

## **PROJECT COMPLETION REPORT (PCR)**

Project Title:

**Validation and up-scaling of Tricho-products for  
soil borne disease management in vegetable  
Crops  
(ID: TF 09 NR)**

Project Duration: May 2013 to May 2016

### **CGP Project: KGF BKGET 1<sup>st</sup> Call**

Submitted to:

**Executive Director**

Krishi Gobeshona Foundation (KGF)  
AIC Building (3 rd Floor), BARC Campus  
Farmgate, Dhaka-1215

Submitted by:

**Dr. Mossamat Shamsunnahar**

Principal Investigator &  
Principal Scientific Officer  
Plant Pathology Section  
Horticulture Research Center  
BARI, Joydebpur, Gazipur 1701

October, 2016

**Project Completion Report**  
**on**  
**Validation and up-scaling of Tricho-products for soil borne disease management in**  
**vegetable Crops (TF 09 NR)**

**CGP Projects: KGF BKGET 1<sup>st</sup> Call**

Project Duration: From May 2013 to May 2016

**A. Basic Project Information:**

- i. Project ID No-(FRP): TF 09-NR
- ii. Project Title: Validation and up-scaling of Tricho-products for soil borne disease management in vegetable Crops
- iii. Name of Coordinator (if any): Not applicable
- iv. Name of Principal Investigator (PI):
  - a. Dr. Mossammat Shamsunnahar, PSO, Plant Pathology Section, HRC, BARI, Gazipur
- v. Name of Co-investigator (s):
  - b. Dr. A K M Khorsheduzzaman, SSO, Entomology Section, HRC, BARI, Gazipur
  - c. Dr. Md. Golam Kibria, SSO, Plant Pathology Section, HRC, BARI, Gazipur
  - d. Md. Rafi Uddin, PSO (Horticulture), RARS, BARI, Jessore
  - e. Dr. Md. Zulfikar Haider Prodhan, SSO (OFRD), ARS, Chelopara, Bogra
- vi. Name of the applying organization with address: HRC, BARI, Joydebpur, Gaipur-1701
- vii. Name of associate/collaborating organization(s), if any: Not applicable
- viii. Project duration (months) 36 months; From May 2013 to May 2016
- ix. Project commencement date (As per MoU): May 20, 2013
- x. Project locations/sites : i) Churamonkathi, Jessore sador, Jossore & ii) Khanpur, Sherpur, Bogra
- xi. Project size: No. of Upazilas covered: 2  
Total no. of sites/locations: 2



Location of project sites in Map

Total no. of farmers involved: 40 (considering two farmers from each farm family);

Trichoderma spore production in the laboratory and composting house/device preparation and Tricho-compost production started from summer 2013 and its application in farmers' field started from summer 2014

Land area per farm family used in decimal: 10

Total land area used in decimal per season: 200

Crop seasons (4) with crop varieties used:

Summer 2014: pointed gourd, bottle gourd and country bean

Winter 2014-15: country bean, brinjal, cabbage and cauliflower

Summer 2015: pointed gourd, brinjal, tomato and cucumber

Winter 2015-16: Bottle gourd, country bean, cauliflower & Summer 2016: Cucumber

xii) Project cost (total): **Tk. 40.986 lac** (Year-1: Tk. 13.776 lac; Year-2: Tk. 13.367 lac; Year-3: Tk. 13.843 lac)

xiii) Fund received in **Tk. 3960170** & Expenditure made in **Tk. 3960075.7** during project period

## B. Summary

*Trichoderma* is a beneficial antagonistic fungus which presents in all types of soils. The fungi are opportunistic, avirulent plant symbionts, as well as being parasites of other fungi. The potential *Trichoderma* isolates are formulated using different organic and inorganic carriers either through solid or liquid fermentation technologies. They are delivered either through seed treatment, bio-priming, seedling dip, soil application or foliar spray. Bangladesh Agricultural Research Institute developed dip compost based formulation named Tricho-compost by mixing of a definite concentration of spore suspension of a *Trichoderma harzianum* strain with measured amounts of processed organic materials. The composting process produces drainage enriched with *Trichoderma*, called Tricho-leachate which can be collected and reused. Tricho-compost and-leachate found to be effective to combat fungal, nematode and bacterial diseases of vegetable crops. Moreover, Tricho-compost is highly rich in various nutrient elements that may enrich soil fertility & provide nutrition to the crops. However, the use of Tricho-products is very limited in our country. Therefore, the project was undertaken (i) to develop skill and knowledge for bio-composting at farmers' level, (ii) to apply the Tricho-compost and-leachate for disease management of vegetable crops and (iii) to reduce the use of pesticide and chemical fertilizer in vegetable crops.

Community based farm participatory approaches were taken to introduce the technology. One family was considered one farm. A total of twenty farm families from two project sites with each of ten decimal lands were selected to launch Tricho-compost and-leachate production and using in vegetable crops. A total of 20 pair raw material composting devices (one per family) were prepared in participatory farmers' houses. Total 3.24 hectares of land was utilized within four crop seasons during project period. Focus Group Discussion (FGD) was performed for baseline survey on farmers' problems of vegetable cultivation prior to launch project. A five member team comprising of production specialist, plant pathologist, entomologist and economist were built for FGD. Extension personnel of DAE, NGO representative and participatory farmers took part in the discussion. Training and workshop were arranged for updating knowledge and information on *Trichoderma* technology. Participatory farmers training was arranged to introduce project activities. Project assigned lab (one) and field (two) assistant were recruited and posted in respective project sites. Lab assistant worked in the laboratory for lab work. Field assistant continuous looked after and assisted the farmers to execute project activities. PI along with CI was visited project sites and suggested for performing project activities.

Spore suspension of *T. harzianum* was produced in the laboratory of plant pathology section, HRC, BARI and supplied for compost production in project sites. A total of 68 liter of *T. harzianum* seed spore suspension ( $3 \times 10^{12}$  cfu/ml) was produced during project period. Participatory farmers collected waste materials and produced compost using seed spore suspension of *T. harzianum*. About 36.96 ton Tricho-compost and 1070 liter Tricho-leachate were produced from two project sites. A number of trials were conducted for up-scaling Tricho-compost and -leachate production and using at farmers' level. Tricho-compost was incorporated in soil and Tricho-leachate was applied as foliar spray for disease management.

A total of eighty adaptive trials were conducted during project period for validation of Tricho-products at farmers' level. Among them, twenty adaptive trials with pointed gourd, seven with bottle gourd, eight with country bean, three with tomato, seventeen with brinjal, nineteen with cauliflower, four with cabbage and two with cucumber were performed. Soil borne disease was reduced and yield increased by 37.49 to 42.44% in 2014, and 20.74 to 33.73% in 2015 in pointed gourd due to soil incorporation of Tricho-compost. Phytophthora fruit rot of pointed gourd was reduced by 33.71 to 36.84% in 2014

and 34.79 to 37.78% in 2015 due to foliar spray of Tricho-leachate. Benefit cost ratio (BCR) was increased by 31.31 to 32.16% in 2014 and 19.73 to 27.73% in 2015 for pointed gourd production in Tricho-products field. Anthracnose fruit rot of bottle gourd was reduced by 27.37% in 2014 and 48.67% in 2015-16 and yield increased by 31.86% in 2014 and 28.22% in 2015-16 in Tricho-products field in Jessore. BCR increased over control was 27.83% in 2014 and 24.30% in 2015 due to Tricho-products application in bottle gourd fields. Anthracnose fruit rot was reduced by 37.65 to 52.81% and marketable yield increased by 29.53 to 33.53% in summer country bean using Tricho-products regardless of locations. While anthracnose rot of winter country bean were reduced by 66.67% and 58.78%, and yield increased by 20.05 and 30.42% in 2014-15 and 2015-16, respectively at Bogra. BCR was increased by 28.15 to 31.99% in summer country bean and 20.05 to 30.42% in winter country bean.

Bacterial wilt of brinjal was reduced by 67.83 to 82.5% and yield increased by 20.25 to 37.01% in Tricho-compost and-leachate application treatment. *Phomopsis* blight reduced over control was 65.79% in 2014 and 50.19% in 2015 in brinjal at Bogra. BCR of brinjal production was increased by 20.23 to 31.39% regardless of locations and year of crop production. Bacterial wilt disease was reduced by 79.59% and yield increased by 27.54% in tomato due to application of Tricho-products. *Fusarium* wilt of cauliflower was reduced by 66.67 to 84.88% and yield increased by 18.23 to 38.08% in Tricho-compost and-leachate application fields. BCR was increased by 18.23 to 38.80% in cauliflower production regardless of location and year of crop production. Similarly for cabbage production BCR was increased by 20.57% in Tricho-product application field. Fruit rot was reduced by 43.97 to 46.59% and yield increased by 27.76 to 30.74% in cucumber in Tricho-compost and-leachate application treatment. In Tricho-products applied field, BCR for cucumber production was increased by 21.43 to 28.40%.

Due to Tricho-compost and-leachate, Urea, TSP, DAP, MoP and ZnSo<sub>4</sub> application was reduced by 25.00 to 33.33%, 22.22 to 30.77%, 16.67 to 22.22%, 30.77 to 37.50%, respectively in pointed gourd regardless of locations. In bottle gourd field, fertilizer application reduced over farmers' practices was 41.67, 36.36, 16.67 and 30.0% in Urea, TSP, DAP and MoP fertilizers, respectively. In country bean, fertilizer application reduced over farmers' practices were 29.41 to 38.89%, 28.57 to 33.33%, 18.75 to 28.57%, 23.40 to 30.0% and 16.67 to 33.33% in Urea, TSP, DAP, MoP and ZnSo<sub>4</sub> fertilizers, respectively regardless of locations. Fertilizer application in compost plots was reduced by 25.0 to 33.33%, 26.09 to 27.27%, 23.08 to 25.00%, 22.22 to 28.57%, 28.57 to 37.5%, and 16.67 to 25.0% in Urea, TSP, MoP, Gypsum, ZnSo<sub>4</sub> and Borax, respectively in brinjal crop. In tomato Urea, TSP, DAP, MoP, Gypsum, ZnSo<sub>4</sub> and Borax were reduced by 25.0, 25.0, 20.0, 30.0, 25.0, 28.57 and 25.0%, respectively. While in cauliflower crop 18.18 to 20.0%, 16.67%, 20.0 to 25%, 16.67 to 18.18%, 20.0 to 33.33%, 16.67 to 33.33% and 16.67 to 25.0% less amount of Urea, TSP, DAP, MoP, Gypsum ZnSo<sub>4</sub> and Borax, respectively were applied regardless of locations. Urea, TSP, DAP, MoP and Gypsum application was reduced by 28.00, 28.57, 16.67, 20.0 and 33.33%, respectively in Tricho-compost applied field of cabbage. Due to use of Tricho-compost, Urea, TSP, DAP, MoP and ZnSo<sub>4</sub> application reduced about 40.0, 46.67, 16.67, 33.33 and 33.33%, respectively in cucumber field.

After fourth application of Tricho-compost and vegetable production, soil microbial population was studied. Bearmann funnel technique for soil nematodes and serial dilution method for fungal and bacterial population count were used. Tricho-compost soil, plant parasitic nematode reduced and beneficial nematodes (bacterivorus and fungivorus) population increased. About 63.64 to 70.21% plant parasitic nematode decreased.

On the other hand, about 88.31 to 89.15% fungivorous and 136.82 to 156.48% bacterivorous nematode population increased in Tricho-compost application soil. The genera with the greater number of fungi were *Aspergillus*, *Glomus*, *Penicillium*, *Cladosporium*, *Rhizopus*, *Trichoderma*, *Fusarium*, *Mucor*, *Alternaria*, and *Humicola* in both soil samples. Microbial colonies of decomposer fungi were higher in compost application field than non-amendment plots. Fungal and bacterial populations were increased by 123.08 to 139.50% and 71.31 to 85.68% regardless of locations.

A total of 135 persons (22 from DAE, one from BADC, 12 from NGO, 12 from BARI, four scientific assistant and 84 farmers) were received training on *Trichoderma* technology during project periods.

### C. Introduction

Due to the awareness of human health and conservation of soil and environmental quality, increasing attention has been paid to alternative disease management systems for producing vegetable crops. Application of compost fertilizer along with manure fertilizer, various IPM tools such as healthy seed, crop rotation, good cultural practices, use of pheromone trap, hand weeding, hand picking of insect-pest and diseases are considered as alternative management options. These practices seem to be potential to enhance soil quality, promote microbial diversity and abundance, and to reduce disease incidence. On the other hand, agricultural and house-hold waste creating a great problem throughout country. It has been reported that about 70% house-hold wastes are organics. At present, approximately 0.5 -1.0 kg organic wastes are produced per family. In this connection, 13.0 tons wastes produced daily and 4.9 million tons annually in Bangladesh. There is no proper use of these wastes due to lack of proper initiatives. Water hyacinth, consider as water weed, can be a natural source of fertilizer. Appropriate technology could help rapid conversion of those solid wastes to nutritious bio-fertilizer.

More than 100 vegetables are grown in Bangladesh. Among them, 33 are considered as major (Rashid *et al.* 2008). Annual vegetable production was 2993 thousand tons in 2009-10 cropping season which is increasing day by day (Anon. 2010). The present rate of vegetable consumption is 35-40 g/day/person against recommended 220g/day/person accordingly to WHO (Anon. 2005). As per recommendation, Bangladesh needs to produce 11.24 million metric tons which is 6.3 fold higher than the present production.

Bangladesh Agricultural Research Institute started research on development and use of *Trichoderma* since 1998. However, large scale production and composting method has been begun to practice uses *Trichoderma* in Bangladesh (Anon. 2009). Mixing of a definite concentration of spore suspension of a *Trichoderma harzianum* strain with measured amounts of processed organic materials was developed *Trichoderma*-based compost fertilizer named Tricho-compost (Nahar *et al.* 2010a). The composting process produces drainage enriched with *Trichoderma*, called Tricho-leachate (Anon. 2009) which can be collected and reused, with any surplus exchanged between farmers or sold at the farmer markets. These two bio-products suppressed soil borne fungal pathogens (*Sclerotium*, *Fusarium* and *Rhizoctonia*), root-knot nematode (*Meloidogyne* spp.) and bacteria (*Ralstonia solanacearum*) in artificial inoculated condition (Faruk *et al.* 1999, Sultana 2012, Nahar *et al.* 2010a). Grameen Krishok Sohayak Sangstha (GKSS) & Mennonite Central Committee (MCC) have been producing *Trichoderma* based compost fertilizer by using technology developed through IPM CRSP, a USAID funded project of BARI since 2009.

Research on *Trichoderma* and its bio-formulation also started at BAU, Mymensingh since 1998 (Faruk *et al.* 1999). Natore Development Society, a private agency is using *Trichoderma* in small scale for decomposing household and market waste (Ilias *et al.* 2005, Rahman *et al.* 2009).

In India, *Trichoderma* infused compost is used against *Fusarium* wilt and *Pythium* rot, which attack vegetable crops. In Indonesia, it is used against clubroot of broccoli. In the Philippines, it is used to combat anthracnose bulb rot, damping off and pink rot of onions. In India and the Philippines, *Trichoderma* is sprayed on seedling as a treatment for vegetable crops. And in Honduras, it is used on watermelon for the control of *Fusarium* wilt (Muniappan 2012).

Vegetable under IPM systems, especially *Trichoderma* based production was recorded less insect, pest and disease infestation compare to non-IPM system (Anon. 2012). Brinjal shoot and fruit borer infestation reduced about 20% in Tricho-compost application field (Anon. 2012). In order to protect environment, BARI Tricho-compost along with other BARI developed IPM technologies (sex pheromone, hand picking of insect, hand weeding, release of bio-control agents) may be considered as pest management option in vegetable fields.

*Trichoderma harzianum*, *T. viride* and *T. virens* are the three common species used in biological control. These biological control agents promoted seedling establishment, enhanced plant growth and elicited plant defense reaction in different crops had been reported by many scientists (Biswas and Sen 2000, Celar and Valic 2005, Hajieghrari 2010, Nahar *et al.* 2010a). Mechanism of disease suppression by *Trichoderma* are hyperparasitism, antibiosis, induced resistance in the host plant and competition for nutrients and space (Benitez *et al.* 2004, Howell 2003, Hoyos-Carvajal *et al.* 2009, Haggag and Abosedera 2005).

Addition of organic matter in soil provides a nutrient source for beneficial microbes that suppress other harmful fungi, bacteria and nematode (Nahar *et al.* 2010 b). Tricho-compost reduced seedling mortalities caused by *Pythium*, *Rhizoctonia*, *Sclerotium* and *Fusarium* spp by 40.92% to 64.45%. Root knot nematode infestation was reduced by 80.69% to 91% in vegetable production fields (Nahar *et al.* 2010 a). Beneficial impact of Tricho-compost was study in IPM system, indicated increase abundance of beneficial micro-fauna (*Rhabditis* spp., beneficial soil nematode), which is indication of soil organic enrichment (Nahar *et al.* 2010b). Therefore, to suppress pathogens and produce healthy soil environment, it is necessary to large scale adoption of the Tricho-compost technology in the vegetable growing fields. Considering above all, the present proposal was proposed.

#### **D. Specific project objective(s): (As per FRP/PIR)**

1. To control/reduce soil borne diseases and to increase yield of vegetable crops by using Tricho-products.
2. To reduce the amount of pesticide and chemical fertilizer in vegetable crops production.
3. To improve knowledge and skill of farm family on production and use technology of Tricho-products and to create awareness among the farmers of the project area about its benefit in vegetable production.

## E. Detailed Technical Report

### a. Statement of the Researchable Problem:

Southern part of the country such as Jessore is considered one of the vegetable growing areas, facing problems with insect pest and diseases, resulting vegetable production reduced in quantity and quality aspect. The other vegetable growing areas such as Bogra district is facing similar problems and using toxic chemicals as foliar spray or directly in soil incorporation. Kabir *et al.* (1996) reported that farmers of Jessore region sprayed 144 times in brinjal in a single cropping season. Using chemicals often overdoses, more frequencies and even mixing of two or more chemicals as cocktail formulation to achieve better yield. Not only have abused pesticides in the production, vegetable are becoming poisonous for consumers' health as well as polluted environment, several living organism are being killed and disrupting the ecosystem of soil. To overcome the situation, eco-friendly disease management system would be the option. Therefore, BARI developed two organic components (Tricho-compost and-leachate) were validated at farmers' level for diseases management and up scaled their knowledge for production the products in home stead areas.

Base line survey data on problems associated with vegetable production practices, disease incidence and management, yield loss, yield, income etc. were collected through Focus Group Discussion (FGD). In Jessore area, a total of 20 farmers (two from each farm family, usually husband and wife) with land area ranged from 99.0 to 660.0 decimal were selected (Table 1). Cabbage, cauliflower, brinjal, cucurbits, country bean, spinach, tomato, amaranth etc. are grown in Jessore area (Table 2). However, the most popular one is brinjal. Summer brinjal cultivation area is about 29.4 decimal, while it is in winter about 36.0 decimal (Table 3). Farmers using fertilizer that are 2 to 3 times higher than recommended dose (Table 4 & 5). With the high management, average yield of summer and winter brinjal was 27.13 and 37.09 t/ha, respectively (Table 6). Net return was Tk. 55187/ha for summer and Tk. 145721/ha for winter brinjal crop. The benefit cost ratio was higher for winter brinjal (1.65) as compared to of summer (1.26) (Table 7). Eighty five percent farmers mentioned about insects and diseases as the major problem for vegetable production at project area in Jessore (Table 8).

However, adulteration in fertilizer and pesticide (75%), low output price (50%), high input cost (45%), labour crisis (45%), lack of irrigation facilities (45%) and fake packing of seed (30%) were also indentified as the other problems for vegetable production at Jessore area.

Similarly, in Bogra, 20 farmers (two from each family, usually husband and wife) with land area ranged from 99.0 to 825.0 decimal were selected (Table 9). Cabbage, cauliflower, country bean, tomato, cucurbits, spinach, chilli, potato, red amaranth etc. are grown in Bogra area (Table 10). Farmers are growing cabbage and country bean on average 33.7 and 18.05 decimal lands, respectively (Table 11). Cabbage varieties such as such as Atlas 70, KK-Cross, summer orior, tropical 33, kumfu, local etc. were found to cultivate in the study area. Yield of Atlas 70, KK-Cross, summer orior, tropical 33, kumfu and local were 78.91 ton, 44.91 ton, 51.95 ton, 52.74 ton, 53.36 ton and 46.79 ton per hectare, respectively. The average yield was found 54.77 ton/ha (Table 12). Different type of country bean varieties such as BARI Shim 1, BARI Shim 2, BARI Shim 4, local, Naldoga, IPSA 1 etc. were found to cultivate. The average yield was found 14.51 ton/ha (Table 12). Farmers obtained Tk.141421/ha net return and Tk.204877/ha gross margin in cabbage, whereas country bean produce Tk.81683/ha net return and Tk.148244/ha gross margin. The BCR was higher in

cabbage (1.59) compared to country bean (1.39) (Table 13). In general, the pesticides application rate is lower (close to recommended dose) in Bogra compared to Jessore (several times higher than recommended dose). Farmers mentioned adulteration in fertilizer and insecticides (90%), insect infestation (85%), disease infestation (80%), lack of quality seed & low output price (75%) were the major problems of cultivating cabbage. However, high input price (65%), lack of irrigation water (60%), labour crises (60%) and seed & fertilizer are not available in time (55%) were also problems to the cabbage growers (Table 14). (Annexure 1 & II)

During our focus group discussion, one farmer, Md. Hasrat Ali Gazi from Jessore told that his family never had any brinjal during summer season because of frequent spray of pesticides. He said “In last Ramadan, my daughter asked me to bring some brinjal for preparing BEGUNY, but I did not find any brinjal field where the farmer was not sprayed for a single day”. Farmers applied huge quantities of chemical fertilizers and amount of fertilizer application increased with increasing crop age. For example in brinjal farmers used the maximum fertilizer at late fruiting stage (Fig. 1.). The most damaging diseases were foot and root rot of seedling, wilting disease of vegetables, root-knot nematode, phomopsis blight of brinjal, gummosis disease of bottle gourd and pointed gourd. Shoot and fruit borer of brinjal, pod borer country bean, jessid, aphid, diamondback moth, and armyworm (*Spodoptera litura*) of cabbage etc were identified as major pests of vegetable crops in assigned project sites. Farmers used toxic chemical in the name of vitamin. The project was designed to combat the above mentioned issues.

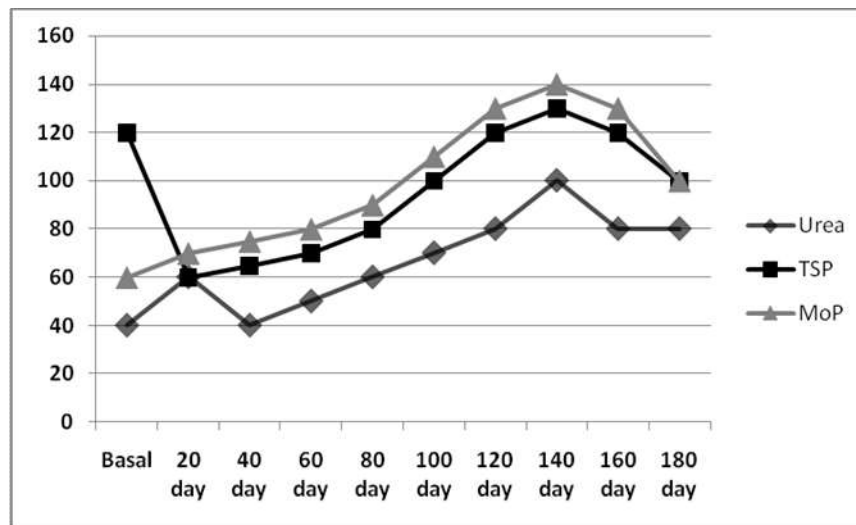


Fig.1. Fertilizer application in Eggplant field at Jessore

Adulteration and excess use of chemical fertilizers, using hazardous pesticides that hampered human health, lack of alternative disease and insect management options, shortage of good quality seeds, high input costs and low output cost were considered in project implementation.

## **b. Research Approaches and Methodologies:**

### **Approaches:**

Community based farm participatory approaches were taken to introduce the technology. One family was considered as one farm. Contribution of husband and wife were taken in accountable and considered two farmers in one farm family. Existing rules and regulations of BARI were followed for implementing project. A total of twenty farm families from two project sites with each of ten decimal land produced vegetable crops using Tricho-products. Total 3.24 hectare land was utilized within four crop season during project period. Focus Group Discussion (FGD) was performed for baseline survey data on farmers' problems of vegetable cultivation prior to launch the project. A five member's team comprising of production specialist, plant pathologist, entomologist and economist were built for FGD. Extension specialists of DAE, NGO's representative and participatory farmers took part in the discussion. Training and workshop were arranged for updating knowledge and information on Trichoderma technology. Participatory farmers training was arranged to introduce project activities and training classes were delivered through power point presentation.

Laboratory facilities were taken from plant pathology section, Horticulture research centre, BARI. Project assigned lab (one) and field (two) assistants were recruited by BARI authority within three months and posted in respective sites. Lab assistant worked in the laboratory and helped in other office work. Field assistant continuous looks after and assists farmers to execute project activities. PI along with CI was visited project site and suggested for performing project activities.

Spore suspension of *T. harzianum* was produced in the laboratory of plant pathology section under HRC and supplied for compost production in two project sites. Participatory farmers collected waste materials and produced compost using *Trichoderma* spore suspension with supervision of field assistants. Vegetables were selected after discussion with farmers where disease, pest and local market demand were taken into consideration. A numbers of experiments were conducted for validation of Tricho-compost and-leachate production and using at farmers' level. Tricho-compost was incorporated in soil and Tricho-leachate was applied as foliar spray for disease management. Statistical analysis was performed to compare between Tricho-products applied and un-applied farmers' practices treatments.

### **Methodologies:**

#### ***1. Section of effective isolate of Trichoderma harzianum***

An effective isolate of *Trichoderma harzianum* from plant pathology laboratory of HRC, BARI was purified as mother culture. Effectiveness of *T. harzianum* was tested against *Sclerotium rolfsii* through 'Dual Culture Technique' (Skidmore and Dickinson, 1976). The percent inhibition of radial growth was calculated by the formula of Behzad *et al.*, (2008) and Rini and Sulochana (2007).

$$\text{Percent inhibition of radial growth} = \frac{R_1 - R_2}{R_1} \times 100$$

Where  $R_1$  is radial growth of pathogen in absence of antagonistic agent (control) and  $R_2$  is the radial growth of pathogen in presence of antagonistic agent.

Radial growth of *S. sclerotiorum* was inhibited towards *T. harzianum* on PDA media. The growth reduction was about 73.78% in presence of *T. harzianum* after 120 hours of incubation (Fig. 2.). However, *T. harzianum* destroyed the whole mycelial growth of *S. sclerotiorum* after 10 days of incubation (Table 15) (Annexure III).

## **2. Spore multiplication of *Trichoderma harzianum* in the Laboratory**

Yeast enriched Richard's solution were used for mass multiplication of the spore of *T. harzianum*. Large size patri-plate (17 cm diameter) and 250 ml conical flask were used for *T. harzianum* culturing (Fig. 3). Total 68 Liter of *T. harzianum* seed spore suspension ( $3 \times 10^{12}$  cfu/ml) was produced during May 20, 2013 to May 31, 2016 (Table 16) (Annexure III)

## **3. Preparation of composting house/device**

In both locations, ten compost material loading houses were prepared in 10 selected farmer's houses. Among 20 pair houses, 18 pair (9 pair per location) was prepared by using project assigned low cost technology and 2 pair (one pair per location) were made by advanced methods (Brick house) (Table 17 & 18). Three same size cementing rings (each of 0.7 m diameter, 0.4 m height and 5 cm thick) were vertically arranged to prepare cemented composting chamber house. Two houses were under one common shade. The shade was made by tin on the top of the houses (Fig. 4. 1.). A layer of polyethylene sheet was spread beneath of the ring houses. Brick house was made by using perforated bricks. The size of the house was 5 ft length x 4.5 ft width x 4.0 ft height. Such two houses made under a tin shade having a common middle wall, leachate disperse drainage and leachate deposit hole (Fig 4.2.) (Annexure IV).

## **2. Tricho-compost and -leachate production at farmers' level**

Kitchen and field vegetable waste materials were collected from nearby houses. Poultry litter was collected from a poultry farm. Cowdung and poultry litter was deposited in a suitable place of the farm houses. Measure amount of cowdung (28%), de-composted (minimum 6 months) poultry litter (36%), processing (chopping) water hyacinth (28%), vegetable waste/kitchen waste (2%), fine sawdust (3%), mushroom waste/ash/moc (1%), maize bran (1%) and neem leaf (0.5%), were spread one after another on a polyethylene sheet such a way that its' thickness was 15 to 20 cm. Molasses (1.5 kg) and *Trichoderma* solution ( $3 \times 10^7$  cfu/ ml) were mixed one bowl of water that act as stock solution. However, the above mentioned materials, about 200 litre of water was necessary for standard mixture. Tricho-molasses mixing solution were sprayed on raw materials and mixed rigorously that it looks like paste. Capacity of raw material loading in one pair cemented ring house is 50 bamboo baskets (BB) which was about to 420 kilogram of raw materials and fine Tricho-compost produced 210 kilogram (Table 19). While one brick made house (length 5 ft, width 4.5 ft and height 4 ft) about contain 840 kilogram (100 bamboo basket) and fine Tricho-compost produced 420 kilogram per loading (Fig. 5.). To get mature compost it takes 35 to 45 days. About 36.96 ton Tricho-compost and 1070 liter Tricho-leachate was produced from two project sites during reporting period (Table 20, 21, 22 & 23) (Annexure V)

### 3. Adaptive trial on the use of Tricho-products in vegetable crops (Annexure VI)

A total of 80 adaptive trials were conducted on disease management by using Tricho-compost and-leachate with vegetable crops viz. pointed gourd, bottle gourd, country bean, brinjal, tomato, cauliflower, cabbage and cucumber. Ten decimal lands were used per farm family per adaptive trial. Farmers' practice was considered as control treatment. For the same vegetables, one farmer was considered as one replication. Pair Plot Technique was used for experiment design and 't' test was performed for statistical analysis. In summer 2014 and winter 2014-15 nineteen experiments were conducted, while in 2015, twenty three experiments were conducted. In winter 2015-16, eighteen and summer 2016 one experiment were conducted. List of experiment was given below:

List of summer and winter vegetable experiments during project periods (summary table)

Crop	Location /Season	Summer 2014	Winter 2014-15	Summer-2015	Winter 2015-16 & *Summer 2016	Total
Pointed gourd	Jessore	6	-	4	-	10
	Bogra	5		5		10
Bottle gourd	Jessore	2	-	-	5	7
	Bogra	-	-	-	-	-
Country bean	Jessore	1				1
	Bogra	1	3		3	7
Brinjal	Jessore	1	2	5	-	8
	Bogra	3	1	5		9
Tomato	Jessore	-	-	3	-	3
	Bogra	-	-	-	-	
Cauliflower	Jessore	-	4	-	4	8
	Bogra	-	5	-	6	11
Cabbage	Jessore	-	4	-	-	4
	Bogra	-		-	-	-
Cucumber	Jessore	-		1	1*	2
	Bogra	-	-	-	-	-
	Total	19	19	23	19	80

\*Cucumber experiment was conducted in summer 2016

Details of adaptive trials were given below:

#### Expt. 3. 1. Disease management of pointed gourd by using Tricho-compost and-leachate

##### 3. 1. 1. Introduction

Pointed gourd (*Trichosanthes dioica*) is a tropical vegetable crop rich in vitamin. The plant is a perennial, dioecious, and grown on macha. It is a perennial vegetable crop and has better keeping quality and can stand long distance transportation to other areas where it is not cultivated. In tropics, pointed gourd produces maximum yields for 3-4 years, after which yield potentiality gradually declines (Samalo and Parida 1983). The pointed gourd thrives well under hot or moderately warm and humid climate. Sandy loam soil is ideally suitable for its. Both pre-rooted and fresh vine cuttings are used for propagation. The yield of pointed gourd is lower due to several reasons.

Among them insect, pest and diseases, especially root knot nematode, *Meloidogyne* sp. causes root damage and produced knot in root of pointed gourd which also helps to enter the vascular pathogen- *Fusarium* spp. As a result sudden wilt of the whole plant occurred during rainy season. About 70 to 80% damage occurred due to root knot nematode and *Fusarium* wilt disease complex. Application of *Trichoderma*-based compost might be helped to minimize the disease incidence and increase the yield.

### **3. 1. 2. Materials and Methods**

Vine cuttings made from previous year crop and rooted during November-December and planted January-February in order to obtain a crop in the same year. However, both of the project locations plants from previous years root sucker are most popular. From one plant's root suckers developed a bunch of seedlings. Farmers select the strong 2/3 seedlings and the lefts are destroyed. After seedling germination, intercultural operations raise bed, fertilization and irrigation was started. A male: female ratio of 1:9 was maintained for ensuring maximum fruit set (Maurya *et al.* 1985).

#### **Treatments:**

- i) Soil application of Tricho-compost @ 2.5 ton per hectare + chemical fertilizer 80% + foliar application of Tricho-leachate @ 20ml/ liter of water
- ii) Farmers' practices (cowdung @ 2.5 t/ha + chemical fertilizers+ pesticide spray)

Tricho-compost @ 2.5 ton per hectare along with chemical fertilizer 80% was applied in the field before raising bed. The distance between plants was kept between 1.5-2.0 m × 1.5-2.0 m (Singh 1989; Yadav 1989). Farmers produced pointed gourd by using Tricho-compost as soil application for soil borne disease control and Tricho-leachate as foliar spray for foliage disease control. Tricho-compost was used after final land preparation before 7 to 10 days of seedling transplanting or after germination of pointed gourd seedling in case of ratoon crop. Tricho-leachate was sprayed on foliage in 15 days interval as preventive measures. Farmers' practices were maintained by using cowdung and chemical fertilizer (Table 26 & 27). Pheromone trap is set for fruit fly control. Bordeaux paste was used for Gummosis disease control. Fields were kept under regular supervision.

#### **Project sites:**

##### **Jessore:**

Farm family 1 (Md.Hajrat Ali Gazi & Mrs. Shanaz Begum), 2 (Md.Golam Rosul & Mrs. Mosammat Fahima Begum), 4 (Md. Ibrahim Sardar & Mrs. Momina Khatun), 6 (Md. Mahabbat Ali & Mrs. Moss. Laboni), 9 (Abu Shiddik Mandol & Mrs. Moss. Hashina Begum) and 10 (Md. Haider Ali & Mrs. Swapna Begum) grew pointed gourd in summer 2014. Neighbor farmers, who did not use any Tricho-products maintained as control plots.

Farm family 2 (Md.Golam Rosul & Mrs. Mosammat Fahima Begum), 3 (Anarul Islam Litu & Mrs. Rini Begum), 4 (Md. Ibrahim Sardar and Mrs. Momina Khatun), 8 (Abu Shiddik Mandol and Moss. Hashina Begum) grew pointed gourd by using Tricho-products summer 2015 (Table 24). Neighbor farmers, who did not use any Tricho-products maintained as control plots.

##### **Bogra:**

Farm family 6 (Md. Kabir Alam & Moss. Shahanaz Parvin), 7 (Md. Rana Mahmud & Moss. Chaina Begum), 8 (Md. Golam Faruk & Mrs. Shahanaz Parvin), 9 (Md. Ibrahim & Mosammat Champa Begum) and 10 (Md. Liton Ahmed & Moss. Nilufar Yasmin) grew

pointed gourd by using Tricho-products in summer 2014. Neighbor farmers, who did not use any Tricho-products maintained as control plots.

Farm family 3 (Md. Akteruzzaman and Moss. Salma Begum), 6 (Md. Kabir Alam & Shahanaz Parvin), 8 (Md. Kabir Alam & Moss. Shahanaz Parvin), 9 (Md. Ibrahim & Moss. Champa Begum) and 10 (Md. Liton Ahmed & Moss. Nilufar Yasmin) grew pointed gourd by using Tricho-products in winter 2015-16 (Table 25). Neighbor farmers, who did not use any Tricho-products maintained as control plots.

### **3. 1. 3. Results and Discussion**

#### ***Effect of Tricho-compost and-leachate on fertilizer application***

In Tricho-compost application plots, less amount of Urea (33.3%), TSP (30.77%), DAP (16.67%) MoP (30.77%) and ZnSo<sub>4</sub> (33.3%) fertilizer were applied compared to farmers' practices plots in pointed gourd field at Jessore project site. While in Bogra, application of Urea, TSP, DAP and MoP was reduced about 25.0%, 22.22%, 22.22% and 37.5%, respectively (Table 26).

#### ***Effect of Tricho-compost and-leachate on disease and yield***

*Phytophthora* fruit rot was remarkably lower in Tricho-products application plots compared to farmers' practices regardless locations (Table 28 & 29). Only 5.00 and 2.96% fruit rot was recorded in compost and leachate application plots while it was 10.36 and 7.62% in farmers' practices plots in Jessore and Bogra, respectively in 2014. Similar trend was also observed in 2015. Fruit rotten reduced over control by 33.71 and 36.84% in Jessore and Bogra, respectively in 2014 while it was reduced 37.78 and 34.79% in Jessore and Bogra, respectively in 2015. Marketable and total fruit yield was significantly higher in compost application plots compared to farmers' practices plots in both locations in both the years. Marketable yield increased over control by 37.49 and 42.44% in 2014, and 20.74 and 33.73% in 2015 in Jessore and Bogra, respectively.

#### ***Effect of Tricho-compost and-leachate on Benefit Cost Ratio***

Selling price varied 15 to 35 taka per kilogram pointed gourd within a season. However, maximum of the time, selling price was 25 to 30 taka per kilogram of pointed gourd. Benefit Cost Ratio for Tricho-products application treatment were 2.48 and 3.05 in 2014 and 3.31 and 3.08 in 2015 in Jessore and Bogra, respectively. On the other hand, it was only 1.89 and 2.30 in 2014 and 2.76 and 2.41 in 2015 in Jessore and Bogra, respectively in farmers' practices. BCR was increased by 31.31 to 32.16% in 2014 and 19.73 to 27.73% in 2015 regardless of locations (Table 30 & 31).

### **Expt. 3. 2. Disease management of bottle gourd by using Tricho-compost and-leachate**

#### **3. 2. 1. Introduction**

Bottle gourd (*Lagenaria siceraria*) is an important year round vegetable in Bangladesh. Fruits are globular, bottle- or club-shaped. Like pointed gourd it is also grown on macha. Disease and insect infestation are also responsible for low yield. Among diseases, root knot nematode, *Fusarium* wilt and Gummosis causes serious problems and reduced yield about 80%. Application of Tricho-compost may reduce the incidence of soil borne diseases BARI Lau 2

and local variety were chosen by the farmers. Sandy loamy soils with good drainage and the pH ranges from 6.5 to 7.5 are suited for bottle gourd cultivation.

### 3. 2. 2. Materials and Methods

Seedlings were grown in polyethylene bag. Soil in polyethylene bag was treated with Tricho-compost @ 20 g compost in one kilogram soil.

Main field soil was prepared by using Tricho-compost @ 2.5 ton per hectare and chemical fertilizers 80% mixing with soil at final land preparation. Seedlings were transferred to raise bed in the pits of the 30 cm x 30 cm x 30 cm size maintaining 2.5 x 2 m spacing. In control plots farmers used cowdung @ 2.5 ton and chemical fertilizers (Table 32). Tricho-leachate was sprayed at 15 days interval from crops establishments as a preventive measure.

#### Treatments:

- i. Soil application of Tricho-compost @ 2.5 ton per hectare + chemical fertilizer 80% + foliar application of Tricho-leachate @ 20ml/ liter of water
- ii. Farmers' practices (cowdung @ 2.5 t/ha + chemical fertilizers+ pesticides spray)

#### Project site:

##### Jessore:

Farm family 3 (Md. Anarul Islam Litu & Mrs. Rini Begum), 5 (Md. Obaidul Islam & Mrs. Hasnahena) grew bottle gourd by using bottle gourd in 2014. Farmers' practices maintained as control treatment.

Farm family 1 (Md.Hajrat Ali Gazi & Shanaz Begum), 3 (Anarul Islam & Litu Mrs. Rini Begum), 5 (Md. Obaidul Islam & Mrs. Hasnahena), 8 (Md. Solaiman Bepari & Moss. Sufia Khatun) and 10 (Md. Haider Ali & Mrs. Swapna Begum) grew bottle gourd 2015-16 (Table 24). Farmers' practices maintained as control treatment.

### 3. 2. 3. Results and Discussion

#### *Effect of Tricho-compost and-leachate on fertilizer application in bottle gourd*

In bottle gourd field, fertilizer application reduced over farmers' practices was 41.67, 36.36, 16.67 and 30.0% in Urea, TSP, DAP and MoP fertilizers, respectively at Jessore region during 2014 and 2015-16 (Table 32).

#### *Effect of Tricho-compost and –leachate on disease and yield*

Anthrachnose fruit rot caused by *Colletotrichum* sp. was recorded lower in Tricho-compost and –leachate application plots. Fruit rot was higher in 2014 than 2015-16. Fruit rot reduced over farmers' practices 27.37% in 2014 and 48.67% in 2015-16. Marketable and total fruit yield were significantly higher in Tri-compost and –leachate application plots compared to farmers' practices. Marketable yield increased over farmers' practices by 31.86 and 28.22% in 2014 and 2015-16, respectively (Table 33).

#### *Effect of Tricho-compost and-leachate on Benefit Cost Ratio*

Selling price varied 15 to 35 taka per kilogram of bottle gourd within a season. However, the maximum of the time, selling price was 25 taka per piece (about a kilogram) of bottle gourd. BCR for Tricho-products application plots was 2.28 in 2014 and 2.48 in 2015 while it was only 1.79 in 2014 and 2.00 in 2015 in farmers' practices plots. BCR increased over control was 27.83% in 2014 and 24.30% in 2015 (Table 34).

### **Expt. 3. 3. Disease management of Country bean by using Tricho-compost and-leachate**

#### **3. 3. 1. Introduction**

Country bean (*Dolichos lablab*) under legume family is a very popular vegetable grown all over the country. It is cultivated commercially in different parts of Bangladesh. In Bogra area summer country bean are cultivating. However, the crop is attacked by many pests and diseases causing yield loss. Among the diseases, root knot caused by *M. incognita* is highly damaging and yield reducing factor of country bean throughout the country. Due to only root-knot the crop suffers heavily, growth is retarded, fruit setting reduced, size and yield decreased and in serious condition, the plant die due to secondary infection with fungi and bacteria. In the late season the big size galls are easily visible at the base of the plants. However, many farmers are still unaware about the real problem or cause behind the plant mortality. A number of approaches aimed for controlling root-knot nematodes through application of nematicides, cultural management, biological measures like *Trichoderma* spp. Under these circumstances, compost infuse with *Trichoderma* may reduce nematode-fungal disease complex and increase yield of country bean.

#### **3. 3 2. Materials and Methods**

Seedlings were grown in pit soil at main field that was prepared by Tricho-compost @ 2.5 ton per hectare and reduced amount of chemical fertilizer mixing with soil at final land preparation.

##### **Treatments:**

- i.). Soil application of Tricho-compost @ 2.5 ton per hectare + chemical fertilizer 80% + foliar application of Tricho-leachate @ 20ml/ liter of water
- ii). Farmers' practices (cowdung @ 2.5 t/ha + chemical fertilizers+ pesticide spray)

Main field soil was prepared by using Tricho-compost @ 2.5 ton per hectare and chemical fertilizers 80% mixing with soil at final land preparation. Seedlings were transferred to raising bed in the pits of the 30 cm x 30 cm x 30 cm size at 2.5 x 2 m spacing. In control plots farmers used cowdung @ 2.5 ton and chemical fertilizers (Table 35 and 36). Tricho-leachate was sprayed at 15 days interval from crops establishments as a preventive measure.

##### **Project site:**

###### **Jessore:**

Farm family 8 (Md. Solaiman Bepari Bisu) & Mrs. Moss. Sufia Khatun) grew summer country bean (variety: Rahim) by using Tricho-products (Table 24). Neighbor farmers, who did not use any Tricho-products maintained as control plots.

###### **Bogra:**

Only one farm family 2 (Md. Hannan Sheikh & Moss. Mitu Begum) grew country bean in summer 2014. Framers' practices maintained as control.

Farm family 3 (Md. Akteruzzaman & Moss. Salma Begum), 8 (Md. Golam Faruk & Mrs. Shahanaz Parvin) and 9 (Md. Ibrahim & Mosammat Champa Begum) grew country bean in winter 2014-15 . Farmers' practices maintained as control plots.

While in winter 2015-16, Farm family 1 (Md. Mamunur Rashid & Moss. Farida Parvin), 3 (Md. Akteruzzaman & Moss. Salma Begum) and 9 (Md. Ibrahim & Moss. Champa Begum) grew winter country bean (Table 25).

### **3. 3. 3. Results and Discussion**

#### ***Effect of Tricho-compost and-leachate on fertilizer application in country bean***

In country bean, fertilizer application reduced over farmers' practices was 38.89, 33.33, 28.57, 30.0 and 33.33% in Urea, TSP, DAP, MoP and ZnSo<sub>4</sub> fertilizers, respectively at Jessore region while it was reduced 29.41, 29.41, 33.33, 28.57, 18.75, 23.40 and 16.67% in Urea, TSP, DAP, MoP, Gypsum and ZnSo<sub>4</sub>, respectively at Bogra (Table 35 & 36).

#### ***Effect of Tricho-compost and-leachate on disease and yield of summer country bean***

Anthrachnose fruit rot caused by *Colletotrichum* was lower in Tricho-compost and-leachate application. Only 4.56 and 3.21% rotten fruit were harvested in compost application plots in Jessore and Bogra, respectively. While it was 9.82 and 8.82% in non-amended farmers' practices plots in Jessore and Bogra, respectively. Fruit rotten reduced over control by 37.65 and 52.81% in Jessore and Bogra, respectively. Mean marketable and total yield was numerically higher in Tricho-products application field compared to control field. Marketable yield increased over control by 33.53 and 29.53% in Jessore and Bogra, respectively (Table 37).

#### ***Effect of Tricho-compost and-leachate on Benefit Cost Ratio of summer country bean***

Selling price varied 15 to 56 taka within a season for a kilogram of summer country bean in Jessore and Bogra project site. However, the maximum of the time, selling price was 35 taka per kilogram of summer country bean. BCR for Tricho-cpmpost and-leachate application plots was 1.93 and 2.19 in Jessore and Bogra, respectively while in farmers' practices, it was 1.46 and 1.71, respectively. BCR increased in Tricho-compost plots over farmers practices were 31.99 and 28.15% in Jessore and Bogra, respectively (Table 38).

#### ***Effect of Tricho-compost and-leachate on disease and yield on winter country bean***

In winter country bean at Bogra, severity of anthracnose disease was lower in Tricho-product application plots. Anthracnose fruit rot was only 1.47 and 1.84% in Tricho-compost and-leachate application fields, while it was 5.06 and 4.46% in farmers' practices plots. Fruit rot reduced over farmers' practices was 66.67 and 58.78%, in 2014-15 and 2015-16, respectively. Anthracnose disease was scored 0-5 scoring scale and it was observed that Anthracnose disease significantly reduced in Tricho-products application plots. Marketable yield significantly increased in Tricho-products application plots. Yield increased was 20.05 and 30.42% in 2014-15 and 2015-16, respectively (Table 39).

#### ***Effect of Tricho-compost and-leachate on Benefit Cost Ratio of winter country bean at Bogra***

In Bogra project site, selling price varied 15 to 45 taka with in a season for a kilogram winter country bean. However, the maximum of the time, selling price was 20 taka per kilogram of summer country bean. BCR was 2.14 and 2.24 in 2014-15 and 2015-16, respectively in Tricho-products application field, while it was only 1.78 and 1.74 in 2014-15 and 2015-16, respectively in farmers' practices. BCR increased over farmers' practices was 20.88 and 29.19% in 2014-15 and 2015-16, respectively (Table 40).

### **Expt. 3. 4. Management of brinjal diseases by using Tricho-products**

#### **3. 4. 1. Introduction**

Brinjal (*Solanum melongena* L.) belongs to Solanaceae family. It is one of the most important vegetables in Bangladesh grown round the year. In the year 2006-07, 333 thousand metric tons brinjal was produced in 46 thousand hectare of land which covers almost 14% of the total vegetable area (BBS, 2008). Contrary to the common belief, it is quite high in nutritive value and can be well compared with tomato. Brinjal fruit contains high amount of carbohydrates (6.4%), protein (1.3%), fat (0.3%), calcium (0.02%), phosphorus (0.02%), iron (0.0013%) and other minerals. Apart from this, it also contains  $\beta$ -carotene (34 mg), riboflavin (0.05 mg), thiamine (0.05 mg), niacine (0.5 mg) and ascorbic acid (0.9 mg) per 100g fruit (Choudhary, 1976). The world acreage under brinjal was estimated to be 1.5 million ha with a production of 25.07 million tons and average productivity of 16.67 tons per ha in 2001-02.

Brinjal is tolerant to drought. Well drain, light soils with a pH of 5.5-5.8 are more suitable for the cultivation of brinjal. However, the crop is facing serious problem with insect-pest and diseases. Among the causes of low yield, incidence of various diseases such as *Phomopsis* blight, bacterial wilt, *Fusarium*, root-knot nematode are the main constrain to vegetable production in our country. Use of Tricho-compost may reduce the incidence of diseases.

#### **3. 4. 2. Materials and Methods**

Seedlings were grown in seed bed nursery by using Tricho-compost @ 1.5 t/ha and Tricho-leachate 500 ml/ m<sup>2</sup> in soil. Main field soil was prepared by Tricho-compost @ 2.5 ton per hectare and 80% chemical fertilizers mixing with soil at final land preparation. Seedlings were transferred to raise bed maintaining crop spacing 80 cm x 50 cm. In control plots, farmers used cowdung @ 2.5 t/ha and chemical fertilizer (Table 41 & 42). Tricho-leachate was sprayed in Tricho-compost plots at 15 days interval from crops establishments as preventive measures.

##### **Treatment:**

- i). Soil application of Tricho-compost @ 2.5 ton per hectare + 80% chemical fertilizer + foliar application of Tricho-leachate @ 20ml/ liter of water
- ii). Control (cowdung @ 2.5 t/ha + chemical fertilizers+ pesticide spray)

##### **Project sites:**

###### **Jessore:**

Farm family 2 (Golam Rasul & Mrs. Mosammat Fahima Begum), Farm Family 6 (Md. Mahabbat Ali & Mrs. Moss. Laboni), Farm family 7 (Md. Shohidul Islam & Mrs. Sokhina Begum) grew brinjal in 2014. Non-amendend control treatment was maintained in the same field.

Farm family 1 (Md. Hajrat Ali Gazi & Shahnaz Begum), 6 (Md. Mahabbat Ali & Mrs. Moss. Laboni); 7 (Md. Shohidul Islam & Mrs. Sokhina Begum), 8 (Md. Solaiman Bepari Bisu & Moss. Sufia Khatun), 10 (Md. Haider Ali & Mrs. Swapna Begum) grew brinjal during 2015 (Table 24). Control was maintained in the same farmers' field.

###### **Bogra:**

Farm family 1 (Md. Mamunur Rashid & Moss. Farida Parvin), 3 (Md. Akteruzzaman & Moss. Salma Begum) and 5 (Md. Mukul Sarker & Mrs. Forida Begum) grew brinjal by using Tricho-products during 2014 (Table 25). In the same field control was maintained.

Farm family 1 (Md. Manunur Rashid & Moss. Farida Parvin), 2 (Md. Hannan Sheikh & Moss. Mitu Begum) 4 (Md. Tofazzal Hossain & Mrs. Bulbuli Begum), 5 (Md. Mukul Sarker & Mrs. Forida Begum) and 7 (Md. Rana Mahmud & Moss. Chaina Begum) grew brinjal by using Tricho-products during 2015 (Table 25). In the same field control was maintained.

### **3. 4. 3. Results and Discussion**

#### ***Effect of Tricho-compost and-leachate on fertilizer application in brinjal***

Fertilizer application in compost plots reduced over control was 33.33, 27.27, 25.00, 22.22, 28.57 and 16.67% in Urea, TSP, MoP, Gypsum, ZnSo<sub>4</sub> and Borax, respectively in brinjal at Jessore. While, at Bogra project site, it was reduced 25.0, 26.09, 23.08, 28.57, 37.5 and 25.0% in Urea, TSP, MoP, Gypsum, ZnSO<sub>4</sub> and Borax, respectively (Table 41 & 42).

#### ***Effect of Tricho-compost and-leachate on disease and yield***

Bacterial wilt of brinjal crop reduced significantly due to application of Tricho-compost in soil. Bacterial reduced by 82.5 and 73.39% in 2014 and 2015, respectively at Jessore in Tricho-compost treatments. Fruit damaged caused by *Phomopsis* sp. was higher in 2015 than 2014 regardless of locations. Total yield and marketable yield increased remarkably in Tricho-products application fields. Yield increased over control was 35.23 and 37.01% in 2014 and 2015, respectively (Table 43)

Bacterial wilt and *Phomopsis* rot of brinjal also significantly reduced in Bogra location. *Phomopsis* blight reduced over control was 65.79 and 50.19% in 2014 and 2015, respectively. Marketable yield increased significantly in Tricho-compost and-leachate application plots. Yield increased over control was 20.25 and 27.02% in 2014 and 2015, respectively (Table 44).

#### ***Effect of Tricho-compost and-leachate on Benefit Cost Ratio of Brinjal***

Selling price varied 15 to 45 Tk. with in a season for a kilogram of brinjal. However, the maximum of the time, selling price was 20.00 Tk. per kilogram of brinjal. For Tricho-compost application field, Benefits Cost Ratio was 2.58 and 3.32 in 2014 and 2015, respectively, while in farmers' practices field it was 1.99 and 2.53, respectively in Jessore. BCR increased in 29.68 and 31.39% in 2014 and 2015, respectively in Tricho-compost plots over farmers practices (Table 45).

In Bogra project site, Benefits Cost Ratio was 2.01 and 2.74 in Tricho-compost application fields in 2014 and 2015, respectively, while farmers' practices field it was 1.67 and 2.25 in 2014 and 2015, respectively. BCR increased in Tricho-compost treatment over farmers' practices was 20.23 and 21.83% in 2014 and 2015, respectively (Table 46).

## **Expt. 3. 5. Disease management of Tomato diseases by using Tricho-compost and-leachate**

### **3. 5. 1. Introduction**

Tomato (variety Shafol) is one of the important vegetable crops in Bangladesh. Due to hot and humid weather, summer tomato is attacked by various soil-borne diseases during August-September. Tricho-products were used to control the diseases.

### 3.5. 2. Materials and Methods

Seedlings were grown in seed bed nursery by using Tricho-compost @ 1.5 t/ha and Tricho-leachate 500 ml/ m<sup>2</sup> in soil. Main field soil was prepared by using Tricho-compost @ 2.5 ton per hectare and ¾ chemical fertilizers mixing with soil at final land preparation (Table 47). Seedling was transferred to raising bed maintaining crop spacing 60 cm x 50 cm. In control plots farmers used full dose of chemical fertilizers. Tricho-leachate was spray at 15 days interval from crops establishments as preventive measures.

#### Treatments:

- i). Soil application of Tricho-compost @ 2.5 ton per hectare + chemical fertilizer 80% + foliar application of Tricho-leachate @ 20ml/ liter water
- ii). Farmers' practices (cowdung @ 2.5 t/ha + chemical fertilizers+ pesticide spray)

#### Project site:

##### *Bogra:*

Farm family 1 (Md. Mamunur Rashid & Moss. Farida Parvin), 4 (Md. Tofazzal Hossain & Mrs. Bulbuli Begum) and 7 (Md. Rana Mahmud & Moss. Chaina Begum) grew tomato (variety: Shafol) by using Tricho-compost in winter 2015-16 (Table 25). Control was maintained in the same field.

### 3. 5. 3. Results and Discussion.

#### *Effect of Tricho-compost and-leachate on fertilizer application in tomato at Bogra*

Fertilizer application in compost plots reduced over control was 25.0%, 25.0%, 20.0%, 30.0%, 25.0%, 28.57% and 25.0% in Urea, TSP, DAP, MoP, Gypsum, ZnSo<sub>4</sub> and Borax, respectively in tomato at Bogra (Table 47).

#### *Effect of Tricho-compost and –leachate on disease and yield of tomato*

Bacterial wilt disease reduced remarkably due to application of Tricho-compost. Wilt reduced over control was 79.59%. Application of Tricho-compost and-leachate also reduced ( $P<0.05$ ) fruit rot caused by *Alternaria* sp. and *Colletotrichum* sp. Only 1.37% fruit rot was recorded in Tricho-compost treatment while it was 3.25% in farmers practices (control) field. Fruit rot reduced over control was 79.59%. Total yield and marketable yield increased in Tricho-compost application field. Marketable yield increased over farmers practice was 27.54% (Table 48).

#### *Effect of Tricho-compost and-leachate on Benefit Cost Ratio of tomato*

Net return was higher in summer tomato than other vegetables. Net return was 13,82,750 Taka per hectare land, while it was 10,30,750 Taka per hectare in farmer's field. BCR was 6.30 and 4.98, in Tricho-products and farmers practices, respectively. BCR increased in Tricho-compost treatment over farmers' practices was 26.47 (Table 49).

### Expt. 3. 6. Disease management of Cauliflower by using Tricho-compost and-leachate

#### 3. 6.1. Introduction

Soil-borne pathogens viz., *Pythium*, *Fusarium*, *Rhizoctonia*, *Sclerotium* cause foot and root rot of seedlings of seed bed as well as main fields. In main field, *Fusarium* rot and wilt is serious problem for cauliflower production. On the other hands, larvae of Diamond back moth (*Plutulla xylostella*) and *Spodoptera litura* cause serious damage in the growing stage of cauliflower. Due to health hazard and environmental pollution, searching alternative

control measures to combat the damages caused by insects and diseases of cauliflower. Application of *Trichoderma* based products such as Tricho-compost and Tricho-leachate found to be effective to control the diseases (Anon. 2011). Card damage caused by *Fusarium* and *Alternaria* may control by spraying Tricho-spore but the practice is not available in Bangladesh. Therefore, the study was taken to find out the effectiveness of Tricho-products for soil borne disease management of cauliflower at farmers' fields. Pheromone trap was used for insect control.

### 3. 6. 2. Materials and Methods

Seedlings were grown in seed bed nursery by using Tricho-compost @ 1.5 t/ha and Tricho-leachate 500 ml/m<sup>2</sup> soil.

Main field soil was prepared by using Tricho-compost @ 2.5 ton per hectare and 80% chemical fertilizers mixing with soil at final land preparation. Farmers practices was maintained 2.5 t/ha cowdung and chemical fertilizer (Table 50). Seedlings were transferred to raise bed maintaining crop spacing 60 cm x 40 cm. In control plots farmers used full dose of chemical fertilizers. Tricho-leachate was sprayed at 15 days interval from crops establishments.

#### Treatments:

- i). Soil application of Tricho-compost @ 2.5 ton per hectare + chemical fertilizer 80% + foliar application of Tricho-leachate @ 20ml/ liter of water
- ii). Farmers' practices (cowdung @ 2.5 t/ha + chemical fertilizers+ pesticide spray)

#### Project sites:

##### Jessore:

Farm family 5 (Md. Obaidul Islam & Mrs. Hasnahena); Farm family 7 (Md. Shohidul Islam & Mrs. Sokhina Begum); Farm family 8 (Md. Solaiman Bepari & Mrs. Moss. Sufia Khatun) and Farm family 9 (Abu Shiddek Mandol & Mrs. Moss. Hashina Begum) grew cauliflower by using Tricho-products. Neighbor farmers, who did not use any Tricho-products maintained as control plots.

Farm family 4 (Md. Ibrahim Sardar & Mrs. Momina Khatun), 6 (Md. Mahabbat Ali & Mrs. Moss. Laboni), 7 (Md. Shohidul Islam & Sokhina Begum) and 9 (Abu Shiddik Mandol & Moss. Hashina Begum) grew cauliflower by using Tricho-products in winter 2014-15 (Table 24). Neighbor farmers, who did not use any Tricho-products maintained as control plots.

##### Bogra:

Farm Family 2 (Md. Hannan Sheikh & Moss. Mitu Begum), 5 (Md. Mukul Sarker & Mrs. Forida Begum), 6 (Md. Kabir Alam & Moss. Shahanaz Parvin) and 7 (Md. Rana Mahmud & Moss. Chaina Begum) grew cauliflower by using Tricho-products. Control was maintained in the same field.

In 2015-16, Farm Family 2 (Md. Hannan Sheikh & Moss. Mitu Begum), 4 (Md. Tofazzal Hossain & Mrs. Bulbuli Begum), 5 (Md. Mukul Sarker & Mrs. Forida Begum), 6 (Md. Kabir Alam & Moss. Shahanaz Parvin), 8 (Md. Golam Faruk & Mrs. Shahanaz Parvin) and 10 (Md. Liton Ahmed & Moss. Nilufar Yasmin) grew cauliflower by using Tricho-products in winter 2015-16 (Table 25). Control was maintained in the same field.

### 3.6.3. Results and Discussion:

#### *Effect of Tricho-compost and-leachate on fertilizer application*

In Jessore project site, 18.18%, 16.67%, 25%, 18.18%, 20.0%, 33.33% and 16.67% of Urea, TSP, DAP, MoP, Gypsum ZnSo<sub>4</sub> and Borax, respectively fertilizer were applied in cauliflower fields in Jessore site. While in Bogra site, in Tricho-compost application plots, 20.0%, 16.67%, 20.0%, 16.67%, 33.33%, 16.67% and 25.0% less amount of Urea, TSP, DAP, MoP, Gypsum ZnSo<sub>4</sub> and Borax, respectively fertilizer were applied in cauliflower fields at Bogra (Table 50 & 51).

#### *Effect of Tricho-compost and-leachate on disease and yield of cauliflower*

*Fusarium* wilt of cauliflower remarkably reduced after transplanting in Tricho-compost and – leachate application treatment in both of the years regardless of locations (Table 52 & 53). Wilt reduced over control was 77.59 and 84.88% in winter 2014 in Jessore and Bogra, respectively. While, it reduced by 66.67 and 70.15% in Tricho-compost and -leachate application treatment at Jessore and Bogra, respectively in 2015. Card damaged caused by *Fusarium* sp. *Alternaria* sp. and *Colletotrichum* sp. was remarkably reduced both of the years regardless of location due to application of Tricho-compost. Marketable yield was higher ( $P<0.05$ ) in Tricho-compost and-leachate application treatment regardless of year and locations. Yield increased over control was 19.3 and 38.08% in 2014, and 18.23 and 32.37% in 2015 at Jessore and Bogra, respectively.

#### *Effect of Tricho-compost and-leachate on Benefit Cost Ratio*

Selling price varied from 15 to 35 taka per card (on average 20 taka/kg). Benefit Cost Ratio for Tricho-products application treatment were 3.79 and 3.93 in 2014 and 3.93 and 3.12 in 2015 at Jessore and Bogra, respectively. While it was 3.04 and 3.31 in 2014 and 2.83 and 2.33 in 2015 at Jessore and Bogra, respectively in farmers' practice field. BCR increased in Tricho-compost treatment over farmers' practices was 24.49 and 18.23% in 2014 and 32.37 and 38.80% in 2015 in Jessore and Bogra, respectively (Table 54 & 55).

## **Expt. 3. 7. Disease management of cabbage disease by using Tricho-compost and-leachate**

### **3. 7.1. Introduction**

Soil-borne pathogens viz., *Pythium*, *Fusarium*, *Rhizoctonia*, *Sclerotium* cause foot and root rot of seedlings of seed bed as well as main fields. In main field, *Fusarium* wilt and *Alternaria* leaf spot are the serious problem for cabbage production. On the other hands, larvae of Diamond back moth (*Plutulla xylostella*) and *Spodoptera litura* cause serious damage in the growing stage of cabbage. Due to health hazard and environmental pollution, searching alternative control measures to minimize the damages caused by insects and diseases of the cabbage. Application of *Trichoderma* based products such as Tricho-compost and Tricho-leachate found to be effective to control the diseases (Anon. 2011). *Alternaria* leaf spot caused by *Alternaria* sp. may control by spraying Tricho-leachate but the practice is not available in Bangladesh. Therefore, the study was taken to find out effectiveness of Tricho-products for soil borne disease management of cabbage at farmers' fields. Pheromone traps were used for insect control.

### **3. 7. 2. Materials and Methods**

Seedlings were grown in seed bed nursery by using Tricho-compost @ 1.5 t/ha and Tricho-leachate 500 ml/m<sup>2</sup> soil.

Main field soil was prepared by using Tricho-compost @ 2.5 ton per hectare and 80% chemical fertilizers mixing with soil at final land preparation. Farmers practices was maintained 2.5 t/ha cowdung and chemical fertilizer (Table 56). Seedlings were transferred to raise bed maintaining crop spacing 60 cm x 40 cm. In control plots farmers used chemical fertilizers. Tricho-leachate was sprayed at 15 days interval in Tricho-compost plots from crops establishments.

**Treatments:**

- i) Soil application of Tricho-compost @ 2.5 ton per hectare + chemical fertilizer 80% + foliar application of Tricho-leachate @ 20ml/ liter of water.
- ii) Farmers' practices (cowdung @ 2.5 t/ha + chemical fertilizers+ pesticide spray)

**Project sites:**

**Jessore:**

Farm family 1(Md. Hajrat Ali Gazi & Mrs. Shanaz Begum), 3 (Md. Anarul Islam Litu & Mrs. Rini Begum), 4 (Md. Ibrahim Sardar & Mrs. Momina Khatun) and 10 (Md. Haider Ali & Mrs. Swapna Begum) grew cabbage by using Tricho-products during 2014-15 (Table 24). Control plots were maintained in the same fields.

**3.7. 3. Results and Discussion**

***Effect of Tricho-compost and-leachate on fertilizer application***

Urea, TSP, DAP, MoP and Gypsum application reduced over control was about 28.00, 28.57, 16.67, 20.00 and 33.33%, respectively in cabbage field (Table 56).

***Effect of Tricho-compost and-leachate on disease and yield***

Alternaria leaf spot was scored 0-5 scoring scale and disease severity reduced significantly in Tricho-compost application field. Disease severity reduced 55.0% over control treatment. At harvest, head damaged also reduced and marketable increased remarkably in Tricho-compost and-leachate application plots. Yield increased over control was about 18.56% (Table 57).

***Effect of Tricho-compost and-leachate on Benefit Cost Ratio***

The selling price varied 3 to 20 within a season and average price was 6 Tk. per kilogram. Benefit Cost Ration for Tricho-products application treatment was 2.52, while it was 2.09 in farmer's practices. BCR increased over control was 20.57% (Table 58).

**Expt. 3. 8. Management of Cucumber diseases by using Tricho-products**

**3. 8. 1. Introduction**

Cucumber (*Cucumis sativus* L.) a popular fresh market vegetable use as salad and cultivated throughout the world. In the country, total production of cucumber is about 62673 metric tons produced from 9120.24 hectares of land and the average yield in about 6.87 t/ha (Anon, 2010). One of the major constraints for cucumber production is diseases, such as rot knot nematode, *Fusarium* wilt, angular leaf spot, powdery mildew etc. Single approach may not effective to control the diseases. Soil treat with organic amendments and foliar spray may combat the diseases. Therefore, the experiment was taken.

**3. 8. 2. Materials and Methods**

Seedlings were grown directly in seed bed nursery by using Tricho-compost @ 1.5 t/ha and Tricho-leachate 500 ml/m<sup>2</sup> in soil.

Field soil was prepared by mixing of Tricho-compost @ 2.5 ton per hectare and 80% chemical fertilizers at final land preparation. Four seeds were sown in a pit while bed size was 1 m X 2 m. In control plots farmers used cowdung @ 2.5 t/ha and chemical fertilizer (Table 59). Tricho-leachate was sprayed in Tricho-compost plots at 15 days interval from crops establishments as preventive measures.

**Treatments:**

- ii). Soil application of Tricho-compost @ 2.5 ton per hectare + 80% chemical fertilizer + foliar application of Tricho-leachate @ 20ml/liter of water.
- ii). Control (cowdung @ 2.5 t/ha + chemical fertilizers+ pesticide spray)

**Project site:**

**Jessore:**

Cucumber was grown by farm family 5 (Md. Obaidul Islam & Mrs. Hasnahena) in summer 2015 and farm family 2 (Md.Golam Rosul & Mrs. Moss. Fahima Begum) in summer 2016 (Table 24).

**3. 8. 3. Results and Discussion**

***Effect of Tricho-compost-products on chemical fertilizer application***

Due to use of Tricho-compost, Urea, TSP, DAP, MoP and ZnSo<sub>4</sub> application reduced over farmers' practice was about 40.0, 46.67, 46.67, 16.67, 33.33 and 33.33%, respectively (Table 59).

***Effect of Tricho-compost and-leachate on disease and yield***

Fruit rotten due diseases was less in Tricho-compost plot. Fruit rotten was only 7.34 and 10.50% in Tricho-compost treatment in 2015 and 2016, respectively, while it was about 16.36 and 19.66% in farmers practice in 2015 and 2016, respectively. Fruit rotten reduced over control was about 43.97 and 46.59% in 2015 and 2016, respectively. Average marketable yield increased in Tricho-products application plots. Marketable yield increased over control was 27.76 and 30.74%, respectively in Jessore (Table 60).

***Effect of Tricho-compost and-leachate on Benefit Cost Ratio***

Selling price varied 15.0 to 35.0 taka per kilogram cucumber within a season. Benefit Cost Ratio was 2.47 and 2.60 in compost plot, while it was only 1.93 and 2.14 in farmer's practices in 2015 and 2016, respectively. BCR increased was 21.43 to 28.40% in Tricho-products application field (Table 61).

**Expt. 3. 9. Effect Tricho-products on soil fungi and nematode population at farmers' field**

**3.9. 1. Introduction**

Soil organism contributes to important soil functions such as supporting the growth of plants both in natural plant communities and agricultural crop production. Microbes may play important role for absorbing, neutralizing and transforming compounds that might otherwise become pollutants in the environment. It has involvement in every chemical transformation take place in soil. However, soil microbial diversity is influenced by both organic and inorganic matter. Soil organic matter is generally used to represent the organic constituents in the soil (Dick 1992). The soil organic matter provides a favorable habitat for the micro-organisms to grow as compared to inorganic soil.

It has been consistently reported that soil incorporation of compost favors the growth of nematode population in soil. Soil nematodes communities considered as primary decomposer regulate nutrient cycling (Ingham *et al.* 1985). Nematodes assist in organic matter decomposition by grazing on soil microbes, in effect selecting for an active community with a high rate of N mineralization. Therefore, it is not surprising that nematodes are increasingly used in soil food-web analysis (Bongers and Ferris 1999, Ferris *et al.* 2001).

Nematodes are usually classified into trophic groups according to their main sources of nutrition (Wasilewska 1971, Bonger 1990). The major groups are: plant-parasitic that feed on plants, microbivorous fungul, bacterial and omnivores) feed primarily on fungi, on bacteria or on products of decay, and carnivorous or predatory nematodes that feed on other nematodes and other small soil-inhabiting animals.

In most of the aerated or cultivated soils fungi share a major part of the total microbial biomass. Many important plant pathogens and plant growth promoting microorganisms are bacteria. Fungi are critical decomposers in soil habitat like bacteria, and fungi derived nutrients for their growth from organic matter (Bossio *et al.* 1998). Microbial biomass in the soil display a positive linear relationship with annual net primary productivity, demonstrating that the growth of microorganisms and of crops can be controlled and influenced by using organic matter (Zak *et al.* 2000). For the comparison of microbial diversity in compost and non-compost fields, the soil samples were taken after one and two season compost applications. More over to observe the microbial interaction with *Trichoderma* incorporated soil.

## **9. 2. Materials and Methods**

### ***Soil sample collection***

Soil samples were collected from Tricho-compost application and non-amended plots after four times of crop cultivation. Three cores of soil were collected randomly from each of 10 plots using a soil auger. Collected soil samples were mixed thoroughly to form a composite sample and reduce the variance associated with aggregated spatial patterns of microbes in soil (Barker and Campbell 1981). All soil samples were stored in the dark overnight at 5°C and existing field moisture levels to minimize changes in microbial populations and biochemical reactions (Barker *et al.* 1969).

### ***Nematodes extraction, identification and counting***

Nematodes were extracted from 10 g soil sub-samples taken from each composite soil sample collected from Bogra project site using the Bearmann funnel technique (Flegg and Hooper 1970). Nematodes were collected at 24 h intervals for 72 h, heat-killed, and fixed with tri-ethanolamine formaldehyde (TAF) solution (Shepherd 1970). Specimens were identified to the genus level using an inverted compound microscope at 40X and diagnostic keys by Goodey (1963), Siddiqi (1986), Jairajpuri and Ahmed (1992). Nematode genera were assigned to a trophic group (plant parasitic, fungal feeders, bacterial feeders, omnivores and predatory) according to Yeates *et al.* (1993).

### ***Isolation, identification and counting soil fungi***

The samples were processed using soil dilution plate method. One gram of soil sample was serially diluted with sterilized distilled water up to  $10^{-1}$ ,  $10^{-2}$ ,  $10^{-3}$ ,  $10^{-4}$ ,  $10^{-5}$   $10^{-6}$ . One ml of  $10^{-5}$  dilutions was added to 15 ml of potato dextrose agar media in 9 cm diameter sterile petri dishes and incubated for 3 three days at  $\pm 30^{\circ}$  C. On the other hand one ml of  $10^{-6}$  dilutions was added to 15 ml nutrients agar media in 9 cm diameter sterile petri dishes and incubated for 24 hour at  $\pm 30^{\circ}$  C. Single separate colonies on the agar plates were selected at random

according to standard medium and cultured and purified separated media for identification. The slides were observed under microscope. Fungi and bacteria were identified by following the mycological literature.

### **3.9. 3. Results and Discussion**

#### ***Soil nematodes***

The plant-parasitic or plant-feeding nematodes were considered to be harmful to plants. On the other hand, fungal- and bacterial-feeding nematodes are considered to be beneficial to plants (Ferris *et al.* 1996, Kimpinski and Sturz 2003). The distribution and abundance of plant parasitic and beneficial nematodes are dependent on their environment, which may define as interaction of all things that might influence the chances of nematodes to survive and reproduce. In Tricho-compost soil, plant parasitic nematode significantly reduced. In opposite beneficial nematodes such as bacterivorous and fungivorous population was remarkably increased (Table 62). About 63.64 to 70.21% of plant parasitic nematode was decreased and about 88.31 to 89.15% of fungivorous and 136.82 to 156.48% of bacterivorous nematode population increased due to soil incorporation of Tricho-products. Omnivores nematode population increased significantly only in Bogra, but not at Jessore. Omnivore nematode population was increased by 83.72% in Bogra.

The rate of decomposition of organic amendments influences the supplies of plant nutrients and plays a key role in structuring soil nematode communities. Nitrate and ammonical nitrogen accumulated during decomposition are toxic to plant-parasitic nematodes (Mian and Rodriguez-Kabana 1982).

#### ***Soil fungi and bacteria***

The serial dilution method was followed to determine the microbial population in soil. The genera with the greater number of species in fungi were *Aspergillus*, *Glomus*, *Penicillium*, *Cladosporium*, *Rhizopus*, *Trichoderma*, *Fusarium*, *Mucor*, *Alternaria*, and *Humicola* in both soil sample fields. Microbial colonies of decomposer fungi were higher in compost application field than non-amendment plots. After fourth application of Tricho-compost and vegetable production, 123.08 and 139.50% of fungal population increased in soil of Jessore and Borga, respectively (Fig.5. & Table 63). While in case of bacteria, about 71.31 and 85.68% population was increased in Jessore and Borga, respectively (Table 64).

Pathogenic fungal and bacterial colonies were lower in compost application fields. Higher number of microbial colonies per gram soil was counted in Tricho-compost application plots. Thus from the results we concluded that organic compost incorporated soil was rich in microbial population and also diversity in comparison to inorganic management soil. It was because the soil with organic matter provides a favorable habitat for microbial population whereas inorganic soil with chemical fertilizers has harmful effect on the growth of microbial population and cannot survive. More over *Trichoderma* incorporation in soil killed harmful micro-organisms that parasitic for plants. Therefore, synergistic beneficial effect improved soil health.

### **c. Results and Benefits**

**(i). List objective-wise activities clearly, resulting in specific output(s), such as**

<b>Specific Project Objective(s)</b>	<b>Planned activities performed against each objective</b>	<b>State progress made clearly during the reporting period against each activity</b>	<b>Outputs/results achieved during this period</b>
1. To control/ reduce soil born diseases and to increase yield of vegetable crops by using Tricho-products.	1.1 Recruitment committee headed by Director Research has been formed	<ul style="list-style-type: none"> <li>Recruitment committee recommended for recruitment.</li> </ul>	✓ One Lab and two Field Assistants had been appointed to respective project sites.
	1.2. Selection of project sites and farmers with land area/ farmer.	<ul style="list-style-type: none"> <li>Two sites (Vatra, Khanpur, Sherpur, Bogra and Bagdanga, Churamonkati, Jessore) were selected.</li> <li>10 farm families and 10 decimal lands each of farm families has been included to do the work.</li> </ul>	✓ Total 20 farm families with 3.24 ha lands (10 farm families and 1.62 ha land in each of Jessore and Bogra) have involved to do work with Tricho-products.
	1.3. Conducting a quick survey on existing (baseline) vegetable crop varieties with production practices, disease incidence and management, yield loss, yield, income etc.	<ul style="list-style-type: none"> <li>Base line data was collected through Focus Group Discussion meeting.</li> </ul>	<ul style="list-style-type: none"> <li>✓ Farmers facing problems with insect pest, disease, adulteration of pesticide and fertilizer, low output cost, high input cost, quality seeds etc. for crop production were identified.</li> <li>✓ The amounts of Urea, TSP and MoP fertilizer were 3 to 4 times higher than recommended dose for crop production.</li> <li>✓ Hazards chemicals such as Dursban, Aerostar, Wonder, Papes, Dufen, Alarm-2, Sobicron, Virtaco, Ripcord, Dithane M-45, Bavistin, Tilt etc. are applying on vegetable crops.</li> </ul>
	1.4 Preparation of Project Inception Report (PIR) & Project Brief (PB) for submission to KGF.	<ul style="list-style-type: none"> <li>Inception Report (PIR) &amp; Project Brief (PB) were prepared.</li> </ul>	✓ Two copies of inception report & 150 copies of project brief were submitted.
	1.5. Collection of organic waste materials.	<ul style="list-style-type: none"> <li>Kitchen and field vegetable waste materials were collected.</li> <li>Cowdung and poultry litter were deposited in nearby farm houses.</li> </ul>	✓ A total amount of 73.92 ton waste materials made available for preparation of compost.
	1.6. Preparation of bio-composting devices/ house	<ul style="list-style-type: none"> <li>Ten pair (total 20 pair) of compost devices/ houses were prepared in farmer's houses at each of project sites (Sherpur, Bogra &amp; Churamonkati, Jessore).</li> </ul>	✓ Compost devices (one pair/ family) were used for preparing compost.

Specific Project Objective(s)	Planned activities performed against each objective	State progress made clearly during the reporting period against each activity	Outputs/results achieved during this period
	1.7. Production of spore suspension of <i>T. harzianum</i> in Plant Pathology laboratory of HRC, BARI, Gazipur.	<ul style="list-style-type: none"> <li>✓ Mother culture of <i>T. harzianum</i> was purified and maintained in the laboratory</li> <li>✓ Effectiveness test against soil borne pathogens was completed</li> <li>✓ Mass multiplication of Tricho-spore was completed.</li> </ul>	<ul style="list-style-type: none"> <li>✓ Effective Tricho-spore solution is available in the laboratory</li> <li>✓ Sixty eight liter seed spore suspensions were supplied in project sites.</li> </ul>
	1.8. Production of Tricho-compost by using organic waste & <i>T.harzianum</i> .	✓ A total amount of <b>36.96 ton</b> final product of Tricho-compost and <b>1070 liter of leachate</b> were produced in two project sites.	✓ Tricho-compost 36.96 ton and-leachate 1070 liter were available to use in winter vegetable crops.
	1.9. On farm adaptive trials were conducted with summer and winter selected vegetable crops using Tricho-compost and -leachate.	<p><b>On farm trials with pointed gourd at Jessore &amp; Bogra</b></p> <ul style="list-style-type: none"> <li>• Six adaptive trials in summer 2014 and four experiments in summer 2016 were conducted in Jessore, while in Bogra each of five experiments were conducted in summer 2014 and in summer 2015, respectively with pointed gourd.</li> </ul> <p><b>On farm trials with bottle gourd at Jessore &amp; Bogra</b></p> <ul style="list-style-type: none"> <li>• Two adaptive trials were conducted in summer 2014 and five experiments were conducted in winter 2015-16 with bottle gourd.</li> </ul> <p><b>On farm trials with country bean at Jessore &amp; Bogra</b></p> <ul style="list-style-type: none"> <li>• With summer country bean, one adaptive trials at Jessore and one adaptive trials at Bogra was conducted in 2014.</li> <li>• Three adaptive trials were conducted in winter 2014-15 and three experiments were conducted in winter 2015-16 with winter country bean.</li> </ul>	<p><b>Results of on farm adaptive trials</b></p> <p>Regardless of locations-</p> <ul style="list-style-type: none"> <li>✓ Application of Tricho-compost and –leachate reduced disease incidence and increased yield of pointed gourd.</li> <li>✓ Phytophthora fruit rot of pointed gourd was reduced by 33.71 to 36.84% in 2014 and 34.79 to 37.78% in 2015.</li> <li>✓ Marketable yield increased by 37.49 to 42.44% in 2014, and 20.74 to 33.73% in 2015 in pointed gourd.</li> <li>✓ BCR increased 31.31 to 32.16% in 2014 and 19.73 to 27.73% in 2015 in Tricho-products fields in pointed gourd</li> <li>✓ Anthracnose fruit rot of bottle gourd reduced over farmers’ practices 27.37% in 2014 and 48.67% in 2015-16.</li> <li>✓ Marketable yield increased by 31.86% in 2014 and 28.22% in 2015-16 in Tricho-products fields of bottle gourd</li> <li>✓ BCR increased over control was 27.83% in 2014 and 24.30% in 2015 due to Tricho-products in bottle gourd fields.</li> <li>✓ Anthracnose fruit rotten was reduced by 37.65 to 52.81% and marketable yield increased by 29.53 to 33.53% in summer country bean in Tricho-products used plots.</li> <li>✓ BCR was increased by 28.15 to 31.99% in summer country bean in Tricho-compost and-leachate application field</li> <li>✓ Anthracnose rot was reduced by 66.67% in 2014-15 and 58.78% in 2015-16 in winter country bean due to Tricho-products application.</li> <li>✓ Marketable yield increased by 20.05% in 2014-15 and 30.42% in 2015-16 in Tricompost and-leachate treatment in winter country bean crop.</li> </ul>

Specific Project Objective(s)	Planned activities performed against each objective	State progress made clearly during the reporting period against each activity	Outputs/results achieved during this period
		<p><b>On farm trials with Brinjal at Jessore &amp; Bogra</b></p> <ul style="list-style-type: none"> <li>• One adaptive trials in summer 2014 and two experiments in winter 2014-15 and five experiments in summer 2015 were conducted at Jessore project site.</li> <li>• Three adaptive trials in summer 2014, one experiment in winter 2014-15 and five experiments in summer 2015 were conducted at Bogra project site.</li> </ul> <p><b>On farm trials with tomato at Jessore &amp; Bogra</b></p> <ul style="list-style-type: none"> <li>• Only three adaptive trials were conducted in summer 2015 at Bogra project site.</li> <li>• None of the adaptive trials was conducted with tomato at Jessore project site.</li> </ul> <p><b>On farm trials with cauliflower at Jessore &amp; Bogra</b></p> <ul style="list-style-type: none"> <li>• Four adaptive trials in winter 2014-15 and 2015-16 with cauliflower were carried out at Jessore project site.</li> <li>• While in Bogra project site, five adaptive trials in 2014-15 and six adaptive trials in 2015-16 were conducted with cauliflower.</li> </ul> <p><b>On farm trials with cabbage at Jessore &amp; Bogra</b></p> <ul style="list-style-type: none"> <li>• Only five adaptive trials were conducted at Jessore project site in 2014-15.</li> </ul> <p><b>On farm trials with cucumber at Jessore &amp; Bogra</b></p> <ul style="list-style-type: none"> <li>• One adaptive trial was conducted in summer 2015 and the other trial in summer 2016 was conducted at Jessore project site.</li> </ul>	<ul style="list-style-type: none"> <li>✓ Bacterial wilt of brinjal was reduced by 82.5% in 2014 and 73.39% in 2015 in Tricho-compost and -leachate treatment at Jessore.</li> <li>✓ While it was reduced by 87.93 to 82.5% in 2014 and 67.83 to 73.39% in 2015 in Tricho-compost and -leachate treatment at Bogra.</li> <li>✓ <i>Phomopsis</i> blight reduced over control was 65.79% in 2014 and 50.19% in 2015 in brinjal crop at Bogra.</li> <li>✓ Marketable Yield increased over control was 35.23 and 37.01% in 2014 and 2015, respectively in Tricho-compost and-leachate treatment of brinjal at Jessore.</li> <li>✓ Similarly marketable yield increased over control was 20.25 to 35.23% in 2014 and 27.02 to 37.01% in 2015 in Tricho-compost and -leachate field of brinjal at Bogra.</li> <li>✓ BCR increased in 20.23 to 29.68% in 2014 and 21.83 to 31.39% in 2015 in Tricho-compost of brinjal regardless locations.</li> <li>✓ Bacterial wilt disease was reduced 79.59% and yield increased 27.54% in tomato due to application of Tricho-products</li> <li>✓ BCR increased in Tricho-compost treatment over farmers' practices was 26.47 in tomato.</li> <li>✓ <i>Fusarium</i> wilt of cauliflower was reduced by 77.59 to 84.88% and yield increased by 19.3 to 38.08% in 2014 while in 2015 it was reduced by 66.67 to 70.15% and yield increased by 18.23 to 32.37% in Tricho-compost and-leachate application fields.</li> <li>✓ BCR increased in Tricho-compost treatment over farmers' practices was 18.23 to 24.49% in 2014 and 32.37 to 38.80% in 2015 in cauliflower.</li> <li>✓ Foliar application of Tricho-leachate reduced the disease severity of <i>Alternaria</i> leaf spot by 55.0% and increased yield by 18.56% in cabbage.</li> <li>✓ Benefit Cost Ratio increased over control was 20.57% due to application of Tricho-product in cabbage.</li> <li>✓ Fruit rotten was reduced about 43.97% and yield increased 27.76% in 2015 while it reduced 46.59% and yield increased 30.74% in 2016 in Tricho-compost and-leachate application fields in cucumber.</li> <li>✓ BCR was increased 21.43 to 28.40% due to Tricho-products use in cucumber production.</li> </ul>

Specific Project Objective(s)	Planned activities performed against each objective	State progress made clearly during the reporting period against each activity	Outputs/results achieved during this period
<p>2. To reduce the amount of pesticide and chemical fertilizer in vegetable crops production</p>	<p>2.1. Effect of Tricho-compost and Tricho-leachate on chemical fertilizer application in vegetable fields.</p>	<p><b>Effect of Tricho-products on chemical fertilizers</b></p> <ul style="list-style-type: none"> <li>Two treatments were used-i) soil application of Tricho-compost @ 2.5 ton per hectare + chemical fertilizer 80%+ foliar application of Tricho-leachate @ 20 ml/liter of water; ii) Farmers' practices (cowdung @ 2.5 t/ha + chemical fertilizers+ pesticides spray).</li> </ul>	<p><b>Results and benefits Tricho-products over chemical fertilizers:</b></p> <ul style="list-style-type: none"> <li>✓ Due to Tricho-compost and-leachate, Urea, TSP, DAP, MoP and ZnSo<sub>4</sub> application reduced about 33.33, 30.77, 16.67, 30.77 and 33.3%, respectively at Jessore project site in pointed gourd field.</li> <li>✓ In Bogra, application of Urea, TSP, DAP and MoP was reduced about 25.0, 22.22, 22.22 and 37.5%, respectively in pointed gourd field</li> <li>✓ In bottle gourd field, fertilizer application reduced over farmers' practices was 41.67, 36.36, 16.67 and 30.0% in Urea, TSP, DAP and MoP fertilizers, respectively at Jessore</li> <li>✓ In country bean, fertilizer application reduced over farmers' practices were 29.41 to 38.89%, 28.57 to 33.33%, 18.75 to 28.57%, 23.40 to 30.0% and 16.67 to 33.33% in Urea, TSP, DAP, MoP and ZnSo<sub>4</sub> fertilizers, respectively regardless of locations.</li> <li>✓ Fertilizer application in compost plots reduced by 25.0 to 33.33%, 26.09 to 27.27%, 23.08 to 25.00%, 22.22 to 28.57%, 28.57 to 37.5%, and 16.67 to 25.0% in Urea, TSP, MoP, Gypsum, ZnSo<sub>4</sub> and Borax, respectively in brinjal crop regardless of locations.</li> <li>✓ Fertilizer application in Tricho-product plots reduced 25.0, 25.0, 20.0, 30.0, 25.0, 28.57 and 25.0% in Urea, TSP, DAP, MoP, Gypsum, ZnSo<sub>4</sub> and Borax, respectively in tomato at Jessore.</li> <li>✓ In cauliflower fields, 18.18 to 20.0%, 16.67 to 16.67%, 20.0 to 25%, 16.67 to 18.18%, 20.0 to 33.33%, 16.67 to 33.33% and 16.67 to 25.0% less amount of Urea, TSP, DAP, MoP, Gypsum ZnSo<sub>4</sub> and Borax, respectively were applied regardless of location.</li> <li>✓ Urea, TSP, DAP, MoP and Gypsum application reduced 28.00, 28.57, 16.67, 20.00 and 33.33%, respectively in Tricho-compost applied field of cabbage.</li> <li>✓ Due to use of Tricho-compost, Urea, TSP, DAP, MoP and ZnSo<sub>4</sub> application reduced about 40.00, 46.67, 46.67, 16.67, 33.33 and 33.33%, respectively in cucumber field.</li> </ul>

Specific Project Objective(s)	Planned activities performed against each objective	State progress made clearly during the reporting period against each activity	Outputs/results achieved during this period
	2.2. Soil nematode and fungal population study in Tricho- compost and - leachate application fields.	<p><b>Effect of Tricho-products on soil microbes</b></p> <ul style="list-style-type: none"> <li>• Bearman Funnel Methods was used for soil nematode study.</li> <li>• Soil Dilution Plate Methods was used for fungal and bacterial population study.</li> </ul> <p>PDA was used for fungal colony and nutrient agar for bacterial colony developments.</p>	<p><b>Results and benefits of Tricho-products on soil microbes after fourth application</b></p> <ul style="list-style-type: none"> <li>✓ In Tricho-compost soil, plant parasitic nematode population reduced and beneficial nematodes such as bacterivorus, fungivorus nematode population increased</li> <li>✓ After fourth application of Tricho-compost and-leachate, plant parasitic nematode was decreased by 63.64 and 70.21% in Jessore and Bogra project sites.</li> <li>✓ Fungivorus nematodes population was increased by 89.15 and 88.31% in Jessore and Bogra, respectively.</li> <li>✓ Similarly Bacterivorus nematodes population was increased by 136.82 and 156.48% in Jessore and Bogra, respectively.</li> <li>✓ Omnivore nematode population increased by 83.72% in Bogra project site.</li> </ul>
3. To improve knowledge and skill of the farm family on production and use of Tricho-products and to create awareness among the farmers of the project area about its benefit in vegetable production.	3.1. Organizing participatory farmer's training on production and use of Tricho-products in vegetable crops.	<ul style="list-style-type: none"> <li>• Participatory farmer's training was organized in each project sites of Jessore and Bogra.</li> </ul>	<ul style="list-style-type: none"> <li>✓ A total of 25 participants including 20 farmers, two DAE personnel, two NGO's representatives and one project Field Assistant attended in the training program at Jessore.</li> <li>✓ In Bogra, a total of 25 participants including 20 farmers, one DAE personnel, one NGO's representative, two Scientific Assistants and one project Field Assistant attended in the training program.</li> </ul>
	3.2. Arrangement of workshop for ongoing activities of projects.	<ul style="list-style-type: none"> <li>• Workshop was organized in each project sites (Jessore and Bogra).</li> <li>• Twenty five participants including scientist from different departments, person from Department of Agricultural Extension and representative from Non-Government Organization joined the workshop arranging in Jessore.</li> <li>• Similarly in Bogra project site, scientist from different departments, persons from</li> </ul>	<p><b>Comments and suggestions of participants:</b></p> <ul style="list-style-type: none"> <li>✓ Tricho-compost as nutrient sources and disease combat component in vegetable crops, however the technology is not known to all. Therefore, more advertisement necessary to spread the technology.</li> <li>✓ Arranged more workshops on <i>Trichoderma</i> technology including DAE, NGOs' and private sectors.</li> <li>✓ Include extension people to spread the use technology of <i>Trichoderma</i> at farmer level in different districts.</li> <li>✓ Spore suspension (seed) of <i>Trichoderma</i> should be available at</li> </ul>

Specific Project Objective(s)	Planned activities performed against each objective	State progress made clearly during the reporting period against each activity	Outputs/results achieved during this period
		Department of Agricultural Extension and representative from Non-Government Organization joined in the workshop.	farmers' level. ✓ Arrangements of training in different area of Bangladesh. ✓ Development of <i>Trichoderma</i> production laboratory in private or at NGOs' levels.
	3.3. Arrangement of neighbor farmers training on <i>Trichoderma</i> technology	<ul style="list-style-type: none"> <li>Neighbor farmers training was arranged in both of the project sites</li> </ul>	✓ A total of 25 participants including 20 farmers (10 participatory & ten neighbor), two DAE personnel, two NGO's representatives and one project Field Assistant were attended in the training program at Jessore. ✓ In Bogra, a total of 25 participants including 20 farmers (10 participatory & ten neighbor), one DAE personnel, one NGO's representative, two Scientific Assistants and one project Field Assistant were attended in the training program.
	3.4. Arrangement of Trainers' training (TOT) with scientist, extension personel and NGO representatives on <i>Trichoderma</i> technology	<ul style="list-style-type: none"> <li>Trainers' training was arranged in both of the locations.</li> <li>Representatives from Department of Agricultural Extension, BADC, Non-Government Organization, scientist from BARI, farmers' representative attened in trainers' training.</li> <li>Power point presentation was made by the speakers on Importance of Tricho-products for disease management in vegetable crops, Tricho-compost and Tricho-leachate production at farmer's level, and Tricho-products application in vegetable crops.</li> </ul>	✓ Eight representatives from Department of Agricultural Extension, one from BADC, three from Non-Government Organization, three scientists from BARI, two farmer representatives and one project staff joined the trainers' training arranging in Jessore. ✓ While in Bogra, eight from Department of Agricultural Extension, four from Non-Government Organization, five scientists from BARI and one farmer representatives joined trainers' training program. ✓ Very informative and valuable interaction was made among Trainers and Trainees in training classes. ✓ DAE and NGO repretatives requested to arrange more training in this regards in future.

## (ii). Outputs/Results:

Total 20 farm families with each of 10 decimal lands were involved to do work with Tricho-compost and-leachate. A total amount of 73.92 ton organic waste materials were collected for preparation of compost. Sixty eight liter seed Trichoderma was supplied (34/project site) to Jessore and Bogra to produced Tricho-compost and-leachate. Participatory farmers were learned the production technology of Tricho-compost and-leachate through training. Mixing of organic waste materials with spore suspension of *T. harzianum* and using composting house/device, farmers produced the Tricho-compost and collected Tricho-leachate as by-products of compost. A total of 36.96 ton Tricho-compost and 1070 liter Tricho-leachate were produced by the participatory farmers during project period.

Application of Tricho-compost and-leachate reduced disease incidence, and increased yield and quality of vegetable crops. Phytophthora fruit rot of pointed gourd was reduced by 33.71 to 37.78% and yield increased by 20.74 to 42.44% regardless of locations and years. Anthracnose fruit rot of bottle gourd was reduced by 27.37 to 48.67% and yield increased by 28.22 to 31.86%. Anthracnose fruit rot was reduced by 37.65 to 52.81% and yield increased by 29.53 to 33.53% in summer country bean, while in winter country bean it was reduced by 66.67- 58.78% and yield increased by 20.05 to 30.42% in Tri-compost and-leachate treatment. In our base line survey data of yield of country bean was 14.77 that were obtained by the farmers after using huge amount of fertilizers and pesticides. In compared to base line survey data, yield of country increased about 19.77% in Tricho-compost and Tricho-leachate application field. Bacterial wilt was reduced by 67.83 to 87.93 and Phomopsis blight by 50.19 to 65.79% in brinjal regardless of locations and year. With the high management practice and huge amount of fertilizer application, average yield of summer and winter brinjal were 27.13 and 37.09 t/ha, respectively (baseline survey data). While net return was only 55,187 Tk./ha for summer and 1,45,721 Tk./ha for winter brinjal. After application of Tricho-compost and-leachate with 80% less amount of chemical fertilizers, yield obtained by 23.03 to 31.46 t/ha, while farmers practices (control) it obtained by 18.37 to 24.76 t/ha. Net returned was obtained by 3,61,200 to 5,32,000 Tk./ha and 2,16,800 to 3,35,800 Tk./ha in Tricho-compost and-leachate treatment and farmers' practices (control), respectively. In compared to baseline survey data and farmers practices, average net incomes were increased by 344.58% and 175.05%, respectively due application of Tricho-compost and-leachate in brinjal. Similar trend also observed in case of other vegetables. BCR was increased by 18.23 to 38.80% in different vegetable crops.

Application of chemical fertilizers also reduced in Tricho-compost fields. Urea, TSP, DAP and MoP application were reduced by 18.18 -41.67%, 16.67%, 16.67-33.33%, 18.75-33.3% in Tricho-compost application field. More over harmful (parasitic) soil nematodes were reduced and beneficial (bacterivorous and fungivorous) nematodes population increased remarkably due to Tricho-products application in soil. After fourth application, about 63.64 to 70.21% plant parasitic nematode decreased, and about 88.31 to 89.15% fungivorus and 136.82 to 156.48% bacterivorus nematode population increased in soil. Similarly, beneficial fungal and bacterial populations were increased by 123.08 o 139.50% and 71.31 to 85.68%, respectively.

Formulated products of *Trichoderma* are commercially marketed as a potent biopesticides, biofertilizer and also used in soil amendments (Harman 2000, Harman *et al.* 2004). Depending upon the strain, the use of Trichoderma in agriculture can provide numerous advantages: (1) Colonization of the rhizosphere (rhizosphere competence) allowing rapid

establishment within the stable microbial communities in the rhizosphere, (2) control of pathogenic and competitive/deleterious microflora by using a variety of mechanism, (3) Improving of the plant health and (4) stimulation of root growth (Behzad *et al.* 2008, Harman *et al.* 2004). These studies are supporting our finding.

**(iii). Benefit/Outcome:**

Beside disease control, Tricho-compost is a source of organic matter. Soil organic matter plays an important role in sustaining soil fertility, and hence in sustainable agricultural production. In addition to being a source of plant nutrient, it improves the physico-chemical and biological properties of the soil. As a result of these improvements, the soil: becomes more resistant to stresses such as drought, diseases and toxicity; (ii) helps the crop in improved uptake of plant nutrients; and (iii) possesses an active nutrient cycling capacity because of vigorous microbial activity. These advantages manifest themselves in reduced cropping risks, higher yields and lower dependency on inorganic fertilizers for farmers.

Farmers were learned the production and use technology of Tricho-compost and leachate. Neighbor farmers also learned from project's participant farmers and through training (neighbor's farmers training). Farmers are using Tricho-compost to produce their vegetable (tomato, brinjal, pointed gourd, country bean, cabbage, cauliflower, cucumber, chilli, and potato), fruits (mango, papaya, citrus etc.) and cereal crops (rice, maize). Use of Tricho-compost and -leachate reduced the using of chemical fertilizers, and suppressed soil borne disease such as gummosis, Bacterial and Fusarium wilt, root-knot nematode and foliage infection such as phytophthora fruit rot disease. The following benefit are achieved-

- A total of 36.96 ton Tricho-compost and 1070 liter Tricho-leachate were produced by the participatory farmers.
- Both male and female farmers were involved in the production of Tricho-compost.
- By selling compost and leachate farmers generated some money. So it could be source of income for farmers. .
- Soil borne disease of vegetable crops reduced up to 87.93%.
- Yield of vegetable crop increased up to 42.44%.
- Application of chemical fertilizers was reduced by 16.67 to 41.67% in different chemical fertilizers of vegetable crops.
- Income of farmers was increased up to 175%
- BCR of vegetable production was increased up to 38.80%.
- Bacteriovorous nematode (Indicator of soil enrichment) population increased by 136.82 to 156.48%.
- Population of beneficial fungi (decomposer of soil organic matter) population was increased up to 139.50%.
- Population of beneficial bacteria (decomposer of soil organic matter) population was increased up to 85.68%.
- Leaflet, folder and booklet were prepared about three thousand copies and distributed to the stakeholders.
- Tricho-products production and use technology was shown in TV news for spreading the technology among farmers and stakeholder.

#### **d. Technology Developed:**

##### **Disease management package of pointed gourd**

Pointed gourd (*Trichosanthes dioica*) is a tropical vegetable suffering from various insect pest and diseases. Among them nematode- Fungi disease complex, Gummosis, *Phytophthora* fruit rot, Fruit fly and Mealy bug were identified the major production problems. Soil Incorporation of Tricho-compost along with Bordeaux pest for gummosis, Tricho-leachate for *Phytophthora* fruit rot, sweet gourd smashes traps (poison bait traps) for Fruit fly and hand cleaning with soap water spray to control Mealy bug infestation were found to effective. Therefore, Tricho-compost @ 2.5 ton per hectare + foliar application of Tricho-leachate @ 20ml/liter + Bordeaux pest application + Poison bait traps + hand cleaning with soap water spray may use as a package for pointed gourd production. The package was found cost effective and produced higher yield that was documented during adaptive trials. TV and radio advertisement is necessary for awareness development. The package can be used for other cucurbits vegetables

##### **Disease management of brinjal using Tricho-products**

Brinjal (*Solanum melongena* L.) belongs to Solanaceae family. It is one of the year round most important vegetables grown in Bangladesh. Among the production constrains, bacterial and Fusarium wilt, Phomopsis blight, root-knot nematode and brinjal shoot and fruit fly are the majors. Tricho-compost @ 2.5 to 3.0 ton per hectare + foliar application of Tricho-leachate @ 20ml/liter + use of pheromone traps along with hand picking + clean cultivation may use as a package for brinjal cultivation. TV and radio advertisement is necessary for awareness development. The package can be used for other Solanaceous vegetables

##### **Disease management of cold crops using Tricho-products**

Soil-borne pathogens viz., *Pythium*, *Fusarium*, *Rhizoctonia*, *Sclerotium* cause foot and root rot of seedlings of seed bed as well as main fields. In main field, *Fusarium* wilt and *Alternaria* leaf spot are the serious problem for cabbage and cauliflower production. On the other hands, larvae of Diamond back moth (*Plutella xylostella*) and *Spodoptera litura* cause serious damage in the growing stage of cabbage. Application of Tricho-compost @ 2.5 to 3.0 ton per hectare + foliar application of Tricho-leachate @ 20ml/liter found to be effective to control the diseases. On the other hand, use of pheromone trap + hand picking insect larva found to very effective to control insect and diseases. Therefore, Tricho-compost @ 2.5 to 3.0 ton per hectare + foliar application of Tricho-leachate @ 20ml/liter + use of pheromone traps along with hand picking of larva may use as a package for cold crop cultivation. TV and radio advertisement is necessary for awareness development. The package can be used for other cold crops.

#### **e. Publications made/under process:**

##### **Publication:**

Scientific paper-1 published, and the other 3 under process.

Folder-1, Leaflet-1 poster -1 and Booklet -1 published

TV news-1, Local newspaper -5

#### **f. Training/workshop organized:**

##### **Participatory farmers training:**

Participatory farmers training were arranged with project participating farmers, DAE personnel and NGO's representatives in both the locations. A total of 25 participants including 20 farmers, two DAE personnel, two NGO's representatives and one project Field Assistant attended in the training program at Jessore. In Bogra, a total of 25 participants including 20 farmers, one DAE personnel, one NGO's representative, two Scientific Assistants and one project Field Assistant attended in the training program. Importance of compost fertilizers in vegetable crop production, Tricho-compost production and application technology in vegetable crops, Identification and management of insect, pest and diseases in vegetable crops were included in the training program ([Annexure IX](#)).

##### **Organizing workshop on project activities:**

Workshop was organized with scientist, DAE personnel, NGO representative and farmers on project activities in both of the project sites. ([Annexure VIII](#)).

Twenty five participants including scientist from different departments, persons from Department of Agricultural Extension and representative from Non-Government Organizations joined the workshop arranged in Jessore. The workshop was chaired by Dr. Md. Sirazul Islam, CSO, RARS, Jessore and Dr. M Nurul Alam, Executive Director, Krishi Gobeshona Foundation, BARC, Dhaka was honored as special guest. Mr. Nittaranjon Biswas, DD, Department of Agriculture Extension, Jessore played role as critic. Key note paper was presented through power point presentation.

Similarly in Bogra project site, scientists from BARI, persons from Department of Agricultural Extension and representative from Non-Government Organization joined the workshop. The workshop was chaired by Mr. Chandi Das Kundu, DD, Department of Agriculture Extension, Bogra. Special guest was Dr. Kazi M. Kamaruddin, Program Director, Krishi Gobeshona Foundation, BARC, Dhaka. Key note paper was presented through power point presentation. All the comment and suggestion was documented and implemented in ongoing project.

##### **Comments and suggestions:**

- Farmers remarked Tricho-compost as nutrient sources and disease combat component in vegetable crops, however the technology is not known to all, therefore more advertisement necessary to spread about the technology.
- Arranged more workshops on *Trichoderma* technology including DAE, NGOs' and private organizations.
- Include extension people to spread the use technology of *Trichoderma* at farmer level in different districts.
- Spore suspension (seed) of *Trichoderma* should be available at farmers' level.
- Arrangements of training in different area of Bangladesh.
- Mechanical mixture machine (*Trichoderma* and organic matters) necessary to make available in production area.
- Development of *Trichoderma* production laboratory in private or at NGO level.

**Neighbor farmers training:**

Neighbor farmers' training was arranged with neighbor farmers, DAE person and NGO's representatives in both the locations. A total of 25 participants including 20 farmers, two DAE personnel, two NGO's representatives and one project Field Assistant attended in the training program at Jessore. In Bogra, a total of 25 participants including 20 farmers, two DAE personnel, one NGO's representative, two Scientific Assistants of BARI attended in the training program. Importance of compost fertilizers in vegetable crop production, Tricho-compost production and application technology in vegetable crops, Identification and management of insect-pest and diseases in vegetable crops were included in training program (Annexure IX).

**Organizing Trainers' Training (TOT):**

In Jessore project site, Trainer Training on validation and up-scaling of Tricho-products for soil borne disease management in vegetable crops was arranged at RARS, Jessore on April 19, 2016. Eight representatives from Department of Agricultural Extension, one from BADC, three from Non-Government Organization, three from Bangladesh Agricultural Research Institute, two farmer representatives and one project staff joined the trainer training program arranged in Jessore. Power point presentation was made by the speakers on Importance of Tricho-products for disease management in vegetable crops, Tricho-compost and Tricho-leachate production at farmer's level, and Tricho-products application in vegetable crops. Very informative and useful interaction was made among the Trainers and Trainees in training classes. DAE, BADC and NGO representatives requested to arrange more training in this regards.

In Bogra project site, Trainers' Training on validation and up-scaling of Tricho-products for soil borne disease management in vegetable crops was arranged at Sherpur Upazila Agriculture Office, Bogra on April 21, 2016. Eight representatives from Department of Agricultural Extension, four from Non-Government Organization, five from Bangladesh Agricultural Research Institute and one farmer representatives joined the training. Power point presentation was made by the speakers on Importance of Tricho-products for disease management in vegetable crops, Tricho-compost and Tricho-leachate production at farmer's level, and Tricho-products application in vegetable crops. Very informative and valuable interaction was made among Trainers and Trainees in training classes. DAE and NGO representatives requested to arrange more training in this regards ([Annexure IX](#)).

**g. Graduate Studies:** [Indicate whether the research staff under this project are graduated or registered for M.S/PhD degrees] -Not applicable

**h. Linkages Developed:**

During project period, memorandum of understanding (MoU) was made with Mennonite Central Committee (MCC), Bangladesh and Grameen Krishi Sohahak Sohostha (GKSS) and one private agency (Bay-biotech). NGOs and private agency worked together may help to spread technology all over the country.

**i. Equipment/appliance Purchased:**

Sl.No	Name of Equipment	Unit Cost (Tk.)	Total Cost (Tk.)
1	Bi-cycle (3 no.)	12000.00	36000.00
2	Calculator (3 no.)	1000.00	3000.00
3	Computer with printer (1 no.)	55800.00	55800.00
4	Digital camera (1 no.)	15000.00	15000.00
	Total	-	10900.00

## F. Highlight of Research Findings

Due to crop intensification the crop production and cultivation of mono-crop repeatedly in the same land soil fertility is being reduced, Poor soil fertility leads crop to become susceptible to diseases. On the other hand, farmer using huge amount of chemicals often overdoses, more frequencies and even mixing of two or more chemicals as cocktail formulation to achieve better yield. Application of compost fertilizer along with eco-friendly disease management options would be the only way to overcome the situation.

Base line survey data were collected through Focus Group Discussion (FGD). A total of 40 farmers (two from each farm family, usually husband and wife) with each of 10 decimal lands were selected to produce and use Tricho-products in vegetable crops. During our focus group discussion, one farmer, Mr. Hasrat Ali Gazi from Jessore told he never eats any brinjal in summer time due to huge spray of chemicals. However, he gave his opinion; if farmers have used Tricho-products, they rarely need to use the pesticides for insect and disease management. Both male and female farmers were involved in the production of Tricho-compost.

A total of twenty farm families from Jessore and Bogra were trained on production technology and produced 36.96 ton Tricho-compost @ 12.32 ton per year and 1070 liter leachate @ 356.67 liter per year. A total of 3.23 ha land were cropped using Tricho-products where each of twenty farm families utilized ten decimal land for cropping summer and winter vegetables in four seasons.

Training was received by a number of farmers, DAE, BADC person, NGO person, researcher and scientific assistant which were 84, 22, 1, 12, 12 and 4, respectively on Trichoderma technology. Twenty five participants including scientist from different departments, persons from DDE and representative from NGO joined the workshop arranged in Jessore and Bogra. Arrangement of more training and workshops on Trichoderma technology were suggested by DAE person and NGO representative. Comments and suggestions in workshop were implemented in project.

A total of eighty adaptive trials were conducted during project period for validation of Tricho-products at farmers' level. Among them, twenty adaptive trials with pointed gourd, seven with bottle gourd, eight with country bean, three with tomato, seventeen with brinjal, nineteen with cauliflower, four with cabbage and two with cucumber were performed. Application of Tricho-compost and-leachate reduced phytophthora fruit rot by 33.71 to 37.78% and increased yield by 20.74 to 42.44% in pointed gourd. White it reduced anthracnose fruit rot by 27.37 to 48.67% and increased yield by 28.22 to 31.86% in bottle gourd. Similar trend also observed in case of country bean and cucumber. Bacterial wilt of brinjal was reduced by 67.83 to 82.5% and yield increased by 20.25-37.01% in Tricho-compost and-leachate application treatment. Similar results also recorded in tomato. In cauliflower, *Fusarium* wilt was reduced by 66.67 to 84.88% and yield increased by 18.23 to 38.08% in Tricho-compost and-leachate application fields. While in cabbage, alternaria leaf spot reduced by 55% and yield increased by 18.45%.

Net return was higher in Tricho-compost and-leachate application fields regardless of vegetable crops. Net return from brinjal was 5,32,000 Tk./ha in Tricho-compost and-leachate application field, only 33,58,00 Tk./ha in farmers' practices field at Jessore. At Bogra, net return from summer tomato was 13,82,750 Tk./ha in Tricho-compost and-leachate treatment and 10,30,750 Tk./ha in farmers practices. BCR was increased by 20.23 to 31.39% in brinjal and 26.47% in tomato. BCR was increased by 19.73 to 32.16% in pointed gourd, 24.30 to

27.83% in bottle gourd, 28.15 to 31.99% in summer country bean and 20.05 - 30.42% in winter country bean.

In cold crops, BCR was increased by 18.23 to 38.80% in cauliflower and 20.57% in cabbage due to application of Tricho-products.

Soil incorporation of Tricho-compost @ 2.5 t/ha reduced the requirement of Urea, TSP, DAP and MoP application about 18.18 to 41.67%, 16.67%, 16.67 to 33.33% and 18.75 to 33.3%, respectively regardless of crop varieties and locations. Soil microbial population significantly increased.

Harmful soil nematode population reduced about 55 to 62% and beneficial nematodes population increased about 115 to 170%. While beneficial fungal population increased about 91 to 122% after three applications of Tricho-compost. Continuous application of Tricho-compost may bring soil microbes in equilibrium position and soil productivity in sustainable condition.

### **G. Conclusion**

A total of twenty farm families with each of 10 decimal lands were selected from Jessore and Bogra to be learned on production and use technology of Tricho-products. Participatory farmers were trained through training and learning practically. Farmers' collected about 73.92 ton of organic waste materials to prepare compost fertilizer. Trichoderma seed spore was multiplied in the laboratory of plant pathology section. HRC, BARI. Tricho-compost was produced by mixing of various organic materials with seed spore of *T. hazianum* and Tricho-leachate was collected as by-products of compost. About 36.96 ton Tricho-compost and 1070 liter leachate were produced during project period. A total of eighty adaptive trials were conducted with four cropping seasons using Tricho-products.

Application of Tricho-compost and-leachate reduced bacterial wilt about 67.83 to 82.5% in brinjal and 79.59% in summer tomato. Fusarium wilt was reduced about 66.67 to 84.88% in cauliflower. *Phomopsis* blight of brinjal was reduced about 50.19 to 65.79%. Phytophthora fruit rot of pointed gourd was reduced about 33.71 to 36.84%. Anthracnose disease of country and bottle gourd was reduced about 37.65 to 52.81% in summer country bean, 58.78 to 6.67% in winter country bean and 27.37 to 48.67% in bottle gourd.

Yield of brinjal, tomato, pointed gourd, bottle gourd, summer country bean, winter country bean, cauliflower and cabbage about 20.25 to 37.01%, 27.54%, 20.74 to 42.44%, 28.22 to 31.86%, 29.53 to 33.53%, 20.05 to 30.42%, 18.23 to 38.08% and 18.56%, respectively were increased. BCR was increased by 19.73 to 32.16% in pointed gourd, 24.30 to 27.83% in bottle gourd, 28.15 to 31.99% in summer country bean, 20.05 to 30.42% in winter country bean, 20.23 to 31.39% in brinjal, 18.23 to 38.80% in cauliflower, 20.57% in cabbage and 21.43 to 28.40% in cucumber due to application of Tricho-compost and-leachate.

Trichoderma species control nematode infestation by feeding of infective nematodes. It competes with other disease causing microbes for nutrition and space, and controls diseases by the production of several lytic enzymes and antibiotics. Trichoderma are also helpful in solubilization and sequestration of inorganic nutrients. It induces defense responses in crop plants (Induced resistance). Therefore, beneficial microbial population increased and parasitic nematode population decreased significantly due to application of Tricho-compost. On the other hand, compost released nutrient that reduced the quantities of inorganic fertilizer. Technology was disseminated to other farmers, DAE person and NGO personnel through training and workshop.

## **H. Recommendation**

Most people are not aware of using Tricho-compost which is an effective way to increase healthy plant production, help save money, reduce the use of chemical fertilizers, and conserve natural resources. When correctly applied, compost has many beneficial effects on soil properties, thus creating suitable conditions for beneficial microbes which suppressed detrimental plant pathogens, led to develop better plant growth and consequently promote higher yield and quality of crops.

However the technology is new. Need more training and workshop for understanding the technology at policy level and end user. Therefore the following are the recommendation:

- i) Laboratory development at private or NGO level to available Trichoderma seed spore for farmers' use.
- ii) Workshop and Seminar with Policy makers, Agri. Business men, Agro. Processors, and stakeholder.
- iii) Training on Tricho-products production and use at farmers' level.
- iv) Market development for selling pesticide free vegetable.
- v) Facilities development for soil testing that would enhance farmers to use compost fertilizer in their soil.
- vi) Advertisements through Radio, TV or any popular media.

**I. Financial Statement:** Fund received and Expenditure made during the project period.

(In thousand Tk)

Particulars/Line items								
Fund Received in Installments								
1 <sup>st</sup> inst.	2 <sup>nd</sup> inst.	3rd inst.	4 <sup>th</sup> Inst.	5 <sup>th</sup> inst.	6 <sup>th</sup> inst.	7 <sup>th</sup> inst.	8th inst	Total
275.52	413.28	551.04	538.77	401.01	553.72	692.15	534.68	3960.17

Particulars/Line Items		Approved Total Budget	Exp. Upto previous Report (May/13 to Nov./15.)	Current Exp. Reporting period (Dec./15 to May/16)	Cumulative Exp.	Rest of Budgeted Amount
Sl. No	B. I. Expenditure: Recurring (Operational cost)	1	2	3	4=(2+3)	5=(1-4)
1	1.2 Remuneration of Accounting /Typing Support Service, if any (part time basis-consolidated)	990	810	180	990	0
2	2.1 Research & Development (R&D) related cost i.e. all inputs, lab./ farm chemicals & other necessary supplies etc.	108	90	18	108	0
	2.2 Contrac. (Special nature, if any, i.e. soil, plant & fertilizer analysis; pesticide residue analysis etc.)	1692.6	1093.757	471.032	1564.789	127.811
3	Maintenance&repairinglab/field/equip..					
4	Training	160	100	60	160	0
5	Workshop/Seminar/Meeting etc.	93.6	93.6		93.6	0
6	6.1 Travel expenses (TA/DA) as per own organizational rules (as per KGF Rules (Non-govt.Org).	324	107.7375	112.21	219.9475	104.0525
	6.2 Vehicle hiring/oil & fuel for organization's vehicle for travel.	440	238.506	291.9377	530.4437	-90.4437
7	Office supplies and contingency (not exceeding 15% of the total cost for stationeries, publications, printing of reports, internet, service, mailing etc.)	178	89.9075	93.5885	183.496	-5.496
9	Institutional Overhead Charge (if any, max 10% of total oper. cost)	0	0	0	0	0
	<b>B.I. Sub-total B.I (1-9)</b>	<b>3986.2</b>	<b>2623.508</b>	<b>1226.7682</b>	<b>3850.2762</b>	<b>135.9238</b>
	<b>B. II: Non-recurring (Capital cost)</b>					
10	10.1. Lab. and Field Equipment	0	0	0	0	0
	10.2. Office Equipment	112.4	109.8	0	109.8	2.6
11	Books, Journals, etc.		0	0	0	0
	<b>B.II. Sub-total (10-11)</b>	<b>112.4</b>	<b>109.8</b>	<b>0</b>	<b>109.8</b>	<b>2.6</b>
	<b>Grand Total Expenditure: GT(B.I+B.II)</b>	<b>4098.6</b>	<b>2733.3075</b>	<b>1226.7682</b>	<b>3960.0757</b>	<b>138.5243</b>

<b>Balance (A-GT)= 3960170-3960075.7=94.30 as per Bank Statement = 94.30</b>				
<b>Financial Progress: (a) Fund Received in Tk 3960170 (b) Fund utilized as per SoE in Tk 3960075.7</b>				
% achieved =	<table border="1"> <tr> <td>b</td> <td rowspan="2">X100=99.99%</td> </tr> <tr> <td>a</td> </tr> </table>	b	X100=99.99%	a
b	X100=99.99%			
a				

.....  
Signature of PI with seal

## **J. Self Assessment of the Project**

### **1. Have you been able to achieve all specific objectives of your project?**

Yes

### **2. Who is/are the target beneficiary group/s of your project output/result? Farmers/Policy makers/Agri. Business men/ Agro. Processors etc.**

Farmers, policy makers and Agri. Business men

### **3. How the project outputs/results obtained would benefit the target beneficiary groups? And how these could be transferred to those target groups?**

Farmers and agri. business men would be benefited from the project. Farmer, who has learned to produce Tricho-compost, he wouldn't be depended on commercial any other organic compost which is usually the higher market prize (Tricho-compost @ 20 Tk./kg and Tricho-leachate @ 700Tk./L). Farmer has also learned to use technology of Tricho-compost and-leachate for disease management in vegetable fields. So the trained farmers would able to minimize the crop loss occurred by the pathogens which would led to maximize the yield of vegetable crops. Farmers will be sold the safe vegetable in higher prize and generated more money; ultimately the family will be benefited. On the other hand Agri. Business men can take the technology in an organic fertilizer business. Tricho-compost may consider as a valuable bio-fertilizer/organic fertilizer. It provides a stable organic matter that improves the physical, chemical, and biological properties of soils, thereby enhancing soil quality and crop production. By his/her own production, he can use for vegetable production and the rest of the products he can sell for generating money.

More over the vegetable produced in Tricho-compost and-leachate application field would be safe food for consumption. So, safe food production could be a big business for Agri. Business men. Produce safe food, conserve soil health, reduce input cost and maximizing yield cold be the way of a policy maker to protect environment.

### **4. Do you think that you have successfully completed the project? Yes/No;**

#### **Success story/communication brief**

#### **Success in vegetable production using Tricho-products**

Soil borne plant pathogens especially fungi cause important losses and are most aggressive. Some of the important soil borne plant pathogens such as *Pythium*, *Phytophthora*, *Botrytis*, *Rhizoctonia*, *Fusarium* and *Meloidogyne* has spread very fast and have detrimental effects on crops of economic importance. With the advent of chemical compounds it was thought that a permanent and reliable solution of soil borne plant pathogens have been achieved but it was realized that pesticide application is not safe to the environment as the toxicants cause environmental pollution and has harmful effects on human beings. Unfortunately to control a target soil borne plant pathogen with a pesticide, over 100 species of non target organisms are adversely affected (Alabouvette and Couteadier 1992).

Despite realization of adverse effects of chemical pesticides on plants, animals and environment they are being applied indiscriminately to control soil borne plant pathogens. Hence, to reduce the use or dose of chemicals, one possibility is to utilize the disease suppressing activity of certain microorganisms which should be highly antagonistic against the targeted soil borne plant pathogens. Such microorganisms are commonly referred to as bio-control agents such as *Trichoderma* species and their commercial formulations as bio-fertilizers. Different type and name of organic fertilizer is available in the market. However, very few of them have the disease control ability. On the other hand disease control depends on the effectiveness of the bio-control agent and formulation of the products. These mechanisms are complex and what has been defined as biocontrol is the final result of different mechanisms acting synergistically to achieve disease control (Howell, 2003).

Biocontrol results either from competition for nutrients and space or as a result of the ability of *Trichoderma* biocontrol agents to produce and/or resist metabolites that either impede spore germination (fungistasis), kill the cells (antibiosis) or modify the rhizosphere, e.g., by acidifying the soil, so that pathogens cannot grow. Biocontrol may also result from a direct interaction between the pathogen itself and the biocontrol agent, as in mycoparasitism, which involves physical contact and synthesis of hydrolytic enzymes, toxic compounds and/or antibiotics that act synergistically with the enzymes. *Trichoderma* species can even exert positive effects on plants with an increase in plant growth (mineralization) and the stimulation of plant defense mechanisms.

***Success in summer tomato production:***

Farmers in Bogra region are producing summer tomato (August planting) by using Tricho-compost and-leachate and selling tomato with high prize (50 to 80/-per kilograms). Farmers told they got about 1.25 Lac Taka by selling tomato from 10 decimal lands. While farmers' practices field (control) field farmers sold only 50 thousand Tk. (plant died due to bacterial wilt). We asked the reason of lower or higher yield. Mr. Tafazzal mentioned that tomato was seriously affected by wilt disease. But his field (compost and leachate applied) was free from wilt or other diseases. Not only quantity, quality (colour & fleshiness) also increased. He got higher market prize. Mr. Mamum gave the siliar speech regarding his tomato crop (Mr. Mamum, Bogra, Cell: 01949302124 and Mr. Tafazzal, Bogra, Cell:01731031919).

***Success in brinjal Production:***

Mr. Monwar, a brinjal farmer at Jessore mentioned that he sold brinjal about two lac Tk. from ten decimal lands. Large size, shiny and testy brinjal are producing due to application of Tricho-compost and leachate. He also mentioned that none of plant died in his field (compost and leachate applied) due to wilt, which is major problem in brinjal production. Mr. Monwar was not our project assigned farmers, but later one he requested to include him. We found him very promising and dynamic Trichoderma farmer (Farmer Mr. Monwar, Jessore Cell: 01753731707) (Fig. 6.a. & 6.b.).

***Success in pointed gourd and bottle gourd production:***

For pointed gourd and bottle production, farmers were used Tricho-compost fertilizer and very small amount of chemical fertilizers. Fusarium wilt and gummosis disease problem were reduced in Tricho-compost application field. Large size, shiny and testy pointed gourd and bottle gourd were harvested from Tricho-compost field. Mr Hasrat Ali told that if they used only compost and leachate, they will be achieved similar yield. Farmers; were very happy to use Tricho-products in their field (Mr Hasrat Ali, Jessore, cell:01717807804; Golam Faruk, Bogra, Cell: 01737413997) (Fig.7.).

***NGO activities***

In Shahjahanpur Upazilla of Bogra, farmers are producing Tricho-compost and Tricho-leachate with the supervision of MCC Bangladesh. Trichoderma seed spore suspension is being supplied by plant pathology section, HRC, BARI with the help of KGF project. About 525 farmers, 212 persons are producing Tricho-compost in their homestead. Among them 50 farmers were selected to supply vegetables who fulfilled the criteria of not using any pesticides in their vegetable production. They are using Tricho-compost and-leachate along with organic products, pheromone trap, cultural and physical weapon. MCC, Bangladesh is awarded in Vegetable Fair 2016 for their pesticide free vegetables marketing (Cell: 01840-139275; Mr Jahangir) (Fig. 8). At present, farmers is selling about 2700 kg vegetables and earning money 75000/- monthly. The other NGO, GKSS, Gubtoli, Bogra is commercially producing Tricho-compost and Tricho-leachate. Monthly production capacity of Tricho-compost is 50 to 60 ton and Tricho-leachate is about 1500 liter.

## **5. Impact of the project on the productivity, economy and environment**

Biological composting processes break-down the complex compound such as lignin, cellulose, hemicellulose, polysaccharides, proteins, lipids etc and converted into simple inorganic element as available nutrient. The material put into soil without conversion will undergo conversion inside the soil. This conversion process takes away all energy and available nutrients from the soil affecting the crop. Hence conversion period is mandatory before application of organic matter in soil.

Tricho-composting reduced the volume of organic waste. Final weight of compost is very less compared to raw materials. During composting temperature kill pathogen, weed seeds and seeds. Matured compost comes into equilibrium with the soil. More over a number of wastes from several sources are blended together and become a source of nutrients. On the other hand, it reduces the risk of pollution and provides a stable organic matter that improves the physical, chemical, and biological properties of soils, thereby enhancing soil quality and crop production. It suppressed plant diseases and pests, promote higher yields of agricultural crops. By his/her own production, he can use for vegetable production and the rest of the products he can sell for generating money.

Cost-effectively remediate soils contaminated by hazardous waste. Capture and destroy 99.6 percent of industrial volatile organic chemicals (VOCs) in contaminated air. Provide cost savings of 25 to 35% over conventional soil, water, and air pollution remediation technologies, where applicable.

### **K. Acknowledgement**

Agricultural technologies are generated by different organizations for promoting livelihood and enhancing economic benefit of end users. Developed technologies have no impact or value unless it is work properly in the farmers field. So, it is essential to validate those technologies at stakeholder levels before formal recommendation. Therefore, research team is very much grateful to farmers who involved and cooperated for implementing the project. Research team is also thankful to Director General as well as Director (Research), Director (HRC) and HRC office for their generous support and help to run the project smoothly. Appreciations are also extended to CSO, RARS, Jessore; PSO, OFRD, Bogra; DAE and NGO personnel from respective Upazilas for cooperation and valuable suggestions for carrying out the project. Special thanks to the Project Scientists and Lab and Field Assistant for their entire efforts during the project period. Last but not the least, we extend our heartfelt thanks to KGF authority for financing and other efforts rendering during the project period.

### **L. Endorsement:**

#### Principal Investigator (PI)

Name:

Signature:

Seal:

Date:

#### Head of Organization/Authorized Person

Name:

Signature:

Seal:

Date:

**Focused Group Discussion (FGD) on Vegetable production practices at Jessore**

Date: August 17, 2013

Location: Baghdanga, Churamonkati, Jessore sadar, Jessore

Facilitator: Dr. M Shamsunnahar, Principal Scientific Officer, HRC, BARI, Gazipur

Dr. M. Kamrul Hasan, Agricultural Economist, BARI, Gazipur

Md. Rafi Uddin, Principal Scientific Officer, RARA, BARI, Jessore

Latifa Yeasmin, Senior Scientific Officer, HRC, BARI, Gazipur

<p><b>Participants: 10 Male &amp; 10 Female farmers</b></p> <ol style="list-style-type: none"> <li>1. Md.Hajrat Ali Gazi</li> <li>2. Mrs. Shahnaz Begum</li> <li>3. Md.Golam Rosul</li> <li>4. Mrs. Mosammat Fahima Begum</li> <li>5. Md.Anarul Islam Litu</li> <li>6. Mrs. Rini Begum</li> <li>7. Md. Ibrahim Sardar</li> <li>8. Mrs. Momina Khatun</li> <li>9. Md. Obaidul Islam</li> <li>10. Mrs. Hasnahena</li> <li>11. Md.Mahabbat Ali</li> <li>12. Mrs. Moss. Laboni</li> <li>13. Md.Shohidul Islam</li> <li>14. Mrs. Sokhina Begum</li> <li>15. Md. Solaiman Bepari (Bisu)</li> <li>16. Mrs. Moss. Sufia Khatun</li> <li>17. Abu Shiddik Mandol</li> <li>18. Mrs. Mosammat Hashina Begum</li> <li>19. Md. Haider Ali</li> <li>20. Mrs. Swapna Begum</li> </ol>	<p><b>NGO, DAE and project personnel.</b></p> <ol style="list-style-type: none"> <li>21. Dr. Md. Saiful karim, Jagorony Chakro Foundation, Jessore</li> <li>22. Md. Zakir Hossain, SAAO, DAE, Jessore</li> <li>23. Shamim Humayun, SAAO, DAE, Jessore</li> <li>24. Mr. Robiul Islam, Ulashi Srijony Shango (USS), Jhikorgacha, Jessore.</li> <li>25. Hemel Dutto Rony, Field Assistant, KGF project, Churamonkati, Jessore</li> </ol>
---	---

**Issues discussed**

1. Farm size, homestead size, household size, education, age etc.
2. Vegetables cultivated in the homestead and crop field
3. Crop wise fertilizer management, use of organic and inorganic fertilizers
4. Use of pesticides and insect, pest and disease management
5. Yield and price of vegetables
6. Land type, soil type
7. Problem associated with vegetable production and marketing

**Table.1.** List of selected farmers and farm size at Bagdanga, Churamonkati, Jessore Sador, Jessore

Sl. No.	Name of the farmers	Farm size (decimal)	Remark
1	Md.Hajrat Ali Gazi	660	Husband & wife
2	Mrs. Shanaz Begum		
3	Md.Golam Rosul	198	Husband & wife
4	Mrs. Mosammat Fahima Begum		
5	Md.Anarul Islam Litu	99	Husband & wife
6	Mrs. Rini Begum		
7	Md. Ibrahim Sardar	99	Husband & wife
8	Mrs. Momina Khatun		
9	Md. Obaidul Islam	99	Husband & wife
10	Mrs. Hasnahena		
11	Md.Mahabbat Ali	115.5	Husband & wife
12	Mrs. Moss. Laboni		
13	Md.Shohidul Islam	99	Husband & wife
14	Mrs. Sokhina Begum		
15	Md. Solaiman Bepari (Bisu)	99	Husband & wife
16	Mrs. Moss. Sufia Khatun		
17	Abu Shiddik Mandol	132	Husband & wife
18	Mrs. Mosammat Hashina Begum		
19	Md. Haider Ali	330	Husband & wife
20	Mrs. Swapna Begum		

**Table 2.** List of major vegetables grown commercially in Jessore area

<b>Summer</b>	<b>Winter</b>
Brinjal	Cabbage
Pointed gourd	Cauliflower
Tomato	Bottle gourd
Ash gourd	Brinjal
Bitter gourd	Tomato
Amaranth	Country bean
Country bean	Spinach

**Farm Size of the Respondents**

The land holding per farm ranged from 99.0 decimal to 660.0 decimal.

**Table 3.** Plot size of brinjal in the study areas

Location	Per farm summer brinjal area (decimal)	Per farm winter brinjal area (decimal)
Jessore (n=20)	29.4	36.0

**Table 4.** Fertilizer application in brinjal (summer)

Items	Amount (kg/ha)				
	Urea	TSP	MoP	Furadan	Cowdung
Basal	30-50	110-130	50-60	12-15	10000-15000
20 DAP	50-70	50-70	60-80	-	-
40 DAP	30-50	50-70	60-80	-	-
60 DAP	40-60	60-80	70-90	-	-
80 DAP	50-70	70-90	80-100	-	-
100 DAP	60-80	90-110	100-120	-	-
120 DAP	70-90	110-120	120-140	-	-
140 DAP	90-110	120-140	130-150	-	-
160 DAP	70-90	110-130	120-140	-	-
180 DAP	70-90	90-110	90-110	-	-

**Table 5.** Fertilizer application in winter brinjal

Items	Amount (kg/ha)				
	Urea	TSP	MoP	Furadan	Cowdung
Basal dose	30-50	110-130	50-60	15	10000-15000
20 DAP	50-70	50-70	60-80	-	-
40 DAP	40-60	60-80	70-90	-	-
75 DAP	50-70	70-90	80-100	-	-
90 DAP	60-80	90-110	100-120	-	-
105 DAP	50-70	70-90	80-100	-	-
120 DAP	40-60	60-80	70-90	-	-

**Name of pesticides sprayed in brinjal:** Dursban, Aerostar, Wonder, Papes, Dufen, Alarm-2, Sobicron, Virtaco, Ripcord, Dithane M-45, Bavistin, Tilt etc.

**Spray schedule:** Every alternative day in the summer season (5-6 months) fruiting times (brinjal) everyday, even morning and afternoon. In winter season, two or three sprays per week for 3-4 months.

**Table 6.** Yield of summer brinjal by variety used in the study areas

Variety	Yield (t/ha)	
	Summer brinjal	Winter brinjal
Chega	25.09 (13)*	37.78 (16)*
Gulchega	31.99 (2)	31.99 (2)
Irit	32.95 (1)	-
Kata	31.98 (1)	-
Local	29.67 (2)	29,88 (1)
Partib	37.68 (1)	-
Soli	-	28.30 (1)
All varieties	27.13 (20)	37.09 (20)
Average yield (Res. field)		

\*Figures in the parenthesis indicate number of respondents

**Table 7.** Per hectare cost and return in producing brinjal in Jessore area

Items	Summer brinjal		Winter brinjal	
	Amount/no.	Return (Tk/ha)	Amount/no.	Return (Tk/ha)
Variable cost:				
Human labour (man-days)	314	69080	332	73040
Animal power (pair-day)	0.6	180	-	0
Mechanical power (Tk)	-	6813	-	5623
Seed/seedling (Tk.)	-	7565	-	6120
Fertilizers:				
Farm yard manure (kg)	4501	4501	4374	4374
Urea (kg)	441	9261	347	7287
TSP (kg)	521	12504	439	10536
DAP (kg)	27	756	11	297
MoP (kg)	419	6285	371	5565
Gypsum (kg)	129	774	184	1104
Zinc sulphate (kg)	8	1040	11.5	1495
Borax (kg)	2	160	3.6	288
Support/macha	-	2983	-	-
Pesticides (No.)	110	35691	72	22910
IPM (Tk.)	-	191	-	-
Irrigation (No.)	4.1	10203	6.9	14391
Interest on operating capital	-	4115	-	4179
A. Total variable cost	-	172102	-	157209
B. Fixed cost (Rental value of land)	-	44041	-	67980
C. Total cost (A+B)	-	216143	-	225189
D. yield (kg)/Gross return	27133	271330	37091	370910
E. Gross margin (D-A)	-	99228		213701
F. Net return (D-C)	-	55187	-	145721
G. Benefit cost ratio (D/C)	-	1.26		1.65
H. Production cost (Tk./kg):				
Full cost basis	-	7.73	-	5.91
Cash cost basis	-	6.1	-	4.08

**Input price/kg:** Cowdung-Tk.1.0, Urea-Tk.21.0, TSP-Tk.24.0, DAP-Tk.28.0, MoP-Tk.15.0, Gypsum-Tk.6.0, Zinc sulphate-Tk.130.0 and Borax-Tk.80.0. Human labour: Tk.220/man-day and Animal power: Tk.300/pair-day.

**Average output price:** Tk.10.0/kg

**Table 8.** Problems of production and marketing of brinjal in the study areas

Problems	Farmer responded
<b><i>Problems of production:</i></b>	
Lack of irrigation facility	9 (45)
Lack of quality seed	4 (20)
Labour crisis	9 (45)
Disease infestation	17 (85)
High input cost	9 (45)
Insect infestation	17 (85)
<b><i>Problems of marketing:</i></b>	
Adulteration in fertilizer and pesticide	15 (75)
Bad communication	2 (10)
Fake packing of seed	6 (30)
Lack of storage facility	4 (20)
Low output price	10 (50)
High transportation cost	6 (30)

Figures in the parenthesis indicate percent farmer responded

\* Due to multiple responses the summation of all responses might be exceed hundred.

## Annexure 11

### Focused Group Discussion (FGD) on Vegetable production practices at Bogra

Date: September 03, 2013

Location: Vatra, Khanpur, Sherpur, Bogra

Facilitator: Dr. M Shamsunnahr, Principal Scientific Officer, HRC, BARI, Gazipur  
Dr. A K M Khorsheduzzaman, SSO, Entomology Section, HRC, BARI, Gazipur  
Dr. Md. Golam Kibria, SSO, Plant Pathology Section, HRC, BARI, Gazipur  
Dr. Md. Zulfikar Haider Prodhan, SSO (OFRD), ARS, Chelopara, Bogra

Participants: 10 Male & 10 Female farmers	21. Md. Amzad Hossain, SA, ARS, Bogra
1. Md. Mamunur Rashid	22. Md. Faruq Ahmed, SA, ARS, Bogra
2. Mrs. Moss. Farida Parvin	23. Md. Abdus Sobhan, SAAO, DAE, Sherpur, Bogra
3. Md. Hannan Sheikh	24. Mr. Abdus Sattar, Executive Director, Moytri Palli Unnayan Shongostha
4. Mrs. Moss. Mitu Begum	25. Md Mizanur Rahman, Field Assistant, KGF project, Sherpur, Bogra
5. Md. Aktaruzzaman	
6. Mrs. Moss. Salma Begum	
7. Md. Tofazzal Hossain	
8. Mrs. Bulbuli Begum	
9. Md. Mukul Sarker	
10. Mrs. Forida Begum	
11. Md. Kabir Alam	
12. Mrs. Moss. Shahanaz Parvin	
13. Md. Rana Mahmud	
14. Mrs. Moss. Chaina Begum	
15. Md. Golam Faruk	
16. Mrs. Shahanaz Parvin	
17. Md. Ibrahim	
18. Mosammat Champa Begum	
19. Md. Liton Ahmed	
20. Mrs. Moss. Nilufar Yasmin	

#### Issues discussed

1. Farm size, homestead size, household size, education, age etc.
2. Vegetables cultivated in the homestead and crop field
3. Crop wise fertilizer management, use of organic and inorganic fertilizers
4. Use of pesticides and insect, pest and disease management
5. Yield and price of vegetables
6. Land type and soil type
7. Problem associated with vegetable production and marketing

**Table 9. List of selected Farmers and Farm size at Vatra, Khanpur, Sherpur, Bogra**

Sl. No.	Name of the farmers	Farm size including homestead (decimal)	Remark
1	Md. Mamunur Rashid	825	Son & mothers
2	Mrs. Moss. Farida Parvin		
3	Md. Hannan Sheikh	495	Husband & wife
4	Mrs. Moss. Mitu Begum		
5	Md. Aktaruzzaman	99	Husband & wife
6	Mrs. Moss. Salma Begum		
7	Md. Tofazzal Hossain	297	Husband & wife
8	Mrs. Bulbuli Begum		
9	Md. Mukul Sarker	297	Husband & wife
10	Mrs. Forida Begum		
11	Md. Kabir Alam	198	Husband & wife
12	Mrs. Moss. Shahanaz Parvin		
13	Md. Rana Mahmud	99	Son & mothers
14	Mrs. Moss. Chaina Begum		
15	Md. Golam Faruk	264	Husband & wife
16	Mrs. Shahanaz Parvin		
17	Md. Ibrahim	198	Husband & wife
18	Mosammat Champa Begum		
19	Md. Liton Ahmed	198	Son & mothers
20	Mrs. Moss. Nilufar Yasmin		

**Major vegetables grown commercially in the area****Table 10. List of major vegetables grown commercially in the area**

<b>Summer</b>	<b>Winter</b>
Pointed gourd	Cabbage
Sweet gourd	Cauliflower
Ash gourd	Tomato
Bitter gourd	Bottle gourd
Brinjal	Country bean
Spinach	Chilli
Red amaranth	Potato

**Cabbage and country bean cultivated area**

On an average per farm cabbage cultivated area was recorded 33.7 decimal and that of country bean was 18.05 decimal.

**Table 11. Plot size of cabbage and country bean in the study area**

Location/ Farm category	Per farm cabbage area (decimal)	Per farm country bean area (decimal)
<b>Location:</b> Bogra (n=20)	33.7	18.05

**Table 12.** Variety cultivated and yield of cabbage in the study area

Cabbage		Country bean	
Variety	Yield (t/ha)	Variety	Yield (t/ha)
Atlas 70	78,91 (6)	BARI Shem 1	21,73 (8)
KK- Cross	44,93 (2)	BARI Shem 2	13,86 (3)
Summer Orior	51,95 (4)	BARI Shem 4	15,97 (2)
Tropical 33	52,74 (4)	Local	71,33 (2)
Kumfu (Hybrid)	53,35 (3)	Naldoga	14,45 (2)
Local	46,79 (1)	IPSA 1	13,93 (3)
All varieties	54,78 (20)	All varieties	14,519 (20)

Figures in the parenthesis indicate number of respondents

**Table 13.** Per hectare cost and return in producing cabbage and country bean

Items	Cabbage		Country bean	
	Amount/No.	Cost and return (Tk./ha)	Amount/No.	Cost and return (Tk./ha)
<b>Variable cost:</b>				
Human labour (m-d)	304	66880	236	51920
Animal power (p-d)	2.1	630	3.5	1050
Mechanical power (Tk.)	-	19053	-	5958
Fertilizers:				
Farm yard manure (kg)	4327	4327	3100	3100
Oil cake (kg)	6.6	158.4	-	-
Urea (kg)	291	6111	176	3696
TSP (kg)	317	7608	256	6144
DAP (kg)	19.8	554.4	5	140
MoP (kg)	168	2520	89	1335
Gypsum (kg)	139	834	186	1116
Zinc sulphate (kg)	6.8	884	10.5	1365
Borax (kg)	4.0	320	-	-
Seed/Seedling (No.)	43518	43518	-	5600
Irrigation (No.)	4.5	19414	5.0	20561
Pesticides (No.)	14.5	20399	5.3	14789
Support (Tk.)	-	-	-	20418
Interest on operating capital	-	4330	-	3462
<b>A. Total variable cost</b>	-	<b>178,541</b>	-	<b>141936</b>
<b>B. Fixed cost (Rental value of land)</b>	-	<b>63456</b>	-	<b>66561</b>
<b>C. Total cost (A+B)</b>	-	<b>241997</b>	-	<b>208497</b>
<b>D. Gross return (kg)</b>	<b>54778</b>	<b>383418</b>	<b>14509</b>	<b>290180</b>
<b>E. Gross margin (D-A)</b>	-	<b>204,877</b>	-	<b>148244</b>
<b>F. Net return (D-C)</b>	-	<b>141421</b>	-	<b>81683</b>
<b>G. Benefit cost ratio (D/C)</b>	-	<b>1.59</b>	-	<b>1.39</b>

<b>H. Production cost (Tk./kg):</b>				
<b>Full cost basis</b>	-	<b>4.40</b>	-	<b>14.37</b>
<b>Cash cost basis</b>	-	<b>3.24</b>	-	<b>9.78</b>

Input price (Tk/kg): Cowdung: 1.0, Oil cake:24.0, Urea:21.0, TSP:24.0, DAP:28.0, MoP:15.0, Gypsum:6.0, Zinc sulphate:130.0 and Borax:80.0. Human labour: Tk.220/man-day and Animal power: Tk.300/pair-day. Cabbage price: Tk.7.0/kg. Country bean: Tk.20.0/kg

**Table 14.** Problem of cabbage and country bean production and marketing

Problems	Farmers response (no.)	
	Cabbage	Country bean
<b><i>Problems of production:</i></b>		
Adulteration in fertilizer and insecticides	18 (90)	15 (75)
Dearth of cash money	9 (45)	14 (70)
Disease infestation	16 (80)	16 (80)
Insect infestation	17 (85)	16 (80)
Labour crisis	12 (60)	10 (50)
Lack of quality seed	15 (75)	14 (70)
Natural calamities	10 (50)	7 (35)
Lack of irrigation water	12(60)	10 (50)
<b><i>Problems of marketing:</i></b>		
High input price	14 (65)	11 (55)
Lack of transport and bad communication	9 (45)	13 (65)
Low output price	15 (75)	14 (70)
Seed and fertilizers are not available in time	11 (55)	4 (20)
Excessive middleman	7 (35)	7 (35)

Figures in the parenthesis indicate percent farmer responded

\* Due to multiple responses the summation of all responses may exceed hundred.

### Annexure III

Table 15. Radial growth of mycelium of pathogen in presence and in absence of *T. harzianum*

Petri-plate	Radial growth of mycelium (cm)		(% ) Growth inhibition= $\frac{R_1 - R_2}{R_1} \times 100$
	Control plate (R <sub>1</sub> )	Treated plate (R <sub>2</sub> )	
1	7.5	1.8	76.00
2	7.5	2.1	72.00
3	7.5	2	73.33
Mean	7.5	1.97	73.78

**Table 16.** *Trichoderma* spore suspension production in the laboratory, HRC, BARI, Gazipur during May, 2013 to May 31, 2016

Sl. #	Time of <i>Trichoderma</i> culture	Duration of spore multiplication	Spore suspension (L)
1	August 05 to 15, 2013	7 to 12 days necessary for spore development and multiplications.	2
2	September 06 to 17, 2013		2
3	October 15 to 26, 2013		2
4	November 5 to 16, 2013		2
5	February 05 to 15, 2014		2
6	March 05 to 15, 2014		2
7	April 15 to 25, 2014		2
8	May 01 to 20, 2014		2
9	June 02 to 14, 2014		2
10	July 05 to 15, 2014		2
11	August 06 to 17, 2014		2
12	September 02 to 15, 2014		2
13	October 05 to 15, 2014		2
14	November 08 to 20, 2014		2
15	January 15 to 30, 2015		2
16	February 09 to 12, 2015		2
17	March 12 to 24, 2015		2
18	April 05 to 15, 2015		2
19	May 05 to 15, 2015		2
20	June 05 to 18, 2014		2
21	July 07 to 17, 2014		2
22	August 06 to 17, 2014		2
24	September 05 to 20, 2014		2
25	October 05 to 15, 2014		2
26	November 10 to 22, 2014		2
27	December 15 to 30, 2015		2
28	January 02 to 12, 2016		2
29	February 09 to 12, 2016		2
30	March 01 to 10, 2016		2
31	March 15 to 25, 2016		2
32	April 01-10, 2016		2
33	April 13-23, 2016		2
34	May 01 to 10, 2016		2
	<b>Total</b>		

**Composting house preparation:**

Table 17. Number of Tricho-compost house at Bagdanga, Churamonkati, Jessore

Farm family no.	Name of the farmers	Cement ring made house	Brick made house	Total
1	Md.Hajrat Ali Gazi	-	2	2
	Mrs. Shanaz Begum			
2	Md.Golam Rosul	2	-	2
	Mrs. Mosammat Fahima Begum			
3	Md.Anarul Islam Litu	2	-	2
	Mrs. Rini Begum			
4	Md. Ibrahim Sardar	2	-	2
	Mrs. Momina Khatun			
5	Md. Obaidul Islam	2	-	2
	Mrs. Hasnahena			
6	Md.Mahabbat Ali	2	-	2
	Mrs. Moss. Laboni			
7	Md.Shohidul Islam	2	-	2
	Mrs. Sokhina Begum			
8	Md. Solaiman Bepari (Bisu)	2	-	2
	Mrs. Moss. Sufia Khatun			
9	Abu Shiddik Mandol	2	-	2
	Mrs. Moss. Hashina Begum			
10	Md. Haider Ali	2	-	2
	Mrs. Swapna Begum			
Total		18	2	20

**Table18.** Number of Tricho-compost house at Vatra, Khanpur, Sherpur, Bogra

Farm family no.	Name of the farmers	Cement ring made house	Brick made house	Total
1	Md. Mamunur Rashid	-	2	2
	Moss. Farida Parvin			
2	Md. Hannan Sheikh	2	-	2
	Moss. Mitu Begum			
3	Md. Akteruzzaman	2	-	2
	Moss. Salma Begum			
4	Md. Tofazzal Hossain	2	-	2
	Mrs. Bulbuli Begum			
5	Md. Mukul Sarker	2	-	2
	Mrs. Forida Begum			
6	Md. Kabir Alam	2	-	2
	Shahanaz Parvin			
7	Md. Rana Mahmud	2	-	2
	Moss. Chaina Begum			
8	Md. Golam Faruk	2	-	2
	Mrs. Shahanaz Parvin			
9	Md. Ibrahim	2	-	2
	Moss. Champa Begum			
10	Md. Liton Ahmed	2	-	2
	Moss. Nilufar Yasmin			
Total		18	2	20

**Raw material loading:****Table 19.** Quantity of organic materials need for Tricho-compost production

Sl. no.	Raw materials	Quantity in volume basis (no. BB*)/ two cement ring house	Quantity in volume basis (no. BB*)/ one brick made house	Percentage
1	Cowdung	14	28	28
2	Poultry refuse	18	36	36
3	Processed water hyacinth	14	28	28
4	Vegetable waste	1	2	2
5	Fine sawdust	1.5	3	3
6	Mushroom waste/ Ash/moc	0.5	1	1
7	Maize bran	0.5	1.0	1
8	Neem leaf	0.25	0.5	0.5
9	Molasses	0.25	0.5	0.5
10	<i>T. harzianum</i> ( $3 \times 10^7$ )	300 ml	600 ml	-
	Total	50BB +300 ml	100 BB+ 600ml	100

**\*Bamboo basket (one bamboo basket = 8.4 kilogram average wt.)**

## Mass production of Tricho-compost and Tricho-leachate

**Table 20.** Tricho-compost production at Bagdanga, Churamonkati, Jessore during December 2013 to November 30, 2015

Farm family #	Compost harvest (kg)/loading								Total (kg)
	1st	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	6 <sup>th</sup>	7 <sup>th</sup> *	8 <sup>th</sup> *	
Farm 1	420	420	420	420	420	420	420	420	3360
Farm 2	210	210	210	210	210	210	210	210	1680
Farm 3	210	210	210	210	210	210	210	210	1680
Farm 4	210	210	210	210	210	210	210	210	1680
Farm 5	210	210	210	210	210	210	210	210	1680
Farm 6	210	210	210	210	210	210	210	210	1680
Farm 7	210	210	210	210	210	210	210	210	1680
Farm 8	210	210	210	210	210	210	210	210	1680
Farm 9	210	210	210	210	210	210	210	210	1680
Farm 10	210	210	210	210	210	210	210	210	1680
Total	2310	2310	2310	2310	2310	2310	2310	2310	18480

\*compost harvesting during reporting periods

**Table 21.** Tricho-leachate production at Bagdanga, Churamonkati, Jessore during December 2013 to November 30, 2015

Farm family #	Compost harvest (kg)/loading								Total (L)
	1st	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	6 <sup>th</sup>	7 <sup>th</sup>	8 <sup>th</sup> *	
Farm 1	21	17	18	19	17	18	17	17	144
Farm 2	5	6	5	6	6	5	6	6	45
Farm 3	6	6	6	6	5	6	6	5	47
Farm 4	4	4	4	4	7	6	5	5	39
Farm 5	5	5	5	5	5	6	6	6	43
Farm 6	5	6	5	6	6	5	5	7	44
Farm 7	6	5	5	5	7	5	5	5	42
Farm 8	6	6	6	6	5	6	6	6	48
Farm 9	4	5	4	5	5	6	6	5	40
Farm 10	5	5	5	5	5	6	6	6	43
Total	67	65	63	65	70	69	68	68	535

\*leachate harvesting during reporting periods

Farm family 1(Farm 1)= Md. Hajrat Ali Gazi & Mrs. Shanaz Begum, Farm 2= Md.Golam Rosul & Mrs. Mosammat Fahima Begum, Farm 3 = Md.Anarul Islam Litu & Mrs. Rini Begum, Farm 4= Md. Ibrahim Sarder & Mrs. Momina Khatun, Farm 5= Md. Obaidul Islam & Mrs. Hasnahena, Farm 6= Md.Mahabbat Ali & Mrs. Moss. Laboni, Farm 7= Md.Shohidul Islam & Mrs. Sokhina Begum, Farm 8 = Md. Solaiman Bepari (Bisu) & Mrs. Moss. Sufia Khatun, Farm 9= Abu Shiddik Mandol & Mrs. Moss. Hashina Begum, and Farm 10= Md. Haider Ali & Mrs. Swapna Begum

**Table 22.** Tricho-compost production at Vatra, Khanpur, Sherpur, Bogra during December 2013 to November 30, 2015

Farm family #	Compost harvest (kg)/loading								Total (kg)
	1st	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	6 <sup>th</sup>	7 <sup>th</sup> *	8 <sup>th</sup> *	
Farm 1	420	420	420	420	420	420	420	420	3360
Farm 2	210	210	210	210	210	210	210	210	1680
Farm 3	210	210	210	210	210	210	210	210	1680
Farm 4	210	210	210	210	210	210	210	210	1680
Farm 5	210	210	210	210	210	210	210	210	1680
Farm 6	210	210	210	210	210	210	210	210	1680
Farm 7	210	210	210	210	210	210	210	210	1680
Farm 8	210	210	210	210	210	210	210	210	1680
Farm 9	210	210	210	210	210	210	210	210	1680
Farm 10	210	210	210	210	210	210	210	210	1680
Total	2310	2310	2310	2310	2310	2310	2310	2310	18480

\*compost harvesting during reporting periods

**Table 23.** Tricho-leachate production at Vatra, Khanpur, Sherpur, Bogra during December 2013 to November 30, 2015

Farm family #	Compost harvest (kg)/loading								Total (L)
	1st	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	6 <sup>th</sup>	7 <sup>th</sup>	8 <sup>th</sup> *	
Farm 1	21	17	18	17	19	18	17	17	144
Farm 2	5	6	5	6	6	5	6	6	45
Farm 3	6	6	6	6	5	6	6	6	47
Farm 4	4	4	4	4	7	6	5	5	39
Farm 5	5	5	5	5	5	6	6	6	43
Farm 6	5	6	5	6	6	5	5	6	44
Farm 7	6	5	5	5	6	5	5	5	42
Farm 8	6	6	6	6	6	6	6	6	48
Farm 9	4	5	4	5	5	6	6	5	40
Farm 10	5	5	5	5	5	6	6	6	43
Total	67	65	63	65	70	69	68	68	535

\*leachate harvesting during reporting periods

Farm family 1(Farm 1)= Md. Mamunur Rashid & Moss. Farida Parvin, Farm 2= Md. Hannan Sheikh & Moss. Mitu Begum, Farm 3 =Md. Akteruzzaman & Moss. Salma Begum, Farm 4= Md. Tofazzal Hossain & Mrs. Bulbuli Begum, Farm 5= Md. Mukul Sarker & Mrs. Forida Begum, Farm 6= Md. Kabir Alam & Moss. Shahanaz Parvin, Farm 7= Md. Rana Mahmud & Moss. Chaina Begum, Farm 8 =Md. Golam Faruk & Mrs. Shahanaz Parvin, Farm 9= Md. Ibrahim & Mosammat Champa Begum and Farm 10= Md. Liton Ahmed & Moss. Nilufar Yasmin

**Annexure VI**

Table 24. List of adoptive trials with vegetable crops using Tricho-compost and-leachate for four cropping season in Jessore

Sl #	Name of the farmers	Summer 2014	Winter 2014-15	Summer 2015	Winter 2015-16 & Summer 2016
1	Md.Hajrat Ali Gazi	Pointed gourd (Local)	Cabbage (Green 60)	Brinjal (Gaol)	Bottle gourd (Local)
	Shanaz Begum				
2	Md.Golam Rosul	Pointed gourd (Local)	Brinjal (Chega)	Pointed gourd (Local)	Cucumber (Local)
	Mrs. Moss. Fahima Begum				
3	Anarul Islam Litu	Bottle gourd (Local)	Cabbage (Green 60)	Pointed gourd (Local)	Bottle gourd (Local)
	Mrs. Rini Begum				
4	Md. Ibrahim Sardar	Pointed gourd (Local)	Cabbage (Green 60)	Pointed gourd (Local)	Cauliflower (Tropical 11)
	Mrs. Momina Khatun				
5	Md. Obaidul Islam	Bottle gourd (BARI Lau 2)	Cauliflower (Tropical 11)	Cucumber (Local)	Bottle gourd (Local)
	Mrs. Hasnahena				
6	Md.Mahabbat Ali	Pointed gourd (Local)	Brinjal (Chega)	Brinjal (Gaol)	Cauliflower (Tropical 11)
	Mrs. Moss. Laboni				
7	Md.Shohidul Islam	Brinjal (Chega)	Cauliflower (Tropical 11)	Brinjal (Gaol)	Cauliflower (Tropical 11)
	Sokhina Begum				
8	Md. Solaiman Bepari (Bisu)	Summer country bean (Rahim)	Cauliflower (Tropical 11)	Brinjal (Gaol)	Bottle gourd (Local)
	Moss. Sufia Khatun				
9	Abu Shiddik Mandol	Pointed gourd (Local)	Cauliflower (Tropical 11)	Pointed gourd (Local)	Cauliflower (Tropical 11)
	Moss. Hashina Begum				
10	Md. Haider Ali	Pointed gourd (Local)	Cabbage (Green 60)	Brinjal (Gaol)	Bottle gourd
	Mrs. Sawpna Begum				

Table 25. List of adoptive trials with vegetable crops using Tricho-compost and-leachate in Bogra four cropping season

Sl. #	Name of the farmers	Summer 2014	Winter 2014-15	Summer 2015	Winter 2015-16
1	Md. Mamunur Rashid	Brinjal (Green ball)	-	Brinjal (Green ball)	Country bean (Local) & Tomato (Sofol)*
	Moss. Farida Parvin				
2	Md. Hannan Sheikh	Country bean	Cauliflower (Hybrid 70)	Brinjal (Green ball)	Cauliflower (Alfa chan)
	Moss. Mitu Begum				
3	Md. Akteruzzaman	Brinjal (Green ball)	Country bean (BARI Shim 4)	Pointed gourd (Dhapa)	Country bean (local)
	Moss. Salma Begum				
4	Md. Tofazzal Hossain	-	Brinjal (Green ball)	Brinjal (Green ball)	Cauliflower (Alfa chan) & Tomato (Sofol)*
	Mrs. Bulbuli Begum				
5	Md. Mukul Sarker	Brinjal (Green ball)	Cauliflower (Hybrid 70)	Brinjal (Green ball)	Cauliflower (Alfa chan)
	Mrs. Forida Begum				
6	Md. Kabir Alam	Pointed gourd (Dhapa)	Cauliflower (Variety Alfa)	Pointed gourd (Dhapa)	Cauliflower (Alfa chan)
	Shahanaz Parvin				
7	Md. Rana Mahmud	Pointed gourd (Dhapa)	Cauliflower (Hybrid 70)	Brinjal (Green ball)	Tomato (Sofol)*
	Moss. Chaina Begum				
8	Md. Golam Faruk	Pointed gourd (Dhapa)	Country bean	Pointed gourd (Dhapa)	Cauliflower (Alfa chan)
	Mrs. Shahanaz Parvin				
9	Md. Ibrahim	Pointed gourd (Dhapa)	Country bean	Pointed gourd (Dhapa)	Country bean (local)
	Moss. Champa Begum				
10	Md. Liton Ahmed	Pointed gourd (Dhapa)	Cauliflower (Hybrid 70)	Pointed gourd (Dhapa)	Cauliflower (Alfa chan)
	Moss. Nilufar Yasmin				

\*Date of transplanting: August 2015

**Tables of adaptive trials:**

**Table 26.** Compost and chemical fertilizer application in pointed gourd field for 10 decimal lands at Jessore

Treatment	Compost (kg)	Urea (kg)	TSP (kg)	DAP (kg)	MoP (kg)	ZnSO <sub>4</sub> (kg)
Tricho-compost	Tricho-compost 100 kg	10	9	10	9	600
Farmers' practices	Cowdung 100 kg	15	13	12	13	900
Fertilizer application reduced over farmers' practices (%)		33.33	30.77	16.67	30.77	33.33

**Table 27.** Compost and chemical fertilizer application in pointed gourd field for 10 decimal lands at Bogra

Treatment	Compost (kg)	Urea (kg)	TSP (kg)	DAP (kg)	MoP (kg)
Tricho-compost	Tricho-compost 100 kg	30	7	7	12.5
Farmers' practices	Cowdung 100 kg	40	9	9	20
Fertilizer application reduced over farmers' practices (%)		25	22.22	22.22	37.50

**Table 28.** Effect of Tricho-compost and-leachate on disease and yield of pointed gourd at Jessore farmers fields during summer 2014-15(n=5) & 2015 (n=4) cropping season

Treatment	Phytophthora fruit rot (t/ha)		Fruit rot (%)		Fruit rotten reduced over control (%)		Total yield (t/ha)		Marketable yield (t/ha)		Yield increased over control (%)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T <sub>1</sub>	1.18±0.024	0.84± 0.09	5.00	2.96	33.71	37.78	24.80±1.69	28.52±2.19	23.62±1.71	27.68±2.19	37.49	20.74
T <sub>0</sub>	1.78±0.016	1.36± 0.07	10.36	5.67	-	-	18.15±0.51	23.93±1.72	17.18±0.53	22.08±1.74	-	-
't' test	0.0001	0.018	-	-	-	-	0.0018	0.02	0.0012	0.002	-	-

T<sub>1</sub>= soil application of Tricho-compost @ 2.5 t/ha + Chemical fertilizer 80%+ + Foliar spray of Tricho-leachate @ 20ml/L water at 15 days interval

T<sub>0</sub>= Farmers' practices (Cowdung @ 2.5 t/ha +Full dose of chemical fertilizers + pesticide spray)

**Table 29.** Effect of Tricho-compost and-leachate on disease and yield of pointed gourd in farmers' fields at Bogra during summer 2014 (n=5) & 2015 (n=5) cropping season

Treat-ment	Phytophthora fruit rot (t/ha)		Fruit rot (%)		Fruit rotten reduced over control (%)		Total yield (t/ha)		Marketable yield (t/ha)		Yield increased over control (%)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T <sub>1</sub>	0.60±0.04	0.688± 0.09	2.43	2.45	36.84	34.79	25.49±2.07	28.71±2.21	24.88±2.03	28.03±2.21	42.44	33.73
T <sub>0</sub>	0.95±0.06	1.055± 0.06	7.62	5.03	-	-	18.42±1.22	22.01±1.87	17.47±1.25	20.96±1.84	-	-
't' test	0.019	0.05	-	-	-	-	0.002	0.002	0.002	0.002	-	-

**Table 30.** Benefit Cost Ratio analysis for pointed gourd production in Tricho-compost and-leachate applied fields at Jessore during summer 2014 &15 cropping season

Treat	Yield t/ha		Gross return (Tk.)*		Fixed cost (Tk.)		Treat. cost (Tk.)		Total cost (Tk.)		Net return (Tk.)		BCR		BCR increased (%)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T <sub>1</sub>	23.62	27.68	519640	692000	64000	64000	145200	145200	209200	209200	310440	482800	2.48	3.31	31.31	19.73
T <sub>0</sub>	17.18	22.08	377960	552000	64000	64000	135800	135800	199800	199800	178160	352200	1.89	2.76		

\*Taka 22/ kg

**Table 31.** Benefit Cost Ratio analysis for pointed gourd production in Tricho-compost and –leachate applied fields at Bogra during summer 2014 &15 cropping season

Treat	Yield t/ha		Gross return (Tk.)*		Fixed cost (Tk.)		Treat. cost (Tk.)		Total cost (Tk.)		Net return (Tk.)		BCR		BCR increased	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T <sub>1</sub>	25.49	28.03	637250	644575	64000	64000	145200	145200	209200	209200	428050	435375	3.05	3.08	32.16	27.73
T <sub>0</sub>	18.42	20.96	460500	481965	64000	64000	135800	135800	199800	199800	260700	282165	2.30	2.41		

\*Taka 25/ kg

T<sub>1</sub>= soil application of Tricho-compost @ 2.5 t/ha + Chemical fertilizer 80%+ + Foliar spray of Tricho-leachate @ 20ml/L water at 15 days interval

T<sub>0</sub>= Farmers' practices (Cowdung @ 2.5 t/ha +Full dose of chemical fertilizers + pesticide spray)

**Table 32.** Compost and chemical fertilizer application in bottle gourd field for 10 decimal lands at Jessore

Treatment	Compost (kg)	Urea (kg)	TSP (kg)	DAP (kg)	MoP (kg)
Tricho-compost	Tricho-compost 100	7	7	10	7
Farmer's practices	Cowdung 100	12	11	12	10
Fertilizer application reduced over farmers' practices (%)		41.67	36.36	16.67	30.00

**Table 33.** Effect of Tricho-compost and-leachate on disease and yield of bottle gourd in farmers' fields at Jessore during summer 2014 (n=2) & winter 2015-16 (n=5) cropping season

Treatment	Anthracnose fruit rot (t/ha)		Fruit rot (%)		Fruit rot reduced over control (%)		Total yield (t/ha)		Marketable yield (t/ha)		Yield increased over control (%)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T <sub>1</sub>	1.3	0.58±0.07	5.46	2.21	27.37	48.67	25.19	26.76±0.59	23.88	25.99±0.54	31.86	28.22
T <sub>0</sub>	1.79	1.13±0.10	9.857	5.58			19.9	21.40±0.54	18.11	20.27±0.54		
't' test	0.034	0.0054					0.001	0.00011	0.026	0.00013		

**Table 34.** Benefit Cost Ratio of bottle gourd production in Tricho-compost and-leachate -applied fields at Jessore during summer 2014 (n=2) & winter 2015-16 (n=5) cropping season

Treat	Yield t/ha		Gross return (Tk.)*		Fixed cost (Tk.)		Treat. cost (Tk.)		Total cost (Tk.)		Net return (Tk.)		BCR		BCR increased	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T <sub>1</sub>	23.88	25.99	477600	519800	64000	64000	145200	145200	209200	209200	268400	310600	2.28	2.48	27.83	24.30
T <sub>0</sub>	18.11	20.27	362200	405400	64000	64000	138800	138800	202800	202800	159400	202600	1.79	2.00		

20 Taka/ kg

T<sub>1</sub>= soil application of Tricho-compost @ 2.5 t/ha + Chemical fertilizer 80%+ + Foliar spray of Tricho-leachate @ 20ml/L water at 15 days intervalT<sub>0</sub>= Farmers' practices (Cowdung @ 2.5 t/ha +Full dose of chemical fertilizers + pesticide spray)

**Table 35.** Compost and chemical fertilizer application in country bean field for 10 decimal lands Jessore

Treatment	Compost(kg)	Urea (kg)	TSP (kg)	DAP (kg)	MoP (kg)	ZnSo <sub>4</sub> (kg)
Tricho-compost	Tricho-compost 100	11	12	5	14	200
Farmer's practices	Cowdung100	18	18	7	20	300
Fertilizer application reduced over farmers' practices (%)		38.89	33.33	28.57	30.00	33.33

**Table 36.** Compost and chemical fertilizer application in country bean field for 10 decimal lands at Bogra

Treatment	Compost (kg)	Urea (kg)	TSP (kg)	DAP (kg)	MoP (kg)	Gypsum (kg)	ZnSo <sub>4</sub> (kg)
Tricho-compost	Tricho-compost 100 kg	12	8	5	6.5	5	350
Farmers' practices	Cowdung 100 kg	17	12	7	8	6.53	420
Fertilizer application reduced over farmers' practices (%)		29.41	33.33	28.57	18.75	23.40	16.67

**Table. 37.** Effect of Tricho-compost and-leachate on disease and yield of country bean in farmers' field at Jessore during summer 2014 (n=1) cropping season

Treatment	Anthracnose fruit rot (t/ha)		Rotten fruits (%)		Fruit rotten reduced over control (%)		Marketable yield (t/ha)		Marketable yield increased over control (%)	
	Jessore	Bogra	Jessore	Bogra	Jessore	Bogra	Jessore	Bogra	Jessore	Bogra
Tricho-compost	0.53	0.42	4.56	3.21	37.65	52.81	11.51	13.08	33.53	29.63
Farmer's practices	0.85	0.89	9.82	8.82	-	-	8.62	10.09	-	-

T<sub>1</sub>= soil application of Tricho-compost @ 2.5 t/ha + Chemical fertilizer 80%+ Foliar spray of Tricho-leachate @ 20ml/L water at 15 days interval

T<sub>0</sub>= Farmers' practices (Cowdung @ 2.5 t/ha +Full dose of chemical fertilizers + pesticide spray)

**Table 38.** Benefit Cost Ratio analysis for country bean production in Tricho-compost and-leachate applied fields at Jessore (n=1) and Bogra (n=1) during summer 2014

Treat	Yield kg/ha		Gross return (Tk.)*		Fixed cost (Tk.)		Treatment cost (Tk.)		Total cost (Tk.)		Net return (Tk.)		BCR		BCR increased (%)	
	Jessore	Bogra	Jessore	Bogra	Jessore	Bogra	Jessore	Bogra	Jessore	Bogra	Jessore	Bogra	Jess-ore	Bogra	Jess-ore	Bogra
T <sub>1</sub>	11.51	13.08	402850	457800	64000	64000	145200	145200	209200	209200	193650	248600	1.93	2.19	31.99	28.15
T <sub>0</sub>	8.62	10.09	301700	353150	64000	64000	142800	142800	206800	206800	94900	146350	1.46	1.71		

\*Taka 35/kg

**Table 39.** Effect of Tricho-compost and -leachate on disease and yield of country bean in farmers' fields at Bogra during winter 2014-15 (n=3) & in 2015-16 (n=3)

Treat	Anthracnose fruit rot (t/ha)		Anthracnose fruit rot (%)		Fruit rotten reduced over control (%)		Disease scoring 0-5 scale		Marketable yield (t/ha)		Yield increased over control (%)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
T <sub>1</sub>	0.33±0.04	0.4±0.04	1.47	1.84	66.67	58.78	1.63±0.19	1.67±0.33	22.42±0.96	21.34±0.72	20.05	30.42
T <sub>0</sub>	0.93±0.03	0.76±0.05	5.06	4.46			3.40±0.19	3.33±0.33	18.37±0.99	16.36±0.56		
't' test	0.007	0.05					0.018	0.04		0.036		

T<sub>1</sub>= soil application of Tricho-compost @ 2.5 t/ha + Chemical fertilizer 80%+ + Foliar spray of Tricho-leachate @ 20ml/L water at 15 days interval

T<sub>0</sub>= Farmers' practices (Cowdung @ 2.5 t/ha + Full dose of chemical fertilizers + pesticide spray)

**Table 40.** Benefit Cost Ratio analysis for country bean production in Tricho-compost and -leachate applied fields at Bogra during winter 2014-16 (n=3) & 2015-16 (n=3).

Treat	Yield t/ha		Gross return (Tk.)		Fixed cost (Tk.)		Treat. cost (Tk.)		Total cost (Tk.)		Net return (Tk.)		BCR		BCR incr	
	2014	2015	2014*	2015**	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T <sub>1</sub>	22.42	21.34	448400	469480	64000	64000	145200	145200	209200	209200	239200	260280	2.14	2.24	20.88	29.19
T <sub>0</sub>	18.37	16.36	367400	359920	64000	64000	143200	143200	207200	207200	160200	152720	1.78	1.74		

\*Taka 20/kg in 2014 & \*\*Taka 22/kg in 2015

**Table 41:** Compost and chemical fertilizer application in Brinjal field for 10 decimal lands at Jessore

	Compost(kg)	Urea(kg)	TSP(kg)	MoP(kg)	Gypsum(kg)	ZnSo <sub>4</sub> (g)	Borax(g)
Tricho-compost	Tricho-compost 100	20	40	18	7	500	500
Farmer's practices	Cowdung100	30	55	24	9	700	600
Fertilizer application reduced over farmers' practices (%)		33.33	27.27	25.00	22.22	28.57	16.67

Table 42: Compost and chemical fertilizer application in brinjal field for 10 decimal lands at Bogra

Treatment	Compost(kg)	Urea(kg)	TSP(kg)	MoP(kg)	Gypsum(kg)	ZnSo <sub>4</sub> (g)	Borax
Tricho-compost	Tricho-compost 100	15	17	10	5	500	300
Farmer's practices	Cowdung100	20	23	13	7	800	400
Fertilizer application reduced over farmers' practices (%)		25.00	26.09	23.08	28.57	37.5	25.00

**Table 43.** Effect of Tricho-compost and-leachate on disease and yield of brinjal in farmers' fields at Jessore during summer & winter 2014-15 (n=3) & 2015 (n=5)

Treat	Bacterial wilt* (%)		Wilt reduced over control (%)		Damaged fruits (%)		Total yield (t/ha)		Marketable yield (t/ha)		Yield increased over control (%)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Tricho-compost	5.6±0.92	5.8±0.66	82.5	73.39	0.67	11.95	29.72±1.45	42.61±4.48	29.52±1.46	38.06±4.27	35.23	37.01
Control	32±2.31	21.8±3.34	-	-	2.46	23	22.38±0.77	33.57±2.94	21.83±0.80	27.78±2.78	-	-
't' test	0.006	0.001	-	-	-	-	0.016	0.009	0.014	0.001	-	-

\*Wilt caused by *Ralstonia solanacearum*

**Table 44.** Effect of Tricho-compost and-leachate on disease and yield of brinjal in farmers' fields at Bogra during summer & winter 2014-15 (n=4) & 2015 (n=5)

Treat	Bacterial wilt (%)		Wilt reduced over control (%)		<i>Phomopsis</i> blight (%)		<i>Phomopsis</i> blight reduced over control		Marketable yield (t/ha)		Yield increased over control (%)	
	2014	2015*	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T <sub>1</sub>	4.67±1.20	7.4±0.51	87.93	67.83	4.33±0.33	4.752±0.475	65.79	50.19	23.03±0.54	31.455±1.41	20.25	27.02
T <sub>0</sub>	38.67±8.21	23.0±2.35	-	-	12.67±0.88	9.54±1.00	-	-	18.37±0.75	24.76±1.35	-	-
't' test	0.04	0.002	-	-	0.0026	0.002	-	-	0.0063	0.0024	-	-

**Table 45.** Benefit Cost Ratio analysis for brinjal production in Tricho-compost and-leachate applied fields at Jessore during 2014 (n=3) & 2015 (n=5)

Treat	Yield (t/ha)		Gross return (Tk.)*		Fixed cost (Tk.)		Treat. cost (Tk.)		Total cost (Tk.)		Net return (Tk.)		BCR		BCR increased (%)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T <sub>1</sub>	29.52	38.06	590400	761200	64000	64000	165200	165200	229200	229200	361200	532000	2.58	3.32	29.68	31.39
T <sub>0</sub>	21.83	27.78	436600	555600	64000	64000	155800	155800	219800	219800	216800	335800	1.99	2.53	-	-

\*20Taka/ kg

**Table 46.** Benefit Cost Ratio analysis for brinjal in Tricho-products application fields Bogra results of brinjal 2014 (n=3) 2015, n=5 at Jessore project sites.

Treat	Yield t/ha		Gross return (Tk.)*		Fixed cost (Tk.)		Treat. cost (Tk.)		Total cost (Tk.)		Net return (Tk.)		BCR		BCR incr	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T <sub>1</sub>	23.03	31.455	460600	629100	64000	64000	165200	165200	229200	229200	231400	399900	2.01	2.74	20.23	21.83
T <sub>0</sub>	18.37	24.76	367400	495200	64000	64000	155800	155800	219800	219800	147600	275400	1.67	2.25		

20Taka/ kg

T<sub>1</sub>= soil application of Tricho-compost @ 2.5 t/ha + Chemical fertilizer 80%+ + Foliar spray of Tricho-leachate @ 20ml/L water at 15 days interval  
T<sub>0</sub>= Farmers' practices (Cowdung @ 2.5 t/ha +Full dose of chemical fertilizers + pesticide spray)

**Table 47.** Fertilizer application in tomato field for 10 decimal land at Bogra

Treat	Compost (kg)	Urea (kg)	TSP (kg)	DAP (kg)	MoP (kg)	Gypsum (kg)	ZnSo4 (g)	Boron (g)
T <sub>1</sub>	Tricho-compost 100	15	15	2	7	6	500	300
T <sub>0</sub>	Cowdung	20	20	2.5	10	8	700	400
Fertilizer application reduced over farmers' practices (%)		25.0	25.0	20.0	30.0	25.0	28.57	25.0

**Table 48.** Effect of Tricho-compost and-leachate on disease and yield of tomato in farmers fields (n=3) at Bogra during, 2015-16.

Treat	Bacterial wilt	Wilt reduced over control	Fruit rot* (t/ha)	Fruit rot (%)	Rot reduced over control (%)	Total yield (t/ha)	Marketable yield (t/ha)	Yield increased over control (%)
T <sub>1</sub>	3.33±0.88	79.59	0.83±0.04	1.37	57.80	66.59±2.62	65.76±2.64	27.54
T <sub>0</sub>	16.33±2.90		1.34±0.12	3.25		52.9±1.52	51.56±1.40	
't' test	0.036		0.031			0.034	0.031	

\*Fruit rot caused by *Colletotrichum* sp. and *Alternaria* sp.

Date of transplanting: August, 2015

**Table 49.** Benefit Cost Ratio analysis of tomato production in Tricho-compost and-leachate application fields (n=3) at Bogra during 2015 - 16

Treat	Yield kg/ha	Gross return (Tk.)*	Fixed cost (Tk.)	Treatment cost (Tk.)	Total cost (Tk.)	Net return (Tk.)	BCR	BCR increased over control (%)
T <sub>1</sub>	65.75	1643750	64000	197000	261000	1382750	6.30	26.47
T <sub>0</sub>	51.59	1289750	64000	195000	259000	1030750	4.98	

25 taka/kg

T<sub>1</sub>= soil application of Tricho-compost @ 2.5 t/ha + Chemical fertilizer 80%+ + Foliar spray of Tricho-leachate @ 20ml/L water at 15 days interval

T<sub>0</sub>= Farmers' practices (Cowdung @ 2.5 t/ha +Full dose of chemical fertilizers + pesticides spray)

**Table 50.** Fertilizer application in cauliflower field for 10 decimal land at Jessore

Treat	Compost (kg)	Urea (kg)	TSP (kg)	DAP (kg)	MoP (kg)	Gypsum (kg)	ZnSo <sub>4</sub> (kg)	Borax (g)
T <sub>1</sub>	Tricho-compost 100	18	20	15	18	4	2	500
T <sub>0</sub>	Cowdung 100	22	24	20	22	5	3	600
Fertilizer application reduced over farmers' practices (%)		18.18	16.67	25	18.18	20	33.33	16.67

**Table 51.** Fertilizer application in cauliflower field for 10 decimal lands at Bogra

Treatment	Compost (kg)	Urea (kg)	TSP (kg)	DAP (kg)	MoP (kg)	Gypsum (kg)	ZnSo <sub>4</sub> (g)	Borox (g)
Tricho-compost	Tricho-compost 100	8	10	8	5	4	500	300
Farmer's practices	Cowdung 100	10	12	10	6	6	600	400
Fertilizer application reduced over farmers' practices (%)		20	16.67	20	16.67	33.33	16.67	25

**Table 52.** Effect of Tricho-compost and-leachate on disease and yield of cauliflower in farmers' fields at Jessore during winter 2014-15(n=4) & 2015-16 (n=4)

Treat	<i>Fusarium</i> wilt (%)		Wilt reduced over control (%)		Card damaged* (t/ha)		Card damaged reduced over control (%)		Marketable card yield (t/ha)		Yield increased over control (%)	
	2014	2015*	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T <sub>1</sub>	4.06±1.31	3.66±1.20	77.59	66.67	0.31±0.033	0.34±0.01	41.51	39.03	23.71±2.14	24.63±0.64	19.3	38.08
T <sub>0</sub>	18.13±5.89	11.00±2.30			0.53±0.047	0.56±0.04			19.13±2.42	17.83±1.17		
't' test	0.057	0.026			0.026	0.018			0.0079	0.043		

T<sub>1</sub>= soil application of Tricho-compost @ 2.5 t/ha + Chemical fertilizer 80%+ + Foliage spray of Tricho-leachate @ 20ml/L water at 15 days interval  
T<sub>0</sub>= Farmers' practices (Cowdung @ 2.5 t/ha + Full dose of chemical fertilizers + pesticides spray)

**Table 53.** Effect of Tricho-compost and-leachate on disease and yield of cauliflower in farmers' fields at Bogra during winter 2014-15(n=5) & 2015-16 (n=6)

Treatment	<i>Fusarium</i> wilt (%)		Wilt reduced over control (%)		Card damaged (t/ha)		Card damaged reduced (%)		Marketable card yield (t/ha)		Yield increased over control (%)	
	2014	2015*	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Tricho-compost	2.6±0.40	3.33±0.67	84.88	70.15	0.65±0.09	0.31±0.028	68.1	60	22.37±1.15	17.77±1.26	18.23	32.37
Control	17.2±2.11	11.17±1.83	-	-	1.53±0.14	0.60±0.059	-	-	18.92±1.08	13.34±0.72	-	-
't' test	0.0014	0.014	-	-	0.054	0.017	-	-	0.031	0.011	-	-

**Table 54.** Benefit Cost Ratio analysis for cauliflower production in farmers' fields at Jessore during winter 2014-15(n=4) & 2015-16 (n=3)

Treat	Yield t/ha		Gross return (Tk.)*		Fixed cost (Tk.)		Treat. cost (Tk.)		Total cost (Tk.)		Net return (Tk.)		BCR		BCR incr	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T <sub>1</sub>	23.71	24.63	426780	492600	64000	64000	125200	125200	189200	189200	285000	303400	3.79	3.93	24.49	38.80
T <sub>0</sub>	19.13	17.83	344340	356600	64000	64000	125800	125800	189800	189800	192800	166800	3.04	2.83		

\*Taka 20/kg

**Table 55.** Benefit Cost Ratio analysis of cauliflower production in farmers' fields at Bogra during winter 2014-15(n=5) & 2015-16 (n=5)

Treat	Yield t/ha		Gross return (Tk.)*		Fixed cost (Tk.)		Treat. cost (Tk.)		Total cost (Tk.)		Net return (Tk.)		BCR		BCR increased(%)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T <sub>1</sub>	22.37	17.77	492140	390940	64000	64000	125200	125200	189200	189200	302940	201740	3.93	3.12	18.80	33.85
T <sub>0</sub>	18.92	13.34	416240	293480	64000	64000	125800	125800	189800	189800	226440	103680	3.31	2.33		

\*Taka 22/kg

T<sub>1</sub>= soil application of Tricho-compost @ 2.5 t/ha + Chemical fertilizer 80%+ + Foliar spray of Tricho-leachate @ 20ml/L water at 15 days interval

T<sub>0</sub>= Farmers' practices (Cowdung @ 2.5 t/ha +Full dose of chemical fertilizers + pesticide spray)

**Table 56.** Fertilizer application in cabbage field for 10 decimal lands at Jessore in 2014-15

	Compost(kg)	Urea (kg)	TSP (kg)	DAP (kg)	MoP (kg)	Gypsum (kg)
Tricho-compost	Tricho-compost 100	18.00	20.00	15.00	20.00	4.00
Farmer's practices	Cowdung 100	25.00	28.00	18.00	25.00	6.00
Fertilizer application reduced over farmers' practices (%)		28.00	28.57	16.67	20.00	33.33

**Table 57.** Effect of Tricho-compost and-leachate on disease and yield of cabbage at farmers' fields (n=4) in Jessore during winter 2014-15

Treatment	Alternaria leaf spot disease (0-5 scale)	Disease severity reduced (%)	Head damaged (t/ha)	Marketable head yield (t/ha)	Yield increased over control (%)
Tricho-compost	1.25±0.25	55.00	1.19±0.10	82.91±5.98	18.56
Farmer's practices	2.5±0.50		1.43±0.05	69.93±7.00	
't' test	0.015		0.025	0.013	

**Table 58.** Benefit Cost Ratio analysis of cabbage production in Tricho-compost and-leachate application fields (n=3) at Jessore during winter 2014-15.

Treatment	Yield kg/ha	Gross return (Tk.)	Fixed cost (Tk.)	Treatment cost (Tk.)	Total cost (Tk.)	Net return (Tk.)	BCR	BCR increased over control (%)
Tricho-compost	82.91	497460	64000	133200	197200	300260	2.52	20.57
Farmer's practices	69.93	419580	64000	136800	200800	218780	2.09	-

T<sub>1</sub>= soil application of Tricho-compost @ 2.5 t/ha + Chemical fertilizer 80%+ + Foliar spray of Tricho-leachate @ 20ml/L water at 15 days interval  
T<sub>0</sub>= Farmers' practices (Cowdung @ 2.5 t/ha +Full dose of chemical fertilizers + pesticide spray)

**Table 59.** Compost and chemical fertilizer in cucumber field for 10 decimal lands at Jessore in 2015-16

Treatment	Compost (kg)	Urea (kg)	TSP (kg)	DAP (kg)	MoP (kg)	ZnSo <sub>4</sub> (kg)
Tricho-compost	Tricho-compost 100 kg	6	8	10	8	600
Farmers' practices	Cowdung 100 kg	10	15	12	12	900
Fertilizer application reduced over farmers' practices (%)		40	46.67	16.67	33.33	33.33

**Table.60.** Effect of Tricho-compost and –leachate on disease and yield of cucumber in farmers fields (n=1) at Jessore during summer, 2015 & 16.

Treatment	Rotten fruit (t/ha)		Rotten fruits (%)		Fruit rotten reduced over control (%)		Marketable card yield (t/ha)		Yield increased over control (%)	
	2015	2016*	2015	2016	2015	2016	2015	2016	2015	2016
Tricho-compost	1.98	2.64	7.34	10.50	43.97	46.59	24.95	26.17	27.76	30.74
Control	3.53	4.03	16.36	19.66			18.03	20.02		

**Table 61.** Benefit Cost Ratio analysis of cucumber production in Tricho-compost and-leachate application fields (n=1) at Jessore during summer 2015 & 16

Treat	Yield t/ha		Gross return (Tk.)*		Fixed cost (Tk.)		Treat. cost (Tk.)		Total cost (Tk.)		Net return (Tk.)		BCR		BCR increased (%)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
T <sub>1</sub>	24.95	26.18	499000	523600	64000	64000	137800	137800	201800	201800	297200	321800	2.47	2.60	28.40	21.43
T <sub>0</sub>	18.025	20	360500	400000	64000	64000	123200	123200	187200	187200	173300	212800	1.93	2.14		

\*Taka 20/kg

T<sub>1</sub>= soil application of Tricho-compost @ 2.5 t/ha + Chemical fertilizer 80%+ + Foliar spray of Tricho-leachate @ 20ml/L water at 15 days interval  
 T<sub>0</sub>= Farmers' practices (Cowdung @ 2.5 t/ha +Full dose of chemical fertilizers + pesticide spray)

**Table 62.** Effect of Tricho-compost and-leachate on nematode tropic groups in soil after thrice application at Jessore and Bogra

Treatment	Herbivore		Fungivorus		Bacterivorus		Omnivore		Predatory	
	Jessore	Bogra	Jessore	Bogra	Jessore	Bogra	Jessore	Bogra	Jessore	Bogra
Tricho-compost	4±0.41	3.5±0.65	122±11.66	116.75±7.70	260.5±35.83	302.0±52.62	18.25±1.88	19.75±3.30	1.0±0.40	0.75±0.25
Farmers' practices	11±1.87	11.75±2.69	64.5±10.5	62±6.99	110±10.08	117.75±21.60	12±1.29	10.75±0.85	1.0±0.40	0.5±0.28
't' test	0.027	0.029	0.0032	0.0022	0.039	0.040	0.105	0.042	1	0.391
Population increased or decreased over control (%)	(-) 63.64%	(-)70.21%	89.15%	88.31%	136.82%	156.48%	52.08%	83.72%	-	50%

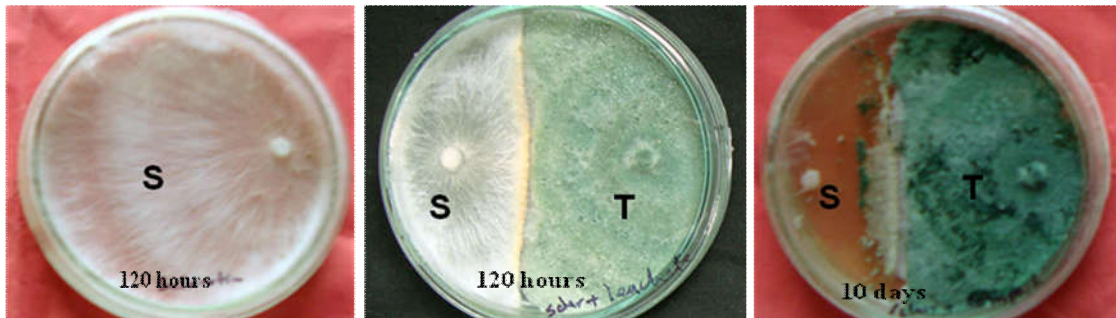
**Table 63.** Occurrence of fungal colony in serial dilution method in Tricho-compost and non-compost fields at Jessore and Bogra

Treatment	Frequency of count	Total bacterial colony on PDA media after four time compost application			
		Jessore		Bogra	
		Number of colony in serial dilution	Number of colony per gm dry soil	Number of colony in serial dilution	Number of colony per gm dry soil
Tricho-compost	1	92	92x10 <sup>5</sup>	70	70x10 <sup>5</sup>
	2	56	56x10 <sup>5</sup>	53	53x10 <sup>5</sup>
	3	52	52x10 <sup>5</sup>	87	87x10 <sup>5</sup>
	4	90	90x10 <sup>5</sup>	75	75x10 <sup>5</sup>
Farmers' practices	1	54	54x10 <sup>5</sup>	31	31x10 <sup>5</sup>
	2	27	27x10 <sup>5</sup>	20	20x10 <sup>5</sup>
	3	28	28x10 <sup>5</sup>	45	45x10 <sup>5</sup>
	4	21	21x10 <sup>5</sup>	23	23x10 <sup>5</sup>
Mean fungal colony on PDA media					
Tricho-compost	4	72.5	72.5x10 <sup>5</sup>	71.25	71.25 x10 <sup>5</sup>
Farmers' practices	4	32.5	32.5 x10 <sup>5</sup>	29.75	29.75 x10 <sup>5</sup>
't' test	-	0.028	-	0.0018	-
Colony increased over control (%)	-	123.08	-	139.50	-

**Table 64.** Occurrence of bacterial colony in serial dilution method in Tricho-compost and non-compost fields at Jessore and Bogra

Treatment	Frequency of count	Total bacterial colony on PDA media after four time compost application			
		Jessore		Bogra	
		Number of colony in serial dilution	Number of colony per gm dry soil	Number of colony in serial dilution	Number of colony per gm dry soil
Tricho-compost	1	178	178x10 <sup>6</sup>	190	220x10 <sup>6</sup>
	2	278	278x10 <sup>6</sup>	270	180x10 <sup>6</sup>
	3	149	149x10 <sup>6</sup>	148	178x10 <sup>6</sup>
	4	219	219x10 <sup>5</sup>	235	210x10 <sup>6</sup>
Farmers' practices	1	109	109x10 <sup>6</sup>	134	93x10 <sup>6</sup>
	2	167	167x10 <sup>6</sup>	112	110x10 <sup>6</sup>
	3	118	118x10 <sup>6</sup>	79	155x10 <sup>6</sup>
	4	87	87x10 <sup>6</sup>	129	135x10 <sup>6</sup>
Mean bacterial colony on PDA media					
Tricho-compost	4	206	206.0x10 <sup>5</sup>	210.75	210.75 x10 <sup>6</sup>
Farmers' practices	4	120.25	102.25 x10 <sup>5</sup>	113.5	113.5 x10 <sup>6</sup>
't' test	-	0.0316		0.0237	-
Colony increased over control (%)	-	71.309	-	85.68	-

Figures of the experiments:



S=*S. rolfsii* (Pathogen) and T= *T. harzianum* (bio-control agent)

**Fig. 2.** Effectiveness test of *T. harzianum* against *S. rolfsii* through dual culture technique



**Fig. 3.** Spore suspension of *T. harzianum* production in the Laboratory



**Fig. 4.** Cemented ring (1) and brick made (2) house of Tricho-compost production



Fig. 5. After loading raw materials in composting device (left), leachate (right) coming out



Fig. 5. Beneficial fungal population in soil with (left) & without (right) management of Tricho-compost and -leachate



Fig. 6. a. Management of brinjal field with Tricho-compost and –leachate (farmer happy)



Fig. 6. b. Management of brinjal field with (right) and without (left) Tricho-compost and –leachate



Fig. 7. a. Management of pointed gourd with Tricho-compost and -leachate



Fig. 7. b. Management of bottle gourd with Tricho-compost and -leachate



Fig. 8. Pesticide free vegetables are selling in super market in Bogra (crop management with Tricho-compost and –leachate)

**Training and workshop:****Participatory Farmers' Training Module**

For the project

**Validation and Up-Scaling of Tricho-Products For Soil Borne Disease Management in Vegetable Crops**

Time	Topics	Speaker
9.00-10.00	Inauguration	
10.00-10.30	Break for tea	
10.30-11.30	Importance of compost fertilizer in vegetable crops	UAO of respective Upazilla
11.30-12.30	Tricho-compost production and using technology in vegetable crops	PI
12.30-14.00	Break for lunch & prayer	
14.00-15.00	Production technology of vegetable crops	CI
15.00-16.00	Identification and management of vegetable diseases	CI
16.00-17.00	IPM strategy for insect pest management in vegetable crops	CI

## Participatory Farmers' Training at Jessore:

**Vannue:** Bagdanga, Churamonkati, Jessore Sador, Jessore

**Date:** August 18, 2013

**Speaker:** Dr. M. S. Nahar; Dr. M. Sirazul Islam; Mr. Biren Mozumder; Mr. Rafi Uddin and  
Dr. F M A Rouf

### List of participants

Sl. No.	Name of the farmers	Address
1	Md. Hajrat Ali Gazi	Farmers, Bagdanga, Churamonkati, Jessore
2	Mrs. Shanaz Begum	-do-
3	Md. Golam Rosul	-do-
4	Mrs. Mosammat Fahima Begum	-do-
5	Md. Anarul Islam Litu	-do-
6	Mrs. Rini Begum	-do-
7	Md. Ibrahim Sardar	-do-
8	Mrs. Momina Khatun	-do-
9	Md. Obaidul Islam	-do-
10	Mrs. Hasnahena	-do-
11	Md. Mahabbat Ali	-do-
12	Mrs. Moss. Laboni	-do-
13	Md. Shohidul Islam	-do-
14	Mrs. Sokhina Begum	-do-
15	Md. Solaiman Bepari (Bisu)	-do-
16	Mrs. Moss. Sufia Khatun	-do-
17	Abu Shiddik Mandol	-do-
18	Mrs. Mosammat Hashina Begum	-do-
19	Md. Haider Ali	-do-
20	Mrs. Swapna Begum	-do-
21	Dr. Md. Saiful Karim	Jagorony Chakro Foundation, Jessore
22	Md. Zakir Hossain	SAAO, DAE, Jessore
23	Shamin Humayun	-do-
24	Mr. Robiul Islam	Ulashi Srijony Shango (USS), Jhikorgacha, Jessore
25	Hemel Dutto Rony	Field Assistant, KGF project, Churamonkati, Jessore

### Participatory Farmers' Training at Bogra

Venue: Vatra, Khanpur, Sherpur, Bogra

Date: September 4, 2013

Speaker: Dr. M. S. Nahar; Mr. Abdur Rahim; Dr. Md. Julfikar Haider Prodhan;  
Dr. Md. Khorsheduzzaman and Dr. Md. Golam Kibria

#### List of participants

No.	Name of the farmers	Address
1	Md. Mamunur Rahid	Farmers, Vatra, Khanpur, Sherpur, Bogra
2	Moss. Farida Parvin	-do-
3	Md. Hannan Sheikh	-do-
4	Moss. Mitu Begum	-do-
5	Md. Akteruzzaman	-do-
6	Moss. Salma Begum	-do-
7	Md. Tofazzal Hossain	-do-
8	Mrs. Bulbuli Begum	-do-
9	Md. Mukul Sarker	-do-
10	Mrs. Forida Begum	-do-
11	Md. Kabir Alam	-do-
12	Moss. Shahanaz Parvin	-do-
13	Md. Rana Mahmud	-do-
14	Moss. Chaina Begum	-do-
15	Md. Golam Faruk	-do-
16	Mrs. Shahanaz Parvin	-do-
17	Md. Ibrahim	-do-
18	Mosammat Champa Begum	-do-
19	Md. Liton Ahmed	-do-
20	Moss. Nilufar Yasmin	-do-
21	Md. Amzad Hossain	SA, ARS, Bogra
22	Md. Faruq Ahmed	-do-
23	Md. Abdus Sobhan	SAAO, DAE, Sherpur, Bogra
24	Mr. Abdus Sattar	Executive Director, Moytri Palli Unnayan Shongstha, Bogra
25	Md Mizanur Rahman	Field Assistant, KGF project, Sherpur, Bogra

**Workshop  
On  
Validation and up-scaling of Tricho-products for soil borne disease management in vegetable  
Crops**

Time	Topics	Speaker
9.00-10.00	Inauguration	
10.00-10.30	Break for tea	
10.30-11.30	Importance of Tricho-products for disease management in vegetable crops	PI
11.30-12.30	Production of Tricho-compost and Tricho-leachate at farmers' level.	PI
12.30-14.00	Break for lunch & prayer	
14.00-15.00	Using technology of Tricho-products in vegetable crops.	CI
15.00-17.00	Open discussion and prepare a document with comments and suggestion	Workshop participants

**Workshop participants at Jessore**

**Vannue:** Regional Agriculture Research Station, Jessore

**Date:** April 4, 2015

**Chairman:** Dr. Md. Sirazul Islam, CSO, RARS, Jessore

**Key note speaker:** Dr. M. Shamsunnahar, PSO, HRC, BARI and PI of the project

**Critic:** Mr. Nittaranjon Biswas, DD, Department of Agriculture Extension, Jessore

**Special Guest:** Dr. M Nurul Alam, Executive Director, Krishi Gobeshona Foundation, BARC, Dhaka

**List of participants**

Sl. No.	Name of participants	Address
1	Kamrun Nahar	Additional Agriculture Officer
2	Dr. Md. Abdul Khaleque	PSO, RARS, Jessore
3	S M Khalid Saifulla	Upazila Agriculture Officer
4	Mr. Monirul Islam	SO, RARS, Jessore
5	Mr. Rafi Uddin	PSO, RARS, Jessore
6	Md. Rezaul Islam	Chetona Manobik Unnayon Kandro
7	Md. Babul Anwar	SO, RARS, Jessore
8	Hemel Dutta Rony	Field Assistant, KGF project, Jessore
9	Mohammad Mustafa	SAAO, DAE, Jessore
10	Md Abdus Samad Azad	SAAO, DAE, Jessore
11	Kritidipto Bala	Ulashi Srijony Shango (USS), Jhikorgacha, Jessore
12	Mr. Shukanto Das	Niljongo Tatipara, Jessore
13	Md Yousuf Ali	Bagdanga, Churamonkati, Jessore
14	G M Monwar	-do-
15	Md.Hajrat Ali Gazi	-do-
16	Md. Haider Ali	-do-
17	Gazi Abdullah	-do-
18	Abu Shiddik Mandol	-do-
19	Md.Golam Rosul	-do-
20	Md. Solaiman Bepari (Bisu)	-do-
21	Md.Anarul Islam Litu	-do-
22	Mrs. Moss. Laboni	-do-
23	Mrs. Momina Khatun	-do-
24	Mrs. Hasnahena	-do-
25	Md.Shohidul Islam	-do-

**Workshop participants at Jessore**  
**Vannue:** Sherpur Upazila Office, Bogra  
**Date:** March 28, 2015

**Chairman:** Mr. Chandi Das Kundu, DD, Department of Agriculture Extension, Bogra

**Key note speaker:** Dr. M. Shamsunnahar, PSO, HRC, BARI and PI of the project

**Critic:** Dr. Md. Kamrul Hasan, PSO, OFRD, BARI, Gazipur

**Special Guest:** Dr. Kazi M. Kamaruddin, Program Director, Krishi Gobeshona Foundation, BARC, Dhaka

**List of participants**

No.	Name of the participants	Address
1	Md. Abdur Rahim	UAO, Department of Agriculture Extension, Bogra
2	Dr. Md. Julfikar Haider Prodhan	PSO, OFRD, Chesolopara, bogra
3	Md. Tanvir Hasan	SO, OFRD, Chesolopara, bogra
4	Sharmin Akter	AEO, Sherpur, Bogra
5	Md. Faruk Ahmed	SA, OFRD, Sherpur, Bogra
6	Md. Mizanur Rahman	FA, Sherpur, Bogra
7	Md. Jahangir Alam	MCC, Thanthonia, Bogra
8	Md. Abdus Sobhan	SAAO, Sherpur, Bogra
9	Md. Hafizur Rahman	SAAO, Sherpur, Bogra
10	Md. Mastofa Kamal	Gramin Unnaon Prokalpo, Shahajahanpur, Bogra
11	Dr. Md. Khorsheduzzaman	SSO, ARS, Thakurgaon
12	Dr. Md. Rahmat Ali Molla	SSO, OFRD, Bogra
13	Md. Abdullah	ED, Grameen Unnayon Prokalpo, Shahajahanpur, Bogra
14	Md. Anwar Hossain	Grameen Unnayon Prokalpo, Shahajahanpur, Bogra
15	Md. Mukul Sarker	Vatra, Khanpur, Sherpur, Bogra
16	Md. Amzad Hossain	SA, OFRD, Sherpur, Bogra
17	Md. Mamunur Rashid	Farmers, Vatra, Khanpur, Sherpur, Bogra
18	Mosammat Champa Begum	-do-
19	Md. Akteruzzaman	-do-
20	Md. Tofazzal Hossain	-do-
21	Md. Hannan Sheikh	-do-
22	Md. Liton Ahmed	-do-
23	Md. Rana Mahmud	-do-
24	Md. Kabir Alam	-do-
25	Md. Golam Faruk	-do-

**Neighbor Farmers' Training Module**  
For the project  
**Validation and Up-Scaling of Tricho-Products For Soil Borne Disease Management in Vegetable Crops**

Time	Topics	Speaker
9.00-10.00	Inauguration	
10.00-10.30	Break for tea	
10.30-11.30	Importance of compost fertilizer in vegetable crops	UAO of respective Upazilla
11.30-12.30	Production of Tricho-compost and Tricho-leachate at farmers' level	PI
12.30-14.00	Lunch break	
14.00-15.00	Application of Tricho-products in vegetable crops.	CI
15.00-16.00	Disease management of vegetable crops by using Tricho-products.	PI
16.00-17.00	Management of insect pest in vegetable crops.	CI

**Neighbor Farmers' Training in Jessore**

Date: 24-01-2016

Vannue: RARS, Jessore

List of participants present in Neighbor Farmers' training program

Sl. no.	Participants Organization	Participants (no.)
1	Farmers representatives	20
2	Department of Agricultural Extension	2
3	Non-Government Organization	2
4	KGF staff	1
	Total	25

**Trainer Training (TOT) in Bogra**

Date: 28-01-16-2016

Vannue: Upazila Office, Sherpur, Bogra

List of participants present in TOT program

Sl. no.	Participants Organization	Participants (no.)
1	Farmers representatives	20
2	Department of Agricultural Extension	2
3	Non-Government Organization	1
	Bangladesh Agricultural Research Institute	2
	Total	25

**Trainer's Training Module**  
For the project  
**Validation and Up-Scaling of Tricho-Products For Soil Borne Disease Management in Vegetable Crops**

Time	Topics	Speaker
9.00-10.00	Inauguration	
10.00-10.30	Break for tea	
10.30-11.30	Importance of compost fertilizer in vegetable crops	DD of respective Upazilla
11.30-12.30	Production of Tricho-compost and Tricho-leachate at farmers' level	PI
12.30-14.00	Lunch break	
14.00-15.00	Application of Tricho-products for soil health management in vegetable crops.	CI
15.00-16.00	Disease management of vegetable crops by using Tricho-products.	PI
16.00-17.00	Management of insect pest in vegetable crops.	CI

**Trainer Training (TOT) in Jessore**

Date: 21-04-2016

Vannue: RARS, Jessore

List of participants present in TOT program

Sl. no.	Participants Organization	Participants (no.)
1	Farmers representatives	2
2	Department of Agricultural Extension	8
	BADC	1
3	Non-Government Organization	3
	Bangladesh Agricultural Research Institute	3
4	KGF staff	1
	Total	18

**Trainer Training (TOT) in Bogra**

Date: 19-04-2016

Vannue: Upazila Office, Sherpur, Bogra

List of participants present in TOT program

Sl. no.	Participants Organization	Participants (no.)
1	Farmers representatives	1
2	Department of Agricultural Extension	8
3	Non-Government Organization	4
	Bangladesh Agricultural Research Institute	5
	Total	18

## ট্রেনিং ম্যানুয়াল

কৃষক পর্যায়ে ট্রাইকো-কম্পোস্ট ও ট্রাইকো-লিচেট তৈরী এবং সবজি ফসলের রোগ দমনে এর ব্যবহার

### রচনায়

ড. মোছাম্মৎ সামছুন্নাহার

মোঃ রফি উদ্দিন

ড. জুলফিকার হায়দার প্রধান

ড. এ কে এম খোরশেদুজ্জামান

ড. গোলাম কিবরিয়া

### সহযোগিতায়

উদ্যানতত্ত্ব গবেষণা কেন্দ্র

বাংলাদেশ কৃষি গবেষণা ইনস্টিটিউট

জয়দেবপুর, গাজীপুর-১৭০১

### অর্থায়নে

কৃষি গবেষণা ফাউন্ডেশন

বাংলাদেশ কৃষি গবেষণা কাউন্সিল

ফার্মগেট, ঢাকা ১২১৫

## ট্রাইকোডারমা ও ট্রাইকোডারমা সম্বলিত জৈব প্রডাক্ট

### ভূমিকাঃ

ফসলের ক্ষতিকর রোগজীবাণু দমনে ট্রাইকোডারমার ব্যবহার বিশ্বব্যাপী স্বীকৃত। আমাদের দেশে ট্রাইকোডারমার উপর গবেষণা শুরু হয়েছে ১৯৯৮ সাল থেকে। কিন্তু বানিজ্যিক অবকাঠামোর অভাবে কৃষক পর্যায়ে এটি ততটা জনপ্রিয়তা অর্জন করতে পারে নাই। আইপিএম-সিআরএসপি, উদ্যানতন্ত্র গবেষণা কেন্দ্র, বারি ২০০৬ সালে ট্রাইকোডারমার বানিজ্যিক অবকাঠামোর উপর গবেষণা শুরু করে। বিভিন্ন প্রকার জৈব পদার্থ এবং ট্রাইকোডারমার অনুবীজ একত্রে মিশিয়ে উক্ত কম্পোস্টটি তৈরী করা হয় যাকে ট্রাইকো- কম্পোস্ট বলে। কম্পোস্ট সার তৈরীর সময় হাউজ থেকে নির্গত তরল নির্যাসকে ট্রাইকো-লিচেট বলে। বাংলাদেশ কৃষি গবেষণা ইন্সটিটিউট, গাজীপুর এর কারিগরি নির্দেশনা ও এমসিসি, বাংলাদেশ এর সহযোগিতায় গ্রামীণ কৃষি সহায়ক সংস্থা (এনজিও) ট্রাইকো-কম্পোস্ট ও লিচেট এর বানিজ্যিক উৎপাদন শুরু করে। কৃষক পর্যায়ে সর্বপ্রথম ২০১০ সালে এমসিসি, বাংলাদেশ এর সহায়তায় বগুড়া ও জয়পুরহাট এলাকায় উক্ত কম্পোস্টটির উৎপাদন ও ব্যবহার শুরু হয়। পরবর্তীতে দিনাজপুর, রংপুর ও গাইবান্ধা এলাকায় এর প্রসার ঘটে। বাংলাদেশ কৃষি গবেষণা ইন্সটিটিউট, গাজীপুর কর্তৃক উদ্ভাবিত ট্রাইকোডারমা মিশ্রিত জৈব সার ট্রাইকো-কম্পোস্ট কৃষকের জমিতে প্রয়োগ করে বিভিন্ন রকমের সবজি যেমন - বাঁধাকপি, টমেটো, করলা, বেগুন, বরবটি, পালংশাক, লাউ, পটল, মরিচ এবং আলু উৎপাদনে ব্যাপক সাড়া জাগিয়েছে। ২০১৩ সালে বাংলাদেশ কৃষি গবেষণা ইন্সটিটিউট "Validation and up-scaling of Tricho-products for soil borne disease management in vegetable Crops" শীর্ষক কৃষি গবেষণা ফাউন্ডেশন, বিএআরসি এর একটি প্রকল্প সহায়তায় যশোর ও বগুড়া অঞ্চলে কৃষক পর্যায়ে এর উৎপাদন ও ব্যবহার শুরু হয়েছে। এখানে উল্লেখ্য যে, ২০১৪ সালে বাংলাদেশ কৃষি গবেষণা ইন্সটিটিউটকে কৃষি মন্ত্রণালয় 'বারি ট্রাইকো- কম্পোস্ট সার' নামে জৈব সার উৎপাদনের অনুমতি দিয়েছে।

### ট্রাইকোডারমা কি?

ট্রাইকোডারমা এক ধরনের উপকারী ছত্রাক। এটা মাটিতে বসবাস করে। এ ছত্রাকটি দ্রুত বাড়তে পারে এবং জীবনচক্র সম্পন্ন করতে পারে। ট্রাইকোডারমা প্রজাতির অনেক ছত্রাক পাইরেনস, আনথ্রাকুইনসহ নানা জাতীয় গ্যাসীয় পদার্থ নির্গত করতে পারে যা গাছ বিধ্বংসী ধ্বংস করতে সক্ষম।

### ট্রাইকোডারমার প্রজাতি :

মাটি থেকে ট্রাইকোডারমার অনেকগুলো প্রজাতি পাওয়া যায় তবে কার্যকারীতার দিক থেকে হার্জিয়ানাম, ব্রিডি ও ভাইরেনস প্রজাতির ছত্রাক সমূহ সুনামের সঙ্গে রোগ দমনে বিভিন্ন দেশে ব্যবহৃত হচ্ছে। বর্তমানে ট্রাইকোডারমা হার্জিয়ানাম ও ব্রিডি মাটিবাহিত রোগ দমনে বিশ্বে ব্যাপক সাড়া জাগিয়েছে।

### ট্রাইকোডারমা কেন ব্যবহার করবেন?

ট্রাইকো কম্পোস্ট ব্যবহার করলে জমির উর্বরতা শক্তি বৃদ্ধি পায়। উদ্ভিদের রোগ প্রতিরোধ ক্ষমতা বৃদ্ধি পায়। জমিতে গন্ধক, দস্তা প্রভৃতির ঘাটতি পূরণ করে এবং গাছের বৃদ্ধি কারক হরমোন সরবরাহ করে থাকে। মাটিতে পানি ধারণ ক্ষমতা বাড়ায়। মাটির গঠন উন্নত করে। অন্যদিকে কৃষিক্ষেত্রে সমস্যা সৃষ্টিকারী অনেক ধরনের ক্ষতিকর ছত্রাকজীবাণু দেখা যায় যেগুলো পরজীবী ছত্রাক বলে। ক্ষতিকর এ ছত্রাকগুলো গাছের শিকড় ও কান্ডের গোড়া পচিয়ে গাছকে মেরে ফেলতে পারে। ট্রাইকোডারমা সহজেই ক্ষতিকারক ছত্রাককে ধ্বংস করতে পারে। সাধারণতঃ ফসলের মাটিবাহিত গোড়া পঁচা, শিকড় পঁচা বা কান্ড পঁচা রোগসমূহ ট্রাইকোডারমা ব্যবহার করে সহজেই দমন করা যেতে পারে। এটা ছাড়াও ফসলের শিকড়গিট কৃমি দমনেও যথেষ্ট ভূমিকা রাখতে পারে। ফসলের ফলন বাড়ে ও গুণগত মান ভাল হয়।

### ট্রাইকোডারমার প্রজাতির রোগ দমনের কৌশল :

ট্রাইকোডারমা সেলুলেজ, গ্লুকানেজ এবং কাইটিনেজ নামক এনজাইম নিঃসরণ করে ক্ষতিকর ছত্রাকজীবাণুর কোষ প্রাচীরের গ্লুকান ভেঙ্গে দেয় ও জীবাণু কোষ ধংশ করে। দ্রুত বংশ বিস্তার করে ও মূলাধঃগলে পরিবেষ্টিত থাকে যা ক্ষতিকর জীবাণুকে সেখানে প্রবেশে বাধা দেয়। বিভিন্ন ধরনের এন্টিবায়োটিক তৈরী করে যা রোগ সৃষ্টিকারী ছত্রাকজীবাণুর বংশ বিস্তারে বাধা দেয়।

### ফসলের প্রধান মাটিবাহিত রোগসমূহ :

পিথিয়াম, ফাইটোপথোরা, রাইজোকটনিয়া, স্ক্লেবোসিয়াম, ফিউজারিয়াম প্রজাতির ছত্রাকগুলো গাছের গোড়া পঁচা, শিকড় পঁচা বা কান্ড পঁচা রোগসমূহ ঘটায়। ফলে চারা থেকে শুরু করে যে কান বয়সের গাছ আক্রান্ত হয়ে ফসলের ব্যাপক ক্ষতিসাধন হয় এবং চাষীরা তখন ফসল নিয়ে বিপাকে পরে। কাল্পিত ফলন পাওয়া যায় না।

### ট্রাইকোডারমা ব্যবহারের বিভিন্ন ফর্ম বা রূপ :

ট্রাইকোডারমা প্রজাতির ছত্রাকগুলো বিভিন্ন রূপে (ফর্মে) যথাঃ- বার্লি, সোলার খোসা বা ভূট্টা ভাঙ্গার উপর জন্মানো (সলিড ফর্ম), তরল মাধ্যমে তৈরী করা যায়। সাধারণতঃ ছত্রাকের অনুবীজ পাউডারের সাথে মিশিয়ে পাউডার বেস ট্রাইকোডারমা যা কম্পোস্টিং এর কাজে বা সরাসরি ফসলের মাটিবাহিত রোগ দমনে ব্যবহৃত যায়। তবে সাধারণতঃ তরল মাধ্যমে জন্মানো ট্রাইকোডারমা দ্বারা জৈব উপাদান পচিয়ে ট্রাইকো-কম্পোস্ট তৈরী করা হয় যা ফসলের মাটিবাহিত রোগ দমনে ব্যাপক ভূমিকা রাখে।

### নেতিয়ে পড়া (ড্যান্স্পিং অফ) রোগ দমন :

বিভিন্ন প্রজাতির ছত্রাক যথাঃ-পিথিয়াম, স্ক্লেবোসিয়াম, রাইজোকটোনিয়া, ফিউজারিয়াম ছত্রাকের আক্রমণে এ রোগা হতে পারে। শীতকালীন আগাম সবজির চারা তৈরী করার সময় এ রোগ বেশী দেখা যায়। কাণ্ডের নীচের দিকে মাটি বরাবর বাদামী রঙের পানি ভেজা দাগ পড়ে। আক্রান্ত জায়গায় চারার গোড়া পঁচে যায় ও চারা মারা যায়।। বীজতলার এ রোগের প্রাদুর্ভাব সর্বাধিক দেখা যায়। অনুকূল পরিবেশে এক সপ্তাহের মধ্যে বীজতলার সমস্ত চারা মারা যেতে পারে। এ রোগের জীবাণু প্রধানতঃ মাটিতে থাকে। এ সকল রোগের আক্রমণ বীজ অঙ্কুরোদগমনের আগেও হতে পারে অর্থাৎ বীজ বপনের পর মাটিতে বসবাসরত ছত্রাকের আক্রমণে বীজ নষ্ট হয়ে যেতে পারে। ছত্রাক জীবাণু গাছের পরিত্যক্ত অংশ কিংবা মাটিতে বেঁচে থাকে এবং বৃষ্টি ও সেচের পানির মাধ্যমে এ রোগের বিস্তার ঘটে। ট্রাইকো-কম্পোস্ট @ ১.৫ টন/হেঃ ও ট্রাইকো-লিচেট @ ৫০০ মিলি/মি<sup>২</sup> এ ব্যবহার করে সবজির চারার ৮০-৯০% মরা রোগ দমন করা যায়।

### ফিউজারিয়াম উইল্ট রোগ দমন :

আগাম কপিচাষে ফিউজারিয়াম উইল্ট রোগ ব্যাপক ক্ষতি করে। বাড়ন্ত চারা বা ফলন্ত গাছ নেতিয়ে পড়ে মারা যায়। ফলন কমে যায় ও কৃষক ব্যাপকভাবে ক্ষতিগ্রস্ত হয়। ট্রাইকো-কম্পোস্ট @ ২.৫ টন/হেঃ এ ব্যবহার করে এই রোগটি দমন করা যায়।

### ব্যাকটেরিয়া জনিত ঢলে পড়া রোগ দমন :

ক্ষেতের মধ্যে সুস্থ গাছে হঠাত ঢলে পড়ে। বিকাল বেলা গাছ আবার সুস্থ দেখা যায়। ব্যাকটিয়াল কোষ গাছের ভাস্কুলার নালি বন্ধ করে দেয় বিধায় গাছ খাদ্য ও পানি নিতে পারে না বিধায় গাছে ঢলে পড়ে।

সেচের পানির মাধ্যমে এক ক্ষেত থেকে অন্য ক্ষেত যায়। ট্রাইকো-কম্পোস্ট @ ৩.০ টন/হেঃ এ ব্যবহার করে এই রোগটি দমন করা যায়।

### শিকড় গিট রোগ দমন :

বাংলাদেশের অধিকাংশ সবজিতে শিকড়গিট রোগের আক্রমণ হয়। মেলোডোগাইন প্রজাতির এক ধরনের কৃমি এ রোগের জন্য দায়ী। শিকড়ে আক্রান্ত স্থলের কোষসমূহ দ্রুত বৃদ্ধি পাওয়ায় ঐ স্থান ফুলে উঠে ও গিটের সৃষ্টি করে। আক্রান্ত গাছ দুর্বল, খাট ও হলুদাভ দেখায়। বর্ষাকালে ক্রমান্বয়ে শিকড় পঁচে যায়। গাছের গোড়ার মাটি সরিয়ে শিকড়ে গিটের উপস্থিতি দেখে সহজেই এ রোগ সনাক্ত করা যায়। সাধারণত আক্রান্ত চারা বৃষ্টি বা সেচের পানি ও কৃষি যন্ত্রপাতির সাহায্যে এ রোগ বিস্তার লাভ করে। এখানে উল্লেখ্য যে ট্রাইকো-কম্পোস্ট তৈরীর ৪০% মুরগীর বিষ্ঠা ব্যবহৃত হয় যা শিকড়গিট রোগ দমনে বিশেষ ভূমিকা পালন।

### ট্রাইকো- কম্পোস্ট ও ট্রাইকো- লিচেট উৎপাদন

টিন অথবা কুটার চালাসহ একটি পার্শ্ব ছিদ্র বিশিষ্ট পাকা চৌবাচ্চা/হাউজে অথবা স্যানিটারী/সিমেন্ট রিং দ্বারা বানানো হাউজে ট্রাইকো কম্পোস্ট তৈরী করতে হয়। সিমেন্ট রিং এর ব্যাস : উচ্চতা : পুরুত্ব পর্যায়ক্রমে ৭০ : ৪০ : ৫ সে. মি.। এই রূপ তিনটি সিমেন্ট রিং একটির উপর আর একটি সাজিয়ে মাটির চাড়ির কম্পোস্ট হাউজ তৈরী করা হয়। পাকা চৌবাচ্চার দৈর্ঘ্য : প্রস্থ : উচ্চতা পর্যায়ক্রমে ৫ : ৩.৫ : ৩.৫ ফুট অনুপাতে হলে ভালো হয়।

ধাপ ১ঃ কম্পোস্ট তৈরীর উপাদান সমূহ যথাঃ গোবর (২৮%), মুরগীর বিষ্ঠা (৩৬%), সবজি উচ্ছিষ্ট অংশ (১০%), কচুরিপানা (২০%), কাঠের গুড়া (৩%), ভুট্টার ব্রান ১%, ছাই (১%) এবং নীমপাতা (১%) আয়তন অনুপাতে মিশানো হয়। সিমেন্টের তিন রিং বিশিষ্ট এক জোড়া হাউজে মোট ৪২০ কেজি পরিমাণ জৈব উপাদান জাগ দেওয়া যায়।

ধাপ ২ঃ এক কেজি চিটা গুড় ২০ লিটার পানিতে গুলিয়ে একটি বড় আকারের পাত্রে রাখতে হবে। ট্রাইকোডারমা ছত্রাকের অনুবীজ ৪৫০ মি. মি. (৩ x ১০<sup>৯</sup> সি এফ ইউ @ ১লি./টন জৈব উপাদান) এই গুড়ের পানিতে মিশ্রিত করে মূল দ্রবণ বানানো হয়।

ধাপ ৩ঃ কম্পোস্ট তৈরীর উপাদান সমূহ স্তরে স্তরে সাজিয়ে পানি মিশ্রিত মূল ট্রাইকোডারমা অনুবীজ দ্রবণ দ্বারা ভিজানো হয় ও ভালোভাবে মিশানো হয়। উক্ত মিশ্রণ পার্শ্ব ছিদ্র বিশিষ্ট কম্পোস্ট হাউজে পঁচনের জন্য জাগ দেওয়া হয়। কম্পোস্ট হাউজটি কালো মোটা পলিথিন দিয়ে ঢেকে রাখা ভাল।

ধাপ ৪ঃ হাউজে জাগ দেওয়ার পর মিশ্রিত উপাদান হতে তরল নির্যাস বের হয়ে আসে যা কমপক্ষে তিনদিন পর্যন্ত হাউজে পুনরায় উঠিয়ে দেয়া হয়। তিনদিন পর হতে তরল সংগ্রহ ও সংরক্ষণ কাজ শুরু হয় শেষ নির্যাস আসা পর্যন্ত। সিমেন্টের তিন রিং বিশিষ্ট এক জোড়া হাউজে জাগ দেওয়া ৪২০ কেজি জৈব উপাদান থেকে ৫/৬ লিটার পরিমাণ তরল নির্যাস সংগ্রহ করা যায়। ট্রাইকোডারমা মিশ্রিত এই তরল নির্যাসকে ট্রাইকো-লিচেট বলে।

ধাপ ৫ঃ বিশ-পঁচিশ দিন পচনের পর জাগের উপাদান সমূহ উল্টিয়ে পাল্টিয়ে দেয়া হয় এবং এভাবে ৩৫ থেকে ৪৫ দিনে কম্পোস্ট সার তৈরী হয়।

ধাপ ৬ঃ চৌবাচ্চা অথবা মাটির চাড়ি থেকে কম্পোস্ট বাহিরে এনে রৌদ্রে শুকিয়ে আর্দ্রতা কমাতে হয় (<২০%) ও পরিশেষে চালুনি (৪ মি.মি.) দিয়ে চেলে ব্যবহারপোযোগী করে নেওয়া হয়। সিমেন্টের তিন রিং বিশিষ্ট এক জোড়া হাউজে মোট ২১০ কেজি পরিমাণ ট্রাইকো-কম্পোস্ট পাওয়া যায়।



চিত্র : ট্রাইকো-কম্পোস্ট ও -লিচেট তৈরীর ধাপ সমূহ

স্মারনিকাঃ-১। ট্রাইকো-কম্পোস্ট ও -লিচেট এর রাসায়নিক বিশ্লেষণ

ক্রমিক নং	পি এইচ ও রাসায়নিক উপাদান	ট্রাইকো-কম্পোস্ট (%)	ট্রাইকো-নির্যাস (%)
১.	পি এইচ	৮	৬.৪
২.	জৈব কার্বন	২০.০	২.০৫
২	নাইট্রোজেন	১.২০	০.০১
৩	ফসফরাস	১.৪১	০.০৫
৪	পটাশিয়াম	০.৯৩	০.০৫
৫	সালফার	০.২৪	০.১
৬	ক্যালসিয়াম	১.৭১	-
৭	ম্যাগনেশিয়াম	০.৪০	-
৮	কপার	০.০১	-
৯	লৌহ	০.১২	-
১০	দস্তা	০.০২৬	০.০০২
১১	তামা	০.০১	-
১২	বোরন	০.০২	-

### সব্জির চারা উৎপাদন ও মাঠ ফসলে ট্রাইকো- কম্পোস্ট ও ট্রাইকো- লিচেটের ব্যবহার

চারা উৎপাদন করে যে সব সবজি চাষ করা হয় তার মধ্যে বাধাঁকপি, ফুলকপি, ওলকপি, ব্রকলি, বেগুন, টমেটো, মরিচ ও পিঁয়াজ উল্লেখযোগ্য। বর্তমানে আগাম শীত, গ্রীষ্ম ও বর্ষাকালীন সময়ে সবজি চারা উৎপাদন ক্রমশ প্রসার লাভ করছে। উৎকৃষ্ট চারা উৎপাদনের জন্য নিম্নোক্ত কয়েকটি বিষয় বিবেচনা করা দরকার।

#### বীজতলার স্থান নির্ধারণ :

বীজতলার জমি অপেক্ষাকৃত উঁচু হওয়া উচিত যাতে বৃষ্টির বা বন্যার পানি দ্রুত নিষ্কাশন করা যায়। ছায়াবিহীন, পানির উৎসের কাছাকাছি এবং বাতাস চলাচলের উপযোগী স্থানে বীজতলা করা প্রয়োজন। বীজতলার মাটি বেলে দো-আঁশ এবং উর্বর হওয়া উচিত।

#### বীজতলা তৈরি :

একক বীজতলা সাধারণতঃ এক মিটার চওড়া ও তিন মিটার লম্বা হবে। পাশাপাশি দুটি বীজতলার মধ্যে কমপক্ষে ৬০ সেমি ফাঁকা রাখতে হবে। বীজ বপনের কয়েকদিন আগে বীজতলার মাটি ২০-২৫ সেমি গভীর করে ঝুরঝুরা ও ঢেলা মুক্ত করে তৈরি করতে হবে। বীজতলা সাধারণতঃ ১০-১৫ সেন্টিমিটার উঁচু করে তৈরি করতে হবে। এক কেজি ট্রাইকো- কম্পোস্ট সার জমি বীজতলার মাটি তৈরির শেষ পর্যায়ে ব্যবহার করতে হবে। কম্পোস্ট প্রয়োগ এর পর মাটি ভালোভাবে পানি দিয়ে ভিজিয়ে দিতে হবে। মাটিতে রাসায়নিক সার না দেয়াই ভালো। উর্বরতা কম হলে প্রতি হাপোরে ১০০ গ্রাম টিএসপি সার মিশাতে হবে বীজ বপনের অন্তত এক সপ্তাহ আগে। বাণিজ্যিক ভাবে চারা উৎপাদন জন্য ইট-সিমেন্ট দিয়ে স্থায়ী বীজ তলা তৈরিই শ্রেয়। বৃষ্টির পানি ও অতিরিক্ত সূর্যতাপ থেকে বীজতলাকে রক্ষা করার জন্য আচ্ছাদন দিতে হবে। কম খরচে বাঁশের ফালি করে বীজতলার প্রস্থ বরাবর ৫০ সেমি পরপর পুতে নৌকার ছেঁ এর আকার তৈরী করে বৃষ্টির সময় পলিথিন দিয়ে এবং প্রখর রোদে চাটাই দিয়ে রক্ষা করা যায়। চারা লাগানোর পর বীজ তলার চার দিকে সেভিন পাউডার ছিটিয়ে দিতে হবে যাতে করে পিঁপড়া, পোকামাকড় ভিতরে আসতে না পারে। এছাড়াও সেভিন ব্যবহার করা যেতে পারে।



চিত্র : অস্থায়ী বীজ তলা (১) ও স্থায়ী বীজ তলা (২)

#### বীজতলায় ট্রাইকো- কম্পোস্ট ও ট্রাইকো- লিচেট প্রয়োগ পদ্ধতিঃ

- কম্পোস্ট ও লিচেট মূলত মাটি শোধন ও মাটিবাহিত রোগ, পোকামাকড় দমনের কাজ করে।
- বীজ তলার মাটি কুপিয়ে কয়েকদিন সৌরতাপে ফেলে রাখা হয়। এর পর মাটি ভেঙ্গে ঝুরঝুরা করা হয়।
- বীজ লাগানোর ৮/১০ দিন পূর্বে ট্রাইকো- কম্পোস্ট ছিটিয়ে মাটির সাথে মিশানো হয় ও বেশী করে পানি দিয়ে ভিজিয়ে দেওয়া হয়।
- মাটিতে জো আসলে মাটি ভালোভাবে ভেঙ্গে ঝুরঝুরা করে তা বীজ লাগানোর উপযুক্ত করা হয়।

- এখানে উল্লেখ্য সাদা অথবা কালো পলিথিন দিয়ে বীজতলা ঢেকে দিলে পলিথিনের ভিতরে বীজতলার মাটির তাপমাত্রা যথেষ্ট বৃদ্ধি পায় ফলে কম্পোস্ট কার্যকারীতা বেড়ে যায় ও মাটিবাহিত রোগজীবানু দমনে অধিক ভূমিকা রাখে ।
- বীজ অংকুরোদগমের পর, চারা বর্ধনশীল পর্যায়ে ৭ দিন অন্তর লিচেট স্প্রে করতে হবে। প্রতি লিটার পানিতে ২০ মি.লি. হারে লিচেট মিশিয়ে তা চারায় স্প্রে করতে হবে।



চিত্র ৪ : কম্পোস্ট বীজতলায় প্রয়োগ (১) ও প্রয়োগকৃত চারা (২)

#### মাটি শোধন ও রোগ দমন কৌশলঃ

- ট্রাইকো-কম্পোস্ট এর মধ্যে ট্রাইকোডারমা নামক উপকারি ছত্রাক অণুজীব থাকে। কম্পোস্ট প্রয়োগের পর তা থেকে অণুজীব সমূহ মাটিতে বিস্তার লাভ ও মাটি বাহিত রোগ দমন করে।
  - ট্রাইকোডারমার হাইপি প্যাথোজেনের হাইপি উপর সরাসরি খায়।
  - ট্রাইকোডারমিন নামক এন্টিবায়োটিক তৈরী করে যা প্যাথোজেনকে মেরে ফেলে।
  - দ্রুত বর্ধনশীল বিধায় চারার মূল অঞ্চল ঘিরে থাকে সেখানে কোন প্যাথোজেন প্রবেশ করতে পারে না।
  - ট্রাইকোডারমা গাছের রোগ প্রতিরোধী ক্ষমতা বৃদ্ধি করে।

#### বীজ শোধন ও বীজ বপনঃ

প্রতি কেজি বীজে ট্যাক্স পাউডার মিশ্রিত ট্রাইকো- স্পোর ৫ গ্রাম ব্যবহার করে ভালোভাবে ঝাকিয়ে বীজ শোধন করা যায়। বীজ শোধনের ফলে বীজের সাথে লেগে থাকা বা মাটিতে বীজের সংস্পর্শে আসা রোগ-জীবাণু ধবংস হয়। বীজতলায় সারি করে বা ছিটিয়ে বীজ বপন করা যায়, তবে সারিতে বপন করা উত্তম। সারিতে বপনের জন্য প্রথমে নির্দিষ্ট দূরত্বে (৪ সেমি) কাঠি দিয়ে ক্ষুদ্র নালা তৈরি করে তাতে বীজ ফেলে মাটি দিয়ে ঢেকে দিতে হবে। ছোট বীজের বেলায় বীজের দ্বিগুন পরিমাণ শুকনো ও পরিষ্কার বালু বা মিহি মাটি বীজের সাথে ভালভাবে মিশিয়ে মাটিতে বীজ বপন করতে হয়। যে সমস্ত বীজের আবরণ শক্ত, সহজে পানি প্রবেশ করেনা, সেগুলোকে সাধারণতঃ বোনার পূর্বে পরিষ্কার পানিতে ১৫-২০ ঘন্টা অথবা শতকরা এক ভাগ পটাশিয়াম নাইট্রেট দ্রবণে এক রাত্রি ভিজিয়ে বপন করতে হয় (যেমন লাউ, চিচিঙ্গা, মিষ্টি কুমড়া, করলা, উচ্ছে ও বিঙ্গা)।

### চারার যত্নঃ

চারার গজানোর পর থেকে ১০-১২ দিন পর্যন্ত হালকা ছায়া দ্বারা অতিরিক্ত সূর্যতাপ থেকে চারা রক্ষা করা প্রয়োজন। পানি সেচ একটি গুরুত্বপূর্ণ পরিচর্যা তবে বীজতলার মাটি দীর্ঘ সময় বেশী ভেজা থাকলে অঙ্কুরিত চারার রোগাক্রান্ত হওয়ার সম্ভাবনা বৃদ্ধি পায়। চারা গজানোর ১০-১২ দিন পর বীজতলায় প্রয়োজন মত দূরত্ব ও পরিমাণে চারা রেখে অতিরিক্ত চারাগুলি যত্ন সহকারে উঠিয়ে দ্বিতীয় বীজতলায় সারি করে রোপণ করলে মূল্যবান বীজের সাশ্রয় হবে। দেখা গেছে ১০-১২ দিনের চারা দ্বিতীয় বীজতলায় স্থানান্তরিত করা হলে কপি গোত্রের সবজি ও বেগুন, টমেটো চারার শিকড় বিস্তৃত ও শক্ত হয়, চারা অধিক সবল হয়।

### বীজতলায় চারার রোগ দমনঃ

- বীজতলায় বপনকৃত বীজ গজানোর পূর্বে এবং পরে কচি চারা রোগাক্রান্ত হতে পারে।
- ড্যাম্পিং অফ রোগ বাংলাদেশে চারা উৎপাদনের এক বড় সমস্যা। বীজতলার মাটি সব সময় ভেজা থাকলে এবং মাটিতে বাতাস চলাচলের ব্যাঘাত হলে এ রোগ বেশী হয়।
- চারার কাণ্ড মাটি সংলগ্ন স্থানে পচে গিয়ে নেতিয়ে পড়ে। মাটি বাহিত প্যথোজেন যেমন- ফিউজেরিয়াম, পিথিয়াম, রাইজোকটোনিয়া, স্কেরোসিয়াম, কুমি ও ব্যাটেরিয়া সমূহ এই রোগের জন্য দায়ী।
- ট্রাইকো-কম্পোস্ট প্রয়োগ করে চারার রোগ ৮০% কমানো যায়।। চারা গজানোর পর থেকে সাতদিন অন্তর চারায় লিচেট স্প্রে করলে সম্পূর্ণ রূপে রোগ দমন হবে। বীজতলার মাটি সুনিষ্কাশিত রাখা রোগ দমনের প্রধান উপায়।

### চারার রোপণ :

কপি জাতীয় সবজি, টমেটো, মরিচ, বেগুন ইত্যাদির চারা ৩০-৪০ দিন বয়সে মাঠে রোপণের উপযুক্ত হয়। রোগ মুক্ত সুস্থ চারা রোপনের জন্য বাচাই করা ও বিকেল বেলায় চারা লাগানো উচিত।

### মাট ফসলে ট্রাইকো- কম্পোস্ট ও ট্রাইকো- লিচেটের ব্যবহার :

সবজির জমি ৪-৫ বার ভালভাবে চাষ দিয়ে মাটি বুরবুরা করে মই দিতে হয়। জমি তৈরীর শেষ চাষের সময় প্রতি শতাংশ জমিতে ৮-১০ কেজি পরিমাণ ট্রাইকো-কম্পোস্ট সার প্রয়োগ করে ভালভাবে মাটির সাথে মিশিয়ে দিতে হবে। জমিতে কম্পোস্ট সারটি মিশিয়ে সেচ দিতে হবে। ৮-১০ দিন পর জো আসলে মাটি ভালোভাবে নেড়ে উল্টিলে দিতে হবে। মাটির ঢেলা ভেঙ্গে মিহি করে বীজ বা চারা লাগানো হয়।

ট্রাইকো-কম্পোস্ট একদিকে ক্ষতিকর রোগজীবাণু ধ্বংস করে অন্যদিকে জমির উর্বরতা শক্তি বাড়ায় ও সুস্থ-সবল ফসল উৎপাদনে সহায়তা করে। পাতা জাতীয় সবজি ফসলে যথা বাঁধাকপি, ডাটা ও গিমা কলমি উক্ত কম্পোস্ট সার ব্যবহার করলে ২০% অনুমোদিত রাসায়নিক সার কম প্রয়োগ করতে হয়। আবার বেগুন, টমেটো ইত্যাদি ফসলে ২৫% অনুমোদিত রাসায়নিক সার কম দিলেও কাজিখত ফলন পাওয়া যায়। সবজি চাষের অন্যান্য পদ্ধতি পূর্বের ন্যায়ই অনুসরণ করতে হবে। ফসলের বাড়ন্ত পর্যায়ে রোগ প্রতিরোধক হিসাবে ট্রাইকো- লিচেটের ব্যবহার করা হয়। প্রতি লিটার পানিতে ২০ মিলি লিটার হারে লিচেট মিশিয়ে তা ১০-১৫ দিন অন্তর গাছে স্প্রে করা হয়। জৈব সারের সাথে ট্রাইকোডারমা মিশ্রিত থাকায় পটল বা বেগুনক্ষেতে রেকর্ডযোগ্য কোন রোগ দেখা যায় নাই।



চিত্র : কম্পোস্ট মাঠে প্রয়োগ (১) ও লিচটে সব্জিতে স্প্রে (২)



চিত্র : কম্পোস্ট প্রয়োগকৃত পটলক্ষেত(১) ও বেগুনক্ষেত(২)

### ট্রাইকো-কম্পোস্ট ব্যবহারের হার বা ডোজ :

জমির উর্বরতা ও ফসলভেদে কম্পোস্ট সার ব্যবহারের মাত্রা কমবেশী হয়। গবেষণালব্ধ ফলাফলে দেখা যায় হেক্টর প্রতি ২.৫ টন থেকে ৩.০ টন কম্পোস্ট প্রয়োগ করে বহুবিধ সব্জি ফসলের আশানুরূপ ফলন পাওয়া যায়। সব্জি ছাড়াও পেঁপে, কলা ইত্যাদি ফল চাষেও চাষীরা কম্পোস্ট ব্যবহার করা যায়।

### ট্রাইকো-কম্পোস্ট সার ব্যবহারের পদ্ধতি :

ভালোভাবে তৈরীর পর কম্পোস্ট সারটি মিশিয়ে সেচ দিতে হবে। জমিতে জো আসার পর ভালোভাবে নেড়ে চেড়ে বীজ বা চারা লাগানো হয়। এই কম্পোস্ট সার ফসল বপনের পূর্বে ৭-১০ দিন জমিতে পচিয়ে নিলে ভালো ফল পাওয়া যায়।

### রোগ দমন ও ফলন বৃদ্ধিতে ট্রাইকো-প্রডাক্ট এর গুরুত্ব :

ট্রাইকো-কম্পোস্ট ব্যবহারে জমির উর্বরতা শক্তি ও উদ্ভিদের রোগ প্রতিরোধ ক্ষমতা বৃদ্ধি পায়। ট্রাইকোডারমা মাটির ক্ষতিকর ছত্রাকজীবাণু ধ্বংস করে এবং গাছের ঢলে পড়া, গোড়া পঁচা, কান্ড পঁচা ও শিকড় গিট রোগ দমন করে এবং ফসলের ফলন ও গুণগত মান ভাল হয়। বীজ তলায় এটি সব্জি চারার মড়ক রোগ কমায়। বাঁধা কপির চারার মড়ক ও ফিউজারিয়াম উইল্ট যথাক্রমে ৬৫%

ও ৭৮% কমায়। মাঠে বিভিন্ন সবজি যেমন- বেগুন, টমেটো, বাধাকপি, ফুলকপি, সীম, লাউ, পুঁইশাক, পটল, ডাটা, ইত্যাদিতে ব্যবহার করে দেখা গেছে এটি শিকড়ের গিট রোগ দমন করে ৪৫- ৫৮%। ফুলকপির ছত্রাক জনিত চলে পড়া রোগ দমন করে ৫৫-৮৩% এবং টমেটো ও বেগুনের ব্যাকটেরিয়াল উইল্ট কমায় ৫৫-৮০%। অন্যদিকে নিয়মিত পাতায় ট্রাইকো-লিচেটের ব্যবহারে বাঁধা কপির অলটারনারিয়া জনিত পাতায় দাগ কমে ৪৫-৫৫%। পটলের ফাইটোপ্ঠোরা জনিত ফল পঁচা রোগ কমে ৫৫ - ৬৮% ও লাউয়ের শুকনাক্ষত রোগ কমে ৪৫-৫৪%। একই জমিতে ট্রাইকো-কম্পোস্ট প্রয়োগ ছাড়া জমির তুলনায় ট্রাইকো-কম্পোস্ট প্রয়োগকৃত জমিতে পটল, লাউ, সীম ও বাঁধাকপির ফলন যথাক্রমে ৩১%, ৪০%, ২৫% ও ২৬% বেশী পাওয়া গেছে। ট্রাইকো-কম্পোস্ট সার ব্যবহারে সবজির সতেজতা বৃদ্ধি পায় এবং টমেটোর টিএসএস এর পরিমাণ বৃদ্ধিতেও সহায়ক বলে গবেষণায় পাওয়া গেছে। কৃষক পদ্ধতির তুলনায় ট্রাইকো-কম্পোস্ট প্রয়োগকৃত জমিতে লাউ, সীম, ফুলকপি, বাধাকপি ও বেগুনে আয় যথাক্রমে ২৩%, ২০%, ২০%, ১৭% ও ২৫% বৃদ্ধি পেয়েছে।

ট্রাইকো- কম্পোস্ট পুষ্টি উপাদান সমৃদ্ধ বিধায় রোগ দমনের পাশাপাশি এটি মাটিতে জৈব পদার্থ সংযোজন করে মাটির গুণাগুণ বৃদ্ধি করে। একটি আদর্শ মাটিতে জৈব পদার্থের পরিমাণ যেখানে কমপক্ষে ৫% থাকা দরকার সেখানে আমাদের মাটিতে আছে ১% এর নীচে। এর প্রধান কারণ মাটিতে অতিমাত্রায় রাসায়নিক সার ব্যবহার ও জৈব সার সংযোজন না করা। জৈব সার গাছের বৃদ্ধির জন্য প্রয়োজনীয় উপাদান সমূহ মাটিতে সরবরাহ করে। অন্যদিকে মাটির গঠন প্রকৃতি উন্নত করে, ফলে গাছের শিকড় সহজে মাটির ভিতরে বিস্তার লাভ করতে পারে। তাছাড়া জৈব পদার্থ মাটির পানি ধারণ ক্ষমতা বাড়ায়। রাসায়নিক সার ব্যবহার করে আপাত দৃষ্টিতে ফলন বাড়লেও মাটির পুষ্টি উপাদান সংরক্ষিত হয় না যা জৈব সার দ্বারা হয়। মাটির অণুজৈবিক কার্যকারিতা বৃদ্ধির জন্য মাটিতে যথেষ্ট পরিমাণ জৈব পদার্থ থাকা প্রয়োজন। এক কথায় মাটির স্বাস্থ্য রক্ষায় জৈব সারের কোন বিকল্প নাই।

গবেষণার ফলাফলে প্রতীয়মান হয়েছে যে, সবজি চাষে ট্রাইকোডারমা মিশ্রিত জৈব সার ব্যবহার করলে রাসায়নিক সারের প্রয়োজন কম হয়। সবজি ফসলে ট্রাইকো-কম্পোস্ট ব্যবহারের ফলে ইউরিয়া, টিএসপি, ডিএপি, এমপি, জিপসাম, জিংক সালফেট ও বোরাক্স সারের ব্যবহার যথাক্রমে ৪১%, ৩৮%, ১৫%, ৩২%, ১৪%, ২৪%, ও ৮% কমেছে যশোর প্রকল্প এরিয়া। অন্য দিকে বগুড়ায় ইউরিয়া, টিএসপি, ডিএপি, এমপি, জিপসাম, জিংক সালফেট ও বোরাক্স এর ব্যবহার কমেছে যথাক্রমে ২২%, ২১%, ১৫%, ২০%, ১৮%, ১৫% ও ১৬%। যাহাতে মাটির উর্বরা শক্তি বৃদ্ধি পাবে, মাটি ও পরিবেশ দূষণ মুক্ত হবে, রাসায়নিক সার সাশ্রয় তথা বৈদেশিক মুদ্রার সাশ্রয় হবে। উল্লেখযোগ্য পরিমাণে সবজির উৎপাদন বৃদ্ধির সাথে সাথে উহার পুষ্টিমানও বৃদ্ধি পাবে। কাজেই সবজি চাষে ট্রাইকো-কম্পোস্ট সার ব্যবহারের কোন বিকল্প নাই।

#### কোথায় তৈরী হচ্ছে ট্রাইকোডারমা ও ট্রাইকো-কম্পোস্ট ?

বর্তমানে আইপিএম আইএল (সিআরএসপি) ও কৃষি গবেষণা ফাউন্ডেশনের আর্থায়নে ট্রাইকোডারমা বাংলাদেশ কৃষি গবেষণা ইনস্টিটিউট এর উদ্যানতত্ত্ব গবেষণা কেন্দ্রের উদ্ভিদ রোগতত্ত্ব শাখার ল্যাবরেটরিতে তৈরী, সংরক্ষণ ও বর্ধনের কাজ হচ্ছে। কৃষি গবেষণা ফাউন্ডেশনের আর্থায়নে ট্রাইকো-কম্পোস্ট সার কৃষক পর্যায়ে তৈরী হচ্ছে বগুড়ার শেরপুর উপ-জেলার খানপুর ইউনিয়নের ভাট্টা গ্রামে ও যশোর সদর উপ-জেলার চুড়ামনকাঠি ইউনিয়নের বাগডাঙ্গা গ্রামে।

## সবজি ফসলের রোগবালাই ও তার দমন ব্যবস্থাপনা

### রোগের নামঃ আর্লি ব্লাইট/ অলটারনেরিয়া ব্লাইট

ফসলের নামঃ টমেটো, বাঁধাকপি, ফুলকপি, মুলা

রোগের কারণঃ অলটারনেরিয়া সোলানি (টমেটো), অলটারনারিয়া ব্রাসিসি ও অলটারনারিয়া ব্রাসিসিকোলা (বাঁধাকপি, ফুলকপি)

রোগের লক্ষণ : রোগের জীবাবু গাছের পাতা, কাণ্ড ও ফল আক্রমণ করে থাকে। আক্রান্ত পাতার উপর কালো বাদামী রংয়ের বৃত্তাকার দাগ পড়ে। ক্ষতস্থানটিতে অনেকগুলি চক্রাকার দাগ থেকে যাহা এরোগের একটি বিশেষত্ব। ব্যপকভাবে আক্রান্ত পাতা ঝরে পড়ে। পুষ্প মঞ্জুরীর বোঁটা আক্রান্ত হলে ফুল ও অপ্রাপ্ত ফল ঝরে পড়ে। ফলের গায়ে ও বৃত্তাকার দাগের সৃষ্টি হয়।

উৎপত্তি ও বিস্তারঃ ফসলের পরিত্যক্ত অংশ, আক্রান্ত ফল ও বীজের মধ্যে রোগ বেঁচে থাকে। সাধারণতঃ বৃষ্টি, সেচের পানি ও বাতাসের মাধ্যমে রোগের বিস্তার ঘটে।

দমন ব্যবস্থাপনাঃ

- গাছের পরিত্যক্ত অংশ ও আগাছা নষ্ট করা।
- পরিমিত ও সময়মত সুষ্ণ সার ও সেচ প্রয়োগ।
- ট্রাইকো-লিচেট প্রতি লিটার পানিতে ২০ মিলি মিশিয়ে সজির বাড়সড় অবহা থেকে ১০/ ১৫ দিন অন্তর স্প্রে করা।
- মারাত্মকভাবে আক্রান্ত হলে বুভরাল প্রতি লিটার পানিতে ২ গ্রাম মিশিয়ে ১০ দিন অন্তর অন্তর ১/ ২ বার স্প্রে করা।

### রোগের নামঃ নাবী ধসা/মড়ক বা লেট ব্লাইট

ফসলের নামঃ টমেটো

রোগের কারণঃ ফাইটপথোরা ইনফ্যাসট্যাস

রোগের লক্ষণ : পাতার উপর পানি ভেজা দাগ পড়ে। দাগ দ্রুত বাড়তে থাকে এবং বাদামী থেকে কালচে রং ধারণ করে। নিম্ন তাপমাত্রা, বাতাসের বেশী আর্দ্রতা, কুয়াশাচহ্ন আবহাওয়ায় রোগ দ্রুত সম্পূর্ণ মাঠে ছড়িয়ে পড়ে।

উৎপত্তি ও বিস্তারঃ গাছের পরিত্যক্ত অংশ ও আক্রান্ত বীজ। বাতাস, বৃষ্টি ও সেচের পানির মাধ্যমে

দমন ব্যবস্থাপনাঃ

- রোগমুক্ত এলাকা হতে সুস্থ বীজ সংগ্রহ করা।
- ট্রাইকো-লিচেট প্রতি লিটার পানিতে ২০ মিলি মিশিয়ে সজির বাড়সড় অবহা থেকে ১০/ ১৫ দিন অন্তর স্প্রে করা।
- মারাত্মকভাবে আক্রান্ত হলে
- রিডোমিল গোল্ড (০.২%) ১০ দিন অন্তর ১/২ বার স্প্রে করা।
- সালানেসি পরিবারের বাহিরের ফসল দ্বারা শস্য পর্যায় অবলম্বন করা।

## রোগের নামঃ পাতা কুকড়ানো বা লিফ কার্ল

ফসলের নামঃ টমেটো

রোগের কারণঃ লিফ কার্ল ভাইরাস

রোগের লক্ষণ : গাছ খর্বাকৃতির হয়। পাতা ভীষণ ভাবে কুকড়িয়ে যায়। বয়স্ক কোকড়ানো পাতা পুরু ও মচমচে হয়ে যায়। গাছে অতিরিক্ত শাখা প্রশাখা জন্মায় ও গাছ সম্পূর্ণরূপে ফুল, ফল ধারণ ক্ষমতা হারিয়ে ফেলে।

উৎপত্তি ও বিস্তারঃ সাদা মাছি দ্বারা এ ভাইরাস বিস্তার লাভ করে থাকে।

দমন ব্যবস্থাপনাঃ

রোগাক্রান্ত গাছ দেখামাত্র তুলে নষ্ট করা

সুস্থ গাছ থেকে বীজ সংগ্রহ করা।

সাদা বা হলুদ ট্রাপ ব্যবহার করে বাহক পোকা দমন।

## রোগের নামঃ ফল ও কাণ্ড পচা

ফসলের নামঃ বেগুন

রোগের কারণঃ ফোমপসিস ভেকসান

রোগের লক্ষণ : মাটির সংযোগস্থলে গাছের কাণ্ড হঠাৎ সরু হয়ে যায়। কাণ্ডের বাকল শুকিয়ে মরে গেলে ভিতরে কোষতন্ত্র বেরিয়ে পড়ে। আক্রান্ত ফল দ্রুত পচে যায়।

উৎপত্তি ও বিস্তারঃ মাটি, আক্রান্ত গাছের পরিত্যক্ত অংশ ও বীজ।

দমন ব্যবস্থাপনাঃ

- সুস্থ ও রোগমুক্ত বীজ ব্যবহার করা
- চারা লাগানোর তিন সপ্তাহ আগে হেক্টর প্রতি আধা পাঁচা (কমপক্ষে ৬ মাস) মুরগীর বিষ্ঠা ৫ টন বা সরিষার খৈল ৬০০ কেজি বা ট্রাইকো- কম্পোস্ট ২.৫ টন জমিতে প্রয়োগ করে দমন করা যায়।
- ট্রাইকো-লিচেট প্রতি লিটার পানিতে ২০ মিলি মিশিয়ে সজির বাড়সড় অবহা থেকে ১০/ ১৫ দিন অন্তর স্প্রে করা।
- ব্লুভরাল (০.২%) পানির সাথে মিশিয়ে স্প্রে করা।

## রোগের নামঃ লিটল লিফ

ফসলের নামঃ বেগুন

রোগের কারণঃ মাইকো-প্লাজমা

রোগের লক্ষণ : আক্রান্ত পাতার আকৃতি খুব ছোট হয়। পাতাগুলি গুচছাকৃতির মনে হয় ও গাছ খর্বাকৃতির ও বন্ধ্য হয়।

উৎপত্তি ও বিস্তারঃ সংস্পর্শ ও পোকাকার মাধ্যমে এ রোগ বিস্তার লাভ করে।

দমন ব্যবস্থাপনাঃ

- আক্রান্ত গাছ দেখা মাত্র তুলে ফেলা।
- সোলানেসি পরিবারের আগাছা ধংস করা।
- সাদা বা হলুদ ট্রাপ ব্যবহার করে জ্যাসিড পোকা দমন করা।

## রোগের নামঃ পাউডারি মিলডিউ

ফসলের নামঃ লাউ/ কুমড়া / কুমড়া জাতীয় সবজি

রোগের কারণঃ ওইডিয়াম প্রজাতির ছত্রাক

রোগের লক্ষণ : পাতার উপরের দিকে সাদা পাউডারের মত প্রলেপ পরে। গাছের স্বাভাবিক বৃদ্ধিতে ব্যাঘাত ঘটে। আক্রমণের প্রথম স্তরে দাগগুলি সাদা ও ধীরে ধীরে হলুদ হয়ে সম্পূর্ণ পাতাই শুকিয়ে ঝরে পড়ে।

উৎপত্তি ও বিস্তারঃ গাছের পরিত্যক্ত অংশ, বিকল্প পোষক, বায়ু প্রভৃতির মাধ্যমে এ রোগ সুস্থ গাছে ছড়িয়ে পরে।

দমন ব্যবস্থাপনাঃ

- আক্রান্ত গাছের পরিত্যক্ত অংশ, বিকল্প পোষক পুড়িয়ে ফেলা।
- পরিমিত সার ও সময়মত সেচ প্রয়োগ।
- ট্রাইকো-লিচেট প্রতি লিটার পানিতে ২০ মিলি মিশিয়ে সজির বাড়সড় অবহা থেকে ১০দিন অন্তর স্প্রে করা।
- থিওভিট বা টিল্ট (০.১%) সিস্চন।

## রোগের নামঃ মোজাইক

ফসলের নামঃ টমেটো, বরবটি, ঢেড়শ, কুমড়া জাতীয় সবজি

রোগের কারণঃ ভাইরাস

রোগের লক্ষণ : রোগের ফলে পাতার আন্তঃ শিরা এলাকায় সবুজ দাগ পড়ে। বাড়ন্ত পাতার স্বাভাবিক আকৃতি নষ্ট হয়ে যায়। পাতা ফল অসমাকৃতি ও ছোট হয়।

উৎপত্তি ও বিস্তারঃ সংস্পর্শ দ্বারা এবং পোকাকার মাধ্যমে এ রোগ বিস্তার লাভ করে।

দমন ব্যবস্থাপনাঃ

- আক্রান্ত গাছ তুলে পুড়িয়ে অথবা মাটিতে চাপা দিয়ে ধ্বংস করা।
- সাদা বা হলুদ ট্রোপ ব্যবহার করে পোকা দমন করা।
- কীটনাশক দিয়ে পোকা দমন করা।
- রোগমুক্ত গাছ থেকে বীজ সংগ্রহ করে লাউ, কুমড়ার চাষ করা।

## রোগের নামঃ ঢলে পড়া বা ব্যাকটেরিয়াল উইন্ট

ফসলের নামঃ বেগুন, টমেটো

রোগের কারণঃ রাসট্যানিয়া সোলানেসিয়া-রাম

রোগের লক্ষণ : গাছের নতুন পাতা ঢলে পড়ার মাধ্যমে এ রোগের প্রাথমিক লক্ষণ প্রকাশ পায়। প্রাথমিক অবস্থায় প্রখর রোদে এই লক্ষণ দেখা যায় এবং রাত্রি বেলায় আবার মিলিয়ে যায়। পরে আস্তে আস্তে গাছের পাতা ও শাখা প্রশাখা ঢলে পড়ে এবং গাছ সবুজ অবস্থায় মারা যায়। আক্রান্ত গাছের কাণ্ড, শাখা বা পাতার বাঁটা কেটে পানিতে ডুবিয়ে রাখার পর সাদা সুতার মত ব্যাকটেরিয়া বের হয়ে আসতে দেখা যায়।

উৎপত্তি ও বিস্তারঃ মাটি ও গাছের পরিত্যক্ত অংশ। সেচের পানি ও মাটির মাধ্যমে এ রোগের জীবানু বিস্তার লাভ করে।

দমন ব্যবস্থাপনাঃ

- প্রতিরোধজাত যেমন-মানিক, রতন প্রভৃতি চাষ করা।
- বাদাম, সরিষা, ভূট্টা প্রভৃতি দ্বারা শস্য পর্যায় অবলম্বন।
- চারা লাগানোর ২ সপ্তাহ আগে হেক্টর প্রতি আধা পঁচা (কমপক্ষে ৬ মাস) মুরগীর বিষ্ঠা ৫ টন বা সরিষার খৈল ৬০০ কেজি বা ট্রাইকো- কম্পোস্ট ২.৫ টন জমিতে প্রয়োগ করে চলে পড়া দমন করা যায়।
- রোগাক্রান্ত গাছ দেখামাত্র গোড়ার মাটিসহ তুলে ফেলা।
- রোগাক্রান্ত জমিতে টমেটোর চাষ না করা।
- গ্রাফটিং পদ্ধতিতে চাষাবাদ করা।

### রোগের নামঃ ব্লটনট নেমাটড

ফসলের নামঃ বগুন, টমেটো, বরবটি, চেড়শ, পুঁই, কুমড়া জাতীয় সবজি

রোগের কারণঃ মেলডোগাইন প্রজাতির কৃমি

রোগের লক্ষণ : শিকড়ে ছোট ছোট গিট দেখা যায়। গিটগুলো আলেড় আলেড় বড় হয়। রোগাক্রান্ত গাছটি খাটো ও খর্বাকার হয়। রোগাক্রান্ত শিকড়ে সহজেই পচন ধরে। মাটিবাহিত অন্যান্য রোগের প্রকোপ বাড়ে। পরিশেষে গাছ মরেও যেতে পারে।

উৎপত্তি ও বিস্তারঃ কৃমি মাটিবাহিত রোগ ও রোগাক্রান্ত শিকড়ের মাধ্যমে ছড়ায়।

দমন ব্যবস্থাপনাঃ

- চারা উৎপাদনে বীজতলায় ৬ সেন্টিমিটার পুর-স্ফুরে কাঠের গুড়া বিছিয়ে দিয়ে পোড়ালে কৃমি ও অন্যান্য রোগ জীবাণু দমন হয়।
- বীজ বা চারা লাগানোর ২ সপ্তাহ আগে হেক্টর প্রতি আধা পঁচা (কমপক্ষে ৬ মাস) মুরগীর বিষ্ঠা ৫ টন বা সরিষার খৈল ৬০০ কেজি বা ট্রাইকো- কম্পোস্ট ২.৫ টন জমিতে প্রয়োগ করে কৃমি দমন করা যায়।
- ফুড়াডান (কার্বফুরান) হেক্টর প্রতি ২৫ কেজি হারে ব্যবহার করে কৃমি রোগ সহজে দমনে কর

## Annexure IX

- Alabouvette, C. and Y. Couteadier, 1992. Biological Control of Plant Diseases: Progress and Challenges for the Future. In: Biological Control of Plant Diseases, Tjamos, E.C., G.C. Papavizas and R.J. Cook (Eds.). Plenum Press, New York, pp: 415-426.
- Anonymous 2011. Annual report of Integrated Pest Management Collaborative Research Support Program (IPM-CRSP). Horticulture Research Centre, BARI, Gazipur 1701.
- Anonymous, 2005. WHO report of survey on nutritional in Bangladesh.
- Anonymous, 2009. Annual report of Integrated Pest Management Collaborative Research Support Program (IPM-CRSP). Horticulture Research Centre, BARI, Gazipur 1701.
- Anonymous, 2010. Annual report of Integrated Pest Management Collaborative Research Support Program (IPM-CRSP). Horticulture Research Centre, BARI, Gazipur 1701.
- Anonymous, 2010. Statistical Year Book of Agriculture. Bangladesh Bureau of Statistic. P.39.
- Anonymous, 2012. Annual report of Integrated Pest Management Collaborative Research Support Program (IPM-CRSP). Horticulture Research Centre, BARI, Gazipur 1701.
- Barker, K. R. and Campbell, C. L. 1981. Sampling nematode populations. Plant parasitic nematodes, (eds B. M. Zuckerman & R. A. Rhode). Academic Press, New York, NY. 111 :451-471.
- Barker, K. R., Nusbaum, C. J. and Nelson, L. J. 1969. Effects of storage temperature and extraction procedure on recovery of plant parasitic nematodes from field soils. J. Nematol. 1:240-247.
- BBS, 2008. Statistical Bulletin Bangladesh BBS 2008. p65.
- Behzad H., Mousa T., Mohammad, R. M. and Mahdi, D. 2008. Biological potential of some Iranian *Trichoderma* isolates in the control of soil borne plant pathogenic fungi. Afr. J. Biotechnol. 7: 967-972.
- Benitez, T., Rincon, A. M., Limon, M. C. and Codon, A. C. 2004. Biocontrol mechanisms of *Trichoderma* strains, a review article, Intl. Microbiol. 7: 249-260.
- Biswas, K. K. and Sen, C. 2000. Management of stem rot of Groundnut caused by *Sclerotium rolfsii* through *Trichoderma harzianum*. Indian Phytopath. 53 (3): 290-295.
- Bongers, T. 1990. The maturity Index: An ecological measure of environmental disturbance based on nematode species composition. Oecologia 83: 14-19.
- Bongers, T. 1999. The Maturity index, the evolution of nematode life history traits, adaptive radiation and cp-scaling. Plant and Soil 212: 13-22.
- Bossio D.A., Scow, K.M. and Gunpala, N. and Graham, K.J. 1998. Determination of soil microbial communities and the effect of agricultural management, season and soil type on their phospholipid fatty acid profile. Microbiol Ecol. 36:1-12.

- Celar, F. and Valic, N. 2005. Effects of *Trichoderma spp* and *Glicladium roseum* culture filtrates on seed germination of vegetables and maize. J. Plant Dis. Prot. 112(4): 343-350.
- Choudhary, B. 1976. Vegetables (4<sup>th</sup> edn.), National Book Trust, New Delhi, pp.50-58.
- Dick R.P. 1992. Long term effects of agricultural systems on soil biochemical and microbial parameters. Agric. Ecol. Environ. 40:25-36. [2] Barns S.M., Takala, S.L. and Kurke, C.R. 1999. Wide distribution and diversity of members of the bacterial kingdom acidobacterium in the environment. Appl. Environ. Microbiol. 65:1731-1737.
- Faruk, M. I., Bari, M. A., Rahman, M. A., Nahar, M. S. and Khanan, N. N. 1999. Suppression of root-knot nematode (*Meloidogyne* sp.) of tomato using antagonistic isolates of *Trichoderma* species. Bangladesh J. Plant Path. 15 (1&2).
- Ferris H., Bongers, T. and de Goede, R. G. M. 2001. A framework for soil food web diagnostics: extension of the nematode faunal concept. Appl. Soil Ecol. 18: 13-29.
- Ferris, H., Venette, R. C. and Lau, S. S. 1996. Dynamics of nematode communities in tomatoes grown in conventional and organic systems, and their impact on soil fertility. Appl. Soil Ecol. 3: 161-175.
- Flegg, J. M. and Hooper, D. J. 1970. Extraction of free-living stages from soil. Laboratory methods to work with plant and soil nematodes (ed J. F. Southey). HMSO, London, UK. pp. 5-22
- Goodey, T. 1963. Soil and fresh water nematodes. Methuen & Co. Ltd., London, UK.
- Haggag, W. M. and Abosedera, S. A. 2005. Characteristics of Three *Trichoderma* Species in Peanut Haulms Compost Involved in Biocontrol of Cumin Wilt Disease, Intl. J. Agril. and Biol. 7 (2): 222-229
- Hajieghrari, B. 2010. Effects of some Iranian *Trichoderma* isolates on maize seed germination and seedling vigor, African J. Biotech. 9(28): 4342-4347.
- Harman, G.E., 2000. Myths and dogmas of biocontrol: changes in perceptions derived from research on *Trichoderma harzianum* T22. Plant Dis., 84: 377-393. Harman, G.E., C.R. Howell, A. Viterbo, I. Chet and M. Lorito, 2004. *Trichoderma* species-opportunistic, avirulent plant symbionts. Nat. Rev. Microbiol., 2: 43-56.
- Zak D.R., Pregitzer, K.S., Curtis, P.S. and Holmes, W.E. 2000. Atmospheric CO<sub>2</sub> and the composition and function of soil microbial communities. Ecol. Appl., 10:47-59.
- Howell, C. R. 2003. Mechanisms employed by *Trichoderma* species in the biological control of plant diseases: the history and evolution of current concepts. Plant Dis. 87: 4-10
- Hoyos-Carvajal, L., Ordua, S. and Bissett, J. 2009. Growth stimulation in bean (*Phaseolus vulgaris* L.) by *Trichoderma*. Biol. Control, 51: 409-416.
- Ilias, G. N. M, Rahman, M. A., Molla, A. H., Begum, M. F. and Alam, M. F., 2005. Composting of Municipal Garbage by using *Trichoderma*- A new approach in context of Bangladesh, Bangladesh j. genet. Biotech. 6 (1&2): 75-78.

- Ingham, R. E., Trofymow, J. A., Ingham, E. R. and Coleman, D. C. 1985. Interactions of bacteria, fungi and nematode grazers: effect on nutrient cycling and plant growth. *Ecol. Monogr.* 55: 119-140.
- Jairajpuri, S. M. and Ahmad, W. 1992. *Dorylaimida: Free-living, Predacious and Plant-Parasitic Nematodes*. E. J. Brill, Leiden, The Netherlands.
- Kabir, K. H., Baksh, M. E., Rouf, F. M. A. and Ahmed, A. 1996. Insecticides use pattern in vegetables at farmers level of Jessore region in Bangladesh. *Bangladesh J. Entomol.* 7 (1&2), 214-254.
- Kimpinski, J. and Sturz, A. V. 2003. Managing crop root zone ecosystems for prevention of harmful and encouragement of beneficial nematodes, *Soil Till. Res.* 72: 213–221.
- Maurya, K. R., S. Barooah, R. K. Bhattacharya, and R.K. Goswami. 1985. Standardization of male plant population in pointed gourd. *Ann. Agr. Sci.* 30:1405–1411.
- Mian, I H. and Rodriguez-Kabana, R. 1982. Organic amendments with high tannin and phenolic contents for control of *Meloidogyne arenaria* in infested soil. *Nematropica* 12: 222-234.
- Muniappan, R. 2012. Use of *Trichoderma* in Agriculture. *In: Proceeding of 7th International IPM symposium on IPM on the world stage, held in March 27-29, 2012, Memphis, Tennessee, USA* page 48.
- Nahar M. S. Rahman, M. A., Yasmin, L., Afroz, M., Rezaul Karim, A. N. M. and Miller, S. A. 2010b. IPM system on nematode trophic in soil ecosystem. *Bangladesh J. Plant Path* 26 (1&2): 15-21.
- Nahar, M. S. Rahman, M. A., Ilias, G. N. M., Rahaman, M. A., Yasmin, L., Afroz, M., Rezaul Karim, A. N. M. and Miller, S. A. 2010a. Effect of Tricho-compost on soil borne diseases and production of some vegetable crops. *Bangladesh J. Plant Path* 26 (1&2): 1-7.
- Rahman, A., Begum, M. F., Rahman, M., Bari, M. A., Ilias, G. N. M. and Alam, M. F. 2009. Isolation and identification of *Trichoderma* species from different habitats and their use for bioconversion of solid waste, *Turk J. Biol.* 35 (2011) 183-194
- Rashid, M. A., Ahmed S., Halim, G. M. and Zaman, Q. 2008. *Vegetable production manual*. Vegetable Division. Bangladesh Agricultural Research Institute, Joydebpur, Gaszipur 1701. 342 p.
- Rini, C. R. and Sulochana, K. K. 2007. Usefulness of *Trichoderma* and *Pseudomonas* against *Rhizoctonia solani* and *Fusarium oxysporum* infecting tomato, *J. Tropic. Agri.* 45 (1-2): 21-28
- Samalo, A. P. and P. B. Parida. 1983. Cultivation of pointed gourd in Orissa. *Indian Farming* 33:29–31
- Samalo, A. P. and Parida, P B 1983. Influence of spacing and levels of Nitrogen on vine borer incidence and yield of pointed gourd. *Indian J. Agric Sci.* 53(7): 574-577.
- Shepherd, A. M., 1970. Preparation of nematodes for electron microscopy. In: Southey JF (ed) *Laboratory methods for work with plant and soil nematodes*, HMSO, London, pp. 88-95.
- Siddiqi, M. R. 1986. *Tylenchida: Parasites of Plants and Insects*. CAB International, Slough, UK.

- Singh, A. K., R.D. Singh, and J. P. Singh. 1989. Studies on floral biology of pointed gourd (*Trichosanthes dioica* Roxb.). *Vegetable Sci.* 16:185–190.
- Singh, A. 1986. Change detection in the tropical forest environment of northeastern India using Landsat. In *Remote Sensing and Tropical Land Management*, edited by M. J. Eden and J. T. Parry (London: John Wiley & Sons), pp. 237-254.
- Skidmore, A. M. and Dickinson, C. M. 1976. Colony interactions and hyphal interference between *Sepatoria nodorum* and phylloplane fungi. *Trans. Br. Mycol. Soc.* 66:57-64.
- Sultana, J. N., Pervez, Z., Rahman, H. and Islam, M. S. 2012. *In-Vitro* Evaluation of Different Strains of *Trichoderma harzianum* and *Chaetomium globosum* as Biological Control Agents Seedling Mortality of Chilli. *Bangladesh Res. Pub. J.* 6(3): 305-310.
- Wasilewska, L. 1971. Trophic classification of soil and plant nematodes. *Wiad. Ekol.* 17: 379–388.
- Yadav, J. P., K. Singh, R. C. Jaiswal, and K. Singh. 1989. Influence of various spacings and methods of training on growth and yield of pointed gourd (*Trichosanthes dioica* Roxb.). *Vegetable Sci.* 16:113–18.
- Yeates G. W., Bongers T, De Goede, R. G. M., Freckman, D. W. and Georgieva, S. S. 1993. Feeding habits in nematode families and Genera – an outline for soil ecologists. *J. Nematol.* 25: 315–331.