Fourth year

Quarterly Activity Report No.3 January-March, 2006

Food Security in Bangladesh: Improving Wheat, Maize and Papaya Production, and Impacts of Arsenic Contamination

USAID Grant No. 388-G-00-02-00070-00

Submitted by

International Maize and Wheat Improvement Center (CIMMYT)

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Introduction

Since July 2002, the CIMMYT office in Bangladesh has been implementing the project **Food Security in Bangladesh: Improving Wheat, Maize and Papaya Production and Impacts of Arsenic Contamination,** with the financial assistance of USAID (Grant No. 388-G-00-02-00070-00).

Since then, we have been submitting quarterly activity reports and annual project reports to USAID. In this latest report, we describe activities completed during the period January to March 2006.

The CIMMYT stall at the America Week in Chittagong 14-16 March 2006, attracted a lot of visitors

During the report period, the project continued with work in five themes:

1. Facilitation and Promotion for Adoption of Mechanization by Growers
2. GIS - Bangladesh Country Almanac
3. Whole Family Training in Maize
4. Impacts of Arsenic Contamination on Agricultural Sustainability and Food Quality
5. Papaya Improvement through Ring Spot Viral Disease Resistance.

Work on transgenic papaya will continue until June 2007 and all other components will continue until June 2006. The achievements against each activity for the period January to March 2006 are described under the respective project components in the following sections.

Overall objectives of the program remain:

- Strengthen the partnership between the National Agricultural Research System (NARS)-NGO-Private Sector-CIMMYT and US Universities to achieve the goal of food security through wheat, maize and papaya production enhancement saving scarce natural resources and for better human nutrition
- Assist the Wheat Research Center (WRC), Horticulture Research Center (HRC) and Plant Breeding Division of Bangladesh Agricultural Research Institute (BARI) in their efforts to increase productivity of wheat, maize and papaya in Bangladesh

- Improve the rice-wheat system research activities of Bangladesh and strengthen exchange of research experiences in the subcontinent
- Offer leadership in assessment of the impacts of arsenic contamination on food security in Bangladesh
- Build up human capacity in Bangladesh to address food security issues in the targeted institutions
- Assist Government of Bangladesh in technology and extension strategies where appropriate for agricultural sectors to sustain self-sufficiency of food production.

Visitors see the CIMMYT stall at the America Week in Chittagong 14-16 March 2006

A CIMMYT scientist is discussing CIMMYT activities with visitors at the America Week in Chittagong 14-16 March 2006

Facilitation and Promotion for Adoption of Mechanization by Growers

Key activities planned	Target number	Time & duration	Achievements
a. Planning meeting with counterparts	Various	July-June 2006	Various meetings organized and completed at Rajbari, Faridpur and Dinajpur in report period
b. Farmer participatory demonstration of procured or imported agricultural accessories	At least 50 sets of seeders	July-June 2006	• 50 seeders (38 Dongfeng and 12 Sifeng) procured and sold / distributed among the farmers for the 2005-2006 season o Number of Seeders sold this quarter: ▪ 2 units to Bangladesh Rice Research Institute (BRRI) ▪ 1 unit to Wheat Research Center for ADB funded project ▪ 3 units to farmers at Dinajpur ▪ 2 units to farmers at Rajbari • Procured three close drum threshers and use demonstrated during the wheat season
c. Survey on existing agricultural accessories	Survey the existing accessories to determine their status	July 05-June 06	An additional adoption survey of PTOS in two districts (Dinajpur and Rajshahi) was planned but funds do not allow implementation. A survey on "Area coverage by the BHT" is planned.
d. Repairing and servicing of existing equipment		July 05-June 06	• Some repair work done • Provided backstop services to end users
e. Training of NGO, NARS technicians, owners, users and operators	One weeklong workshop per month	July 05-June 06	• Two training sessions completed at Rajbari district. A total of 114 power tiller accessory owners, technicians, operators and NGO personnel received training on the following topics: o Operation and maintenance course on power tiller, seeder, thresher and weeder o Modern wheat cultivation o Modern jute cultivation

Key activities planned	Target number	Time & duration	Achievements
			o Modern onion and garlic cultivation • Planned to train 20 people on maize sheller repair, operation and maintenance by March 2006. The training will be conducted by BARI and CIMMYT.
f. Hand over the equipment to end users	At least 50 BHT seeders/ power tiller and /other accessories	July 05-June 06	• 38 units of seeder (28 Dongfeng and 10 Saifeng) handed over to farmers in a high profile event presided over by BARI DG. • 27 power tillers were sold to the farmers by a private company, through project financing. Funds are being paid back by farmers in installments. • 2 tine sets sold to the farmers. • A few close drum threshers will be procured and handed over to farmers during the wheat harvesting season
g. Research and development of Agricultural Accessories	Seeding/ harvesting/ inter cultivation /tillage/etc.	July 05-June 06	• Research proposals received from: o FMPE-Division of BARI amounting to Tk. 188,000/- Meeting was organized on the proposal with concerned organizations on 31/10/05 at CIMMYT Dhaka office. All participants agreed to conduct the research as FMPE submitted in their proposal. The work has been going well under BARI supervision during January-March 2006. o Wheat Research Center also submitted a research proposal to "Accelerate and popularize RCT machinery with the small land holders of Bangladesh" on 1/11/05, amounting to Tk. 232,000/- . We agreed to support a maximum 170,000/- and the research activities are going well. o Modified PTOS wheat seeder for direct seeded boro rice planting with WRC. Conducted farmer participatory demonstration in Dinajpur on 0.8 ha of land (Fig. 1.1). o Also with WRC, about 2.0 ha of maize is planted by the power tiller operated bed planter on farmers fields in Dinajpur. Farmers said this system could reduce by about 30% the cost for hilling up and seeding on beds compared to conventional systems (Fig. 1.2).

Key activities planned	**Target number**	**Time & duration**	**Achievements**
			o Four field days were organized in Jamalpur, Faridpur and Rajbari. About 500 farmers and representatives from different government and non-government organizations participated in these events. During these field days participants were shown the different ag accessories, their uses and benefits (Fig. 1.3).
h. Field visit and monitoring	Various	July 05-June 06	Various visits made before and during early parts of 2005-06 Rabi and 2006 Kharif 1 seasons. The BHT owners / users are confident now and they planned to sow jute seed by the PTOS during the jute growing season. During the jute planting season we expect that about 200 ha of jute land will be planted by the power tiller operated seeder directly.
i. Field technicians, full time	2 technicians (1 for Dinajpur and other for Rajbari)	July 05-June 06	Two field technicians have been working at WRC Dinajpur and Rajbari, as planned.

Fig 1.1: Farmers are working in the direct seeded Boro rice field planted by PTOS in Nashipur, Dinajpur

Fig. 1.2: Demonstration plot of maize field planted by power tiller operated bed planter in Dinajpur

Fig. 1.3: Farmers' field day on different agricultural accessories in Faridpur on March 6, 2006

GIS-Bangladesh Country Almanac (BCA): A User Friendly GIS Tool for Agricultural, Forestry and Natural Resource Management

Key Activities Planned	Targeted Number/ Activity	Planned Time & Duration	Achievements during this quarter
a. Technical Implementation Committee Meetings	12 meetings	July 05-June 06	Several TIC meetings were held in the report period.
b. Dissemination / Training / Policy workshops	10 workshops with approx. 500 participants	July 05-June 06	• Organized dissemination workshop at Jahangir Nagar University, Savar on March 9, 2006 where 112 teachers and professors from different disciplines attended. Professor Khandaker Mustahidur Rahman, Vice-chancellor of Jahangir Nagar University inaugurated the workshop (Fig. 2.1). The participants were satisfied with the new version of BCA and showed interest to have training for the users. • Organized a training workshop on BCA at Bangladesh Agricultural Research Council (BARC), Farmgate where 25 participants from Bangladesh Agricultural University, Mymensingh attended (Fig. 2.2).
c. Data procurement and preparation works (crops, biophysical, fisheries, forestry, health / nutrition, livestock, socio-economic)	List of datasets identified	July 05-May 06	The following data have been obtained from different sources and we created shape files to fit with the BCA format: • Marketing price and commodity data on crops, fruits, vegetables, spices • Child risk measure in rural area • Rights of children and adolescents • Water and sanitation • Maternal health • Diarrhoea prevalence last 15_days_<5 years (%) • Treatment given during diarrhoea_both sex_<5 years • Diarrhoea treated by_both sex_<5 years (%) • Fast / difficult breathing_last 2 weeks_<5 yrs child

Key Activities Planned	Targeted Number/ Activity	Planned Time & Duration	Achievements during this quarter
			• Knowledge to seek help_acute respiratory infection • Household using iodized salt (%) • Vitamin A received on last NID_12-59 months (%) • Malnutrition MUAC <12.5cm_12-59 months (%) • Colostrum given_both sex (%) • Child given honey / sugar / water imm. after birth (%) • Exclusive breastfeeding rate_children_< 4months (%) • Period of exclusive breastfeeding_b_sex_5_23 months • Duration of continued breastfeeding_13-59 months (%) • Type of injury <18 years_per 1000 (%) • Current condition after injury <18 yrs_per 1000 (%) • Children with disability_both sex (%) • Infant immunization The large amount of data detailed above was obtained from different sources. Most of the data were at the district level (new 64 districts) and some were at the thana level. Data collected had some problems to feed directly into BCA. Therefore, we invested a lot of time to manage the data and to give a good shape to BCA's format. These included: 1. Most of the data were unorganized, i.e. not consistent with BCA data format. 2. In the BCA database, the number of thanas in the thana base map is 465 where all thanas in a metropolitan area are placed under one metropolitan thana. Thana-wise data collected from BBS has the same number of thana as in BCA, whereas DAE used 507 thana in recording thana-wise crop data. DAE considers these as agricultural thanas.

Key Activities Planned	Targeted Number/ Activity	Planned Time & Duration	Achievements during this quarter
		March-April 2006	3. All data files did not have same spelling of district and thana names and also the districts and thanas were not placed in the same order. 4. None of the data files contained geo codes of the districts or of thanas. These are necessary to join with BCA base maps. 5. Units of measurement were not the same throughout. 6. All data files were in Excel but in most cases there was cell merging for reporting regional and divisional totals in case of district level data and district, regional and divisional totals in the case of thana level data. This created a problem in sorting data and merging files. 7. A few files contained inconsistent / erroneous data. To remove these problems and make the data files acceptable to BCA, all the data files were thoroughly examined, edited, corrected for errors and geo coded. In cases where the number of thanas was larger than that in the BCA database, the relevant thanas were merged. Before geo coding and merging, the spellings of district or thana names were made unique with the same spelling as in the BCA database. To facilitate sorting and file merging, data in a file was labeled only by district or thana wherever applicable. The process was tedious and took considerable time to complete. The BCA 3.0 version with a tremendous volume of data is available now and will be sent to valid users very soon.
d. Upazila / block level digitization	DAE Block for selected Thana / District	January-March 06	Further discussion on the block level planning was made. It was decided that Jamalpur, Sherpur and Tangail districts will be digitized to manage the Upazila database with the district. Computers are available in the Upazila offices and therefore the block data can be maintained by the Upazila and district offices.

Key Activities Planned	Targeted Number/ Activity	Planned Time & Duration	Achievements during this quarter
e. Mini grant to promote use of BCA to various organizations / NGOs / Private sectors	Three in various locations	January - March 06	We planned to award mini grants, but fund reductions did not allow.
f. Product output validation activities with selected datasets	Various locations	February-April 06	Field validation of BCA outputs / products need to be further refined before their dissemination and wider application. However, funds did not allow.
g. Exploration and Establishment of BCA user group	Various organizations and universities	December 05-May 06	Identified some organizations / universities for training who will arrange to accelerate the use of BCA internally in future.
i. Partners support / Lab activity / Mobility	Lab / field / mobility	July 05-June 06	To support the ongoing activities, partners will be provided physical facilities in the BARC lab.
j. Publications ((20 mini grant reports), user manual (250 pages), brochure, BCA CD produced, video tutorial, evaluation, agenda)	500 copies of each item	August 05-June 06	• 270 distributed in report period • New brochure on the latest released has been drafted • 10 minigrant reports have been abridged to include in the new version of BCA as case studies.
k. Basic promotion activities: flier, WWW	WWW site update regularly	April-June 06	Using the ARCIMS, the digital maps are being uploaded on the web so users have the maps and can query the data. The server will be maintained at CIMMYT HQ.

Fig. 2.1: Professor Khandaker Mustahidur Rahman, Vice Chancellor of Jahangir Nagar University inaugurated the BCA dissemination workshop on March 9, 2006. 112 teachers and professors from different disciplines attended.

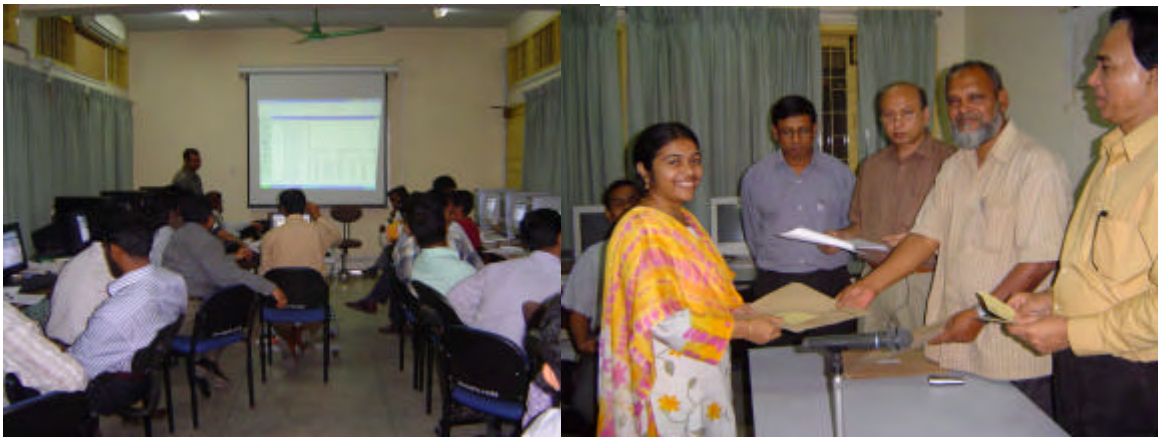


Fig. 2.2: A two-day long BCA training workshop was organized at BARC where professors and teachers from different disciplines attended. Left: A BCA partner is demonstrating the new BCA version and participants are engaged in practicing, Right: one of the participants is receiving a certificate from the chief guest after completion of the course.

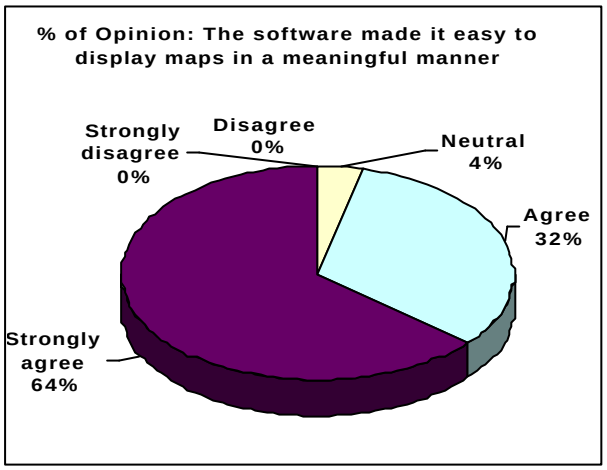
Dissemination and Training Workshop

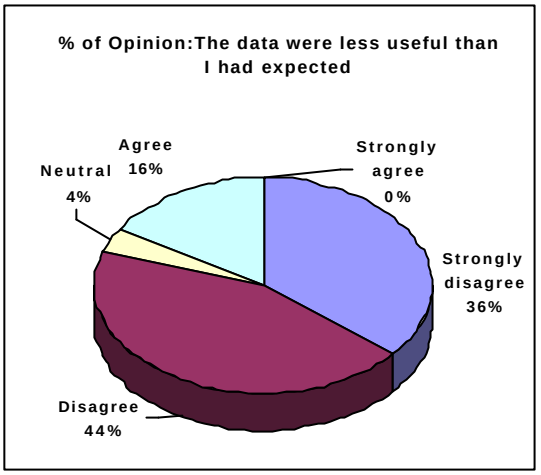
Two dissemination and training workshops were organized in January–March 2006, in collaboration with regional networks in different locations. Participants who attended the workshops gave the BCA team invaluable feedback on tools and data needs. They took part in discussion for improving the software tools and data. They were impressed with the training and showed interest to contribute in the research areas. Some of the participants from BAU expressed their feelings to Director, BAURES that they would use this training for their own project work, MS and Ph.D thesis work and also in home assignments to postgraduates. They were also surprised to see the selected site information in a table. This software allows extracting location-spec information from the BCA database in several ways. To get information for a particular site a user needs only click on the Site selection tab and all explored layer information or any underlying data exists for the selected location can be displayed by expanding any data layer in the map layers. Software can provide the desired information in a table which can be copied to any other external software. To get the same results from other GIS software, a user would need to follow a lot of steps and need considerable training, which is not cost effective.

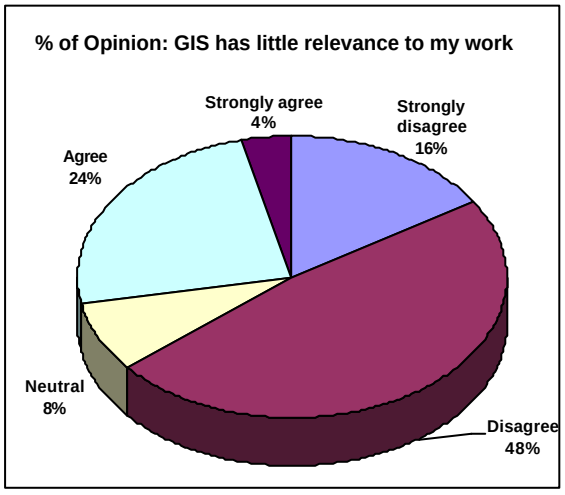
Normally an evaluation sheet is distributed among the participants to get the feedback which elicited extremely positive responses (see following charts).

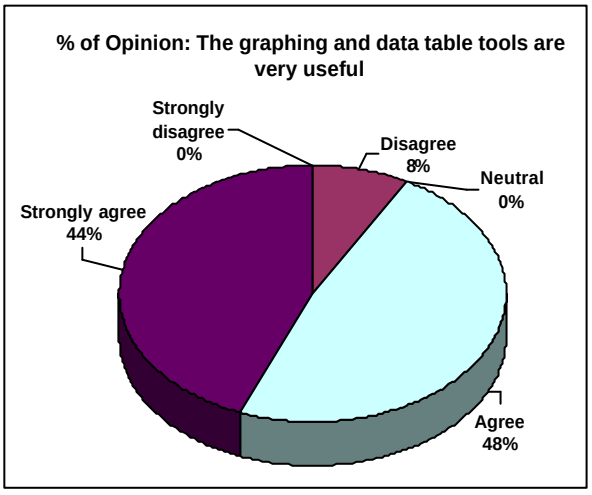
Some valuable comments included: 1) Software made it easy to display maps in a meaningful manner 2) Data were less useful than expected 3) Easiness of the characterization tool 4) National-level data are more useful than Upazilla level data 5) Useful graphic and data table, 6) Recommending BCA to others.

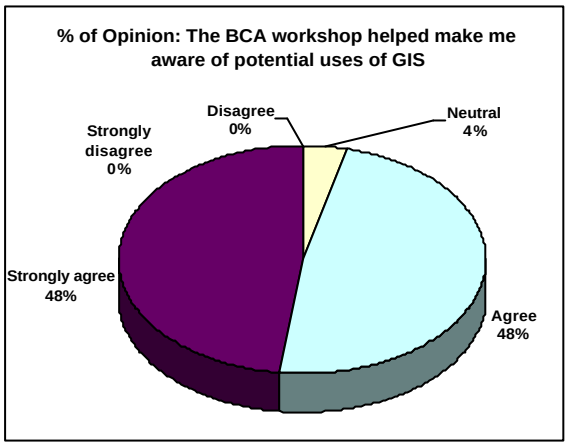
Charts: Opinions reported by the trainees on different elements of BCA software during training conducted January-March 2006

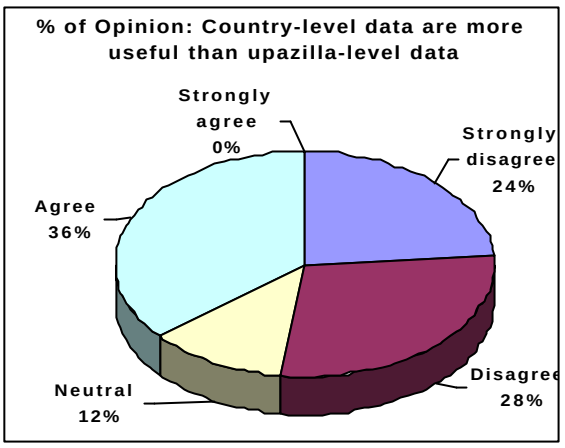


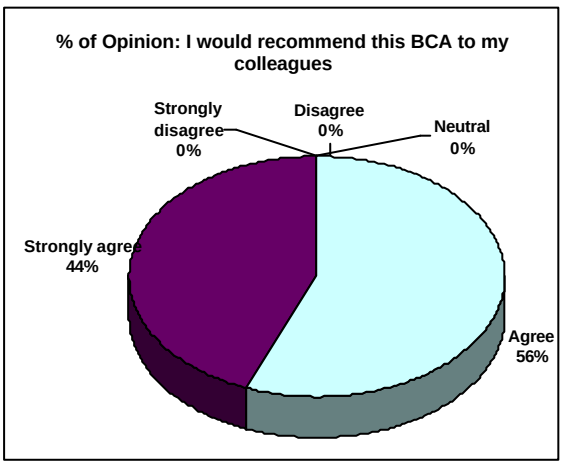


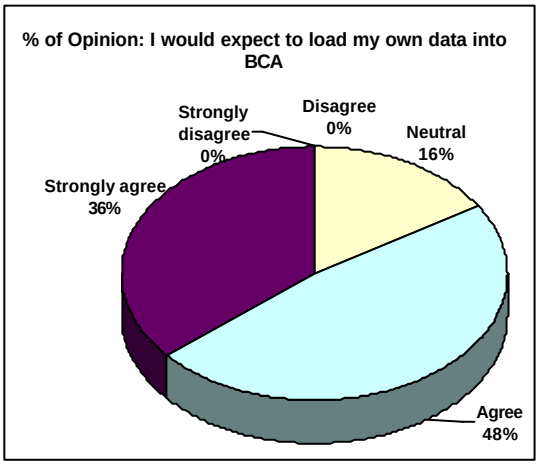





% of Opinion: The BCA workshop helped make me aware of potential uses of GIS
Disagree 0%
Neutral 4%
Strongly disagree 0%
Strongly agree 48%
Agree 48%


% of Opinion: Country-level data are more useful than upazilla-level data
Strongly agree 0%
Strongly disagree 24%
Agree 36%
Neutral 12%
Disagree 28%


% of Opinion: I would recommend this BCA to my colleagues
Strongly disagree 0%
Disagree 0%
Neutral 0%
Strongly agree 44%
Agree 56%


% of Opinion: I would expect to load my own data into BCA
Strongly disagree 0%
Disagree 0%
Neutral 16%
Strongly agree 36%
Agree 48%

Whole Family Training in Maize

Key activities planned	Targeted no. /achievement	Time & duration	Achievements
a. Review 2004-05 WFT Progress and Planning Meeting and update for the Year 2005-06	Various meetings	July / Aug 05-Feb 06	Review and planning meetings with NARS (BARI)-NGO-private sectors-CIMMYT done. Decision made to update the posters with the new maize agronomy, including intercropping systems and maize varieties, and completed.
b. Bangla manual and poster printing	2,500 manuals 25 sets of posters	July 2005-June 2006	• 2,500 sets of manual printed with the inclusion of new maize agronomy (e.g. intercropping with maize) and distributed to the trainers and families. The updated training manuals and posters were used in the TOT and family training sessions conducted in report period. • Updated 27 sets of posters and distributed to trainers and research organizations, NGOs and private entrepreneurs, and used in the TOT and family training sessions.
c. Trainers' training	250 trainers	July 2005-June 2006	100% TOT completed. In all training venues, 100% male participants participated in the TOT except in Bandarban where 33% female participants attended. The trainers build their capacity to train families independently with other non-trained farmers interested in maize cultivation.
d. Train Farmer Families	2000 Farmer Families Trained	July 2005-June 2006	100% family training completed in report period. On average, 51% of the total trainees were male and 49% were female. The trained families were found to grow maize (BHM-3) in ways they learnt during training. Fig. 3.1 shows a maize field of BHM-3 cultivated by trained families at Jamalpur.

Key activities planned	**Targeted no. /achievement**	**Time & duration**	**Achievements**
e. Maize germplasm importation and distribution among GOs / NGOs / private sector	Maize trial sets / inbreds	Sept 2005-Feb 2006	CIMMYT maize germplasm imported and distributed to the GO and NGO partners for evaluation. Fig. 3.2 shows the maize germplasm under evaluation by BARI being visited by Kevin Pixley, senior CIMMYT maize breeder and Director, based in Mexico and two CIMMYT maize breeders from India.
f. Applied research and technology demonstrations: i. Varietal trials ii. Promising lines evaluation trials iii. Maize based intercropping systems iv. Fertilizer management for maize-base systems v. Demo. on BARI released hybrid maize vi. Demo. on maize intercropping systems vii. Demo. on different maize establishment methods (bed, zero tillage) viii. Demo. on modified N management	Various	Oct 2005-April 2006	1. BARI released maize hybrids (BHM-2, 3 and 5) tested in varietal trials in 8 locations found to perform better than popular locally adopted hybrid Pacific-11. The crop will be ready to be harvested by the last week of May 2006. 2. Promising lines developed by BARI scientists of Jamalpur RARS found to perform better and will be ready to be harvested in the last week of May. 3. In maize based intercropping, intercrops like lalshak, potato and coriander liked by farmers due to their high market demand and price. Maize crop (BHM-3) found not affected by intercrop during field visit. 4. Demonstration of BARI released hybrid, BHM-3, with 2000 trained families reported to perform well. A BHM-3 field visited by DG BARI at Jamalpur is depicted in Fig. 3.3. 5. Data from all other trials will be ready to be analyzed after harvest in May. 6. Modified N-management (½ N as basal + ½ N at 8-leaf stage) liked by farmers and crop was showing better growth than the old N-management plots during field visit.

Key activities planned	Targeted no. /achievement	Time & duration	Achievements
g. Promotion of BARI released hybrid maize through F1 seed and parental seed increase.	kg seed production	Aug-June 2005/06	3,000 kg of BARI hybrid seed procured and distributed among the 2000 maize whole-family trained farmers. Farmers reported good stand establishment and crops performing better than existing commercial hybrids. BARI plant breeding producing 5 t F_1 seed of BHM-3 and BHM-5 for demonstration by DAE during the 2006 growing season.
h. Pest (insect) survey in the maize production environment	Conduct surveys	Nov 05 - April 06	Deferred for next year (if budget available)
i. Field day on maize cultivation technologies	Management practice	Nov 05-Jun 06	Ten field days in 10 locations organized. Fig. 3.4 shows one of these field days in Jamalpur organized by RARS, Jamalpur.
j. NARS partners existing facilities improvement and skill development of GO and NGO on hybrid maize seed production and modern maize cultivation	Lab/field research/ storage/ mobility	July 05 - Jun 06	BARI conducted a two-day hybrid maize seed production training workshop in March 2006 with their own funds and with technical assistance from CIMMYT. Total trainees were about 30.
k. Monitoring trainers and family training, research and demonstration fields	Various	July 05-June-06	CIMMYT scientists, along with partners, made various visits to trained families during report period and gave suggestions and solutions to problems experienced by the farmers.

Fig. 3.1: BHM-3 field cultivated by a trained maize farmer in Jamalpur

Fig. 3.2: CIMMYT maize breeders from Mexico and India visiting CIMMYT maize germplasm evaluation trial at the experimental station BARI, Gazipur February 2006

Fig. 3.3: A BHM-3 field in Jamalpur being visited by the DG BARI March 2006

Fig. 3.4: Participants at a field day in Jamalpur

Development of Ring Spot Virus Resistant Transgenic Papaya in Bangladesh

Key activities planned	Targeted no. of trainees /achievement	Time & duration	Achievements
i. Work on regulatory and bio-safety guidelines and processing of application for import and testing of transgenic papaya	Conduct various informal and formal meetings	July 2003-June 2006	The process of application to import and test transgenic papaya in Bangladesh continued. There were a few questions regarding transgenic papaya at the core committee of NTCB held at BARC in February which need clarification for the application procedure. Once these are answered and incorporated into the application, it will be resubmitted to the DG BARI : 1. Since the biolistic transformation method was used, how much of the vector sequence (sequences outside the expression cassette) was incorporated in the papaya genome? 2. Copy number of the integrated gene and junction sequences of the integration site/s. 3. If there was any backbone integration then does that include tetracycline and gentamycin resistance genes? 4. What is the possibility of recombination events happening between the CP genes of Taiwanese strains and the local strains upon infection in the field? Is there any possibility of developing new strains? 5. Safety of *nos*, *nptII*, *uidA* and the other sequences used in the expression cassette for human consumption? 6. FDA permission documents. 7. EPA release documents. USDA is gathering the necessary information and will incorporate it into the revised report for BARI.

Key activities planned	Targeted no. of trainees /achievement	Time & duration	Achievements
			Assuming that the GOB accepts the resubmitted application and approves field trials, our goal is now to have the seed ready for the August/September 2006 sowing which is the second season for papaya sowing during the year, i.e. right after the heavy monsoon rains. Deregulation of the 'SunUp' and 'Rainbow' (both commercialized in the U.S.) transgenic papaya in Japan could set an important precedent for getting approval of the transgenic papaya in Bangladesh, Thailand, and other parts of the world. It is hoped that clearance of the transgenic papaya in Japan will pave the way for a less extensive deregulation process of the transgenic papaya in Bangladesh and other countries.
ii. Development of transgenic papaya with the synthetic gene constructs		Jan., 2005 – June, 2006	One objective of the project is to develop a range of transgenic papaya of Hawaiian solo cultivars and 'Khakdum' Thailand papaya that would provide broad resistance to PRSV. These cultivars could be used as is or as germplasm for developing cultivars that are suitable for Bangladesh. The synthetic gene technology is new and thus not as well tested as the entire coat protein and segmented gene technologies. Our transformation experiments have yielded the following: Number of lines on selection media that normally kills nontransgenic papaya: Hawaiian Solo 'Kapoho': 128 Hawaiian Solo 'Sunrise': 89 Thailand 'Khaekdum': 296 Initial characterization of lines that have started on plants that have yielded sufficient tissue for testing. The sequence of testing is to grow them on

Key activities planned	**Targeted no. of trainees /achievement**	**Time & duration**	**Achievements**
			antibiotic media to identify kanamycin resistant lines (number of plants shown above), then to test tissues by ELISA for the presence of the enzyme (neophosphotransferase) that imparts resistance to kanamycin, and then to do PCR to test for the target viral gene. These experiments are ongoing as calli development into plantlets. Initial ELISA tests have identified 19 kanamycin-resistant plants. More testing is being done. Plants should be ready for testing for virus-resistance during 2006 and 2007.
iii. Construction of transgenes with the 'segmented' coat protein genes of PRSV isolates from Bangladesh		Nov., 2004 – June, 2006	PRSV isolates were collected and sent to Hawaii for analysis of their coat protein sequences. These analyses were done and were part of the submission of the application for importation and testing of potential transgenic lines. The genes were sequenced and then engineered to have a 'segmented' gene construct that would be tailored for Bangladesh. That is, this gene construct would have segments of coat protein genes of PRSV isolates from Bangladesh. This technically challenging task was completed and plasmids are now ready for transformation into papaya.
iv. Screening of segmented transgenic lines at Cornell University	Testing appropriate lines	Jan., 2005 – June, 2006	A fast track effort was done to speed up the project by using transgenic lines with a gene construct that contained segmented genes from PRSV isolates from Thailand, Taiwan, and Hawaii. These lines were of transgenic cultivars of Hawaiian solo 'Kapoho' and 'Sunrise'. The lines had originally been screened against PRSV isolates from Thailand, Taiwan, and Hawaii. They were subsequently brought from Cornell to Hawaii where they were evaluated horticulturally and screened against PRSV from Hawaii. The selected cultivars are horticulturally good and resistant to PRSV under field conditions in Hawaii. Since coat protein analysis of PRSV isolates from Bangladesh showed that these coat proteins were very similar to those of PRSV from Hawaii, we expect that these papaya lines would be resistant to

Key activities planned	Targeted no. of trainees /achievement	Time & duration	Achievements
			Bangladesh isolates. Five different transgenic lines were sent to Cornell University for analysis for their resistance to PRSV isolates. The plants grew slowly (due to winter conditions) but well (Figs. 4.1 and 4.2). PRSV isolates were shipped to Cornell University, the isolates were inoculated to *Cucumis metuliferus*, which is a host that we have routinely used to propagate PRSV isolates. The inoculated *C. metuliferus* showed positive ELISA readings which showed that infection had been established. Concurrently, he inoculated *C. metuliferus* with PRSV from Hawaii. As expected, the PRSV from Hawaii incited severe symptoms on *C. metuliferus* but unexpectedly the Bangladesh isolates showed very mild to almost no symptoms, although virus could be detected by ELISA. These inoculated *C. metuliferus* were used to inoculate nontransgenic and transgenic papaya seedlings. However, symptoms of infection did not develop on transgenic or nontransgenic papaya. We need to establish the inocula on papaya by directly inoculating the dried inocula.
v. Development of papaya agronomic guidelines for Bangladesh			Between January and March 2006, Ms. Jackie King continued her research activities in northwest Bangladesh. She currently has two field experiments at the Rangpur On-Farm Research Division (OFRD) research station and an additional four experiments on farmers' fields in Pabna and Ishurdi (Figs. 4.3 and 4.4).. She will complete her field research in April 2006. After which, she will return to the U.S.A. to conduct laboratory analyses and write her dissertation. Ms. King's research will provide information on the horticultural management and production of papaya in Bangladesh.

Fig. 4.1:Different transgenic lines being tested for their resistance to PRSV isolates, USA

Fig. 4.2: Papaya growth being measured in a pot

Fig. 4.3: Papaya research in the farmer's field in the north west of Bangladesh

Fig. 4.4: Beautiful papaya fruits carried by a smiling girl in the papaya garden

Impact of Arsenic Contamination on Agricultural Sustainability and Food Security

Key Activities Planned	Targeted no. of equipment/ samples/persons	Planned Time & Duration	Achievements	Remarks
a. Graduate degree programs in Bangladesh / USA	Four Bangladeshi scientists (three at BAU and one at CU)	Final year: July 2005-June 2006 (for in-country fellows)	The three fellows in Bangladesh completed their thesis research experiments (both greenhouse and field experiments) and relevant laboratory analyses at the BARI-CIMMYT Arsenic Laboratory and BAU Central Laboratory. Their thesis research topics and objectives were given in the July-Sep 2005 quarterly report. They have started their thesis write-up and some parts have been reviewed by the PhD Committee Members. The fellow doing his PhD at Cornell has completed his course work. He is now conducting a greenhouse experiment as a part of his thesis research. He is working with all BRRI varieties exposed to low As (7 mg / kg soil) and high As (45 mg / kg soil). He will look at As accumulation and speciation in rice as related to the chemistry of As in the water-soil system. His findings may lead to insights in rice cultivar difference in response to As, which could become an important tool in As management.	The in-country PhD fellows are expected to complete their thesis research and write-up by June 2006.

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b. Assessment of As in irrigation waters, soils and crops of Bangladesh	30 sites in low-As and high-As areas	October 2005-May 2006	The work was postponed due to fund constraints. The work will be done in collaboration with SRDI in future, if and when new funding is available.	This will provide a time-series data set that will give insights into the pattern of As accumulation (or depletion) in soils of Bangladesh. So far as our knowledge goes, there are no such As data in the country.
c. Study of As in water, soil and rice in a T.Aman –Boro pattern at one long-term monitoring site	One shallow tube well (STW) command area in Faridpur to serve as a long-term monitoring site	July 2005-May-June 2006	An experiment was conducted in T. Aman 2005 in a high-As irrigation command area at Paranpur, Faridpur. Arsenic in the soil and porewater was monitored. There were clear indications that high As in soil and porewater was adversely affecting the growth of the plants by reducing the root and shoot biomass. Ultimately, grain yield was affected by soil As. High As accumulation in roots, straw and grains was observed. We planned to repeat the experiment in Boro when additional As would come from the STW water. Accordingly, an experiment was set up with the popular Boro variety, BRRIdhan 29, as the test variety. Six replicated experimental plots (rep: 4) were set up in the STW command area. The plots had a range of total soil As from 11 to 68 mg/kg. Simultaneously, an *in situ* "net house"	These findings may have very important implications. So far we noticed elevated As in rice grains, without yield reduction, but now we got the first indication of a build-up of As in the water-soil system to levels that seem to threaten yield in farmers' fields. Productivity could be at risk in areas where As build-up in the soil goes

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			was built with a bamboo structure (see Fig. 5.1) where a pot experiment was set up with soils from the experimental fields to observe the effect of As on plant growth and yield under controlled conditions. Additionally, a comparison between irrigation water from STW (high As) and a river (low As) is being made in the "net house" pots to see if surface water irrigation could reduce the effect of high As in the field. Forty-day-old seedlings of BRRIdhan 29 were transplanted in the fields and the "net house" pots in mid January 2006. Soil pH-Eh and pore-water As concentrations and rice plant growth are being monitored through sampling once a month following transplanting. So far over the last three months, a consistent decrease in the soil redox potential (Eh) with a concurrent increase in bio-available As in the ambient soil solution has been observed. Remarkable effects of As on plant growth parameters (plant height, tillers/plant) have been observed both in the field plots and the "net house" pots (see Fig. 5.2). These are expected to be reflected in the As-yield relationships. The crop is expected to be harvested in mid to late May. Laboratory analyses at the BARI-CIMMYT Lab for As in plant parts during the vegetative stages are	unchecked. Long-term studies at a few more monitoring sites need to be conducted to confirm the potential impact of As not only on food quality but also crop productivity.

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			in progress. Root, straw and grain samples will be collected at harvest and analyzed for As and other relevant elements including Fe, Mn and P. Sub-samples of rice grain will be sent to CU/TAMU for As speciation determination with ICP-MS.	
d. Field experiments on As management	One field trial in a high-As area	Dec 2005 - June 2006	A field was selected in Kanaipur, Faridpur for an experiment on the effect of rice cultivation methods and water management on As uptake by rice. Here, the STW which was installed three years ago is pumping out water exceptionally high in As, 400 µg/L. Within three years of irrigation with such high-As water, the soil As level is presently around 20 mg/kg which may increase fast. In our experiment, the main treatments are growing rice conventionally and on raised beds, the hypothesis being that on raised beds the As would be less mobile, and, therefore, less bio-available. Measurements and monitoring, sample collection and analysis plans are the same as those for the experiment at Paranpur described in the section above. So far, significant differences between the raised beds and conventional fields have not been found. Additionally, at this site, we have taken soil	This site where STW water As was found to be very high and where both rice and maize are grown could be an interesting site for long-term monitoring site where trends in water As concentration and As accumulation in soils and traditional rice crops and the more recent maize crop could be determined and strategies for As management could be developed.

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			samples from maize fields (near the STW and far away from the STW). The maize field soil near the STW had an As content of 23 mg/kg, and that far from the STW had 9 mg/kg. Farmers are growing maize in fields which were traditionally Boro fields. The farmers were motivated to grow maize by two local Sub-Assistant Agricultural Officers (SAO) of DAE who had earlier received training from the CIMMYT Maize WFT program. At this site, we will have an opportunity to see whether varying As in soil affects As accumulation in maize stalk and grain. Samples will be collected from the maize fields and analyzed at the BARI-CIMMYT Lab.	