Natural Resource Management

1. Name of the technology : Bio NPK Liquid Formulation

Source of technology : IARI, ICAR, New Delhi

Description of the technology: Bio NPK Liquid Biofertilizer is a unique kind of bioformulation comprising nitrogen (N_2) fixing (*Azotobacter chroococum*), P-solubilizing (*Paenibacillus tylopili*) and K-solubilizing (*Bacillus decolorationis*) bacteria. It has a longer shelf life (12–24 months) without loss of microbial populations and properties upon exposure to high temperature.

Bio NPK can be used for cereals, millets, pulses, vegetables and oil producing commercial crops. Inoculation can be done through seed treatment, root dip for seedlings and soil application for tree plants. The technology has been validated for Maize, fodder crops, groundnut, rice and wheat. In addition, the technology has given good results in citrus orchards, papaya, ginger and turmeric.

2. Name of the technology : BIOGROW Liquid Formulation

Source of technology/variety : IARI, ICAR, New Delhi

Description of the technology: BIOGROW has been developed using consortium of different bacterial species "viz., Bacillus sp. BC39, Bacillus sp. RC25, Pseudomonas sp. K30 and Pseudomonas sp. K31," endowed with phosphorus solubilization, IAA and siderophore production attributes.

BIOGROW can be used for vegetable crops particularly solanaceous crops like tomato, brinjal, potato and for floriculture crops. The technology is commercialized and available on website of Agrinnovate India Ltd.

3. Name of the technology : Bio Phos and Bio Phos+ Liquid Formulation

Source of technology/variety : IARI, ICAR, New Delhi

Description of the technology: Bio Phos and Bio Phos+ are liquid formulations of P-solubilizing bacteria containing Kluyvera cryocrescens and Paenibacillus tylopili respectively. It has a longer shelf life (12 months) without loss of microbial populations and properties upon exposure to high temperature.

Bio Phos and Bio Phos+ can be used for cereals, millets, pulses, vegetables and oil producing commercial crops. Inoculation can be done through seed treatment, root dip for seedlings and soil application for tree plants. The technology is commercialized and available on website of Agrinnovate India Ltd.

4. Name of the technology : Bio Zn Liquid Formulation

Source of technology/variety : IARI, ICAR, New

Description of the technology: Bio Zn: A liquid formulation containing highly efficient Zinc solubilizing bacteria (Bacillus endophyticus) that can be used in different types of soils. It has a longer shelf life (12 – 24 months) without loss of microbial populations and properties upon exposure to high temperature.

Bio Zn can be used for cereals, millets, pulses, vegetables and oil producing commercial crops. Inoculation can be done through seed treatment, root dip for seedlings and soil application for tree plants. The technology is commercialized and available on website of Agrinnovate India Ltd.

5. Name of the technology : Bio Potash Liquid Formulation

Source of technology/variety : IARI, ICAR, New Delhi

Description of the technology: Bio Potash: A liquid formulation having highly efficient K-solubilizing bacterium Bacillus decolorationis that can be used in different types of soils.

Bio Potash can be used for maize, wheat, mustard and potato. Inoculation can be done through seed treatment, root dip for seedlings and soil application for tree plants. The technology is commercialized and available on website of Agrinnovate India Ltd.

6. Name of the technology : Bio-Bacter Liquid Formulation

Source of technology/variety : IARI, ICAR, New Delhi

Description of the technology: Bio-Bacter: A liquid formulation having highly efficient nitrogen fixing Azotobacter chroococcum that can be used in different types of soils.

Bio-Bacter is a multipurpose formulation that shows no specificity to the crop plants. It can be used for all plants to supply biologically fixed nitrogen. Inoculation can be done through seed treatment, root dip for seedlings and soil application for tree plants. Especially for wheat, mustard, maize and chickpea. The technology is commercialized and available on website of Agrinnovate India Ltd.

7. Name of the technology : RhizoNBAIM Liquid Formulation

Source of technology/variety : IARI, ICAR, New Delhi

Description of the technology: RhizoNBAIM: A liquid formulation having highly efficient nitrogen fixing rhizobial strains specific to chickpea, pigeonpea, mungbean, urdbean, groundnut, pea and lentil.

Rhizobia are specific for leguminous crops. Rhizobia specific to chickpea, pigeonpea, mungbean, urdbean, groundnut, pea and lentil have been developed for seed inoculation. The technology is commercialized and available on website of Agrinnovate India Ltd.

8. Name of the technology : Bio-Pulse

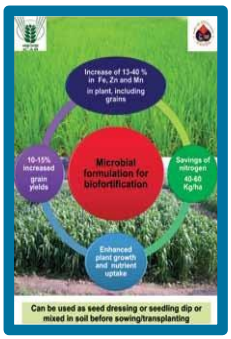
Source of technology/variety : IARI, ICAR, New Delhi

Description of the technology: Bio-Pulse is talc based bioformulation of Trichoderma harzianum and Bacillus amyloliquefaciens and has biocontrol; plant growth promotion; nutrient mobilization and root colonization properties. It has a longer shelf life of 12 – 18 months).

Bio-Pulse can be used for cereals, millets, pulses, vegetables, plantation crops, etc. Inoculation can be done through seed treatment, root dip for seedlings and soil application for tree and plantation crops.

9. Name of the technology : BioFort

Source of technology/variety : IARI, ICAR, New Delhi

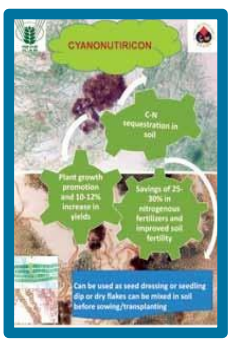


Description of the technology: BioFort -Microbial formulation for effective micronutrient mobilization to wheat and rice grains. Two formulations, each containing a consortium of three plant growth promoting rhizobacteria were developed - (Bacillus pumilus PW1 + Providencia sp. PW5 + Brevundimonas diminuta PW7) for wheat and (Providencia sp. PR3 + B. diminuta PR7 + Ochrobactrum anthropi PR10) for rice. Field trials have proved that these inoculants can be used interchangeably in both crops

These microbial formulations (using compost: vermiculite, 1:1 as carrier) can enhance plant growth, improves N and P nutrient availability/ uptake and significant micronutrient enrichment of grains in rice and wheat. Shelf life tested for six months with no significant loss of activity, if stored in shade below 25 ºC

10. Name of the technology : Cyanonutricon

Source of technology/variety : IARI, ICAR, New Delhi



Description of the technology: Cyanonutricon- Plant growth promoting cyanobacterial formulation containing four cyanobacterial strains (Anabaena torulosa BF1, Nostoc carneum BF2, Nostoc piscinale BF3 and Anabaena doliolum

BF4) promising for enriching macro and micronutrients and improving their availability in soil.

Formulation for rice, wheat, maize, cotton, vegetables and flowers. Developed using compost: vermiculite, 1:1 as carrier. Found to be promising under SRI/ SWI, DSR/ZT and conventional mode of rice/wheat cultivation. Can be used as seedling dip or broadcast in fields before sowing/transplanting or as dried algal flakes for soil application in pots and fields; also suitable as seed dressing/potting mix supplements for nurseries of vegetable/flower crops. Shelf life tested for six months, if stored in shade below 25 ºC.

11. Name of the technology : Kalpa Organic Gold

Source of technology/variety : IARI, ICAR, New Delhi

Description of the technology: Kalpa Organic Gold: Vermicompost prepared from coconut leaves mixed with cow dung and using local isolate of Eudrilus earthworm obtained from CPCRI.

For Coconut leaves

12. Name of the technology : Kalpa Soil Care, Microbial biopolymer for smart farming

Source of technology/variety : IARI, ICAR, New Delhi

Description of the technology: Kalpa Soil Care: Urea free coir-pith compos

Description of the technology: Microbially derived biopolymer is a metabolic product of a *Rhizobium* sp. associated with halophytic weed *Psoralea corylifolia* L. The product is a carbohydrate-rich polymer, having excellent gelability, heat stability, and has diversity of reactive functional groups that can interact with variety of metal ions including micronutrients. Further the product has unique ability to induce microbial colonization, which is an important aspect for sound crop performance and soil health. The product is completely green in nature, and undergoes microbial decomposition in soil environment

The biopolymer is suitable for use in variety of crops including cereals, millets, legumes, vegetables, spices, and oilseed crops. Application of the biopolymer can be done through foliar spray, drip-irrigation system, seed-treatment, root-dipping for seedlings.

13. Name of the technology : Microbial biopolymer for smart farming

Source of technology/variety : IARI, ICAR, New Delhi

Description of the technology: Microbially derived biopolymer is a metabolic product of a Rhizobium sp. associated with halophytic weed Psoralea corylifolia L. The product is a carbohydrate-rich polymer, having excellent gelability, heat stability, and has diversity of reactive functional groups that can interact with variety of metal ions including micronutrients. Further the product has unique ability to induce microbial colonization, which is an important aspect for sound crop performance and soil health. The product is completely green in nature, and undergoes microbial decomposition in soil environment

14. Name of the technology : Plant growth promoting strain of Bacillus megaterium NBAII EXB53 for vegetable crops

Source of technology/variety: IARI, ICAR, New Delhi

Description of the technology: Bacillus megaterium NBAII EXB-53 strain has been identified as a plant growth promoter in different vegetable crops like chilli, capsicum, tomato, eggplant, cauliflower and cabbage.Talc and liquid based formulations have been developed with shelf life of 12 months. It is ecofriendly strategy of obtaining healthy and robust vegetable seedlings which can also reduce the use of fungicides for vegetable seed treatment.

Chilli capsicum, tomato, egg plant, cauliflower and cabbage. Seed treatment.

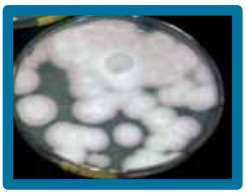
15. Name of the technology : Arka Krishi Vriddhi

Source of technology/variety : IARI, ICAR, New Delhi

Description of the technology: Arka Krishi Vriddhi is a bio pesticide containing 1% wettable powder formulation of Trichoderma harzianum IIHR Th-2.

It can be delivered as seed treatment, substrate treatment and soil application in capsicum, onion, cabbage, cauliflower, crossandra, roses, gerbera, banana, grapes, guava, acid lime, papaya, tomato and egg plant.

16. Name of the technology : Arka Krishi Kawach



Source of technology/variety : IARI, ICAR, New Delhi

Description of the technology: Arka Krishi Kawach is a biopesticide containing 1% wettable powder formulation of Purpureocillium lilcinum (formerly Paecilomyces lilacinus) IIHR Pl-2. It is a nematophagous fungus strongly parasitizing the eggs, egg masses and females of plant parasitic nematodes.

This bioagent can be inoculated as seed treatment, substrate treatment and soil application in all horticultural crops.

17. Name of the technology: Azotobacter chroococcum W5 (NAIMCC-B-00061/MTCC 25045), Paenibacillus tylopili (NAIMCC-B-01548) and Bacillus decolorationis (MTCC 25044)

Source of technology: ICAR-National Bureau of Agriculturally Important Microorganisms, Mau- 275103

Target crops: Wheat, rice, maize, chickpea, soybean, papaya, fodder oat and berseem

Description of the technology: Seed treatment (100 mL formulation diluted to one litre with water for seeds to be sown in one acre); root dip for seedlings (500 mL formulation diluted to 2.5 L with water for seedlings to be planted in one acre) and soil application for tree plants (10 mL/tree)

18. **Name of the technology**: Bacillus endophyticus (NAIMCC-B-01543)

Source of technology/variety: ICAR-National Bureau of Agriculturally Important Microorganisms, Mau- 275103

Target crops: Wheat, maize and soybean

Description of the technology : Seed treatment (100 mL formulation diluted to one litre with water for seeds to be sown in one acre); root dip for seedlings (500 mL formulation diluted to 2.5 L with water for seedlings to be planted in one acre)

19. **Name of the technology**: Bacillus decolorationis (MTCC 25044)

Source of technology/variety: ICAR-National Bureau of Agriculturally Important Microorganisms, Mau- 275103

Target crops: Maize, wheat, mustard and potato

Description of the technology : Seed treatment (100 mL formulation diluted to one litre with water for seeds to be sown in one acre).

20. **Name of the technology**: *Azotobacter chroococcum* (NAIMCC-B-00061/MTCC 25045)

Source of technology/variety: ICAR-National Bureau of Agriculturally Important Microorganisms, Mau- 275103

Target crops: Wheat, rice and maize

Description of the technology : Seed treatment (100 mL formulation diluted to one litre with water for seeds to be sown in one acre); root dip for seedlings (500 mL formulation diluted to 2.5 L with water for seedlings to be planted in one acre).

21. **Name of the technology**: Nitrogen fixing rhizobial strains specific to chickpea, pigeon pea, black gram, pea and lentil

Chickpea: *Mesorhizobium ciceri* Ca7 (NAIMCC-B-02476)

Pigeon pea: *Bradyrhizobium yuanmingense* APP151 (NAIMCC-B-02407)

Green gram: *Bradyrhizobium yuanmingense* MV3 ((NAIMCC-B-02475)

Pea: *Rhizobium multihospitium* P15 (NAIMCC-B-02717)

Lentil: *Rhizobium lentis* LTL3 (NAIMCC-B-02478)

Source of technology/variety: ICAR-National Bureau of Agriculturally Important Microorganisms, Mau- 275103

Target crops: Specific rhizobia for each of the pulse crops viz., chickpea, pigeon pea, green gram, pea and lentil

Description of the technology: Seed treatment (100 mL formulation diluted to one litre with water for seeds to be sown in one acre).

22. **Name of thetechnology**: *Pseudomonasputida* P7 (NAIMCC-B-00922) and Paenibacillus favisporus B30 (NAIMCC-B-01801)

Source of technology/variety: ICAR-National Bureau of Agriculturally Important Microorganisms, Mau- 275103

Target crops: Maize and rabi sorghum

Description of the technology: Seed treatment 30 g/kg seeds; soil application 2.5 kg/ha. (Mix with 50 kg of well decomposed FYM and apply to one hectare).

23. **Name of the technology**: *Pseudomonas putida* (NAIMCC-B-02719)

Source of technology/variety: ICAR-National Bureau of Agriculturally Important Microorganisms, Mau- 275103

Target crops: Cocoa and Vegetable crops

Description of the technology: Soil application (25 g per plant); for transplanted seedlings booster dose can be given at 100 g per plant; for vegetable crops at 2 kg/acre

24. **Name of thetechnology**: *Pseudomonasgessardii* BHU1, *Pseudomonas putida* S1(6) *and Pseudomonas aeruginosa* BM6

Source of technology/variety: ICAR-National Bureau of Agriculturally Important Microorganisms, Mau- 275103

Target crops: Groundnut

Description of the technology: Carrier based: 4 g of formulation to be suspended in 50 mL of water along with 5 g of sugarcane jaggery and then mixed with one kilogram of groundnut kernel; Liquid: 10 mL of bio formulation diluted with 40 mL of water along with 5 g of sugarcane jaggery and then mixed with one kilogram of groundnut kernel

25. **Name of the technology**: Metabolic product of a *Rhizobium sp.* (NCIM 5599)

Source of technology/variety: ICAR-National Bureau of Agriculturally Important Microorganisms, Mau- 275103

Target crops: Sorghum, soybean, maize, brinjal, onion and fenugreek

Description of the technology: Foliar spray (50 mL/m2); drip-irrigation system (5-10 kg/ ha); seed-treatment/seed-coating (10 g/ kg); soil drenching (5-10 kg/ha)

26. **Name of the technology**: *Azotobacter vinelandii* SRIAz3

Source of technology/variety: ICAR-National Bureau of Agriculturally Important Microorganisms, Mau- 275103

Target crops: Rice

Description of the technology: Seedling root dip treatment at 500 mL/ha

27. **Name of Technology:** Zinc solubilising bacteria as inoculants for Zn nutrition and biofortification

Source of Technology: TNAU

Year of release: 2022

Details of technology: Zinc solubilizing bacterial strains capable of solubilizing insoluble form of Zn into soluble form and thereby the Zn availability to the is made crop available throughout the crop period. ZSB inoculation ensures Zn availability, reduces ZnSO4 application (50%), enhances the Zn uptake and fortifies the Zn in rice grains. The biofertilizer is a supplement for Zn nutrition to rice and other crops.

28. **Name of Technology:** Optimization of N, P and K requirement for Barnyard millet (Echinochloa frumentacea (Roxb.) Link) in Red and Black Soils.

Source of Technology: TNAU

Year of release: 2022

Details of technology: The optimal NPK (50:15:15) dose for Barnyard millet will help in optimal and balanced application and increase the yield of 20% in light textured red soil with BC ration 2.36. In heavy textured black soil application of NPK @ 40:15:15 increase the yield of 17% with BC ratio of 2.41

29. **Name of Technology:** Nodule Associated Plant Probiotics for Blackgram

Source of Technology: TNAU

Year of release: 2022

Details of technology: The blackgram root nodule endophypic yeast assist rhizobium species /nitrogen fixing bacteria in legumes to fix more nitrogen from atmosphere into root nodule and promote the plant growth in multifarious ways. It is increasing the crop yield as well as maintenance of soil health. The technology given Benefit Cost Ratio ratio of 2.53.

30. **Name of the technology:** Low Cost Covering for Protecting Polythene Pond Lining

Source of the technology: ICAR-VPKAS, Almora

Description of technology: Blocks are made using locally available material (sand collected from river / gadhera or nala /rivulets and sandy soils having more than 80 percent sand and stone) with 1:7:2 ratio of cement, sand and gravel. These blocks are used to cover the LDPE pond lining for protection.

31. **Name of the technology:** Drip Irrigation for Small Terraces / Kitchen Gardens of Hills

Source of the technology: ICAR-VPKAS, Almora

Description of technology: One plastic tank of 500/1000 litter capacity (capacity of tank depend on area and rate of availability of water from source. Terrace risers / roof top used for gravity energy to give appropriate head to run the drip system. The sprinkler as well as drip system can be run with the 2 meter terrace risers which give pressure 2.90 m head including 0.9 m height of 500 litre plastic tank. The drip system can also be run with tank placed on soil surface with 0.9 m head without any extra terrace riser head. The clogging problem of drippers is major problem. One of the farmers suggested replacement of drippers with hole. Thus holes were made with the help of needle in 16 mm lateral pipes. These holes deliver water to the plants and work as dripper under low pressure and sprinkler under high pressure condition.

It is for irrigating small terraces, fields and kitchen gardens and saves 60 to 80 per cent water. System is very useful as it can be installed in hills very easily and runs on gravity energy.

32. **Name of the technology**: Low Cost LDPE Lined Water Storage Tank

Source of the technology: ICAR-VPKAS, Almora

Description of technology: Tanks of 20 to 500 m3 size can be constructed as per farmer's need. The tanks in general are constructed in a Trapezoidal shape having slope of 1:1 and 1 to 1.5 meter depth. The LDPE film of 200 to 400 micron (800 to 1000 gauge) and conforming to BIS standard 2508/1977/ BIS: 2508-1984 is used. LDPE film should be chosen according to width of tank to avoid leakage. Another lining material which is being used now a days for lining is multilayered cross laminated 200 to 250 GSM polythene sheet, which is popularly known by trade name i.e. silpaulin. If managed well, a tank can work 05 (without any pitching) to 40 years (with river boulder, bricks, and locally made blocks pitching).

A 100 m3 tank can irrigate 200 m2 vegetable area in one filling . A farmer can earn gross income around RS 35 to 40,000 per year by growing vegetable crops in one year rotation i.e. capsicum tomato and onion.

33. **Name of the technology:** VL Portable Polyhouse

Source of the technology: ICAR-VPKAS, Almora

Description of technology: In higher hills, it is difficult to find a single field/ terrace of at least 100 m2 or larger area. Even if the field or terrace of 100 m2 size is available, then either it is narrow in width (2 to 5 m) or it is not straight in length (being curved in shape). Also merging the two or more fields/terraces not only involves huge earth work but also increases the cost. It also raises the vertical height between two field/terraces. A small size (62.4 m2 surface area with 12.0 m length x 5.2 m width x 2.6 m height) low cost portable polyhouse structure can be very useful under such field conditions. This portable polyhouse is made up of 3 pieces which can be placed adjacent to each other and can be covered with single piece polythene. It can easily be shifted from one field/ terrace to the other as per requirement.

Protection of crops from any adverse environment, Increase in production, & can protect crops by preventing the entry of animals and birds

34. Name of the technology: High Density Plantation of Mango in Lower Hills

Source of the technology: ICAR-VPKAS, Almora

Year of adoption/ development/notification:

Description of technology: In this intervention a dwarf variety of mango (say Amrapali) is taken for plantation with a spacing of 3x3 m. A total number of 22 plants can be planted in 200 m2 area (One Nali). Pits of 100 cm3 are dug during the month of June and filled with 25 kg well rotten FYM and soil. The time of planting is the beginning of monsoon season. During planting, earth ball of the sapling should remain intact and the graft union above ground level. In the initial two to three years, it is advisable to protect plants against frost and low temperature injury by covering them and resorting to flood irrigation. In the first year, in non-bearing trees, 70 g Nitrogen, 100 g Phosphorous and 50 g Potash are applied. The above doses are multiplied with the age of the tree for application in the subsequent years. The recommended doses of fertilizers are applied twice in a year i.e. beginning of monsoon (June-July) and after the fruit harvesting (September), whereas, FYM is applied in a single dose during the month of September. The first harvesting of fruits can be taken from the beginning of 4th year of plantation.

The plantation with normal density plantation fetches net return of Rs. 4896/200 m2, whereas, plantation with high density can give Rs. 10654 from the same area. The net return in high density planting in lower hills is more than double the traditional method and this profit can be earned much earlier. The high net return is due to high density plantation and late season harvesting in lower hills.