Project Completion Report
On
Ecological Determinants of Bamboo Flowering and Rodent Population Outbreaks in the Chittagong Hill Tracts

CGP Projects: Phase-I

Project Duration: 24 Months; From May 2009 to April 2011

A. Basic Project Information

i. Project Code/ID Number: CGP/C-HF-104
ii. Project Title: Ecological Determinants of Bamboo Flowering and Rodent population Outbreaks in the Chittagong Hill Tracts
iii. Name of Principal Investigator: Dr. Nazira Q. Kamal
iv. Name of the applying organization with address : Association for Integrated Development – Comilla (AID-COMILLA, Village: Raghupur, Post Office: Rajapar, Union: Jagannathpur, Upazila: Comilla , Adarsho Sadar, Comilla-3500
v. Project duration (year/months) 24 months ; From May 2009 to April 2011
vi. Project commencement date (As per MOU) May 2009
vii. Project Locations/Sites: Ruma Upazila of Bandarbon District
viii. Project cost (total) TK 2,000,000.00 (Year-1: TK1,229,000.00, Year-2: TK771,000.00)
ix. Fund received in TK 1,837,800.00 and Expenditure made in TK.1, 837,800.00 during the reporting period.

B. Summary/Executive Summary

Rodent population outbreaks due to *Melocanna baccifera* flowering in the Chittagong Hill tracts were first noted in 2007 on crop production cycle. *Melocanna baccifera*, is the dominant bamboo species (>80%) found throughout the Bengal Bay border area of India (Mizoram, Tripura States), Bangladesh (Chittagong Hill Tracts) and Myanmar (Chin, Rakhine States). This species of bamboo gregariously flowers on an approximate 50-year cycle, setting off a chain of events which leads to large rodent population outbreaks, severe crop damage and regional famine. This current seed masting event spread southwards from India into Bangladesh in 2007 and has continued with each progressive season up to the present.

Ecological survey on removal trapping of rodents started in March 2009 in several habitats (bamboo forest, rice fields, villages and houses) in Ruma Upazilla, Bandarban District on a monthly basis using a combination of kill and live traps (Sherman single capture, multicapture cage, single capture cage). Breeding and taxonomic data were collected from all captured animals showing the dominant species of rodents in all habitats were *Rattus*

and *Mus* species complexes. At the same time, data on the bamboo physiology were collected regarding seed fall timing, abundance, germination, and seed damage by rodents using 30 plots ($1m^2$), 10 m apart arranged in three separate transects. Evidence will be presented that suggests a clear linkage between bamboo masting and rodent population growth, with rodents benefitting from the a seasonal food availability provided by a superabundance of bamboo seed that falls several months prior to when rice crops are normally harvested.

A total of 2,066 small mammals were captured in all trapping habitats including inside houses, outside houses, bamboo forest, jhum field and community houses. Study shows that *Rattus rattus* are the dominant rodent species in all habitats and followed by *Mus musculus.* Species diversity is high, 10 different rat species were identified but taxonomic separation of *Mus* spp. and *Rattus* spp. is required. A highest 14 embryos were found in female *Rattus rattus* species. On an average 30% rat damaged seeds were observed in 30 plots ($1m^2$), 10 m apart plot. Percent germination is very high (>90%). Seeds can germinate while still on the stalk. Research study shows that rat damaged seeds can still germinate and ats also continue to eat from germinated seeds.

Set up of three TBS (Trap barrier System) and no fence in Jhum rice fields were done for the comparison of rice crop field damage assessment by rats: the mean number of cut tillers per square meter at no fence (±3.27) and at the TBS (±1.06). The result showed that setting of TBS surrounding the Jhum fields are more effective for rat management.

C. Introduction

Gregarious flowering and mast seeding of bamboo is a well-accepted phenomenon throughout the world. Bamboo flowering intervals are genetically triggered and range from less than 10 years to more than 120 years. The two dominant species of bamboo found within the Chittagong Hill Tracts (CHT), *Melocanna baccifera* and *Dendrocalamus hamiltonii*, flower on an approximate 50 year cycle. These two species comprise greater than 80% of all bamboo grown in the CHT region and their current synchronised flowering phase reached the CHT in 2007. This flowering cycle is expected to continue until 2011, followed by a mass die off of the bamboo and its regeneration over 5-6 years thereafter. This relatively rare event causes widespread ecosystem changes that have not yet been properly studied and analysed anywhere within the Bengal Bay eco-region (India, Bangladesh, Myanmar) nor, indeed, anywhere else in the world where this phenomenon occurs. The most notable ecosystem change resultant from the bamboo flowering is a dramatic rise in rodent numbers. Although it is not scientifically confirmed, it is assumed that the rodents eat the bamboo seeds, using the abundant food resource to increase their breeding potential and as a result expand their population. It has also been purported that bamboo seeds may contain potential estrogenic compounds that stimulate reproduction, which again is not confirmed. Farmers in the CHT also notice other ecosystem changes, such as higher crop damage by birds and pigs, but it is not known whether these animals

have been driven out of the forest because of a breakdown in the food web or because of similar population expansions through eating the abundant bamboo seeds.

Several aid agencies were worked out in the rat affected hill communities to recover the original life. Both international and National NGOs were studied within the rat affected communities.WFP distribution of emergency relief starts in early 2008, assessment of food security/nutrition status. UNDP commissioning of several reports on health and nutrition as well as a scientific report, trap distribution, rat management training programme.FAO commissioning of damage assessment.

In the mean time, Krishi Gobeshona Foundation competitive call for agricultural research projects and funding awarded for two years research to AID-Comilla and Dhaka University, starting March 2009.

D. Specific project objective(s)

Broad objective(s)

To understand the ecological consequences bamboo forests undergoing synchronous gregarious flowering, seed masting, senescence and regeneration on small mammal and other vertebrate species population dynamics and the livelihood impacts of the event upon rural communities living nearby.

Specific Objectives (s)

1) Monthly trapping of rodents in different habitats
2) Taxonomic identification of specimens captured
3) Breeding status of specimens captured
4) Rodent stomach content analysis in relation to bamboo physiological state
5) Collection of localized bamboo seed fall timing and relative abundance indices
6) Socio-economic assessment of rodent damage to people's livelihoods before, during, and after rat floods
7) Evaluation of potential ecologically-based rodent management options to mitigate damage caused by rat floods
8) A temporal and spatial analysis of rodent population dynamics in respect to bamboo flowering, fruiting and senescence
9) A temporal and spatial analysis of habitat utilisation of different rodent species in respect to bamboo flowering, fruiting and senescence
10) submit at least two scientific manuscripts to the highest level of international peer-reviewed journals on project derived data and analysis
11) Supervise PhD student and build capacity within Bangladesh institutions on rodent ecology and management

E. Detailed Technical Report

a. Statement of the Problem

Rodent outbreaks following bamboo flowering are a well-accepted scientific phenomena reported to occur in several countries including Argentina, Peru, Brazil, Chile, Madagascar, Japan, Laos, Myanmar, India and Bangladesh. Rodent outbreaks in other countries where bamboo is found in abundance are also found in historical literature. However, the long intervals between flowering events for many bamboo species, e.g. 130 years for the main species of bamboo in China, means that proper scientific surveys and ecosystem analyses are, indeed, extremely rare. As yet, no longitudinal surveys of rodent population dynamics during bamboo flowering events are available from any part of the world. Any references to bamboo flowering and rodent outbreaks are usually "snap shot" surveys that offer no insight into rodent breeding potential, immigration and recruitment. Linkages between bamboo flowering and rodent outbreaks have not been proven and the causes of rat floods are mere speculation. The impact of rat floods is well documented with several historical documents referring to widespread famine and mass migration of people living in affected areas during such events.

A UNDP-sponsored mission in October 2008 to the CHT provided an opportunity to collect some preliminary evidence and data on the rat flood phenomena. Areas of Ruma and Thanchi Upazila in Bandarban District were visited that are currently flowering and/or flowered last year. These results showed an unusually high rat trap success index and the presence of previously undocumented rodent species that are not found elsewhere in Bangladesh. Further taxonomic investigation is required to determine whether the specimens belong to *Berylmys bowersi* or whether the specimens are a new species within the genus *Berylmys* or indeed within another genus more commonly found in southeastern Asia. This UNDP mission has provided evidence of accessible operational bases where the research could be carried out, where bamboo flowering is currently ongoing in large parts of the forest around communities and where we expect rodent outbreaks to occur in the 3rd and 4th quarters of 2009.

The current bamboo flowering in Bangladesh is due to the species *Melocanna baccifera* and *Dendrocalamus hamiltonii* which flower on an approximate 50 year cycle and comprise greater than 80% of all bamboo grown in the CHT region. These species are also the predominant species found in Mizoram State in India and Chin State in Myanmar. The flowering event initiates in the north-eastern part of its range and proceeds in south-westerly waves of flowering over a 3-4 year period in a given area. Hence the current flowering event started in Mizoram in 2004, reaching Bangladesh in 2007 and Myanmar in 2008. The previous events started in 1958 and 1910.

b. Research Approaches and Methodologies

i. Approaches

Prof N.J. Sarker will act the main supervisor of the PhD student who will be registered at Dhaka University. Dr Belmain, Dr Kamal and Dr S. Sarker will act as co-supervisors throughout the student's studies.

As PI, Dr Kamal will be the overall responsible for ensuring rigorous adherence to empirical methodologies that are scientifically sound and appropriate for the ecological context of the research programme. Methodology development for all activities will be decided through joint discussion and agreement among the PI and all co-investigators and the PhD student. All investigators, together with other involved project staff and the PhD student will be joint authors on all papers produced from the project activities.

Dr Belmain will be the main responsible for studies related to rodent biology, taxonomy, behaviour and ecology.

Dr S Sarker will be the main responsible for developing and assessing the optimisation of ecologically-based rodent management tools for mitigating rat floods in rural communities.

Prof N.J. Sarker will be the main responsible for developing and assessing bamboo forest surveys on seed production, seed fall timing and indices of seed abundance.

Dr Kamal will be the main responsible for socio-economic surveys, damage assessments and livelihood impacts of rat floods.

The AID-COMILLA is being performing management responsibilities and financial aspects. In Ruma a research lab were established for continuing research programme such as rodent breeding, taxonomy and rodent diet analysis.

ii. Methodologies

An exploratory research studies are carried out in Ruma Upazila under Bandarban Hill District, Chittagong Hill Tracts: five villages were randomly selected for the research studies. The villages are: Neweden, Munlai, Happyhill, Maulpi and Basatlang para.

Ruma was selected for research work because large amounts of flowering bamboo were noted in November 2008 and again in November 2009. We started our research in Ruma Upazila earlier in March 2009.

Appropriate field survey methods were used. Different types of traps were used such as kill, Sherman and multiple capture traps in different habitats such as Indoor household, Outdoor household, Jhum rice crops, Bamboo forests and Community houses. Trapping in each habitat will be done with 50 traps, with each habitat replicated six times, with four consecutive trap nights per month. This data set will allow an analysis of relative population abundance over time and space which can be simply analysed. Captured animals are processed for breeding data, assessing maturity, and evidence of current and/or historical breeding (e.g. uterine condition and the presence of uterine scars allows an accurate collection of frequency and size of previous litters born). Specimen size and measurements are used for breeding and taxonomic purposes, and representative samples are further processed through (70% ethanol) preservation so that samples can be taxonomically confirmed through genetic tests carried out a later date.

1) Habitat trapping across four habitats

Habitat trapping started in March'09 and ended in December'09. These trapping were done in two villages namely Neweden and Munlai para in different habitats. These habitats include: inside houses, outside houses, bamboo forests and Jhum fields. Two trap lines were used with 40 traps each villages and trap line mixed with small/larger Sherman, single/multiple cage and kill traps. Traps rotated to different habitat each week.

2) Community-led household trapping

Community trapping started in July'09 and still continuing. These trapping were done largely in houses and run by community. Three traps line were used in Neweden, Munlai and Basatlang para. Traps rotate around villages and number of traps varies between communities, but roughly 50 kill traps per village were used. Captured rats were handed over to project staff for processing.

3) Continuous trapping in bamboo habitat

These trapping started in July'09 and continued upto December 2009. Three trap lines were used in three different forests each with 30 traps. Traps were set up at 6.00 pm everyday and checked each early morning. Trap lines mixed of large and small shermans, multi/single cage and kill traps. Again in January 2010 to April 2011 we set up three trap lines in newly bamboo flowering forests. A total of 250 kill traps were carefully positioned and monitored.

4) Rat flood trap barriers

These trapping started in July'09 and continued upto December'09 and also set up again in July to December in 2010. Three trap lines were used for rat flood barriers. For this purpose plastic fence were used all the way around the farmer's jhum field with multi-capture traps. These traps were carefully positioned and all are facing outwards. The number of traps per TBS varies but roughly every 10 metres apart and every village possed one TBS field. Traps were checked regularly in each TBS field.

5) Tracking tiles in houses

Tracking tiles were set up in two villages namely: Neweden and Munlai Para. These tiles were placed in 10 household per village, two per house were placed in ground and ceiling.

6) Bamboo seed fall survey

Bamboo seed fall surveys started in July'09 and continued upto December 2009. These surveys were done in three different villages namely: Neweden, Munlai and Basatlang para. Three transects were used in different bamboo forests and 10 sample plots per transect. Each plot was 10 m apart and each sample plot was $1m^{2.}$ Samplings were done once a month. Number of bamboo seeds counted and noted for damaged and undamaged, germinated and ungerminated and also noted for estimate amount of seed that has not yet fallen. Again in February, 2010 and continued upto December 2010 we started bamboo seed fall tracking in newly flowering bamboo forests in the same location but different bamboo forests.

7) Crop damage assessments

Crop damage assessments started depending on crops growing stage in the jhum areas. We started counting cut tiller from the tillering stage to harvesting. Three Trap barrier system (TBS) Jhum fields and, 3 un-fenced Jhum fields and 2 indigenous fenced Jhum fields were selected for comparing crop damage assessment and six sampling plots were selected per field, two at bottom of the hill, two at top of hill, and two in middle of the hill. Sampling was done from $1m^2$ area in each plots.

8) Pre and post harvest loss assessment

Pre and post harvest loss assessment were done in three villages namely Basatlang, Munlai and Neweden. These assessments were done counting the rat burrows in the jhum field before and after harvesting the jhum rice field. The burrow count was done 7 days in both the occasions.

9) Socio-economic analysis

Socio-economic analyses of rodent damage carried out from December 2010 to March 2011using Knowledge, Attitude and Practice questionnaires administered at the household level.

c. Results and Benefits

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

Specific Project Objective(s)	Planned activities performed against each objective	State progress made clearly during the reporting period against each activity	Outputs/results achieved during this period
1. To understand the ecological consequences resultant from gregarious bamboo flowering, seed masting, senescence and regeneration of small mammal.	1.1Habitat trapping across four habitats 1.2 Community trapping in three locations run by community 1.3 Tracking tiles in household 1.4 Bamboo seed fall survey in three different bamboo forests 1.5. Bamboo seed production tracking survey in 8 different bamboo forests where 4 without cutting, 2 to burn and 2 to cut bamboo forests were selected 1.6 Captured from all habitat rodent species were processed for breeding and taxonomy	1.1Trapping in four habitats: inside houses, outside around village, bamboo forest and jhum fields were done in two villages. A total of 80 traps were used for these trapping. Traps rotate each week in each habitat. 1.2 Trapping in community houses run by community in three different villages namely Neweden, Munlai and Basatlang para. A total of 150 traps were set up in those villages. 1.3 Monthly 30 sample plots were taken for counting bamboo seeds falling, noting undamaged seed and damaged seed by rats in 3 bamboo flowering forests in 2009. 1.4. Monthly 80 sample plots were taken for counting bamboo flower panicles, rat damaged panicles, undamaged seed on the stalk and seeds falling, noting undamaged seed and damaged seed by rats in 8 bamboo flowering forests in 2010 where 4 without cutting, 2 to cut and 2 to burn forest were selected.	1.1 A total of 1857 rats (male 829 and female 1028) were captured in five different habitats. 1.2 A total 1508 rats were captured in hhouseholds level. Captures suggest population reduction over time. 1.3 A total of 350 rats captured in all outdoors habitats. captures rates was low in all outdoor habitats 1.4 About one third of bamboo seeds were rat damaged. Percent germination of seed is high (>90%) 1.5. Results shows that all rodent species eat *Melocanna* bamboo seeds. 1.6 Bamboo seeds can germinate while on the stalk 1.7. Rats damaged bamboo seeds can also germinated.
2. Understanding of rodent biology, behavior and ecology as affected by gregarious flowering of bamboo.	2.1 Continuous rat trapping in 3 bamboo forests 2.2 Rat trapping in the newly bamboo flowering forests in Maulpi, Munlai and Neweden para. 2.3 Captured from all habitat rodent species were processed for breeding and taxonomy	2.1 Continuous rat trapping was done in 3 bamboo forests in Munlai, Neweden and Basatlang para. A total of 90 traps were set up in each 30 traps per forest. 2.2 A total 250 kill traps were carefully positioned at the 3 newly bamboo flowering areas namely Munlai, Neweden and Mualpi para. All captured rats samples were measured (head, body and tail length, weight, sex and uterine scars) and preserved in alcohol for further taxonomic studies	2.1 A total 196 rats were captured in the continuous rat trapping in bamboo and newly flowering bamboo forests. 2.1 About 10 rodents species were identified during the reporting period other species still waiting for indentification. 2.3. A highest number of 17 embryos were found in *Rattus rattus* species which was a

			lot in history in Bangladesh. 2.2 Species diversity is high, but taxonomic separation of *Mus* spp. and *Rattus* spp. is required
3. Socio-economic assessment of rodent damage to people's livelihoods due to rat floods	3.1 Preparation of questionnaire 3.2 Pre-test & finalize the questionnaire 3.3 Selection of sample areas, data collection & analysis data	3.1 Preparation of questionnaire has completed. 3.2 Selection of sample areas is completed in 3 different indigenous communities at Ruma Upazila.	3.1 Few farmers feel rat floods can be controlled, there is much fear and rumour 3.2 Many farmers change their cropping patterns during rat flood years to plant more early ripening varieties, despite their lower yields because the late ripening varieties are more at risk to the rat flood 3.3 Many farmers cut and sell their seeding bamboo forests before the planting season. They then plant their rice on top of the slashed/burned bamboo forest, due to lack of land or lack of understanding that this may cause higher rat damage to their crop.
4. Optimization of knowledge and tools for mitigating rat floods that is socially acceptable, cost beneficial and effectively delivered within affected rural agricultural communities of the CHT	4.1 Rat floods trap barriers system 4.2 Rodent damaged assessment 4.3 Pre and post harvest loss assessment in jhum field	4.1 These trapping started in July'09 and ended December'09 and also again set up July to December in 2010. Three trap lines were used for rat flood barriers. Plastic fence were used all the way around the farmer's jhum field with multi-capture traps inserted around. 4.2. Rodent damage assessments were done in 6 different jhum fields. 4.3. Pre and post harvest loss assessment were done in 6 different jhum fields.	4.1 The mean number of cut tillers damaged by rats without fence is ±3.27 whereas with fence is ±1.06 started from tillering stage to harvest 4.2 The result showed that setting of TBS surrounding the Jhum fields are more effective for rat management.

(ii). Outputs/Results: Monthly captured rats in all habitats

A total of 1857 rats were captured in all habitats including inside houses, outside houses, jhum fields, bamboo forests and community households in four different locations by monthly trapping from March 2009 to April 2011. **Figure 1** shows that population capture rate reduction over time.

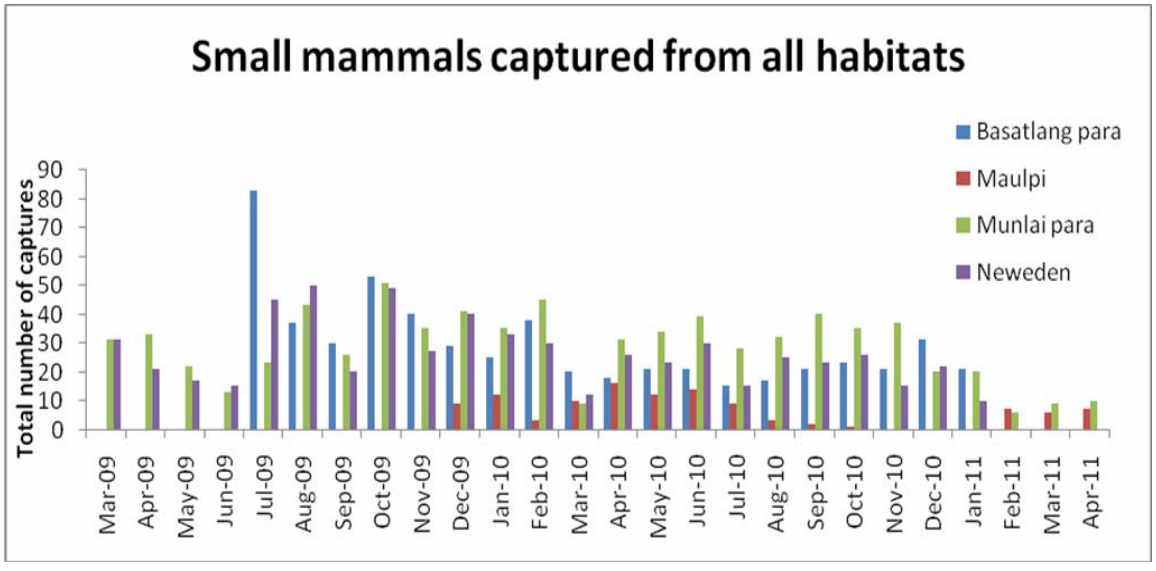

Figure 1: Total number of rats captured from March 2009 to April 2011

1) Habitat analysis by trapping effort

Highest numbers of rat captured were found in the community in all different trapping locations followed by inside houses and new bamboo flowering areas **(Fig-2).** Figure-2 suggests capture rate are low in all outdoor habitats such as jhum fields, outside around village, continuous bamboo forest and trap barrier system.

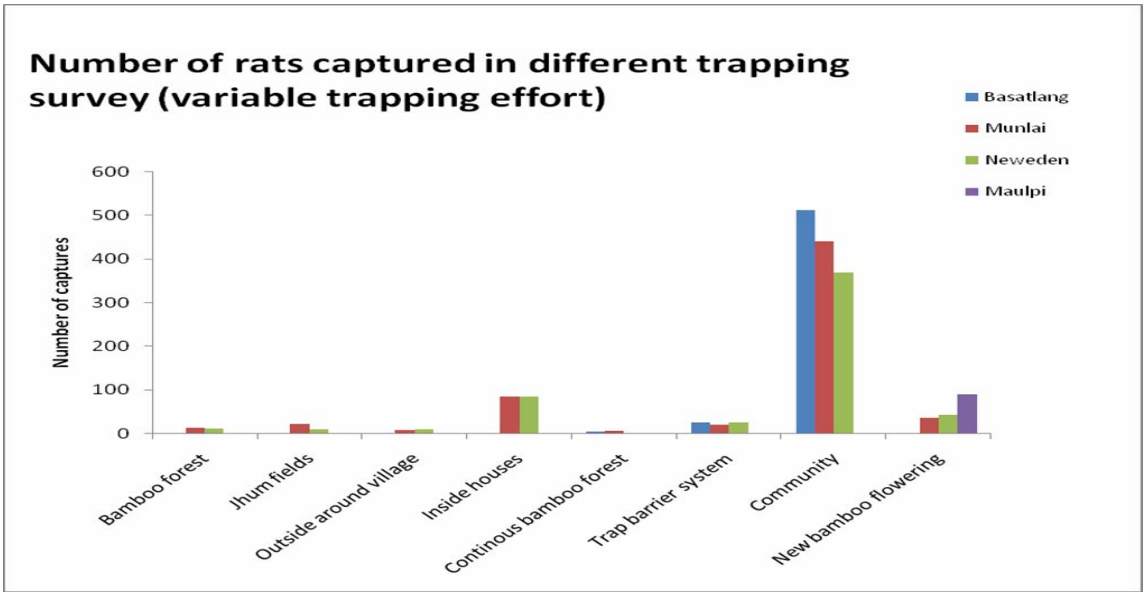

Figure 2: Rat captured in all habitats

2) Small mammal's diversity in the study area

Figure 3 shows that small mammal's diversity is high in the study area. A total of 11 small mammals were captured of which 10 species are rodents. *Rattus rattus* represents the highest number of rat captures followed by *Mus musculus*. *Berylmys bowersi* is the first noted rodent species in Bangladesh. But taxonomic separation of all the captured rodent species is to be required for taxonomically confirmed.

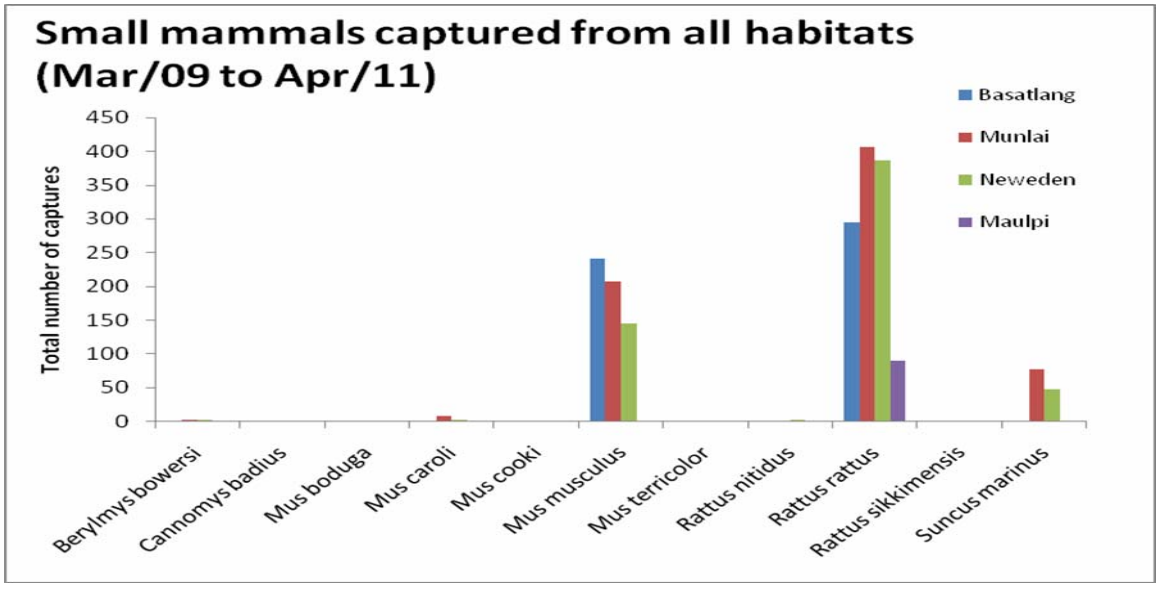

Figure 3: Small mammals species diversity in the study area

3) Breeding Condition of *Rattus Rattus*

Figure 4 represents the highest number (67) of breeding females were found in month of October '09 in all habitats. But highest percentages (more than 80%) of female *Rattus rattus* were found in breeding condition in the month of July'09 in all habitats. It is clear that rats started breeding in the month of March and April and regenerated huge number of young liters and start to multiply in the month of July to September. At the same time rice fields are ready to harvest and damaged by rodents.

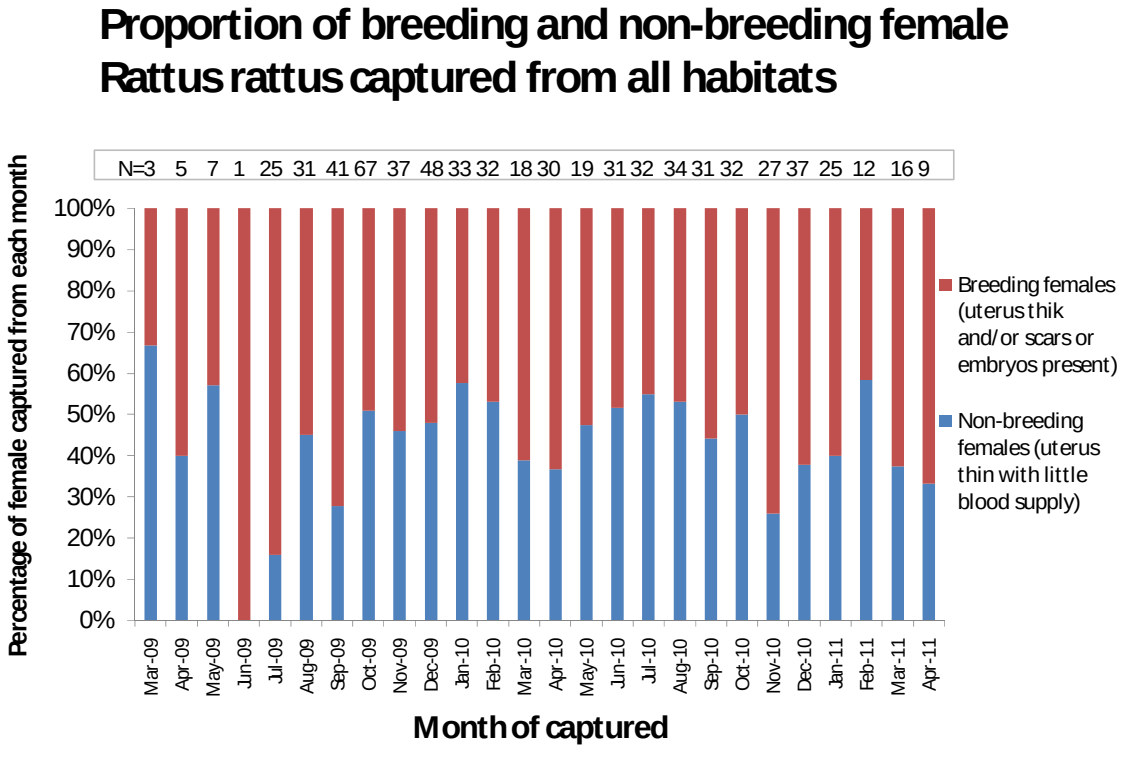

Figure 4: Proportion of breeding and non breeding female *Rattus rattus* condition

4) Bamboo seed fall survey

To observe the rat damaged bamboo seed on the ground were counted, total number of seed fallen from the stalk, partially eaten seed on the ground by rodents, undamaged seed, damaged germinated seed, undamaged germinated seed and percent of seed that has not fallen from July 2009 to December 2009. **Figure 5** illustrats that highest numbers of rat damaged seeds were found in July and August and highest number of rat damaged germinated seeds were observed from August to September.

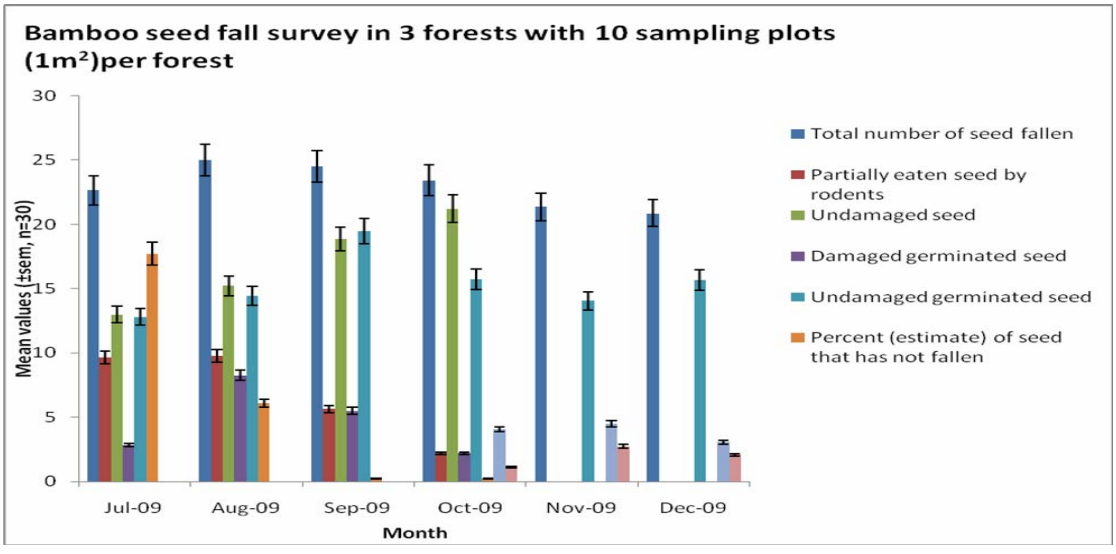

Figure 5: Monthly counting of bamboo seed fall survey

On the otherhand, **Fig 6** shows that about one third of the seeds are partially rat damaged in the bamboo forest. It is clear that rats eat the bamboo seeds and going to start multiply rat populations.

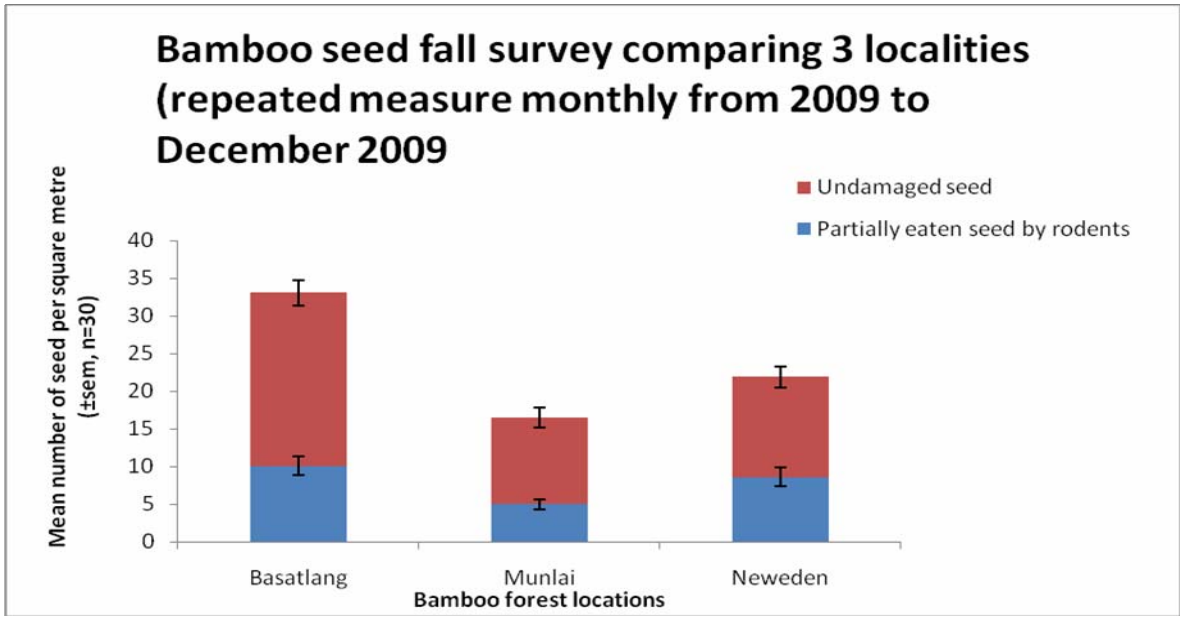

Figure 6: Undamaged seed and partially eaten seed by rodents in the bamboo forests

5) Crop damage assessment

To understand the rat damaged rice field we assessed cut tillers from 6 sample plots where 2 bamboo fence, 2 TBS field and 2 without fence jhum fields in different locations. **Figure 7** indicates that both TBS and bamboo fence were effective for rat barriers whereas without fence we found mean number of cut tillers about ±3.5. These assessments were done from tillering stage to harvest stage.

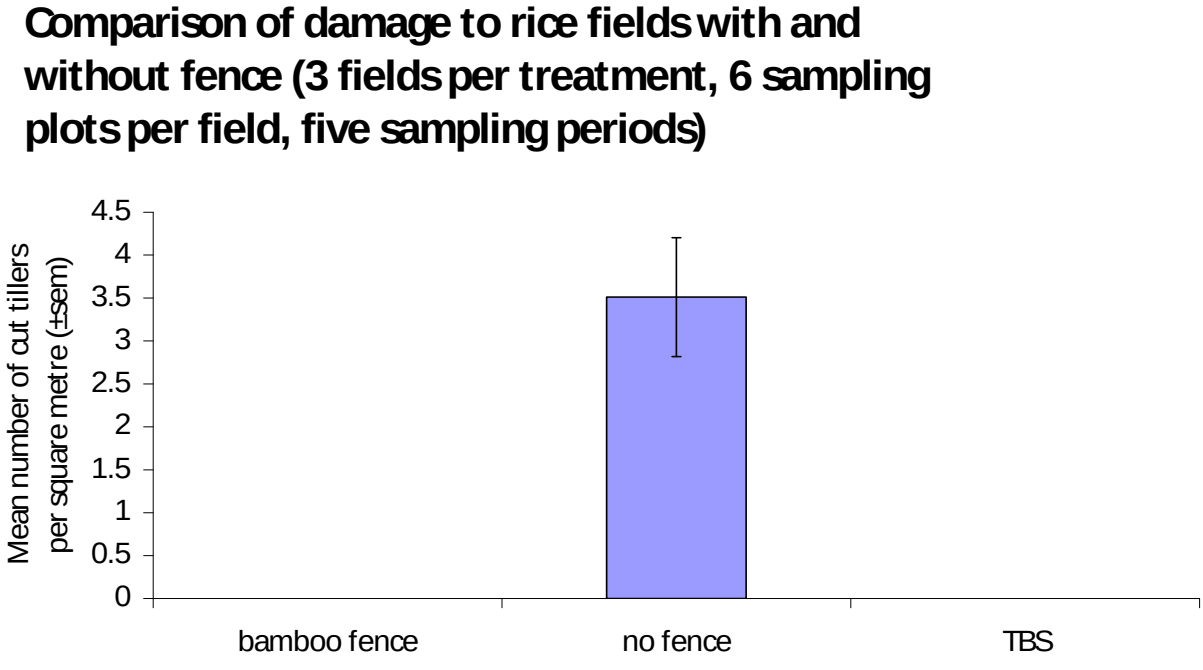

Figure 7: Comparison of rice field damaged assessment counting cut tillers

6) Knowledge, Attitude and Practice survey

Socio-economic survey was carried out in the study area using structured questionnaire. A total 90 peoples were interviewed. Three communities were randomly selected for that survey such as Marma, Bawm and Tripura. Surveys of observed damage to crop fields, food stores and household goods will be systematised for monthly assessment to measure potential temporal changes before, during and after the rat flood event. We observed that few farmers feel rat floods can be controlled; there is much fear and rumour. Many farmers change their cropping patterns during rat flood years to plant more early ripening varieties, despite their lower yields because the late ripening varieties are more at risk to the rat flood. Many farmers cut and sell their seeding bamboo forests before the planting season. They then plant their rice on top of the slashed/burned bamboo forest, due to lack of land or lack of understanding that this may cause higher rat damage to their crop.

(iii). Benefit/Outcome

It is proved that rodent outbreaks due to bamboo flowering and damage to farmer's jhum fields have scientific evidence. Now CHT peoples understand clearly what causes of rat floods and its mitigation with appropriate technology. Trap barrier systems (TBS) technology is one of the most suitable technologies to protect the jhum fields from rat floods. During the rat floods peoples expected to lose hundred percent of jhum crops. Our experiment shows that only TBS can protect the jhum fields from the rat infestations.

Different types of traps used in the household area can minimize the store loss of the CHT peoples during the rat floods. Study also shows that peoples loosed not only jhum fields but also community households. They can use kill traps to protect store house damage from the rats.

From the outcome of the project, we could understand of ecological consequences resultant from gregarious flowering of bamboo, seed masting and regeneration of small mammals such as rodent outbreaks. In addition, we identified most dominant rat species in that locality which species actually responsible for the rat floods. This knowledge, we can apply in the jhum fields for controlling the rat floods.

Further, Chittagong hill tracts communities are now fully aware of rat floods where project were implemented such as timing of bamboo flowering, timing of seed production and predicting rat infestation in the jhum fields.

d. Technology Developed

We used different types of technology in the project such as Trap Barriers System (TBS) in the jhum fields and ecologically based rat management in the community household's and around the village area.

Firstly, TBS is the new technology first time used in the Chittagong Hill Tracts jhum fields. Most of the CHTs peoples didn't use any technology to protect the rat floods. We showed that TBS is the one of the main strategy to protect the farmer's jhum fields from the rat outbreaks. Traditionally were observed some indigenous community practices of bamboo fence barriers in the jhum fields. But it is cost effective and labor based compare to TBS.

Ecologically based rodent management is another technology was used in the project area. Using traps instead of poison or killing the rats is the most ecologically sustainable for rat control. Poison bait makes detrimental effect in the environment. So, community peoples eagerly used traps to control the rats.

e. Publications made/under process

Publication made

S.R. Belmain, **N. Chakma**, N.J. Sarker, S.U. Sarker, S.K. Sarkar, and N.Q. Kamal. 2010. The Chittagong story: studies on the ecology of rat floods and bamboo masting. In: Grant R. Singleton, Steven R. Belmain, Peter R. Brown and Bill Hardy, editors. Rodent Outbreaks: Ecology and Impacts. Los Banos (Philippines): International Rice Research Institute. 289 p. http://snipurl.com/1nxyii

Publication under process

1. The ecological effects on *Melocanna* bamboo masting on rodent populations: Can rat floods be controlled in the Chittagong Hill Tracts of Bangladesh? Oral presentation at the 4th International Conference on Rodent Biology and Management (ICRBM). Bloemfontein, South Africa, 12-16 April 2010.

f. Training/workshop organized

1. Rodent training for the field staff while project was being implemented
2. Community training for different trap use in the house area during the project implementation.

g. Graduate Studies:

Under this project the research staff is registered for PhD degree at Zoology Department under Dhaka University. His registration number is 89 and session: 2009-2010. His thesis topic is entitled: *Rodent Population Outbreaks in Relation to Bamboo Flowering in the Chittagong Hill Tracts: Its Impacts on Crop Production and Environment*. Registration certificate herewith attached.

h. Linkages Developed:

It is community participatory types of research program because farmers, Headman, Karbari were actively involved in implementation period. Further, union member, chairman and DAE block level and upazila level officers were also participated during study period.

We informed our research programe both district and Upazila level administration office in Bangladesh such as Department of Agriculture Extension and also we informed our research work both national organization/Institutions like Dhaka University and international organizations/institutions like IRRI, Philippines, CSIRO, Australia and Free State University, Bloemfontein in South Africa and Greenwich University, UK and we got appreciation both nationally and internationally.

For information and awareness of rodent diseases after rodent outbreaks in affected areas the Oxford Scientific Film Ltd conducted a documentary film at Ruma upazila. This documentary film broadcasted earlier in 2011 at Discovery Channel, Animal Planet.

i. Equipment/Appliances Purchased: [Give a list of equipment/appliances purchased, if any during the reporting period.]

Item No.	Name and specification of each item	Cost (Tk.)
i.	Laptop Computer HP Brand for PhD student	100,000.00
ii.	Sherman Traps Large (UK Made)	110,000.00
iii.	Sherman Traps Small (UK Made)	90,000.00
iv	Kill Trap	53,000.00
v	Multi-capture Cage Trap	160,000.00
vi	Taxonomic Kit (4 unit)	21,000.00
vii	Formalin / Ethanol	140,000.00
Total		**674,000.00**

F. Highlight of Research Findings

- A total of 1857 rats (male 829 and female 1028) were captured in all habitats (bamboo forest, inside houses, outside around villages, jhum fields and community houses) in five different locations.

- Research study shows that *Rattus rattus* are the dominant rodent species in followed by *Mus musculus* in the study area.

- Species diversity is very high, 10 rodent species were indentified. *Rattus rattus* and *Mus musculus* is the dominant rodent species in the study area and taxonomic separations is required.

- A highest of 17 embryos were observed in female *Rattus rattus* species, June to July is the peak period for breeding

- Community trapping performance shows better results for preventing store foods and other household materials.

- Research study shows that *Melocanna* bamboo flowering initiations were observed in the month of late September and October. These flower initiations may be related to altitude, starts earlier at higher altitudes.

- First bamboo seed developments were observed in the month of late December and bamboo seed fall started on the ground in the month of May. Seed germination was observed in month of June and July.

- Study also shows about one third of seeds are rat damaged and rat damaged seeds can still germinate. Rats also continue to eat from germinated seeds.

- Percent germination is very high (>90%). Seeds can germinate while still on the stalk

- All captured rodent species eat *Melocanna* bamboo seeds, *Rattus rattus* is dominant rat species in bamboo forest area too.

- Both Trap Barrier System (TBS) and bamboo fence were effective against rats of Jhum fields. But TBS is much more effective than bamboo fence.

G. Conclusion

Rodent outbreaks due to bamboo flowering in the Chittagong hill tracts is real and scientifically confirmed phenomena that rats eat the bamboo seeds and become regenerated within short period of time. After that rat army jump to the farmer's jhum fields and causes regional famine. In some parts of CHTs areas rat floods were continued from 2-3 years. It depends on synchrony of bamboo flowering. Sometimes it is variable and bamboo flowers all in a year. Understanding the ecological and anthropological factors driving the temporal and spatial variation of bamboo masting events will not stop the entire process and prevent rat floods, but it may lead to effective prediction of rodent population outbreaks.

It is clear that TBS is the most effective barriers system to protect the farmer's jhum fields against rats. Using different types of traps in the community to prevent households store loss is another strategy to control the rats.

H. Recommendation

- Chittagong hill tracts community peoples are need to be aware about not only rat infestation in the jhum field but also rodent born diseases.
- Most of the rat affected CHTs are inhabit in remote hilly areas, so it is not possible to collect all information during the reporting period.
- As an ecological research it is not able to collect all necessary data within given 2 years research. So, another six month period of research is needed to extend for getting better results.
- Households store losses need to be assessed. During the reporting we couldn't perform this research activity.
- Distribution of rat traps in all the CHT villages before rat infestations
- Ecological rat management training should be provided to the CHT indigenous community.

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

(in thousand Tk) **1,837,800.00**

Particulars/Line Items		1st Year	2nd Year	Total	Approved Budget
A. Fund Received:		1,229,000	608,800	1,837,800	2,000,000
B1. Expenditure: Recurring (Operational cost)					
1.	1.1Remuneration of Contractual Staff/ PI (full time basis) 1.2 Remuneration for Accounting/Typing support service, if justified (part time basis)	144,000	108,000	252,000	288,000
2.	Honorarium of PI (CI if justified), part time basis-must not be drawn without KGF approval.*	285,000	45,000	330,000	405,000
3.	Research & Development (R&D) related cost i.e. all inputs, lab./ farm chemicals & other necessary supplies etc.				
	3.1. Sherman Trap (Large)	110,000	-	110,000	110,000
	3.2. Sherman Trap (Small)	90,000	-	90,000	90,000
	3.3 Kill Trap	53,000	-	53,000	53,000
	3.4. Multi-capture Cages Trap	80,000	80,000	160,000	160,000
	3.5 Tzxonomic Kit	20,000	1,000	21,000	21,000
	3.6.Consumables (Formalin, Ethanol, Gloves, Shop etc.)	30,000	110,000	140,000	140,000
	3.7. Line Trap Barrier System		100,000	100,000	100,000
4.	Maintenance and repairing of lab. /field equipment, etc.				
5.	Training				
6.	Workshop/Seminar/Meeting etc.				
7.	7.1 Travel expenses (TA/DA) as per own organizational rules (Public Sector) or as per KGF Rules (Non-govt.Org).	252,000	135,000	387,000	432,000
	7.2 Vehicle hiring for travel, if justified.	65,000	29,800	94,800	101,000
8.	Contractual Services (special nature, if any, i.e. soil, plant & fertilizer analysis; pesticide residue analysis etc.)				
9.	Office supplies and contingency (not exceeding 15% of the total cost for stationeries, publications, printing of reports, internet service, mailing etc.)				
10.	Any other items (please specify with justification).				
11.	Institutional Overhead Charge (if any, max 10% of total operating cost)				
B2-Expenditure:Non-recurring (Capital cost)					
12.	Equipment & Appliances (upon approval of KGF) 12.1. Lab. and Field Equipment 12.2. Office Equipment	100,000		100,000	100,000
13.	Books, Journals, etc.				
	Grand Total Expenditure (1-13)	**1,229,000**	**608,800**	**1,837,800**	**2,000,000**

* is admissible only after the performance evaluation of the annual progress report as per Mou

Note: Closing balance as per Bank statement is AID-COMILLA contribution for Bank account opening

Financial Progress: Expenditures made/Fund received x100= 100 %

Note: [Financial progress report must be accompanied with Bank reconciliation statement for the period]

J. Self Assessment of the Project

1. Have you been able to achieve all specific objectives of your project? Yes/√No; If no, please explain the reasons.

We are not able to achieve all specific objectives during the reporting period. Ecological research study is not sufficient to work only for 2 years. To fulfill the all research objectives, further six month period of extension is justified. Because of Rodent taxonomy of preserved rats is yet to be confirmed. Rodent taxonomy is very important in case of agricultural research. Further, we didn't assess household's stored damage during the reporting period. Moreover, we say 85% of the research works were completed during the reporting period.

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

3. How the project outputs/results obtained would benefit the target beneficiary group/s? and how these could be transferred to the that/those target group/s?

The results obtained from the project would benefit the target beneficiary groups are various ways. Farmers/policy maker can be predicted next time rat floods in the Chittagong Hill tracts area and can take necessary steps before rat attacks in the jhum fields and households.

Chittagong hill tracts peoples can make TBS all around the jhum fields before rat infestations occurs and can protect their jhum using TBS. They would get knowledge from our research findings about bamboo flowering and rodent outbreaks. CHTs community peoples can use traps in their households during rat infestations and monitor the rat floods.

4. Do you think that you have successfully completed the project? √Yes/No; If yes, please provide one page success story/communication brief of your project in simple language with relevant pictures where applicable.

Mr. Saplon Bawm, 40 years old, lives in Basatlang para under Ruma Upazila, Bandarban. His main occupation is Jhuming (slash and burn). During the rat floods in the year of 2008 he lost all of the jhum crops due to the rat attacks. Firstly, He didn't know when rats' army will come and attack his rice crops. Before attacking his jhum, he expects "I will get more jhum crops this year and planning to buy a solar in his house". After rat damaged his dreams couldn't be fulfilled further he borrowed money from the creditors and worked hard to struggle his life.

In the mean time KGF has competitive called for agricultural research and has awarded 2 years research by AID-Comilla to work in the Chittagong Hill Tracts. After launching the project in Ruma, three villages were randomly selected and Basatlang para one of them. While implementing the project in that area we met Mr. Saplon and told us the story about

rat attacks in his jhum and houses. Then we decided to distribute traps for community trapping in that area and finally community peoples get rid of households store loss from the rats. They can protect store house loss from the rat. In case of farmer's jhum crops to protect from the rat attacks, we set up a Trap Barrier Systems (TBS) in one jhum field and another selected without TBS field in the Mr. Saplon's jhum fields. Finally we found no rat damage in the TBS jhum fields where as more than 30% rat damaged were found in without jhum field.

5. Please describe briefly the outcome/benefit and likely impact of your project on the productivity, policy, society, economy and environment.

During the rat floods in the CHTs most of the peoples expected to lose 100% crops loss. They couldn't safe anything in the jhum fields even severed rat damaged were found in the farmer's household's area. By doing research we found that using TBS in the jhum fields and community intensive trapping in the household's area can protect the wealth from the rats.

CHT peoples didn't get proper aid during the rat infestation period in time. We can submit out research findings to the respective authority so that next time they can take necessary steps.

Using poison to control the rats in the households/rice fields has detrimental effects in the environment. We applied ecologically based rodent management in the study area. It is a scientific based rat management both households and jhum fields such as community trapping and trap barriers system.

K. Acknowledgement:

At first we like to thank Krishi Gobeshona Foundation (KGF) for funding 2 years agricultural research projects. Without continuous support of financial and logistics from KGF we couldn't implement our research objectives. In addition, we also thank project principal investigators and co-supervisors especially Dr Nazira Q. Kamal, Prof Noor J. Sarker, Prof Sohrab U. Sarker, Dr Sontash K. Sarker and Dr Steven Belmain.

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L. Endorsement:

Principal Investigator (PI)	Head of Organization/Authorized Person
Name: Dr. Nazira Q. Kamal	Name: Rokeya Begum Shafali
Seal:	Seal:
Date: May 03, 2011	Date: May 03, 2011

PICTORIAL REPORT OF THE PROJECT

Figure 1: Initial bamboo flowering in the forest

Figure 2: Bamboo flowering panicles

Figure 3: Bamboo seed on the stalk

Figure 4: Rat damaged bamboo seed

Figure 5: Rat trapping in the bamboo forest

Figure 6: Rat trapping in the jhum fields

Figure 7: TBS in the jhum field

Figure 8: Rats dissection training

Figure 9: Measuring rat

Figure 10: Rat tagging for further taxonomy

Figure 11: Counting rat damaged cut tillers in the jhum field

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