to the best of our knowledge). An indigenous pilot plant has been set for production of protein isolates from groundnut DOCs,

having capacity of 40 kg of raw material/day.



Protein Isolate Pilot Plant of ICAR-CIPHET

Salient Feature

- Based on alkali solubilisation and acid precipitation process and suitable for production of protein isolates/concentrates from de-oiled meals/cakes.
- Isolates produced from this plant have more than 90% protein. Other de-oiled cakes i.e. soy meal, sunflower cake, mustard cake etc. can also be used for the purpose.
- This pilot plant comprises of Extraction tank, Decanter centrifuge, Precipitation tank, Control panel for automated operation, Spray dryer of suitable capacity. Its capacity is 40 kg/day in terms of de-oiled cakes/meals.
- Ultra-filtration unit can also be attached with the pilot plant for enhanced protein recovery.

Benefit

- Low cost (Rs 150-200/kg) of protein isolate production as compared to imported soy protein isolate with retail price of Rs. 900-1000/kg in the market.
- Availability of cost effective protein to address the protein malnutrition of the country.

Training

Training is imparted by ICAR-Central Institute for Post-Harvest Engineering & Technology (CIPHET), Ludhiana.

Developer: D N Yadav, S K Nanda, R K Gupta, ICAR-CIPHET, Ludhiana

Contact Details: Director, (director.ciphnet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana-141004 Punjab (www.ciphnet.in)

Process for Extraction of Kernel Oil of Wild Apricot



Wild apricot fruit is not suitable for table purposes, but oil can be extracted from its kernel and is used as edible oil. Apricot kernel oil being rich in polyunsaturated fatty acids and vitamin E and has many medicinal and cosmetic applications.

The decortication of stone is a tedious, time consuming process and involves women drudgery. This process makes the decortications of apricot stones simple thus reducing the drudgery and time consumed.

Status of Commercialisation:

The Technology has been commercialized.

Salient Feature:

- The technology for extraction of apricot kernel oil consist of mechanical decortications, kernel separation with gravity method, extraction of kernel oil with table oil expeller, filtration and packing.
- Apricot stones/seeds are broken using mechanical decorticator with breaking efficiency of 80-100 kg stones per hour. Kernels separated by specific gravity separation by dipping the decorticated mass in 20 per cent salt solution. The kernels are sun drying and then passed through 'Table Oil Expeller' for oil extraction. Oil yield of 43.5 percent can be achieved.
- The clear and transparent oil is obtained, and the market price of the oil is around Rs. 350/lt.
- Besides, cake can be further utilized for cosmetic.
- The recovery of oil from 10 tonnes of apricot kernel was found to the tune of 1408 liters.

Benefit

- One unit can earn profit of Rs. 1.33 lakh per annum.

Training

Training is imparted by ICAR-Central Institute for Post-Harvest Engineering & Technology (CIPHET), Ludhiana.

Developer: P. C. Sharma Devina Vaidya and Anil Gupta, YSPUHF, Solan, HP (AICRP on PHET)

Contact Details: Director, (director.ciphnet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana-141004 Punjab (www.ciphnet.in)

Pilot Plant for Pectin Extraction

The conventional processing of apple fruits for juice, cider and fruit juice concentrate removes 75 per cent of fresh weight as juice and remaining 25 per cent as solid residues (peel, core, seed, calyx, stem and soft tissue) known as apple pomace, which contains pectin (16.95%).

Status of Commercialisation:

The Technology is ready for commercialisation.

Salient Feature

- Pectin is a complex heterogeneous polysaccharide which mainly consists of 1,4- linked α -D-galacturonic acid units partly methyl esterified composed of 300 to 1000 chains of anhydrogalacturonic acid units.
- Pectin extraction process has been optimized and pilot plant for extraction of pectin has been designed and fabricated.
- Pectin serves as stabilizing agent, emulsifier and thickener and prevents increase in blood lipid, blood sugar and cholesterol etc.
- Quality characteristics of chemically extracted Pectin (14% recovery) are at par with commercial pectin.
- Benefit Cost Ratio 1:5

Benefit:

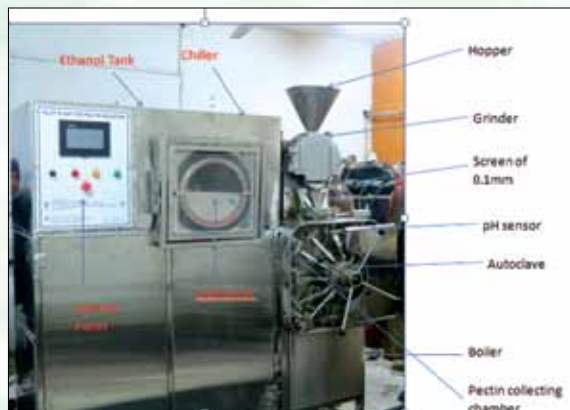
The developed system is able to extract pectin from fruit processing industry wastes. Thus, this system can utilize the wastes and produce commercial product of pectin.

Training

Training is imparted by Department of Food Science & Technology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni.

Developer: Devina Vaidya, Manisha Kaushal, Anil Gupta and Anil Verma, YSPUHF, Solan, HP (AICRP on PHET)

Contact Details: Director, (director.ciphet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana-141004 Punjab (www.ciphet.in)



Binderless Briquetting of 100% Crop Residue

Crop residues are available in plenty in the rural catchments' areas. The utilization of these available residues is limited due to their low bulk density, which makes handling difficult, transport and storage expensive.

The ideal answer in this situation is to convert these residues into high density and high-value solid fuel i.e. briquettes. Briquetting can be done either through piston press or screw press technology. The commercial briquetting machine is developed for briquetting of saw dust. A process and protocol were developed for briquetting of crop residues by design refinement in die section of piston press briquetting systems. The briquettes from soybean straw, pigeon pea stalk, Lantana weed stalk, cotton stalk, and jute sticks, etc. have been prepared successfully with 100% residues without binder.



Status of Commercialisation:

The Technology is ready for commercialisation.

Salient features

- Biomass briquettes have a long shelf-life and can be produced in a variety of sizes.
- Binderless briquetting of crop residue is cost effective, easy and feasible solution of crop residues management.
- Briquetted crop residues increase density of residues in bulk quantity, thus costs of storage, maintaining & transportation is reduced by almost 10 times. Also, storage and transportation become easier than raw residues.
- Crop residues briquette has good acceptability in the boilers, brick kiln and gasifiers etc., which are operated on wood or hard coal, etc.
- The briquette is found to be good domestic fuel and act as replacement of fuel wood in rural sector.

Benefits

- Briquettes are a very clean fuel and has stable quality.
- Switching over to briquettes can be avoided by direct combustion of loose biomass association of dust pollution.
- Reduction in deforestation in rural area.
- Entrepreneurship opportunity in rural catchments.

Training

Training is imparted by ICAR-CIPHET, Ludhiana

Developer: AK Dubey, Sandip Gangil, CR Mehta and KC Pandey, ICAR-CIAE, Bhopal

Contact Details: Director, (director.ciae@icar.gov.in) ICAR-Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh (www.ciae.nic.in)

The Multi-Purpose Eco-friendly “SORF Machine

The high load (10-15 t ha⁻¹) and tough nature of loose trash generated after sugarcane harvest hampers the fertiliser placement and other field operations, therefore open-burning is a common practice in ratoon sugarcane. *In-situ* retention of sugarcane trash can play an important role in replenishing soil quality and reducing environmental pollution.

A new prototype of multi-purpose machine popularly known as “SORF” machine has been developed to perform multiple operations of stubble shaving, off-barring, root pruning and placement of basal dose of fertilisers in one go while retaining the trash at the soil surface.

*The technology is proven and awaiting commercialization



Multi-purpose SORF machine in action

Salient Features

- The machine facilitates efficient management of sugarcane waste (Trash) and provides an eco-friendly option for ratoon management to sugarcane growers.
- The “SORF” machine broadly consist of power transmission unit, central horizontal rotating disc attachment with fixed peripheral blades for stubble shaving and two vertical discs for off-barring along with root pruning cum fertiliser placement mechanisms
- It performs multiple operations of stubble shaving, off-barring, root pruning and placement of basal dose of fertilisers in one go while retaining the trash at the soil surface.
- The fabrication cost of the equipment is only around 1.25 Lakhs.

Benefit

- It help in improving soil health, conserving water and reducing environmental pollution.
- It improves the N-use efficiency and productivity of sugarcane ratoon crop under surface retained trash conditions.
- This can also contribute to reduction in drudgery of farm women.
- B:C ratio of up to 12.6 % can be attained over farmer’s practice of trash burning and broadcast application of fertilizers.

Developer: R.L. Choudhary, A.K. Singh, ICAR-IISR, Lucknow; G.C. Wakchaure, P.S. Minhas, K.K. Krishnani and N.P. Singh, ICAR-NIASM, Baramati

Contact Details: Director, (director.sugarcane@icar.gov.in) ICAR-Indian Institute of Sugarcane Research, Lucknow, UP (www.iisr.nic.in)

Director, (director.niasm@icar.gov.in) ICAR-National Institute of Abiotic Stress Management, Malegaon, Baramati, Maharashtra (www.niam.res.in)

Eco-friendly and Sustainable Wastewater Treatment for Safe Reuse in Agriculture

It is a novel, environment-friendly and economically remunerative sewage treatment technology based on the selected hyper-accumulative emergent wetland plants and the native micro-organism interactions.

This technology is taken under the Government of India's flagship Swachhhta Action Program (SAP). It has also been selected as a Good practice example under the "Safe Use of Wastewater in Agriculture" initiative of the United Nations and as an innovation in Indian Agriculture by the National Skills Foundation of India. The technology bagged the prestigious civilian SKOCH (Platinum) Award under the Transformational Innovation Category in 2017.

Salient Features

- The technology has zero energy, zero-chemical and zero-skilled man power demand and it take care of muti-pollutant and pathogen loads, along with salt – remediation, through specific economically important non-competitive (halophytic/ non-halophytic) macrophytes, planted in either solo or mixed culture designs.
- The technology is capable of reducing turbidity by 99%, pathogen load by 99.9%, BOD by 87%, and nutrients and heavy metals by 80 to 99%.
- Compared to conventional wastewater treatment technologies it requires about 80-85% lower capital expenditure demand, it has extremely low (i.e. maximum Rs. 0.60 per kiloliter, KL) operational expenditure (OPEX) demand and the technology is at least 1500 times more sustainable and causes at least 33 times lesser environmental stress.
- The demonstrative operations are running at Indian Agricultural Research Institute, New Delhi; at a village in Mathura, Uttar Pradesh; at residential boarding school Jawahar Navodaya Vidyalaya, Kansiram Nagar, U.P. by UP Jal Nigam in Uttar Pradesh; at CAZRI, Jodhpur, Rajasthan.

Benefit

- This technology has the capacity to add a good value to land being used for wastewater treatment for their say safe (metal & pathogen free) reuse in aquaculture/ agriculture, the same piece of land can also serve to be used as an eco-park and/ or a source of community revenue generation through integrated Cash from Trash particle board, briquette, pellet manufacturing, handicrafts, etc business models.

Training

Two days training is imparted by WTC, ICAR, New Delhi.

Developer: Ravinder Kaur, Water Technology Centre, ICAR-IARI, New Delhi

Contact Details: Director, (director@iari.res.in), ICAR-Indian Agricultural Research Institute, New Delhi (www.iari.res.in)



Visit of the Honorable Parliamentary Standing Committee on Agriculture at the Community scale Wastewater Treatment Plant of ICAR-IARI, New Delhi

Used Paper Mulch Applicator

Cotton farming covers approx. 120 lakh ha area in the country. Weeding is the second most labour-intensive exercise in cotton farming situations. In general plastic mulching for controlling weeds is practised which is not environmentally friendly, though it is very effective in controlling weeds and improving cotton productivity. Labour requirement for weeding is 30-40-man days/ha at approximate cost of Rs. 11000-12000/ha. Inter-row inter-culture operations are mostly done using bullock operated blade harrows and cost about Rs. 4000-5000/ha. Therefore, total cost of weeding in cotton is Rs. 15000-17000/ha.



Mulching technology with waste Newspaper has been shown to be effective and economically viable, at the same time being environment friendly. Therefore, used newspaper has a potential for mulching between rows of cotton.

Status of Commercialisation:

The Technology is ready for transfer/upscaling.

Salient Feature

- In this technology used newspapers are laid back to back and turned into a roll on a roller. The roller is then mounted on a frame, having a pressing roller at the other end and two shovels on both sides to cover the edges of laid paper on the ground with soil. The paper from roll passes through the pressing roller and is anchored at the loose end with soil/stones. The frame is dragged by one or two persons along the row laying the paper mulch.
- For mechanical laying of papers numerous plastic mulch applicators are already available. These can be adapted with minor modifications and adjustments for laying newspaper as mulch.
- There is an issue of making rolls out of newspapers, which is labour consuming, as it entails sticking newspaper ends with glue. This can generate additional income if taken up as a cottage industry.
- One of the possible environmental benefits would be a reduction in the use of herbicide. Weeding is basically done by women labourers. From their point of view, drudgery will be reduced and would lead to better quality of life.

Benefit:

Cost of laying the newspaper mulch with the applicator will be Rs. 2000/ha and cost of newspaper would be Rs. 5250/ha. Total cost Rs 7250/= per ha is less than half the cost of manual weeding and inter-culture operations with bullock operated harrows (Rs 15000-17000/ha).

Developer: Gautam Majumdar and Blaise Desouza, ICAR-CICR, Nagpur

Contact Details: Director, (vijayvnm@yahoo.com) ICAR-Central Institute for Cotton Research Nagpur, Maharashtra (www.cicr.org.in)

On-The-Go Urea Solution Spraying System for Straw Baler

Enhanced utilization of paddy straw residue from combine harvested field is an effective method to reduce crop residue burning issues. One of the possible ways to increase the palatability and digestibility of poor quality roughages like rice



and wheat straw is urea treatment. Hence, a urea solution spraying system for straw baler (rectangular type) to pretreat paddy straw during baling operation has been developed. Urea solution having concentration of 8% (8 kg of urea in 100 litre of water) is used.

Salient Features

- The developed system consists of a plastic tank, spray boom with flat fan nozzles, HTTP pump, hose pipe, strainer, pressure relief valve and pressure gauge.
- The working capacity of straw baler with urea spraying system was observed 109 bales/h for paddy at straw load of 8.3 t/ha.
- The nutritive value of straw like crude protein, in vitro dry matter digestibility, and metabolizable energy was found to be improved as compared to the untreated straw.
- The cost of retrofitted urea solution spraying system is ₹30000/-.
- The cost of urea treatment with developed spraying system is ₹0.50/- per kg of straw.

Benefits

- It saves time and labours.
- The cost urea treatment is low as compared to manually straw treatment.
- Treated bale can be transported at fodder scarcity place.
- Urea treated straw improves the animal health and milk yield.

Precautions

- The calf of below six month and pregnant cattle should not be fed with treated straw.
- The fungal growth straw should not be taken for urea treatment.
- The treated straw should be fed after exposure of air for at least 10 minute.
- The starting quantity of urea treated straw should be regulated from lesser quantity to higher in periodic manner.

Developer: Satya Prakash Kumar, Dilip Jat, ICAR-CIAE, Bhopal; S.B.N. Rao, M. Chanasekharaiah, ICAR-NIANP, Bengaluru

Contact Details: Director, (director.ciae@icar.gov.in), ICAR-Central Institute of Agricultural Engineering, Bhopal – 462 038, Madhya Pradesh (www.ciae.nic.in)

Director, (directornianp@gmail.com) ICAR- National Institute of Animal Nutrition and Physiology, Bengaluru, Karnataka (www.nianp.res.in)

Annular Core Biochar Production System



The unit is designed and developed to generate the char at different temperatures. The char generated at different have different type of properties. The crop residues which are being burnt can be converted into useful value-added products, i.e., char. The generated char can be used for fuel, water cleaning agent, soil amendment and carbon sequestration agent.

Status of Technology Transfer/ Commercialisation:

The unit has been sold to three places in India. It can be designed on customized designed and supplied to user from ICAR-CIAE, Bhopal.

Benefits:

- The system converts the crop residues in to useful valued products.
- The system process conditions can be changed depending upon the need of application.
- System design can also be changed depending upon the extent of use and type of biomass. The design can be customized for reactor capacity of 20 l to 100 l and for heating capacity of 4 kW to 12 kW.
- The char recovery is from 20-30 % depending on the temperature. At higher temperature the recovery is lower but the carbon content in the char is higher.
- The carbon content of 70-90 % can be obtained. The iodine value from 200 to 500 mg/g can be obtained. The pH of char from 6 to 9 can also be altered.
- Precise thermal regulation, Easy replacement of heating elements, Current leakage protection, Outflow gas control and Customized design.

Developer: Sandip Gangil and VK Bhargav, ICAR-CIAE, Bhopal

Contact Details: Director, (director.ciae@icar.gov.in) ICAR-Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh, (www.ciae.nic.in)

100 kW Natural Draft Gasifier for Thermal Applications



The unit is designed and developed to generate the heat from biomass. The gasifier can be used for water boiling, steam generation and also for community kitchen. The wood chips, forest woody biomass and briquettes made from crop residues (with or without binder) can easily be used to operate this system. Crop residue can directly be used with mixing of 50 % with wood chips.

Status of Technology Transfer/ Commercialisation:

The unit has been disseminated at community kitchen level in one of school at Bhopal in India. It can be fabricated at PPC-CIAE and supplied to user from ICAR-CIAE, Bhopal.

Benefits:

- The system converts the biomass in to useful heat energy.
- The wood savings ranges from 15% to 25 % for conducting the same work when this system is employed. The gasification efficiency is above 60 %.
- Unit cost around Rs. 1 Lakh.
- Useful for community kitchens and bio dhabas, cottage industry needing hot water.

Developer: Sandip Gangil and Anil K Dubey (Retd.), ICAR-CIAE, Bhopal

Contact Details: Director, (director.ciae@icar.gov.in) ICAR-Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh, (www.ciae.nic.in)

Pilot Scale Reactor for Biochar Production

The reactor system for production of biochar from crop residue using briquette as fuel has been developed. It consists of reactor drum and combustion chamber. It is mounted inside the combustion chamber for uniform heating. The combustion chamber consists of double bricks made up with refractory bricks. There is provision to rotate the drum at its axis. A blower has been fitted to blow the air for combustion. The recovery of biochar after pyrolysis of soybean straw and pigeon pea stalk was observed to be 37 and 27 % respectively. It was observed that the energy value increased from 16.56MJ/kg to 24.81 MJ/kg due to charring of soybean straw while it increased from 15.23 to 26.30 MJ/kg for pigeon pea stalk.



Soybean biochar and straw



Pigeon pea biochar and straw

Status of Technology Transfer/ Commercialisation:

Technology is ready for transfer.

Salient features

- It is a biomass fired biochar reactor.
- The size of reactor is 1.25m diameter and 2m length.
- The provision has been made to re-circulate the vapour into the combustion system as they have fuel gases, like hydrogen, methane and carbon mono oxide.
- The temperature of 500 °C (Design temperature) can be reached after 30 minute of firing.
- Biomass briquettes requirement is 60-100 kg briquette per batch.
- Cost of the technology is about Rs 4.00 lakh with operating cost of Rs. 1567 per batch.

Benefits

- Pilot scale production of biochar.
- Additional value from crop residues/biomass.
- The methane and hydrogen generated during the process of biochar are reused as fuel for biochar production hence less pollution to the environment.
- Can be scale up for large scale production of biochar.

Developer: VK Bhargav and Sandip Gangil, ICAR-CIAE, Bhopal

Contact Details: Director, (director.ciae@icar.gov.in) ICAR-Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh, (www.ciae.nic.in)

Batch Type Bio-Crude Production Unit



A laboratory level batch type bio-crude production unit capable of converting biomass to bio-crude in slow pyrolysis mode. The unit has been tested with recovery of ~ 48% bio-crude from pigeonpea stalks. The condenser has been designed with concept of tube-cell heat exchanger with provision of cleaning in case of excessive tar deposition. Temperature of the stainless-steel reactor can be varied from ambient to 700-degree C. There is also provision for injecting nitrogen for maintaining inert atmosphere during pyrolysis process. Pyrolytic behaviour of biomass can also be studied in this unit.

Status of Technology Transfer/ Commercialisation:

Technology is ready for transfer.

Salient features

- Stainless steel reactor of 2 kg biomass loading capacity.
- Precise temperature control of ambient to 700°C.
- Horizontally laid reactor makes easier operation as well as higher recovery.

Developer: Sandip Mandal, Sandip Gangil and VK Bhargav, ICAR-CIAE, Bhopal

Contact Details: Director, (director.ciae@icar.gov.in) ICAR-Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh, (www.ciae.nic.in)

Technological Package of Charring, Briquetting and Cook Stoves for Utilization of Crop Residues

The technology package includes a charring kiln, a char briquetting machine and suitable cook stove for char briquettes. It is a suitable package for Agri Entrepreneurs/ Farmer Producer Organizations. It is developed to reduce crop residue burning and enhance the fuel quality of the crop residue by converting it into the biochar briquettes. This technology



would lead to employment generation in rural areas through entrepreneurship development, reduce dependency on forest fuel woods, save the forest from deforestation, improve air quality and support rural economy.

Status of Technology Transfer:

Technology is ready for transfer.

Salient features

- The charring kiln is simple portable unit for converting agricultural residues in to a charred mass.
- The Briquetting machine is a screw type extruder, which converts charred biomass into cylindrical briquettes.
- The package includes a three charring kiln of capacity (char output): 80 kg/day, one Char briquettes machine of capacity: 75 kg/h and forty Cooking Stove: 0.5 kg briquette per h (briquettes consumption).
- Enhanced fuel efficiency and calorific value of briquettes made from agricultural residue and reduced pollution.
- Can be adopted by any region with availability of crop residues such as soybean, cotton, pigeon pea, lantana, etc.
- Human and electric energy consumption per hour is 6.86 MJ and 3.75 kWh, respectively.

Benefits

- The farmer will get clean burning fuel from locally available materials.
- Women will not need to travel long distance to collect fuel wood which will save time & effort for other productive works.

Developer: ICAR-CIAE, Bhopal

Contact Details: Director, (director.ciae@icar.gov.in) ICAR-Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh, (www.ciae.nic.in)

Portable Briquetting Machine for Paddy Straw



Thus, briquetting of paddy straw could be one of the sustainable options for management of waste residues, that is otherwise burnt and create environmental pollution. Manual energy is used for feed stalk preparation and electrical energy is used for operating machine. Besides being environment friendly, it could help create gainful employment opportunities in the rural areas. If briquettes fetch the entrepreneur 6 Rs/kg it could result in the net earnings of around 1.5 lakhs for the farm family.

Status of Technology Transfer:

Technology is ready for transfer

Salient features

- This machine is developed for briquetting of paddy straw.
- The machine is of 50 kg/h capacity comprises of feeding hopper, screw auger, die and power unit (10 hp).
- The briquettes exhibited excellent resistance to shattering and it has been durable as well. The calorific value of paddy straw briquettes produced is 3600 kcal/kg.
- Easy in transportation and handling due to portability of machine.
- The cost of unit including hammer mill is Rs 50000/-.
- Breakeven point is 15000 kg production/year whereas payback period is about 54 days.

Benefits

- Efficient utilization of unused paddy straw.
- Availability of fuel for domestic cooking in rural areas.

Developer: Harsha Wakudkar, AK Dubey (Retd), VK Bhargav and S. Jadhav, ICAR-CIAE, Bhopal

Contact Details: Director, (director.ciae@icar.gov.in) ICAR-Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh, (www.ciae.nic.in)

CIAE 10 kW Updraft Gasifier

This gasifier is forced updraft gasification system wherein the air was supplied through electric blower. This has been developed for thermal application in agro-processing industry. For ash removal, a window of 120 mm x 180 mm size was provided near the bottom portion of the gasifier.



The insulation (thickness 25 mm) was provided on the inner surface of the reactor. The fabrication materials of gasifier are sheets, bars, flats, angle iron, and rods of mild steel, galvanized iron pipes, brass valves and insulation material (Insulyte-11). The biomass consumption and flame temperature of this gasifier with the wood chips is 10-12 kg/h and 691-1046 °C, respectively. The gasification efficiency with wood chips varied from 70.8 - 76.8% and calorific value of the gas varied from 1138 - 1215 kCal/m³. The performance of the gasifier with soybean straw yielded the gasification efficiency from 69.9 - 73.0% and calorific value of the gas varied from 1089 - 1115 kCal/m³. The gasification efficiency with groundnut shell varied from 69.3 - 73.7% whereas the calorific value varied from 1094 - 1146 kCal / m³.

Status of Technology Transfer:

Technology is ready for transfer.

Salient features

- This gasifier is suitable for agro-residues such as soybean straw, pigeon pea straw, maize cobs, groundnut shell and briquettes of charred biomass.
- The gasifier has the capacity of 10 kW with biomass consumption of 10-15 kg/ h.
- Cost of the gasifier is Rs 60000/-.
- It is designed for multi-fuel feedstock.

Benefits

- Environmentally friendly technology.
- Saving of fuel wood.
- Utilization of briquettes of crop residues/biomass.
- Reduction in field burning.
- Can be scaled up for agro industrial application.

Developer: Sandip Gangil and Anil Kumar Dubey, ICAR-CIAE, Bhopal

Contact Details: Director, (director.ciae@icar.gov.in) ICAR-Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh, (www.ciae.nic.in)

Arecanut Sheath Shredder



Arecanut Sheath



Arecanut Sheath Shredder



Shredded sheath

In arecanut growing areas of Karnataka, dry arecanut sheath has been found to be a good alternative as fodder for the cattle in the region. However, shredding of areca sheath is required to make it palatable to the cattle. A compact shredder of capacity 100 kg/h has been developed to achieve longitudinal and transverse cut of arecanut sheath in single pass of cutting blade. The machine has been tested at Milk Co-operative Society, Panaje Arlapadavu (post), Puttur Taluk Dakshina Kannada District Karnataka.

Status of Technology Transfer:

Technology is ready for transfer

Salient features

- Compact and portable machine with high output capacity.
- Suitable of individual farmers.
- Areca nut sheath shredded into uniform size suitable for cattle feed.

Benefits

- Areca nut sheath can be utilized as animal feed.
- Cost effective shredding of areca nut sheath.

Developer: VK Bhargav and BB Gaikwad, ICAR-CIAE, Bhopal

Contact Details: Director, (director.ciae@icar.gov.in) ICAR-Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh, (www.ciae.nic.in)

Biomass based Decentralized Electricity Generation System



Biomass based decentralized electricity generation system at village Mana, Raizen District

ICAR-CIAE has successfully integrated, operated, demonstrated and disseminated the different units and systems available to generate the electricity from biomass. The Biomaterial is powdered and briquetted before feeding to downdraft gasifiers. The gasifier generates the producer gas which after conditioning is sent to gas genset for generation of electricity.

Status of Technology Transfer:

Technology is ready for transfer

Benefits:

- Conversion of crop residue in to electricity.
- Economic gain to farmers producing crop residues.
- Development of agro residues market giving opportunity for traders and labours. Leading to employment generation.
- From 1.5 kg biomass 1 unit of electricity can be produced and the cost of electricity is nearly 7-8 Rs per kWh.
- 100 kW system needs around 1 crores of investment.

Developer: AK Dubey, Sandip Gangil, CR Mehta and KC Pandey, ICAR-CIAE, Bhopal

Contact Details: Director, (director.ciae@icar.gov.in) ICAR-Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh, (www.ciae.nic.in)

CIAE Biomass Briquette based 10 kW Cook Stove



Indian agriculture produces 550 MT of crop residues annually and approximately 90-140 MT of the residues are burned on-farm. Burning of residue, creates extreme environmental issues, whereas these residues could be utilized as fuel for domestic and small industrial applications. Difficult handling, irregular combustion of biomass and inefficient designs are the main reason for low acceptance of such systems in small scale industries. Therefore, crop residue briquette based, low cost and user-friendly combustion systems with the heat control range of 2 to 10 kW is developed.

Status of Technology Transfer:

Technology is proven ready for transfer

Salient feature:

- It is energy efficient (37 to 41%) and minimum fuel consumption (0.5 kg/kW) i.e 66 to 78% lesser than existing wood-based systems.
- It is low cost since battery (7 A, 12 V) operated DC components are used.
- Biomass based rapid combustion system has lower surface temperature (up to 51°C) due to proper insulation. System has good stability, easy handling and reduced emission.
- It is biomass briquette based continuous feed combustion and forced draft combustion system (10 kW).

Benefits:

- It utilises crop residue in the form of fuel and can replace coal, fuel wood and oil use at small scale industries.
- It has provision for heat control (2 to 10 kW); therefore, it can be used for various operations with better efficiency.
- It is portable, and battery can be charged using solar panel therefore can be used at remote places.
- Suitable for small scale industries, restaurants, community cooking, dhabas, namkeen factories etc.

Developer: Swapnaja K Jadhav, ICAR-CIAE, Bhopal

Contact Details: Director, (director.ciae@icar.gov.in) ICAR-Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh, (www.ciae.nic.in)

Straw Combine with In-Built Trailer



Straw combine is used to recover wheat stubbles after operation of combine harvester and is operated by a tractor. Wheat stubbles collected by straw combine is converted to straw and collected in the inbuilt trolley. Some grain is also collected apart from straw. The capacity of the machine on an average is 0.4 ha/h at operating speed of 2.5 km/h and straw recovery is about 55-60%. Two persons are required for its operation. The cost of operation is Rs. 1500/ha. The machine can cover about 75-100 ha/year. The quality of straw (*bhusa*) is comparable with mechanical thresher. There is an additional grain recovery of 50-100 kg/ha. The cost of grain recovered is almost equal to the amount paid for hiring the machine.

Status of Technology Transfer:

Technology has been transferred.

Salient feature:

The CIAE design straw combine has a in-built trailer for straw collection. Thus, the total length of the tractor with straw combine is less as compared to conventional straw combines where straw combine is followed by a trailer for straw collection. Due to higher length the conventional straw combines require higher turning radius for turning the machine at headlands.

Developer: RNS Yadav (Retd) ICAR-CIAE, Bhopal

Contact Details: Director, (director.ciae@icar.gov.in) ICAR-Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh, (www.ciae.nic.in)

Post-Harvest Mechanization Package for Minimal Processing of Banana Central Core



Slicing Unit



Dicing Unit

Fibre removing
unitSurface water
removing unitJuicer
Grinder

Juice Squeezer

Banana central core is an abundant natural resource in tropical and subtropical regions, which is a good source of nutrition. About 5-7 tons of central cores can be extracted from one hectare. Complete post-harvest mechanization package of equipment viz., banana central core slicer, dicer, fibre removing equipment, surface water removing equipment, juicer/grinder and juice squeezer has been developed for minimal processing of banana central core.

Status of Technology Transfer:

Technology is ready for transfer

Salient Features:

(a) **Slicing Unit:** The slicing equipment is used for slicing central core. The initial cost of the machine is Rs. 55000. The capacity of the equipment is 35 - 40 kg/h. (b) **Dicing Unit:** The sliced pieces are diced into small cubes. The initial cost of the machine is Rs. 55000. The capacity of the equipment is 40 kg/h. (c) **Fibre removing unit:** After dicing of banana central core, the secondary fibre is removed in the fibre removing unit. The initial cost of the machine is Rs. 20000. The capacity of the unit is 10 kg/batch. (d) **Surface water removing unit:** The surface water in the diced banana central core is removed, to increase the shelf life. The initial cost of the machine is Rs. 30000. The capacity of the unit is 7 kg/batch. (e) **Juicer Grinder:** For extraction of juice, the central core has to be reduced to fine size before the juice is squeezed out from it. Provision has been made to tilt the juicer for easy unloading after grinding. The initial cost of the machine is Rs. 30000. The capacity of the unit is 4 kg/batch and 40-45 kg/h. (f) **Juice Squeezer:** The juice extraction in this equipment is hygienic, without direct contact of human hands and thus helps to reduce contamination. The initial cost of the machine is Rs. 20000. The capacity of this unit is 2 kg/batch or 40-45 kg/h.

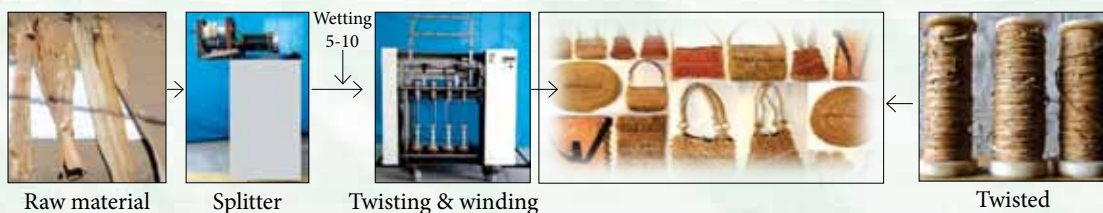
Benefit:

By using this package of equipment, one can save time and cost up to 65% and labour by 75%. About 5 tonnes of banana central core from one ha of banana plantation when value added as diced product would be valued as 1.25 lakh rupees and if processed as juice would have a value of Rs 2.25 lakh rupees

Developer: Ravina Naik, Dawn CP Ambrose, ICAR-CIAE Regional Centre, Tamil Nadu
K N Shiva, ICAR-NRCB, Tamil Nadu

Contact Details: Director, (director.ciae@icar.gov.in) ICAR-Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh, (www.ciae.nic.in)

Mechanization Package for Rope Making from Outer Sheath of Banana Pseudo Stem



Out of the 14-18 sheaths available in a pseudostem of banana, the outermost 6-8 sheaths yield coarse fibre which is used for rope making. Ropes from outer sheath of banana pseudostem is in high demand for different applications but is traditionally produced from labour intensive hand spinning or by ratt machines. A package of equipment to mechanize the rope making process has been developed which consists of equipment for splitting the outer sheath of banana pseudostem and equipment for twisting and winding of splitted strands from outer sheath of banana pseudostem.

Salient Features:

- **Equipment of splitting of outer sheath of banana pseudostem:** The initial cost of the machine is Rs. 30000. The capacity of the unit is 3-3.5m/min.
- **Equipment for twisting and winding of splitted strands from outer sheath of banana pseudostem:** The initial cost of the machine is Rs. 1.0 lakh. The capacity of the equipment is 800 m/h.

Benefits:

- The twisted rope obtained from outer sheath of banana pseudostem is used for production of various eco-friendly handicraft materials like bags, window curtains, table mat etc. thus generating additional revenue to farmers / entrepreneurs / processors.
- The outer sheath of banana pseudostem when processed for rope making would fetch about 2.4 lakhm of banana sheath rope valued at about Rs 1.0 lakh/ha.
- The developed equipment has got advantages over manual method of twisting and winding in terms of more uniform twist, lower space requirement, less dependency on skilled labour, cheaper than manual labour and higher output.

Developer: Ravina Naik, SJK Annamalai, ICAR-CIAE Regional Centre, Tamil Nadu
K N Shiva, ICAR-NRCB, Tamil Nadu

Contact Details: Director, (director.ciae@icar.gov.in) ICAR-Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh, (www.ciae.nic.in)

Nanocellulose from Cotton Linters and other Agro-Residues



ICAR-CIRCOT has taken the lead in ICAR system to explore the economical means of nanocellulose production from diverse agro-residues in addition to cotton linters. The major attraction of nanocellulose is its high mechanical strength (Tensile strength = 1 to 10 GPa; Young's modulus = 100 – 130 GPa), more surface area to volume ratio (50 – 200 m²/g), biodegradability and novel rheological (shear-thinning) and optical properties.

Status of Technology Transfer:

Technology is ready for transfer

Salient Features

ICAR-CIRCOT successfully prepared nanocellulose from cotton linters and cotton wastes by novel and energy-efficient chemo-mechanical process. Simultaneously, this process was modified to suit other agro-residues like banana pseudostem fibres, sugarcane bagasse and other natural fibre biomass. For technology demonstration to users, ICAR-CIRCOT established the World's unique Nanocellulose Pilot Plant at Mumbai that uses cotton biomass as the raw material, with a capacity of 10 kg nanocellulose per shift of 8 hours.

Benefits

This nanocellulose pilot plant is used for demonstration of the production technology to various stakeholders, product development, technology incubation and licensing to start-ups and entrepreneurs. This nanocellulose improves the spinning potential of cotton fibres in textile industry, enhances the strength in biodegradable starch films, act as super-absorbent substrate in wound healing pad and improves the efficacy in filters. High end product development from cotton waste and other agro-residues enhances the market value of cotton and other agro-biomass that in turn enhances the income of farmers.

Developer: ICAR-CIRCOT, Mumbai

Contact Details: Director, (director.circot@icar.gov.in) ICAR-Central Institute for Research on Cotton Technology, Mumbai, Maharashtra (www.circot.res.in)

Preparation of Premium Grade Pellets from Cotton Stalk



Cotton stalk is abundantly available in India, most of which are burnt in fields causing air pollution and degrading soil nutrients. This farm waste has heating value of about 4000 kcal/kg, which makes it most appropriate raw material for preparation of fuel pellets. However, cotton stalks are not very popular raw material for preparation of commercial pellets. ICAR-CIRCOT developed a new process which has resulted in premium grade cotton stalks pellet comparable with that of any other biomass pellets.

Status of Technology Transfer:

Technology is ready for transfer

Salient features:

- The milled cotton stalks of 3 mm size as raw material, 8% cashew nut shell powders as binder and 20% moisture content are optimum process parameters for preparation of premium grade pellets of 6 mm diameter from cotton stalks.
- Premium pellets of 8-, 10- and 12 mm diameter can also be prepared from cotton stalks by varying sizes of the milled cotton stalks.
- Premium grade cotton stalk pellets have 6% ash content, 4000 kcal/kg calorific value, 630 kg/m³ bulk density, 0.06% fines and 98.0 % pellet durability index.
- Premium grade cotton stalk pellets thus obtained are about 40% cheaper to commercial grade pellets prepared from pine wood.
- These pellets can be used as alternative to LPG for cooking in hotels and road side *dhabas*.
- These pellets can also be used for firing and co-firing in power plants and in other industries for heating purpose.
- Farmer can earn about Rs. 1500/tonne for supply of cotton stalks for pelletisation while entrepreneurs can earn a profit of about Rs. 700/tonne for supply of pellets.

Developer: ICAR-CIRCOT, Mumbai

Contact Details: Director, (director.circot@icar.gov.in) ICAR-Central Institute for Research on Cotton Technology, Mumbai, Maharashtra (www.circot.res.in)

Pellet Stove as Alternative to LPG for Cooking in Restaurants and Dhabas



Cotton stalk pellets are not being used in traditional pellet stoves as it causes choking due to presence of 6-8% ash in it. ICAR-CIRCOT has developed a 'Continuous Feeding Pellet Stove (CFPS)' technology that can handle pellets with high ash content without causing any chokage and operational troubles. This will help to promote the uses of cotton stalk pellets for cooking in restaurants and *dhabas*.

Status of Technology Transfer:

- The technology has been transferred for commercialization to M/s. Vidarbha Sales, Nagpur.

Salient Features:

- Single phase power supply of 230 V is required for operation of the ICAR-CIRCOT Pellet Stove.
- Pellet utilization capacity of 6-9 kg/h.
- Length, width and height of the stove is 1000x480x520 mm. The gross weight is 60 kg.
- It can handle pellets of 6- and 8-mm diameter.
- About 70 % savings in cooking cost as compared to LPG to the restaurants and food industry.
- Reduced dependability on LPG import and FOREX savings to the significant extent.
- Farmer can earn about Rs. 1500/tonne for supply of cotton stalks for pelletisation while entrepreneurs can earn a profit of about Rs. 700/tonne for supply of pellets.

Developer: ICAR-CIRCOT, Mumbai

Contact Details: Director, (director.circot@icar.gov.in) ICAR-Central Institute for Research on Cotton Technology, Mumbai, Maharashtra (www.circot.res.in)

Green Crematorium using Cotton Stalk Briquettes

It is traditional in India to perform the cremation by burning of firewood in open space. The firewood equivalent to 25-30 lakh fully grown trees is burnt annually in India for about 75 lakh cremations contributing to deforestation and global warming. The natural air draft used in traditional firewood-based cremation leads to incomplete burning causing emissions



of large amounts of hazardous air pollutants like CO_x, NO_x and other volatile organic compounds into the environment. Moreover, there is requirement of 10 liters kerosene for fire initiation in traditional cremation process that deteriorates the environment further. The uses of kerosene alone contribute to about 20 lakh tonne CO₂ emission, annually. In order to address the issues of air pollution and finding alternative to firewood cremation, ICAR-CIRCOT, Mumbai has developed an innovative cotton stalk briquette based *Efficient and Rapid Burning Crematorium*.

Status of Technology Transfer:

Technology is ready for transfer

Salient Features:

- It requires 200 kg briquettes and 1/2 kg camphor and 1 kg ghee for each cremation.
- The innovative design and utilization of forced air supply system leads to over 40% saving in fuel requirement and significant reduction in air pollution.
- The efficient burning and compact design results into saving of over 50% on cremation expenses.
- The acceptability of ICAR-CIRCOT Crematorium by the society at all large is not an issue as all traditional customs like *Mukhagni* and *Kapalkriya* can be performed as usual.
- Cremation without use of kerosene.

Developer: ICAR-CIRCOT, Mumbai

Contact Details: Director, (director.circot@icar.gov.in) ICAR-Central Institute for Research on Cotton Technology, Mumbai, Maharashtra (www.circot.res.in)

Utilizations of Cotton Stalk for the Preparation of Particle Board



About 30 million tons of cotton stalk is generated annually in India. Most of them is treated as waste despite a portion of it is used as fuel by rural masses. Cotton stalk is comparable to other hardwood plants in respect of fibrous structure and chemical composition which indicate the avenue for their exploitation in manufacturing of particle boards.

Status of Technology Transfer:

Technology is ready for transfer

Salient features

- ICAR-CIRCOT developed a process involve chipping of cotton stalks, rechipping, sieving, mixing with binder and other chemicals, mat formation followed by pressing in a hot hydraulic press to get the boards.
- The properties of boards produced from cotton stalks are on par with other boards from forest and other agricultural residues.
- Easy to collect and transport cotton stalk and farmers can earn additional income by sale of cotton stalks.
- Provides opportunity for establishment of chipping center in rural or nearby area.
- Availability of cheap raw material (cotton stalk) for board making industries.

Training

Training is being imparted at Ginning Training Centre (GTC) of ICAR-CIRCOT, Nagpur.

Developer: ICAR-CIRCOT, Mumbai

Contact Details: Director, (director.circot@icar.gov.in) ICAR-Central Institute for Research on Cotton Technology, Mumbai, Maharashtra (www.circot.res.in)

Cashew Shell Cake-based Updraft Gasifier

Cashew shell cake (CSC) is the by-product of cashew nut processing industry and huge quantity of this material is utilized inefficiently, causing extensive pollution to the environment by the direct combustion.

Approximately a total of 7.39 lakh MT (2018-19) of shell cake is generated and only 12.5 % is utilized in cashew processing units.

Updraft gasifier expectedly increases the efficiency of energy conversion and reduces the environmental pollution.

Status of Technology Transfer:

Technology commercialized

Salient Features:

- Cashew shell cake (CSC) cause extensive pollution to the environment by the direct combustion. Updraft gasifier for cashew shell cake can be used for generation of energy in an efficient way with lesser pollution.
- A cashew nut shell cake-based updraft gasifier equipment is suitable for application/s needing thermal requirement in the range of 10 to 12 kW. Producer gas generated from cashew shell cake passed through conduit and reaches the burner. The flame can be used for various purposes in cashew processing or allied industries.
- Reactor serves as gasifying media, blower, ash outlet and gas burner are the essential equipment required and the size of the machine is 1.7m x 0.6m x 1.0 m.
- Cost of the machine is Rs 30,000/- per unit and power requirement is around 0.25 hp. Operational capacity is 14 kg feed stock per hour and it is continuous type.

Benefit:

- Unlike, direct burning of loose biomass in conventional grates which is associated with very low thermal efficiency and widespread air pollution, this gasifier generates producer gas with high calorific value with minimal pollution.
- It can be used in cashewnut processing unit itself for steam generation towards nut conditioning and kernel drying.
- BCR: 1.15:1.

Training

Training can be provided at ICAR-Directorate of Cashew Research, Puttur.

Developer: D Balasubramanian, ICAR-DCR, Karnataka

Contact Details: Director, (director.dcr@icar.gov.in) ICAR-Directorate of Cashew Research, Darbe, Karnataka (www.cashew.res.in)

Beehive Briquette and Mould



Beehive briquettes are mainly biochar briquettes made from char and clay mud mixed in a certain proportion along with water. The biochar is made from agricultural waste material. Dried beehive briquette produces smokeless blue flame during burning for 2.5 to 3 h. To make beehive briquette specially developed mould known as briquette mould is used.

Status of Technology Transfer:

Technology is ready for transfer.

Salient Feature:

- The beehive briquette consists of one part of mud and two parts charcoal by volume.
- The beehive briquette developed is circular in shape having diameter of 145 mm and height of 85 mm with 21 holes of 12 mm diameter.
- It took around 350 h to dry the briquette up to less than 10 % (d.b) in conventional sun drying method.
- The calorific value of the briquette is approximately 18-20 MJ/kg and emission of CO, CO₂, CH₄, NO and NO_x ranges between 0.05-0.1 %, 0.1-0.5%, 100-200 ppm, 0.5-3.0 ppm and 0.5-3.5 ppm respectively which is well within the permissible limit.

Benefit

- Farmer can easily make the beehive briquette by purchasing briquette mould.
- It can be used for cooking and space heating.
- This could be an eco-friendly alternative clean source of household fuel to save electricity and wood fuel.

Developer: ICAR Research Complex for NEH Region, Umiam, Meghalaya

Contact Details: Director, (director.icar-neh@icar.gov.in) ICAR-ICAR Research Complex for NEH Region, Umiam, Meghalaya (www.icarneh.ernet.in)

Green Energy Initiative through Paddy Straw based Biogas Plant

For efficient use of the paddy straw, paddy straw biogas plant was installed at KVK Patiala in the year 2013. In the year 2019 an updated version of the model was introduced with a mild steel-based digester constructed and installed as an external unit. This model biogas plant is functioning efficiently for providing training and demonstrations on waste management to the farmers as well as for the domestic use at the KVK for general cooking purposes in routine activities.

Status of Technology Transfer:

Technology is ready for upscaling and transfer.

Salient Feature

The paddy straw biogas plant is a mild steel digester of 20 quintal capacity. It has to be filled with both paddy straw (16 quintals) and cow dung (4 quintals). The filling of biogas digester is to be done in alternate layers of cow dung and paddy straw for proper mixing material. The amount of gas produced is 3-4 cubic meter per day. An ideally filled biogas plant can produce gas equivalent to 2.5-3 LPG cylinders of gas per month. It can further lead to a saving of Rs 2500-3000 per month. However, the flame produced by biogas is weaker than the LPG cylinder which leads to more cooking time. The total cost of the biogas plant is Rs 2,15,000.

Benefits

Since the initial installation of the biogas plant is quite costly for individual farmer. The model is more viable on community level as the cost of the plant will come down per household. In coming time adoption of this technology is imminent as a cheaper alternative to LPG cylinders.

Training

The biogas plant has been demonstrated as well as farmers have been provided one day trainings for biogas plant uses and benefits at Krishi Vigyan Kendra Patiala, Punjab as well as Punjab Agricultural University (PAU), Ludhiana.

Developer: Gurnaz Singh Gill, Jasvinder Singh, Pragya Bhadauria, J.S Mahal and Rajbir Singh, KVK Patiala, Punjab

Contact Details: Director, (rajbirsingh.zpd@gmail.com) ICAR-Agricultural Technology Application Research Institute, Zone I, PAU Campus, Ludhiana, Punjab (www.atariicar.res.in)



Porous Bricks from Crop Residue

The conventional bricks are made from locally available soil by crushing it to a fine consistency and tempering with water to produce plastic clay. Common salt is optionally added to the soil to avoid thermal cracking. The plastic clay is pressed into rectangular moulds either by hand or moulding machine before sun drying. The porous bricks are made by mixing crop residues such as paddy straw, wheat straw and sawdust in brick earth to get higher water absorption, surface evaporation and lower dry weight than those of the conventional bricks.



Porous Bricks

Status of commercialization:

- The technology has been transferred to the following entrepreneurs.
- Rajinder Dev & Co. Village Bhanohar P.O. Mullanpur, Distt. Ludhiana.
- Dr. Jatinder Singh Dhaliwal, Project, Krishana Foods and Seed Processor, Plot no: 26, Industrial Area, Gurdaspur-143521(Punjab).

Salient Features

- The bricks have lower self-weight, density.
- Have higher porosity than conventional bricks.
- The bricks require much lower transportation and labour charges for handling in comparison to the existing bricks.

Benefit

- The improved properties of the porous bricks will render better insulation in buildings, higher cooling effect in evaporatively cooled storage structures.

Training

Training and licensing of the technology is imparted by ICAR-Central Institute of Post-Harvest Engineering and Technology (CIPHET), Ludhiana.

Developer: Sangeeta Chopra, S.N. Jha, Dilip Jain, ICAR-CIPHET, Ludhiana

Contact Details: Director, (director.ciphnet@icar.gov.in), ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana-141004 Punjab (www.ciphnet.in)

