

ICAR Research Complex for NEH, Umiam, Meghalaya

Document for the last five years technological output of the institute as required under EFC/SFC- XII plan

a) Very specific and technologically validated output/outcomes-

Abiotic stress management and climate resilient agriculture

- Trend of climate change as envisaged through change in rainfall and temperature in NE Region was studied using gridded rainfall data of IMD. The trends obtained for the recent period (1991-2007) was compared with the baseline period (1951-1990). Annual total rainfall in NE region recorded a reduction of 4.5% in the recent compared to the baseline period. But the change is not uniform in all the states. Arunachal Pradesh, Nagaland, Assam, Mizoram and Tripura have recorded reduction in total annual rainfall, whereas Meghalaya, Manipur and Sikkim experienced a gain during the same period. The rainy days are decreasing in all the states indicating uneven distribution in the recent and future times.
- Both maximum and minimum temperatures are increasing, but increase in minimum temperature is more alarming. The resultant effects on crops, in terms of increased evapotranspiration and respiration, through increased water and heat stress are imminent in this region.
- Intensity of 1-day maximum rainfall intensity has shown an increasing trend in Assam, Meghalaya, Manipur and Sikkim indicating higher probability of highly erosive rainfall events and subsequent loss of fertile top soils and decline in crop productivity.
- Vulnerability of the hill districts to climate change was found much higher in NE region compared to the plains, as nine out of ten most climate vulnerable districts of NE are hilly. Mizoram is the top climate vulnerable state and Tripura is the least, in the NE region.
- The adverse impacts of climate change on crop and livestock have been tried to nullify through multi-faceted but integrated research on identification of suitable adaptation and mitigation measures and increasing the level of people's perception on climate change and to challenge it successfully.
- About 600 rice genotypes tested for heat tolerance and 9 promising heat-tolerant rice genotypes were identified; these are RCPL 1-74, RCPL 1-132, RCPL 1-136, RCPL 1-185, RCPL 1-186, RCPL 1-188, RCPL 1-409, RCPL 1-460 and RCM-17.
- RC Maniphou 7 and RC Maniphou 6 were identified as very good submergence (flood) tolerant rice cultivars at Manipur. Several improved lines of rice with capability to escape drought/heat stress were identified at Sikkim. Though local cultivars are of long duration,

a cultivar Sikkim Takmaru (Lama Dhan) was found to have ability to escape drought/thermal stress due to its low growth period (119 days).

- In Tripura, Identification of major QTLs for grain yield under drought stress in rice varieties for use in marker assisted breeding to improve yield was completed among 863 genotypes.
- Eleven promising heat tolerant maize genotypes were identified with high temperature tolerance at germination, seedling, flowering and grain filling stages: RCMGP 20, RCMGP 39, RCMGP 40, RCMGP 47, RCMGP 55, RCMGP 63, RCMGP 105, RCMGP 122, RCMGP 124, RCMGP 125 and RCMGP 131. Higher phenolic content was noted in RCMGP 63 and RCMGP 105 under elevated temperature indicating a stronger plant defence system against heat stress.
- Tomato cultivar Arka Rakshak was found to have highest yield, stress tolerance index (STI) and stress tolerance efficiency (STE). Tomato variety Manileima was found most tolerant to frost condition, RC Manikhamenashinba-land Selection 9A found to exhibit tolerance to water stress and high temperature.
- A To conserve soil and water resources, improve carbon sequestration and land productivity in sloppy land, a land use model involving natural forest, fodder crops, cover crops, cereals, pulses and oilseeds has been developed. The land use model enhanced SOC stock by 8.5% and reduced soil loss significantly.
- Mulching with rice straw in mustard is a good measure to retain residual soil moisture after harvest of rice. The surface soil moisture was higher by 8.8 to 30.7% under mulch than no-mulch condition, which affected the mustard growth and development. The radiation absorption was increased by 7.2 to 114.1% under mulch treatments. Recycling of rice straw is contributing to soil carbon sequestration/mitigation of GHG emission in a place where straw burning is the common practice.
- *Jalkund* (micro water harvesting structure at hill top) water utilized in a tomato-pig based system (200 tomato plants and 5 piglets) provides a net benefit of Rs. 9495/- per unit jalkund with B:C ration of 1.67. This technology has widely been adopted in all the hill states of NE India.
- Zero tilled vegetable (pea and capsicum) cultivation in lowland rice fallows found to enhance farm income and resource use efficiency substantially. Average estimated water savings under zero tilled practices are 23 and 4%, respectively, in pea and capsicum. The net income enhancement from pea and capsicum cultivation under zero tilled condition are to the tune of Rs. 21,240/- and Rs. 9,600/- per ha, respectively.
- Application of biochar was found to have significant positive effect ($p < 0.05$) on improvement of soil pH (increase soil pH by 0.26-0.30 units) within two months. Also improves SOC (by 4.9-7.4%) and available nitrogen (by 4.5-21.3 ppm) over the control (110 ppm), while in combination with fertilizers increase in N content ranged from 4.5-15.7 ppm.

- Among the pig breeds, Khasi local (Niang Megha) with narrow, short face having concave snout, small and erect ears and Ghungroo with broad and flattened face, short and curved snout having large, pendulous and heart shaped ear help in heat dissipation were found more climate resilient than the exotic breeds.
- Climate resilient low-cost deep litter housing model for pigs was designed and developed using locally available resources which are suitable for high rainfall at mid/high altitude region.
- In indigenous poultry, medium sized, active, varied plumage colour, predominantly black with various shades of brown.; and single comb with light pink colour, black eye colour, wattle poorly developed with red earlobe were found as highly climate resilient breeds.

NRM/Crop Production

- Institute has developed as many as 32 location specific farming systems, watershed and agroforestry based land use models for natural resource conservation and livelihood improvement of farmers in the NEH region,
- Developed No-till production technology for pulses and oilseeds for rice and maize fallow lands
- Package of practices for organic production of 32 crops have been standardized on cropping system basis.
- Soil Testing Kit was developed and popularized for rapid soil testing at farmers' field.
- Acid tolerant crops and varieties evolved/identified.
- Modified Systems of Rice Intensification (SRI) and integrated crop management (ICM) practices have been standardized and popularized in the NEH region. In Tripura alone 20 % of the rice cultivating area is under SRI/ICM.
- Improved rice and maize production technology including soil and water conservation practices for improving *jhum* farming has been developed.

Crop Improvement and Horticulture

- Released 14rice varieties, seven (7) pulses, one oilseed, two (2) tuber drops, 6 tomato, 2 brinjal, one turmeric , one papaya , one pineapple and one Jatropha were released for the North East region. Till date institute developed 59 crop varieties out of which 37 varieties of rice.
- Phenotypic and physiological evaluation of 650 rice germplasm identified a set of 9 lines as tolerant and among them RCPL 1-460 and RCPL 1-74 are moderately tolerant to 37 / 26°C day / night temperature under artificial light (3000 lux).
- A set of 16 maize germplasm lines were identified as tolerant to elevated temperature of 35° C. Among them RCMGP- 63, RCMGP-105 and RCMGP-47 were found to be heat tolerant at anthesis stage.

- Nutritional quality analysis of popular rice varieties and germplasm of NEH region identified some special varieties like Taothabi (high lysine), Moringphou (high methionine and calcium), Chahouamoba (high Fe), Luwai (high protein).
- Diversity analysis of chilli has been done with 32 SSR markers. A unique genotype from Mizoram has been identified which shows morphological similarity to king chilli but is genetically different.
- Genetic resources of horticultural crops viz., citrus (20), guava (15), peach (3), Kiwifruit (5), passion fruit (5), plum (3), sohiong (2), sohshang (2), ginger (124), turmeric (191), king chilli (6), chilli (10), tomato (23), brinjal (25), french bean (48), dolichos bean (12), ash gourd (6), bottle gourd (6), chow-chow (82), pumpkin (5), sweet potato (15), colocasia (40), gerbera (45), *Momordica* spp (4) and orchid (19) were maintained in field gene bank institute farm.
- Identified stress tolerance crop varieties for climate resilience under NICRA.

Crop Health Management

- Sequenced a complete mitochondrial genome of a phytophagous ladybird beetle, *Henosepilachna pusillanima* (Mulsant) (Coleoptera: Coccinellidae)
- Hypo card prepared from *Hyposoter beninus* used for management of cabbage butterfly – a new approach in insect pest management
- 50,134 insect specimens belonging to twelve orders were collected from different agro ecosystems and 1438 insect species were identified.
- Standardized mushroom production technology and integrated disease management for blast and other important pathogens.

Livestock and Fish

- Three breed cross pig was developed by crossing Hampshire male with selected local female pigs and F1 female was again crossed with Duroc male in order to get lean meat along with good mothering ability, high litter size and better adaptability to the local conditions.
- Smallholder low cost deep litter pig housing model along with water harvesting structure has been developed
- Prototype vaccine developed against classical swine fever virus
- The Institute was able to detect for the first time PRRS virus (Porcine Reproductive and Respiratory Syndrome) in the country.
- Standardized composite fish culture, rice+ fish farming and fish based IFS
- Successfully introduced and popularized Amur Common carp (a Hungarian improved strain) and Pengba (*Osteobrama langeri*) –an engendered fish species to the NE India in

addition to two indigenous minor carps for mid hill aquaculture among the farmers of the hill region.

- Breeding technology for pabda and other important fish including indigenous fish standardized.

Mechanization

- A power tiller operated pneumatic planter was designed and fabricated which is suitable for seeding of pigeon pea, rice bean, cowpea, corn and soybean in the hilly terrain.
- A simple low-cost reciprocating weed cutter was designed with a cutter bar width of 400 mm. The equipment is faster and less energy intensive compared to traditional tools.
- Ratio of soil and charcoal, drying characteristics, emission and burning characteristics of beehive charcoal briquettes has been standardized. The economic analysis showed that a briquette can be produced with cost of Rs.6/- and earned Rs. 2100/- month by producing 6000 briquettes

Jhum Improvement and Organic Farming

- Land-use model for sloping lands comprising field crops, horticultural crops, MPTs and soil and water conservation practices for sustainable production and climate resilience in Eastern Himalayas have been developed.
- Improved rice cultivation techniques in jhum field for enhancing productivity and sustaining soil health: Jhuming (shifting cultivation) is still practiced in an area of 0.88 Mha in the North Eastern Region of India. Due to reduction of *jhum* cycle from 15-20 years in past to 2–3 years at present, land degradation in the form of deforestation, soil erosion and soil fertility depletion is taking place at a massive scale. Rice occupies a significant area under *jhum*. Growing local varieties, no fertilizer or manure application, poor crop establishment techniques, soil erosion due to cultivation in high slopes and lack of pest and disease management practices are the major constraints of *jhum* rice whose productivity hardly goes beyond 1 t/ha. Thus, cultivation of high yielding varieties along with improved agronomic management practices for rice in *jhum* areas is advocated improving productivity and sustainable soil health.
- **Integrated Organic farming system (IOFS) model for valley land (under NPOF):** The North Eastern Region of India has been identified as potential zone for organic food production in the country. Very low use of chemical fertilizers (about 12 kg/ha in hills), negligible use of pesticides, large availability of organic manure (residues, livestock excreta, forest litter, weed biomass etc), high soil organic carbon and favorable climatic conditions are some of the advantages for organic food production in the region. Organic farming needs large quantity of manure (say 10-20 t/ha depending on crops, soil, cropping system etc.) to meet crop needs. However, the requirement for manure can be reduced substantially if an integrated approach is adopted to harness complementarities of crop-livestock-fisheries interactions. Various farming components are integrated in such a manner that there is year round availability of crops which generates produce, employment and income regularly. Most importantly, the wastes from one component serve as input for other component and reduce dependence on external inputs.

Cropping systems are selected by integrating fertility building (say legume) and fertility exhaustive crops (say maize) and other characters of varying nature say root depth, plant height, nutrient need etc.

Farming System Research

- **Micro-watershed farming System models natural resource conservation, food and nutritional security** : Eight micro-watersheds comprising of Dairy based land use (FSW-1), Mixed forestry (FSW-2), Silvi-pastoral land use (FSW-3), Agro-pastoral system (FSW-4), Agri-horti-silvi-pastoral (FSW-5), Silvi-horticultural system (FSW-6), Natural forest block (FSW-7) and Timber-based farming system (FSW-8) is being evaluated on long term basis at ICAR Research Complex for NEH Region, Umiam, Meghalaya.
- **Farming system model for food and nutritional security of small and marginal farmers**: One hectare area was earmarked for accommodating different components of IFS in which 7000 m² area was allotted to agri/vegetable based cropping system, 2000 m² was to horticulture and 500 m² was under water harvesting pond on which fish culture was started. The 500 m² area was allotted for livestock sector, vermicompost unit, threshing floor and miscellaneous uses.
- MPT based agroforestry systems for improving productivity and sustainability of slopping land
- Three tier agroforestry system for the slopping land of the mid altitudes of the NEH region
- **Agri-horti system for improving productivity and sustainability of slopping land**: The north eastern hill region is a typical hilly ecosystem characterized with undulating topography. The area also experiences high rainfall coupled with accelerated soil erosion and surface run off. Productivity of the slopping lands is very low. Such land configuration has great potential for horticulture based agroforestry systems. Therefore, performance of various fruit trees have been evaluated with different combinations of agricultural crops for development of suitable fruit tree based agroforestry system for the region.

Description of some important Crop varieties developed

- **Megha Turmeric-1**: Clonal selection from the local genotype Lakadong, suitable for plain as well as hilly region of north eastern states, Maturity: 300-315 days, Average yield: 27-30 t/ha, Tolerant to leaf blotch and leaf spot. Suitable for processing into dried rhizome, powder as well as extraction of oleoresin. Recommended as stable variety for high yield and curcumin content by AICRP on Spices.
- **Megha Tomato-2**: An indeterminate, high yielding, cultivar of tomato developed by pedigree breeding using parental lines EC-1773 x Shakti (LE-79). The fruits are oblong in shape, weighing 55-75g, rich in lycopene (8.46 mg), TSS (4.8-5.6⁰B), acidity (0.4-0.6) and ascorbic acid (18.23-25.20 mg) content. The fruits are also having longer shelf life (15-18days) due to thick pericarp (5-6 mm) and are suitable for long distance marketing. This variety is tolerant to bacterial wilt and wilting percentage ranged from 5.5-11% under field

conditions. This variety is found tolerant to moisture stress and is suitable for the rainfed cultivation. Being an indeterminate variety it is also suitable for the protected conditions. The average yield ranged from 40-45t/ha. Under All India Co-ordinated trials variety was recommended for the registration as bacterial wilt resistant line.

- **Megha Tomato-3:** This variety is also high yielding and indeterminate in growth habit developed by pedigree breeding using parental lines PusaSheetal x Lima. The fruits are round in shape and weight ranged from 55-75g. This variety is also rich in lycopene (8.40mg), TSS (4.6-5.5⁰B), acidity (0.5-0.7) and ascorbic acid (16.8 - 24.60mg) content. Average shelf life of fruits is 12-15 days. Variety is suitable for fresh consumption and processing purpose. It is tolerant to bacterial wilt and wilting percentage ranged from 7.0-13.0%. This variety is also found tolerant to moisture stress and low temperature. The yield ranged from 40-45t/ha. Under the farmers' fields the variety has reported yield of 350-380q/ha. This variety has been released by Meghalaya State Variety Release Committee in 2010.
- **Megha Taro-1:** Clonal selection from the local collection (Fig.4). AICRP on Tuber Crops recommended for Agro climatic Zone-III. Suitable for valley and *jhum* land. Rich in starch content: 22-25%, high in dry matter: 27-32%, low in oxalic acid: 0.20-0.40mg/100g; Suitable for leaf, petiole and corm purposes, for processing into pickle, poultry and pig feed etc. Maturity: 180-210 days, tolerant to leaf blight. Potential yield: 225-250q/ha.
- **Megha Guava - 1 (RCGH-1)** -is a progeny of cross Sour Type x Red Fleshed. Plant growth was upright, erect with dark green broad leaves. Yield potential was 17-19 t/ha under mid hill condition. Fruits were medium size; fruit shape was globose, greenish yellow in color with red dots at ripening. Pulp was creamy white, soft seeded, rich in vitamin C (230.66-246 mg/100g), pectin (1.26-1.37%) and dietary fibers (3.41-3.52%). Fruits matured 8-12 days earlier than other varieties under mid hill conditions and was suitable for table and processing purpose.
- **Megha Saw Priam (RCGH-4)**- a progeny of cross Red Fleshed X Allahabad Safeda, was bred to develop colored high yielding guava variety. It has semi-spreading growth habit with yield potential of 11-14 t/ha under mid hill condition. Fruits are medium to big in size; fruit shape is elliptical to ovate with greenish yellow color at maturity. Pulp is red colored and products *viz.*, jam, jelly, juice; RTS prepared developed and retained attractive color.
- **Megha Khongpheram Paudiik (RCGH-7)**-is a progeny of cross Lucknow-49 X Pear Shaped guava. Variety has drooping growth habit suitable for high density planting with yield potential of 12-15 t/ha under mid hills. Fruits are medium size, light green in colour at maturity. Pulp is creamy white with less and soft seeded (107-119 seeds/100g fruit weight), high in sugar (7.96-8.39%), pectin (1.29-1.40%) and phenol content (358.14 - 369 mg GAE/100g) suitable for table and processing purpose.

- **Megha Priam Thiang (RCG-11)**-a seedling progeny selection from Meghalaya, selected for low seed content. Plant growth is semi spreading type with yield potential of 11-13 t/ha under mid hills. Fruits are sweet (TSS: 11.88-12.50 OB) with low seed content (42-55 seeds/100 g fruit wt), rich in pectin (1.28-1.32%), phenol content (330.65-340.11 mg GAE/100 g) and vitamin C (207-215.33 mg/100g) suitable for table and processing.

Rice Varieties

TRC-Borodhan-1:

- Released by CVRC and SVRC for cultivation in *boro* season of the state
- Tolerant to cold, 140-150 days duration
- Potential yield: 5.0-6.0 t/ha

TRC-87-251:

- Suitable for transplanted and direct seeded condition of all seasons.
- Drought tolerant
- Duration: 85 days
- Yield potential: 2.5 t/ha (upland)

TRC-229-F 41:

- Suitable for lowland, waterlogged (up to 50 cm) and swamp areas.
- Maturity duration: 146 days
- Potential Yield: 5.0 t/ha,

TRC-216-14:

- Suitable for low lands of Tripura
- Average productivity: 4.5 t/ha.

Tripura KharaDhan 1 (IET 22837 , RP 5208-4/ IR 87707-446-B-B-B):

- Rice Variety released in 2014 by SVRC Tripura (Notification NO. F. 21 (170) Agri(SS)/2012-13/1152-77, dated: 18 October, 2014)
- Suitable for rainfed drought prone lowlands of Tripura.
- Yield: 5.6-5.8 t/ha under normal conditions.

Tripura KharaDhan 2: (IET 22835/RP 5208-2/IR 87707-182-B-B-B)

- Rice Variety released in 2014 by SVRC Tripura (Notification NO. F. 21 (170) Agri(SS)/2012-13/1152-77, dated: 18 October, 2014)
- Identified for rainfed drought prone lowlands of Tripura.
- Yield potential: 5.6-5.8 t/ha under normal conditions.

Tripura JalaDhan-1(TRC 2008 -1/IET 22167):

- Stress Tolerant Rice Variety released in 2014 by SVRC Tripura (Notification NO. F. 21 (170) Agri(SS)/2012-13/1152-77, dated: 18 October, 2014)
- Identified for semi deep-water or utlalands of Tripura.
- The variety is very good for making high quality puffed rice
- Yield: 4.8-5.2 t/ha in Kharif season in semi deep water conditions.

Tripura Hakuchuk 1: (TRC 2013-4):

- Stress Tolerant Rice Variety released in 2014 by SVRC Tripura (Notification NO. F. 21 (170) Agri(SS)/2012-13/1152-77, dated: 18 October, 2014)
- Identified for direct seeded upland as well as transplanted lowland early duration.
- Yield: 5.44 t/ha in 100 days under transplanted conditions.

Tripura Hakuchuk 2: (TRC 2013-5):

- Stress Tolerant Rice Variety released in 2014 by SVRC Tripura (Notification NO. F. 21 (170) Agri(SS)/2012-13/1152-77, dated: 18 October, 2014).
- Suitable for transplanted and direct seeded upland conditions.
- Yield potential: 5.54 t/ha.
- Duration 100 days under transplanted conditions.

Tripura AusDhan: (TRC 2013-12):

- Stress Tolerant Rice Variety released in 2014 by SVRC Tripura (Notification NO. F. 21 (170) Agri(SS)/2012-13/1152-77, dated: 18 October, 2014)
- Identified for transplanted and as well as direct seeded upland. Yield potential: 5.45 t/ha.
- Duration 100 days under transplanted condition.

Tripura SaratDhan: [TRC 2008-5 (IET 22113)]:

- Suitable for Irrigated and rainfed shallow lowland in boro season.
- Yield potential: 5.5 – 5.7 t/ha in kharif season, 5.8-6.0 t/ha in boro season.

Tripura NirogDhan: TRC 2008-6 (IET 22580):

- Released for irrigated and favourable rainfed shallow low lands.
- Yield potential: 6.0-6.1 t/ha in kharif and 6.2-6.4 t/ha in boro season

Tripura ChikanDhan: TRC 2008-4 (IET 22112):

- Released for irrigated and favourable rainfed shallow lowland, performs better in boro season.
- Fine grain premium quality rice.
- Yield: 5.6-5.8t/ha in boro season under irrigated conditions.

Gomati Dhan (TRC-2005-1/IET 21512):

- Released by SVRC Tripura (2012) for rainfed shallow lowland and irrigated land in kharif season.
- 130-135 days duration and 105 cm tall.
- Tolerant to major diseases and insect pests.
- Very good grain and cooking quality.
- Yield: 5.8 -6.0 t/ha in *kharif* season, 6.0-6.4t/ha in *boro*.

- Already covered more than 75000 ha in Tripura and gaining popularity across Assam, Meghalaya and Mizoram.

Khowai (TRC 2005-3/ IET 21564):

- Released by SVRC Tripura (2012) for cultivation under irrigated conditions of kharif and *boro* season.
- 120-125 days & 118 cm tall.
- Tolerance to major diseases and insect pests prevailing in Tripura.
- Yield: 5.4 -5.6 t/ha in *kharif* season & 5.6-5.8 t/ha in *boro*.
- Widely adopted by the farmers in South Tripura, West Tripura and Dhalai districts of Tripura

Naveen (CR749-20-2)/IET14461):

- Released by SVRC Tripura (2012) for boro cultivation in Tripura.
- Duration 120-125 days & 105 cm tall.
- Yield: 5.0 – 5.5 t/ha in kharif& 5.5-6.0t/ha in boro.
- Dominant cultivar of boro season covering more than 90000 ha area.

Pulses and Oilseed Varieties

Greengram - TRIPURA MUNG 1 (TRC MUNG 131-1)

- Released by SVRC Tripura (2014) for rainfed uplands and medium lands of Tripura.
- N0. F.21(170)-Agri(SS)/2012-13/1152-77, dated: 18 October, 2014. Yield: 1300-1400 kg/ha.

Blackgram- TRIPURA MASKOLAI (TRC URD 99-2):

- Released by SVRC Tripura (2012) for rainfed uplands and medium lands of Tripura.
- No. F. 21 (170)-Agri(SS)/ 2007-08/343-364.
- Yield: 1500-1600 kg/ha.

Sesame- TRIPURA SIPING (TRC TIL 1-8-1-1):

- Released for rainfed uplands of Tripura.
- Higher oil content (42%).
- High level of tolerance to Phytophthora blight.
- Low pod shattering

Tripura Toria (TRC T-1-1-5-1):

- Recommended for rainfed condition; grows very well on residual moisture after kharif rice.
- 86 days duration & 116 cm tall.
- Oil content 42.6%.
- Yield: 9 q/ha.

Fieldpea- TRCP-9:

- Duration: 93-95 days, 98-104 cm tall.
- Yield: 1800-2000 kg/ha,
- Protein : 20.89%

Field pea- TRCP-8:

- Identified by CVRC 2010 (F. No. 17-6/2009- SD. IV, April, 2010) for the states of Uttarakhand Hills, Jammu and Kashmir and North Eastern States of the country.
- Moderately resistance to Powdery Mildew and Rust.
- Yield: 1800-2100 kg/ha
- Protein: 19.86%

Tuber Crops**Elephant Foot Yam Tripura Yam Batema (TRC Badama):**

- Released by SVRC Tripura (2014) for cultivation in uplands and medium lands of Tripura
- Notification N0. F. 21 (170)-Agri(SS)/2012-13/1152-77, dated: 18 October, 2014).
- Yield: 45-55 t/ha.

Greater Yam- Tripura Tha (TRC Greater Yam):

- Released by (SVRC Tripura 2012) for Upland (No. F. 21 (170)-Agri (SS)/ 2007-08/343-364).
- Yield: 45-50 t/ha.

Fruit Crops**Pineapple-Tripura Ananas (PQM1):**

- Released by SVRC, Tripura (2014) for Upland.
- Natural mutant from Pineapple CV Queen.
- Flowering in the months of July –August thereby it can fill the supply gap in Queen and Kew availability.
- Fruits look attractive with deep orange fruit and yellow gold colour flesh.
- With 23.52% lesser number of eyes/fruit.
- Zero incidence of heart rot at Tripura condition
- Yield: 50-55t/ha under high density

Papaya- Tripura Papita (RCTP1):

- Released by SVRC Tripura (2014).
- It has remarkably higher average fruiting zone of 214.68 cm on an average.
- Average fruit weight is 2.05 kg.

- Tolerant to Papaya Ring Spot Virus
- Yield: 63.25 kg/plant

Vegetables

Brinjal- TRC Bholanath:

- Selection from local germplasm Bholanath released by SVRC Tripura, (2012).
- Resistant to bacterial wilt.
- Plant height 95-100 cm, fruit length 16.5-18 cm, fruit breadth 19.5-21 cm and fruit weight 160-190g.
- Most preferred brinjal variety for fry purpose in Tripura.
- Yield: 400 -450 q/ha.

Brinjal-TRC Singhnath:

- Selection from local Singnath germplasm, released by SVRC Tripura (2012).
- Resistant to bacterial wilt.
- Plant height 125-130 cm, fruit length 23-27 cm and fruit breadth 10-13 cm and fruit weight 85-100g.
- Yield: 400 -450 q/ha.

Other technologies Developed

- Standardization of organic manures as a substitute of lime for amelioration of acid soils
- Biochar for acid soil amelioration and soil carbon sequestration
- Resource Conservation practices in maize-mustard cropping system in terrace land situation
- *Standardization of rootstock for Khasi Mandarin in NEH Region:* Different rootstocks were tried with Khasi Mandarin scion for yield and quality. It was found that Rangpur Lime, *Citrus volcameriana* and *Citrus taiwanica* were the best promising rootstock for Khasi Mandarin
- *Improvement of shelf life of peach:* Peach is a fruit crop with low shelf life. Different packaging materials like low density polyethylene (LDPE), corrugated fibre board (CFB) box, LDPE + KMnO₄ and CFB + KMnO₄ and two storage condition viz., room temperature and refrigeration were used to prolong the shelf life of fruits. The shelf life of peach was extended up to 21 days when stored in LDPE + KMnO₄ and refrigerated at 4°C. Thus LDPE + KMnO₄ and stored at 4°C may be used for extending the shelf life of peach fruits.
- *Off-season production under low tunnels*
- *Vegetative propagation techniques for Sohiong (Prunus nepalensis):* Wedge and tongue grafting on one year old seedling of sohiong rootstock during October has been

standardized. Graft success was found to be higher in tongue grafting (70 %) than wedge grafting (60 %). Thus tongue grafting has been recommended for propagation of Sohiong.

- *Standardization of protocol for multiplication of indigenous orchids*
 - Sohiong RTS, Jam and Nectar
 - Guava leather, nectar, spread and cheese
 - Instant ginger candy
 - Khasi mandarin and chow-chow blended beverage
 - Jack fruits leather
 - Ready-to-cook green jackfruits (Minimally processed)
 - Chow chowtooty fruity and shreds
- *Fruit fly trap RC-1*: North eastern region of India, a one of the mega biodiversity hot spots and has enormous potential for production of fruits and vegetables. Fruit flies of the genus *Bactrocera* are important pests of both fruits and vegetables and one of limiting factors in successful production of these commodities. Therefore, mass trapping of male fruit flies (male annihilation technique) would have immense importance in reduction in marketable yield of the fruit and vegetables.
- *Development of Rapid Soil Health Testing Kit*: Rapid Soil Health Testing Kit (RSHTK) was developed in pursuit of initiating soil test based nutrient recommendation for enhancing agricultural productivity, food security and environmental quality. It helps in rapid in-situ assessment of chemical and biological health of soil. It is to realize the dream of 'soil testing at farmer's doorstep'
- IPM technology for the management of brinjal fruit and shoot borer on brinjal.
- Mass rearing technique of parasitoid wasp, *Hyposoter beninus* Gravenhorst (Hymenoptera: Ichneumonidae)
- Low cost specialized multi-utility rearing cage for larval and pupal parasitoids and their factitious hosts
- Wild Mushroom Herbarium: A repository of wild mushroom species from northeastern Himalaya.
- Low cost climate resilient environment-affinitive pigpen model.
- Innovative value Addition to Pig Bristles.

For the first time, Division of Animal Production has developed pig bristles into useful value added products in the country.

- Turkey Farming and Quail Farming has been initiated in the region.
- Patent Filed for Low cost portable Dummy sow with mating grunt voice system.
(Application no: 430/KOL/2013, Published on:24/10/2014)
- Documentation and establishment of diagnostic capability for all the major zoonotic diseases in the NEH region.
- Rapid and reliable detection of pathogen from food of animal origin.
- Classical swine fever diagnostics and vaccine.
- Diagnostic capabilities for trans-boundary diseases of pigs.
- Mastitis detection kit.
- Surveillance, monitoring and investigation of disease outbreaks in the region was one of the main activities of the division: Handling of various risk group organism, molecular diagnostic facility, culture facility and Repository facility.
- Development of agro tools
 - Ergonomically developed long handle weeders.
 - Developed metallic tip dibbler for steep slopes.
 - Adjustable zero till furrow opener.
 - Light weight fruit harvesters developed for hilly orchards.
 - Modified Hand operated Winnower.
 - Portable pedal operated paddy thresher for hills.
 - Power paddy thresher for hills
 - Power Tiller operated inclined plate planter
 - Power tiller operated pneumatic planter
 - Portable Charring Kiln
 - Continuousbiochar production unit (Biochar-1000)
- Designing of climate resilient intensified maize based cropping systems for rainfed mid hill ecosystem of Sikkim
- Maize+beans-vegetable pea: a resource efficient cropping system for rainfed conditions of mid hills of Sikkim
- Standardization of organic conservation agriculture practices for maize- pea systems under rainfed conditions

b) Visible and implementable achievements

<p>1. <i>Jhum</i> improvement for livelihood security: a flagship programme</p> <ul style="list-style-type: none"> • Development of varieties of major crops and crop management practices for improvement of productivity of <i>Jhum</i> lands. • Development of technology for faster restoration and rehabilitation of <i>Jhum</i> land through mechanical and biological measures. • Demonstration of the available technologies in selected and adopted <i>Jhum</i> fields and farmers. 	<p>Achievements</p> <ul style="list-style-type: none"> • Rice varieties such Bhalum 3, Bhalum 4, RC Maniphou 6, RC Maniphou 10 (Blast tolerant), TRC Badama (Yam), TRC Greater Yam etc have been developed and released which are suitable for <i>Jhum</i> lands • Integrated approach having soil conservation measures, hedge rows intercropping, Agroforestry, bunding , terracing, improved cropping systems have been packaged as interventions for rehabilitation and restoration of <i>Jhum</i> lands • The technologies have been demonstrated in 50 ha of land in Meghalaya, Mizoram, Nagaland, Manipur and Arunachal Pradesh.
<p>2. Flagship programme on Temperate Horticulture</p> <ul style="list-style-type: none"> • Developing low volume and high value farming systems with crops such as star anise, cherry, apple, kiwi etc • Screening suitable varieties/types of temperate fruits and vegetable crops and their productivity assessment. • Development of location specific package of practices for major temperate horticultural crops. • Standardization of seed production technique of vegetable crops that require temperate climate for flowering. • Protected cultivation of off season vegetables, flowers etc 	<ul style="list-style-type: none"> • Kiwifruit is promoted on farmers' field as a low volume and high value crop under integrated organic farming system in Sikkim. • Screening process of Peach, Pear, Plum, Walnut, and Apple is under progress at ICAR Research Farm. • Varietal evaluation of different cole crops is under progress at ICAR Research Farm as well as at farmers' field. • Organic package of practices are being developed for Kiwi fruit, Pears, Cole crops, Capsicum, Zucchini, Spinach, Coriander, Vegetable pea and Large cardamom (Upto 2000 amsl). • Vegetable pea, Cauliflower, Cabbage, Broccoli, large cardamom suckers and Kiwi saplings production techniques are being standardized. • Cultivation of vegetable crops under low cost poly shalters and poly tunnels has been standardised at Research Farm and at Farmers field. • Cultivation of Lilium and Alstromaria under

	green house conditions promoted at farmers field.
<p>3. Flagship programme on trans-boundary animal and plant diseases.</p> <ul style="list-style-type: none"> • Research on emergence and prevalence of hitherto unknown/emerging diseases of trans-boundary importance. • ELISA, micro array and Taqman based diagnostic protocols for transboundary diseases. • Disease surveillance and monitoring, repository building and reporting systems. 	<ul style="list-style-type: none"> • The institute has had the distinction of the first time detection of PRRS in the country and also first reported the NDM-1 gene from samples of animal origin. • Classical swine fever virus (CSFV), one of the most devastating diseases for the pig industry in North East is endemic here. The division has developed the full diagnostic facility in term of serological, isolation and molecular diagnostics. • Diagnostic facility has been developed and standardized for all major food borne bacterial zoonotic organism viz., Aeromonas spp., Escherechia coli- , Listeria monocytogenes, Mycobacterium spp., Campylobacter, etc. • The Advanced Disease diagnostic and management consortium for major animal diseases have been created with DBT funding.
<p>4. Acid soil management for productivity enhancement</p> <ul style="list-style-type: none"> • Assessment of physiological lime requirement of major crops of the North east and development of suitable management practices. • Development of soil health indices (physical, chemical and biological) for evaluation of amelioration efficiency. • Evaluation of locally available organic sources as alternative to lime for acid soil management 	<ul style="list-style-type: none"> • Physiological lime requirement of acid soils was determined based on lime rate equivalent to Al extracted by 0.2 M LaCl₃ for the one cereal crop. • Soil quality of different farming systems in Meghalaya evaluated and SQI value estimated. • Calcium carbonate equivalent (CCE) of organic manures viz. poultry manure, pig manure, compost and FYM determined. Liming potential of poultry manure was found to be the highest (CCE 449 kg t⁻¹ of the product). The performance of poultry manure as substitute of lime was superior in increasing the yield of maize and mustard crops.
<p>5. Development of location specific varieties, resource conservation technologies, Agroforestry and farming system modules for livelihood improvement.</p>	<ul style="list-style-type: none"> • Resource conservation technologies for rice and maize based cropping systems involving residue recycling, no/minimum tillage and crop rotations with pea, lentil, rapeseed after rice and frenchbean, black gram and green

<ul style="list-style-type: none"> • Development of suitable RCT options for higher productivity. • Study of bio-resource flow pattern in different farming systems • Tree crop interactions in agroforestry system • Evaluation of carbon sequestration potential of different agroforestry systems. • Development of organic package of practices for important field crops, vegetables and fruit crops. • Development of alternate cropping systems resilient to extreme weather conditions. 	<p>gram after maize has been standardized. The same has been amply demonstrated in farmers field across NEH region.</p> <ul style="list-style-type: none"> • Tree crop interaction between <i>Alnus nepalensis</i> and <i>Gmelina arborea</i> with Ginger. Turmeric and upland rice was studied. Alder had positive and Gamhar has negative interaction with Ginger and turmeric. • Carbon sequestration potential of five agroforestry systems in Mizoram, Meghalaya and Tripura has been studied. • To alleviate impact of extreme weather conditions like drought, many cropping systems are being evaluated. Buck wheat, rapeseed, rice bean etc. are identified as more tolerant crops to moisture stress. In addition, rice and maize germ plasms are being screened for heat, drought and submergence tolerance in Umiam, Agartala and Impal conditions. From Tripura drought tolerant rice like Tripura Khara dhan 1, 2 and Tripura Kakuchu 1 and 2 has been released.
<p>6. Genetic improvement of plant and animal resources</p> <ul style="list-style-type: none"> • Improvement of major field crops, vegetables, MPTs, livestock, poultry and fishes • Phenomics studies, Allele mining for biotic (rice blast)/abiotic (temperature, soil acidity) stress tolerance. • Genetic diversity assessment of economically important plants, animals and fishes (ornamental fishes) • Adaptability studies of Murrah Buffaloes in NE region for milk and meat productivity. • Study of reproductive biology including IVM, IVF, OPU and cryopreservation of gametes, embryo cell research in farm animals. • Pollinator diversity and pollination biology of native bees in different 	<ul style="list-style-type: none"> • Released 14 rice varieties, seven (7) pulses, one oil seed, two (2) tuber drops, 6 tomato, 2 brinjal, one turmeric, one papaya, one pineapple and one <i>Jatropha</i> were released for the North East region. Till date institute developed 59 crop varieties out of which 37 varieties of rice. • Phenotypic and physiological evaluation of 650 rice germplasm identified a set of 9 lines as tolerant and among them RCPL 1-460 and RCPL 1-74 are moderately tolerant to 37 / 26°C day / night temperature under artificial light (3000 lux). • A set of 16 maize germplasm lines were identified as tolerant to elevated temperature of 35°C. Among them RCMGP- 63, RCMGP-105 and RCMGP-47 were found to be heat tolerant at anthesis stage. • Three breed cross pig was developed by

<p>crops.</p>	<p>crossing Hampshire male with selected local female pigs and F1 female was again crossed with Duroc male in order to get lean meat along with good mothering ability, high litter size and better adaptability to the local conditions.</p> <ul style="list-style-type: none"> • Smallholder low cost deep litter pig housing model along with water harvesting structure has been developed • Under the AICRP on Pigs, a new breed “Lumsniang” has been developed and released. • Murrah Buffaloes have been introduced and popularized in the states of Meghalaya and Tripura. • Considering the changing climatic conditions of the region and potential of buffaloes to adjust to a wide range of agrarian and diversified agro-climatic situations, ICAR Research Complex for NEH Region, Umiam, Meghalaya has introduced total 7 Murrah germ plasm on March, 2012 for the first time in north east conditions as a pilot study with an aim to access the suitability of Murrah germplasm to north east conditions as this riverine buffalo is a triple purpose species contributing milk, draft-work and meat, compared to the swamp buffalo which is considered a dual-purpose species - draft and meat only. • Artificial insemination has been widely disseminated in pigs and a Patent has been filed for low cost portable Dummy sow with mating grunt voice system. (Application no: 430/KOL/2013, Published on:24/10/2014) • Studies on Estrus synchronization was done in anestrus sow during summer season to improve fertility using PMSG and hCG in combination. Estrus induction rate was more than 90% with farrowing rate of 80% and litter size of more than 7 piglets. • A nucleus-breeding flock of selected Assam Hill goats (n=20) as foundation stock was established on basis on twinning
---------------	---

	<p>and triplets kidding of dam, phenotypic characteristics viz. body size, conformation, weight for age, their ancestral history on production and reproduction. A selective breeding programme was performed to improve the reproductive and productive performance.</p>
<p>7. Health management in animals</p> <ul style="list-style-type: none"> • Development of vaccines and initiate work on prototype development/validation strategies for animal vaccines. • Work on emergence of porcine viruses especially circo and paro virus. Development of amelioration measures against CSFV and detection protocol. Strategies to detect and characteristics multi-drug resistant pathogen. • Development of diagnostics platform with emphasis on rapid turnaround times. Development of containment facilities to handle potentially hazardous pathogens. Emergency response system in handling animal virus/virus/bacteria/parasites need to be put in place. 	<ul style="list-style-type: none"> • Serological and molecular diagnostics standardised and available for emerging porcine diseases viz., Porcine respiratory and reproductive syndrome virus (PRRS); Porcine circo virus (PCV) and Porcine parvo virus (PPV). Rapid surveillance for porcine reproductive and respiratory syndrome (PRRS) using serological and taqman based assays has been standardised. • Screening of fecal samples for detection of rotavirus using standardized SDS-PAGE and RT-PCR. Molecular diagnostics for rotavirus infection in man and animals has been standardised. • Isolation of field samples of Pestis de petis ruminants (PPR) virus by co-cultivation method in Vero cell culture was established. The cytopathic effect of virus appears as cell syncytium by 56 hrs post infection. • Prototype CSF vaccine adapted in RK-13 cell line. Classical Swine Fever Virus was isolated from Field outbreak samples and the virus was adapted in RK-13 cell line up to passage 32. Presence of virus in RK13 cell line was confirmed through conventional PCR and Real Time PCR by targeting the E2 and NS5B genes and 5' NTR gene of CSFV, respectively and is ungoing further trails. • Indirect ELISA for detection of CSF antibodies using cell culture adapted RK-13 viral antigen was developed and standardized and has been undergoing the process of validation in other lab. of the region.
<p>8. Nutrition management in animals</p> <ul style="list-style-type: none"> • Development of quality feed and 	<ul style="list-style-type: none"> • Indigenous feed using kitchen waste and molasses was standardized and feed rials were conducted.

<p>fodders for livestock feeding.</p> <ul style="list-style-type: none"> • Feeding strategies for easing abiotic stress in livestock and poultry. • Use of nano technology in animal feeding • Increase in fodder biomass production and processing of feeds • Mineral nutrient mapping of feeds <p>9. Fish and Fishery development in North East</p> <ul style="list-style-type: none"> • Introduction of location specific fish species for aquaculture and standardization of seed production techniques. • Mass scale propagation of cultivable food fishes of regional importance • Evaluation of diversified and integrated fish culture. • Development of low-cost feed for cultivable fish species. 	<ul style="list-style-type: none"> • Fodder cafeteria creation was done in three blocks. • QPM Maize was selected for feeding piglets and dairy cattle. • The results of studies revealed that the pigs fed with kitchen waste combined with 7% molasses have better growth rate (280g/d) as compared to control group (230g/d) and molasses may help in protecting the animals from climatic stress. • Standardized composite fish culture, rice+ fish farming and fish based IFS • Successfully introduced and popularized Amur Common carp (a Hungarian improved strain) and Pengba (<i>Osteobrama belangeri</i>) –an endangered fish species to the NE India in addition to two indigenous minor carps for mid hill aquaculture among the farmers of the hill region. • Breeding technology for pabda and other important fish including indigenous fish standardized.
<p>10. Farm Mechanization for hilly terrain</p> <ul style="list-style-type: none"> • Development / adaptation of equipment for mechanization of tilled cultivation as well as zero tillage cultivation of major crops on hilly terrain. • Prototype feasibility testing, ergonomic evaluation and modification of tools and implements. • Prototype manufacturing of improved implements, seed storage structures, power tiller operated planters. 	<ul style="list-style-type: none"> • Adjustable zero till furrow opener. • Ergonomically developed long handle weeders. • Developed metallic tip dibbler for steep slopes. • Light weight fruit harvesters developed for hilly orchards. • Modified Hand operated Winnowing. • Portable pedal operated paddy thresher for hills. • Power paddy thresher for hills • Power Tiller operated inclined plate planter • Power tiller operated pneumatic planter • Portable Charring Kiln

	<ul style="list-style-type: none"> • Continuous biochar production unit (Biochar-1000)
<p>11. Generation and management of database on agricultural research in North-East India</p> <ul style="list-style-type: none"> • Operationalizing KIRAN (Knowledge Information Repository of Agriculture in North East). • Crop, location and season specific water balance studies including ET estimation. • Resource mapping and decision support system with the help of GIS and remote sensing tools. 	<ul style="list-style-type: none"> • Knowledge innovation repository on agriculture in North East (KIRAN) has been disseminating agro-advisories on best management practices, weather forecasting and contingency measures through SMS services. • Conceptualization and implementation of a knowledge innovation repository for the north east (Kiran) in 2011 and actively implemented the free SMS agro advisory platform under Kiran on 16th July, 2013. Apart from this coordination, development and updating of the Kiran portal was carried out. This portal won three national awards of recognition and was a pioneering ICT initiative in the north eastern region. • The Kiran project was awarded the • E- India 2014 award • Two Skoch orders of merit for agroadvisory and tracking SMS services in 2015 • Kiran was nominated for the finalist stage in the CSI- e-nihilient award 2015.
<p>12. Medicinal plants Research</p> <ul style="list-style-type: none"> • Development of novel drugs and formulations for critical animal and human diseases from the rich bio-resources of the NE Region • Development of cultivation practices and genetic improvement of selected medicinal plants 	<p>Screening of medicinal plants and preparation for antimicrobial activity was carried out for Meghalaya and Manipur alongwith documentation. As per the information based on personal interview of villagers in Meghalaya it was opined that they rarely depend on indigenous plants for treating ailing animals, which may be due to accessibility of veterinary healthcare. In Imphal west, Manipur used of some plants for treating animals was noticed like <i>Blumeahieracifolia</i> (Chingterapaibi) used in cuts and wounds, <i>Centallaasiatica</i> used in indigestion, <i>Allium porrum</i> (Maroinakupi) for debilitation,</p>

Spilanthesoleiracea (Angkasa-Mizo local name) used in dental problem in animals, *AdhatodavesicaNees* (Nongmangkha) used for fever in animals.

Micro-organisms and preparation of inoculum

The tested organisms included *Escherchia coli* ATCC 25922, *Staphylococcus aureus* ATCC 25923, *Salmonella* Typhimurium ATCC 49416 and *Listeria monocytogenes* laboratory isolate. All the cultures except *Salmonella* Typhimurium was identified in BD Phoenix 100 and stock cultures were maintained at 4°C on slopes of nutrient agar. The plant extracts with potent efficacy against the above cultures were further screened against multidrug resistant organism like *Klebsiella pneumoniae*, *Staphylococcus equorum*, *Staphylococcus aureus*.

Antibacterial study using p-INT dye

Escherchia coli ATCC 25922, *Staphylococcus aureus* ATCC 25923, *Salmonella* Typhimurium ATCC 49416 and *Listeria monocytogenes* laboratory isolate was inoculated in nutrient broth and kept for overnight at 37°C. On the next day, the antibacterial activity of plant extracts was studied at 1:1 dilution from the stock solution of 200 mg/ml. For comparison, non-culture control and non-extract control are also taken. The standard drug, Ampicillin was taken for comparison. The optical density of the plate is read at 490nm (Edziri et al. 2012).

The 10 plant extracts were screened against *Escherchia coli* ATCC 25922, *Staphylococcus aureus* ATCC 25923, *Salmonella* Typhimurium ATCC 49416 and *Listeria monocytogenes* laboratory isolate.

Assays Standardised-

Antibacterial assay: p-int dye assay

Antioxidant assay: DPPH radiacal scavenging

	<p><i>activity, Nitric oxide scavenging activity, Super oxide radical scavenging activity, ABTS radical scavenging activity</i></p> <p><u>Antiproliferative / anticancer activity:</u> <i>MTT assay, Real time PCR based analysis for genes caspase 3, caspase 8, caspase 9, p53, p21, Cell cycle analysis, Annexin based apoptosis assay, Real time PCR based analysis for cell cycle regulators like cyclin E, cyclin D1, cdk4, cyclin B1, cdk1, Annexin based apoptosis assay</i></p> <p><u>Bioassay guided fractionation</u> <i>by column chromatography, ,TLC, HPLC, mass spectroscopy, X-ray crystallography etc. Plant extracts given for fractionation to <u>Don Bosco University, collaborating partner</u></i></p> <p><i>Other collaborating partners are carrying out anti-mycobacterial activity, anti-leishmanial activity etc</i></p>
<p>13. Extension, Training and Transfer of Technology</p> <ul style="list-style-type: none"> • Establishment of V-type nursery for mass production of horticultural planting materials. • Establishment of Technology Park. • Seed production units in rural areas of hill states having potential for aquaculture. • Capacity building of farmers, entrepreneurs and extension officials etc. 	<ul style="list-style-type: none"> • V-type nursery could not be taken up due to paucity of money • Some work was initiated but could not be completed due to shortage of funds • Twelve FRP hatcheries have been installed in different villages of Meghalaya, Tripura, Manipur and Mizoram with a capacity to produce 10 million fingerlings per annum. • About 1500 hectares of lowland rice fallow areas have been brought under zero tillage rapeseed, lentil and pea in NEH Region mostly Manipur, Meghalaya etc. The practice conserved soil moisture and required less irrigation water, saves tillage cost and the soil is protected from erosion due to the retention of surface residues • Introduction of <i>jalkund</i> leads an integration of different component in IFS in which water productivity has increased by three

	<p>times. Around 1000 number of <i>jalkund</i> have been constructed in different parts of NEH region for diversifying agriculture especially during dry season.</p> <ul style="list-style-type: none">• A total of 9854 households benefited from various integrated farming system modules covering more than 5000 ha area in 7 backward Districts of North East under NAIP-3.• Under the Tribal Sub Plan (TSP), total of 41,720 tribal families in 287 villages of 26 districts of Meghalaya, Manipur, Nagaland, Tripura, Arunachal Pradesh, Sikkim, Mizoram and Assam were covered and benefited.• On an average, 63,000 farmers benefited every year from various demonstrations, seeds/breeds and training in seven NEH states including Institute and KVK activities.• Knowledge innovation repository on agriculture in North East (KIRAN) has been disseminating agro-advisories on best management practices, weather forecasting and contingency measures through SMS services
--	--

c) Bullet points/Numerical terms/Economic returns

Technology Developed/Commercialized

- Forty two technologies having commercial importance in natural resource conservation and productivity enhancement have been developed and disseminated.
- Patents: 2 patent application published, 3 filed

Economic Importance:

- Agriculture is the prime source of livelihood for the majority (85%) of rural population in this region. ICAR R C for NEH region is focussing on research on agriculture and allied sector including training and capacity building of the farmers of this region. Around 35000 farmers were covered under different programmes such as NICRA, TSP, Technology Mission, Mega seed project for transfer of technologies. Due to introduction of superior variety and germplasm during the last ten years, rice production of this region increased by 26.11% (from 5396.20 thousand tonnes in TE 2003 to 7457.06 thousand tonnes in TE 2016) The package and practices of organic farming for different crops provided by the ICAR and its regional centres including CAU and SAU has given better nutrient status in organic food. Introduction of superior variety and hybrids of different fruits and vegetable crops with package of practices in Hill Agriculture, all the states have increased their fruits production significantly. Fruit production increased from 2401.9 thousand tonnes in TE 2003 to 4855 thousand tonnes in TE 2016. In case of vegetables including Assam, the production in TE 2003 was 3662.9 thousand tonnes and in TE 2016 the production is 5836 thousand tonnes. India's export share in the global market for turmeric is 78% of which 26% of that is coming from NE region similarly India's export share in the global market for ginger is 5% of which 52% is coming from NE India.

Share of agriculture and Livestock in Gross State Domestic Product (GSDP)

- The share of Agriculture and allied sectors in GSDP is around 21.5% in North-East India (2011-12). Over the years the share of agriculture and allied sector to the Gross Domestic Product (GDP) of India has started declining whereas the share of livestock sector to the agriculture GDP is increasing over the years but the trend is reverse in case of livestock sector in NE states. Growth in both sectors has varied widely across states within the NEH region. However, the inter-state growth in the livestock sector has been more equitable than the crop sector.

Teaching and Guidance

- Teaching/guiding programme with College of Post Graduate Studies (CPGS), CAU - and guided/co- guided about 100 students in 8 disciplines,

- Trained 257 students under IGNOU study centre, activated eleven courses. In addition, Institute produced 43 Ph.Ds.

Awards and Recognitions

- Sardar Patel Outstanding ICAR institute award-2012, Outstanding Interdisciplinary Team Research Award (NRM) - 2011, Fakhruddin Ali Ahmed Award, Vasant Rao Naik Award, LalBahadurShastri award, Dr. HK Jain CAU award, Best KVK award etc. (total 16 awards).
- No of research papers having NAAS rating >6.0= about 275
- Competitive grant projects: about 100.
- Institute has initiated two important awards i.e. Dr. MS Swaminathan Award and Dr DN Borthakur award to recognize scientists for their outstanding contributions. Also the staffs are honored during foundation day celebrations for their significant contributions.

d) Export Avenues

There are export avenues for flowers, livestock produce, exotic herbs, medicinal plants, spices and condiments, processed fruit products and vegetables. These issues are being addressed under the Agri Business incubator project at the institute.

e) Benefits accrued to the farmers (stakeholders)

ICAR Research Complex for NEH Region has been serving the North Eastern Hill Region of India since 1975. The institute has been constantly endeavouring to develop location specific technologies through its ten divisions at the headquarters at Umiam, Meghalaya and its six regional centers at the six hill states of the NE region. Through its 16 KVKs distributed in different NE states, the institute is delivering its technologies to a large number of farmers in the remote localities of the region. Institute is also taking significant role in teaching and guiding students from Central Agricultural University, and other central and state universities. The institute has been working on three flagship programmes viz, improvement of *jhum* cultivation, temperate horticulture and trans-boundary diseases during the XII Five Yearly Plan. A multi institutional and multi-disciplinary project on medicinal plants has been initiated to tap the rich medicinal resources of the NE region. Some competitive projects such as DBT, DST, NICRA, NHB and NMSHE, TSP, KIRAN, etc. are operational in the region. The institute has been disseminating modern technologies for livelihood and nutritional security in the region that include truthfully labeled seeds, quality planting materials, improved animal breeds, poultry and fish seeds including proto-type implements and tools suitable for hill agriculture, soil health testing kits, diagnostic kits for animal parasites, diseases and critical inputs. Several in-house projects, mostly of interdisciplinary nature, are being pursued. The strategic and frontier research on climate change adaptation and mitigation under NICRA is a major research thrust area of the institute. About 15 AICRPs, 5 network and 15 collaborative

projects are in operation. The institute has strong linkage with other ICAR Institutes and Universities, International organizations like IRRI, ICRISAT, ILRI, and IWMI. The Institute also collaborates with government sponsored agencies like NERCOMP, MRDS, NABARD and IFAD; several NGOs and farmers bodies and co-operative societies for technology dissemination.

Specific achievements

About 1500 hectares of lowland rice fallow areas have been brought under zero tillage rapeseed, lentil and pea in NEH Region mostly Manipur, Meghalaya etc. The practice conserved soil moisture and required less irrigation water, saves tillage cost and the soil is protected from erosion due to the retention of surface residues

Introduction of *jalkund* leads an integration of different component in IFS in which water productivity has increased by three times. Around 1000 number of *jalkund* have been constructed in different parts of NEH region for diversifying agriculture especially during dry season.

A total of 9854 households benefited from various integrated farming system modules covering more than 5000 ha area in 7 backward Districts of North East under NAIP-3.

Under the Tribal Sub Plan (TSP), total of 41,720 tribal families in 287 villages of 26 districts of Meghalaya, Manipur, Nagaland, Tripura, Arunachal Pradesh, Sikkim, Mizoram and Assam were covered and benefited.

On an average, 63,000 farmers benefited every year from various demonstrations, seeds/breeds and training in seven NEH states including Institute and KVK activities.

Knowledge innovation repository on agriculture in North East (KIRAN) has been disseminating agro-advisories on best management practices, weather forecasting and contingency measures through SMS services. A total of 5620 farmers are being covered under the programme.

S. No.	Parameters	2013-14	2014-15	2015-16
1	Field Demonstration Organized	200	213	353
2	Skill Building of Farmers and Rural Youth	7825	11000	13425
3	Skill Building of Rural Women	3129	6723	8055

f) Validated technology transferred to other departments/entrepreneurs

Commercialization of Technologies: Under Commercialization of Technologies 3 nos. of technology has been under process of commercialization out of which two has already been commercialized viz. meat & poultry products and the variety Megha Turmeric -1 for multiplication. Also the process of commercializing the Fruit Fly Trapping Kit RC-1: Technology for management of fruit flies in Fruits and Vegetables is under process.

Facilitating a Memorandum of Agreement under Agri Business Incubation Program – “Arise, Launch Pad for Agri-Startup of ZTM & BPD Unit, ICAR-IARI” along with M/s Jeev Anksh Eco Products Private Limited which has requested for incubation at ZTM & BPD Unit, IARI for the project on “Setup of Certified Organic Food Processing unit in Northeast India.”

Outreach Activities: Total 11 nos. of outreach activities organized by various Institutes to develop the technology with the future commercialization prospective.

Capacity Building in IP Management (Training, Workshop, Seminar, etc): 19 nos. of trainings, workshops, seminars, etc has been organized by various Institutes from August 2015 to December 2016.

Other Activities: A total no. of 8 Institutes has organized some other activities under MGMG, PPV&FRA, farmers visit, etc.

A national cold chain summit on entrepreneurship under ZTMU & ABI was organized along with ASSOCHAM India, Ministry of AYUSH Govt. of India at Shillong on 4th – 5th October 2016.

Facilitated licensing of technologies, preparing & signing of Memorandum of Understanding between ICAR RC for NEH Region and various local entrepreneurs.

List of start-ups developed by ICAR RC for NEH Umiam.

Technology (1)	Meat processing, value addition and marketing of different meat products
Startup details	Tynrai Farms Pvt. Ltd. Mr. Kenneth Fancon, Nongrah – Donkgktieh Shillong, Meghalaya 793006 Ph: 8974480495
Status of startups	Graduated in April 2017

Technology (2)	Meat processing, value addition and marketing of different meat products
Startup details	Mr. Teilang Ezekiel Kharmalki, 4th Mile Upper Shillong, Shillong – 793005 Ph: 8257050903
Status of startups	Start up on May, 2017. On the process of scaling up.

Technology (3)	Fish hatchery and fingerlings production
Startup details	Mr. Heubert Richmund Nengnong, Mawlai, Umjaiur, block I, Shillong,

	Meghalaya – 793008 Ph: 08258846124
Status of startups	Start up on August, 2017. On the process of scaling up.

Technology (4)	Fish hatchery and fingerlings production
Startup details	Mr. Randal Lamin, 4th and half mile , Upper shillong, Shillong – Meghalaya – 793005 Ph:- 08974893792.
Status of startups	Start up on August, 2017. On the process of scaling up.

Technology (5)	Megha Turmeric – 1 (A variety of Turmeric commercialized for seed multiplication.)
Startup details	Ri-Bhoi Mihngi Multi-Purpose Co-Operative Society Ltd. Mr. Martin Lyngdoh, Bhoi-rymbong, Ri-Bhoi District, Meghalaya
Status of startups	Commercialized and on the process of scaling up.

Technology (6)	Mastitis Test Detection Kit.
Startup details	Umlyngka Primary Milk Producer Co-operative Society Mr. P. R. Kharbteng, 3rd Mile, Upper Shillong-793005, Shillong, Meghalaya
Status of startups	Technology commercialized.

Technology (7)	Chicken Feather Protein Hydrolysate (FPH) from native bacteria
Startup details	GCC Biotech India Pvt. Ltd. Joychandipur, P.O. Bakrahat, Bishnupur, Dist. South 24 Parganas, Pin 743377, West Bengal, India Reg. Office: 351, Third Floor BMK, Giri Nagar, Kalkaji, New Delhi – 110019, India
Status of startups	Technology commercialized.

Technology (8)	Organic Formulation (Granular) for Crop Production prepared by mixing Azotobacter (10% w/w), Azospirillum (10% w/w), Pseudomonas (10% w/w), Bacillus (10% w/w), Frateuria (10% w/w), Arbuscular mycorrhiza (10% w/w), Trichoderma (2% w/w), Vermicompost (30% w/w), Gram flour (2% w/w) and Molasses (6% w/w).
Startup details	M/S Tulip Agritech 31 C Flat No. 368 Gujarat Housing Board ,

	Vasahat, Pandesara, Surat-394220, Gujarat, India
Status of startups	Technology commercialized.

Technology (9)	Pig Bristle Technology
Startup details	Ka Synjuk Ki Hima Arliang Wah Umiam – Mawphlang Welfare Society Mr. Tambor Lyngdoh, Mawphlang, East Khasi Hills District-793121, Meghalaya Ph. No.: 9863082456
Status of startups	Technology commercialized but production not started yet.

Technology (10)	Honeybee Production
Startup details	Mr. K. D. Kharkrang, Bhoi-rymbong-793103, Ri-Bhoi District, Meghalaya Ph. No.: 8131918013
Status of startups	Started production of honeybees since June, 2016.

Technology (11)	Fruit juice production
Startup details	Mr. Wanlombok Pohlong, Nongshilliang – Nongthymmai Shillong 793014, Meghalaya. Ph: 8575091569
Status of startups	Will be graduating in Agri-business (Fruit juice production) by December, 2017

Technology (12)	Fruit juice production
Startup details	Mr. Sanjib Dhar, Howell road, Laban Shillong- 793004, Shillong, Meghalaya Ph. No.: 9436336726
Status of startups	Will be graduating in Agri-business (Fruit juice production) by December, 2017

Technology (13)	Poultry and piggery farming
Startup details	Mr. Basstanbor Thabah, Nongmysong, Shillong, East Khasi Hills District, Meghalaya Ph. No.: 9856007761
Status of startups	Started June, 2016

Technology (14)	Poultry and piggery farming
Startup details	Mr. Edwardstar Dkhar, Nongpyiur Village, East Khasi Hills District, Meghalaya Ph. No.: 9856931168
Status of startups	Started June, 2016

Technology (15)	Improved agricultural small farm tool and implements
Startup details	Mr. Everestingstar Bey, Tyrso Village, Ri-Bhoi District-793103, Meghalaya Ph. No.: 8794101254
Status of startups	On the process of scaling up.

Orientation training on Entrepreneurs Development on Manufacturing of Agricultural Small Farm Tools and Implements from 29th – 31st March, 2016 wherein 6 progressive farmers including entrepreneurs attended at Division of Agricultural Engineering, ICAR Research Complex for NEH Region, Umiam, Meghalaya .



1. A three months training programmed on Entrepreneurship Development of Manufacturing of Agricultural Small Farm Tools and Implements was conducted at Division of Agricultural Engineering, ICAR Research Complex for NEH Region, Umiam, Meghalaya wherein two incubates recently graduated under ABI 7 ZTMU which commenced from 29th September to 3rd December. Also another two incubates are still pursuing the said programme awaiting successful completion.



2. A national cold chain summit was organized by ICAR Research Complex for NEH Region, Umiam under Agri- Business Incubation (ABI) & ZTMU Centre in collaboration with the ASSOCHAM'S, Ministry of AYUSH, Government of India on 4th to 5th October, 2016 in Shillong, Meghalaya wherein 67 participants attended the said programmed. The aimed of the summit were on developing entrepreneur's skill development on food processing industry for boosting food industry in North Eastern Region.



3. ASSOCHAM's Conference on "Linking Prospective Food Entrepreneurs with Government Schemes & Markets" in collaboration with the Union Ministry of Food and Processing Industries (MoFPI) and ICAR Research Centre for NEH Region on 15th December, 2016 was held at ICAR Research Complex for NEH Region, Umiam, Meghalaya whereas the Conference was inaugurated by the then Governor of Meghalaya, V. Shanmughanathan as the chief guest.





4. Signing of MoU between ICAR RC for NEH Region, Umiam and Ri-Bhoi Mihngi Multi-Purpose Co-Operative Society Ltd. and licensing for seed multiplication of Megha Turmeric-1 was done on 8th November, 2016 in the presence of Shri Sudarshan Bhagat, Hon'ble Union Minister of State of Agriculture and Farmers Welfare.



5. Meeting of directors of 13 institutes of Hills Region across the country was organized and various decisions have been taken on 12th December, 2016 at ICAR RC for NEH Region, Umiam, Meghalaya. The major areas covered on this meeting were on temperate horticulture, organic farming, livestock management and housing was tentatively finalized.





6. Signing of MOU between ICAR Research Complex for NEH Region and Umlyngka Primary Milk Producer Co-operative Society for Mastitis Test Detection Kit.



Signing of MoU by Director, ICAR RC for NEH Region, Umiam and Secretary, Umlyngka Primary Milk Producer Co-opt. Society Ltd., 3rd Mile, Upper Shillong
19th June, 2017

7. Signing of MOU ICAR Research Complex for NEH Region and **GCC Biotech India Pvt. Ltd.** for technological support to commercially produce and market the Chicken Feather Protein Hydrolysate (FPH) from chicken feather waste using native bacteria *Chryseobacterium sp.*, RCM-SSR-7. The chicken feather protein hydrolysate is rich in nitrogen (12%) and essential amino acids and has also shown free radical scavenging

activity. RCM-SSR-7 can produce IAA. The FPH can be used as organic fertilizer and livestock feed additives, in accordance with the technical guidelines and instructions of ICAR (RC) NEH;

8. Signing of MOU ICAR Research Complex for NEH Region and M/S Tulip Agritech 31 C Flat No. 368 Gujarat Housing Board , Vasahat, Pandesara, Surat-394220, Gujarat, India for Organic Formulation (Granular) for Crop Production prepared by mixing Azotobacter (10% w/w), Azospirillum (10% w/w), Pseudomonas (10% w/w), Bacillus (10% w/w), Frateuria (10% w/w), Arbuscular mycorrhiza (10% w/w), Trichoderma (2% w/w), Vermicompost (30% w/w), Gram flour (2% w/w) and Molasses (6% w/w).

List of entrepreneurs and relevant details.

1. Shri. Heubert R. Nengnong,
Mawlai, Umjaiur, block I, Shillong,
Meghalaya – 793008
Ph: 08258846124(M)
2. Miss Bakmenlang Lyngdoh
Nongrah – Donkgtieh Shillong,
Meghalaya 793006
Ph : 07085718359
3. Shri. Randal Lamin
4th and half mile , Upper shillong,
Shillong – Meghalaya – 793005
Ph:- 08974893792.
4. Miss Fellaliza Wanniang
Mawlangwir Village,
Mawkyrwat, South West Khasi Hills District,
Meghalaya.
Ph : 09615104891
5. Miss Alyssa. B. Marak
K.A. Tura,
Po. Chandmari – 794002
West Garo Hills, Meghalaya
Ph; 08119932042
6. Miss Salam Rojita Devi

Andro Bazaar ,
Imphal east District, Manipur
Ph: 9862695513.

7. Mr. Kenneth . E. Fancon
Nongrah – Donkgktieh Shillong,
Meghalaya 793006
Ph: 8974480495
8. Shri. Wanlambok Pohlong
Nongshilliang – Nongthymmai
Shillong 793014, Meghalaya.
Ph: 8575091569.
9. Mr. Sanjib Dhar
Howell road, Laban Shillong- 793004
9436336726
10. Shri. Granny F G Lyngdoh
4th Mile Upper Shillong,
Shillong – 793005
Ph : 8794445766.
11. Shri. Teilang Kharmalki
4th Mile Upper Shillong,
Shillong – 793005
Ph: 8257050903
12. Shri. Khlurphyrnai Marwein
Umden Mission, Umroi
Meghalaya 793103
Ph 8014164911
13. Shri. Pripsphranghing Kharbuhi
Umden Mission, Umroi
Meghalaya 793103
Ph 9615308883.