Annual Report

July 1, 2006 – September 30, 2007

for

Enhancing Technology Adoption for the Rice-Wheat Cropping System of the Indo-Gangetic Plains

Submitted to the Soil Management CRSP Management Entity
University of Hawaii

by

Cornell University

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Table of Contents

I. Objective 1. Develop methods to accelerate technology transfer of soil management products and practices and to scale up technology adoption from local to national and regional scales.

1. Healthy Seedling Production for Rice and Vegetables

Knowledge support systems for the Healthy Seedlings Technology (HST) are needed to provide critical, sustainable support for technology dissemination, backstopping and scaling up. A major emphasis during PY10 was to lay the groundwork for scaling-up by building technical backstopping networks of national agricultural scientists and extension officers and private sector associations (seed companies, input suppliers and commercial nursery groups) as a means of disseminating HST to more farmers beyond the life of the project.

Scaling-up activities

Nepal

National Agricultural Research & Extension - In Apil-May 2007 NARC scientists/technical officers at regional research stations and training centers and Agricultural Development Officers/Subject Matter Specialists based at agricultural extension offices across the central and eastern districts of the Nepal Terai (Figure 1) were trained on HST. We focused on these Terai districts as this is where our nematode gall surveys showed the greatest problems with rice root-knot nematode and also where many projects are working with poor farmers to develop high value crop production (vegetables, spices). In total, 71 resource persons from 8 research stations, 2 regional training centers and 14 district extension offices received training and informational materials for distribution to interested farmers.

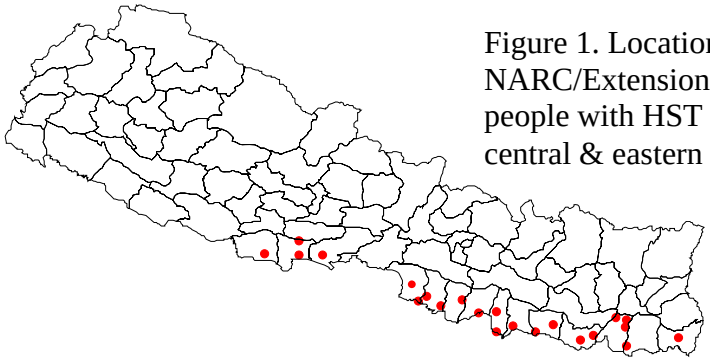

Figure 1. Locations of NARC/Extension resource people with HST training in central & eastern Nepal

Media Linkages - Our approach was to link these trainings with radio and television programs that described the benefits of HST, procedures for doing solarization and to indicate the locations of resource people for more information. A show featuring HST was broadcast June 18, 2007 on Birgunj Radio reaching Para, Bara, Rautahat and Chitwan districts in the Bhojpuri language. Another regular agricultural radio show highlighting Healthy Seedlings was aired nationally on Radio Nepal on September 19, 2007. In collaboration with NARC Communications, Publication and Documentation Division, we also prepared a 20 minute video on HST. A television program on Nepal Television entitled "Krishi Karyakram" included this video during its June 22 and September 11 broadcasts. We will distribute copies

of this video and electronic copies of informational materials to all our partners in Nepal as well as other key Nepal NGOs working in agriculture.

Winrock-SIMI Agro-Vet Network - Value chain approaches linking farmers with agricultural input suppliers also are increasingly being used to establish knowledge support systems. The Winrock-SIMI project works with an established network of input suppliers (agro-vets) in 10 Nepal districts to provide agricultural inputs (fertilizer, seeds, plastic) along with embedded training for their smallholder farmer customers. In January 2007 we provided training on HST for 36 agro-vets as part of SIMI's annual refresher program. An additional 100 agro-vets were trained by SIMI staff in June 2007.

In addition we developed a poster (Figure 2) for use in the shops to raise farmer awareness and generate curiosity about the technology. The poster and HST informational materials were given to Winrock-SIMI for distribution to their agro-vet network.

Ongoing surveys of Winrock-SIMI agro-vets trained by the SMCRSP indicate that the poster is effective in drawing farmers attention and curiosity. On average 5 farmers per month ask about the poster and want additional information about solarization. In addition 85% of the surveyed agro-vets were selling clear plastic for solarization purposes.

Figure 2. Poster for Nepali agro-input supplier shops

<u>Bangladesh</u>

National Extension - A 'white paper' describing HST along with its benefits and impacts was submitted to the Bangladesh Research Council (BARC) as a first step to getting the technology approved for extension by the government. We planned to build a technical backstopping network for HST in Bangladesh with BARC's Technology Transfer Monitoring Unit (TTMU) and the Department of Agricultural Extension (DAE) through the recently funded National Agricultural Technology Program (NATP). However delays in getting the NATP project started have made it difficult to move forward with this plan.

IC Service Provider/Nursery Owner Network - During PY10, we began to work with a large international NGO, Intercooperation (IC), sponsored by the Swiss Development Fund. Our reason for linking with IC at this late date was because they have a very large command area through their current projects (Figure 3); they emphasize high value crops and agro forestry products which are highly responsive to HST; they promote and build the capacity for sustainable knowledge support through local service provider/resource farmers and commercial nursery operators; and work closely with government research and extension organizations to

provide technical information for these service providers and nursery owners. Currently IC works with over 3,600 service providers and 6,000 commercial nursery growers in their command area. During May and June 2007, we provided hands-on training and informational materials on HST for 58 Local Service Providers (LSP) and 168 commercial nursery owners. IC staff will train additional LSPs and nursery owners during the upcoming winter vegetable cropping period. IC and SMCRSP will monitor and evaluate the impacts of the training during the no cost extension period.

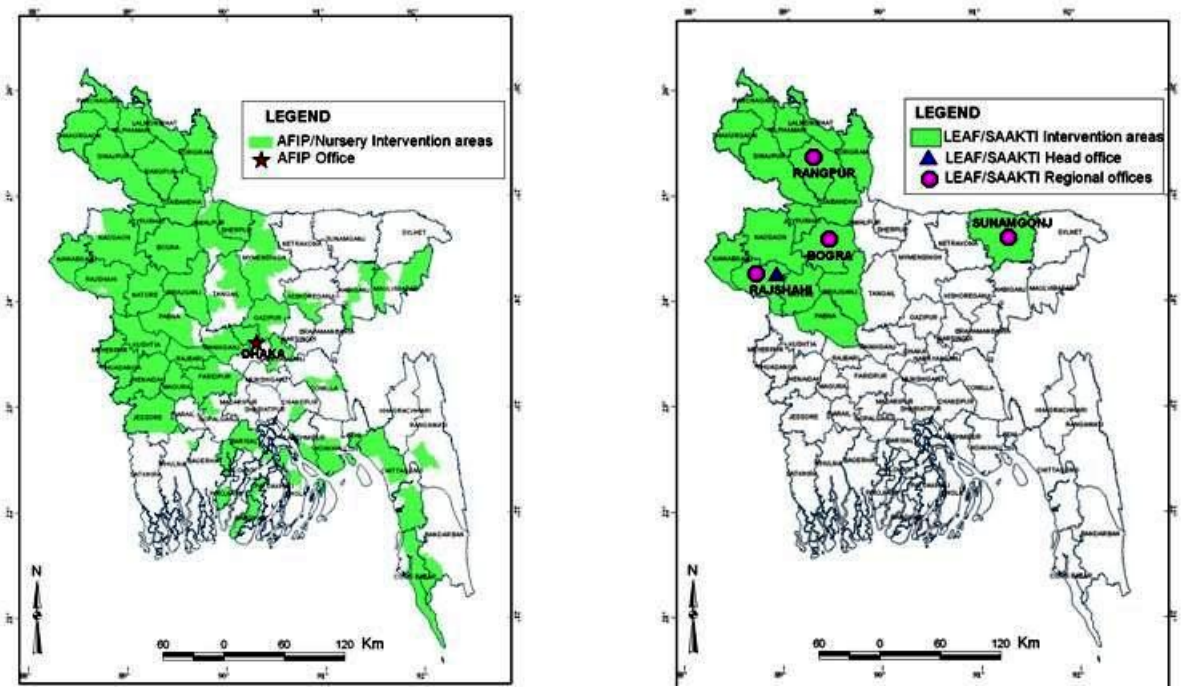

Figure 3. Current command areas of Intercooperation projects

IDE Input Supplier Network - Linkages with agro-input suppliers in Bangladesh, similar to those in Nepal, were established through an existing network organized by International Development Enterprises (IDE), an international NGO, based in Denver, CO. IDE agro-input suppliers are located in the NW Bangladesh districts of Rangpur, Nilphamari, Panchagarh and Lalmonirhat. These businesses receive 100-200 customers per month, so have the potential to influence many farmers with embedded training. In May 2007, a total of 149 input service providers were trained on HST. Posters for shop owners (similar to the Nepal version but in Bangla) and HST handouts were given to IDE for distribution to their agro-input supplier network. Flooding and other logistical problems have delayed IDE from getting the posters and handouts distributed to the whole network. However a recent survey indicated that 33% of the shops with posters and handout materials were selling plastic for solarization (6-13 farmers per shop) and that 10-40 farmers per shop were asking for information about the technology. We will continue to monitor the response of IDE's input supplier network to HST training during the no cost extension period.

East West Seed Company Contract Seed Growers - Very positive effects of HST on seed yields were obtained in collaboration with East West Seed Company (see PY9 annual report).

The company sees the improved seed quality, size and yields from healthy seedlings as a simple, low cost technique to increase their quality seed stocks and sales. As a result, the Company with their own resources trained 17 production managers on solarization, who will disseminate the technology to ~3,200 hybrid contract seed growers in NW Bangladesh. As an incentive, East West will give elite lines to contract growers using solarization. In addition solarization was included in East West's 2007 annual training program for 2,400 seed retailers/distributors and a one page write-up on HST was featured in the April 2007 edition of "Lal Teer Barta," the company newsletter.

Focal Area Forum – In 2002, RDRS and IRRI took the lead to constitute a Focal Area Forum (FAF) of government organizations, NGOs and private sector companies. The purpose of this Forum was to identify improved rice technologies and develop delivery systems to encourage the uptake of these technologies, thereby assuring more sustainable livelihoods for poor farmers in Bangladesh. In February 2007, we were invited to present the Healthy Seedlings Technology to the FAF. Cornell and colleagues from the Wheat Research Centre presented the HST technological approach as well as data from our various partners. While response to the presentation was very positive and the FAF approved HST as a "validated" technology, development of an Action Plan for disseminating HST more widely is stalled for lack of funds.

Information Materials – A Bangla language video describing the benefits of HST and the step-by-step procedures for solarization was made during PY10. CD copies of this 20 minute program will be distributed to key government research and extension offices, national and international NGOs, nursery associations and appropriate private companies. Electronic versions of the HST fact sheet, farmer handout and poster will also be distributed to potential users.

Impacts and Adoption

Dissemination of the Healthy Seedlings Technology also continued through existing partners in Nepal (CARE-ITDC, ETC, Morang District DADO), Bangladesh (RDRS, East West Seeds) and Thailand (Mahasarakham University, Thai Rice Research Institutes). New observations to date include:

- Despite the enthusiasm of farmers interested in using solarization for rice and vegetables at CARE Nepal's Sarlahi and Mahottari district sites, availability of medium gauge plastic was a constraint to adoption. We provided a grant of $250 to ITDC, a local NGO working with CARE in this area, to buy a supply of plastic and to distribute it to local agro-input suppliers in the area. These businesses would then sell the plastic to farmers and regenerate the funds for future purchases. As of July 2007, 7 agro-input suppliers work with ITDC and have sold 254 meters of plastic specifically for solarization (~36 m per supplier).
- It should be noted that uptake and dissemination of HST through CARE Nepal's other programs has been sluggish, primarily because of a change in CARE's program priorities and donor expectations. Nevertheless we can report that HST has now been incorporated into 2 additional CARE Nepal programs, JIWAN and UJYALO. HST training for these two projects has been provided by CARE and ITDC staff.

- An adoption survey was undertaken in April 2007 with 25 farmers (16% male; 84% female) who had participated in the initial ETC program with solarization in 2005. A majority of respondents (76%) were still utilizing HST for tomato (32%), cole crops (16%), rice (8%), chili (12%) and flowers (32%). Most farmers (71%) invested in new plastic from local shops, but 29% also reused the original plastic given by ETC.
- Economic data were also collected from 29 ETC clients growing rice, flowers and vegetables. We documented significant improvements in food security and incomes for ETC households utilizing Healthy Seedlings. Households using HST for rice increased food security by 36 days. Net returns from HST flowers were Rs1,000/ropani (1 ropani = 508 m^2) higher than conventionally grown flowers. For vegetable growers, HST gave Rs300 to Rs2,900/ropani higher net returns than conventional. Average costs for the technology were Rs75 per ropani and resulted in mean yield increases of rice, flowers and vegetables of 21-24%. Mean rates of return per rupee invested in solarization were Rs13 for rice, Rs16 for flowers, Rs8 for cabbage/cauliflower and Rs142 for tomato. High rates of return obtained by tomato farmers were due to savings on pesticides normally used to control diseases and insects. Stronger, healthier plants from Healthy Seedlings appeared to resist pests better than normal plants, without the added pesticide cost.
- Solarization has been linked with extension of the System of Rice Intensification (SRI) by Rajendra Upreti, a particularly active Nepal extension officer working at the DADO-Morang district. Mr. Upreti mobilized his staff in 2006 to provide training and establish demonstrations on HST and SRI for rice and also HST for vegetables in Morang and Siraha districts. Mr. Upreti has also been instrumental in getting write-ups on solarization included in several Nepali extension publications, including "Krishi Prabadi Pustak," a 2006 agricultural technology handbook and "Krishi Ko-Sathi," a monthly newsletter distributed to extension offices throughout the country. A recent survey of 42 farmers and 9 farmer groups in Morang and Siraha districts indicated that 65% of respondents were using HST for SRI rice. Also local agro-input suppliers were reporting increased sales of medium weight plastic for solarization. Monitoring data from 8 farmers in Morang district indicates HST improved SRI yields by an additional 15-33%, while 4 farmers found a much smaller yield benefit of 10% or less.
- The Bangladesh NGO, RDRS has collaborated with us since 2004 to disseminate HST through its extensive Farmer Field School (FFS) network. Solarization is still included as a key technology for new FFS established by RDRS and their partner NGOs. To assess the success and impact of HST through the RDRS technology dissemination process, we surveyed 31 FFS who had been introduced to HST in 2005, utilizing a Focal Discussion Group format. In addition socio-economic/livelihood dimensions were determined from selected individual farmers in each FFS who had adopted the technology. The survey was completed in September 2007, but analysis is still ongoing.
- Additional information was acquired this year from East West Seed Company about the impacts of HST on seed quality and onion seed. As expected vegetable seed quality improved using healthy seedlings. Germination rates improved by 36%, 5%, 28% and 7% for eggplant, onion, chili and tomato seeds, respectively. In addition 1000 seed weight of eggplant, onion, chili and tomato produced from HST increased by 3%, 5%, 8% and 8%, respectively. Onion bulbs from last years trials (produced from normal and HST seedlings) were planted in 2006-07 for seed production. The effect of the larger

HST onion bulbs was quite dramatic in comparison with normal bulbs (Figure 4). These visual differences translated into substantial improvement in yield and seed quality. Seed yields from onion bulbs produced from HST were 3.3 kg/decimal, while seed from conventional bulbs were 1.8 kg/decimal, an increase of 81% !

Figure 4. Onion plants for seed using normal (left panel) and HST bulbs (right panel)

- To date 38 trials/demonstrations with HST have been established across 5 of Thailand's Northeast rice growing provinces. Yield responses to the technology have ranged from 9-23% over conventional practice. In addition our collaborators have actively promoted this technology with farmer groups in Chum Phae, Mahasarakham, Yasothon and Ubon Ratchani provinces using hands-on training and informational materials (Figure 5). A survey of farmers introduced to the technology in 2005 is currently underway in Mahasarakham and Khon Khon provinces to assess adoption and impacts.

Figure 5. Farmers in Yasothon Province, Thailand receiving training on the Healthy Seedling technology

2. Permanent raised beds

ACIAR Workshop

Cornell University was invited to present the SMCRSP experience with permanent raised beds (PRB) at a final project review workshop sponsored by the Australian Centre for International Agricultural Research (ACIAR) in September 2006. Our presentation compared productivity between permanent beds and conventional flat practice, time course trends as well as nitrogen and mulch responses from replicated experiments under a triple crop rice-wheat-mungbean rotation at two sites in Bangladesh (Nashipur and Rajshahi) and one site in the Nepal terai (Ranighat). We also discussed the positive experiences that farmers in Rajshahi Bangladesh are having with the technology. Our experience with permanent raised beds has been quite different from others in South Asia. The reasons for these differences are unclear, but irrigation and crop variety may be two possibilities. A full paper was developed from the workshop presentation and will be published in a peer reviewed ACIAR proceedings in December 2007.

Farmer-to-Farmer Dissemination of Permanent Beds

Response to dissemination of PRB by the Alipur farmer group to other farmer community groups has been very good. Hands-on equipment trainings were held prior to rice and wheat cropping seasons and farmer rallies were arranged during crop growth to get farmer feedback about the technology. As of the wheat 2006-07 season, we have recorded 347 farmers using beds on ~ 420 hectares. Farmers from 7 of the 15 groups who participated in training last year are now utilizing the technology for rice, wheat, maize, mungbean, jute and sesame. We will continue to provide technical backstopping for these new users, to document adoption, impacts, farmer modifications and to address biophysical and economic problems that may arise as the technology spreads to new environments and groups.

Where farmers had side-by-side comparisons of beds and conventional flat, average yields from beds were 18% higher than conventional for rice, 60% higher for wheat and 26% higher for maize. Farmers were also able to diversify their cropping systems with this technology by growing mungbean and maize on beds that would otherwise be fallow under conventional practice. Two farmers in the Alipur group and another in Uzalkolshi grew hybrid rice on beds because of the observed seed savings benefit from the technology.

Table 1. Yield results (t/ha) reported by farmers from the various groups

Group	Rice		Wheat		Mung		Other Crops	
	Beds	Flat	Beds	Flat	Beds	Flat	Beds	Flat
Alipur	5.99-7.48	4.50-4.80	3.59-4.49	2.40-3.29			6.59-7.48^{M}	4.79-5.99^{M}
Shanpukuria	5.99-6.59	4.19-5.39	2.99-3.89	2.40-2.99	0.52-0.90	--	1.65-1.80^{S}	1.20-1.49^{S}
Namodorkhali	4.79-5.98	3.59-4.79	2.99-3.89	2.10-2.69	0.45-0.75	--	--	--
Tiorquri	--	--	--	--	--	--	6.59-8.08^{M}	5.39-6.59^{M}
Nandigram	--	--	3.59-3.96	1.61-1.80	--	--	4.05-4.49^{M}	--
Nowpara	--	--	3.29-4.19	2.69-2.99	0.45-0.60	--	4.34-4.64^{M}	--
Kasipur	--	--	3.59-3.96	1.78-1.87			4.04-4.34^{M}	--
Uzalkolshi	6.29-6.59	4.79-5.39	2.99-4.19	2.40-2.69			4.04-4.34^{M}	--

Other crops: M=Maize, S=Sesame

Machinery – Last year we reported that a constraint to further expansion was lack of credit for purchasing 2 wheel tractors and bed formers. We provided a loan to the Alipur group, which has been repaid; however, we did not feel that this approach was sustainable. Attempts to get group loans from banks failed, but 4 of the farmer groups (Namodorkhali, Shanpukuria, Tiorquri and Alipur) recently obtained loans for purchasing power tillers and bed formers from CARB, a local NGO. Linking farmers to other GO and NGO groups who provide loans for farmers without collateral will be a critical factor with any future expansion programs.

Weed Control and Residue Return - Residue return is considered an important factor for the long term sustainability of permanent beds, especially where soil organic matter levels have been severely depleted. Crop residue mulches also help to control weeds which can become a problem in minimal tillage systems like permanent beds. Farmers using PRB have reported that weeds are a problem for rice and wheat. However few farmers are willing to use rice or wheat straw as mulches to control weeds, because straw is used for feeding animals or cooking fuel. Recently several farmers gathered water hyacinth from ponds and used it as a mulch for wheat. While they found the water hyacinth effective, there is insufficient quantity to provide mulch for all farmers using PRB. We will continue to work with the farmers using PRB to develop effective and acceptable methods to control weeds and to encourage residue return.

Economic Impacts

Additional surveys were completed during PY10 for rice and spring crops to assess the economic impact of PRB on farmers using the technology. After rice harvest, 24 farmers were interviewed, 13 continuing with permanent beds with only reshaping between crops and 11 farmers who had constructed new beds before rice (Table 2).

Table 2. Economic survey for 2006 rice crop

Factor	Permanent (n=13)			New Beds (n=11)		
	Bed	Flat	Change	Bed	Flat	Change
Cropped Area (bigha)[1]	10	14		7	12	
Land Prep. -Tillage (Tk/bigha) -Bed prep. (Tk/bigha)	135 0	363 0	-63%	360 120	360 0	33%
Seed Cost (Tk/bigha)	141	198	-29%	119	200	-41%
Fertilizer & Pesticides (Tk/bigha)	605	715	-15%	516	684	-25%
Irrigation No	1.9	2		1.9	2	
Irrigation Cost (Tk/bigha)	488	708	-31%	469	690	-32%
Weeding Cost (Tk/bigha)	395	323	22%	411	417	-1%
Harvest Cost (Tk/bigha)	539	512		476	489	
Threshing Cost (Tk/bigha)	237	182		193	175	
Total Costs	2,541	3,001	-15%	2,664	3,016	-12%
Yield (kg/bigha)	742	571	30%	629	562	12%
Total Value @ Tk10/kg (Tk/bigha)	7,415	5,714	30%	6,293	5,619	12%
Net Return	4,874	2,713	1.8X	3,629	2,603	1.4X

[1] 3 bigha = 1 acre; 7.41 bigha = 1 ha

Making new beds entailed 33% higher costs relative to conventional flat cultivation; however, for those "permanent" farmers only reshaping beds prior to rice, land preparation costs were reduced 63% compared to conventional practice. As we observed during the wheat season, substantial seed, fertilizer and irrigation cost savings also were documented for rice on beds. New beds and conventional practice had similar weed control costs, but farmers with "permanent" beds had to spend 22% more for weeding than on conventional plots; thus confirming feedback from farmers about weed problems. All combined total costs for PRB from both farmer groups were 12-15% lower than for conventional.

Survey respondents indicated that a majority of the rice produced (68%) was consumed and only 23% was sold in the market. Nevertheless for comparison purposes, we calculated the total rice value using farmers observed yields and the current market price of Taka10/kg. Increased rice yields and overall lower costs with PRB combined to give higher net returns compared to conventional practice. Net returns from sales of rice was estimated to be Taka 1,026 per bigha higher from new beds and Taka 2,161 per bigha from permanent beds.

Economic data were also collected from 30 farmers growing a variety of pre-monsoon/spring crops: mungbean, maize, sesame and jute (Table 3). No conventional plots were available for comparison since tillage and irrigation operations are often limited during the hot and dry conditions of this season. However, the minimal tillage and improved water use efficiency of permanent bed systems makes cultivation during this period more feasible, thereby diversifying farmer practice with an extra crop.

Table 3. Economic survey for 2006 pre-monsoon/spring crops

Factor	Mung	Maize	Sesame	Jute
Number of Respondents	13	9	4	4
Cropped Area (bigha)[1]	13	10.2	2.8	3.6
Land Prep. -Tillage (Tk/bigha) -Bed prep. (Tk/bigha)	175 0	391 0	151 0	110 0
Seed Cost (Tk/bigha)	161	314	124	151
Fertilizer & Pesticides (Tk/bigha)	0	743	0	179
Irrigation No	2	3	0	2
Irrigation Cost (Tk/bigha)	38	538	0	283
Weeding Cost (Tk/bigha)	12	235	115	308
Harvest Cost (Tk/bigha)	201	282	115	399
Threshing Cost (Tk/bigha)	89	200	108	481
Total Costs	676	2,703	613	1,911
Yield (kg/bigha)	59	596	201	415
Market price	42	8	20	18
Total Value (Tk/bigha)	2,478	4,768	4,020	7,470
Net Return	1,802	2,065	3,407	3,559

[1] 3 bigha = 1 acre; 7.41 bigha = 1 ha

PRB made it possible for farmers to obtain net returns of Taka 1,802-3,559 on land that otherwise would be fallow during this season. Sesame and jute production on beds gave the highest net returns followed by mungbean and lastly maize. Actual returns for jute are probably much lower because labor costs for retting and processing were not included in this analysis. High net returns with sesame on beds indicate a particularly lucrative cropping option for resource poor farmers because of the low cost investment (Taka 613/bigha). While the costs for mungbean cultivation on beds were also low, low yields (currently averaging 470 kg/ha) are limiting potential returns. Additional investments in fertilizer (especially P; lime where appropriate), irrigation (at least one) and weed control would significantly improve yields and returns, given the high market price for mungbean. Surprisingly, maize returns were the lowest of all the pre-monsoon/spring crops grown on beds. Average yields were low (4.4 t/ha) and costs of cultivation were the highest of all crops. Farmers are putting a lot of resources into extra tillage (hilling up) and irrigation that is not necessary. Also it is likely that soil acidity in this area is limiting maize yields. We will continue to work with farmers in this area to optimize production and reduce cultivation costs for these crops.

II. Objective 2. Provide government agencies and policy makers with information to support development of programs and policies that encourage the adoption of soil management practices compatible with the long-term conservation of agricultural resources.

1. Liming Program for Bangladesh

Major activities during PY10 involved finalizing all the replicated trial work; collecting information on lime impacts for crops other than rice, wheat and maize; and determining the trade and long term availability of dolomite from Bhutan (sole supplier of dolomitic lime for Bangladesh).

Replicated Trials - Md. Bodruzzaman's PhD thesis research compares wheat, maize and rice yield responses across a range of lime levels (0 to 6 t/ha) which brackets lime requirements for these soils based on NuMaSS, soil-lime incubation and SMP approaches. Dolomitic lime (dolochun) was applied once starting in 2005 in replicated trials set-up at 6 sites in 4 districts of NW Bangladesh (Panchagarh, Birgonj, Kharol and Patgram). Wheat and maize were grown during the 2005-06, 2006-07 winter seasons, followed by rice in the summers.

At all sites wheat and maize yields responded significantly to the 1 t/ha lime rate but few additional increases were obtained at the higher lime rates (2, 4, 6 t/ha). In almost all cases the maximum yield response to lime was equivalent to that indicated by the NuMaSS prediction. At a few sites, yields actually declined at the 6 t/ha rate, indicating a possible induced Zn deficiency. For rice, 4 of the 6 sites showed small but significant increases in yield to 1 t/ha lime in the first year after application.

Maize was the most responsive to lime applications. Yield increases to lime in the first year ranged from 1,358-3,107 kg/ha for maize (2,359 kg/ha averaged across all sites); 450-968 kg/ha for wheat (754 kg/ha averaged across all sites); and 321-672 kg/ha for rice (474 kg/ha averaged

across sites). Similar wheat and maize yield responses to lime were obtained in the second year after 2 crops, indicating a sustained residual benefit from lime which also has been observed at our on-farm lime demonstration sites. Averaged across sites, a single lime application of 1 t/ha increased wheat and maize yields relative to the unamended control, in the first year by 35% and 47%, respectively. The residual benefit of lime on wheat and maize yields in the second year was roughly the same at 34% and 40%, respectively. While the replicated trials will end after the 2007 rice crop is harvested, past experience from our lime demonstration plots indicates that the lime benefit will continue for another year before another application of lime is necessary.

Lime impacts on other crops - Because of the obvious visual impact of lime on crop growth, farmers in these acid soil areas are trying the amendment with other crops. We interviewed several farmers to get an assessment of the potential impact on crops in addition to wheat, maize and rice (Table 4). Lime rates applied ranged from 0.75 to 1 t/ha and yields were based on farmer estimates. While these results need to be corroborated, there clearly is much potential for lime to increase production for a whole suite of crops grown on Bangladesh's acid soils.

Table 4. Farmer observed yield benefits from 0.75-1 t/ha lime applications

Crop	n	Mean Yield (t/ha)		% Change
		With Lime	Without Lime	
Boro (winter rice)	7	7.09	5.41	31%
Aman rice	2	4.52	3.80	19%
Maize	6	8.36	5.91	42%
Wheat	1	2.96	2.09	42%
Potato	2	11.78	7.08	66%
Sweet Potato	3	9.17	6.51	41%
Tomato	1	23.47	17.82	32%
Jute	2	3.22	1.78	81%
Garlic	1	6.70	2.68	150%
Ginger	1	16.09	11.17	44%
Bitter Gourd	1	9.76	7.51	30%
Okra	1	21.47	14.52	48%
Tobacco	2	1.88	0.94	110%
Long Bean	1	36.93	23.47	57%
Peanut	1	3.00	1.31	129%

Lime availability and trade-Bhutan is the sole supplier of dolomitic lime for Bangladesh. According to the Bhutan Department of Geology and Mines, dolomitic lime reserves in the country are quite substantial. Easily mined, proved reserves are estimated at 31.04 million tons, while probable reserves are as high as 13,341 million tons. While annual production has increased 62% since 2000 to 476,516 MT in 2006, it is generally agreed that the dolomite mining industry in Bhutan is underdeveloped. At current production rates, Bhutan's proven reserves will be able to supply lime for ~100 years and probably longer with further exploration of the probable reserves.

A majority of Bhutan's dolomite is exported to India (91%) and the remainder is exported to Bangladesh. Imports of powdered dolomite to Bangladesh were 40,015 MT in 2004; 85,983 MT in 2005 and 40,756 MT in 2006. Dolochun is imported through 8 major Bangladeshi importers primarily for fish production and agricultural purposes. Importers and local dealers indicate the demand for dolochun by the agriculture sector is increasing. For example in 2005-06, nine input traders/dealers in NW Bangladesh reported total sales of 292 MT of dolochun, but in 2006-07, the amount increased 150% to 733 MT. Currently the market price for dolochun is Taka 10/kg (one kg of lime is sufficient to cover 1 decimal of land at the 1 t/ha rate). While prices will likely rise with increasing demand, price control policies may be required to ensure this valuable input remains affordable for Bangladeshi farmers.

Next Steps - We have developed the knowledge base on lime requirements and impacts for Bangladesh to the point that moving quickly to a national scale adoption program is justified. Development of a 'white paper' describing the requirements and impacts of a country-wide lime program will be completed and submitted for implementation by BARC's TTMU and DAE program during the no-cost extension period. Harvest of the 2007 rice crop will complete the field work portion of Md. Bodruzzaman's PhD research; analysis and write-up will be completed by March 2008.

III. FINANCIAL STATEMENT

Provided separately

IV. STATISTICAL SUMMARY

IVa. Participating and Collaborating Scientists and Institutions/Organizations

South Asia

Country	Name	Discipline	Institution
Bangladesh	Anwar, S.M.S.	Agribusiness	Winrock Intnl.-BREAD II
	Baksh, M.E.	Agric. Economics	BARI
	Bodruzzaman, M.	Soil Chemistry	BARI
	Haque, Md. M	Managing Director	Doyel Agro Industrial Ltd
	Hossain, M.I.	Agronomy	BARI
	Hossain, Dr. M.G.	General Manager	East-West Seeds
	Jahiruddin, Dr. M.	Soil Science	BAU
	Kashem, Dr. M.A.	Agric. Extension Education	BAU
	Mazid, M.A.	Agronomy	BRRI/IFAD
	Malaker, Dr. P.K.	Plant Pathology	BARI
	Nath, S. Ch.	Agriculture	BRAC
	Neogi, M.E.	Soil Science	RDRS
	Paul, Dr. D.N.S.	Statistics/GIS	BRRI

Country	Name	Discipline	Institution
	Rahman, Dr. A.E.	Horticulture	BARI
	Samsuzzaman, Dr. S	Agronomy	RDRS
	Sufian, Dr. M.A.	Agronomy	BARI
	Talukder, Md. G.	Agriculture	CARE
	Talukdhar, A.M.H.S.	Agronomy	BARI
	Tex, N.D.	Social Science	CARE
	Titu, A.S.	Artist	SALMAR
	Zaman, Dr. W.	Plant Breeding	East-West Seeds
India	Gupta, Dr. R.K.	Soil Science, Facilitator Rice-Wheat Consortium	RWC-CIMMYT
Nepal	Bhatta, B.	Agronomy	Winrock-SIMI
	Dahal, K.R.	Agronomy	IAAS Rampur
	Gurung, B.K.	Agric. Engineering	Winrock-SIMI
	Joshi, Dr. K.D.	Plant Breeding	U. Wales/DFID
	Khanal, R.	Agriculture	CARE
	Maskey, Dr. (Mrs.) S.M.	Soil Science/Crops Director	NARC
	Pokharel, B.K.	Agronomy	CARE
	Rana, Mrs. M.M.S.	Social Science	ETC-Nepal
	Thapa, Dr. B.	Social Science	CARE
	Tripathi, J.	Agronomy	NARC
Nepal	Upreti, R.	Agronomy	DADO
Thailand	Harnpichitvitaya, Dr D.	Soil Science	MOA
	Jearakongman, Dr. S.	Plant Breeding/Agronomy	MOA
	Khangkhun, Dr. P.	Seed Technology	Mahasarakham U.
	Wongsawas, M.	Plant Pathology	Mahasarakham U.

U.S. Institutions

Name	Department/Discipline	Institution
Abawi, Dr. G.	Plant Pathology	Cornell Univ.
Adhikari, C.	Agronomy	Nepal Country Coord.
Duxbury, Dr. J.	Crop & Soil Sci.	Cornell Univ.
DeGloria, Dr. S.	Crop & Soil Sci./GIS	Cornell Univ.
Hobbs, Dr. P.	Crop & Soil Sci./Agronomy	Cornell Univ.
Lauren, Dr. J.	Crop & Soil Sci.	Cornell Univ.
Lee, Dr. D.	AEM/Agric. Economics	Cornell Univ.
Meisner, Dr. C.	Agronomy	Cornell U.
Thies, Dr. J.	Crop & Soil Sci./Soil Biology	Cornell Univ.
Uphoff, Dr. N.	Government	Cornell Univ.
Welch, Dr. R.	Plant Physiology/Nutrition	USDA

Other International Institutions

Name	Discipline	Institution
Colavito, Dr. L.A.	Agric. Economics	Winrock Intnl.-Nepal
Elahi, Dr. N.E.	Agronomy	CIMMYT-Bangladesh
Harris, Dr. D.	Agronomy	U. Wales/DFID
Johansen, Dr. C.	Agronomy	Consultant-Bangladesh
Johnson, Dr. S.	Soil Chemistry	IRRI
London, Dr. C.	Social Science	ETC-Ithaca
Panaullah, Dr. G.	Soil Science	CIMMYT-Bangladesh
Sayre, Dr. K.	Agronomy	CIMMYT-Mexico

IVb. Publications, Reports and Presentations

Publications

Adhikari, C. 2007. "Grow Healthy Seedlings for More Production". Krishi Patrika Magazine. Jestha-Ashadh 2064 (June-July 2007). 4 pp.

Lauren, J.G., G. Shah, M.I. Hossain, A.S.M.H.M. Talukder, J.M. Duxbury, C.A. Meisner and C. Adhikari. 2007. Research station and on-farm experiences with permanent raised beds through the Soil Management Collaborative Research Support Program. In E. Humphreys and C. Roth (ed.) Permanent beds and rice residue management for rice-wheat systems in the Indo-Gangetic Plains. Australian Centre for International Agricultural Research (ACIAR) Proceedings xx. Canberra, Australia. (In press).

Presentations

Adhikari, C., J.G. Lauren and J.M. Duxbury. 2007. Improved root health with solarization increases rice and vegetable production. 8th National Outreach Workshop. 19-20 June 2007. NARC On-Farm Research Division. Kathmandu, Nepal.

Sah, G., N. Ansari, D.B. Gharti, J.G. Lauren, J.M. Duxbury and C. Adhikari. 2007. Assessment of permanent bed planting method under rice-wheat system. 25th National Summer Crops Research Workshop. 21-23 June 2007. NARC. Kathmandu, Nepal.

IVc. Training

Non-Academic training

Activity/Organization or Location	Date	Total
Nepal		
HST agro-vet training/Winrock SIMI	7,9 January 2007	36
HST NARC, ADO, SMS/Bhairahawa, Parwanipur, Hardinath, Tarahara	23, 24 April 2007; 2,4 May 2007	71

Activity/Organization or Location	Date	Total
Bangladesh		
HST agro-input suppliers/IDE	12,13 May 2007	149
HST LSP & Nursery owners/ IC	15,16, 27,29 May 2007; 16,17 June 2007	226
Perm. Beds farmer to farmer training/Alipur	5 November 2006	300
Perm. Beds Farmer Rally/Alipur	22 February 2007	227
Perm. Beds farmer to farmer training/Alipur	12, 14 June 2007	132

Academic Training

Name	Home Country	Gender	Major	Degree	Grad. Date	Major Advisor
Bangladesh Agricultural University						
Md. Bodruzzaman	Bangladesh	male	Soil Science	PhD	2008	Dr. Jahiruddin

IVd. Acronyms

ACIAR	Australian Centre for International Agricultural Research
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BREAD	Bangladesh Rural Enterprise & Agricultural Development – Winrock
CARB	Centre for Action research-Barind (Bangladesh NGO
CARE	International NGO
CIMMYT	International Maize and Wheat Improvement Center
DAE	Department of Agricultural Extension (Bangladesh)
DADO	District Agricultural Development Office (Nepal)
ETC	Educate the Children – Nepal NGO
FAF	Focal Area Forum
FFS	Farmer Field School
GO	Government organization
HST	Healthy Seedlings Technology
IC	Intercooperation
IDE	International Development Enterprises
IRRI	International Rice Research Institute
ITDC	IPM Technology Dissemination Campaign (Nepal NGO)
MOA	Ministry of Agriculture (Thailand)
NARC	Nepal Agricultural Research Council
NATP	National Agricultural Technology Program (Bangladesh)
NGO	Non Governmental Organization
NuMaSS	Nutrient Management Support System

PRB	Permanent Raised Beds technology
RDRS	Rangpur-Dinajpur Rural Service – Bangladesh NGO
SIMI	Smallholder Irrigation Market Initiative – WINROCK/IDE project, Nepal
SM-CRSP	Soil Management Collaborative Research Support Program
SRI	System of Rice Intensification
TTMU	Technology Transfer Monitoring Unit (Bangladesh)
WINROCK	International NGO