Technology Advancement in Commercialization of Biopesticides: A Potential Agribusiness Venture

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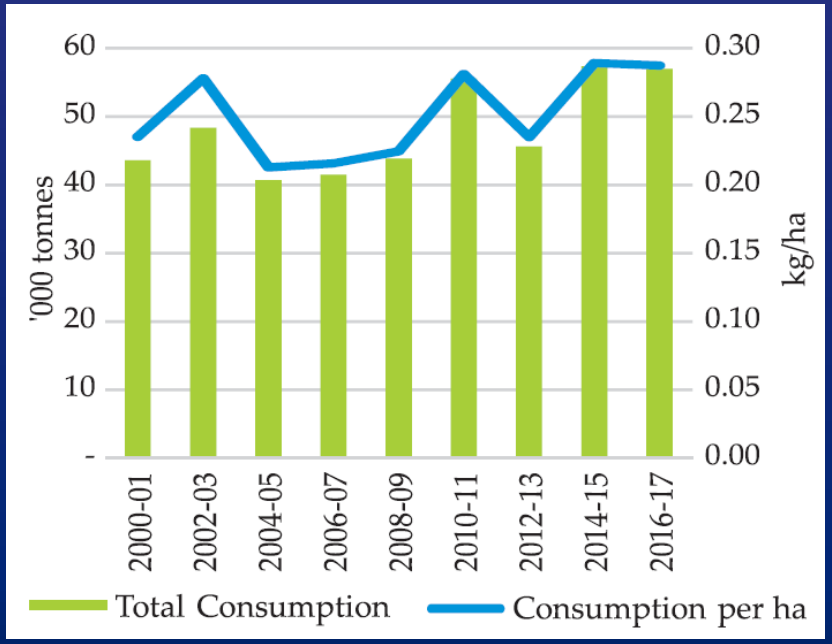
ARE YOU SURE YOUR FOOD IS FREE FROM PESTICIDES?

Pesticides

- Agriculture in developing countries - suffers - high incidence of various pests.
- In India, estimated annual production losses due to pests are as high as **US$ 42.66 million** (Sushil, 2016).
- Chemical pesticides are well known for their effectiveness, their **impact on soil & environment, & presence of residue in food products** are matters of concern.
- **Acute toxicity due to handling & application; globally estimated at 3 million with 220,000 deaths**
- 25 million agricultural workers seek medical attention for pesticide poisoning; health problems (nephritis, immunosuppression)

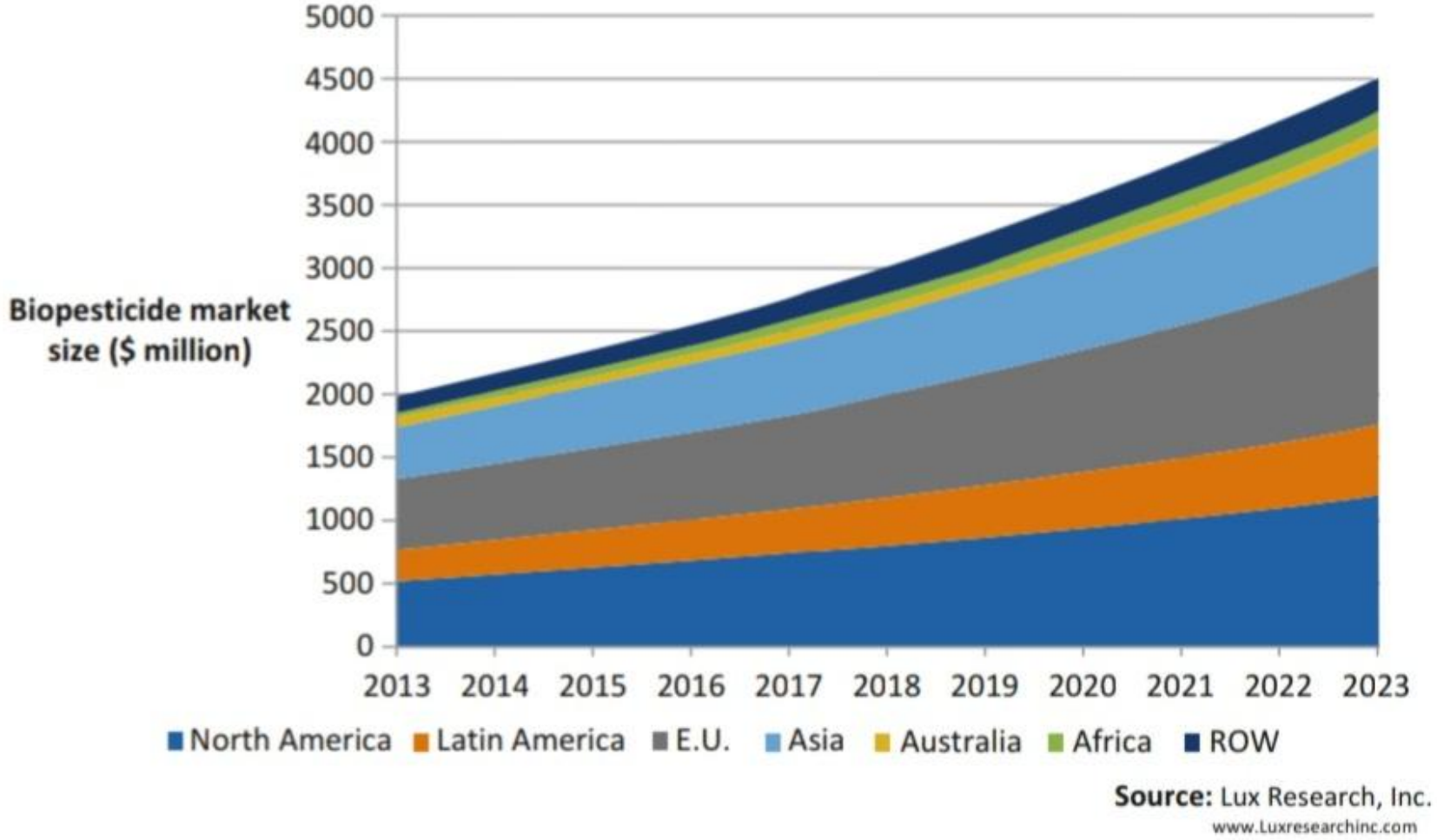
Trend in consumption of pesticides (technical grade) in India



Source: Technical Report: 2017 by ICAR.
Pesticide Use in Indian Agriculture: Trends, Market Structure and Policy Issues

Biopesticides

- **Biopesticides comprisie 5% of total crop protection market globally . In India only 3%**
- **Biopesticides will equalize with synthetics between 2040 to 2050.**
- **In India 287 pesticides are registered for use & technical pesticides are manufactured indigenously. only ~14 biopesticides have been registered with CIBRC.**
- **Biopesticides production is 4.2 % of the overall pesticides market in India.**
- **Presently 12 types of biopesticides are registered (Insecticide Act 1968).**



Estibalitz, 2017

Fig. 4.1 The biopesticide market is approximately $3 billion today and will rise above $4.5 billion by 2023

Biopesticides

- **Mass-produced agent manufactured from a living microorganism or a natural product & sold for the control of plant pests**

- **An entomopathogenic organism should be highly specific & effective against the target pest & should be successfully produced.**

- **Biopesticides fall into three different types according to the active substance: (i) microorganisms; (ii) biochemicals; (iii) semiochemicals.**

- **Bt**
- ***Metarhizium anisopliae***
- ***Trichoderma harzianum***
- ***Pseudomonas fluroscens***
- ***Isaria fumosorosea***
- **NPV**
- ***Pochonia chlamydosporia***
- **EPN**

Bacillus thuringiensis (Strain: NBAIR-BT25) Liquid Formulation for control of FAW *Spodoptera frugiperda*

- Field trial in Maize at farmer's field in Karnataka, Odisha & AP showed 75 to 85% decrease in pest incidence over control.

- **Novelty:** Cheap, Shelf life 1-2 years, highly toxic & can replace synthetic chemicals.

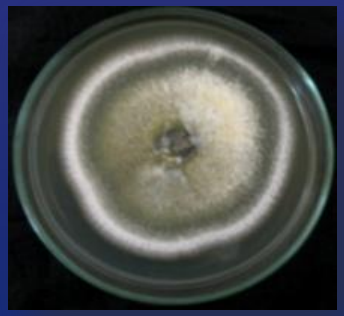
- Technology for liquid formulation is new.
- DNA fingerprint for NBAIR-BT25 obtained from NBAIM, MAU.
- Ribosomal RNA gene, 16S partial sequence submitted to GenBank: MN327970.1

- Toxicology data needs to be generated

- **Dossier is uploaded for CIBRC registration on emergency basis.**

Metarhizium anisopliae (Strain: ICAR-NBAIR Ma 35) for management of Fall armyworm *S. frugiperda* in maize

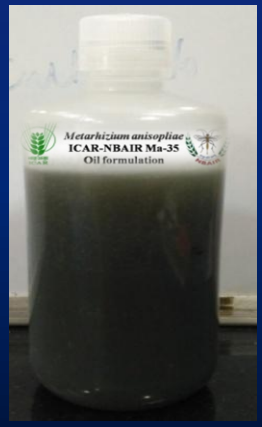
- Lab bioassays conducted (70% mortality)
- Field Efficacy data generated at 2 locations (Bangalore, Karnataka & Anakapalli, A.P) for 2 years (2018-19 & 2019-20)
- 50-76% reduction in the pest damage
- Yield- increased by 20-50%
- Talc/Oil based formulations developed & Shelf life studies completed
- Toxicology data has to be generated
- Dossier is uploaded for CIBRC registration on emergency basis.



M. anisopliae Ma-35

Mycosis on FAW

Talc formulation



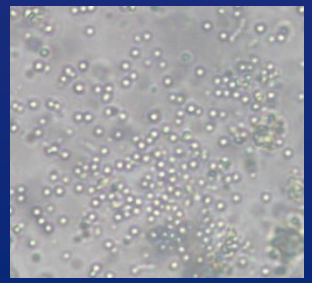
Oil formulation

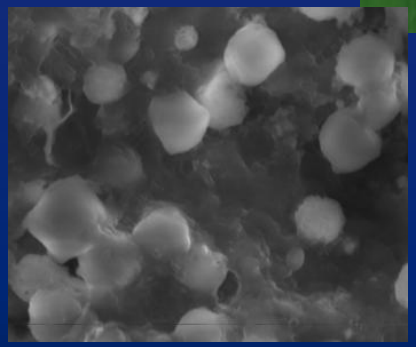
Spodoptera frugiperda nucleopolyhedrovirus (Strain: SpfrNPV NBAIR1) for the management of FAW

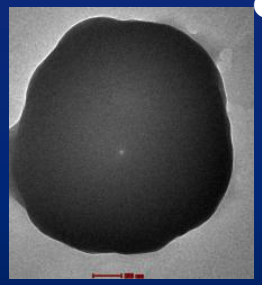
Field validation at 5 states indicated 69 to 83 % pest reduction of FAW

Lab & field efficacy data & DNA ginger printing available

Dossier is ready to be uploaded for CIBRC registration on emergency basis



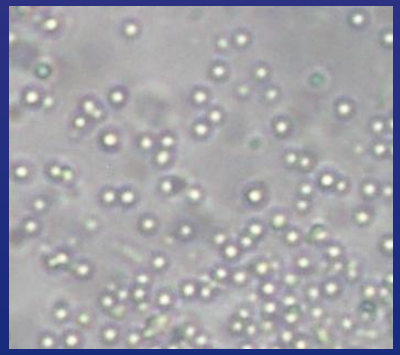




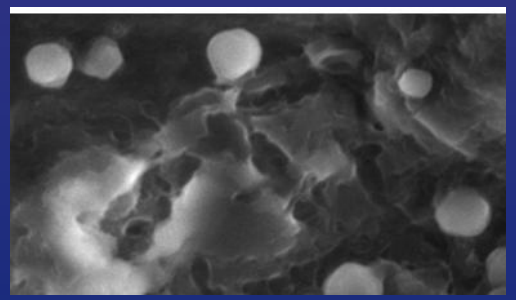
Charcterization and Bioassay of *Spodoptera frugiperda* nucleopolyhedrovirus (SpfrNPV) against maize FAW *Spodoptera*

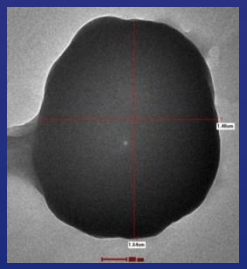
NPV infected Sf larva

NPV suspension



Occulution Bodies under Light microscope

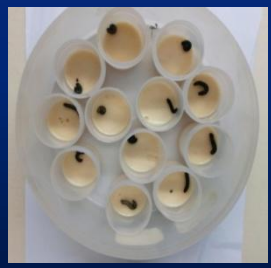




Occulution Bodies under elctron microscope

Bioassay

Instar	Number of larvae used	LC_{50} POBs/mm^2 (6th day)	Slope ± SE	Fiducial limits		χ^2	DF
				Lower	Upper		
1st instar	240	4.71	1.12±0.12	2.231	8.301	1.31	4
2nd instar	240	5.49	0.90±0.11	2.832	11.205	7.20	4
3rd instar	300	6.02	1.0±0.12	3.721	13.330	3.32	4



All the three early instars of FAW were equally susceptible to Spfr NPV (LC_{50} 4.71 to 6.02 POB/ mm^2)

Parasitism by egg parasitoids, *Trichogramma* sp. & *Telenomus* sp. on the eggs of fall armyworm

***Trichogramma* sp.** ***Telenomus* sp.**

Potential entomopathogenic fungus, *Isaria fumosorosea* (Strain ICAR-NBAIR Pfu-5) for the management of rugose spiralling whitefly in coconut & oil palm)

• Developed Talc (2.0% Wettable Powder) & oil based formulation having longer self-life, persistence & higher bio-efficacy as per CIBRC.

➢ Standardized the optimum dosage for foliar application & minimum spray requirement.

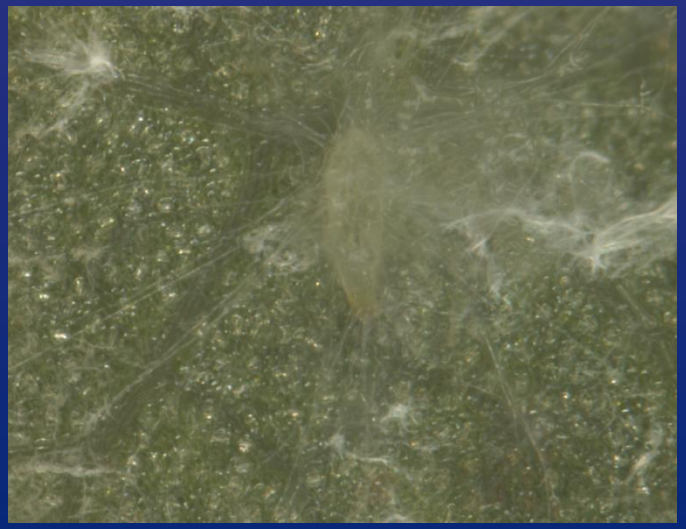
➢ Efficacy about 72-76% mortality in RSW population in coconut & oil palm. Has a wide scope of commercialization & there is a high demand for management of RSW.

➢Eco-friendly, safe & do not have any adverse effects on non-target organisms in coconut & oil palm ecosystem.

Equally effective as chemical insecticide & cheaper than chemical insecticides.

Lab & field efficacy data & DNA finger printing available

Isaria fumosorosea infection on life stages of RSW



Field experiment: After two sprays of *Isaria fumosorosea*

August, 2018

December, 2019

Novel insecticidal formulation of *Heterorhabditis indica* (Strain NBAII Hi1) for the biological control of insect pests

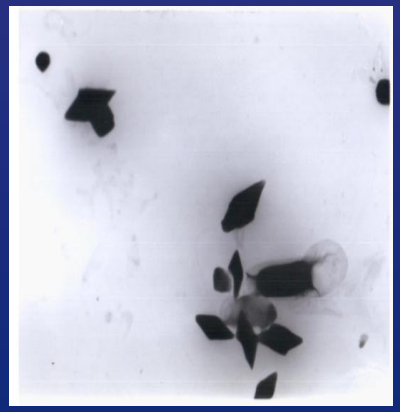
- **WP formulation- Effective for controlling a variety of insects especially for whitegrubs & other soil insects.**
- **Formulation comprising IJs mixed with amorphous, wettable silicate mix powder (90% viable even after 8-12 months of storage) (25°C to 37°C).**
- **Scalability : Around 20,000 litres/annum**
- **No CIBRC registration required for commercialization**

Liquid formulation indigenous *Bacillus thuringiensis* (Strain: NBAII-BTG-4) against lepidopteran pests

- Liquid formulation of *Bt* have mostly replaced WP in the market (easier to use & less expensive).
- Water based flowables are an industrial favourite because of ease of mix & without drying & milling.
- Technology based on indigenous toxic strains of *Bt*
- Formulated based on maximum sporulation & crystal formulation & also a stable water based flowable formulation.

Liquid formulation indigenous *Bt* (contd)..

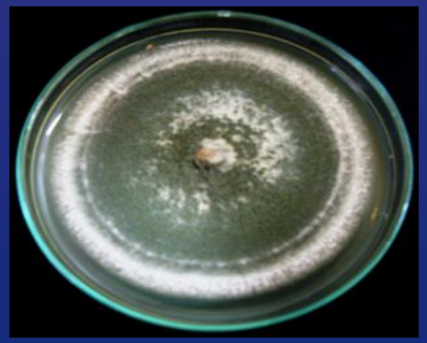
- **Highly toxic to Diamond back moth & *Helicoverpa armigera* than HD-1.**
- **Lowest pod damage (4.0 %) was recorded in pigeon pea compared to control (33.0 %).**
- **Multilocational field trails carried out at 8 AICRP centres revealed effective reduction in pod damage of pigeon pea with NBAII-BtG4 (2%).**
- **Highest grain yield of pigeon pea was recorded in application of NBAII-BtG4 sprayed at 2%.**
- **<u>Complete Dossier ready for CIBRC registration</u>**



Novel WP formulation of *Pochonia chlamydosporia* (Strain: NBAII PC 55) for biological control of plant parasitic nematodes (PPN)

- **Product is a silicate mix based formulation containing viable, biologically active & resistant chlamydospores effective against root-knot & cyst nematodes in tomato, brinjal, capsicum, rice & bhendi.**
- **Offers immense scope for commercial production & large scale use in field as alternative to chemical control.**
- **Chlamydospores are produced using highly productive, simple, demarcated & cost effective using solid state fermentation**
- **Formulation developed is contamination free due to sophisticated downstream processing & has the shelf life of 14-18 months.**
- **Complete Dossier is ready for CIBRC registration**

Metarhizium anisopliae (Strain: ICAR-NBAIR Ma 4) for management of white grubs in sugarcane



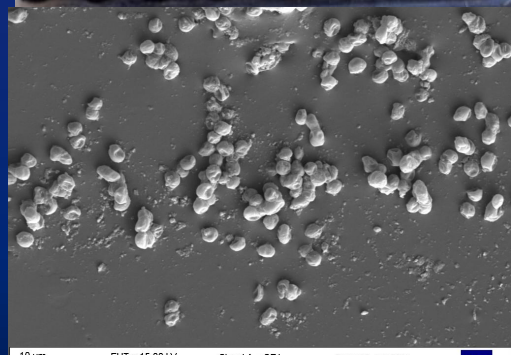
- *Holotrichia* spp. are polyphagous pests causing severe damage to several crops in India.
- *M. anisopliae:* Extensively used for management of root grubs in various crops.
- Highly effective against white grubs in sugarcane & its efficacy was on par with chemical insecticide in the field trials.
- Talc based formulation was developed & soil application method & the dose was standardized.
- 70-90% reduction in the plant damage & increased yield by 40-50%.
- Can be scaled up to large quantities using large-scale fermenters of 500-1000 lit. cap.
- **Complete Dossier ready for CIBRC registration**

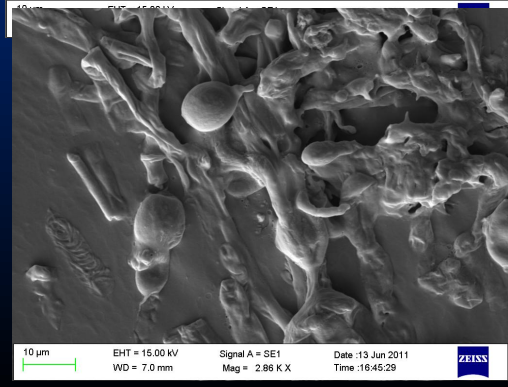
Powder based formulation of *Pseudomonas fluorescens*, a DAPG producing abiotic stress tolerant for rain fed & stressed agricultural soils

- **Bacterium survived in high temperature (50 °C), salinity (1.5M NaCl) & drought tolerance (up to -10.28 Mpa).**
- **Produced plant growth promoting enzymes (phosphatases, proteases, chitinase, cellulase & ACC deaminase).**
- **Produced secondary metabolites (HCN) -involved in disease management.**
- **Effectively inhibited *Sclerotium rolfsii, Rhizoctonia solani* & *Fusarium oxysporum*.**
- **Produce DAPG which makes it effective against major plant fungal pathogens.**
- **Isolate can be used in disease management of pulses, rice, legumes & vegetables grown in rain fed & stressed soils.**
- **<u>Complete Dossier ready for CIBRC registration</u>**

Bioformulation of salinity tolerant *Trichoderma harzianum* (Strain NBAII-HAR-16B) against plant diseases

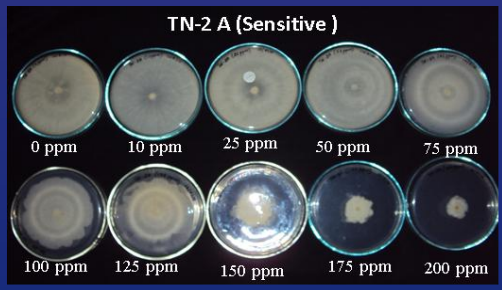
- Has the salinity tolerance (up to 2 M NaCl).
- Effective against soil borne diseases of groundnut & sorghum (*Macrophomina phaseolina*, *Sclerotium rolfsii* & *Aspergillus* spp.
- Induces tolerance in plants as seed treatment/soil application & protects against salinity (4800 ppm of NaCl in soil).
- Field trials at 9 locations showed the efficiency in controlling the soil borne pathogens in groundnut.
- Complete Dossier ready for CIBRC registration

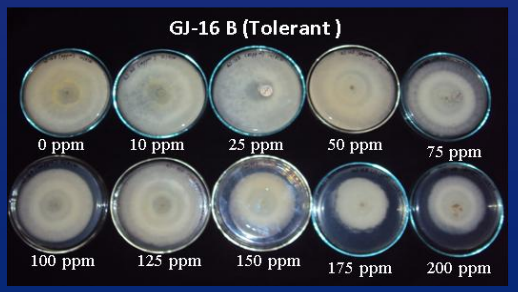




Bioformulation of carbendazim tolerant *T. harzianum* (Strain NBAII-GJ1-16B) against plant diseases

- **Carbendazim tolerance up to 500 ppm**
- **Good biocontrol potential against soil borne pathogens (groundnut & sorghum).**
- **Tolerant to Carboxin, Oxycarboxin & Imidacloprid.**
- **Field trials at 9 locations clearly showed the efficiency of the formulation in controlling the soil borne pathogens in groundnut.**
- **<u>Complete Dossier ready for CIBRC registration</u>**

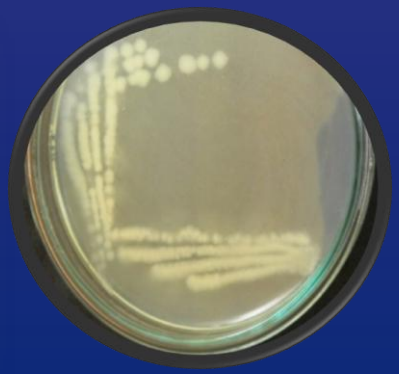




Wettable Powder formulation of *Bacillus megaterium* (Strain: NBAII 63) for the growth & management of Bacterial wilt disease

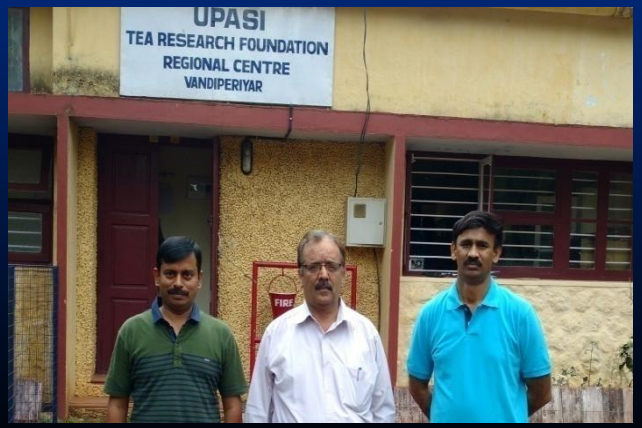
- Effective against *Ralstonia solanacearum* in tomato & brinjal.
- Dosage & methods of application against bacterial wilt disease standardized.
- Shelf life 8 months.
- Growth & yield of the plants is enhanced due to the phosphate solubilisation ability.
- Play a major part in the organic production of tomato & brinjal.
- Farmer can reduce the cost by 25% for bacterial disease management.
- **CIBRC registration not required for commercialization**

Bioformulation of *Bacillus subtilis* (Strain-NBAIR BS1) for the growth promotion & management of Tea Shot Hole Borer *Euwallacea fornicatus*



Field trails showed 68% reduction of shot hole borer

CIBRC registration not required for commercialization



Novel Mass production Technology for Parasitoid *Encarsia guadeloupae* for the Suppression of Rugose Spiralling Whitefly

- ***In situ*** **mass production technique of** ***E. guadelouape*** **standardized**
- **Natural parasitism recorded to the extent of 62-82%.**
- **Large-scale production of the parasitoid for large scale release**
- **Reduction in pesticide usage.**
- **Economically feasible, ecologically compatible & environmentally benign.**
- **More effective than chemical insecticide & cheaper & susainable.**
- **Conservation of biodiversity in ecosystem.**

Biocontrol strategies for Rugose spiraling whitefly (RSW)

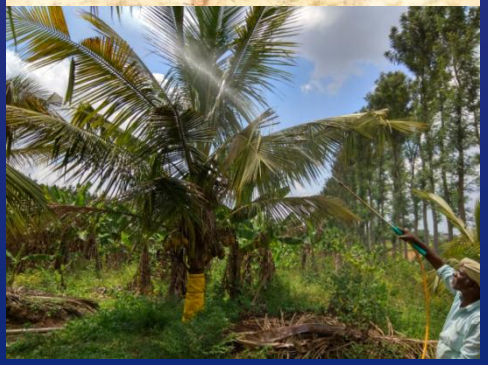
1. Avoid transportation of coconut seedling or any host plants from RSW infested areas.

2. Continuous monitoring on pest through yellow sticky trap and natural parasitism.

3. Re-distribution of parasitoid, ***Encarsia guadeloupae*** to the RSW affected areas through "Field insectary technique".

4. Pesticides holiday declared for the RSW.

5. Conserve natural buildup of ***E. guadeloupae*** through growing banker plants (Banana/ ***Canna indica***) & protect them from pesticides and un-favourable weather factors.



Entomopathogenic fungus, *Isaria fumosorosea*

1. **Foliar application (Two sprays) of *I. fumosorosea* @ 2 x 10^8 spores/ml (5 g/litre of water) at 15 days intervals.**

2. **Under severe outbreak and absence of natural parasitism situation, neem oil 1% may be applied.**

3. **Awareness programme on the natural buildup of the parasitoid *E. guadeloupae* is to be conducted in all epidemic zones to sensitize the farming community.**

4. **Community based approach warranted for the effective management of this invasive pest.**

Multiple insecticide tolerant strain (MITS) of *Trichogramma chilonis*

- **Tolerant to multiple insecticides with a high resistance factor up to 76.5.**
- **Evaluated in 9 states & indicated substantial reduction in sprays & increase in yield (tomato, brinjal, chillies, rice & chillies).**
- **Revenue increased ranged from Rs. 15,000-20,000 / ha / season because of reduced insecticide application & increase in yield.**

High temperature tolerant strain (HTTS) of *Trichogramma chilonis*

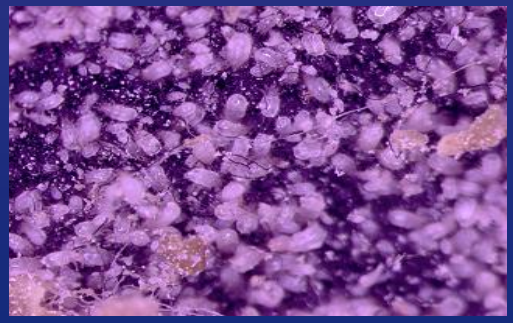
- **Tolerant to high temperature (32-40°C).**
- **Can be used efficiently in high temperature regions.**
- **Parasitize eggs of the most of the lepidopteran pests.**
- **Used as a living, "biological insecticide" that strikes only the target pest with no risk to other natural enemies, human health or the environment.**

Pesticide tolerant strain of aphid lion *Chrysoperla, zastrowi sillemi* (PTS-8) Predator of sucking pests

- Strain PTS-8 has tolerance to different groups of pesticides.
- Recorded highest resistant factor (RF) for different group of insecticides.
- PTS-8 has got higher detoxifying enzymes activity *viz.*, esterase , CYT P450 monoxygenase & GST.
- Field studies revealed that the strain was effective against sucking pests in pesticide stressed conditions.
- No risk to other natural enemies, human health or the environment.

Closed system for mass production of predatory mites

- In India, small scale production of predatory mites is done on tetranychid mites maintained on bean leaves/mulberry leaves.
- Large scale production of predatory mites in net houses on spider mite infested bean plants.
- The new system developed enables the production of predatory mites on astigmatid mites in closed units.
- Scale of production is high with simple infra-structure.
- The astigmatid mites which may be mixed with the released predatory mites do not harm the plants



Biological Control of Invasive Papaya Mealybug, *Paracoccus marginatus*

- **Papaya mealybug, *Paracoccus marginatus* serious invasive pest in India & causes severe yield loss.**
- **Parasitoid *Acerophagus papayae* was imported from APHIS, Puerto Rico**
- **Significant economic impact on papaya, mulberry, casava & vegetables**
- **An annual saving of Rs. 1,623 crores has accrued to the farmers in Tamil Nadu, Karnataka and Maharashtra because of this biocontrol programme.**
- **In addition, the indirect benefit has been the reduced exposure to hazardous pes ti c ides , thus making the environment safe.**

Biocontrol of coconut black headed caterpillar Opisina arenosella

- **Feeds on green tissues and constructs galleries**
- **Leaflets dry up & burnt appearance**
- **Affects photosynthetic efficiency & reduction in nut production**
- **Life cycle- 2-2.5 months**

- **Most effective gregarious parasitoid**
- **Mass produced easily on *Corcyra***
- **8-12 parasitoids/ larva**
- **Female biased sex ratio**
- **Fecundity 60-70/female**
- **Natural parasitism 28-48 %**

Goniozus nephantidis

- **Most effective gregarious parasitoid**
- **Mass produced easily on *Corcyra***
- **8-12 parasitoids/ larva**
- **Female biased sex ratio**
- **Fecundity 60-70/female**
- **Natural parasitism 28-48 %**
- **Commercially produced**

A plant volatile based attractant for enhanced attraction of fruit fly

- Has a cocktail of volatiles which attracted almost 3-times more than the methyl eugenol
- The attractant efficiency has been proved in the field trials.
- Higher number of *Bactrocera* was caught than methyl eugenol & can be used for catching fruit flies in mango, guava & other fruit crops.
- Have longer duration of field efficacy than the methyl eugenol

Adsorption and delivery of molecules using Nanoporous materials.

- Coffee stem borer, *Xylotrechus quadripes* is effectively managed using pheromone.
- Nanoporous matrix for dispensing attractants for pest management.
- Pheromone loaded into nanomatrix had extended duration of release with enhanced trapping efficiency.
- Controlled released dispenser developed requires lower load of pheromones as compared to the load in existing lures in market.
- Performance not affected by weather conditions
- Nanoporous matrix can be used for delivery of chemicals used in pest management.

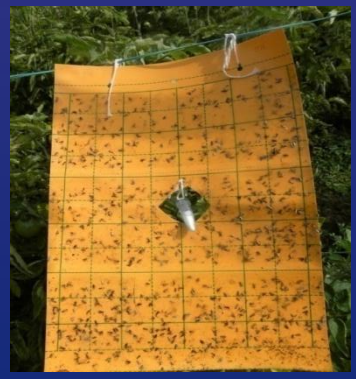
Controlled release dispenser for delivery of tomato pinworm, *Tuta absoluta* pheramone

Adult

Larvae

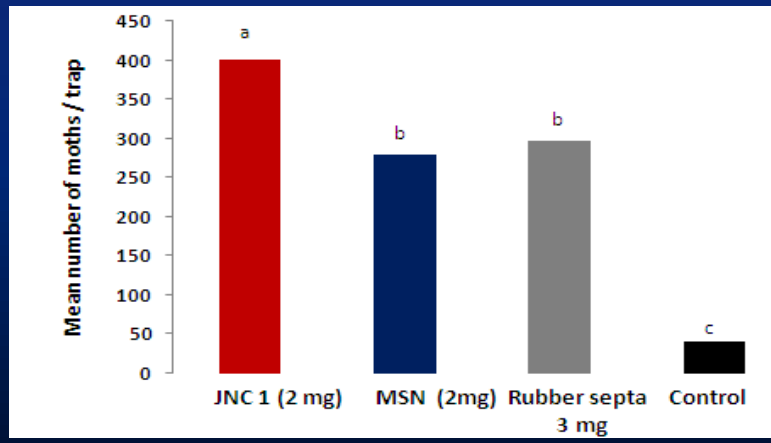
Leaf damage

Fruit damage



Nanomatrix loaded with *T. absoluta* pheromone

- ***T. absoluta* is an alien invasive to India and causes more than 80 % damage in tomato.**
- **A nanoporous matrix developed jointly by ICAR –NBAIR and JNCASR trapped <u>over 400 moths per trap /week and was superior over rubber septa that trapped 300 adults /week.</u>**
- **The technology has been demonstrated in Karnataka, AP, & TN and commercialized to ATGC Biotech Pvt Ltd. Hyderabad.**



Bars having same alphabet do not differ significantly by p =0.05 DMRT

Controlled release matrix for delivery of FAW, *Spodoptera frugiperda* pheromone

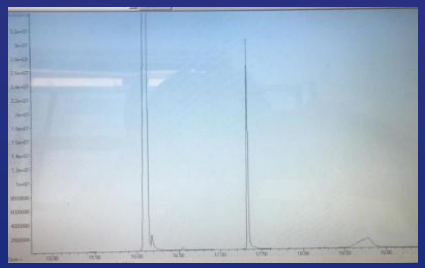
- **The major compound for FAW, *S. frugiperda* pheromone (*Z*)- *9-Tetradecenyl acetate* was characterized using chemical & biological detector.**

- **Field trials using the controlled release dispenser at 3 locations trapped over 20 + 3.13 adult males per trap during three weeks period as compared rubber septa that trapped less than 13 + 2.82 moths per trap.**

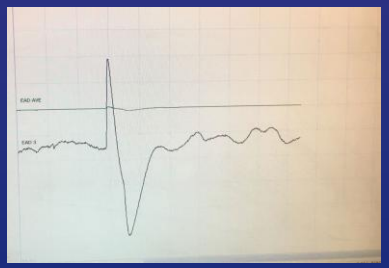
- **Controlled released dispenser is effective for over 45 days.**

- **Identity of *S.frugiperda* adults trapped were confirmed by molecular & morphological techniques.**

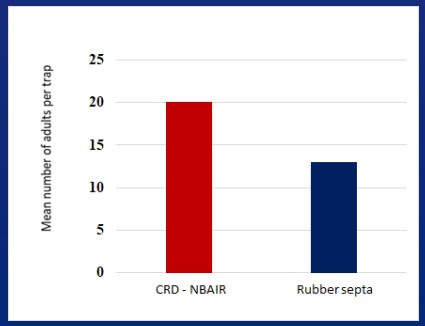
- **Commercialized to ATGC Biotech Pvt. Ltd. Hyderabad.**



Chromatogram of FAW pheromone

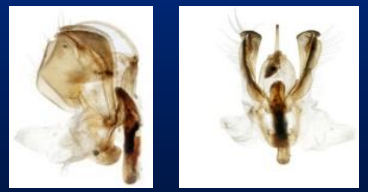


EAG trace of FAW adult



Field efficacy of FAW pheromone

Trapping FAW adult males



S. frugiperda genetalia dissected to confirm the sp. trapped

Protocol for designing lure for impregnating parapheromone to attract male flies of *Bactrocera* spp attacking cucurbit crops for mass trapping & monitoring its population

- Melon flies cause severe damage to the fruits of cucurbitaceous vegetables.

- The impregnation of lures with parapheromone for *B. cucurbitae* is new & novel.

- Impregnation of parapheromone for *B. dorsalis, B. correcta, B. zonata* & *B. papayae is* very effective. However, in the present technology a newer procedure was used.

I. Use of alcohol - highly inflammable - is not entrepreneur friendly.

II. Storage of alcohols is strictly regulated with due permits, stocks used & stocks at balance involving greater bureaucratic procedures – transport difficulties - The principle of synergism of parapheromones has been used in this technology which again the novelty for the first time being employed in this technology development.

A Herbal based Repellant for Termites on woody trees-REPTER

- Termites are the most destructive insects & cause severe damage to crops, woody trees and woods.

- The present technology describes a plant based repellent which is very effective for several months.

- The product is prepared from several botanicals. The product has shown repellent action & resistant from reinfestation by termites on the woody trees for > four months.

- It is effective against all the kinds of woody trees.

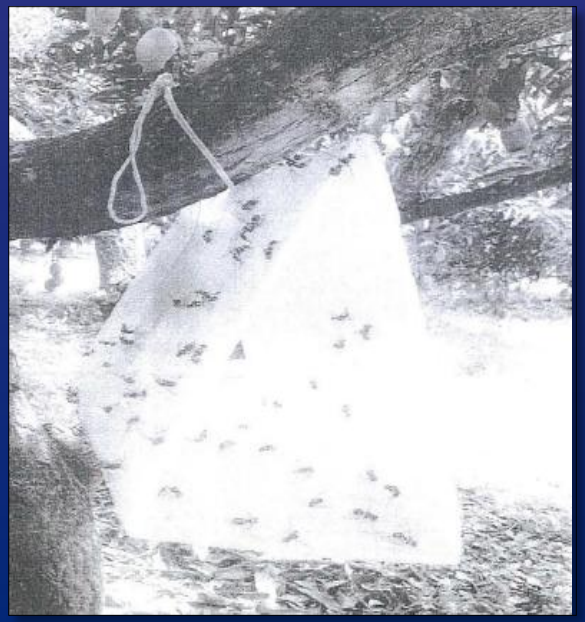
A. Herbal swabber for the management of white stem borer *Xylotrechus quadripes* in Coffee

B. Booster for boosting plant health in coffee

- **Coffee white stem borer, *Xylotrechus quadripes* is a serious pest on arabica coffee.**
- **Uses the repellent action of various combination of plant volatiles for deterring oviposition .**
- **The product is supplied in a semi solid form. This contains several plant composition with some basic adhesive materials.**
- **This product is developed through a collaborative project of ICAR-NBAIR, & field tested with the help of Coffee Board.**

Dorsa-Delta, an efficient trap for mango fruit fly

- The present invention relates to insect attractant compositions comprising volatile organic compounds in effective concentrations impregnated in sawdust & used in sticky delta traps for attracting & incapacitating insects, particularly, the mango fruit fly.



Waste to wealth: Technology on Black Soldier Fly mediated bioconversion of farm and kitchen wastes

Technology Description

- The black soldier fly (BSF), *Hermetia illucens* is useful in converting solid organic waste into manure thereby reducing the quantity of the waste.
- The BSF pre-pupae are also used as valuable nutrient additive in poultry feed and fish meal.
- Rearing method and structure for rearing BSF larvae were standardised and developed.

ICAR - NATIONAL BUREAU OF AGRICULTURAL INSECT RESOURCES

P.B. No. 2491, H.A. FARM POST, BELLARY ROAD, HEBBAL, BENGALURU - 560024, KARNATAKA, INDIA

ICAR-NBAIR's updated Brochure prepared: Acailable at ICAR.NBAIR.RES.IN

Licensees of NBAIR's Technologies

1. Sri Biotech, Hyderabad
2. M.S. Swaminathan Research Foundation, Chennai
3. Excel crop care limited, Mumbai
4. Sri Venkateshwara Chemicals, Secunderabad
5. Multiplex Bio-Tech Pvt. Ltd., Bangalore
6. Sri Biotech, Hyderabad
7. Sun Agro biotech Research Centre, Chennai
8. Agro Bio-tech Research Centre Limited Kottayam, Kerala
9. Allwin Industries, Pithampur, (M.P.)
10. Foundation for Agricultural Resources Management and Environmental Remediation (FARMER), New Delhi
11. Camson Bio Technologies Ltd, Bangalore
12. Dr.Abdul RaufAgri Research foundation
13. Agri Bio Care, Kottayam-Kerala
14. Ponalab, Bangalore
15. UAHS, Shivamogga
16. Bio95.com Agrotech Pvt. Ltd
17. Dr.Abdul RaufAgri Research foundation
18. Bioseed Research India PVT Ltd, Hyderabad
19. Om99 Agrotech Private Limited, Bangalore
20. State Biocontrol Lab, Mannuthy, Kerala
21. Rainbow Agrilife india pvt ltd, Kadapa, A.P
22. Planttech Solutions, Chikkamagaluru, Karnataka
23. Mitrakida, Pvt ltd, Pune
24. Aspartika Biotech Pvt Ltd, Bangalore
25. Natura Crop Care, Bengaluru
26. Godavari Biofertilizer industries, Nashik, Maharastra
27. Khandelwal Biofertilizers private limited, Karnataka
28. Advance Cropcare India Private Limited, Madhya Pradesh
29. Amunra Holidays & Resorts Pvt. Ltd., New Delhi
30. sri bhagyalakshmi farms, bangalore south, karnataka
31. Global Blooms, Bangaluru
32. Mahatma Phule Krishi Vidyapeeth (MPKV), Kolhapur
33. Dhanwantari Distributors Pvt Ltd, Maharashtra
34. Nirmal Seeds. Pvt. Ltd, Pachora, Jalgaon (M.S)
35. ATGC Biotech Pvt Ltd., Hyderabad
36. Kerala Centre for Pest Management, Alapuzha
37. Darshana Horticulture, Maharashtra
38. BioTherm Flavour & Fragrance, Bangalore
39. Vijay Ganesan, Tamil Nadu, India.

Challenges in Commercialization of Biopesticides

- **Maintenance of quality, non-availability of bioagents unlike chemical pesticides & storability.**
- **Many countries amended their policies to reduce the use of chemical pesticides & encourage the use of biopesticides.**
- **Need for fast-track registration of biopesticide products based on justified regulations, promoting the adoption of safer technologies in the development of commercial products.**
- **Policy measures need to be strengthened in order to reduce excessive use of chemical pesticides & to promote the use of biopesticides.**
- **Need for quality audit of biopesticides & establishment of separate enforcement department with adequate manpower for quality control of bio-pesticides.**

- **Role of states in registration & quality assurance. States that are responsible for enforcing standards and quality.**
- **Separate team of inspectors to curb the sale of spurious/ counterfeit pesticides needs to be brought in by state governments.**
- **Separate legal department to look after cases related to the violation of the act.**
- **Bio-pesticides, botanicals, PGRs and pheromones are safer to the environment. Registration of such products along with chemical pesticides under section 9 of the insecticides Act 1968 seems unjustified.**
- **A separate section under the Insecticides Act 1968 may be created through amendments for quick & easy registration of such eco-friendly products.**
- **Generating Expensive biosafety data: ICAR institutes & SAUs with NABL accreditations can be selected to generate bio efficacy data.**

Licensees of NBAIR's Technologies

1	Sri Biotech, Hyderabad	23	Mitrakida, Pvt ltd, Pune
2	M.S. Swaminathan Research Foundation, Chennai	24	Aspartika Biotech Pvt Ltd, Bangalore
3	Excel crop care limited, Mumbai	25	Natura Crop Care, Bengaluru
4	Sri Venkateshwara Chemicals, Secunderabad	26	Godavari Biofertilizer industries, Nashik, Maharastra
5	Multiplex Bio-Tech Pvt. Ltd., Bangalore	27	Khandelwal Biofertilizers private limited, Karnataka
6	Sri Biotech, Hyderabad	28	Advance Cropcare India Private Limited, Madhya Pradesh
7	Sun Agro biotech Research Centre, Chennai	29	Amunra Holidays & Resorts Pvt. Ltd., New Delhi
8	Agro Bio-tech Research Centre Limited Kottayam, Kerala	30	sri bhagyalakshmi farms, bangalore south, karnataka
9	Allwin Industries, Pithampur, (M.P.)	31	Global Blooms, Bangaluru
10	Foundation for Agricultural Resources Management and Environmental Remediation (FARMER), New Delhi	32	Mahatma Phule Krishi Vidyapeeth (MPKV), Kolhapur
11	Camson Bio Technologies Ltd, Bangalore	33	Dhanwantari Distributors Pvt Ltd, Maharashtra
12	Dr.Abdul RaufAgri Research foundation	34	Nirmal Seeds. Pvt. Ltd, Pachora, Jalgaon (M.S)
13	Agri Bio Care, Kottayam-Kerala	35	ATGC Biotech Pvt Ltd., Hyderabad
14	Ponalab, Bangalore	36	Kerala Centre for Pest Management, Alapuzha
15	UAHS, Shivamogga	37	Darshana Horticulture, Maharashtra
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18	Bioseed Research India PVT Ltd, Hyderabad	40	Synergy Biotech, Malur, Karnataka
19	Om99 Agrotech Private Limited, Bangalore	41	AICRP on Biological Control, ICAR Unit-9, Anand Agricultural University, Anand, Gujarat
20	State Biocontrol Lab, Mannuthy, Kerala	42	Crop Science, Dayal Fertilizers (P) Limited. ,Uttar Pradesh
21	Rainbow Agrilife india pvt ltd, Kadapa, A.P	43	Prof. Indumathi M Nambi, Department of Civil Engineering, IIT Madras - 600036
22	Planttech Solutions, Chikkamagaluru, Karnataka	44	Khandelwal BIO-Fertilizer, Belagavi, Karnataka

Glimpse of Technology transfer

Darshana Horticulture LLP, NASIK

KCPM, Alapuzha

ATGC Biotech, Hyderabad

Dhanwantari Distributors Pvt Ltd, Maharashtra

Glimpse of Technology transfer

Nirmal Seeds. Pvt. Ltd,
Pachora, Jalgaon (M.S)

MPKV, Kolhapur

Global Blooms,
Bangaluru

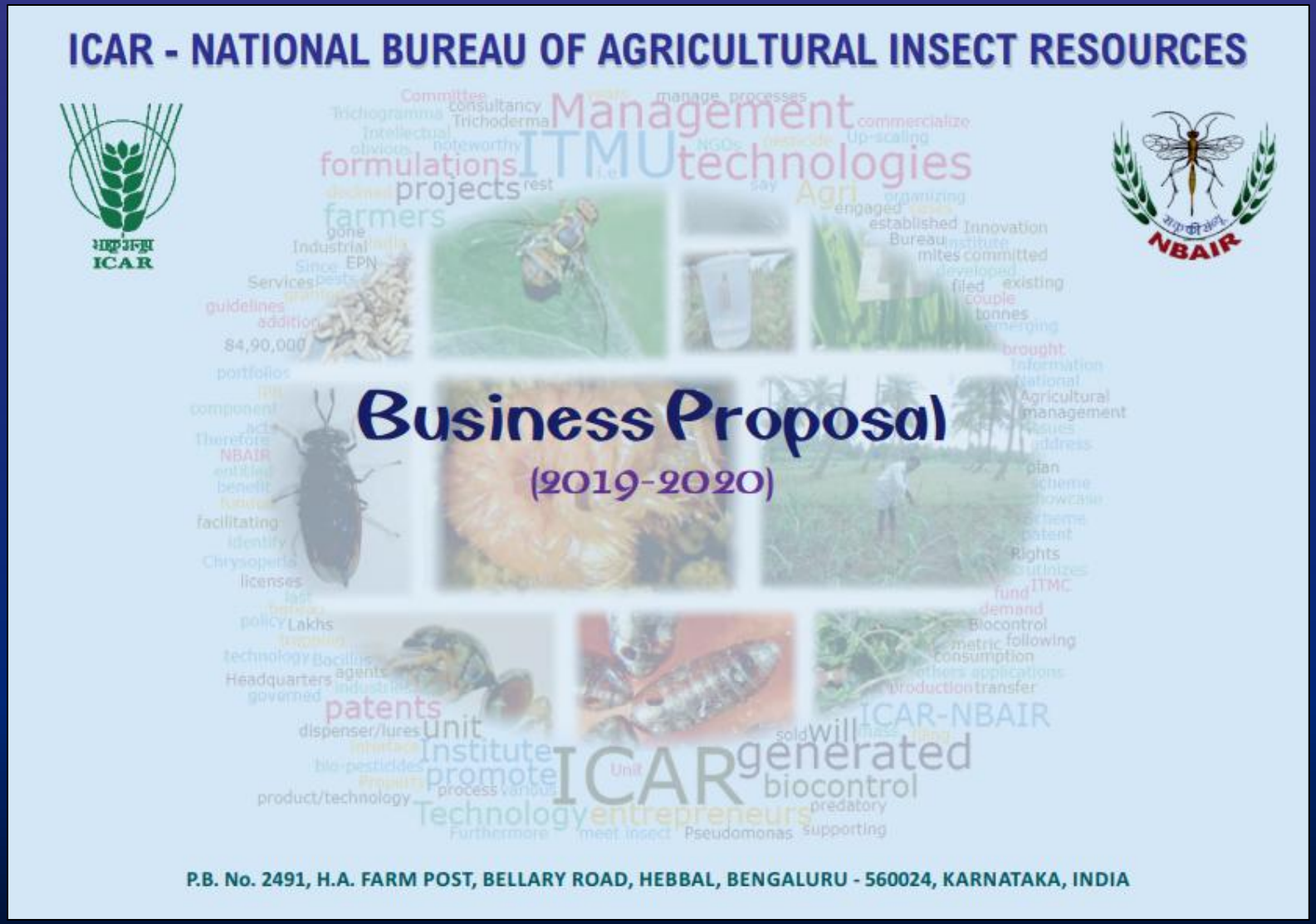
Sri Bhagyalakshmi Farms,
Kolur, Tavarekere (Hobli)

Amunra Holidays & Resorts
Pvt. Ltd., New Delhi

Outreach Activities Organized

Organized one-day ICAR-NBAIR Industry Interface Meet -2019 on 26th June 2019 at ICAR-NBAIR, Yelahanka Campus

Business to Business Meeting (B2B)



ICAR-NBAIR's updated Brochure prepared


THANK
YOU