Technologies for Societal Benefits

By

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Bhabha Atomic Research Centre

Dr. Homi Jehangir Bhabha conceived the Nuclear Program in India. To intensify the effort to exploit nuclear energy for the benefit of the nation, Dr. Bhabha established the Atomic Energy Establishment, Trombay (AEET) in January 1954 for multidisciplinary research Institute. It was renamed as Bhabha Atomic Research Centre (BARC) after the death of Dr. Homi J. Bhabha in 1966. A hallmark of the programme founded fifty years ago under the leadership of Dr. Bhabha has been to achieve self-sufficiency in the country in peaceful applications of atomic energy

In a country of the vast size such as ours, technology innovations and adaptation has to be evolved in a greater measure particularly since such technology has to fit with varied local conditions and need to be applied quickly to enhance the quality of life of larger population. Considering the wealth of technology and innovative capability generated in BARC & DAE units as an off-shoot of R&D in Nuclear Energy and its applications in power and non-power areas, Department has launched DAE – Societal Initiative for utilization of Non-Power Applications (NPAs) and Spinoff technologies (Spinoffs) in the area of water, land, agriculture, food processing and urban-rural waste management. Within this framework of societal initiative, structured programme called "AKRUTI - KRUTIK - FORCE" has been formulated and is being implemented by BARC for techno-economic growth of the rural sector, as one of the many schemes for large-scale deployment of NPAs and Spinoffs. This programme will enable to take the fruits of technology to grass-root level to every villager in the remote corner and provide inclusive growth to the rural sector and tap the hidden innovative capability of large rural population - 4th Key Driver of Major programmes of Department of Atomic Energy (DAE) and DAE Vision for social outreach and awareness.

The enlisted technologies are available with nominal technology transfer fees providing know-how document, training and technical guidance by BARC scientists. Further concession in License fees is offered for deployment in rural / semi-urban areas

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AGRICULTURE AIDE TECHNOLOGIES

1. SOIL ORGANIC CARBON DETECTION KIT (SOCDK)

Typical soil generally contains at least 45% inorganic components, 5% organic components, 25% air and 25% water on average basis. Organic carbon plays major role in biological activity and fertility of the soil. In different parts of the world positive correlation between the amounts of organic carbon and soil fertility has been proved. Indian soil ecosystems are very dynamic due to its sub-tropical climate, resulting rapid degradation of organic matter in these soils. Soil organic carbon content up to 1.5-2.0 % increases soil porosity that supports growth of the soil microorganisms. This increases availability of different nutrients to the plant, resulting in better crop yield. Thus organic carbon is a true indicator of the soil health. Also it is true that soils with sufficient organic carbon in it definitely contains other major elements like Nitrogen, Phosphorous and Potassium in more available form. There are difficulties to analyse organic carbon of soil regularly due to specific reagents, skills and proper setup that are available only at approved laboratories.

As these laboratories are in low number farmers are unable to monitor soil organic carbon on regular basis. Soil Organic Carbon Detection Kit (SOCDK) developed at BARC, ideally a quick, accurate and field test will be able to guide the farmer for this purpose.

ADVANTAGES

- It is user friendly as any farmer can check the percentage of organic carbon in his field by himself.
- It gives quick and reliable results.
- Evaluates the impact of organic carbon amendments supplemented periodically.
- It gives idea of amount of organic manure additions.
- It is economical and time saving.

APPLICATIONS

- Direct use by the farmer for organic carbon detection of soil before sowing of the crop and at the harvest of the crop.
- To take the corrective measures to maintain the soil organic carbon at optimum levels and evaluating the effectiveness of the organic manure supplements.
- Agriculture universities & soil-testing labs for research purpose.

PROCESS

This kit consists of different components and chemicals required for analysis of organic carbon. After collection of the soil sample from the field take one spoon of soil and add 10 ml of chemical solution A & 10 ml of chemical solution B. After mixing gently and allow it to stand for 10-15 min & filter through a given filter paper in the kit. Compare the colour of the clean filtrate with the given colour chart in the kit. The organic carbon content of your soil is the assigned value of most matching colour on the standard chart.

REQUIREMENT

- Raw Material
    - Materials required for the kit are available in local market.
- Equipment
    - Distilled water facility
    - Analytical balance
    - Magnetic stirrer
    - Glass wares
    - Table

INFRASTRUCTURE

- Space -A small room of 600 sq. ft. area (10 ft. x 10ft.) working area
- Water – For Laboratory work
- Power – Both single & three phase power supply.
- Manpower – One Chemist and one skilled worker would be adequate for the purpose. Actual manpower would depend on production capacity.

2. MICROFINE NEEM BIOPESTICIDE

This biopesticide describes a novel technique of making micro size powder of whole neem fruit and other Ayurvedic herbs. Azadirectin, active ingredient of neem, becomes unstable after extraction and when sprayed on the crop, its anti-insecticidal effect becomes short lived. Therefore, this technology utilizes Azadirectin in its original form as in neem fruit without extraction. Since azadirechtin is unstable in solution form, presently available neem based bio pesticides are less efficient and need frequent spraying adding to the cost. Considering this aspect a bio pesticide formulation using whole neem fruit (without extracting oil) in a micro fine powder form (20 micron) has been developed. This has solved the problem of instability of Azadirechtin and cost of extracting of oils is also eliminated. Use of whole neem fruit and other ayurvedic herbs in micro fine dust form as pest controller is the novelty of this biopesticide*****

ADVANTAGES

- All the goodness of Neem is available to the crops
- The formulation particles create a sustained release effect since the ingredients are gradually released and thus a long term protection from insects is achieved
- Insecticidal effect is stronger as degradation of active compound due to moisture, pH and light is reduced
- The product is economical and efficient
- Use of other ayurvedic herbs in micro fine powder adds to the effectiveness of the product

APPLICATIONS

- Agriculture, in general
- In organic farming
- Large scale manufacture by industries manufacturing biopesticide

INFRASTRUCTURE

- Raw Material
  - Neem seeds
  - Inert material as a carrier
  - Additives
- Space
  - Two small rooms one for preparation of formulation and other for packing
  - Lab instruments like ball miller
- Power
  - Both single & three phase power Supply.

- Manpower

    - One skilled person and 2-3 unskilled persons depending on the capacity of the plant.



3. A PURELY ORGANIC, SEED DRESSING BIO-FUNGICIDE FORMULATION OF AN IMPROVED TRICHODERMA VIRENS MUTANT STRAIN WITH TOXICOLOGICAL AND ENVIRONMENT SAFETY DATA

Biological suppression of plant pathogenic fungi has been dominated by use of *Trichoderma* spp. All over the world for the last 3-4 decades, with more than 60% biofungicides formulations being *Trichoderma*-based. In India alone, more than 300 formulation products are available. Even though there is a potential for genetic improvement, through mutagenesis, no mutant strain of *Trichoderma* has been taken to the field level. Biological control is an integral component of organic farming, but almost all the commercial *Trichoderma* formulations contain synthetic additives like the carboxy-methyl cellulose (CMC). BARC has developed a purely organic, granular, seed-treatment formulation based on two major technologies – the tamarind seed based mass multiplication medium (patent filed viz. 1236/MUM/2012), a technology earlier developed by BARC, and a mutant strain of *Trichodermavirens* that produces more antibiotics than the wild type. The purely organic (no chemical additive) granular, seed- dressing formulation, named as "TrichoBARC" is suitable for packaging in small quantity (5 g for treatment of 1 kg seeds, per pouch), thus reducing the cost of seed treatment, making it economical for even small and marginal farmers

ADVANTAGES

- Low cost of production
- Improved bio-control potential over the wild type strain
- Purely organic formulation, hence can be used in organic farming
- Granular formulation, suitable for small size packaging

APPLICATIONS

- Agriculture sector in general
- This could be used by most of the bio-pesticides companies
- Can be used by Agriculture Department establishments like the KVKs

INFRASTRUCTURE

➢ **Raw Materials**

- All the raw materials (Tamarind seeds, Talcum powder) used for the development of this formulation are available locally. The mutant strain of *Trichoderma* can be procured from BARC or this can be adapted to the already available *Trichoderma* strains.

➢ **Equipment**

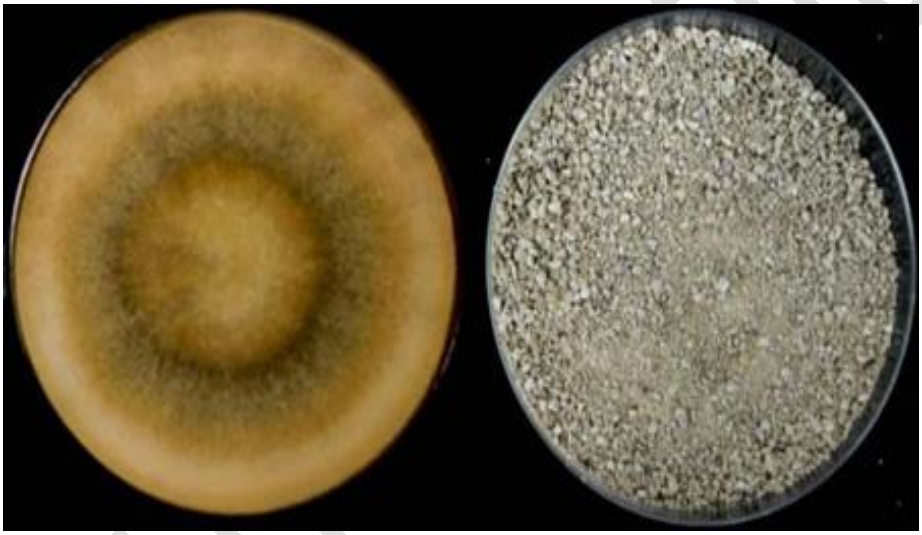
- Autoclave
- Laminar flow

- Refrigerator
- Common glass wares

➢ **Space**
- A small microbiology laboratory of 600 sq. ft. area (30 ft. x 20 ft)

➢ **Power**
- Both single & three phase power connection.

➢ **Manpower**
- One Microbiologist and 1-2 skilled workers would be adequate. Actual manpower would depend on production capacity.



4. BANANA TISSUE CULTURE

Banana is a globally important fruit crop with 97.5 million tons of annual production. In India, banana contributes 37% of the total fruit production and ranks second in importance next to mango. The state of Maharashtra ranks second with respect to the land under the cultivation but first in its production of banana with 60 T/ha per annum.

Edible bananas do not produce seeds and are traditionally grown vegetatively through suckers (5 to 10 in number depending on the variety). Thus, low rate of multiplication limits this method severely. In the recent years, tissue culture propagation of banana through shoot tip as well as floral aspices has been utilized to increase banana production. The process involves initiation of cultures from sterilized shoot tips obtained from the parent banana plant, shooting and rooting in the test tube, primary hardening in the laboratory, secondary hardening in the nursery and plating in the field.

ADVANTAGES

- Disease free elite varieties
- Rapid multiplication & Early harvesting
- Uniform size and age of plants
- High quality fruit bunches
- Available throughout the year

REQUIREMENTS

Infrastructure

- A tissue culture laboratory, A green house or polyhouse facility and an agricultural plot for planting.

➢ Equipment

- Standard glassware
- Sterilization equipment like autoclave.

➢ Manpower

- Two technicians (preferably trained in a tissue culture laboratory) for laboratory work and other ancillary staff.

➢ Capital Cost

- Approximate cost for setting up of a medium size plant requires around 25 lakhs.

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5. MICROPROPAGATION OF TURMERIC

Turmeric (*Curcuma longa* L.) is an economically important spice and medicinal plant used in pharmaceutical and cosmetic industries. It contains curcuminoids, essential oils, and oleoresins which imparts medicinal properties to this crop. As propagation of turmeric is exclusively through rhizomes, the transmittance of diseases takes place through rhizomes from generation to generation and affects productivity and quality. The dormancy of rhizomes delays the cultivation process by nearly two months. The cost of cultivation is also increased as only few plants can be obtained from these rhizomes. Thus, non-availability of good quality planting material, the transmittance of diseases, slow multiplication rate are the major constraints in the improvement of potential productivity of turmeric.

BARC has developed a micropropagation protocol for Turmeric which ensures continuous production of numerous disease free, uniform plantlets throughout the year with rapid multiplication rate in small unit area and within limited time. Plantlets produced through this protocol can be hardened and directly transferred to a field, which reduces the cost of maintenance of rhizomes as planting material.

The specially devised medium initiates shoot multiplication, elongation and rooting simultaneously, reducing the cost as well as labor. As the protocol does not require frequent subcultures, the chances of somaclonal variations are negligible, thereby ensuring genetic uniformity of the regenerated plantlets. Thus, this protocol will be useful in planning and scheduling of production of turmeric plants based on the market demand.

ADVANTAGES

- Uniform and disease free planting material
- Rapid multiplication of plantlets in short time with minimum requirement of initial material (a few axillary buds)
- Reduction in maintenance cost of rhizomes as a planting material
- Availability of planting material throughout the year
- Better method for germplasm conservation of turmeric

APPLICATIONS

- Agriculture sector
- Biotechnology companies

REQUIREMENT

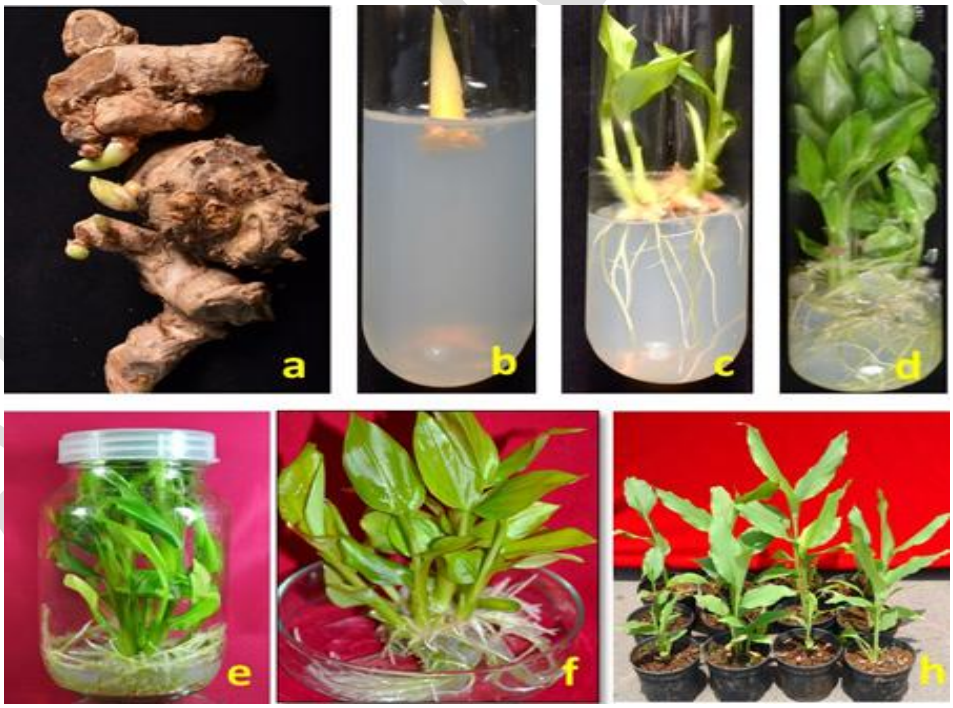
- Raw Material
  - Healthy rhizomes with sprouts.
  - Chemicals: MS medium (Murashige and Skoog, 1962) and hormones used in this protocol is available locally.

- Equipment
  - Autoclave
  - Laminar air-flow unit
  - Water distillation unit
  - pH meter
  - Analytical balance
  - Refrigerator
  - Standard laboratory glass wares

- Space
  - For Standard tissue culture laboratory: A small room of 400 sq. ft. area (20 ft x 20 ft) with routine tissue culture facilities.
  - For Culture room (100 sq-ft): clean, air conditioned and well illuminated room to grow the cultures.

- Power
  - Both single & three phase power Supply.

- Manpower
  - Two skilled technicians for preparing medium and tissue culture work.



6. MICROPROPAGATION OF PINEAPPLE

Pineapple *(Ananascomosus L. Merr.)* belongs to the family Bromeliaceae, and is one of the important commercial fruit crop propagated vegetatively. A good source of vitamins A and B, pineapple is fairly rich in vitamins C, calcium, magnesium, potassium and iron. It is also a source of bromelin, a digestive enzyme. At present pineapple is grown commercially in Assam, Meghalaya, Tripura, Mizoram, West Bengal, Kerala, Karnataka and Goa, and on a small scale in Gujarat, Maharashtra, Tamil Nadu, Andhra Pradesh, Orissa, Bihar and Uttar Pradesh. India ranked sixth with a share of about 8% of the world production of pineapples.

PROPOGATION OF PINEAPPLE BY TISSUE CULTURE

Conventionally the average production is 4-5 propagules per year and it takes considerable time to produce enough planting material. Large-scale production of planting material can be achieved by using the plant tissue culture techniques.

A protocol for large-scale multiplication has been established using shoot tip as well as dormant axillary buds from pineapple crowns with a capacity of producing 1000-1200 plants in a year from a single crown. The protocol has been standardized for the establishment of cultures, multiplication, rooting and hardening of the plants in the green house and their field planting

The process involves initiation of cultures from sterilized shoot tips obtained from the parent Pineapple plant, shooting and rooting in the test tube, primary hardening in the laboratory, secondary hardening in the nursery and plating in the field. The protocol developed by BARC is different and a large number of disease free, elite variety plants can be produced using the protocol.

ADVANTAGES

- Efficient and rapid multiplication protocol.
- Production of disease free planting material on a large scale.
- Production of plants throughout the year irrespective of the season.
- The technique can be employed for in vitro mutagenesis for inducing the genetic variability for the improvement of this fruit crop.

REQUIREMENTS

- **Infrastructure**
  - A tissue culture laboratory, A green house or polyhouse facility and an agricultural plot for planting
- **Equipment**
  - Standard glassware for media preparation and sterilization equipment like autoclave along with laminar air flow unit, standard laboratory reagents, required for a tissue cultured laboratory
- **Manpower Requirement**
  - Two technicians preferably trained in a tissue culture laboratory, for laboratory work and other ancillary staff.

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7. MASS MULTIPLICATION MEDIUM OF BIOFUNGICIDE

TRICHODERMA *spp.*

Biological suppression of plant pathogenic fungi has been dominated by use of ***Trichoderma spp.*** All over the world for last 2-3 decades. ***Trichoderma spp.*** Act as a bio fungicide against many plant pathogenic fungi and have been found to induce systemic resistance in plants. The field applications of ***Trichoderma spp.*** Require mass multiplication which can be done using solid as well as liquid state fermentation. In the industrialized nations, liquid fermentation is extensively used for multiplication of ***Trichoderma spp.*** For commercial formulation.

However, solid state fermentation is preferred in developing countries like India due to low initial investment as well as availability of cheap labour and space. Presently, solid state fermentation technology uses food grains including sorghum and bajra for commercial mass multiplication of ***Trichoderma spp.*** At an industrial scale.

However, the food grains are comparatively expensive, have short storage life and may not be available freely due to climatic stress. Thus there is an urgent need to develop a formulation based on easily available material and with lower input cost. We have developed a low cost mass multiplication medium for faster growth of Trichoderma spp. This material supports better growth of bio fungicide compared to existing methods and addition of synthetic sticker is not required while making its formulation. Another advantage is that this material can be used for both solid as well as liquid fermentation. This material provides longer shelf life of the bio fungicides and also improves the resistance of the plant against diseases. The process is cheaper than the existing methods and is based on the material which is inexpensive and available locally. This technology will thus be a boon to the biopesticide industry based on ***Trichoderma spp.***

ADVANTAGES

- This material is low in cost.
- It supports faster growth of Trichoderma spp and helps in longer shelf life of the fungus.
- There is no need of additional synthetic agent like Triton-X100 or carboxy methyl cellulose
- While making its formulation for field applications.
- This material increases the resistance of plant against diseases and has antibiotic properties in addition.

APPLICATIONS

- Agriculture sector in general.
- This could be used by most of the company's manufacturing bio pesticides.
- Organic manure manufacturers can also use this technology.

REQUIREMENT

- Raw Material
  - All the raw materials used for the mass multiplication of the Trichoderma spp. Are available locally and the materials required for making its formulation are available in local market.

- Equipment
  - Preparation of the Trichoderma spp. Requires small setup of the laboratory with autoclave, laminar air flow and routine material required in microbiology laboratory are sufficient for this technology setup.
- Space-
  - A small room of 400 sq. ft. area (20 ft x 20 ft)
- Power
  - Both single & three phase power Supply.
- Manpower
  - One Microbiologist and 1-2 skilled workers would be adequate for the purpose which can vary depending upon capacity of the unit.

BIODEGRADEABLE WASTE PROCESSING TECHNOLOGIES

8. NISARGRUNA BIOGAS PLANT BASED ON BIODEGRADABLE WASTE RESOURCE

This plant can process biodegradable waste such as kitchen waste, paper, grass, gobar and dry leaves. It offers "Zero garbage and Zero effluent "and provides high quality manure and methane gas. Weed free manure obtained from such waste has high nitrogen contents and acts as an excellent soil conditioner. This plant could be set up for eco-friendly disposal of wet-waste generated in kitchens/canteens of big Hospitals/Hotels/Factories/residential complexes and can avoid health hazards due to dump sites. This technology of biphasic biomethanation has high potential of solving the solid waste management problems of the urban areas and provides organic manure and bio-gas as a fuel.

INTRODUCTION

Waste disposal is one of the major problems being faced by all nations across the world. City like Mumbai generates 7000-10,000 tones waste per day and proper disposal is essential to prevent pollution and maintain esthetics.

Out of this waste, glass, metals, some plastic and paper can be recycled. The biodegradable waste should be processed properly to maintain natural balance of essential elements in the environment.

Disposal of biodegradable waste resource can be achieved by several means like incineration, landfills, dumping in the dumping yards, composting etc. These methods have their own hazards. Incineration can lead to respiratory illnesses. Moreover, it may lead to disruption of biogeochemical cycles of several elements and will have long term effects on biosphere. Vermiculture has been used in recent past in urban area, however, it has limitations of space. One of the economic ways would be to install community based biogas plants for processing.

NISARGRUNA PROCESS

The waste resources which can be processed using Nisargruna Biogas plant include biodegradable kitchen waste, paper waste, green grass, leaf litter, animal remains in abattoirs, hospital waste, green plant waste, cow dung, crop residues, sugarcane, baggase, water hyacinth, etc. The waste is first segregated carefully to remove non-biodegradable material and then homogenized to make a slurry. It is then processed in a sequential manner first by aerobic and then by anaerobic process. The products of the process are biogas consisting of methane, carbon dioxide and water vapor & weed free good quality manure. About 70% of Water can be recycled at the end of the process.

ADVANTAGES

- Environment friendly disposal of waste, which is the need of the hour.
- Generation of fairly good amount of fuel biogas, which will definitely support the dwindling energy resources. The gas can be used for as fuel in the kitchen or for power generation.

- Generation of high quality, weed free manure, which is an excellent soil conditioner. This is very important for replenishing organic carbon in the undernourished soil after years of agriculture.

APPLICATIONS

The Bio gas plants are useful for Municipal Corporations, Hospitals, Hotels, Housing Societies, Govt. Establishments, Abattoirs, Nagar Palika, Grampanchayat, Farmers. At present, 160 Nisargruna plants are functional in the country.

INFRASTRUCTURE

The following infrastructures is required for set-up a 1 tonne/day capacity Bio gas plant:-

- Space : ~ 100 m2
- Manpower : Two unskilled persons
- Power supply : 3 phase AC
- Water Supply : 1.2 kL for one tonne plant/day

9. A RAPID COMPOSTING TECHNOLOGY FOR DECOMPOSITION OF DRY LEAVES, KITCHEN WASTE AND TEMPLE WASTE

A single microbe (cellulolytic fungus) based formulation has been developed for decomposition of many types of biodegradable wastes like kitchen/market waste, dry plant matter (including coconut leaves), straw/agricultural residue and holy waste from temples. Its application shortens the duration of degradation from years and months (required for natural processes, depending on type of biomass) to a few weeks.

Additionally, it greatly reduces the cost of transportation involved in disposal of such wastes. The compost generated in this process has high carbon content which will be beneficial in enriching organic matter-depleted soils. Inorganic fertilizers with high nitrogen content and no organic carbon facilitate temporary enhancement in crop productivity, but have serious long term negative effects on soil productivity. On the other hand, this compost **with 1-2% nitrogen, 28-36% carbon and a high water holding capacity (>150%)** will have pronounced positive effects on soil health in a sustainable manner over long term as well as organic farming. This technology is based on a single, safe and beneficial microbe, and hence simple to adopt. It will also be an important contribution towards "Swachh Bharat Mission".

ADVANTAGES

- This technology is an easy to adopt eco-friendly alternative to waste dumping
- Formulation is simple to mass produce and versatile for different wastes
- Compost generated can be used as a good soil conditioner and nutrient source
- Adds vital organic matter for soil and improves crop health

APPLICATIONS

- Municipalities, Housing Societies, Institutional Canteens, Markets etc.
- Temples, Nurseries, Orchards, farms etc.
- Biotechnology related companies and companies that mass produce microbial cultures.

INFRASTRUCTURE REQUIRED FOR PREPARING FORMULATION

- **Raw Materials**
  - All the raw materials (sorghum grain, talcum powder) used for the development of this formulation are available locally. The strain of Trichoderma can be procured from BARC.
- **Equipment**
  - Autoclave
  - Laminar flow
  - Refrigerator (optional)
  - Common glass wares
- **Space**
  - A small room of 400 sq. ft. area (20 ft. x 20 ft) with minimal facilities.

- **Power**
  - Both single & three phase power connection.
- **Manpower**
  - One skilled man power for preparing formulation and 1-2 skilled workers would be adequate. Actual manpower would depend on production capacity.

INFRASTRUCTURE REQUIRED FOR BIOCOMPOSTING

- **Raw Materials**
  - Formulation
  - Kitchen waste, Temple offerings, Dried leaves and garden waste
  - Coco Peat/ Saw dust/ Coir dust & tarpaulin sheet for covering
- **Equipment**
  - Shredder
  - Water sprinkler
  - Common rake (panja or kanta)
  - Sand filter mesh/sieve
- **Space**
  - Net enclosure/concrete pit/drums (metallic or plastic).
- **Power**
  - Both single & three phase power connection.
- **Manpower**
  - 1-2 skilled/unskilled workers would be adequate. Actual manpower would depend on composting capacity.

WATER FILTER TECHNOLOGIES

10. DOMESTIC WATER PURIFIER

The Domestic water purifier is based on polysulfone type of ultra-filtration membrane in a unique cylindrical configuration to purify the domestic water with respect to microorganism, colour, odour, suspended solids and organics. Due to rapid increase in population in general and urbanization in particular, over exploitation of good quality water sources and poor water supply system, a large population of developing countries do not have access to good quality potable water and is susceptible to water borne diseases which account to about 90% of our visit to a medical doctor. There are few on line devices in market for purification of domestic water (mostly U.V. treatment type) which are not only expensive but needs frequent maintenance/replacement. The "on-line domestic water purification device" is based on polysulfone type of ultra-filtration membrane in a unique cylindrical configuration.

SALIENT FEATURES

- Very effective as it removes bacteria to the extent of >99.99% (4 log scale).
- As the device filters out bacteria, no dead bacteria in product water.
- Removes complete turbidity and produces crystal clear water.
- Work in a dead end device so not a single drop of water is wasted.
- Does not need electricity or addition of any chemical.
- Provision to remove organic or colouring material if they are present in feed.
- Highly strong (both chemically and mechanically) membranes giving high life (3-5 years).
- Almost maintenance free except occasional cleaning of suspended solids which deposits on membrane surface
- Device works between the hydrostatic heads (5 psig to 35 psig) and can produce about 40 litres of pure water per day at about 10 psig head.
- Low cost

ADVANTAGES

- This device is not only much less expensive but superior to existing devices in many ways and has following features:
- Very effective as it removes bacteria to the extent of > 99.99% (4 log scale)
- As the device filters out bacteria, no dead bacteria in product water
- Removes complete turbidity and produces crystal clear water
- Work in a dead end device so not a single drop of water is wasted
- Does not need electricity or addition of any chemical
- Provision to remove organic or colouring material if they are present in feed
- Highly strong (both chemically and mechanically) membranes giving high life (3-5years)

- Almost maintenance free except occasional cleaning of suspended solids which deposits on membrane surface and this does not take more than 3-4 minutes time.
- Device works between the hydrostatic heads (5 psig to 35 psig) and can produce about 40 litres of pure water per day at about 10 psig head.

APPLICATIONS

- To purify the domestic water with respect to microorganism, colour, odour, suspended solids and organics.

REQUIREMENT

- Raw Material
  - All the raw materials like polysulfone polymers, additives and solvents are produced within the country and are available in local market.
- Space-
  - A small room with window air-conditioner/dehumidifier is needed to coat ultrafiltration membrane unit. Constant source of water is needed to produce and test the membrane device.
- Power-
  - All the steps in the presented technology are manual in nature and hence do not require electrical power for process.
- Manpower
  - One Chemist and one technician to observe the process and two skilled workers would be adequate to produce about 25 water purifiers per day.

11. NANOCOMPOSITE ULTRA FILTRATION MEMBRANE DEVICE FOR DOMESTIC DRINKING WATER PURIFICATION W.R.T. ARSENIC, IRON AND MICROBIAL CONTAMINATIONS (NDWP)

Membrane separation processes have gained tremendous advancements in the recent past and continue to surge ahead as a frontier technology in the field of water purification. Nanotechnology, on the other hand, is increasingly being identified as an area of science and technology that could play a role in addressing some of the short-comings of conventional POU devices. Studies suggest that nanotechnology-based materials could lead to cheaper, more durable, and more efficient water treatment technologies that meet the needs of developing countries. Several water treatment methods and devices that incorporate Nano scale materials are being developed. However, it is realized that a well-defined and well-engineered Nano-based POU water purification device for household should come into force to take care of safe-water needs of all sections of our society.

Bhabha Atomic Research Centre is extensively involved in development and deployment of desalination, water purification and water recycle technologies for providing safe drinking water to the masses. BARC has developed a methodology to produce a domestic water purification device which is made of polysulfone based Nano composite ultra-filtration membrane in cylindrical configuration. This configuration/point-of-use device stand alone can be effective for removal of microbial contaminations and decontamination of arsenic and iron in the states like West Bengal, Chhatisgarh, Bihar, Jharkhand, North Eastern states etc. through chemical addition without the need of any electricity and overhead water tank, and hence can be used even in slums and rural areas of the country. The device with two candles can provide 20 Liter per Day of potable water and the contamination level is reduced below the permissible limits as specified by IS 10500 for drinking water standard. This is very simple, well-engineered, single, reliable and cost effective point-of-use device. The present technology describes a methodology to produce a domestic water purification device which is made of polysulfone based Nano composite ultra-filtration membrane in cylindrical configuration. This configuration/device can be effective for removal of microbial contaminations, arsenic and iron without the need of any electricity and overhead water tank.

ADVANTAGES

- Single point-of-use device
- Very simple and rapid
- Cost effective
- Adoptable at domestic level
- Capability of high decontamination
- Product water free from arsenic, iron and microorganisms.
- Can operate without electricity and overhead water tank.

APPLICATIONS

- The process is suitable for treatment of ground/surface water in the states like West Bengal, Chhattisgarh, Bihar, Jharkhand, North Eastern states etc. where water is severely contaminated with arsenic and iron and hence not fit for drinking. It is also suitable for removal of microbial contamination to the desirable limits at domestic level without the need of any electricity and overhead water tank and hence can be used even in slums and rural areas of the country.

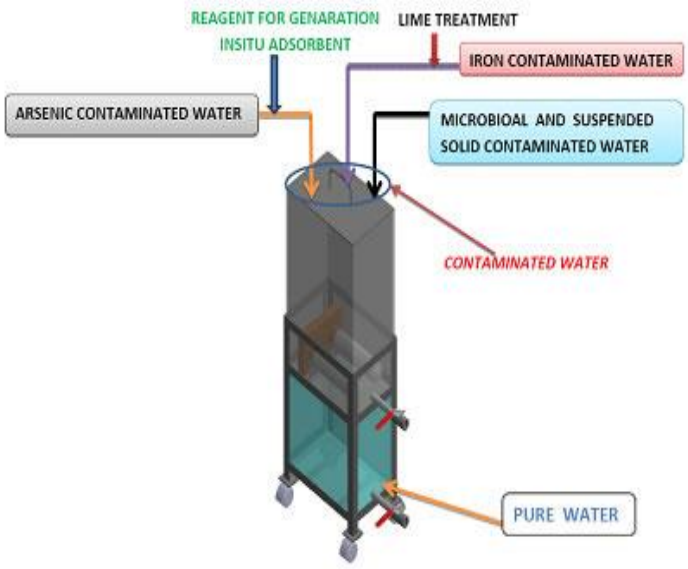
REQUIREMENTS

- Raw Material-Materials are available locally.
- Equipment required
  - Working platform
  - Weighing balances.
  - Exhaust Facility
  - Glass wares

INFRASTRUCTURE

- Space
  - A membrane casting room with control temperature (23 ± 2 °C) and relative humidity (< 40 %).
  - The development of arsenic and iron removal kit requires a small laboratory with few common equipment like weighing balances, exhaust and common glass wares.
- Water Supply
  - As and when required
- Power
  - Both single & three phase power supply.
- Manpower
  - One Chemist and two skilled workers.

Actual manpower would depend on production capacity.



FOOD PROCESSING TECHNOLOGIES

12. DEVELOPMENT OF INSTANT FISH SOUP POWDER

The current technology deals with the development of Instant fish soup powder conceptualized on a similar product called 'Instant Veg or Chicken soup' which is predominantly available in markets across India. The developed product has a better over-all quality & can be stored at ambient temperature for 12 months. The shelf life of this product can be further extended by 6 months using radiation processing (5 kGy) at ambient temperature. Radiation processing of food is a well-known technology based on physical energy where no chemical preservatives are involved and does not increase the temperature of the food. It has been approved by various international and national organizations to ensure 'Food Security & Safety.

ADVANTAGES

- Instant- Easy to prepare – Just mix with hot water/boil & serve
- High quality, nutritious instant food rich with goodness of fish and fresh vegetables
- Nutrient rich appetizer with less calories
- Soup tends to provide satiety with fewer calories than other forms of food.
- Rich source of healthy nutrients, proteins, poly un-saturated fatty acids (ω-3 & 9)
- Having combined effect of various processing methods (hurdles)
- Export quality product & suitable for domestic consumption
- Shelf stable up to 12 months in packed condition at room temperature; Shelf-life can be further extended to 6 months at room temperature using radiation processing (5 kGy)

APPLICATIONS

- Food processing industries involved in Instant/Convenient/ Ready-to-Cook (RTC) or Ready-to-Eat (RTE) food commodities for domestic consumption & export
- As emergency food during natural calamities/disaster management & can be served as military ration

REQUIREMENTS

➢ Raw Material: Fresh fish, fresh vegetables, oil, spices, etc. required for preparation of Instant fish soup powder are available locally.

➢ Equipment

- Steaming & cooking vessels
- Conventional air or Infra-Red dryers
- Homogenizers / Mixers
- Packaging machines / sealers
- Gamma irradiation facility (optional)
- Storage facility / ware house

INFRASTRUCTURE

- Space
  - A covered room of 500 sq. ft. area (25 ft. x 20 ft.) with raw material storage and processing area, refrigerators, steaming and cooking facility, dryers, packaging instruments and ware house (storage)

- Power:
  - Both single & three phase power supply.

- Manpower:
  - One skilled worker and two un-skilled workers would be adequate for production of 100 kg per day. Actual manpower would depend on production capacity.

- Statutory requirement:
  - Statutory clearances related to food industry and applicable registrations for production and sale of the Product based on the technology.

13. PROCESS FOR RETAINING PERICARP COLOUR AND EXTENDING SHELF LIFE OF LITCHI

A sequential surface chemical dip combination process has been developed at BARC for retaining attractive pinkish-red color of litchi fruit during prolonged storage (45 days) at low temperature (4 ºC). The treatment helps in retaining major color pigments (anthocyanins) of litchi pericarp and inactivates the enzyme (polyphenol oxidase) responsible for its browning. The treatment also kills microbes (bacteria, yeast and mold) present on the fruit. All these changes result in quality maintenance of litchi during prolonged storage without adversely affecting its sensory and nutritional properties as the fruits are dip treated with GRAS (Generally Recognized as Safe) chemicals.

Demand for litchi fruit is quite high due to its delicious taste, unique aroma, and juicy nature, but supply is very limited due to its highly perishable, and non-climacteric (ripens on the tree itself) nature apart from localized cultivation and seasonal availability. The color of the fruit turns brown soon after harvest. Fruits also get spoiled soon after harvest due to physiological and microbiological changes. Although India is the second largest producer of litchi, a commercially viable technique is not available here for its shelf life extension. Non-availability of a proper technique is the biggest barrier for ambitious vendors involved in trade of fruits. The technology developed offers a practical solution to the difficulties associated with litchi trade.

ADVANTAGES

- Market availability of processed fruits for prolonged period after harvest season
- Processed fruits are of high quality and have a very good export potential through sea and air route.
- Have industrial potential as many secondary products can be prepared viz; Juice,
- Fermented beverage such as wine, Shelf stable dried litchi fruit, Fruit jam, squash, marmalade, blends with ice-creams, custards and jellies

ADDITIONAL COMMERCIAL ADVANTAGES

- Highly profitable with less investment
- The entire procedure can be scaled up as per the requirement from small to industrial scale
- It does not require any costly instrument and much technical expertise, and hence can be operated by providing minimum training to the personnel
- Longer shelf life can facilitate greater market coverage.
- The product can be supplied in packed and sealed condition
- Requires less man power and energy, Minimum waste generation.
- A consumer can keep the processed-packed fruit in the refrigerator and can consume for more than a month

PRODUCT CHARACTERISTICS

- Retention of attractive color (anthocyanins), nutritional quality, and complete inhibition of post-harvest browning.

- Almost complete microbial decontamination.
- No chemical residues, No harmful effect.
- The product is organoleptically acceptable for more than 45 days

REQUIREMENT

- Raw Materials
  - Fresh shrimp in chilled condition, rock salt and chilled water.
- Equipment
  - Heating facility (viz. LPG stoves/ Electric heater)
  - Thermometer (scale 40-80ºC)
  - Stainless steel container
  - Plastic tubs
  - Hand held sieve
  - Low density polythene packets (LDPE)
  - Heat sealer
  - Muslin cloth
  - Hand gloves
- Space
  - Hygienic working area: (Approximate area required – 1500 sq. ft.)
  - Cold storage or refrigerator facility [temperature 4(±2) ºC] for preserving the processed fruits
- Power
  - Both single & three phase power supply.
- Manpower
  - One skilled worker and one Supervisor

14. A POST-HARVEST TECHNOLOGY FOR DEVELOPMENT OF INTERMEDIATE MOISTURE SHRIMPS/PRAWNS (IM SHRIMPS)

The current technology deals with the development & optimization of a Ready to Cook (RTC) product called **Intermediate Moisture (IM) Shrimp** conceptualized on a similar product called 'Dried Shrimp or Sode (Marathi)' which is predominantly used as a regular seafood preparation specially during rainy or lean season in the western India (Maharashtra & Goa). The IM Shrimp has a better over-all quality, microbiologically, biochemically safe & can be stored at ambient temperature for 4 months. It has better taste, colour, texture & rehydration capacity than similar dried shrimps available in markets. The IM Shrimp technology has potential to cater needs of domestic market as well can be exported. It also ensures availability of this prime seafood commodity during lean season, transportation to far-off places/landlocked states.

ADVANTAGES

- Very good quality, hygienic and nutritionally adequate
- Sensory and texture quality well acceptable
- Good rehydration capacity- retains original taste, texture &colour
- Ensures longer availability during lean season to distant/remote places
- Export quality product
- Can be stored up to 4 months in packed condition at room temperature.

APPLICATIONS

- Ready-to-Cook Shrimp dishes
- Useful for other target groups like defense personnel, school lunch program (mid-day meal), expeditions and astronauts
- Continued availability of high quality IM shrimp for domestic consumption& export purpose.

REQUIREMENT

- Raw Materials
  - Fresh shrimp in chilled condition, rock salt and chilled water.
- Equipment
  - Soft agitators & Strainer
  - Conventional air/Infra-Red/Solar dryer
  - Moisture analyzer
  - Water activity meter
  - Packaging machines/sealers
  - Storage facility / ware house

- Space
  - A room of 450 sq. ft. area (30 ft. x 15 ft.) having chilled water supply, processing area, stirrer / agitation tank, industrial (IR) dryers and packaging instruments.
- Power
  - Both single & three phase power supply.
- Manpower
  - One skilled worker and two un-skilled workers would be adequate for production of 100 kg per day. Actual manpower would depend on production capacity.

15. PROCESS FOR LONG LASTING READY-TO-EAT (RTE) INTERMEDIATE MOISTURE (IM) FRUIT CUBES

Fruits are important constituent of human diet, and besides having nutritional value also provide many good phytochemicals contributing to better health. Due to perishable nature of fruits and lack of sufficient storage facility including cold chain 32lavor32 40% of fresh fruits are lost after harvest in India. The current technology deals with the process development for the fruits namely mango, banana, papaya, pineapple, and apple to prepare intermediate moisture fruit cubes to extend their shelf life, reduce post-harvest losses, ensure their throughout availability, and also promote export. The water activity of the processed product reduced significantly, which prevented the bacterial growth and spoilage. The final processed product could be stored up to 6 months at ambient (room) temperature, whereas, the unprocessed freshly cut samples spoiled within 2 days. The processing ensured the microbiological safety, nutritionally adequacy, and organoleptic acceptability. The developed technology thus will ensure benefits to all the stakeholders including farmers, food industry, and consumers.

ADVANTAGES

- The microbial load is below detectable limit (< 20 colony forming units/gm)
- The product is sensorily acceptable for more than 6 months
- Nutritionally more enriched

APPLICATIONS

- Ready-to-eat convenient product
- Nutritional supplements for breakfast cereals
- Suitable as a blend with ice-creams, custards and jellies
- Fruit jam as a byproduct
- The procedure can be scaled up as per requirement from small to industrial scale
- Lesser energy consumption
- Minimum waste generation
- Round the year operation, as the same manufacturing plant can be used for different seasonal fruits

REQUIREMENT

- **Raw Material**
- Fruits,
- Water for washing
- Jars for storing product.

- **Equipment**
  - Induction cooker, infrared dryer/ hot air oven and packaging machine.
- **Space**
  - A covered space of 25 x 20 sq ft., water supply, Space
- **Power**
  - Both single & three phase power Supply.
- **Manpower**
  - Two skilled technicians.

PAPAYA PINEAPPLE APPLE BANANA MANGO

16. DE-BITTERED GOURD (KARELA) JUICE WITH HIGHATIDIABETIC ACTIVITY

Bitter gourd (*Momordicacharantia L.*), an annual climbing plant belonging to the Cucurbitaceae family, is an extensively investigated tropical medicinal plant. Its fruit, also known as balsam pear, bitter melon or karela has a distinct bitter taste which enhances as the fruit ripens. Bitter gourd has been popular as a natural remedy in Ayurvedic systems owing to its anti-diabetic, anti-malarial, anti-inflammatory, antiviral, contraceptive and insecticidal properties. Bitter gourd juice (BGJ) has a rich array of bioactive phytochemicals including vitamins, minerals and phenolic compounds. Phenolic compounds are known to possess both high antioxidant potential and anti-diabetic activity. Apart from phenolics several other bioactive molecules in bitter gourd include steroidal saponins, charantin, and insulin like peptides, glycoalkaloids, vicine, momorcharin, oleanolic acids, triterpenes, trehalose and momordin. However, simple preparation of juice does not extract bioactive principals to the full extent. Moreover, although health benefits of bitter gourd are well documented and well known, its use is still limited due to its extremely bitter taste which limits its consumer acceptability. BARC has developed a technology for preparation of de-bitter Karela juice having high bioactivity.De-bitter Karela juice is prepared by using all GRAS chemicals and enzymes.

ADVANTAGES

- Simple and easy method of preparation
- Clear appearance and is completely de-bittered
- High antidiabetic activity
- Better physiological properties (such as α-glucosidase and α-amylase inhibition as) compared to commercially available products

APPLICATIONS

- Can be used as an alternative for management of diabetes and obesity.

REQUIREMENTS

- Raw Materials required
  - Bitter gourd
  - Hydrolytic enzymes
  - Additives for de-bittering (GRAS status)
- Equipment
  - Overhead stirrer with motor and temperature control
  - Fruit pulping machine
  - Bottle filling and pasteurizing machine
- Space
  - Shade or Covered room of 600 sq. ft. area (30 ft. x 20 ft) with potable water facilities.

- Power
  - Both single and three phase power supply.

- Manpower

  - Minimum two laboratory technician are required for production of 100 L of de-bittered juice. Actual manpower would depend on production capacity.

17. GLUTTON FREE-MULTIGRAIN PREMIX

ICMR (Indian Council of Medical Research) declared gluten Free (GF) diet as a cornerstone for management of celiac disease (CD). Gluten — a protein complex, which is present in wheat, barley and ryetriggers an unwanted immune response in certain genetically predisposed individuals causing CD. In India, wheat flour is used for making many major staple food items like chapati. Developing a gluten free premix for CD is challenging. Although, many GF premixes are available in market they are either costlier or low in its sensory parameters. So, BARC has developed a GF premix by combining various multigrain flours and radiation processed (RP) dietary fiber. Multigrain were judicially selected not only for better nutritional qualities but also for the bringing the price low. Multigrain used in the developed premix is not only limited for special (=medical) dietary purposes but also for healthy individuals. Addition of RP dietary fiber improved the sensory characteristics of the product.

ADVANTAGES

- Low cost in its price when compared to other available brands.
- Sensorial properties are closer to wheat chapatis as compared to the one prepared from already available commercial brands.

APPLICATIONS

- Protein content (12.9%) of the premix is similar to that of generally available wheat flour in the market.
- High in soluble dietary fiber (11.7%) (Calculated as per to Nutritive Value of Indian foods, 2014, National Institute of Nutrition).
- Can be consumed by CD patients and healthy individuals.

INFRASTRUCTURE

- **Raw Materials**
  - The raw materials required for preparation of RPPs-Gluten free premix are available locally.
- **Equipment**
  - Weighing balance.
  - Powder mixer and sealer.
  - Packaging machines, Gamma irradiation facility (optional)
- **Space**
  - Room of 450 ft^2 area (30’ x 15’) for mixing flour and packaging.
- **Power**
  - Both single & three phase power connection.
- **Manpower**
  - One skilled worker and two un-skilled workers would be adequate for production of 100 kg per day. Actual manpower would depend on production capacity.

18. BANANA HEALTH DRINK

Banana is the most abundant fruit crop grown in India. Banana production in India accounts for over 20% of total banana produced in the world. A comparatively short post-harvest shelf-life of banana coupled with a dearth of sufficient and good quality transportation as well. Storage facilities lead to perishing of 35-40% of this highly nutritious fruit before it reaches the consumer. One effective method of reducing this huge loss would be to extract the juice out of the fruit before it perishes and preserve it. As of now, no commercially established process is available to achieve this. A novel lab-scale process has been developed at BARC for extraction of juice from banana and production of banana powder as a by-product.

PROCESS DESCRIPTION

The moisture content of banana is in bound form as against that in many other fruits like apples and citrus fruits. The BARC process achieves separation and extraction of juice through a series of operations like blending, churning, autoclaving and centrifuging. Clear juice with a yield of upto 55% (w/w) is obtained without addition of any enzymes and can be stored upto 3 months inside a cold storage at a temperature below 4°C without adding any preservatives. The remaining pulp is converted into fine banana powder through freeze-drying followed by grinding.

PRODUCT CHARACTERIZATION

The juice is clear liquid with a distinct banana 37lavor. The composition of the juice obtained from fully ripened Cavendish Banana is composed of sugar 25 to 35 %, solids 25 to 27%, specific gravity 1.07 to 1.14 and the pH ranging from 4.5 to 4.8. The ripe-banana powder, the by-product of the process is a fine and free-flowing hygroscopic powder dark brown in colour. It has a composition of sugar 15-20%, soluble fibre 1.3%, protein 3% and insoluble material 75- 80%.

APPLICATIONS

The juice can be used as a beverage base and a health drink. The banana powder can be used as a substitute for flour in cakes and biscuits, as a flavoring agent in milk or for preparing baby food. It can also be a good choice of food-base for patients of diabetes owing to its low sugar content.

INFRASTRUCTURE

- **Space**
  - A covered area of around 200 m^2, water supply and 3-phase electricity supply
- **Power**
  - Both single & three phase power connection
- **Equipment**
  - Blender, centrifuge, bottling unit, cold storage, IR dryer

- **Statutory Requirements**

18. Statutory clearances related to food industry and a minimum of a small scale industries registration.

- **Manpower requirements**

  - Two technicians for handling the equipment and one helper for sundry work.

19. FOLDABLE SOLAR DRYER (FSD)

Foldable solar dryer is a rectangular box with triangular top. The solar radiations are absorbed by black mat metallic outer surface of dryer. Heat is absorbed by inside air through conducting metallic plates. The geometry of the solar dryer ensures that the resultant hot air moves up and heats the product evenly and dries it by evaporating trapped moisture. Finally, this air escapes through vent at top. The dryer is of modular type and can be easily dismantled into a thin rectangular box for easy transportation & storage.

ADVANTAGES

- By use of this dryer, the drying process is made 5 times faster than normal sun drying procedure resulting in substantial weight reduction.
- 100 kg of grapes can be converted to 25 kg of raisin.
- It has no adverse effect to environment.

APPLICATIONS

- The foldable solar dryer in the capacity of 10, 25 & 100 kg is used for the preparation of raisin, drying of grapes, onion, mango pulp, green leafy vegetables, Amla, jack fruit pulp, Ginger, green pepper, herbal medicines etc. More than 50 varieties have been dried using these dryers at various AKRUTIs.

REQUIREMENTS

- Space
  - Small job shop with facility to cut angles, plates, drilling of holes etc.
  - Hygienic working area: (Approximate area required – 1500 sq. ft.)
- Power
  - Both single & three phase power supply.
- Manpower
  - 2 semi-skilled technicians

20. VIBRO THERMAL DISINFESTOR (VTD)

Fumigation as a means of grain disinfestations has its serious limitations. It can leave residues in the food grains that are toxic to humans. Also it is not eco- friendly as fumigants mostly used are ozone depleting substances and are going to be phased out. Therefore, heat/ thermal disinfestations of food grains can be a simple Vibro Thermal Disinfestor (VTD) alternative. Vibro-thermal disinfestor (VTD) is a simple electricity operated device for disinfestations of food grains. Insect infestation i.e. proliferation of insects on stored grains and pulses is a major cause of concern. It causes enormous losses in quantity and degrades the quality of food grains. There is kernel damage, webbing, adding off odours etc. due to infestation. Further, nutritive value of infested grain is adversely affected. The consumption of infested foods has adverse effects on health such as digestive and pulmonary disorders. Insect infestation jeopardizes export and countries may suffer huge economic losses.

Insects in all their development stage are susceptible to killing by heat when exposed to temperatures of 55°C to 60°C for 30mins. Examples exist where fluidized-bed heating and solar heat are in use for disinfestation on a commercial scale in Australia. BARC has also designed, fabricated and tested a vibro-thermal disinfestor for insect disinfestation of food grains to achieve a shelf life extension up to one year. The system is amenable for scale up and is mobile. The treatment has no effect on germination of seeds as well. The system is simple, can be fabricated without much capital investment and useful for farmers, merchants and exporters of food grains.

VTD SYSTEM

AIR HEATING SYSTEM

It consists of an insulated box made up of plywood, a blower, a heating coil and a sensor. The blower, the coil and air circulation are arranged in such a manner so as to achieve maximum air heating. The temperature of food grains is raised by passing hot air over it. Air is blown through heater and circulated through the system using the blower.

CONVEYOR SYSTEM

The conveyer unit is housed in the plywood box. It consists of 6 trays and a vibrator. There is one hopper fitted to the box for feeding the grains and an outlet for collecting the treated grains.

OPERATION

Grains are loaded in top hopper and passed at a pre-determined flow rate across six sloping metal trays. The tray system is provided with light vibrations to ensure the flow. During flow the grain is heated to a predetermined temperature by hot air that kills all developmental insect stages including the larval and pupal stages of those species that develop inside grain kernels. The hot air is supplied from the top heating module and passed over the material evenly and uniformly with the help of the blower. For monitoring the temperature inside the box sensors are fitted. The grain is collected at the bottom tray after treatment. The heat treated grains has to be stored in an insect impermeable packaging material or in tight silos for getting a shelf life extension up to one year. The power consumed for processing the grains of 40 kg/hr is one unit of electricity (1kWh).

FABRICATION

The unit has been designed in such a way so that it can be fabricated in any workshop with welding and cutting facilities. The material cost required for VTD fabrication is ~ Rs. 11,000. The other cost involved is fabrication and painting etc. It needs 5 amps single phase 230 V AC supply to operate.

MANPOWER

Vibro-Thermal Disinfestor can be operated by one person and no technical knowledge is needed.

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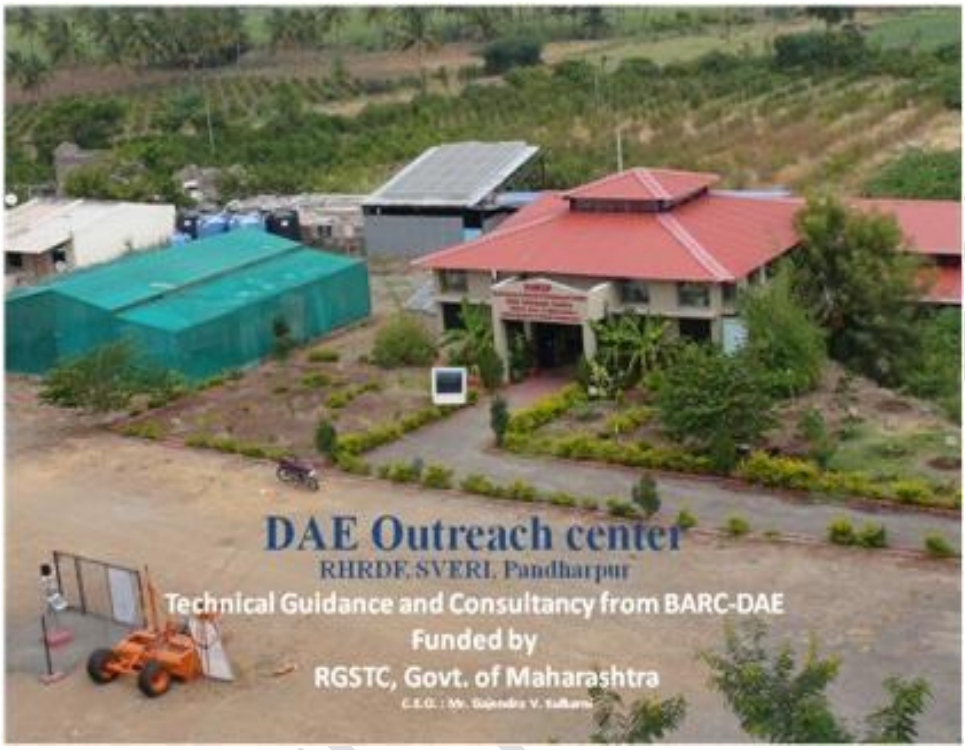
RURAL HUMAN & RESOURCE DEVELOPMENT FACILITY (RHRDF), Department of Atomic Energy – Out Reach Centre (DAE ORC) in campus of Shri Vithal Education & Research Institute (SVERI), Pandharpur, MS



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AKRUTI: Inclusive Rural Development Programme

WORKING PRINCIPLES

"Establish Technologies in Rural Areas"

"Demonstrate and Facilitate Villagers"

"Fabricate, Assemble and Deploy in the Fields & Expand"

Work, Contribute and Earn

Various Products developed through solar dryer technology

www.barc.gov.in/akruti-tp/inder.html

Activities

For details on AKRUTI Programme Contact
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Website: www.barc. gov.in/akruti-tp/index.html