

## Livelihood improvement of farming community in *Haor* Area through system approach

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### Abstract

The Livelihood Improvement of Farming Community in *Haor* Area through System Approach (LIFCHASA) Project of the Department of Agronomy, Bangladesh Agricultural University, Mymensingh worked in Purbo Tethulia village of Mohanganj upazila, Netrakona district from April 2010 to June 2013 with the financial assistance from the National Agricultural Technology Project, SPGR Subproject, Bangladesh Agricultural Research Council with the following objectives i. Increase productivity of field crops, vegetables, livestock and fishes in a household through the use of appropriate technologies and techniques devised/ developed/ designed/ refined by the farmers for ensuring household food security and nutritional upliftment and raising income ii. Diversify enterprises, mobilize resources and intensify farming and non farming activities for *in situ* employment generation iii. Conserve farm environment through efficient mobilization and management of natural resources for sustainable production systems iv. Develop human resources for capacity building of the participants and improve their livelihood through system approach. Research programme was finalized in the Bench Mark Survey Workshop. Farmer selection for different research activities was done as per plan for different five components. The Crop and Agroforestry component conducted experiments both in the homestead land and crop land. In the homestead area, year round vegetables were intervened through community trial for the last three years. Production of timber trees like mahogany, lambu and fruit trees like mango, guava, jujube, litchi, lemon, papaya and jack fruit was also practiced. Timber trees are now at growing stage and among the fruit trees some like papaya, jujube, and lemon are at bearing stage. *African dhaincha* was introduced around homestead fallow/waste land to protect homestead area from wave thrust and to produce biomass fuel. Field trials on rice, vegetables, spices and oil crops were conducted to intensify and diversify the cropping pattern and as well as to utilize the fallow/waste land of the research site. Under livestock component, experiments were conducted on rearing of egg producing hen, duck, fattening of animals, milching animal, artificial insemination and chemical evaluation of available feedstuffs. A continuous vaccination programme against common diseases of poultry was maintained throughout the study period. Farmers' response was very positive towards the experimental results. In the fisheries component, experiments on cage culture in open water, perennial and seasonal pond culture, dry fish and fish pickle were conducted/ done for last three years. . Among the experiments cage culture in open water proved to be a promising technology and fish pickle was highly appreciated in panel test. For the rural hydrology and mechanization component four studies were conducted. The physico-chemical properties of farm land and homestead soils were determined. Additional application of sulphur (S) and zinc (Zn) fertilizers were found not required. Both the surface and groundwater characteristics were studied. The maximum flood water depth was found around 3.50 m at farm land. Irrigation facilities developed by installing a shallow tubewell (STW) resulted higher crop production and motivated farmers to install four new STWs by their own capital. All the households (462) of Purbo Tethulia were intervened from the project. The interventions were either by crop, vegetable, livestock, poultry and fish farming. It was observed that as the

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number of enterprises increased in the farming system, the income also increased. The evidence also showed that the training of the beneficiaries increased their knowledge and skill.

## **Development of dry bed direct seeded boro rice production system towards saving irrigation water and attaining food security**

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### **Abstract**

Boro rice is cultivated in puddle transplanted conventional irrigation (PTR-CI) system. The water scarcity in *boro* season has posed a serious threat to the sustainability of boro rice production. Very recently, dry bed direct seeded boro rice production system has been developed. This system provides an opportunity of producing boro rice with 55% less irrigation major concern of this new technology. In addition, standing water of 2-5 cm is maintained during early reproductive phase (panicle initiation (PI) to heading (H) stage) in the new system, but timing and duration of keeping standing water has not yet been standardized. Three experiments were conducted at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh during 2012-13 boro season using BRRI dhan28 as test crop. The crop was sown at 25cm × 15cm spacing. The unit plot size was 4.0 × 2.5 m for all the experiments. A split-plot design was used in experiment 3 while RCBD was used in other experiments. The experiments are: (1) Effect of Trichoderma and fungicide application on seedling establishment and yield performance of dry direct seeded boro rice, (2) Effect of sowing date on seedling establishment and yield performance of boro rice, and (3) Effect of irrigation scheduling during early reproductive phase on yield performance of boro rice and Experiment 1 included 10 treatment combinations of Trichoderma inoculum, Sulphur fungicide and Propiconazole fungicide. The result showed that seed treatment with Trichoderma harzanium @ 4% before sowing helped obtaining highest seedling establishment as well as yield in boro rice cv. BRRI dhan28. Experiment2 comprised eight sowing dates at 15 days interval from 25 November 2012 and four varieties viz. BRRI dhan28, BRRI dhan29, Hybrid dhan hira 2 and BRRI hybrid dhan3. Hybrid dhan hira 2 appeared as the best variety. However, all these varieties gave high yield for sowing during 23 January and 7 February although BRRI dhan 29 gave high yield for sowing before 23 January. In experiment 3, there were 10 irrigation treatments which included maintaining of standing water for 0, 5, 10, 15, 20, 25, and 30 days after PI; PTR-CT and AWD (alternate wetting and drying) both in conventional transplanted and dry direct seeded system. Result revealed that dry direct seeded rice gave higher yield than the puddle transplanted one. In dry direct seeded system, keeping standing water for 15 days from PI appeared as the best practice. During 2010-11 and 2011-12 a number of experiments were to develop of different agronomic management practices. Using the best agronomic management practices developed out of the two years experiments, field demonstrations of the dry direct seeded boro rice cv. BRRI dhan 28 were conducted in farmers' field at Sutiakhali of Sadar upazilla and Bakshimul of Fulpur upazilla under Mymensingh district. The trial at farmers' field showed better performance of dry direct seeded rice over conventional transplanted flood irrigated rice.

## **Popularization of Quality Protein Maize (QPM) with conservation tillage under indigenous mulches for food security of char-communities**

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### **Abstract**

It has been reported that cucumber residues can provide excellent weed suppression after incorporation of their residues into the soil. But in Bangladesh most of the cucumber plants are discarded after harvesting the cucumber fruits. Therefore, a laboratory experiment was carried out to observe the effect of cucumber plants especially leaves on the germination and growth of cress, alfalfa and barnyardgrass. Cucumber plants especially leaves were collected from farmers' field after final crop harvest. Then the plants were dried at 50°C for 3-4 days. Dried cucumber plants were soaked in distilled water in the ratio of 0, 2.67, 4.00 and 5.33 g of dry cucumber to 1 L of distilled water for 7 days. Dried cucumber plants were also soaked in distilled water in the ratio of 4.0 g of dry cucumber plants to 1 L of distilled water for 0, 3, 5, 7, 9 and 11 days. Then the suspension was filtered with filter paper. Nine mL extract solution was added on to a 90 mm filter paper which was poured in a 90 mm Petri dish. Then 20 seeds of cress, alfalfa or barnyardgrass were placed on the filter paper and incubated for 72 hours around 25°C temperature. Control seeds were also incubated in the same way where distilled water was added on the filter paper instead of cucumber extract solution. After 72 hours germination percentage and shoot and root length of cress, alfalfa and barnyardgrass were measured. The water extract of cucumber plants inhibited the germination, shoot and root growth of cress, alfalfa and barnyardgrass under Petri dish condition. The inhibition increased with increasing soaking period up to 9 days and decreased thereafter. The inhibition in respect of germination, shoot and root growth of cress, alfalfa and barnyardgrass also increased with the increasing extract concentration of the cucumber plants. These results indicate that growth inhibiting substances might leach from cucumber plants into water solution and act as allelopathic substance. Therefore, cucumber plants might be potentially useful for weed management in rice field. But further field studies are needed for practical application of the observed results.

## **Effects of municipal solid waste compost, fertilizers, *Rhizobium* and *Trichoderma* on the growth, yield and N content of wheat**

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### **Abstract**

The effects of municipal solid waste compost (MSW), fertilizers, *Rhizobium* and *Trichoderma* on the growth, yield, N content and N uptake of wheat was studied through a field experiment at the Soil Science Field Laboratory of Bangladesh Agricultural University (BAU farm), Mymensingh during December 2012 to March 2013. The soil belongs to the Sonatala soil series under the AEZ-9 (Old Brahmaputra Floodplain). There were 10 treatments such as T<sub>0</sub>

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= control, T<sub>1</sub> = 100% recommended doses of fertilizer (RDF), T<sub>2</sub> = 100% RDF + compost @ 5 t ha<sup>-1</sup>, T<sub>3</sub> = 100% RDF + *Rhizobium*, T<sub>4</sub> = 100% RDF + *Trichoderma*, T<sub>5</sub> = 100% RDF + *Trichoderma* + *Rhizobium*, T<sub>6</sub> = 100% RDF + compost @ 5 t ha<sup>-1</sup> + *Rhizobium*, T<sub>7</sub> = compost @ 5 t ha<sup>-1</sup> + *Rhizobium* + *Trichoderma*, T<sub>8</sub> = 50% RDF + compost @ 5 t ha<sup>-1</sup> + *Rhizobium* + *Trichoderma*, T<sub>9</sub> = 100% RDF + compost @ 5 t ha<sup>-1</sup> + *Rhizobium* + *Trichoderma*. The experiment was laid out in the Randomized Complete Block Design with three replications. Phosphorus, potassium, sulphur, zinc and boron were applied as basal dose from TSP, MoP, gypsum, zinc sulphate and boric acid @, 25 kg P, 75 kg K, 15 kg S, 2 kg Zn and 1 kg B ha<sup>-1</sup>, respectively. Nitrogen as urea was applied @ 100 kg ha<sup>-1</sup> to the plots as per treatments. Wheat seeds under the treatments T<sub>3</sub>, T<sub>5</sub>, T<sub>6</sub>, T<sub>7</sub>, T<sub>8</sub> and T<sub>9</sub> were inoculated with *Rhizobium* strains and that under the T<sub>4</sub>, T<sub>5</sub>, T<sub>7</sub>, T<sub>8</sub> and T<sub>9</sub> treatments with *Trichoderma*. Data were collected on plant height, spike length, spikelets spike<sup>-1</sup>, filled grains spike<sup>-1</sup>, grain yield, and straw yield. The N contents in grain and straw were determined and the total N uptake was calculated. Application of MSW compost, fertilizers, *Rhizobium* and *Trichoderma* significantly increased the growth parameters, yield, N content and N uptake of wheat over control. The grain and straw yields of wheat due to different treatments ranged from 855 to 4026 kg ha<sup>-1</sup> and 923 to 4113 kg ha<sup>-1</sup>, respectively. The per cent increase in grain yield of wheat over control due to different treatments ranged from 34% to 371%. Application of compost @ 5 t ha<sup>-1</sup> combined with *Rhizobium*, *Trichoderma* and 100% recommended dose of fertilizers (T<sub>9</sub>) produced the highest grain yield of 4026 kg ha<sup>-1</sup> which was superior to all other treatments. The same treatment also gave the highest N uptake by wheat (106.35 kg ha<sup>-1</sup>).

## Sustainable crop production in salinity affected areas of southern Bangladesh through organic and inorganic amendments

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### Abstract

Salinity is a major limiting factor reducing crop yields in coastal areas of Bangladesh. The main objective of this project was to mitigate the adverse effects of soil salinity by organic and inorganic amendments for sustainable crop production. The field experiments were conducted at BRRI station, Sonagazi, Feni with boro rice and wheat crops. Two rice (salt-sensitive; BRRI dhan45 and salt-tolerant; BRRI dhan47) and two wheat (BARI Gom-23 and BARI Gom-25) varieties were used as plant materials. Farmyard manure (FYM) and compost were added to the soils during final land preparation. Gypsum and sulphate of potash were applied in two splits as per treatments. Nitrogen, phosphorous, zinc and boron fertilizers were applied as basal dose. The experiments were laid out in a randomized complete block design with three replications. Soil salinity caused a reduction in growth and yield of boro rice and wheat. BRRI dhan47 (salt tolerant) cultivar comparatively produced higher grain yield than salt sensitive (BRRI dhan45). BARI Gom-23 and BARI Gom-25 performed similar in producing grain and straw yields. Soil amendments with organic or inorganic fertilizers improved growth and yield of rice and wheat under soil salinity. Combined application of organic and inorganic fertilizers showed higher yields of rice and wheat than that of alone during salinity conditions. Both organic and inorganic fertilizers increased nutrient uptake and K<sup>+</sup>/Na<sup>+</sup> ratio in rice and wheat during salinity conditions. Therefore, the present study

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suggests that sustainable crop production might be feasible in coastal areas of southern Bangladesh through organic and inorganic amendments of saline soils.

## **Organic amendments for mitigating soil salinity in rice-maize cropping system**

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### **Abstract**

Salinity causes cellular damage, limiting crop productivity. Accumulation of organic compound is one of the adaptive mechanisms to salinity in plants. The main objective of this project was to mitigate the adverse effects of soil salinity in rice and maize through organic amendments. The field experiments were conducted at the farmer's field of Botiaghata, Khulna with aman and boro rice and maize crops. Four rice (salt-sensitive; BR-23, Mohini & BRRI Dhan29 and salt-tolerant; Binadhan-8) and two hybrid maize varieties (BARI hybrid maize-5 and BARI hybrid maize-9) were used as plant materials. Proline was applied as a foliar spray at a volume of 25 mL per plant at seedling and/or vegetative stages. Farmyard manure (FYM) and poultry manure (PM) were added to the soils during final land preparation. The experiments were laid out in a randomized complete block design with three replications. Salinity caused a significant reduction in growth and yield of T. aman and boro rice. BR-23 (aman rice) produced higher yield than other rice varieties under salinity conditions. Local cultivar Mohini produced the lowest yield under salinity conditions. Application of proline significantly increased growth, and grain and straw yields of both aman and boro rice under salinity conditions. Soil amendments with FYM and PM also increased grain and straw yields of rice during aman and boro seasons. There were no considerable variations in growth and yield of rice due to the different doses of proline and manures. Increased nutrient uptake and  $K^+/Na^+$  ratio in aman and boro rice were observed due to proline application and organic manures. Similar to rice, soil salinity significantly reduced the growth and yield of maize whereas application of proline and organic manures increased the growth and yield of maize under saline condition. Significant increases in nutrient uptake and  $K^+/Na^+$  ratio in maize were observed due to organic amendments with proline and manure. The present study suggests that organic amendments with proline or manure improve salt tolerance in rice and maize by increasing  $K^+/Na^+$  ratio and nutrient uptake.

## **Development of a rapid in-field colorimetric method for soil organic matter determination**

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### **Abstract**

Most of the methods to determine soil organic carbon content are constrained by the time or required equipment, thereby limiting their use in determining soil organic carbon at field level. Therefore, a laboratory study was carried out in the Department of Soil Science of Bangladesh Agricultural University at Mymensingh for developing a low cost quick method for determining soil organic matter at field level. For this purpose, initially 47 soil samples were

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collected from different AEZ covering a sufficient range in texture, soil organic matter and pH for the development of the colour chart. First, three extractants namely NaOH, NaOH + EDTA and NaOH + Pyrophosphate + HCl were tested with soil dilution ratio of 1: 50, 1: 100 and 1: 200 to select a suitable extractant and soil:extractant ratio for extracting organic matter from soil that produced a colour solution. Then a coloured chart was developed based on the coloured solution of soil aliquots of the best performed soil extractant and soil:extractant ratio. Finally, the developed coloured chart was validated by using a set of 16 newly collected soil samples. Humic acid was used as a proxy of soil organic matter for the preparation of standard series and soil organic carbon measurements by CNS analyser were used as reference measurement for comparison of the efficacy of newly developed method. Both the extractant solution and soil dilution showed different degrees of error in OC measurement. Based on both correlation co-efficient and error sum square, NaOH + Pyrophosphate + HCl solution was found as the best extracting solution at 1: 50 dilution. It was observed that the NaOH+ Pyrophosphate + HCl extracts are a coloured solution and these colours are easily visible or detectable by naked eye. More interestingly, it was found that the intensity of the colour increased with the increase of soil organic matter content. Therefore, a colour chart was developed based on the variations in intensity of colour of the soil extracts. This colour chart consists of 4 distinguish colour panel that corresponds to >1 (very low), 1-1.7 (low), 1.8-3.5 (medium) and <3.5 % (high) organic matter as classified by BARC (2005). Furthermore, the developed coloured chart was validated by using a set of 16 newly collected soil samples. The validation test showed that organic matter content as measured by colour chart in 14 soil samples out of 16 matches well with the organic matter content measured by wet oxidation method representing an accuracy of 87.5%. However, further fine tuning is necessary of the developed colour chart with an extensive validation using a large set of soil samples covering all AEZ, wide range in soil type, management and soil texture before recommendation to the farmers.

## **Integrated and balanced use of manures and fertilizers for sustenance of soil fertility and crop productivity in the Rice-Rice and Wheat- Rice systems**

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### **Abstract**

Two independent experiments were carried out at the Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh in 2011-12 and 2012-13 to evaluate the effect of integrated and balanced use of manures and fertilizers for sustenance of soil fertility and crop productivity in the Rice-Rice and Rice-Wheat systems. The manures used were cowdung (CD), poultry manure (PM) and compost (Com) and the fertilizers used were urea, TSP, MoP, gypsum, ZnO and boric acid. The soils of the experimental site 1 and experimental site 2 belong to Sonatala Series having silt loam texture. Both the experiments had six treatments laid out in a Randomized Complete Block Design (RCBD) with four replications. The treatments were T<sub>0</sub> (Control), T<sub>1</sub>: STB-CF (Soil Test Basis-Chemical Fertilizer) (High Yield Goal, HYG), T<sub>2</sub>: OM1 (Organic Matter) (Cowdung, CD) + STB-CF (HYG), T<sub>3</sub>: OM2 (Poultry Manure, PM) + STB-CF (HYG), T<sub>4</sub>: OM3 (Compost, CoM) + STB-CF (HYG) and T<sub>5</sub>: FP (Farmers' Practice). The results demonstrate that application of manures and fertilizers

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significantly increased the grain and straw yields of rice and wheat over control in both Rice-Rice and Rice-Wheat systems. The treatment T<sub>3</sub> receiving poultry manure in combination with soil test basis chemical fertilizers produced the highest grain yield of rice (5070 kg/ha) and wheat (3362 kg/ha) in Rice-Wheat system while the grain yield of Aman rice (5040 kg/ha) and Boro rice (5651 kg/ha) in Rice-Rice system. The uptake of NPKS was also increased due to the application of manures and fertilizers. In addition to increasing crop yield and nutrient uptake, soil properties were also improved due to integrated use of manures and fertilizers. So it can be recommended that integrated use of manures and fertilizers can be practiced for the sustenance of crop productivity and soil fertility.

## Evaluation of different indigenous plant extracts against *Sitophilus oryzae* L. and isolation and identification of active compound(s) from the most promising plant

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### Abstract

Experiments were carried out at the laboratory of the Department of Entomology, Bangladesh Agricultural University (BAU) and Entomology Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, during the period of July, 2011 to June, 2013. The n-hexane, dichloromethane (DCM) and methanol extracts of leaf and seed/fruit of Karanja, *Pongamia pinnata* (L.); Mahogany, *Swietenia mahogani* Jacq.; Neem, *Azadirachta indica* A. Juss and Urmoi, *Sapium indicum* Willd. at 2.0, 4.0, 6.0, 8.0 and 10.0% (w/v) concentrations were evaluated for their insecticidal, repellent, antifeedant and residual effect against rice weevil, *Sitophilus oryzae*. The result showed that extracts of all the four tested plants had insecticidal, repellent, antifeedant and residual effects on the pest. Among the test plants, Urmoi showed the highest toxic effect (mortality, 47.00%), whereas Mahogany possessed the lowest toxic effect (mortality, 35.56%) for rice weevil at 72 HAT. Among the solvents, dichloromethane extract showed more toxicity than other extracts. Mortality percentage increased with the progress of time. The seed/fruit extract was more toxic than leaf extract. Comparing the extracts, the highest repellency (repellency, 56.17%) was observed in urmoo fruit extract and lowest (repellency, 31.82%) on karanja on rice weevil (repellency 56.17%). The results also showed that urmoo plant extract had the highest antifeedant effects and neem showed lowest antifeedant effects having total coefficient of deterrence 126.52% and 89.20%, respectively. Among the extracts, urmoo plant extract had the highest residual effects on the rice weevil. No F<sub>1</sub> adult emergence & grain infestation and the highest inhibition were found in rice grains treated with 10% urmoo plant extract. In case of repellent, antifeedant and residual effect n-hexane, dichloromethane and methanol extract, respectively was the most effective. The effectiveness of most of the plant extracts were found to increase proportionately with the increase of doses and decreases proportionally with the increase of time. The seed/fruit extract was more effective than that of leaf extract. Urmoo fruit powder (200 g) was extracted with dichloromethane (DCM; RT, 24 h) and the extract was evaporated to dryness to get solid material (17.5g). The DCM soluble part was fractionated by solvent-solvent partition into two parts; aqueous 90 % methanol and n-hexane soluble parts. Both fractions were subjected to perform bioassay which showed insecticidal and feeding deterrent activity. The n-hexane soluble part extract showed highest mortality (100%) and total co-

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efficient of detergency was 173.66% whereas 90% aqueous methanol part showed 50% mortality and total co-efficient of detergency was 150.89%. n-Hexane soluble part on silica gel column chromatography yielded twelve fractions in varying amounts. From the 4<sup>th</sup> (compound I: Dibutylphthalate), 5<sup>th</sup> [compound III: Bis (3'-methyl-5'-ethyl-octyl) phthalate], 6<sup>th</sup> & 9<sup>th</sup> fractions four pure compounds were isolated. The methanol soluble part was (3.0g) also subjected to silica gel column chromatography and five fractions were obtained. The fourth fraction was again fractionated by column chromatography and five fractions (MS<sub>1</sub>, MS<sub>2</sub>, MS<sub>3</sub>, MS<sub>4</sub> and MS<sub>5</sub>) were obtained. Two pure compounds were isolated from the 3<sup>rd</sup> and 4<sup>th</sup> (compound II: Dioctylphthalate) fractions of MF<sub>4</sub> (860 mg). The structures of the three compounds were determined by FTIR, LC-mass and High Resolution NMR spectroscopic methods including H-H & C-H COSY, HSQC and HMBC.

### **Screening of okra varieties for resistance against shoot and fruit borer, *Earias vittella* (F) and its integrated management**

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#### **Abstract**

A study was conducted to find out the population abundance, host preference and effectiveness of different insecticides against okra shoot and fruit borer, *Earias vittella* in the field Laboratory, Department of Entomology, Bangladesh Agricultural University, Mymensingh during January to June 2013. For host preference, varieties- BARI-1, Arka Anamika and two hybrid varieties such as Green Finger and Taj Vendhi were used. Among three varieties, Arka Anamika was found to be more resistant (shoot and fruit damage was 7.50 % and 15.33%, respectively) to okra shoot and fruit borer. Variety BARI-1 was found similarly resistant to Arka Anamika. The least resistant variety was Taj vendi (shoot and fruit damage was 24.09% and 33.43% respectively). To manage the OSFB two chemical insecticides and three botanicals were used in bioassay test. Effectiveness of two synthetic insecticides (Decis 2.5 EC and Agritaf 75 WP) and three botanicals (Neem oil, Pitraj oil and Mahogoni oil) were evaluated to control okra shoot and fruit borer. The highest efficacy was found against OSFB in Decis (10.65% & 10.08% shoot & fruit infestation) treated plots followed by Neem oil (13.02% & 10.89% fruit infestation) treated plot and the lowest (23.78% & 33.43% shoot and fruit infestation) efficacy of observed in control plot. Among the botanicals and insecticides the least efficacy was found in Mahogoni oil (14.89% & 11.89% shoot and fruit infestation) treated plot. Besides, a parasitoid *Trichogramma chilonis* and light trap were used to manage OSFB in a safer way. In this study both the two treatments were found similarly effective against OSFB.

## Temperature dependent development and life history traits of *Oligonychus biharensis* (Hirst) (Acari: Tetranychidae)

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### Abstract

Development and reproductive attributes of *Oligonychus biharensis* (Hirst) (Acari: Tetranychidae) was investigated in the laboratory on bean, at different temperatures. *O. biharensis* was able to develop and complete its life cycle at 17.5, 20, 22.5, 25, 27.5, 30 and 32.5±1°C. At 15, and 35°C, the eggs hatched but further development was arrested. The developmental time for egg to adult was the longest at 17.5°C and shortest at 30°C for both males and females. The optimal developmental temperatures (HD) estimated for egg-to-female adult, egg-to-male adult and egg-to-egg development were 31.3, 30.7, and 31.4°C respectively. The net reproductive rates ( $R_0$ ) were 25.70, 33.68, 55.97, 18.22, and 3.38 females per female, respectively. The lower thermal threshold ( $t_0$ ) was 12.36, 12.61 and 12.77°C for egg, egg to adult and egg to egg respectively. Thermal constant ( $K$ ) for the development of *O. biharensis* was 65.55, 143.48 and 156.61 degree day for egg, egg to adult and egg to egg. The intrinsic rate of natural increase  $r_m$ , became high ranging from 0.0782 at 17.5 °C to 0.2458 at 25°C. The intrinsic rate of natural increase ( $r_m$ , day<sup>-1</sup>) and finite rate of increase ( $\lambda$ ) increased with raising temperature from 17.5 to 25°C and then decrease to 32.5°C. These values suggested that *O. biharensis* could be growing quickly in response to increase temperature from 17.5 to 25 °C and provide a basis for predicting the potential geographical range.

## Carrot and onion seed production and related post-harvest innovations to provide well adapted and nutritious vegetables for Bangladesh

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### Abstract

Cytoplasmic male sterility is imperative for successful onion and carrot hybrid seed production. In 2013, molecular markers evaluated clearly identified male sterile and fertile cytoplasm in a collection of Bangladeshi onions. Eight male sterile accessions were identified to form the foundation for onion seed production in Bangladesh. Establish Bangladesh oriented crop production and post-harvest storage guidelines and manuals, programs and cell phone based information to integrate water, nutrient and pest management practices that optimize inputs, minimize off target impacts, and provide sound post-harvest storage practices for seed production. Evaluation of root pruning effects on carrot seed yield, based on preliminary indications this influences seed yield in Bangladesh. Sample evaluation has been completed for last year and initiated for this year. Field trial of onion and carrot in Bangladesh is ongoing by MS and PhD students. Development of plans to evaluate post-harvest storage conditions suitable to preserve and vernalize the carrot and onion crops to induce flowering, and applicable for use in Bangladesh. Samples for vernalization studies

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were grown and collected; evaluation completed. Trials in Bangladesh to evaluate agronomic practices on onion and carrot seed crop productivity are being planned and planted. Identifying germplasm and developing methods for successful carrot and onion seed production will be a milestone to improve the nutritional food security and enhance the rural economy of Bangladesh

## **BAU-Germplasm Centre, Fruit Tree Improvement Program (FTIP)**

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### **Abstract**

Over the past 20 years BAU-GERMPLASM CENTER (BAU-GPC) - FTIP has developed a vast array of improved and conserved resources and science based appropriate technology for fruit tree propagation. Last year, a large number of germplasm have been collected from inside the country as well as outside the country such as USA, Srilanka, Thailand, Laos, India, Pakistan, China and Saudi Arabia. The collected germplasm were planted at the BAU-Germplasm Centre. A survey study has been conducted at the coastal and hilly areas through prescribed questionnaire. A number of germplasm has also been collected from both the areas. The collected germplasm are Kawphal, Monkey jack, River ebony, Velvet apple, Sapota, Pummelo, Wood apple, Custard apple, Golden apple, Bullock's heart, Wax jambu, Mango, Guava, Elephant apple, Star gooseberry, Burmese grape, Carambola, Jamun, Pomegranate, Karanda, Bael, Indian olive, Roktogota, Peyalagota, Chinaduly, Lotkon, Coagula, Budumchua etc. A number of MS and Ph.D. students are conducting their researches on "Morphological study of collected fruit tree germplasm, postharvest behavior of selected fruit tree germplasm, molecular characterization and standardization of propagation techniques of underutilized and endangered fruit tree germplasm". Different systematic approaches like sapling distribution, exchange visit, motivational tour, and demonstrations were performed for implementation of the project. Presently 13 Ph.D and 38 MS students are doing their research from different discipline on conservation, bio-diversity, integrated crop management, post harvest technologies, fruit processing and species selection as well as suitability of multistoried cropping system

## **Collection, conservation, characterization and evaluation of underutilized fruit tree germplasm for coastal and hilly areas of Bangladesh**

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### **Abstract**

Bangladesh Agricultural University Germplasm Centre (BAU-GPC) is implementing a three years project funded by BAS-USDA since January 2011 to find out suitable underutilized fruit tree varieties of coastal and hilly areas of Bangladesh and conserve germplasms at BAU-GPC. A survey study has been conducted at the coastal and hilly areas through prescribed

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questionnaire. A large number of germplasm have been collected from both the areas. The collected germplasm are Kawphal, Monkey jack, River ebony, Velvet apple, Sapota, Pummelo, Wood apple, Custard apple, Golden apple, Bullock's heart, Wax jambu, Mango, Guava, Elephant apple, Star gooseberry, Burmese grape, Carambola, Jamun, Pomegranate, Karanda, Bael, Indian olive, Roktogota, Pyalagota, Chinaduly, Lotkon, Coagula, Budumchua etc. All these germplasm were planted at the BAS-USDA plot in BAU-GPC. Research-students are conducting their research on "Morphological study of collected fruit tree germplasm, postharvest behavior of selected fruit tree germplasm, molecular characterization and standardization of propagation techniques of underutilized and endangered fruit tree germplasm of coastal and hilly regions". Results showed that maximum success was found in air layering (85-95%) on guava, wax Jambu, golapjam and stargooseberry followed by cleft grafting (80-90%) on mango, pummelo, sapota, woodapple, lotkon, peyalgota and custard apple where as success of stem cutting and root cutting were less (0-62%). Results on studies of postharvest behavior of fruits like lotkon, cowa, aonla, waxjambo, dewa, roktogota, sapota etc. showed that shelf life of fruits in transparent polybag at 10°C in incubator wax maximum.

## Molecular study of *Pseudomonas syringae* pv. *syringae* causing leaf blight of litchi and mango in Bangladesh

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### Abstract

Leaf blight of litchi and mango caused by *Pseudomonas syringae* pv. *syringae* seems to a great threat for raising quality and healthy saplings of litchi and mango in Bangladesh. Molecular based analysis was done using the primer 62538038 for characterization of *Pseudomonas syringae* pv. *syringae* causing leaf blight of litchi and mango in Bangladesh. Random Amplified Polymorphic DNA (RAPD) technique was used as a tool. In this study, to know the molecular characterization of bacterial leaf blight of litchi in five locations viz. Rajshahi, Dinajpur, Mymensingh, Barishal and Khagrachori and mango of another five locations viz. Rajshahi, Dinajpur, Mymensingh, Bogra and Rangpur in Bangladesh. In case of litchi, in Barishal region, from the UPGMA dendrogram based on Nei's (1972) genetic distances, Isolate 4 was close to the Isolate 5 with the least genetic distance (0.1111). In Dinajpur region, from the UPGMA dendrogram based on Nei's (1972) genetic distances, Isolate 4 was highest far to the Isolate 5 with the highest genetic distance (1.0000). In Khagrachari region, from the UPGMA dendrogram based on Nei's (1972) genetic distances, Isolate 4 was close to the Isolate 5 with the least genetic distance (0.0000). In Mymensingh region, from the UPGMA dendrogram based on Nei's (1972) genetic distances, Isolate 4 was close to the Isolate 5 and Isolate 2 was close to the Isolate 5 with the least genetic distance (0.0000). In Rajshahi region, from the UPGMA dendrogram based on Nei's (1972) genetic distances, Isolate 4 was close to the Isolate 1 with the least genetic distance (0.2000). The values of pair-wise comparisons of Nei's (1972) genetic distance between 5 different location of *Pseudomonas syringae* pv. *syringae* were computed. From the UPGMA dendrogram based on Nei's (1972) genetic distances, Dinajpur was close to the Barishal with the least genetic distance (0.3567). Thus, the results indicate that the lower or higher level of genetic distance exists among the isolates of *Pseudomonas syringae* pv. *syringae* causal agent of leaf blight of litchi with their different origins. In case of mango, the genetic variations of five

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isolates of *Pseudomonas syringae* pv. *syringae* obtained from five regions were analyzed using the primer RAPD markers by Polymerase Chain Reaction (PCR). The percentage of polymorphic loci was found different from one region to another. The percentage of polymorphic loci was found 80.36 in all regions. Mean diversity across all population for all the loci studied was 0.31. The co-efficient of gene differentiation ( $G_{st}$ ) was 1.00 reflecting the existence of high level of genetic variations among the genotypes. Comparatively the highest genetic distance (0.6931) was observed in Isolates of Rangpur vs. Isolates of Dinajpur; the lowest genetic distance (0.2877) was estimated in Isolates of Rangpur vs. Isolates of Bogra. Considering the genetic distance values; the results indicated that the isolates of five regions were genetically different from each other. The dendrogram (UPGMA) constructed from Nei's (1972) genetic distance produced 2 main clusters of five isolates from five regions. UPGMA dendrogram revealed that isolates of Rangpur, Bogra and Mymensingh form same cluster with least genetic distance. Dinajpur and Rajshahi produce another cluster with least genetic distance. Genetic distance among the isolates of Rangpur, Bogra and Mymensingh is found very near and genetic distance among the isolates of Dinajpur and Rajshahi is found very near which means these isolates may be virulent and their genetic variation is minimum. So the genetic variation among these isolates of different regions is low and indicating geographical variation among the isolates collected from different regions.

## **An integrated approach for the management of wilts and foot rot/collar rot of important vegetables**

**M. D. Hossain\* and M. B. Meah**

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### **Abstract**

Tricho-compost produced from municipal solid waste decomposed by *Trichoderma* when applied in the field @ 1000g/ m<sup>2</sup> resulted higher yield of tomato and cucumber with reducing the soil borne diseases. The influence of formulated *Trichoderma* (biopesticide) on the disease control and growth parameters of tomato, chili and Indian spinach was also studied in the field applying @ 0, 10, 15 & 20 g/m<sup>2</sup>. After one week of biopesticide application, 40-day old healthy seedlings were transplanted. At the flowering and fruiting stages of crops, observations were made on the growth parameters and disease incidence. Except plant height, the other growth parameters such as number of leaves, number of primary and secondary branches, number of flowers and fruits, weight of single fruit and fruit yield were markedly influenced by application of the biopesticide. Both soil-borne and foliar diseases were significantly reduced. Higher disease incidence and lower growth were observed in the untreated (control) plots. The highest dose (20g/m<sup>2</sup>) of biopesticide used in the experiment supported significantly better growth, higher yield and lower disease incidence. Training programme and field demonstration on formulation and mass production of *Trichoderma* were also successfully completed under this research project where farmer and plant doctors were participated.

## **Influence of physiological and environmental factors on growth and sporulation of antagonistic strains of *Trichoderma* spp.**

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### **Abstract**

Thirty isolates of *Trichoderma harzianum* collected from different locations of Bangladesh were studied for morphological and antimicrobial characters. Maximum mycelial growth was obtained by 12 isolates and their mycelial growth varied from 8.21 cm to 9.20 cm. Based on colony colour, isolates were grouped into five such as dark green, green, light green, yellowish green and whitish green. Lowest spore density was found in the isolates of green, light green and whitish green colour. Eleven (11) pathogenic fungi were isolated and purified. Among the 30 isolates of *Trichoderma*, three isolates were found having strong antifungal activity those can effectively control the growth of at least 11 pathogenic fungi. All 5 *Trichoderma* isolates were able to grow in all the tested 4 carbon sources. Galactose and Lactose yielded the lower performance than the other sugars. Isolate 2 yielded the lowest growth among the 5 isolates. Among the tested 4 fertilizers *Trichoderma* isolates exhibited their slightly retard growth in Urea. All 5 *Trichoderma* isolates were able to grow in all the tested K- salts, NH<sub>4</sub>-salts and weak acids. Potassium bi-carbonate, Potassium sulphate, Ammonium Sulphate and lactic acid yielded lower growth in all the isolates. The Lowest spore density was found in all the 5 *Trichoderma* isolates when heavy metal Copper Sulphate salt was treated. Isolate 2 was found most sensitive to all the tested heavy metal ions upto 200 ppm. Among the tested 32 fungicides Bavistin and Shincar inhibited the growth of all *Trichoderma* isolates under this experiments.

## **Study on the prevalence of storage fungi on true seeds of onion**

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### **Abstract**

Onion is a biennial crop. True seeds of onion are sown for bulbs production in the first to be used as planting material for true seed production in the second year. Seed samples were collected from the farmers field of different locations immediately after harvest. Seed were stored in different types of storage containers. Moisture content of the seed samples were determined by moisture meter. Seed borne and storage fungi were detected following blotter incubation method at 30 days interval. Four hundred seeds were tested from each sample. Germination test was done on sand medium. Normal, and abnormal seedlings were counted for germination of 400 seeds in sand medium. The incidence of *Alternaria porii* was high at the early stage of storage. The incidence of *Alternaria porii* was low after 60 days of sample collection. *Aspergillus niger* and *Penicillium notatum* were detected, their incidence were high

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in the samples which had high initial moisture content. Incidence of the storage fungi was high at the later stage of storage. Germination was high during the early stage of storage but low at the later stage of storage. The samples which had high initial moisture content had higher infection of *Aspergillus niger* and *Penicillium notatum*. Population of *Aspergillus niger* was higher than that of *Penicillium notatum* in all seed samples irrespective storage period.

## **Popularization of Quality Protein Maize (QPM) with conservation tillage under indigenous mulches for food security of char-communities**

**M. A. Halim Khan**

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### **Abstract**

Efficacy of indigenous mulches under conservation tillage on yield and Yield contributing characters of QPM accessions was evaluated at farmer's fields in the chars of Brammaputra and Jamuna basins in Mymensingh and Jamalpur districts during November 2012 to April 2013. Three promising QPM accessions, collected from CIMMYT (Mexico) and a BARI hybrid cv. 5 (QPM) were used in the experiment as planting materials. Water hyacinth, rice straw and weed stubbles were used as indigenous mulches each at the rate of 10t/ha. Data on microclimatic parameters and yield and yield attributes of QPM were recorded as and when required. The applied indigenous mulches viz. rice straw & water hyacinth (WH) had significant regulatory effects on soil temperature at the experimental sites. During day time air temperature increased sharply until about noon followed by a slow decrease in afternoon. All the mulches had a retardative effect on soil temperature during day time while during night time they had promotive effect resulting in 2-3°C higher temperature compared to unmulched plots. Unlike soil temperature, soil moisture also varied significantly with the mulches as well as the location. However, soil moisture in Jumuna Basin (Char Belgasa) was little bit higher than that in Brammaputah Basin (Char sirajabad and Char Dorikustia). The night time higher soil temperature together with higher moisture under mulches had most promising impact on the growth and development of maize plant leading to about 2-fold yield improvement over the control. The mean yield for all QPM as observed with water hyacinth mulch was the highest 7.66 t ha<sup>-1</sup>, followed by rice straw mulch 6.54 t ha<sup>-1</sup> and the lowest was 4.54 t ha<sup>-1</sup> in control.

## **Polyhouse technology for on-season and off-season production of high value crops in Bangladesh**

**M. A. Halim Khan**

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### **Abstract**

Experiment in a 15×4.5m prefabricated bamboo structure covered with polythene sheets (polyhouse) was conducted on Cucumber (*Cucumis sativa* L.) using hybrid cv. 'All-Rounder-2', 'Hira-905' and a local cv. 'Modhumoti' along with an equal size open field at the Field

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Laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh during the period from December 2012 to June 2013 to investigate the microclimatic variation, growth performances and yields. Cucumber varieties were grown in 2m x 2m plots with standard spacing and three replications. Microclimatic data indicated that both air and soil temperatures, as measured at different stages of plant growth, were always higher inside polyhouse compared to the open field. A 20-30% PAR reduction, but with a 2-5 °C higher air and soil temperatures and 10-15% more water retention were recorded during the rainless period inside the polyhouse compared to the open field. All the tested varieties grown under polyhouse condition had the superiority as assessed in terms of vine length, number of vines, number of leaves, etc. over the plants grown in the open field. The flowering, fruit setting and fruit maturity were advanced by about 5-10 days in polyhouse compared to their corresponding occurrences in the open field. Plants grown in polyhouse had also reproductive superiority in terms of flowers, fruits, fruit length, fruit diameter, fruit weight and yield ha<sup>-1</sup> over the open field condition. The yield of cucumbers were superior under polyhouse condition resulting in 25-30 t ha<sup>-1</sup> in hybrid and 20 t ha<sup>-1</sup> in local cultivar; while those under open condition were 12-15 tons ha<sup>-1</sup> and 10 tons ha<sup>-1</sup> respectively, i.e. irrespective of the cv<sub>s</sub>. polyhouse plantation of cucumber resulted in more than 2-fold yield improvement over the open field conditions that are in conformity of the previous experimental results on the same crop.

## **Food security in Bangladesh– effect of low temperature on pollination biology and grain yield of rice**

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### **Abstract**

An experiment was conducted to assess and compare the effect of low temperature on pollination biological features e.g., pollen viability & deformity, gynoecium characters – size, shape/deformation, spikelet sterility, etc. and grain yield of different rice cultivars. Six cultivars namely Lucky dhan, Mochi dhan, Mongol dhan, BR14, BRRI dhan29 and SL-8H, of *Boro* rice were used as experimental material. To manipulate the temperature ingredients, the transplanting operations were done four times starting from 07 November, 2012 and continued up to 22 December 2012 at 15 days interval. The experiment was laid out in a split-plot with three replications. Healthy rice seedlings of 30 days old were transplanted at the spacing of 15cm X 25cm (plant-plant X row-row). The standard rice cultivation procedure was followed. The low temperature had adverse effect on the viability of pollen grains. The percentage of non-viable or sterile pollen was up to 38% when the rice seedlings were transplanted at 07 November, 2012. The length of gynoecium – ovary, style and stigma, varies significantly among cultivars, and the length of ovary was about one fourth of the total. The number of sterile spikelet was also higher (up to 16%) in plants developed from early transplanted seedlings (at 22 November, 2012) compared to that of later transplanted seedlings (below 5%). There were significant variations among the rice cultivars in both non-viable pollen and spikelet sterility percentage. At low temperature, the traditional cultivars performed better in respect of non-viable pollen and spikelet sterility percentage, but produced lower grain yield compared to that of Hybrid SL-8H. Among the cultivars, SL-8H produced the highest grain yield (6.98 t/ha) when it was transplanted at 22 November, 2012.

## Understanding the role of temperature in wood formation of some hardwood and coniferous trees in Bangladesh

**S. Begum**

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### Abstract

Environmental factors, such as temperature, provide appropriate physical conditions for the growth and development of trees. Studies of the physiology and dendrochronology of cambial activity indicate that temperature is closely associated with the radial growth of tree stems. In this study, the effects of increases in the ambient temperature on cambial reactivation and xylem differentiation in the stems of jackfruit trees (*Artocarpus heterophyllus*), have been studied in relation with its storage substances. The timing of cambial reactivation and xylem differentiation in 2013 has been observed by light microscopy. There were clear differences between winter and spring. When spring came cambial reactivation occurred followed by xylem differentiation in jackfruit trees. Reserve materials might be important for wood formation in trees. The localization of starch, lipids and protein were observed in phloem, cambium and outer part of xylem. The optical images of anatomical features and localization of reserve materials obtained by light microscopy showed the availability and utilization of such materials within the stem of jackfruit trees. Starch grains in the parenchyma cells are more abundant in the outer xylem than in the inner part of xylem and phloem cells. Both axial and ray parenchyma cells of outer xylem contain starch granules. Lipid and protein droplets are uniformly distributed in the outer xylem. The phloem parenchyma cells have large mass of lipid bodies whereas those are almost absent in cambium and xylem ray parenchyma cells. The results suggest that, in *Artocarpus heterophyllus*, the temperature in the stem is a limiting factor for reactivation of cambium. An increase in temperature might induce the conversion of storage starch to sucrose for the activation of cambial cell division and secondary xylem.

## Rice Biotechnology: Application of Microsatellite Markers for Screening and Identification of Iron Rich Rice Genotypes

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### Abstract

Rice is a staple food for millions of people and having great importance in food and nutritional security. Plant-based foods are potential sources of all essential minerals and organic nutrients that are directly or indirectly required by humans. Unfortunately, mineral contents are low in many of the staple food crops. The deficiency of micronutrients such as iron (Fe) in staple food crops is the most common nutritional disorder especially for preschool children and pregnant woman in Bangladesh. Therefore, screening of iron rich rice genotypes is an essential study on the context of Bangladesh. In this study 52 rice genotypes were analyzed for iron (Fe) concentration by using Atomic Absorbance Spectrophotometer (AAS) at 248.33 nm. Digestion of rice grain samples were carried out by diacid mixture of HNO<sub>3</sub> and HClO<sub>4</sub> (2:1). Iron concentration ranged from 1.32 ppm to 100.45 ppm. The highest iron

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concentration was found in Lal Gotal and the lowest was in Jota Balam. The local landraces had the highest iron (Fe) concentration. Molecular screening of iron rich rice genotypes was carried out by using ten SSR markers. Among the ten markers, RM17, RM21 and RM400 had showed the polymorphism with 52 rice germplasm. As in chemical analysis, local landraces were also performed better in iron content than the cultivated varieties. Thus, local landraces can be the good source for biofortification of popular rice cultivars using different crop improvement methods.

**Intensification of rice based cropping system incorporating short duration oilseed mustard varieties****L. Hassan**

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**Abstract**

Primary constraints to achieving food security are the low yield per unit area and negligible scope for expansion of the area of land for cultivation. Hence, increase in intensity of cultivation and in yields per unit area are the only available options to meet future food needs to feed an ever increasing population. In Bangladesh, most of the farmers are growing T. aman and Boro rice annually in many regions of Bangladesh. Due to the lacking in the availability of short duration catch crop farmers are reluctant to grow any third crop in between T. aman and Boro rice. To address this problem we proposed crop intensification with short duration mustard in between T. aman and Boro rice. The proposed project work will be located at three upa-zillas of Mymensingh district Viz., Sadar, Muktagacha, Haluaghat and three upa-zillas Viz. Lalpur (Natore), Bagha (Rajshahi), and Iswardi (Pabna).

**Production & Dissemination of Short Duration Boro & Aman Rice Seeds to increase cropping Intensity and address Food Security Issues in Bangladesh****L. Hassan**

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**Abstract**

Rice (*Oryza sativa* L.) is the most important economic activity on earth as it is second largest single use of the land for food production and also consumed by the half of the world's population. It occupies about 153 m ha of the world's area and is the staple food for about 90 percent population of South and Southeast Asia (Hossain, 2005). Eighty five percent of rice production is accounts for human consumption (IRRI, 1997). Every year over 80 million people add to the world's population and for about half of these additional populations, increased rice production is imperative to fulfill their demands. Therefore there is an urgent need to address the issue of higher rice requirement from the same or even diminishing areas as arable lands are shrinking. Utilization of the marginal or barren areas due to soil stresses like salinity using tolerant rice varieties could be the probable answer to address the

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issues of climate changes and also to ensure food security in Bangladesh. Agricultural intensification is an increase in the productivity of existing land and water resources in the production of food and cash crops, livestock, forestry, and aquaculture. Generally associated with increased use of external inputs, intensification is now defined as the more efficient use of production inputs. Increased productivity comes from the use of improved varieties and breeds, more efficient use of labour, and better farm management.

**Screening, purification and evaluation of local coastal rice varieties for salt tolerance****L. Hassan**

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**Abstract**

Rice (*Oryza sativa* L.) is a staple food for more than half of the world's population. It is cultivated over an area of more than 150 million ha, but most rice production takes place in Asia. Salinity is considered as one of important physical factors influencing rice production. At the present, salinity is the second most widespread soil problem in rice growing countries after drought and is considered as a serious constraint to increase rice production worldwide. There exists tremendous variation for salt tolerance within species in rice. In Bangladesh, the total saline area forms one third of the 9 million hectares of total national cultivated area in Bangladesh. . Agriculture is a major sector of the economy of Bangladesh and the coastal area is very fertile for growing rice. Increase in salinity intrusion and increase in soil salinity will have serious negative impacts on agriculture. Therefore, development of salt tolerant varieties has been considered as one of the strategies to increase rice production in saline prone coastal areas.

**Development of short duration high yielding rice varieties****L. Hassan**

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**Abstract**

Rice (*Oryza sativa*), the staple food crop of Bangladesh, covered about 10.58 million ha of cropped area in the FY2010-11. The national cropping intensity was 181% during the period 2010-11. Primary constraints to achieving food security are the low yield per unit area and negligible scope for expansion of the area of land for cultivation. Hence, increase in intensity of cultivation and in yields per unit area are the only available options to meet future food needs to feed an ever increasing population. The area of Aus cultivation decreased by about 50% from the year 1990 to 2006 due to lacking in short duration modern varieties. To address this problem the present study will help to develop high yielding varieties of acceptable grain quality, preferably short growth duration to increase land productivity to 3 crops in a year. The main goal of this research is to develop short duration, stable and high yielding rice varieties for Aus, Aman and Boro seasons to fit into the existing cropping patterns. Breeding line SL – 9 and ADT(R)47 selected as donor (male) parent and BRRI

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Dhan 52, BRRRI Dhan 53, BRRRI Dhan 57 as recipient (female) parent for Aman season and Crosses were made among the selected parents. For Boro season, crosses were made in BRRRI Dhan 28 X IR 77734-93-2-3-2, BRRRI Dhan 29 X ADT(R) 47 and BRRRI dhan 55 X IR 77734-93-2-3-2. Crosses will be done in BRRRI Dhan 48 X Parija, BRRRI dhan 55 X Parija, BRRRI Dhan 48 X NERICA 2, BRRRI dhan 55 X NERICA 2, BRRRI Dhan 48 X NERICA 4, BRRRI dhan 55 X NERICA 4 to obtain short duration high yielding Aus rice. The most promising ones will be selected from the hybridized generations following the modified pedigree method.

**Characterization and screening rice genotypes for the desired root hair type****A. H. K. Robin**

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**Abstract**

Twelve selected rice varieties were grown at the field laboratory and a series of measurements at different days after transplantation was carried out to study the dynamic strategy of root branching. Main root axis branched up to secondary order. Root hairs appeared in all orders including the main root axes. Mean main root axis diameter and length measured 0.94 mm and 20.4 cm respectively at 60 days after transplantation. Diameter reduced at the primary and secondary order from that of main root axis, 4.56 and 21.4 times respectively. Root hair diameter measured 4.0  $\mu$ . Root axis length of primary and secondary branches measured 6.15 and 31.3 times shorter compared to the main root axis. Mean root hair length for different varieties measured between 94 and 680  $\mu$ . Data on number of successive root branches appearing at the unit root axis of origin would be useful to model the architecture and calculate the carbon cost of the individual roots. Twelve rice varieties were significantly different for majority of root traits studied, which suggests breeding for any of those desired root traits could be possible.

**Characterization and screening wheat genotypes for the desired root hair type****A. H. K. Robin**

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**Abstract**

The aims of this study were: i) to investigate genotypic variations in root traits at phytomer level of wheat varieties and ii) to select out heritable root traits at phytomer level for recommending in future breeding programs. Two separate experiments were conducted. Seeds of selected wheat varieties were germinated in clean tap water floated in foam net inside the plastic trays in. Seedlings were transferred to hydroponic solution following a completely randomized design at their 12 days of age. The detailed root measurements were carried out including recording of number of live leaves, number of root bearing phytomers, number of roots, number of primary roots, length and diameter of main axes, primary branches, secondary branches and root hairs, density of primary & secondary axes and

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density of root hairs at their axis of origin, dry weights of shoots and roots at the destructive harvest along with root: shoot ratio in both experiments. In Experiment 1, main axis length, root hair density and diameter differed from phytomer to phytomer at 60 DAS for two varieties, *Shotabdi* and *Sonalika*. Density of primary branches at their axis of origin, dry weights of roots and shoots and root:shoot ratio varied significantly among 8 varieties. PC1 brought significant contrast among varieties for the following root traits: number of root bearing phytomer, main axis length, root hair density, root dry weight, shoot dry weight and root:shoot ratio. In Experiment 2, number of root bearing phytomer, total number of adventitious roots, main axis length at root bearing phytomer 1 and 2, primary axis length at phytomer 3, root hair density and dry weights of roots and shoots were significantly different among varieties. PC1 resulted in significant variation among varieties for number of live leaves, new roots appeared, number of root bearing phytomer, total number of adventitious roots, root dry weight and shoot dry weight. PC2 yielded significant difference among varieties for live leaves, main axis length at phytomer 1 & 2, number of new roots, root hair density and diameter. Selection of varieties based on main root axis length at the youngest phytomer & root hair density per unit surface area along with dry weights of roots and shoots could be the recommended for future breeding program as these four parameters consistently resulted in significant variability among varieties. Those selection parameters would be useful for any germplasm screening or varietal screening designed for any abiotic stress tolerance as those traits are heritable and variable.

## **Screening of local garlic strains and production of chromosomal variants under *in vitro* condition**

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### **Abstract**

The experiment was conducted to develop an efficient protocol for *in vitro* regeneration of garlic (*Allium sativum*). Four locally available garlic genotypes designated as G 121, G 122, G 123 and G 124 were used as experimental materials where leaf bases, root tips and basal discs of vigorously growing plant were used as explants. MS (Murashige and Skoog) medium supplemented with different concentrations and combinations of 2,4-D and BAP were used for callus induction and proliferation. Different concentrations and combinations NAA and BAP were used for regeneration of plantlet. For each genotype, healthy explants were isolated and introduced into MS medium supplemented with 2,4-D and combination of 2,4-D and BAP were used for callus induction. Calli were evaluated for callus induction, proliferation and regeneration frequency in each step. Callus induction frequency was 75% and basal disc produced 77.5% callus in such media composition. Genotype G 121 is observed to show 63% callus induction which is highest among genotypes under study. MS +2 .0mg<sup>-1</sup> 2,4-D + 0.5mg<sup>-1</sup> BAP showed the best performance in callus proliferation as well as maintenance of calli. Improved regeneration of shoots and root was observed in media composition. The best response was 38.75% regenerating callus with 2.0mg<sup>-1</sup> NAA and 1.0 mg<sup>-1</sup> BAP from leaf base while 36.43 and 30.41% regenerating callus were obtained with similar composition from basal discs and root tips and respectively. Garlic genotype G 124 showed the highest frequency yielding 35.69% of regeneration. The survival rate of transferred regenerated plantlets was quite satisfactory 55%. Considering overall performance, basal disc is best explant for regeneration. Chromosomal studies are still continuing expecting a fruitful outcome.

## **Competency gap assessment of the farmers on the application of one house one farm approach in Bangladesh**

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### **Abstract**

The purposes of the study were to determine the extent of competency of the farmers on the application of One House One farm approach and to find out the relationships between the extent of competency of the farmers and their selected characteristics. Data were collected from 100 randomly selected farmers (out of 700) from two unions of Mymensingh Sadar Upazila. A pre-tested and structured interview schedule was used to collect data from the farmers during the period of 18 March to 01 April, 2013. The extent of competency of the farmers on the application of One House One Farm approach was the dependent variable of the study. To measure the dependent variables, a total 18 statements about competency of the farmers were selected and each of the competency was put against a four point rating scale such as excellent, above average, average and not at all and the corresponding score were given as 3, 2, 1, and 0 respectively. Therefore, the possible range of score of 20 competencies would be 0-54. The competency gaps of the farmers were measured by Cut-Score method on rating scale. One hundred (100) is the Cut-Score with an assumption if all the respondents go for Average (score: 1). The independent variables, however, were measured by using suitable scales and techniques. Pearson's Product Moment Correlation Coefficient ( $r$ ) was used to explore the relationships between the concerned variables. The findings indicate that majority of the respondents (94 percent) had medium competency compared to 2 percent of them having high competency. On the other hand, there were 4 respondents under low extent of competency. Out of ten selected characteristics, the farmer's level of education, farm size, training exposure, extension media contact, agricultural knowledge and awareness on One House One Farm approach showed significant positive relationships with their extent of competency on the application of One House One Farm approach. Age, household size, annual family income, and organizational participation had no relationships with their extent of competency on the application of One House One Farm approach.

## **Knowledge of the vegetable growers on health and environmental perspective of pesticide exposure**

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### **Abstract**

The main objective of this study was to determine the knowledge of the vegetable growers on health and environmental perspectives of pesticide exposure. The study also explored the relationship between the selected characteristics of the vegetable growers with their knowledge on health and environmental perspectives of pesticide exposure. Eighty vegetable growers were selected randomly from a total of 800 vegetable growers of the selected

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upazilas district. Personal interview schedule was used for collecting data which took 23 days during 23 September to 15 October, 2012. Simple and direct questions and appropriate scales were developed to measure the independent variables. Thirteen selected characteristics of the respondents constituted the independent variables. The selected characteristics such as age, level of education, farm size, land under vegetable cultivation, household size, family income, farming experience, organizational participation, communication exposure, social mobility, knowledge on the use of pesticides, credit received, training exposure and perception of vegetable growers on the use of pesticides. Pearson's Product Moment Correlation Co-efficient ( $r$ ) was computed to describe the relationships between the concerned variables. Vegetable growers' knowledge was measured on the basis of six levels of cognitive domain as postulated by Bloom (1956) and revised by Anderson and Karthwhol (2001). Thirty questions under six dimensions such as remembering, understanding, applying, analyzing, creating and evaluation were developed in accordance with the requirements. Total knowledge score of a respondent ranged from 0–90. The majority (88.75 percent) of the vegetable growers had medium knowledge while 11.25 percent had high knowledge and 0 percent had low knowledge on health and environmental perspectives of pesticide exposure on vegetable cultivation. The mean value (51.88) indicated that the vegetable growers of the study area had medium level of knowledge on health and environmental perspectives of pesticide exposure in vegetable cultivation. The relationships indicated that seven characteristics of the vegetable growers i.e. age, level of education, land under vegetable cultivation, training exposure, communication exposure, social mobility and farming experience had significant positive relationship with their knowledge on health and environmental perspectives of pesticide exposure in vegetable cultivation.

## **Extension of small scale dairy farming through video mediated learning in Mymensingh district**

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### **Abstract**

Milk production is a livestock enterprise in which small-scale farmers can successfully engage in order to improve their livelihoods. Regular milk sales also allow them to move from subsistence to a market based income. The purposes of this study were to determine the extent of small scale dairy farming at farmers level in sadar Upazila of Mymensingh district, to organize field visits for the dairy farmers in creating awareness towards small scale dairy farming, to organize training programme for the farmers interested in establishing small scale dairy farming and to explore the problems encountered by the farmers in maintaining small scale dairy farming. The study was conducted in Sadar Upazila of Mymensingh district during 2012 to 2013. Population was small scale dairy farm owners and data were collected from 20 dairy farm owners through survey and Focus group discussion (FGD). The project involved four study phases viz. exploratory study phase, qualitative study phase, development and demonstration of learning video on small scale dairy farming and quantitative study phase. The study showed that annual milk production of the country is far below the requirement and the major constraints to milk production are the shortage of feeds and fodder, both in terms of quality and quantity, lack of genetically improved dairy cows, poor management and health care, as well as unorganized marketing system for most dairy farmers. The study also

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provided some suggestions such as establishment of small scale dairy enterprises and processing units should be encouraged through appropriate policy and institutional support. The role of women in farm activities, especially dairying and investment in the homestead and cultivated land needs to be assessed relative to future development activities production of value added milk products and quality control and provision of adequate credit support to the farmers should be emphasized.

## **Linking farmers' innovation towards market: The case of botanical pesticide promotion**

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### **Abstract**

The purposes of the study were to promote botanical pesticide (farmers' innovation) among the people of the farming community and to improve income of the farmers through linking their innovation towards market through video mediated learning. It was an action research and was conducted in Uzan Kashiar Char village under Gouripur Upazila of Mymensingh district of Bangladesh from 1<sup>st</sup> July 2012 to 31<sup>st</sup> June 2013. Through participatory research program of another project entitled "**Fostering Women Voices through Videos in Bangladesh**" executed by the Department of agricultural Extension Education, Bangladesh Agricultural University farmers developed botanical pesticide from locally available plants which is effective in controlling vegetable pests. However, due to lack of access to market they could not bring this botanical pesticide into market and thus the present project took some initiatives to promote this innovation towards market involving some initiatives viz. farmers' training, discussion with pesticide dealer, establishing demonstration, field day, learning video demonstration (preparation & use of botanical pesticide), demonstration of promotional videos through local cable network, production of botanical pesticide and monitoring. The study showed that within the project tenure farmers of the research project have produced 320 litre botanical pesticides. They have used 35 litre in their own vegetable crops and sold 285 litre to other farmers. The amount of the sold botanical pesticide was (50 taka/L) 14,250 taka. The study also calculated that amount of chemical pesticide required for 1 acre brinjal field in a season (@60 g per spray) was 960g and cost was (90 taka/10g) 8640 taka while it is possible to manage 1 acre brinjal field with 720 taka when it be managed botanical pesticide. Thus, it is concluded that botanical pesticide is less expensive and environment friendly. Having strong influential capacity video contributed significantly in promoting botanical pesticides in this area.

## Phytoremediation of toxic metal contaminated soil

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### Abstract

First step of the experiment was the screening of jute (var. BJC-7370 and CVE-3), *kenaf* (var. HC-95, HC-3) and *mesta* (var. Samu-93) varieties and were conducted against six levels (0, 20, 40, 60, 80 and 120 mgL<sup>-1</sup>) of Pb and Cr separately. In the second step, these varieties were further screened with four levels (0+ 0, 60+ 60, 100+100, and 120+ 120mgL<sup>-1</sup>) of combined concentration of Pb and Cr. At third step, the resistant varieties obtained from the first and second step were grown in Pb and Cr contaminated soil in pot. Increased levels of only Pb and Cr and combination of Pb and Cr significantly reduced the germination percentage and primary growth parameters but the rate of reduction was comparatively less in case of Pb. Almost all the varieties were able to tolerate up-to 120 mg Pb and Cr L<sup>-1</sup>. Results of chemical analyses showed that *kenaf* HC-95 accumulated more Pb (9.097mg Pb kg<sup>-1</sup>) than *kenaf* HC-3(7.473mg Pb kg<sup>-1</sup>) and *mesta* Samu-93(7.974mg Pb kg<sup>-1</sup>). In case of Cr higher amount was accumulated in *mesta* Samu-93(7.727mg Cr kg<sup>-1</sup>) than *kenaf* HC-95(5.418mg Cr kg<sup>-1</sup>) and *kenaf* HC-3(6.30mg Cr kg<sup>-1</sup>). Considering all the parameters of the experiments, *kenaf* (HC-95 and HC-3) and *mesta* (Samu-93) had high tolerance to Pb and Cr. The varieties of *kenaf* (HC -95 and HC-3), *mesta* (Samu-93) and jute (CVE-3 and BJC-7370) were grown in naturally contaminated soil containing Pb (120 mg Pb kg<sup>-1</sup>) and Cr (110 mg Cr kg<sup>-1</sup>) in the net house pot experiment. The varieties of *kenaf* (HC -95 and HC-3) and *mesta* (Samu-93) showed vigorous growth as compared to jute.

## Heavy metal pollution in roadside soils and vegetation in Dhaka city

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### Abstract

The research work was conducted to determine the concentration of heavy metals in roadside soils and grasses collected from Dhaka metropolitan city, and to assess their pollution level. The concentrations of metals (Cu, Zn, Pb, Cd and Cr) in roadside soil and common grass (*Ageratum conyzodes*) samples were determined by using Atomic Absorption Spectrophotometry (AAS). The pH of all soil samples were slightly acidic to neutral. The variation of EC of the roadside soils of study area was markedly varied due to the effect of place, slope, soil condition, drainage and others. Average concentrations of metals in soil samples were: Pb, 38.9; Cd, 0.33; Cu, 35.75; Zn, 136.10 and Cr, 21.75 µg g<sup>-1</sup>. The highest levels of metal concentrations were found in the samples from heavy traffic. In case of grass samples the concentrations of Pb, Cd, Cu, Zn and Cr were 3.48, 0.52, 75.04, 103.33 and 32.25 µg g<sup>-1</sup>, respectively and heavy metal concentration values were in the order- Zn > Cu > Pb > Cd > Cr. The maximum concentration of Cu was found in the sample collected from Kalabagan and the mean value was 85.20 µg g<sup>-1</sup>, which was above than the critical toxic level for most plants. Similarly, in case of Zn, a critical toxic level for plants is 100 µg g<sup>-1</sup>, which was exceeded by the mean value obtained from the present study. The highest concentration of Pb and Cd was found in the sample collected from Soinik Club and Bijoy Saroni, respectively.

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The study revealed that the contamination factor for Pb, Zn and Cd were several times higher compared to Cu and Cr, which indicates that Pb, Zn and Cd were the major pollutants in the roadside soils of Dhaka metropolitan city. Finally, the  $I_{geo}$  calculations of the roadside soils of the study area also revealed moderate pollution level in soils by Pb, Zn and Cd from anthropogenic sources.

### **Extraction, chromatographic isolation of bark and fruits of *Terminalia arjuna* Bedd (Arjun tree)**

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#### **Abstract**

The medicinal plant *Terminalia arjuna* Bedd (Arjun tree) is a large deciduous, evergreen tree attaining a height of 60 ~ 80 feet, with a spreading crown and drooping branches. The tree is in flower in the summer and the fruits are fully matured in the winter. Here one thing is very encouraging to note that our country abounds with a vast majority of medicinal plants and herbs. People used medicinal plants to alleviate the suffering of their body and mind from time immemorial. Medicinal plants mainly used in the preparation of Unani and Ayurvedic medicine. The bark of this plant is being used by the Hekims and Kabirajes as successful medicine of various diseases since the ancient time. The bark is brown in colour and the sanskrit writers have described it as a cardiac tonic. Chopra *et al.*, reported in the year 1958 that the drug prepared from the arjun bark showed heart stimulating action. It is a source of many potent, biologically active compounds, planted all over Bangladesh. Different parts of the plant are being used for the treatment of different diseases. The availability of medicinal plants demands a systematic investigation on the extraction, isolation and characterization of physiologically active principles. So, the aim of the research work is to extract and isolate the bark powder of arjun tree by the selective solvents like ethyl alcohol and chloroform respectively in both the cold and hot conditions. The bark powder of arjun was also extracted with water in the cold. The crude material obtained from the hot chloroform extraction was identified by thin layer chromatography (TLC). The bright round spots on the TLC plate of the components were pencil marked and their corresponding  $R_f$ -values measured. The three spots of corresponding  $R_f$ -values 0.951, 0.634 and 0.402 in the solvent system benzene: ethyl acetate (10 : 90 v/v) were observed from low to high polarity respectively. The chloroform extract was separated by applying the method of column chromatography using mixed solvent benzene : ethyl acetate (10 : 90 v/v). A compound named  $A_1$  having  $R_f$ -values 0.836 in the solvent system benzene : ethyl acetate (50 : 50 v/v) was isolated.

### **Isolation and characterization of active compounds of kamala tree (*Mallotus philippensis*) and their evaluation as biopesticides**

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#### **Abstract**

The 40-45 day old Kamala tree (*Mallotus Philippensis*) mature fruits were collected from BAU campus. Seed capsules were separated and extracted with different solvents viz. n-hexane,

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benzene, ethyl acetate, ethanol, chloroform and methanol to identify various compounds and evaluate them as biopesticides against some coleopteran and lepidopteran insects. The experiment was conducted in the laboratories of the department of Agricultural Chemistry, Entomology and Bangladesh Council of Scientific and Industrial Research (BCSIR). No pure compound was isolated. Two compounds namely **H-3**, a long chain hydrocarbon, Undecane and **E-3**, an unknown compound were isolated from the chloroform extract of the seeds for the first time. Tentative structures of the compounds were elucidated by  $^1\text{H-NMR}$ ,  $^{13}\text{C-NMR}$  and mass spectra analyses. Both the coleopteran and lepidopteran insects showed higher mortality after 24 hours but almost zero mortality after 72 hours against the compound E-3. The order of toxicity of this compound on the coleopteran insects was Pulse beetle> Red flour beetle>Rice beetle. In the lepidopteran insects, the compound also showed similar mortality after 24 and 72 hours. The mortality was same at 24 and 48 hours. The order of toxicity of the compound was brinjal shoot and fruit borer>Jute hairy caterpillar.

## **Saline-induced changes in the accumulation of biomolecules in land race rice varieties growing in the coastal regions of Bangladesh**

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### **Abstract**

To explore their salt tolerance capability, 127 land race rice genotypes cultivated in the coastal areas, inclusive few established high yielding varieties were subjected to saline stress at different stages of growth of the plant such as germination, seedling and reproduction stage. Along with salt induced changes in agronomic and biochemical parameters, molecular characterization for tolerance to salinity was also taken into account. In germination stage,  $16\text{dSm}^{-1}$  salinity was imposed on imbibed seeds for 5 days. Whereas for other parameters such as dry shoot weight, shoot length, dry root weight and root length, 8 days old seedlings were chosen. Salinity invariably caused quantitative reduction in agronomical parameters. A tolerance index table was prepared from the lowest and highest values of percent reduction of an individual parameter, due to salt stress and scores 1,3,5,7 and 9 was assigned for ranges of reduction. Based on the scores obtained, the genotypes were categorized as highly tolerant (1), tolerant (3), moderately tolerant (5), susceptible (7) and highly susceptible (9). From the mean values of tolerance index scores, as recorded in germination stage, 3 genotypes appeared highly tolerant, 19 were tolerant and 9 genotypes were susceptible. In seedling stage, 120 genotypes of rice plants were grown hydroponically at  $12\text{dSm}^{-1}$  salinity. From the mean of the tolerance index score of parameters namely visual performance, plant height, shoot dry weight, root dry weight, proline content, chlorophyll-a, chlorophyll-b, total sugar and sodium content, genotypes were again categorized as highly tolerant (1), tolerant (3), moderately tolerant (5), susceptible (7) and highly susceptible(9). In the same way, mean of the tolerance index score of parameters such as visual appearance, chlorophyll-a and chlorophyll-b was ascertained in reproductive stage where 52 genotypes retained after culmination in seedling and germination stage, were grown in  $6\text{dSm}^{-1}$  salinity. Finally, the average of mean score of each genotype as obtained in germination, seedling and reproductive stage was determined and referred as final mean score (FMS). Having FMS up to 4, nine genotypes namely Penjek, Khok Shail, Bhute Shalot, Talmugur, Nonabokra, Patnai, Jota Balam, Pokkali and Khesrail were selected as tolerant. Seventeen genotypes were

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marked as moderately tolerant. Genotypes namely Pengek, Jota Balam, Bhute Shalot and Pajam which were selected as tolerant on the basis of FMS, matched with the findings of molecular characterization by SSR marker RM 7075. Deviation was also noticed. To conduct a preliminary study, 12 rice genotypes consisting of susceptible, moderately tolerant, tolerant and land race genotypes, were analyzed for  $\alpha$ -amylase activity in 10 days old seedling and catalase activity in 32 days old seedling. Levels of salinity imposed were 0, 6, 9 and 12 dSm<sup>-1</sup>. The activity of  $\alpha$ -amylase showed an increasing trend with the increasing salinity in almost all varieties, but up to a certain concentration and the change in activity was significant. In the two susceptible genotypes,  $\alpha$ -amylase activity increased by 15.95% and 12.12% at 6dSm<sup>-1</sup> and then declined as the salinity increased. However, changes in catalase activity under different salt concentration were not significant and no regular trend of increase or decrease was noticed. Leaf of 4 genotypes of rice, were analyzed for free amino acid content. Amino acids namely Asp, Glu, Ala and Lys were found to accumulate in higher quantity in saline as well as non-saline condition, compared to others (Gly, Thr, Pro & Leu). Rate of enhancement in proline accumulation due to salinity was higher in tolerant genotypes.

**Seasonal variation of carbon dioxide flux over rice paddy field at the Mymensingh flux study site****M. A. Baten\*, M. A. Miah and A. MIYATA<sup>1</sup>**

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**Abstract**

Carbon dioxide (CO<sub>2</sub>) flux was measured using the eddy covariance technique over rice paddy field at Mymensingh flux study site (24° 43' 31.0"N, 90° 25' 27.3"E; 18 m above sea level) from January 2011 to August 2012, and compared with 5-years average from 2006 to 2010. Gross primary production (GPP), ecosystem respiration (Re) and net ecosystem exchange (NEE) in the experimental period displayed distinct seasonal variations influenced by rice growth, and those seasonal variations generally followed averaged patterns in the previous years with short-term deviations from the averages caused by meteorological conditions. The seasonal variation of GPP showed its peaks of about 12 g C m<sup>-2</sup> d<sup>-1</sup> at full vegetative stage of *Boro* and *Aman* rice. Re also showed a seasonal variation, but its peaks was smaller (5-6 g C m<sup>-2</sup> d<sup>-1</sup>) and broader than those in GPP. NEE also showed a seasonal variation with peaks of assimilation (6 g C m<sup>-2</sup> d<sup>-1</sup>) at full vegetative growth stage. Active CO<sub>2</sub> exchange was also observed during the fallow period in rainy season, while the dry fallow period in winter was rather dormant in CO<sub>2</sub> exchange. In the experimental period, the most noticeable deviation from the averaged trend was an advanced trend of NEE in the 2012 *Boro* season influenced by the earlier transplanting of rice. Another deviation of GPP and NEE from the average observed in late growing season of the 2011 *Boro* rice was caused by early harvest. Differences in cropping periods not only resulted in deviations of seasonal trend from the average but also influenced seasonal and annual CO<sub>2</sub> budget of the paddy field. The Re/GPP ratio was generally stable, but interannual variability of CO<sub>2</sub> budget in the fallow period in rainy season had non-negligible impact on the annual Re/GPP ratio. Management practices thus affected not only seasonal variation of CO<sub>2</sub> flux but also its annual budget. Further data analysis is going on.