

Bt Tomato resistant to fruit borer

Transgenic tomato (Pusa Ruby) has been developed with cry1Ac gene for protection against the fruit borer. The Bt-tomato was field tested with promising results (95-98% protection) and licensed in 2011 to a private company for biosafety testing and commercialization under Public-Private Partnership.

Tomato is the world's largest vegetable crop after potato and sweet potato. It ranks first in the list of canned vegetables. Tomato is also an important vegetable crop in India, grown in an area of approximately 5.5 lakh ha producing about 10 million tonnes per annum. This is one of the most important "protective foods" because of its special nutritive value. It has wide range food uses other than as cooked vegetable and salad, soup, pickles, ketchup, puree, sauces etc. Tomato has very few competitors in the value addition chain of processing. Tomatoes are available round the year and at affordable cost. However, the vegetable is highly susceptible to Lepidopteran pests, mainly the fruit borer (*Helicoverpa armigera*) infestation. There is no resistance source in tomato germplasm. Chemical control of the pest is not only expensive but also ineffective. Safe and effective alternative for the management of these pests is to express insecticidal proteins of *Bacillus thuringiensis* (Bt) by genetic engineering. Cry1Ac is a very effective Bt protein against Tomato Fruit borer.



Benefits / Utility:

potential benefits of Bt tomato are in terms of yield gain, reduction in insecticide-use, and monetary benefits to producers, consumers and society in the context of smallholder agriculture.

Country Context :

Since tomato is a crop of importance to the country, transgenics in tomato for insect

Scalability :

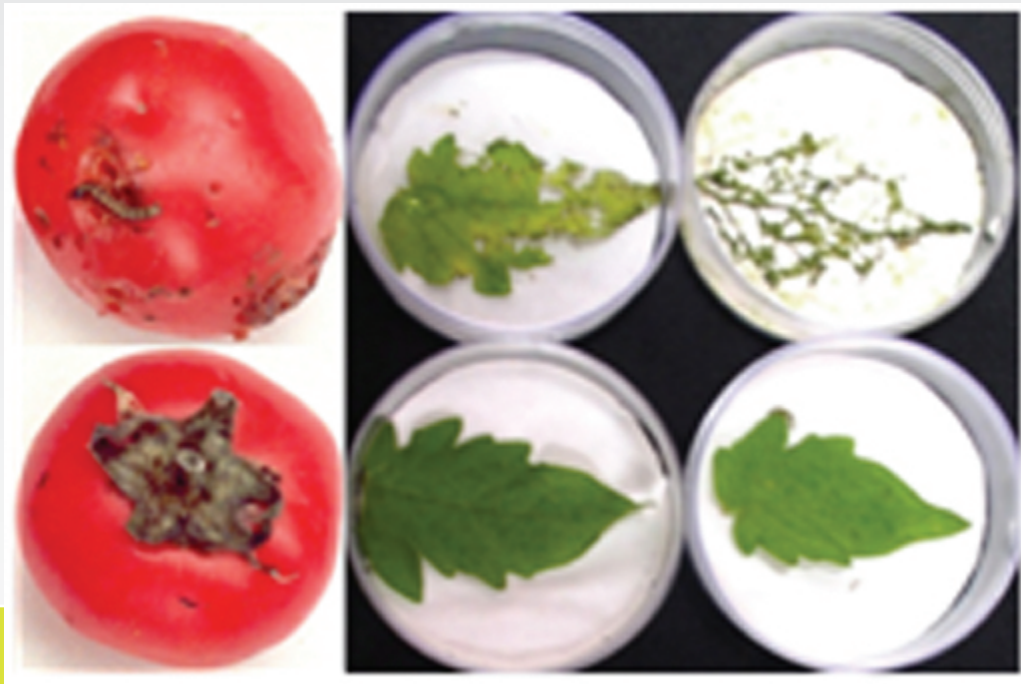
The transgene can be introgressed to any variety for insect resistance

Potential investors to this technical innovation :

Companies engaged in vegetable seed production

Business and Commercial Potential :

Since tomato is one of the widely grown vegetable crops, transgenics with insect resistance has immense commercial potential and utility for the consumers.



Fruit and leaves of untransformed (upper panel) and Bt-transgenic (lower panel) tomato challenged with fruit borer larvae

Name of the Institute :

National Research Centre on Plant Biotechnology,
New Delhi

Stage of Development :

One of the events has been licensed to a private
company

Patent/IPR status :

The event is characterized by the T-DNA flanking sequences and IPR protected

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Ajmer Fenugreek 3

Fenugreek variety for higher yield

A new fenugreek variety Ajmer Fenugreek-3 (AFg-3) has been identified for higher yield as well as better quality especially for diosgenin and 4-hydroxy-iso-leucine content. AFg-3 gave 11.13 % higher seed yield than Hisar Sonali (national check) in coordinated testing at 12 locations across the country over three years in coordinated varietal trial with 1288 kg/ha. This variety is most stable and desirable for yield as per Eberhart and Russel Model. For most of the ancillary traits this variety is at par with national check. It is moderately resistant to powdery mildew and root rot diseases. Its seed contains 1.79 % diosgenin which is higher than national check. Free amino acid 4-hydroxyisoleucine content in the seed of AFg-3 is 0.97 % which is higher than other varieties.

Fenugreek (*Trigonella foenumgraecum*) is an annual herb that belongs to the family leguminosae widely grown in India, Pakistan, Egypt, and Middle Eastern countries. India is the largest producer of fenugreek in the World (Edison, 9). In India, Rajasthan, Gujarat, Uttaranchal, Uttar Pradesh, Madhya Pradesh, Maharashtra, Haryana and Punjab are the major fenugreek producing states. Rajasthan has maximum area and production of about more than 80% of India's total production. Due to its strong flavour and aroma fenugreek leaves and seeds are widely consumed in Indo-Pak subcontinent as well as in other oriental countries as a spice in food preparations, and as an ingredient in traditional medicine. It is rich source of calcium, iron, carotene and other vitamins.

Benefits / Utility :

The variety is medium in height.

Performs well in irrigated condition
It bears broad leaves with less bitterness.

The crop takes 137 days to mature.

Performs well all over the country in irrigated condition

The number of seeds per pod ranges from 17-20.

The seeds are bold with 17-20 g test weight.

Seed yield 20-22 q/ha

Country Context :

India

Scalability :

The technology is very much scalable

The technology can be scaled up as per the requirement

Potential investors to this technical innovation :

Tremendous potential in seed companies, Exporters and processors, nutraceutical and pharmaceutical companies

Business Potential:

Entire country and outside world

Market potential :

Tremendous potential in seed companies, Exporters and processors, nutraceutical and pharmaceutical companies

Financials

Unit seed cost only @ Rs. 80/kg

Non exclusive license for production and selling of seeds: 1.00 lac

Target Market / Customer

Seed companies,
Exporters and processors
Neutraceutical
Pharmaceutical companies

Social impact of the technology

Will enhance the production of coriander with good export potential. Growers can get better incentives producing export quality produce thus increase living standard

The variety is specifically suitable of its medicinal potential

NRCSS has also developed an advanced production technology for getting the maximum yield of AFg 3. This technology deals with all parameters like sowing time, seed rate, manures & fertilizers, irrigation schedule, biotic and abiotic stress management.

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DRMR IJ 31 (Giriraj)

One line describing the technology/ USP/ Marketing Proposition

D RMR IJ 31 also called as "Giriraj" is a high yielding variety of Indian mustard (*Brassica juncea* L), derived from a single cross between HB9908 into HB 9916. This variety was released during 2013 after three year multilocation testing under All India Coordinated Research Project on Rapeseed-Mustard. It was found suitable for cultivation under timely sown (in month of October), irrigated conditions of Punjab, Delhi, Haryana and Rajasthan.

Variety DRMR IJ 31 (Giriraj) showed distinct superiority over the existing varieties of Punjab and Haryana region. The seed yield recorded for this variety during 2010-11 to 2012-13 ranged from 22 to 27 q/ha under timely sown irrigated conditions.

Benefits / Utility:

This is a latest variety for farmers growing mustard under timely sown (in October), irrigated conditions in Punjab, Haryana and Rajasthan. The variety has shown distinct yield superiority over other existing varieties during multilocation testing under AICRPRM. Variety possess bold seed size and high oil content.

Country Context :

India

Scalability :

N.A.

Potential investors to this technical innovation :

Private seed companies

Business and Commercial Potential :

Suitable for Delhi, Haryana, Jammu & Kashmir, Punjab and parts of Rajasthan (adjoining Haryana)

Financials

Mention the scale for which the cost is mentioned: Small/Medium/Large Scale

Cost of Cultivation - Rs 7000/q

Target Market / Customer
Private seed companies

Social impact of the technology
This will increase the total edible oil production in country.

N.A.

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Bt Brinjal Resistant to Fruit and Shoot Borer

Safe and effective alternative for the management of insect pests is to express insecticidal proteins of *Bacillus thuringiensis* (Bt) by genetic engineering. Cultivation of Bt crops for the past 15 years on a global scale has demonstrated significant economic, social and environmental benefits. As early as 1995, efforts were made by NRCPB to develop transgenic brinjal expressing insecticidal protein (Cry1Ab) of Bt. The transgenic lines were field tested on IARI farm under containment conditions, which demonstrated limited protection against BSFB. A novel Bt ICP (Cry1Fa1) was expressed in the variety 'Pusa Purple Long' and field tested. The fruits of non-Bt variety were damaged by BSFB to an extent of 47% and the Bt version was damaged only to 5%. The most effective 'Event 142' was rigorously characterized and licensed in 2005 to a private company for biosafety testing and commercialization under Public-Private Partnership.

Brinjal is an important vegetable crop of India. It is a good source of vitamins and minerals, especially iron. The area under brinjal cultivation is estimated at 0.55 million hectares with a total production of 8.2 million tons. A total of 1.4 million small, marginal and resource-poor farmers grow brinjal. Brinjal is very susceptible to an insect pest namely Brinjal Shoot and Fruit Borer (BSFB). BSFB causes significant losses of up to 60 to 70%. Because of the cryptic nature of the pest the insecticide applications become ineffective. Levels of pesticides and their residues are very high in the fruits, which is a matter of serious concern to human health. There is an urgent need to reduce the dependence on pesticides by using safer alternatives to manage insect pests. Using biotechnological tools, NRCPB has developed transgenic brinjal with Bt a gene (cry1Fa1), which is very effective against BSFB.



Benefits / Utility :

Transgenic brinjal resistant to the fruit borer has tremendous positive effects on the yield of the crop. The introduction of insect resistant brinjal will reduce the use of pesticides and would be the cause for a better health of consumers. Reduction in yield losses due to the transgene would be an advantage for the small resource poor farmers engaged in the crop.

Country Context :

Since Brinjal is a widely grown and consume vegetable in the country, it is very apt for the development of insect resistant brinjal

Scalability :

The transgene can be transferred into any variety for insect resistance

Potential investors to this technical innovation :

Companies engaged in vegetable seed production

Business and Commercial Potential :

Since brinjal is one of the widely grown vegetable crops, transgenics with insect resistance has immense commercial potential and utility for the consumers



Comparative performance of Bt (left) and non-Bt brinjal (right)

Name of the Institute:

National Research Centre on Plant Biotechnology,
New Delhi

Stage of Development :

One of the events has been licensed to a private company

Patent/IPR status :

The event carries a cry1Fa1 gene which is patented. The IPR of the event is by the flanking sequence.

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HD 2967

Grow high yielding yellow rust resistant wheat variety for NWPZ

- Suitable for timely sown irrigated conditions
- Average seed yield is NWPZ: 50.4 q/ ha of NWPZ
- The variety has wide adaptability.
- It carries diversified genes other than 1B/1R.
- It possesses adult plant resistance against most prevalent leaf rust disease as well as of 78S84 and 46S119 two most virulent races of yellow rust disease.
- It has also better degree of resistance against leaf blight.
- It matures in about 143 days (NWPZ)



Wheat is grown in 29.90 million hectares area of the country. Production of wheat is 93.9 million tonnes. The productivity of wheat is 31.40 qtl/ha. It can be enhanced by adoption of high yielding varieties. HD 2967 is high yielding and has potential for wide scale adoption.

Benefits / Utility :

- ❖ High yield
- ❖ Resistance to disease and pest
- ❖ Wide adaptability

Country Context :

Punjab, Haryana, Delhi, Rajasthan (except Kota and Udaipur divisions), plains of J&K, H.P., Uttarakhand

Scalability :

North Western Plain Zone

Potential investors to this technical innovation :

- ❖ Seed companies
- ❖ Farmer Groups

Business and Commercial Potential :

- ❖ High productivity per area under the specified agri ecological situation in the designated zone
- ❖ Disease resistant

Financials :

Mention the scale for which the cost is mentioned

Rs. 30/ Kg of TL Seed

Target Market / Customer

- ❖ Farmers/SHGs
- ❖ Trading companies
- ❖ Government Agencies (NSC, SFCI)
- ❖ NGOs

Social impact of the technology

The farmers who adopted the technology have reaped good returns

Yellow rust resistant variety of wheat for NWPZ

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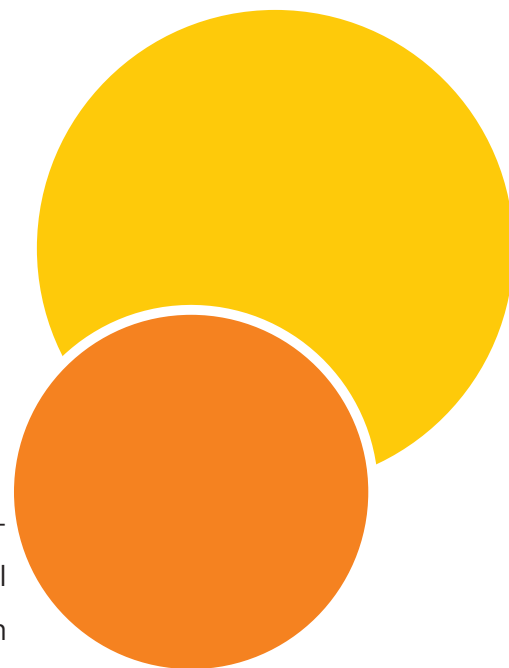
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Biosynthesized P nano-nutrient

An eco-friendly nano-formulation

- Complete bio-source
- Three-fold increase in Nutrient Use Efficiency (NUE)
- 17-54% improvement in crop yield
- 80-100 times less requirement than chemical fertilizer
- 10 times more stress tolerant by the crops
- 30% more nutrient mobilization in the atmosphere

The technology relates to rapid synthesis of agriculturally important mono-disperse nano-nutrients, more particularly nanoparticles of P using fungal extracellular secrets. The conventional fertilizers available in the market contain mega particles but the penetration power is negligible, therefore, cannot be used as fertilizer for foliar application. Moreover, the cost is much higher than nanoparticles.



Benefits / Utility :

- ❖ Enhance Phosphorous availability to plants
- ❖ Improvement in soil health
- ❖ Improvement in plant health
- ❖ Increased crop yields
- ❖ Increase in farmers' income
- ❖ Improvement in standard of living of farmers

Country Context :

India

Scalability :

The technology is very much scalable and with our present operations (1 Litre capacity), we are able to manufacture / produce sufficient for ten hectares in two days. The technology can be scaled up to one thousand times by using a bioreactor.

Potential investors to this technical innovation :

Fertilizer companies
Plant nutrient mixture suppliers
Medicinal companies

Business and Commercial Potential :

No similar kind of technology available in the market

Financials :

Mention the scale for which the cost is mentioned: Small/Medium/Large Scale

Small Scale

Cost: Rs. 22/litre for ready to use formulation

Target Market / Customer

Fertilizer Industries

Farmer Producer Groups / Farmer clusters

Plant nutrient mixer suppliers

Neutraceutical and pharmaceutical companies

Social impact of the technology

- ❖ Increase in farmers' income
- ❖ Improvement in standard of living of farmers'

Limiting factors for large scale commercialization

Shelf life only three months which may increase up to 2 years at low temperature (10°C), but supply chain of agricultural inputs is very long
Initial investment is more but profit would be very high after 2 years of implementation as it is possible to exploit global market very efficiently.
Maintenance of micro-organisms need specialized person.

NRCSS has also developed an advanced production technology for getting the maximum yield of AFg 3. This technology deals with all parameters like sowing time, seed rate, manures & fertilizers, irrigation schedule, biotic and abiotic stress management.

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NANO SULPHUR

The present invention relates to the development of surface modified monoclinic sulphur nanoparticles of average size 20-100, their liquid synthesis using polyethylene glycol- 400 as a surfactant and use as fungicide. Nanoparticles thus synthesized provide excellent fungitoxic efficacy against the fungal pathogens

Objective of inventions:

- To prepare nanoforms of elemental sulphur under condition employing simplified liquid synthesis technique
- Another objective is to propose the use of the novel nanocides as fungitoxic agent against fungal pathogens

There is a serious need for new agrochemicals because target organisms are rapidly developing resistance to fungicides. A need exists, for new fungicides with low undesirable toxicity, better selectivity, low production cost, less environmental hazards and better efficacy. Present invention relates to development of surface modified monoclinic sulphur nanoparticles with excellent fungitoxic efficacy against the fungal pathogens.



Benefits / Utility :

- ❖ Super fungicides with extra anti bacterial properties. Thus show combo effect
- ❖ Acts at very low dose and effective against a large no. of fungal and bacterial pathogens.
- ❖ Low undesirable toxicity, better selectivity, low production cost and better efficacy
- ❖ Long term toxicity studies show generation of resistance is very slow

Country Context :

India

Scalability :

Scalable. Currently produced at the scale of 2000 litres at ISI, Kolkata
Commercial set up would produce 2 million litres per day

Potential investors to this technical innovation :

Small, medium scale companies in India (both private and Govt. Undertakings)

Business and Commercial Potential :

Industrial Application: Pesticide (Fungicide and Bactericide) industries dealing with or interested in base market of marginal, small, medium and large farmers as the product price is low, so marginal farmers also can utilize.

Application in Crops/areas: Cereals, fruit, ornamental and vegetable crops, green house high value crops; Fisheries and Dairy sector feeds and fodders (as no residual toxicity is there)

Financials :

Project cost: Rs 30 Crore

Fix assets (Land and Building) = 50,000 sq. ft

Target Market / Customer

- ❖ Pesticide industries (Fungicide and Bacteriocides)
- ❖ Green house industries dealing with marginal, small, medium and large farmers.

Social impact of the technology :

- ❖ Lesser cost of production. Low price alternative for the existing fungicides and bacteriocides.
- ❖ Eco-friendly, Highly Efficacious.
- ❖ Safe for handling.
- ❖ Development of resistance against these nano fungicides is very slow.

Limiting factors for large scale commercialization :

If the Indian company is interested in the commercial scale production and does not import custom made production machine from companies like Techna group of USA, then other foreign companies would enter the market shortly.

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NPK Liquid Fertilizer

The NPK liquid formulation is a unique formulation that has a nitrogen fixing (*Azotobacter*), P solubilizing (*Pseudomonas strata*) and K-solubilizing (*Bacillus* sp.) bacteria. The three cultures are compatible and coexist in the liquid formulation. The constituent cultures *Azotobacter chroococcum* and *Pseudomonas strata* have been tested at multi location trials and has performed well. The Division has already published more than a dozen Research papers based on the efficacy of these cultures. The third isolate of this formulation, K solubilizing bacteria is a rather new product, and its efficacy under field is still under testing. However the combination of three can help to augment 25-30 kg N, 20-25 kg P₂O₅ and 15-20 kg K ha⁻¹.

One of the major concerns in today's world is the pollution and contamination of soil. The use of chemical fertilizers and pesticides has caused tremendous harm to the environment. An answer to this is the biofertilizer, an environmentally friendly fertilizer now used in most countries. Biofertilizer are organisms that enrich the nutrient quality of soil. The most striking relationship that these have with plants is symbiosis, in which the partners derive benefits from each other.



Benefits / Utility :

- ❖ Longer shelf life, shelf life of a year
- ❖ Can be stored at elevated temperature
- ❖ Convenient and easy to use
Improves soil environment and health.
- ❖ No loss in plant growth promoting activities, even on long storage.

Highly effective and can be used in different types of soils

Country Context :

India

Scalability :

Technology is scalable depending on the requirement of the manufacturing unit.

Potential investors to this technical innovation :

- ❖ Farmers
- ❖ Research & Development Institutes

Business potential :

Entire country and outside world

Market Potential :

Tremendous potential in Fertilizer companies



Brinjal Un-Inoculated with Azotobacter



Brinjal Inoculated with Azotobacter

Target Market / Customer

- ❖ Bio-fertilizers manufacturing companies
- ❖ Agro chemical Industries

Social impact of the technology :

There is a general consensus on the relevance of bio-fertilizers usage particularly for small farmers in the context of current climate change concerns as a cheap and safe source of input for agriculture. Even if part of the increased demand for fertilizers could be met from bio-fertilizers, it is likely to result in savings for poor farmers for example, bio-fertilizer usage has been found to reduce chemical fertilizer usage by about 20% in some cases.

Limiting factors for large scale commercialization :

- ❖ Little information and awareness about Bio fertilizers
- ❖ Difficulty in understanding the usage of Bio fertilizers
- ❖ Lack of availability in market

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Biofertilizer cum Biofungicide/ Biobactericide Composition B5

The invention Biofertilizer cum Biofungicide/ Biobactericide Composition B5 prepared in an inexpensive substrate which allows maximum production of viable cells in shortest time with a shelf life of one year at room temperatures (15-37°C) and gives best results when applied on seed or soil, safe for persons handling it and non target pathogens with no side effects on biodiversity.

The composition B5 is prepared from a bacterium namely *Bacillus subtilis* strain B5 has the ability to provide plant growth promotion and control of soil/seed borne pathogens of potato, vegetables and ornamental crop plants.

B5 is safe for persons handling it and does not affect non target pathogens in environment and consequently no side effect on biodiversity.

It has a killing effect against pathogenic species of *Fusarium*, *Pythium*, *Phytophthora*, *Rhizoctonia*, *Solanacearum* and *Alternaria* in the form of cell lysis or antibiosis.

It inhibits *R. solanacearum*, the cause of bacterial wilt of potato against which no chemical or a resistant variety is effective till date



Benefits / Utility :

- ❖ Controls soil and seed borne diseases up to 80%. Ensures early and uniform germination. Increases crop yield up to 25 %.
- ❖ Production process is simple and easy to adopt.
- ❖ Compatible with systemic and contact fungicide viz, Bavistin, Benlate, Ridomil and Dithane M -45 etc

Country Context :

The technology will be useful for the private companies who are involved in Biofungicide/ Biobactericide formulation worldwide

Scalability :

The B5 formulation can be produced both by large as well as medium scale industries

Potential investors to this technical innovation :
Private industries.

Business and Commercial Potential :

Small/medium scale entrepreneur/industries as well as farmers.

Financials

Mention the scale for which the cost is mentioned: Small/Medium/Large Scale

❖ Plant & machineries including laboratory equipments:

Autoclave, Fridge, Laminar flow, Incubators, sealer, Air conditioners, Exhaust fans, Electronic balance, pH meter, Hotair oven etc. Electricity of power 5 watt is required for running these equipments.

❖ Material & energy balance: Material cost for 1Kg substrate is as follow

● Bentonite powder	(LR, LOBA Co.)	70 gm	Rs.230.00/- approx
● Calcium carbonate	(LR CDH Co.)	275 gm	Rs.75.00/- approx
● Carboxy methyl cellulose	(LR CDH Co.)	20 gm	Rs.20.00/- approx
● Live bacterium cell		5 gm	Rs.

❖ Land & building for a minimum capacity plant:

Approximately 300 sq yards consisting of one inoculation chamber 10 x 10 sq yards, wash room 10 x 10 sq yards, equipment room 10 x 15 sq yards and storage room 10 x 12 sq yards

❖ Manpower requirement:

Estimated manpower is of five men per day (8 hrs shift).

❖ Plant maintenance:

Six monthly checking for maintenance and working of equipments.

Target Market / Customer

Involve less cost and cheaper than available products in the market.

Social impact of the technology

Manufacturing process is simple and easy to adopt. Compatible with systemic and contact fungicide viz. Bavistin, Benlate, Ridomil and Dithane M-45. Ecofriendly with one year shelf life at room temperature.

Eco-friendly with one year shelf life at room temperature

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Trichoderma Harzianum

Bio-Pesticide against Soil Borne Fungal Pathogen

One line describing the technology/USP/Marketing Proposition

A strain Tr-28 of *Trichoderma harzianum* (MTCC8620) identified at VPKAS, Almora is effective against the soil-borne fungal pathogens. The institute found Tr-28 to be highly effective against soil borne pathogens namely, *Rhizoctonia solani*, *Sclerotium rolfsii*, *Sclerotinia* sp., *Fusarium* spp. causing rots, damping off, wilts, blights etc. The institute has developed a talc based formulation of this isolate, which have been evaluated and found to be highly effective for the control of the soil borne pathogens at the farmers' field. It is also compatible with another bio-control agent (BCA) *Bacillus cereus* (strain WGPSB2) effective against white grubs (an important polyphagous insect pest).

The major soil-borne diseases (rots, damping-off, wilts, blights etc) often cause heavy damages to crops throughout the country, especially more severe in Himalayan hills. These pathogens invariably have a broad host range and are difficult to control even with chemicals due to their soil borne nature. Biocontrol agents have been successfully used for the control of these pathogens and *Trichoderma* species are most studied among them.

Benefits / Utility :

Identified isolate possesses broad-spectrum activity against diverse soil-borne plant pathogens. Plant growth promoting activity in 3 vegetable crops viz., (tomato, capsicum, garden pea) providing an additional advantage under conditions of low input cultivation like organic farming, antagonistic activity showed against six soil-borne plant pathogens, *Rhizoctonia solani* (56.1-59.1%), *Sclerotium rolfsii* (43.1-50%), *Fusarium solani* (32-48.8%), *Sclerotinia sclerotiorum* (55.4-68.3%), *Fusarium oxysporum* f. sp. *pisi* (29-34%), *F. oxysporum* f.sp. *lentis* (37.1-43.6%). The cold tolerant nature of the isolate allows usage in a wider geographical area including high altitude regions.

Country Context :

The soil borne pathogens cause heavy crops losses throughout the country. They have broad host range and are difficult to control. The biological control offers a great promise as eco-friendly alternative and particularly helpful in low input marginal and organic farming.

Scalability :

Global consciousness towards health hazards has been increasing and as eco-friendly alternatives, the biopesticide would essentially be a part of the disease management strategy. The future demand for such products will be immense.

Potential investors to this technical innovation :

Bio-agent producing companies

Business and Commercial

Potential :The bioagent, *Trichoderma harzianum* already licensed to NRDC, New Delhi to M/s Bharsa Biotech Solution (P) Ltd., Siliguri) and also has a great potential of commercialization to the different Bio-agents producing company in different part of the country.

Financials :

Mention the scale for which the cost is mentioned: Small/Medium/Large Scale

Protocol for mass multiplication and quality control of the bio-pesticide is developed. The production is based on the indigenous materials easily available in the country. Talc-based formulation of this bioagent requires inputs like talcum powder, barnyard millet grains and low investment on infrastructural facilities, thus, is cost effective.

Target Market / Customer

It is evaluated in the hill regions of Uttarakhand and can be tested and extended to other region also. The company dealing with the bio-pesticides may be potential and direct customer for this technology.

Social impact of the technology

It is biologically safe, use of bio-product will result in reduced/less use of chemicals, thus, no risk of health hazards and safe to environment. It has high potential to manage soil-borne pathogen in different crops with high growth promoting activity of plants resulting in higher yields and returns.

Limiting factors for large scale commercialization :

This isolate works well in the Himalayan region and there should not be any limitation in large scale commercialisation. However, the product may be evaluated in new areas for location specific effectiveness.

It is suitable for both inorganic and organic conditions because of its potential to control diseases caused by diverse plant pathogens in different crops. The high growth promoting activity of the isolate makes it highly suitable for use in low input conditions and organic farming. The cold tolerant nature and the high competitive ability also provide them added advantage when used over diverse geographical areas.

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Biopesticide: Pusa 5SD

- The novel seed dressing bio-formulation “Pusa 5SD” has been developed from the potential isolate of *Trichoderma harzianum* (IARI P-4; MTCC No. 5371) for the management of soil and seed borne diseases of crop plants.
- The novel soil application bio-formulation “Pusa Bio-pellet 10G” has been developed from the potential isolate of *Trichoderma harzianum* (IARI P-4; MTCC No. 5371) for the management of soil and seed borne diseases of crop plants.

The efficacy of Pusa 5SD a seed dressing formulation of *Trichoderma harzianum* was validated at 7 different locations across the country, namely, Sehore and Jabalpur (MP), IARI (Delhi), Rahuri (MH), Durgapura (RJ), Junagadh (GJ) and Samba (J&K) against wilt and root rot of chickpea. Pusa 5SD in combination with Vitavax power reduced disease incidence from 51.1-100% and enhanced the grain yield from 19.9-62.5% in different areas. Pusa 5SD alone reduced the disease incidence from 8.3-63.8% and enhanced the grain yield from 14.7-39.6% in different locations.



Benefits / Utility :

- ❖ Found effective against several soil and seed borne diseases of crop plants, dry root rot, wet root rot, stem rot, etc
- ❖ Increased seed emergence by providing protection to germinating seeds

Growth promoter

Country Context :

South Asia and African countries

Scalability :

Potential investors to this technical innovation :

- ❖ Agro-based Industry
- ❖ Biopesticide Industry

Business and Commercial Potential :

- ❖ The formulations have longer storage life and effective against wide range of plant diseases caused by different plant pathogenic fungi.
- ❖ The strain of *T. harzianum* used for the development of the formulation has ability to suppress different plant pathogenic fungi and also has ability to enhance plant growth as growth promoter and grain yield.

Financials :

Mention the scale for which the cost is mentioned

About Rs. 200/kg formulation

Target Market / Customer

- ❖ Food and Beverage Industry
- ❖ Sugar-free and Calorie-free Products
Diabetic or Obese patients

Social impact of the technology :

- ❖ Eco-friendly option for disease management in plants
- ❖ Compatible with fungicides when applied as seed treatment under sick field conditions

Limiting factors for large scale commercialization :

NIL

- ❖ Pusa 5SD: The formulation showed longer shelf (viability) life and suitable for 2 years of storage at room temperature 25+80C.
- ❖ Pusa Biopellet 10G: The formulation showed longer shelf (viability) life as 1.5 years of storage at room temperature 25+80C.

Scientific Experts :
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Principal Scientist,
Division of Pathology, IARI

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Bacterial Entomo-pathogen based Bio-pesticide for Management of White Grubs

One line describing the technology/ USP/ Marketing Proposition

The bio-agent, *Bacillus cereus* strain WGPSB2 is found effective for the management of white grubs. It is a gram +ive bacteria isolated from diseased white grubs, formulated in talc for field applications. It cause disease to the grubs when ingested by the early stage of grub and kills them. It is found effective to the grubs but safer to other native microbes in soil and not hazardous to other living organisms as tested by IITR, Lucknow. It is an effective alternative for chemical pesticides which are used for the management of white grubs in the region.

Since whitegrubs are serious pests of crops and usually managed using insecticides, a viable biological intervention is essential. Exhaustive surveys revealed whitegrubs are affected by disease causing organisms in the nature. Tapping the potential of these agents for control of the pest is a novel approach. Further studies revealed, *Bacillus cereus* WGPSB2 bacteria, isolated from diseased grub as potential and thus formulated in talc for field applications along with FYM and found effective in managing the pest.

Benefits / Utility :

Bacillus cereus WGPSB-2 caused >80 % mortality of second instar larvae of *Anomala dimidiata* in lab and micro plot conditions at VPKAS and found effective in fields also. It is an effective alternative for chemical pesticides used for the management of white grubs in the region. Talc based application is easy when applied with FYM to the crop. For entrepreneurs, it will be economical to produce in large scale, since the problem of white grubs is prevalent in the region.

Country Context :

Our county with poor and marginal farmers, insect pests are more challenging. Whitegrubs are usually controlled by insecticides which is a main cause of environmental pollution. So this bio-agent will be of great help in combating the whitegrub menace with eco-friendly nature.

Scalability :

Though the technology is tested in Himalayan states, the applicability can be very wide. Further the whitegrubs are everywhere and thus the technology can be made available for any area with pest problem after testing.

Business and Commercial Potential :

The bioagent, *Bacillus cereus* WGPSB2 already licensed to M/s Shibah Welfare, High School Colony, Half Nagarjan, Dimapur-797112 (Nagaland) and also has a great potential of commercialization to the different bio-agents producing company in different part of the country where white grubs is a major problems.

Potential investors to this technical innovation :

National Agricultral Innovation Project

Financials :

Mention the scale for which the cost is mentioned: Small/Medium/Large Scale

The cost of manufacturing of one kilogram of talc based formulation of *Bacillus cereus* WGPSB2 is around rupees 50. This includes the cost of media, talc and labour cost. But if it is carried out in large scale, the production cost may go lower than this. However, it requires a biological laboratory and good quality control system with microscopes for its production.

In field application point of view, the product is normally recommended at the rate of 10 kilograms per hectare area, mixed in farmyard manure two weeks before actual application in the field. Thus comes around Rupees 500 per hectare area.

Target Market / Customer

It is applicable in areas where white grubs are prevalent especially in the hill regions of Uttarakhand, Himachal Pradesh, Jammu & Kashmir etc. Can be tested and extended to other region also where whitegrubs are prevalent. Any company interested in pest management measures may be potential and direct customer for this technology and the regular clients are farmers who face whitegrub problem in their crop production.

Social impact of the technology :

Bacillus cereus WGPSB2 is found biologically safe by IITR, Lucknow. Further it is already present in the region and isolated from the diseased grubs, thus seems to be non hazardous. It is not found to cause any negative impact on the native microbes in the region also. Thus it is considered as a eco-friendly sustainable management approach and a viable alternative to hazardous insecticides under organic and IPM systems.

Limiting factors for large scale commercialization :

Since it works well in the region we do not perceive any limitation in large scale commercialisation of this technology. It is a good technology tested and well proved in the north-western Indian Himalayan hills. However, a small scale testing of the product may be done in new areas before large scale implementation. Further, encouraging results are obtained with its use along with VL whitegrub beetle trap-1 as an integrated management of whitegrub as a community approach.

The *Bacillus cereus* strain WGPSB2 is non hazardous and effective against whitegrubs in the region. This technology of using bio-agent, *Bacillus cereus* WGPSB2 along with VL Whitegrub beetle trap-1 for the management of whitegrubs got the best societal innovation award – 2008 of National Research Development Corporation, New Delhi, India and Gold Medal – 2009 of World Intellectual Property Organisation, Geneva, Switzerland.

Scientific Experts :

S.N. Sushil,
G. Selvakumar,
M. Mohan,
J.C. Bhatt,
H.S. Gupta and J. Stanley

Contact - I

Contact Person :

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Lateral flow immune assay kits (LIFA)

Health status of potato seed can be ensured by using the lateral flow immuno assay (LFIA) based detection of potato viruses at field level. CPRI, Shimla has developed LFIA kits for the detection of five viruses viz., PVX, PVA, PVS, PVM and PVY either individually or in combination of two viruses viz., PVA & PVX, PVA & PVS, and PVY & PVM using a single strip. When the test strip is dipped into the sample being analyzed, the sample liquid flows through membranes and triggers immunochemical interactions resulting in visible coloration in test and reference lines. The assay can be performed within 10-15 min at field level by an unskilled person. It is easy to perform and as sensitive as ELISA. The technology will aid both public and private companies in producing healthy potato seed and farmers to produce their own healthy potato crop which would lead to better yield.



ELISA and PCR-based methods have been developed for laboratory detection of most commercially important potato viruses, which are time consuming and require sophisticated instruments and skilled manpower. But effective monitoring of viral infections requires rapid and sensitive methods of detection both in laboratory and field conditions. Hence the LFIA kits were developed for on-site detection of potato viruses.

Benefits / Utility :

- ❖ The test can be performed within 10-15 min under field conditions.
- ❖ Lower testing cost than the imported kit.
- ❖ Can detect two viruses simultaneously.
- ❖ Can be used for Virus testing at :
 - Seed production programme (Lab & field)
 - Farmers fields
 - Quarantine agencies
 - Breeding programme
 - Research laboratories

Country Context :

India

Scalability :

The kits can be produced both by large and medium scale industries. It is affordable to private companies, large and medium scale farmers and research laboratories.

Potential investors to this technical innovation :

Manufacturers and suppliers of virus detection kits.

Business and Commercial Potential :

The technology will be useful for the private companies who are involved in potato seed production, Researchers working on breeding programmes, progressive potato growing farmers and quarantine agencies. Since it is less time consuming, it can be applied for large scale screening of samples in seed production.

Financials :

Mention the scale for which the cost is mentioned: Small/Medium/Large Scale

- ❖ Total Capital Investment(excluding Land and licensing fees) : Rs 80 lakhs/-
- ❖ Break of capital investment.
- ❖ Variable cost (per month/unit): Rs 2.3 lakhs(single virus/ strip) Rs 2.83 lakhs (2 virus/ strip)
- ❖ Break of variable cost.
 - Consumables – Rs. 2 – 2.5 lakhs per month.
 - Man power – Rs. 0.33 lakhs per month.
- ❖ Expected sale/unit: Rs (can take selling price of a similar product): Rs 40/- per strip or Rs. 800/- per kit for single virus testing. Rs. 50/- per strip or Rs. 1000/- per kit for testing 2 virus / strip

No. of units to be sold for monthly break even on variable cost:

Target Market / Customer

- ❖ Seed production system (Lab & field).
- ❖ Farmers fields – progressive potato growing farmers.
- ❖ Quarantine agencies.
- ❖ Potato breeders.
- ❖ Research laboratories.

Social impact of the technology :

The kits would be of great help for ensuring health status of foundation and certified seed of potato both for public and private agencies. It also will be of particular help for small and marginal farmers who can check health status of their crop before considering the produce for using as seed next year. Hence, the technology will help to ensure the health status of potato crop which would lead to better yield and betterment of farming community.

Limiting factors for large scale commercialization :

- ❖ Availability of good quality antisera.

Scientific Experts :

Dr. A. Jeevalatha, Scientist, CPRI.
Dr. S.K.Chakrabarti, Director CTCRI.
Dr. B.P. Singh, Director, CPRI.

Contact - I

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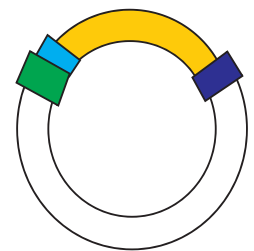
Antigen and antibody Expression constructs for Serodiagnosis of Plant viruses

The present technology offers up-scaling and renewable generation of antigen production which is require for polyclonal antibody generation. The traditional technology is cumbersome and time consuming.

- The technology involves serological (protein based) diagnosis of plant viruses. The traditional methodology has a limitation to produce ELISA based plant virus diagnostic kit as antigen preparation is difficult on renewable basis. The following innovations were made for generating antigen/ antibody in *E. coli* which has prospect for up-scaling and commercial utilization.
- Antigen constructs preparation using full and core conserved region of capsid protein gene sequence that over produced adequate antigen required for polyclonal antibody production.

Engineered monoclonal antibody expression constructs that generate antibody directly in *E. coli*.

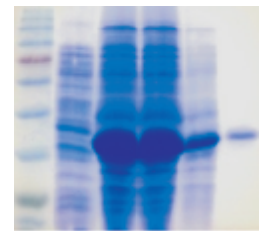
For the diagnosis of plant viruses, antibodies are traditionally generated by immunizing animal with the purified virus. Bacterial (*Escherichia coli*) expression of protein is simple, fast and inexpensive for generating high amount of purified proteins with minimal post translational modifications. The present technology offer generation of engineered antigen and antibody in *E. coli*



Antigen Construct



E. coli expression



Antibody



Serodiagnosis of plant virus

Benefits / Utility :

Diagnostic kits provide opportunity to detect the causal virus, produce virus free planting materials, certifying freedom from virus in quarantine plant materials, breeding resistant cultivars, for assessing susceptibility of germplasm and management decision in application of crop protection measures.

It helps in timely management of virus infection, increasing crop productivity, improving farmer's economical condition of farmer and reducing pesticide application.

Country Context :

In India, plant virus diagnostic reagents and kits are imported and sold. Indigenous serodiagnostic reagents and kits are hardly available.

Scalability :

The constructs can be used conveniently for up-scale production of antigen/antibodies

Potential investors to this technical innovation :

- Immunodiagnostic companies
- Biotech companies

Business and Commercial Potential :

Plant viruses are important constraints in tropical countries including India. A few serodiagnostic companies provide reagents/kits for plant virus diagnosis all over the world. Production indigenous reagents and kits for serodiagnosis of plant viruses will be cheaper and therefore they are commercially highly potential.

Financials :

Mention the scale for which the cost is mentioned

- ❖ Biotech company set-up can conveniently take up production of the reagents
- ❖ Immunisation of one rabbit with ~ 3 mg of expressed antigen in *E. coli* will generate ~20 ml of antiserum.
- ❖ 0.1-0.2 ml of imported antiserum is sold currently in India at the rate of Rs. 15,000-20,000 for testing 1000 samples
- ❖ Kits are sold at Rs. 40,000- 50,000 for 1000 samples
- ❖ Saleable product lines: (a) Different versions of diagnostic kits such as ELISA, DIBA and Western blot assay kits can be prepared by these antigen and antibodies. (b) In addition, individual antigen, antibody (c) Conjugate and (d) Positive and negative controls are also the products that can be sold.

Target Market / Customer

- ❖ Seed companies
- ❖ Referral labs
- ❖ Agricultural extension centers
- ❖ Scientists
- ❖ Immunodiagnostic companies
- ❖ Biotech companies

Social impact of the technology :

- ❖ Timely management of virus infection
- ❖ Productivity of the crops will increase
- ❖ Improvement in the economical condition of farmers
- ❖ Will reduce pesticide application in the environment

Limiting factors for large scale commercialization :

- ❖ International companies are available

For preparation of reagents and assay kits technical support can be provided

Scientific Experts :

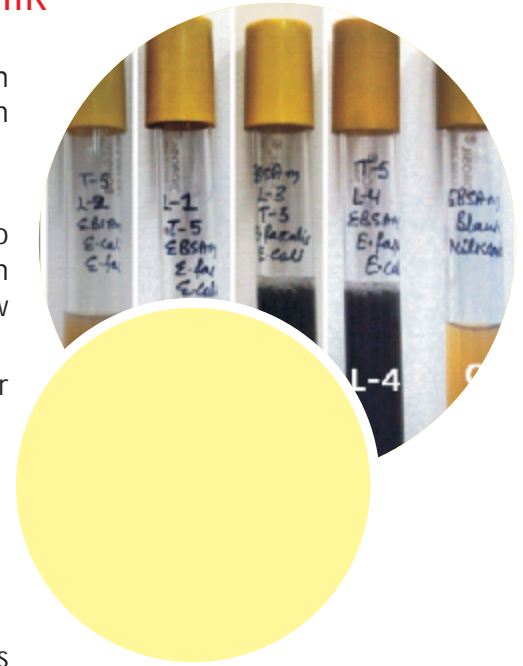
Dr. Bikash Mandal

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A Novel Micro-technique & Media For Selective Enumeration and Detection Of *Enterococci* in Milk"

- The technology involves application of specific Marker enzyme which participates in unique biochemical pathways of specific genera or strain hydrolyze chromogenic substrate complex
 - Release free chromogen which can be detected visually by color change
 - The development of this new "Single Stage Micro Technique" is to facilitate its use in R & D institutions and dairy industry for rapid detection of *Enterococci*. The medium is highly selective for *Enterococci* and allow its detection in single working day.
 - Technology has the potential to replace the existing medium for *Enterococci* for being cost effective
- i. *Enterococci* are monitored as hygiene indicator in dairy plants using conventional methods employing a number of selective agents, incubation conditions, and combinations which are time-consuming and inconvenient to carry out in the laboratory.
 - ii. Its regulatory standards have been fixed for infant milk substitutes whose consumers are included in highly vulnerable group of society i.e., Infants.
 - iii. Commercially available media like citrate azide agar requires an incubation period of 72-96 hrs for detection of *Enterococci* in milk.
 - iv. The newly developed SAEB medium can find industrial application as a routine test for monitoring *Enterococci* at reception dock for checking the hygiene status of milk within 12-24 hrs.



Benefits / Utility :

- i. Cost effective
- ii. Rapid detection of *Enterococci*
- iii. Validated in lab as well as by third party from M/s SGS India Pvt. Ltd., Gurgaon
- iv. Simple one stage assay to execute in dairy processing unit for hygiene monitoring

Scalability :

Assay is flexible and can be modified as per the user's requirements

Country Context :

The assay has wide range of its application in dairy and non dairy sector for screening of *Enterococci* and can also used for hygiene monitoring of dairy environment at domestic as well as globally .

Potential investors to this technical innovation :

Stake holders with business in diagnostic kits and dehydrated media preparation like M/s Neugen Diagnostics India Pvt Ltd; M/s Duke Thompson's India Ltd; M/s Hi-Media Pvt .; Ltd ; Mumbai and Merck Specialties Private Limited can adopt this technology without added cost in their existing facility

Business and Commercial Potential :

The technology is suitable for small and medium enterprises that can transform the process into a kit prototype for industrial application as well as can also be adopted by the dairy / food industry for regulatory compliance without added cost. The technology has the potential to replace the existing medium for *Enterococci* for being cost effective (Rs 98.3 per liter as against Citrate azide agar (CAA) available @ Rs 262.5 per liter, Bile Esculin azide agar available @ Rs 493.5per liter.

Financials :

Mention the scale for which the cost is mentioned

- ❖ Total Capital Investment(excluding Land and licensing fees) : Rs 10-15 lakh
- ❖ Capital investment in routine microbiological facility required for aseptic work which includes bio-safety cabinet, centrifuge, autoclave, pH meter, Electronic balance, Incubator, Auto pipettes, vacuum drying system etc
- ❖ Expected sale/unit: Appr. 1000 test kit per month in the beginning and may go up significantly if assay became a part of regulatory compliance

Target Market / Customer :

1. Dairy industry
2. Milk processing industry
3. Pharmaceutical units
4. FSSAI approved laboratory
5. NABL accredited laboratory
6. R & D independent test houses

Social impact of the technology :

Enterococci are used as indicators of faecal contamination of water and food and are of most interest to clinical, food and water microbiologists. Identification of Enterococci through conventional methods, by determining phenotypic characters is complicated and often requires 48 to 72 hrs. The current technology would be an alternative to existing prior art because it is real time and cost effective and simple to execute in dairy processing unit.

Limiting factors for large scale commercialization :

Modus of operandi to get clearance for product trials from stake holders before licensing / MOU agreement

Scientific Experts :
Dr. Naresh Kumar,
CCPI & P.Scientist, NDRI, Karnal

Contact - I

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Dairy Microbiology Division,
NDRI, Karnal-132001
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Ph: 08901023594

Two stage enzyme assay for detection of *L. monocytogenes* in milk

- Technology is working based on the principle of targeting “enzyme-substrate reaction for specific marker enzyme (s) to release free chromogen that can be visually detected by color change
- Assay can confirm the presence of *L. monocytogenes* with in real time of 4.30 ± 0.10 h after initial pre-enrichment of milk samples in novel selective medium i.e. LSEM for 18/ or 24h
- Appearance of black color indicates the presumptive presence of *Listeria* spp. within the given specified time limits i.e. 24 ± 2 hrs at $1.4 \log$ cfu levels for 25g/ or 23.15 ± 1.0 hrs per g of the milk sample.
- The appearance of Green colour indicates the confirmation of *L. monocytogenes* within specified time limits of 4.30 ± 0.15 hrs in lyophilized Enzyme substrates mixture/ or in 2.30 ± 0.15 hrs in Liquid form
- Technology has been validated with raw milk, pasteurised milk, ice cream, butter, cheeses etc .

L. monocytogenes is well known to cause human listeriosis with high rate of mortality up to 30%. The outbreaks are associated with the consumption of raw milk, pasteurized milk, ice cream and different varieties of cheese causing potential health concern to human beings. In recent development FSSAI has recommended to screen all milk and milk products for *L. monocytogenes* as regulatory compliance to ensure safety of consumers. In view of food safety concern and its regulatory requirements the new technology developed at NDRI has immense industrial application



Benefits / Utility :

- ❖ Effective monitoring of high-risk dairy and other food products for surveillance and safe food delivery
- ❖ Release of food products within one working day in the meet the market demand and supply for ensuring consumers safety
- ❖ Cost effective technology when compared with existing prior art
- ❖ Technology can be used as assay for detection as well as dehydrated media for enumeration purpose

Country Context :

The prevalence of *L. monocytogenes* is more in developed countries leading to regulatory compliance in national regulation FSS act 2011 enacted in our country.

Scalability :

The technology is suitable for small and medium enterprises that can transform the process into a kit prototype for industrial application as well as can also be adopted by the dairy / food industry for regulatory compliance without added cost.

Business and Commercial Potential :

Moderate business and commercial potential is significant in view of global regulatory requirements on *Listeria monocytogenes* in food products.

Potential investors to this technical innovation :

Stake holders with have business in diagnostic kits and dehydrated media preparation can adopt this technology without added cost in their existing facility.

Financials :

Mention the scale for which the cost is mentioned

- ❖ Total Capital Investment(excluding Land and licensing fees) : Rs 20-25 lakhs
- ❖ Break of capital investment in routine microbiological facility required for aseptic work which includes biosafety cabinet, centrifuge, autoclave, pH meter, Electronic balance, Incubator, Auto pipettes, vacuum drying system etc
- ❖ Variable cost (per /unit): Rs 75/-
- ❖ Break of variable cost consumables, dehydrated media, selective agent, enzyme substrates etc.
- ❖ Expected sale/unit: Appr. 1000 test kit per month in the beginning and may go up significantly if assay became a part of regulatory compliance

Target Market / Customer

1. Dairy industry
2. Milk processing industry
3. Pharmaceutical units
4. FSSAI approved laboratory
5. NABL accredited laboratory
6. R & D independent test houses

Social impact of the technology :

- ❖ *L. Monocytogenes* well known to cause human listeriosis with high rate of mortality up to 30%. The outbreaks are associated with the consumption of raw milk, pasteurized milk, ice cream and different varieties of cheese causing potential health concern to human beings. Recently, FSSAI has implemented a "zero tolerance" policy for monitoring *L. monocytogenes* in dairy products
- ❖ Enzyme-substrate assay using chromogenic and fluorogenic substrate (s) have found greater applicability in prior art for detection of high risk food borne pathogens in clinical samples, meat and dairy products, as they are rapid, sensitive and less time-consuming compared to conventional methods.

Limiting factors for large scale commercialization :

Modus of operandi to get clearance for product trials from stake holders before licensing / MOU agreement

Scientific Experts :

Dr.Naresh Kumar,
CCPI & P.Scientist NDRI, Karnal

Contact - I

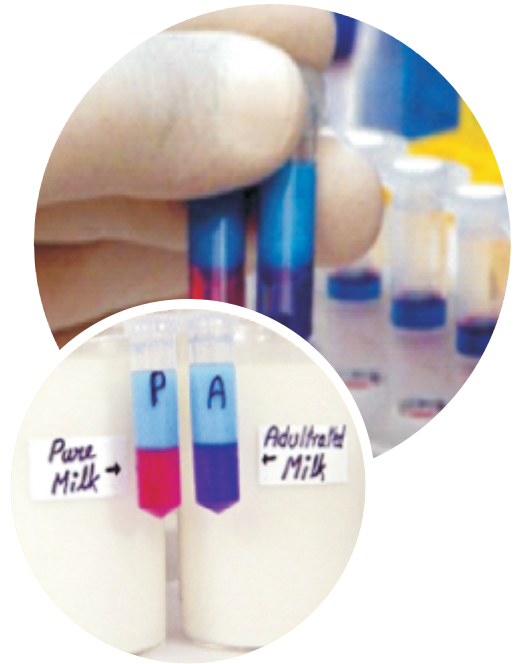
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Dairy Microbiology Division, NDRI,
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A New Colour Based Method for Detection of Detergent in Milk

The test can detect 20 mg of laboratory detergent in 100 ml of milk within 100 seconds

A rapid test for detection of detergent in milk has been developed. The test can detect all the commercially available detergent added in milk. Test just requires mixing of two solution & milk and colour is observed in lower layer. Blue colour indicates presence of detergents while purple colour confirms absence of detergent. Test can be easily used at milk collection centre, reception docks of dairy industries. Test has been validated at a NABL accredited laboratory and in commercial dairy plant.

- Newspaper report and reporting through TV channel suggest that milk is being adulterated with synthetic milk.
- It is believed that detergents are used in preparation of synthetic milk (to emulsify the extraneously added non-milk fat to milk) and therefore adulteration of milk with synthetic milk can be checked by ascertaining presence or absence of anionic detergent in milk.
- Test will assist dairy industries in ascertaining quality of milk.
- Law enforcement agencies can also adopt the test in confiscated milk samples



Benefits / Utility :

- ❖ Detection of adulteration of milk with so called synthetic milk.
- ❖ Detects all brands of commercial detergent available in the market.
- ❖ Simple to perform.
- ❖ No equipment required.
- ❖ No false positive or false negative results.
- ❖ Detection solutions are prepared from inexpensive ingredients/chemicals

Country Context :

The test can find market in India and other countries like Sri Lanka, Nepal, Pakistan, Bangladesh and Bhutan in the sub region.

Scalability :

The test kit can be made for 100 samples, 200 samples and 500 samples. There is no problem associated with scalability.

Business and Commercial Potential :

More than 700 dairy plants and 15 State Cooperative Milk Marketing Federations can be prospective buyers of the technology

Potential investors to this technical innovation :

Dairy industries. Milk processing industry. State Cooperative Milk Marketing Federations. Food Laboratories. Entrepreneurs

Financials :

Mention the scale for which the cost is mentioned

- ❖ Total Capital Investment (excluding Land and licensing fees): Rs 4.8 Lakh.
 - Break of capital investment. Building: Rs 4 lakh. Weighing balance: Rs 0.3Lakh.Furniture: Rs.0.5 Lakhs.
- ❖ Variable cost (per kit): Rs 1.60
 - Break of variable cost.
 - Solutions and reagents: Rs. 0.60
 - Micro-centrifugetubes: Rs. 1.00
- ❖ Expectedsale/unit: Rs (can take selling price of a similar product): No such product isavailable in the market. 100 kits per month, 500 test per kit, Rs. 3.00 per test (expected sale price)
- ❖ No. of units to be sold for monthly break even onvariable cost: 100 kits

Target Market / Customer

- ❖ Common person consuming milk is concerned about quality of milk and their concern will influence adoption of technology.
- ❖ All commercial dairy plants / federations. All manufacturer of kits.
- ❖ Dairy equipmentmanufacturers

Social impact of the technology :

- ❖ The test will act as deterrent for people involved in adulteration. It will help to ensure quality of milk and people will be able to consume milkfearlessly

Limiting factors for large scale commercialization :

- ❖ No limitation

There may be need of one time purchase of dispensers for dispensingmeasured volume of reagents/ milk, if not available at the place of testing.

Scientific Experts :

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Dr. Rajan Sharma, Sr. Scientist, DC Division
Mr. Amit K Barui, Ph. D Scholar

Contact - I

Dr. Y. S. Rajput

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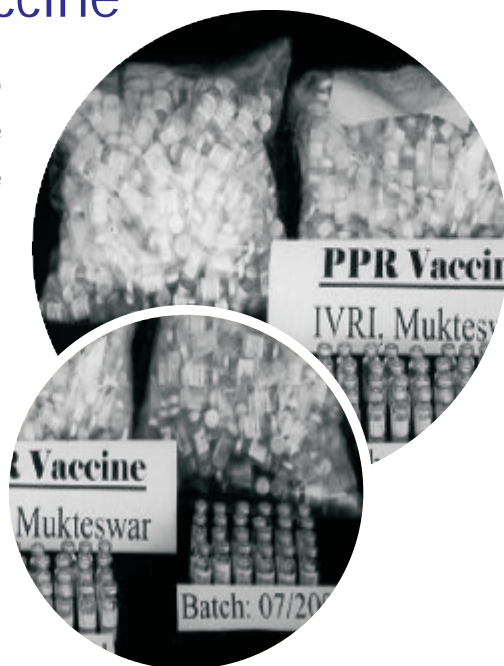
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Live attenuated homologous Peste Des Petits Ruminants (PPR) Vaccine

It is a live attenuated vaccine intended for immunization of goats and Sheep to control PPR, a viral disease commonly known as Goat plague. The vaccine developed at IVRI has been tested to conform to the specifications of the Office Internationale des Epizooties (OIE)-manual of standards for its potency, efficacy and safety. The vaccine uses an Indigenous strain namely "PPRV Sungri 96" virus and is simple to upscale. It is being used under mass immunization campaign in India and has a huge export potential.

Peste des petits ruminants (PPR) also known as goat plague is an OIE list A disease. It is widely prevalent in all parts of the country. The disease is also endemic in our neighbouring countries like Pakistan, Nepal and Bangladesh, Middle East countries and African Continent. It causes death in more than 50% of the affected animals due to high fever, pneumonia, diarrhoea and dehydration. There is a huge potential for export of PPR vaccine in many countries.



Benefits / Utility :

- ❖ PPR vaccine Induces long lasting Immunity in vaccinated animals.
- ❖ It is easy to scale up, thus it is commercially viable.
- ❖ Use of this vaccine is a sure method to protect the animal against PPR or Goat Plague.

Country Context :

According to a rough estimate, in India alone, the annual loss due to PPR in a small ruminant population of over 200 million is approximately Rs 180 crores. There is a scope for about 200 million doses annually within the country.

Scalability :

Vaccine production involves culturing of Vero cells in cell culture flasks and roller bottles. Large scale production is possible through use of roller culture method, thus it is commercially viable.

Potential investors to this technical innovation : Vaccine manufacturers, Biotech Industries, Pharmaceutical Industries in India, other Asian and African countries.

Business and Commercial Potential :

PPR/ Goat plague is prevalent both in Asian and African Continent. About 30-40 % of Goat and sheep population is replaced every year due to high fecundity and consumption. New born kids and lambs will always be available for vaccination using PPR vaccine every year. Further, there is a movement of Global PPR Eradication Program in line with rinderpest eradication programme, wherein vaccination of all goats and sheep is compulsory.

Financials :

Mention the scale for which the cost is mentioned

- ❖ Total Capital Investment (excluding Land and licensing fees) : Rs 50 Million
 - Rs 35 Million for Building, Furniture and Fixture.
 - Rs 15 Million for Equipments
- ❖ Variable cost (per month/unit): Rs 1.0 million/ 10 million Doses
 - Labour cost : Rs 0.6 Million
 - Cost of Consumables: Rs 0.25 Million
 - Electricity, water, maintenance and other cost : Rs 0.15 Million
- ❖ Expected sale/unit: Rs (can take selling price of a similar product): Rs 20 Million/month assuming selling price @ Rs 2 /Dose
- ❖ No. of units to be sold for monthly break even on variable cost: 0.5 Million Doses of Vaccine

Target Market / Customer

All animal vaccine manufacturers in India other Asian and African countries are the target customers, as this disease is prevalent in Asia and Africa. Highest annual demand may be around 200 million doses/ annum in India and 200 million doses in other Asian countries. Similarly around 400 million Doses may be required in various African countries on annual basis.

Social impact of the technology :

PPR is one of the most economically important disease of small ruminants because of high morbidity and mortality losses. The disease affects the economy through lowering the productivity, mortality and treatment costs. The disease also brings about international trade restrictions, as disease-free countries are reluctant to import the animals and animal products from the countries where the disease is endemic. Hence vaccination of goat and sheep population is expected to significantly contribute to productivity of small ruminants. Use of this vaccine at large scale in few states has already brought down disease intensity to 25%. Large scale application of technology may be an important component on poverty alleviation program in the country.

Limiting factors for large scale commercialization :

Practically there is no limit for large scale commercialization of this technology as it has already been commercialized to 5 organizations and is in large scale application. Following improvements will further enhance the value of technology.

1. Development of a marker vaccine, which can differentiate vaccinated and Infected population.
2. Development of a more thermos table method for use of this vaccine.

Scientific Experts :

Dr. B. P. Sreenivasa, *Principal Scientist*
Dr. R. P. Singh, *Principal Scientist*
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Aerial Insect Trap

For sampling air born insects (particularly aphids)

Aerial Insect Trap had been designed, fabricated and standardized. The trap is effective in sampling the air and trapping the air born insects. It is zero energy based trap. The natural wind energy rotates it.

Insect pest monitoring is vital for taking right decision at right time. The philosophy of pest control has undergone a radical change in the light of the limitations of chemical pesticides, their environmental hazards and other devastating side effects. There has been shift from scheduled pesticide sprays to the determination of economic threshold level of pest before venturing into any control measures. Estimation and evaluation of pest population is, therefore, cardinal in decision making process for pest control interventions in pest management programmes. A number of insect sampling tools are available viz., visual observation, insect light trap, pheromone traps, sticky traps; all have advantages and limitations together. Therefore, a new zero energy sampling tool- "Aerial Insect Trap" was invented, developed, standardized and patented.



Benefits / Utility :

- i) It is zero energy trap moves with the help of air thrust.
- ii) One can increase the height of the trap by doing adjustment in the telescopic arrangement as per the requirement of the crop (crop growth).

Country Context :

India

Scalability :

For Small to Medium scale Entrepreneurs.

Potential investors to this technical innovation :

For Small to Medium scale Entrepreneurs engaged in the agriculture business.

Business and Commercial Potential :

Approx. Rs. 10 lakh.

Financials :

Mention the scale for which the cost is mentioned: Small/Medium/Large Scale

For Small to Medium scale

Target Market / Customer

SAUs/ICAR/State Govt./NGO/Entrepreneur

Social impact of the technology :

- i) It helps in sampling air born insects (particularly aphid) on crops (mustard).
- ii) It helps in advising the farmers whether to apply pest management strategy or not depending upon pest's incidence on the crops.
- iii) One trap per village can indicate the initiation of pest attack in that particular village and thus it is an economical way of estimating the pest infestation in the area.

Limiting factors for large scale commercialization :

It is target specific gadget required only in limited quantities.

Already commercialized

Scientific Experts :
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Autoclavable microencapsulator

Unique autoclavable system for production of microencapsulated ingredients.

The microcapsules are produced using two fluid glass nozzle atomizers of different configurations in which the pressurized air or inert gas is used to break up the jet of matrix fluid (solution of sodium alginate/ chitosan/ carageenan/combination of these alone along with some other filler material such as starch to impart controlled release properties). The kinetic energy of high pressure air or inert is used for breakup of matrix fluid jet. The small droplets produced fall in reaction vessel. The reaction vessel contains divalent cations or polycationic substances; which results in ionotropic gelification yielding microcapsules.

The Microencapsulator is designed for production of wet alginate microcapsules ranging in size from 1500 μm down to around 50 μm .

Microencapsulation paves way for development innovative functional foods. Microencapsulation is progressively attracting the interest of food ingredient manufacturers as a way of achieving much-needed differentiation and enhancing product value. With the growing urbanization and increasing quality consciousness the market for processed foods and functional foods is expected to grow more rapidly.



Benefits / Utility :

- ❖ Useful in preparing functional foods and will ultimately lead to better health and nutrition.
- ❖ Microencapsulated ingredients can be used to
 - Mask undesirable flavours.
 - Prevent chemical reactions.
 - Improve delivery, control delay.
 - Increase stability of finished product.
 - Reduce production losses.
 - Increased quality of finished product.
 - Increase plant capacity without capital expense.
 - Improve production yield.
 - Increase saleable products and increase profit.

Country Context :

Functional foods are becoming popular with the health conscious people and the microencapsulation will lead to the development of innovative functional foods.

Scalability :

The capacity of the system is 3 kg of wet alginate microcapsules per batch.

Business and Commercial Potential :

- ❖ Autoclavable system.
- ❖ Preparation of innovative functional foods and other ingredients.

Potential investors to this technical innovation :

Suitable for industries and entrepreneurs involved in the production of innovative functional foods and microencapsulated ingredients.

Financials :

Mention the scale for which the cost is mentioned (15 Units/year)

Suitable for entrepreneurs having a workshop and already fabricating food processing machineries.

- Total Capital Investment(excluding Land and licensing fees) : Rs 33,00,000
- Break up of capital investment:
- Custom hiring charges (For workshop): Rs: 1,00,000
- Technical knowhow: Rs 2,00,000
- Fabrication material: Rs 30,00,000
- ❖ Variable cost (per /unit): Rs 69000/-
- Break up of variable cost
- Labour: Rs 8000/-
- Utilities: Rs 7000/-
- Raw material: Rs:50000 /-
- Others: Rs: 4000/-
- ❖ Expected sale/unit: Rs (can take selling price of a similar product): Rs 4,00,000
- ❖ No. of units to be sold for monthly break even on variable cost: 2

Target Market / Customer

- ❖ Industries and entrepreneurs engaged in the production of microencapsulated ingredients.

Social impact of the technology :

Microencapsulated ingredients can be used to

- ❖ Mask undesirable flavours.
- ❖ Prevent chemical reactions.
- ❖ Improve delivery, control delay.
- ❖ Increase stability of finished product.
- ❖ Reduce production losses.
- ❖ Increased quality of finished product.
- ❖ Increase plant capacity without capital expense.
- ❖ Improve production yield.
- ❖ Increase saleable products and increase profit.

Limiting factors for large scale commercialization :

- ❖ Low margins to manufacturers of functional foods

Scientific Experts :

Kairam Narsaiah,
Shyam Narayan Jha,
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Makhana popping and decortication machine

This machine is able to roast and pop the makhana kernel and produce high amount of grade I popped kernel.

The newly developed makhana popping machine is able to roast and pop the kernel at about 35-40kg raw wet seeds per hour and produce high amount of grade I popped kernel. It has replaced manual roasting and popping operations. The machine consists of a hopper, screw conveyor type roaster (having two continuous barrels of 1m length, one roaster is heated with thermic oil (3kW) and other roaster by mounting three band heaters of 3kW). The screw is rotated by belt pulley drive with motor of 0.5 to 1hp power. The residence time of roasting in barrel is controlled by controlling the speed of belt and pulley drive. Working temperature of both roasters varies between 200-340°C. Power supply to all heaters should be controlled through individual switches. Temperature of both roasters should be controlled using good quality temperature controller cum indicators. Speed of the screw conveyor should vary between 10-50 RPM.

Makhana is a popped kernel of seeds of an aquatic fruit called gorgon nut (*Eurya ferox*). It is considered to be a highly nutritious dry fruit grown mainly in Bihar, Assam, some parts of UP, West Bengal, Tripura, J&K, etc. Its popped fruit is being marketed throughout country as dry fruits and is also exported in substantial amounts. Its value added products such as instant makhana kheer mix, salted and sweetened makhana etc. For which popped makhana is used as main base material are also being made and sold by various entrepreneurs engaged in food industries.



Benefits / Utility :

- ❖ Mechanized process
- ❖ Reduces time of processing
- ❖ Reduces the drudgery of the labourers.
- ❖ Production of high amount of grade I kernel.
- ❖ High throughput
- ❖ Decortication is also possible.
- ❖ Energy saving.

Country Context :

The production catchment consists of Bihar, Assam, some parts of UP, West Bengal, Tripura, J&K, etc. Its wild form is also available in China, Japan, Taiwan etc. where seeds are not popped but technology can be disseminated

Scalability :

- The newly developed makhana popping machine is able to roast and pop the kernel at about 35-40kg raw wet seeds per hour and produce high amount of grade I popped kernel.

Business and Commercial Potential :

Industries involved in the production of value added products such as instant makhana kheer mix, salted and sweetened makhana etc. for which popped makhana is used as main base material. Popped makhana is used almost in all religious rituals and exported to many countries.

Potential investors to this technical innovation :

Industries involved in the production and marketing of popped makhana, its value added products such as instant makhana kheer mix, salted and sweetened makhana etc. for which popped makhana is used as main base material.

Machinery manufacturers/fabricators may be potential buyers of drawing and design for commercialization.

Financials :

Mention the scale for which the cost is mentioned (20 Units/year)

Suitable for entrepreneurs having a workshop and already fabricating food processing machineries.

- ❖ Total Capital Investment(excluding Land and licensing fees) : Rs 21,65,000
 - Break up of capital investment
 - Custom hiring charges (For workshop): Rs: 4,00,000*
 - Technical knowhow: Rs 1,65,000*
 - Fabrication material: Rs 16,00,000*

- ❖ Variable cost (per /unit): Rs 25000/-
 - Break up of variable cost
 - *Labour: Rs 10,000/-*
 - *Utilities: Rs 5,000/-*
 - *Raw material: Rs: 5000/-*
 - *Others: Rs: 5000/-*

- ❖ Expected sale/unit: Rs (can take selling price of a similar product): Rs 2,00,000
- ❖ No. of units to be sold for monthly break even on variable cost: 03

Target Market / Customer

- ❖ Makhana processors
- ❖ Wholesalers of makhana
- ❖ Makhana farmers

Social impact of the technology :

- ❖ It is a Mechanized process reducing the time of processing as well as the drudgery of the labourers.
- ❖ Production of high grade makhana
- ❖ Reduction in carbon credit.

Limiting factors for large scale commercialization :

- ❖ Demand is limited to 100 units/year
- ❖ Seasonal availability of makhana

Scientific Experts :
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Pomegranate Aril Extractor

The machine is capable to process the whole pomegranate at a rate of approximately 30-35 fruits per minute.

The "Pomegranate Aril Extractor" relates to a mechanical and continuous system for processing of whole Pomegranate of any size, shape and variety; and for recovery of clean, whole and undamaged arils. The system comprises the essential components such as Pomegranate Fruit Breaking unit, Drive unit, Collection Trays where separated arils and extraneous matters are received, Vibrating Sieve unit; and the clean arils and extraneous matter Collection troughs. The fruit breaking unit consists of innovative mechanisms with knives arrangement to continuously break the fruit in such a way that the major portion (85-90%) of arils is safely separated out from the broken peels. The rest of the arils that is about 10-15% remains attached with the peels are further getting separated over the vibrating screen designed specifically for this purpose. The machine is capable to process the whole pomegranate at a rate of approximately 30-35 fruits per minute with extraction capacity of 90-94% and with little damage of arils that is about 2-4%.



Pomegranate arils are not consumed mostly because of the cumbersome process of removing arils from peel.

Benefits / Utility :

- ❖ The whole Pomegranate breaking and arils separation mechanism is highly efficient with little damage and waste.
- ❖ The machine provides continuous operation for rapid processing of large quantities in any shape, size and variety of the Pomegranate. •The peels and other extraneous matter are separated out and yielding clean arils that can be used for further processing or for fresh eating/marketing

Country Context :

Owing to the cumbersome process of removing the arils from peels, pomegranate arils are not consumed.

Scalability :

- ❖ Higher aril extraction capacity that is around 5.0 quintal per hour (approximately 35-40 fruit per minute)
- ❖ Aril extraction/separation efficiency is in the range of 90-94% depending on variety and Pomegranate characteristics
- ❖ Mechanical damage received by arils is only 2-4%
- ❖ Man power required for safe and smooth running of "Pomegranate Aril Extractor" is 2-3 persons
- ❖ Electrical power required- 0.75 kW (1.0hp)
- ❖ Over all dimension; Length-1480mm, Width-660 mm, Height-1710mm

Potential investors to this technical innovation :

The technology of aril extraction is beneficial for the agro-entrepreneurs and farmer-entrepreneurs

Business and Commercial Potential :

- ❖ The technology is helpful in creating market for Pomegranate arils which are not consumed mostly because of the cumbersome process of removing arils from peel.
- ❖ Secondly the fresh fruits can be processed for fresh and frozen arils and packed, resulting in reduced post harvest losses. •The separated arils can be further processed for juice, dried arils, jellies etc.
- ❖ Thus the machine provide opportunity for establishing a processing industry for pomegranate & in that way enhancing the income of the farmers by producing more fruits for processing.

Financials :

Mention the scale for which the cost is mentioned

- ❖ Total Capital Investment (excluding Land and licensing fees) : Rs 47,36,028
 - Break up of capital investment
 - Fixed capital
 - Machinery and equipment: 25,50,000*
 - Working capital
 - Staff and labour cost (per month) +Raw material (per month) + Utilities+ other expenses = Rs 4,92500 (Rs 1477500/- For three months)*
 - Variable cost (per month/unit): *Rs 1477500/- For three months*
 - Break up of variable cost: *Staff and labour cost (per month) +Raw material (per month) + Utilities+ other expenses = Rs 4,92500*
- ❖ Expected sale/unit: Rs (can take selling price of a similar product): Rs 1,05,00,000 (30Nos @Rs 3,50,000)
- ❖ No. of units to be sold for monthly break even on variable cost:2
- ❖ Payback period:0.44 year.

Target Market / Customer

The technology of aril extraction is beneficial for the agro-entrepreneurs and farmer-entrepreneurs

Social impact of the technology :

- ❖ Creating a market for Pomegranate arils which are not consumed mostly because of the cumbersome process of removing arils from peel.
- ❖ The fresh fruits can be processed for fresh and frozen arils and packed, resulting in reduced post harvest losses.
- ❖ The separated arils can be further processed for juice, dried arils, jellies etc.
- ❖ Thus the machine provide opportunity for establishing a processing industry for pomegranate & in that way enhancing the income of the farmers by producing more fruits for processing.

Limiting factors for large scale commercialization :

Pomegranate is a seasonal fruit, hence, the machine will be of use only in the production period of pomegranate.

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Cryogenic Grinding Technology

Cryogenic grinding of spices for better flavour and taste

The main processed product of spices is ground powder. Adding value to processed product largely depends on the ability to retain of original flavour and medicinal properties of spices. The aim of grinding is to obtain smaller particle size with good product quality in terms of flavour and aroma or colour. Processed spices demand is directly linked with its consumption in food processing industry and this is set to grow in India in coming period with growth of population and fast changing food habits as well as increase in spending power of middle and upper class in India.

Seed spices are known for their pleasant aroma and medicinal properties. In the normal grinding process, heat is generated when energy is used to fracture a particle into a smaller size. This generated heat is responsible for loss of volatile oil and produces dark coloured powder. The loss of volatile can be significantly reduced by cryogenic grinding technique using liquid nitrogen.



Benefits / Utility :

- ❖ Improves the aroma by minimizing the loss of essential oils
- ❖ Reduced oxidation of spice oils and increased stability
- ❖ Better natural colour,
- ❖ Finer particle size can be achieved
- ❖ Overall grinding capacity can be increased by 2 to 3 times
- ❖ Absolute control of particle size, shape and distribution

Country Context :

India and developing countries

Scalability :

- ❖ The technology is very much scalable
- ❖ The technology can be scaled up as per the demand

Potential investors to this technical innovation :

Food processors

Business Potential :

The technology is useful for spices as well as herbs of medicinal importance

Market potential :

Tremendous potential in food processing industries and pharmaceutical companies

Financials :

Value of the technology:

Financial Requirement:

Fix assets (Land and Building) = Building Area (Length: 20 x 20 x16 Feet): 6.00 lakh

Machinery = Rs. 32 Lakh for 50 Kg/hr and 72 lakh for 200 kg/hr

Manpower= Rs. 6 Lakh PA

Other contingency:12.0 lakh PA

Total Cost: Rs. 56 or 96 lakh Lakh

Target Market / Customer :

- ❖ Exporters and processors
- ❖ Nutraceutical
- ❖ pharmaceutical companies

Social impact of the technology :

India is the largest exporter of raw spice and earns considerable foreign exchange. Value-addition to spice in general is need of time to ensure more profit in domestic and international spice trade. This will not only provide better quality spice products to end user but also help spice growers to improve their livelihood and life.

Limiting factors for large scale commercialization :

There is no limiting factor in large scale commercialization

Spices are used in whole, grounded form-pure and also forms part of various blended special purpose spices, which are used to add flavours to various dishes throughout India and Asia. India despite being the largest producer of seed spices could not exploit their value-addition potential as majority of export is in the form of raw produces. There is a great potential for increasing export of Indian spices in the form of value-added products. To realize this potential, there is need to enhance the quality as per the international standard through post-harvest technology and value-addition at different level of post-production system. This technology will not only provide better quality spice products to end user but also help spice growers to improve their livelihood and life.

Scientific Experts :
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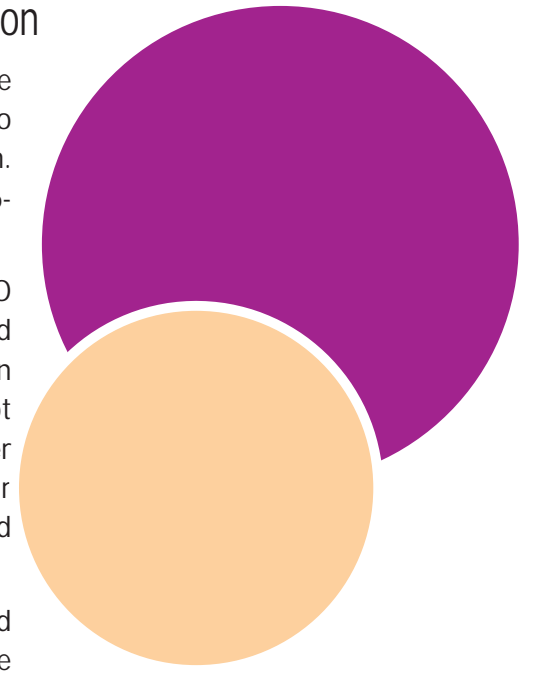
Essential Oil Extraction from Seed Spices

Efficient, cost effective technology for essential oil extraction from seed spices and making double distilled water for arid and semi arid region

NRCSS developed an indigenous technology by which we can cool the discharged water from Clevenger apparatus and again feed this to condenser of the system. Moreover at a time 6-7 apparatus can be run. Almost 100 liter of water is sufficient for running 6-7 apparatus for whole day (6-8 hr). Using this technology we can extract essential oil from 15 samples per day.

The similar technology can effectively be used for making distilled water. RO based technology is not suitable for making distilled water from underground saline water which is very common in arid and semi arid areas. Steam distillation method using all glass apparatus provide good quality water but consume a lot of water for steam condensation. Using our technology one can produce 20 liter double distilled water in a day with consumption of less than 100 litre water for condensation. This technology will be very useful where water is scarce and ambient temperature is very high.

Essential oil is the key compound for flavor and aroma in seed spices crops and responsible for the quality of any spice crop. Extraction of essential oil is done using all glass Clevenger apparatus. This apparatus needs boiling of ground spice in distilled water and condensation of steam with cold water running through glass condenser. Extraction of oil from one sample takes almost 3-4 hrs with consumption of significant amount of water needed for condensation. Further, during the months of March to August the water stored in roof tanks become so hot that is unable to condense the steam. For this problem some companies advise to use heat exchanger for which they charge around Rs. 70000-80000 or even more.



Benefits / Utility :

- ❖ This is a cost effective technology
- ❖ May be used in less advance laboratories
- ❖ The similar technology can effectively be used for making distilled water
- ❖ Suitable for arid and semi arid regions
- ❖ Suitable for the places where water availability is less

Country Context :

India and developing countries

Scalability :

- ❖ The technology is very much scalable
- ❖ The technology can be scaled up as per the demand

Business Potential :

The technology is useful for extraction of essential oil from spices as well as herbs of medicinal importance

Market potential :

Tremendous potential in food processing industries and pharmaceutical companies

Potential investors to this technical innovation :

Food processors

Financials :

Value of the technology: Rs 1.0 lakh (Non exclusive license)

Financial Requirement:

Rs 5000-10000

Target Market / Customer

- ❖ Exporters and processors
- ❖ Nutraceutical
- ❖ Pharmaceutical companies

Social impact of the technology :

Rajasthan and Gujarat state cover a large geographical area fall under arid and semi arid climatic conditions. Apart from this part of Haryana, UP, MP AP, Maharashtra and Tamil Nadu falls under semi arid regions. Availability of water for drinking and other purpose is becoming lesser and shrinking due to uncertainty of monsoon and global warming. Many important scientific institutes engaged in research and development is situated in these areas.

Limiting factors for large scale commercialization :

There is no limiting factor in large scale commercialization

NRC on Seed Spices, Ajmer is also situated in semi arid tract of Rajasthan. Essential oil extraction is a fundamental process for evaluating quality characteristics and germplasm assessment. A good number of samples have to be evaluated for essential oil content in available germplasm of seed spices on routine basis. Available technology is not suitable for extraction of oil from a large sample group.

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