Accelerating Agriculture Productivity Improvement (AAPI)
Mid-Term Performance Evaluation

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Acronyms, Abbreviations, Definitions and Exchange Rate

AAPI	Accelerating Agriculture Productivity Improvement
AWD	Alternate Wetting and Drying
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
BCIC	Bangladesh Chemicals Industry Corporation
BDT	Bangladesh taka
BFA	Bangladesh Fertilizer Association
BIHS	Bangladesh Integrated Household Survey
BRRI	Bangladesh Rice Research Institute
C&F	Cost and Freight
cm	centimeter
CO_2	Carbon Dioxide
DAE	Department of Agricultural Extension
DAP	Diammonium Phosphate
FMO	Field Monitoring Officer
FOB	Free on Board
FTF	Feed the Future
GDP	Gross Domestic Product
GOB	Government of Bangladesh
g	gram
GPI	Gender Parity Index
ha	hectare
HIES	Household Income and Expenditure Survey
HYV	High-Yielding Variety
IFDC	International Fertilizer Development Center
IRRI	International Rice Research Institute
IFPRI	International Food Policy Research Institute
ILSAFARM	Improved Livelihood for Sidr-Affected Rice Farmers
kg	kilogram
mm	millimeter
MoA	Ministry of Agriculture
MOP	Muriate of Potash
NFPCSP	National Food Policy Capacity Strengthening Program
N	Nitrogen
N_2O	Nitrous Oxide
NGO	Non-Governmental Organization
NO	Nitric Oxide
NPK	Nitrogen-Phosphorus-Potassium
SAAO	Sub-Assistant Agricultural Officer
TSP	Triple superphosphate
UDP	Urea Deep Placement
USAID	United States Agency for International Development
WEAI	Women's Empowerment in Agriculture Index

Aman rice	Transplanted in July-August and harvested in November-December
Aus rice	Transplanted in May-June and harvested in August-September
Boro rice	Transplanted in January-February and harvested in May-June
Fiscal year	July 1 to June 30
Paddy	Unhusked or rough rice; 1.5 tons of paddy mills to 1 ton rice
Upazila	Sub-district; an administrative unit equivalent to a county
Exchange rate	US $ to Bangladesh taka (BDT) 1 July 2013: US $1 = BDT 77.8 Average for 1 July 2012 through 30 June 2013: US $1 = BDT 80.3

Executive Summary

The goal of the Accelerating Agriculture Productivity Improvement (AAPI) project in Bangladesh is to improve food security and rural incomes. AAPI, a five-year project running from September 2010 to September 2015, is supported by the United States Agency for International Development (USAID) through a grant to the International Fertilizer Development Center (IFDC) and by Government of Bangladesh (GOB) through the Department of Agricultural Extension (DAE).

During 2008-2010, USAID's Improved Livelihood for Sidr-Affected Rice Farmers (ILSAFARM) project promoted urea deep placement (UDP) to help farmers in eight districts in the south and southwest recover after the 2007 Sidr cyclone. Beginning in 2010, the AAPI project continued activities in the ILSAFARM project area and expanded to Mymensingh and Sherpur districts in north-central Bangladesh and Gopalganj in the southwest. In September 2011, USAID and IFDC revised the AAPI project to add 11 districts in the south and southwest beginning with *Boro* rice in early 2012. AAPI thus supports USAID's Feed the Future (FTF) focus on southwest Bangladesh.

In much of Asia and Africa, farmers apply N to rice by broadcasting prilled urea (granules 1-2 millimeter [mm] in diameter) onto wet soil. With such practices, rice plants get only about 25-30 percent of the applied N; much of the rest is lost to the air or to surface water runoff. One way to reduce N losses is to compress prilled urea to form briquettes (commonly 1.8-2.7 grams [g]) and to place these briquettes 7-10 centimeters (cm) into the soil. These urea briquettes are referred to in Bangladesh as *Guti* urea.

Through several decades of experience in Bangladesh, farmers shifting from prilled to *Guti* urea have found average yield gains of around 15 percent despite applying one-third less urea. Yield gains can be explained by plants getting more N, because the percentage of applied N reaching rice plants from *Guti* urea is characteristically more than double the percentage from prilled urea.

Purpose and method of this evaluation: The purpose of this mid-term evaluation is to assess the performance of the project after 30 months of implementation, to establish a basis for assessing impact over the remaining life of the project and to recommend actions, within the mandate of the project, to increase agricultural production. The evaluation is based on surveys (including a survey of 1,000 farm families in May-June 2013), project documents, interviews, reports, papers and data.

Impact on Bangladesh's gross domestic product (GDP): From a baseline in 2010 (or other year, depending on available data) to *Aus* and *Aman* 2012 and *Boro* 2013, the AAPI project extended use of *Guti* urea to an estimated 1,346,000 hectares (ha), including 1,000,000 ha in FTF districts in the southwest. In shifting from prilled urea to *Guti* urea, farmers increased yields by an average of 0.46 tons/ha, or 624,000 tons on 1,346,000 ha. At economic prices for urea (based on prices in world trade) and rice (using the export parity price when it exceeds local prices) the additional 1,346,000 ha fertilized with *Guti* urea generated additional value added of $251 million in 2012/13. Most of this increase ($187 million) was due to higher yields.

A portion of the increase in value added at the farm level ($54 million) comes from lower costs. Farmers using *Guti* vs. prilled urea used $40/ha less urea (or $19 less at subsidized prices). The additional labor required to apply *Guti* urea and to harvest and thresh more rice is offset by fewer days to weed fields fertilized with *Guti* urea (which is less accessible to weeds). Less than one percent of the AAPI project's impact on GDP comes from value added in small business producing *Guti* urea.

Benefit-cost ratios for USAID, GOB, farmers and *Guti* producers: From September 2010 through June 2013, USAID invested $14.66 million in AAPI, while GOB contributed $7.95 million through the DAE, for a total of $22.6 million. Projecting that benefits (increased GDP) continue for 10 years, and using a 13 percent annual rate of discount, the present value of benefits is $1.54 billion, and the benefit-cost ratio for USAID and GOB investments in AAPI through June 2013 is 68 ($1.54 billion/$22.6 million).

A benefit-cost ratio for farmers is undefined because estimated costs per hectare are less with *Guti* vs. prilled urea. *Guti* producers have a favorable benefit-cost ratio, earning $25.70/ton from the sale of *Guti* vs. prilled urea against total variable and fixed costs of $15.08/ton, yielding a benefit-cost ratio of 1.7.

Rice self-sufficiency, fertilizer subsidies and foreign exchange: In 2012/13, Bangladesh was self-sufficient in rice, importing only 29,000 tons, while also exporting some high value rice. The 624,000 tons of additional rice produced due to AAPI's activities allowed Bangladesh to feed itself without imports. Over the next 3-5 years, further expansion of *Guti* urea use to an additional 1-3 million ha through AAPI as well as other projects and programs could be expected to boost Bangladesh's rice production by another 0.4 to 1.5 million tons (estimating *Guti* use increases rice yields per ha by 400-500 kg). The fly in the ointment is that rice prices and production can fall if GOB continues to block exports.

Farmers using *Guti* urea rather than prilled urea on 1,346,000 ha in 2012/13 used a weighted average of 78 kg/ha less urea, reducing urea purchases by a total of 105,000 tons. GOB's average urea subsidy for 2012/13 was $260/ton. The total subsidy saved over 105,000 tons for paddy harvested in 2012/13 is $27.3 million. From 2007/08 through 2012/13 urea sales in Bangladesh have trended down even though farmers are producing more rice. The decline was notably stronger in AAPI districts than in the rest of the country.

AAPI improved Bangladesh's foreign exchange current account in 2012/13 by an estimated US $335 million, including savings of US $44 million on 105,000 tons of urea not imported and US $291 million on 624,000 tons of rice not imported.

Impact of *Guti* use on farm households: Seventy percent of all sampled farmers (69 percent in FTF districts) used *Guti* urea on at least one rice crop in 2012/13. Although the percentage of farms using *Guti* urea increases with farm size, because there are so many more marginal and small vs. medium and large farms, marginal and small farms account for 68 percent (59/87) of users and 59 percent (160/273) of rice area fertilized with *Guti* urea in 2012-2013.

The average *Guti* user in the AAPI project area in 2012/13 cultivated a total of 0.39 ha of paddy with *Guti* urea, producing 288 kg more rice than he or she would have produced with prilled urea. Among households in FTF districts, average additional production was 297 kg.

The average marginal farm using *Guti* urea on rice in 2012/13 produced an additional 135 kg, sufficient to feed the average marginal farm household for 1.7 months. Most additional rice produced by small farmers using *Guti* urea, and virtually all produced by medium and large farms, goes to the market.

One measure of the impact of *Guti* urea use on farm income is the difference between the farmer's gross margin per hectare from fields with *Guti* urea vs. prilled urea. Among all farms using *Guti* urea, the average additional income from rice fertilized with *Guti* urea was $78 from an average of 0.39 ha; this gain averaged $77 across all households in FTF districts. Average marginal and small farms that used *Guti* urea realized additional incomes of US $41 and US $54, respectively.

Among farmers who ever used *Guti* urea, the most commonly reported use of their additional income was to improve food. Other uses common among all farm categories were to buy new clothes and educate children.

According to some measures of economic and social welfare, marginal farm households using *Guti* urea appeared to be somewhat better off than farmers not using *Guti*. Marginal farms using *Guti* were more likely to send their children to school and more likely to have invested in household improvements, consumer durables, agricultural equipment and livestock over the last two years. They also reported eating high value foods more often. However, among small farms and medium-large farms, differences between farms that ever and never used *Guti* urea were more random.

Marginal, small and medium-large farms that used *Guti* urea reported lower annual non-rice incomes by US $53, US $132 and US $110, respectively, compared to farms that never used *Guti* urea. One possible explanation for these income differences is that households busy with non-rice production are less likely to pay attention to yield gains available with *Guti* use on rice.

Impact of expanded *Guti* urea use on rural businesses and labor: From September 2010 through June 2013, the AAPI project guided approximately 900 rural entrepreneurs to get into the business of producing *Guti* urea. Considered together, these businesses invested a total of $600,000 and earned $5 million from *Guti* production in 2012/13.

AAPI's indirect impact on rural businesses and labor far exceeds its stimulus to *Guti* producers. From farm-gate to urban wholesale markets, the value of the additional 624,000 tons of rice produced in 2012/13 increased by an estimated 15-20 percent, generating $25-35 million in wages and incomes for rice traders, processors and transporters. Farmers spending their additional incomes on food, clothes, children's education, consumer durables, housing improvements, etc. increased demand for goods and services from rural businesses and laborers.

Gender: During 2010-2013, the AAPI project has progressively increased women's participation in project activities from the initial target of 20 percent to 50 percent in the *Boro* season of 2013. Targets that were considered ambitious several years ago have been exceeded. The AAPI project involves women in project activities in ways that impact directly on many of the factors that the International Food Policy Research Institute (IFPRI) and USAID have identified as weaknesses in women's position in agriculture in Bangladesh.

Among the 1,000 farmers surveyed for this mid-term evaluation, 36 were women with a distribution of farm sizes similar to the total sample. Sixty-one percent of farms headed by women used *Guti* urea on any rice crop in 2012/13 compared to 69 percent of all farms. Women shifting from prilled to *Guti* urea realized relatively large gains in gross margins per hectare, but only $55 per household. Women-headed households using *Guti* urea to boost yields produced an average of 139 kg more rice per household, sufficient to feed an average family for almost 2 months.

Environment: Shifting from prilled to *Guti* urea improves the local and regional environment by reducing nitrogen volatization and runoff and improves the global environment by reducing carbon dioxide (CO_2) emissions. The 105,000 tons of urea saved through AAPI interventions reduced CO_2 emissions during urea production by 189,000 tons.

With support from USAID, AAPI in 2012 initiated research through the Bangladesh Agricultural University (BAU) and the Bangladesh Rice Research Institute (BRRI) to measure paddy field emissions of nitric oxide (which contributes to regional acid rain and global ozone depletion) and nitrous oxide (a greenhouse gas with an effect 300 times stronger than CO_2). This research is significant on a world scale, because little is currently known about the emissions and the factors that increase or decrease emissions.

Activities contributing to the success of the project: The project's success depends crucially on parallel promotion of demand and supply. AAPI's large-scale extension activities among farmers – most of which are coordinated with DAE – generate demand for *Guti* urea. At the same time, AAPI assists local entrepreneurs to produce *Guti* urea to meet local demand.

In the survey for this mid-term evaluation, 850 of 1,000 farmers said they had heard of *Guti* urea. Eighty-four percent of these farmers reported information from government extension agents, while 61 percent mentioned demonstration plots.

Medium-term sustainability: Both the ILSAFARM and AAPI projects found that most farmers who use *Guti* once continue to use it. In the survey for this mid-term evaluation, 697 out of 1,000 farmers reported ever using *Guti*, of which 694 (99.6 percent reported using *Guti* urea on one or more rice crops in 2012/13. Farmers who had ever used *Guti* urea reported multiple benefits with *Guti* urea, including increased yield (mentioned by 96 percent of users), less urea use (91 percent) and more profit (78 percent).

In the AAPI project area, most *Guti* urea is produced by businesses selling 100-200 tons per year, operating their machines only 225-450 hours per year. Even so, most *Guti* producers in the AAPI project area see a good return on their investment due to the Tk 2/kg premium that farmers pay for *Guti* vs. prilled urea. In Tangail and Comilla districts, where *Guti* production and use has continued for more than 10-20 years, production appears to be more concentrated in medium-scale producers, and the markup from prilled to *Guti* urea is less than Tk 1/kg. Over time, *Guti* production in the AAPI project area may similarly concentrate, lowering costs to farmers while sustaining acceptable profits for producers.

Long-term sustainability and global dissemination: The factors that could facilitate global dissemination of the use of urea briquettes in Asian and African rice paddies are similar to the

factors that favor long-term sustainability in Bangladesh. These factors are two: (i) developing strategies for briquette use that allow farmers to apply as much or as little urea as they wish to suit yield targets, field conditions and personal preferences; and (ii) developing one or more applicators that reduce the time and expense to apply urea briquettes. These two factors are linked.

Current recommendations urge farmers to space plants in 20 cm apart and 20 cm apart along each row, placing one *Guti* between every four plants. Flexibility in the rate of urea application with *Guti* could be achieved by increasing the row-to-row distance to 25 cm; farmers could achieve any desired rate of urea application by depositing *Guti* at various frequencies along alternate rows. An applicator that applies smaller *Guti* urea more often along a wider row does not have to be so exact to place *Guti* between plants. Furthermore, with wider rows, damage to rice plants is less.

Recommendations:

1. **Keep doing what you're doing. AAPI has been a tremendously successful project.**
2. **Look for funding to extend *Guti* urea into Rajshahi Division as soon as possible.**
3. **Alert officials in USAID and GOB that *Guti* fertilizer use has had a big impact on rice production and that more can be expected from further expansion of *Guti* fertilizer use.** GOB and donors have decisions to make about food policies and food policy advice.
4. **Support *Guti* urea producers to establish an association.** To bring this to pass, AAPI could negotiate a memorandum of understanding with the Bangladesh Fertilizer Association (BFA), committing AAPI to channel some training and other support for *Guti* producers through BFA and committing BFA to establish a *Guti* producers sub-group.
5. **Suggest GOB to allow an extra Tk 1/kg subsidy on urea sold to dealers for *Guti* production.** This could be administered by asking dealers to collect receipts from each sale of *Guti* urea. When dealers next buy urea, the Bangladesh Chemicals Industry Corporation (BCIC) could allow Tk 1 credit for each kilogram of *Guti* urea sold as demonstrated by the receipts.
6. **Ask Government to withdraw the demand for a Tk 30,000 security deposit for fertilizer sub-dealers who buy *Guti* machines.** Purchase of a *Guti* machine is equivalent to a security deposit – it demonstrates that entrepreneurs intend to stay in the business.
7. **Fund and promote research to use *Guti* urea in maximum yield trials.** This would compel researchers to adopt methods of *Guti* urea application that can accommodate varied and high rates of application per hectare.
8. **Fund and promote research to develop push-style applicators able to deposit *Guti* at various specified distances along rows at least 25 cm wide.**
9. **Introduce NPK granules in a way that allows farmers to determine the relative proportion of each nutrient in a granule.** Along with standard NPK recipes, AAPI could encourage "custom blend" NPK granules that contain what a specific farmer wants.
10. **Consider minor adjustments to project monitoring to improve information on project impacts, including shifting the source of information for gross margin calculations from seasonal post-harvest surveys to AAPI's Crop Cut Surveys.** Yield data from crop cuts are more reliable than from farmers' recall.

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1 Introduction

1.1 Project History and Area

The goal of the Accelerating Agriculture Productivity Improvement (AAPI) project in Bangladesh is to improve food security and rural incomes. To do so, the project promotes an improved method for applying urea to paddy (rice) fields, i.e., placing urea briquettes in the soil rather than broadcasting prilled urea into rice fields. AAPI, a five-year project running from September 2010 to September 2015, is cooperatively supported by the United States Agency for International Development (USAID) through a grant to the International Fertilizer Development Center (IFDC) and by the Government of Bangladesh (GOB) through Ministry of Agriculture and its Department of Agricultural Extension (DAE).

The AAPI project is the latest in a series of U.S.-funded projects promoting urea deep placement (UDP) in Bangladesh. Promoting UDP was a minor component in USAID's Fertilizer Distribution Improvement II project during 1988-1992 and in USAID's Agro-based Industries and Technology Development Project I in 1996-2000. Subsequently, following a run-up in the international price of urea – the free on board (FOB) price for urea from the Black Sea increased from US $269/ton in August 2007 to US $770/ton in August 2008 (World Bank, 2013a) – GOB looked to UDP to reduce field-level nitrogen (N) losses and thereby urea imports and subsidies.

Responding to GOB's interest in UDP, USAID in 2008 supported a one-year project to extend UDP to 80 upazilas (an upazila is an administrative sub-district; Bangladesh is divided into approximately 510 upazilas). The U.S. Department of Agriculture supported a follow-on project in 2009-2011 to extend UDP to another 80 upazilas. These two projects focused on upazilas in the southeast and east (parts of Chittagong and Sylhet Division), north-central (parts of Dhaka Division) and northwest (parts of Rangpur Division). Also during 2008-2010, USAID's Improved Livelihood for Sidr-Affected Rice Farmers (ILSAFARM) project promoted UDP as a strategy to help farmers in eight districts in the south and southwest (see Map 1) recover after the 2007 Sidr cyclone. These three projects demonstrated success with a two-pronged strategy to promote UDP: (a) ensuring farmers' access to urea briquettes (commonly known in Bangladesh as *Guti* urea) by motivating rural entrepreneurs to buy (subsidized) small machines to produce *Guti* urea locally; and (b) showing and telling farmers what they can gain by buying and using *Guti* urea rather than prilled urea.

Note: The AAPI project area covers 22 districts, including:

- Twenty districts in the south and southwest: Bagerhat, Barguna, Barisal, Bhola, Chuadanga, Faridpur, Gopalganj, Jessore, Jhenidah, Jhalokati, Khulna, Madaripur, Magura, Meherpur, Narail, Patuakhali, Pirojpur, Rajbari, Satkhira and Shariatpur.
- Two districts in north-central Bangladesh: Mymensingh and Sherpur.

The ILSAFARM project, 2008-2010, worked in eight districts in the south and southwest: Bagerhat, Barguna, Barisal, Jhalokati, Madaripur, Patuakhali, Pirojpur and Shariatpur.

Map 1: AAPI Project Area

These three relatively small and time-bound projects during 2008-2010 set the stage for USAID and GOB to make a larger and longer commitment to extend *Guti* urea, leading to the establishment of the AAPI project in September 2010. In its first year, AAPI continued activities in the ILSAFARM project area and expanded to Mymensingh and Sherpur in north-central Bangladesh and Gopalganj in the southwest. Initially, AAPI planned to expand to several districts in the northwest (Bogra and Rajshahi) and east (Brahmanbaria, Chandpur and Comilla). However, plans changed. During 2011, USAID established its Feed the Future (FTF) program in Bangladesh, focusing USAID's agricultural aid on the south and southwest, a relatively less-developed region. In September 2011, USAID and IFDC revised the AAPI project to add 11 districts in the south and southwest beginning with *Boro* rice in early 2012 (see Map 1) while continuing work in nine districts in the south and southwest as well as Mymensingh and Sherpur in the north (but not expanding as initially planned to Bogra, Rajshahi, Brahmanbaria, Comilla and Chandpur).

1.2 Urea Deep Placement (UDP)

In much of Asia and Africa, farmers apply N to rice by broadcasting prilled urea (granules 1-2 millimeter [mm] in diameter) onto wet soil – a basal application around the time farmers transplant seedlings followed by two or more topdressings. With such practices, rice plants get only about 25-30 percent of the applied N. Much of the rest is lost to the air (through volatilization) or to surface water runoff, while some N stays in the soil and may be available for later crops (Rong-Ye and Zhao-Liang, 1982; Thomas and Prasad, 1982; Byrnes, Vlek and Craswell, 1979; Savant, Craswell and Diamond, 1983).

One way to reduce N losses is to compress prilled urea to form briquettes (commonly 1.8-2.7 grams [g], *circa* 10 mm in diameter) and to place these briquettes 7-10 centimeters (cm) into the soil. With sub-soil placement of urea, very little N is lost to surface water or air. Applying urea in briquettes leads to concentrations of ammonia that inhibit bacteria that fix N in the soil (Thomas and Prasad, 1982). In clay and silt soils that hold water, concentrated N from UDP remains available for roots to access for more than two months, and plants are able to get a high percentage of the N from UDP. However, in sandy soils, water percolation leaches N from briquettes into groundwater, so that UDP does not improve the efficiency of N use.

Through several decades of experience in Bangladesh, farmers shifting from prilled to *Guti* urea have obtained higher yields despite using less urea. For example, demonstrations, crop cuts in farmers' fields and surveys in ILSAFARM and AAPI during 2010-2013 found average yield gains with *Guti* versus (vs.) prilled urea around 15 percent despite application of about one-third less urea (Table 1).

Table 1: Higher Rice Yields and Lower Urea Applications per Hectare (ha) with *Guti* vs. Prilled Urea

Source	Rice Yields with *Guti* vs. Prilled Urea			Urea Use with *Guti* vs. Prilled Urea		
	With *Guti* Urea (kg)	With Prilled Urea (kg)	% Greater Yield with *Guti* Urea	*Guti* Urea (kg)	Prilled Urea (kg)	% Less Urea with *Guti* Urea
ILSAFARM Final Survey, 2010, weighted average of 3 seasons	3.68	3.13	18%	129	178	28%
Crop cuts in farmers' fields, *Boro* 2011	7.00	6.10	15%	169	260	35%
Crop cuts in farmers' fields, *Aus* 2012	2.89	2.52	15%	111	159	30%
Gross margins survey, *Aus* 2012	3.31	2.78	16%	111	149	25%
Gross margins survey, *Aman* 2012	3.64	2.87	27%	122	185	34%
AAPI demo plots, *Aman* 2012	3.42	2.94	16%	113	167	32%
Crop cuts in farmers' fields, *Aman* 2012	3.29	2.89	14%	113	163	31%
AAPI demo plots, *Boro* 2013	4.71	4.13	14%	169	268	37%
Crop cuts in farmers' fields, *Boro* 2013	4.56	4.04	13%	169	268	37%
Gross margins survey, *Boro* 2013	4.92	4.21	14%	170	272	37%

Note: Kilogram = kg.

Source: ILSAFARM and AAPI project documents; IFDC, 2011.

Yield gains with *Guti* vs. prilled urea can be explained by plants getting more N even though farmers apply less (Table 2). Because the percentage of applied N reaching rice plants from *Guti* urea is characteristically more than double the percentage from prilled urea, applying one-third less *Guti* urea than prilled urea gives plants more N. For example, if plants get 65 percent of N from 169 kg of *Guti* urea but only 30 percent of N from 253 kg of prilled urea, plants fertilized with *Guti* urea will get 16 kg more N (Table 2). Rice plants getting an additional 16 kg of N could produce 800 kg additional paddy (using a 1:50 ratio of N uptake to yield; see Zang and Wang, 2005). Another factor favoring higher yields with *Guti* urea might be that N from *Guti* urea is continuously available, so that plants are never stressed for N.

Table 2: Hypothetical Numerical Example to Explain Observed Yield Increases with *Guti* vs. Prilled Urea

Item	Urea Applied to *Boro* Rice (33% less with *Guti* Urea)	N Applied (46% of Urea)	N Taken by Plants (65% of N from *Guti*; 30% from Prilled Urea)	Additional Yield with *Guti* Urea (estimating a ratio of N uptake to paddy of 1:50)
Guti urea	169 kg	78 kg	51 kg	
Prilled urea	253 kg	117 kg	35 kg	
Difference between *Guti* and prilled urea	-84 kg applied urea	-39 kg applied N	+16 kg N uptake	+800 kg paddy, equivalent to +533 kg rice

Source: Choudhury and Kennedy (2005) report an experiment on rice in Bangladesh showing 30 percent N uptake with prilled urea and 62.4 percent with *Guti* urea. The 1:50 ratio between N uptake and paddy yield is the ratio of N in above ground plant biomass compared to yield; this ratio ranges from at least 1:42 to 1:94 (Zhang and Wang, 2005).

The observation that higher yields with *Guti* urea are due to plants getting more N has implications for strategies to extend UDP to other countries in Asia and Africa and to ensure long-run sustainability of *Guti* urea use in Bangladesh (see further discussion of this point in Section 9, below).

2 Purpose and Method of This Evaluation

2.1 Purpose and Strategy

The purpose of this mid-term evaluation is to assess the performance of the project following completion of the first 30 months of implementation (including the final season of AAPI's scale-up plan), to establish a basis for assessing impact over the remaining life of the project and to recommend possible future actions, within the mandate of the project, to increase agricultural production in the project area (Appendix 1 gives the terms of reference for this evaluation).

This evaluation estimates the impacts of the AAPI project at national and household levels in 2012/13 relative to what would have happened without the project (2012/13, the fiscal year from July 1, 2012 to June 30, 2013, includes the harvests for *Aus* and *Aman* rice in 2012 and *Boro* rice in 2013). Most of these impacts depend on increases in hectares (ha) with *Guti* urea from baseline to 2012/13. However, the baseline situation is less useful in assessing project impact on yields, incomes and welfare because many factors other than *Guti* urea use change over time. The best way to isolate the impact of *Guti* urea use per hectare or per farm household is to compare users and non-users in the same season. Data for such comparisons are available from various sources, and more can be gathered as needed (e.g., for future evaluations).

The terms of reference for this evaluation provide a list of indicators to use to measure the AAPI project impact. This list includes indicators that AAPI project staff and USAID have been using to monitor AAPI performance as well as some additional indicators specific to this evaluation (see Appendix 2). The AAPI project's detailed and well-documented monitoring shows impact according to its assigned indicators. This evaluation accepts most of what the AAPI project reports with a few minor adjustments and recommendations. Most of the effort in this evaluation has gone into other measures of project impact and consideration of what can be done to build on AAPI's success to date.

In addition to promoting *Guti* urea, the AAPI project has spent modest amounts of time and effort promoting and/or developing other agronomic practices. The project promotes alternate wetting and drying (AWD) through farmer training and demonstrations and promotes and develops deep placement of NPK (nitrogen, phosphorus and potassium) granules through research, *Guti* dealer training, farmer training and demonstrations. Because these technologies have to date had no more than a marginal impact on production, this evaluation does not include them in calculations of project impact on economy and welfare.

2.2 Outline

Section 3 estimates the project's economic impact at the national level, including impact on Bangladesh's gross domestic product (GDP), GOB savings on urea subsidies and foreign exchange and impact on rice self-sufficiency at the national level.

Section 4 examines the impact of *Guti* urea use on farm households, businesses and laborers in the project area. Sections 5 and 6 consider the project's impact on the environment and on gender equity. Section 7 examines factors that contribute to the success of the project.

Section 8 considers sustainability in Bangladesh over the short- and medium-term, while Section 9 identifies factors that should be addressed to ensure long-run sustainability as well as international dissemination of UDP with briquettes.

Section 10 presents recommendations.

2.3 Sources of Information

This evaluation is based on surveys, project documents, interviews (with farmers, *Guti* urea producers and project, donor and government staff) and relevant non-project reports, papers and data (see references).

The surveys contributing to this evaluation include a three-stage random sample survey of 1,000 farm families in the project's 22 districts in May-June 2013 (Annex 2 presents the survey questionnaire and describes the process to select households and to manage the survey); a January 2013 survey of 150 *Guti* producers; surveys of 383 farmers after the 2012 *Aus* season and another 383 after the *Aman* season to determine farmers' gross margins for those crops; and the 2010 final impact evaluation survey for the ILSAFARM project.

3 Economic Impacts at the National Level

3.1 Project Impact on Bangladesh's GDP

From a baseline in 2010 (or other pre-project year, depending on available data) to 2012/13 (*Aus* and *Aman* 2012 and *Boro* 2013), the AAPI project extended use of *Guti* urea to an estimated 1,346,000 additional ha, including 1,000,000 ha in 20 FTF districts in the southwest and 346,000 ha in Mymensingh and Sherpur districts in north-central Bangladesh (see Table 3).

Table 3: Estimated Additional Rice Area with *Guti* Urea Due to the AAPI Project, as of *Boro* 2012/13 (ha)

Area, Year	*Aus*	*Aman*	*Boro*	Total
2012-2013 rice area with *Guti* urea in AAPI project area (*Aus* and *Aman* 2012 and *Boro* 2013)	135,000	572,000	828,000	1,535,000
FTF districts	130,000	429,000	580,000	1,140,000
Mymensingh and Sherpur	5,000	142,000	248,000	395,000
Baseline estimates of area with *Guti* urea	29,000	66,000	94,000	189,000
FTF districts	29,000	49,000	62,000	139,000
ILSAFARM (*Boro*, *Aus* and *Aman* 2010)	27,500	47,900	60,800	136,200
12 additional FTF districts (*Boro*, *Aus* and *Aman* 2010 or 2011)[b]	1,200	600	1,200	3,000
Mymensingh and Sherpur (*Boro*, *Aus* and *Aman* 2008)	0	17,000	32,000	49,000
Note: Estimated rice area with *Guti* in 2009-2010[a]	0	0	0	0
Additional area with *Guti* urea due to AAPI in 2012-13 vs. baseline year	106,000	506,000	734,000	1,346,000
FTF districts	101,000	380,000	518,000	1,000,000
Mymensingh and Sherpur	5,000	125,000	216,000	346,000

a. Under Bangladesh's interim government in 2008, USAID's 80 upazila project extended *Guti* urea use to an estimated 49,000 ha (32,000 ha of *Boro* rice and 17,000 ha of *Aman* rice) in 17 upazilas of Mymensingh and Sherpur Districts (estimated as 17/80 x 150,000 ha of *Boro* rice reported for all 80 upazilas, and 17/80 of approximately 79,000 ha of wet season rice reported for 80 upazilas (IFDC, no date [a]; IFDC, no date [b]); during 2009, DAE staff in the two districts, believing the new Awami League government initially opposed *Guti* urea, discouraged use of *Guti* urea in the two districts.

b. ILSAFARM's 2008 baseline survey reported pre-project production of 212 tons of *Guti* urea, sufficient for 1,500 ha (IFDC, 2010). Extrapolating from those data, baseline area with *Guti* urea use in 2010 and 2011 may be estimated as 3,000 ha, considering that the 12 additional FTF districts have twice as many farmers as ILSAFARM's eight districts.

Note: Sums and differences do not always match due to rounding.

Sources: Rice areas with *Guti* urea in 2012/13 are from AAPI quarterly reports. Baseline data for ILSAFARM's eight districts is from ILSAFARM's final evaluation (IFDC, 2010. Note (a) below explains baseline data for Mymensingh and Sherpur. Note (b) below explains baseline data for the 12 additional FTF districts AAPI entered in 2010-2011.

The AAPI project's impact on Bangladesh's GDP can be estimated from the additional rice area fertilized with *Guti* urea multiplied by the difference in value added per hectare (Table 4). At economic prices for urea and rice, the additional 1,346,000 ha of rice area fertilized with *Guti* urea generated additional value added of US $251 million in 2012/13. (The economic price for urea is the hypothetical farm-gate price based on the price of urea in world trade, without subsidies; the economic price for rice is the actual farm-gate price or the hypothetical farm-gate price based on the export parity price, whichever is greater; see details in Appendix 4.)

Most of this increase (US $187 million out of US $251 million) was due to higher yields with *Guti* vs. prilled urea. On average, each hectare of paddy shifted from prilled urea to *Guti* urea produced an additional 460 kg of rice worth US $139.

A portion of the increase in value added at the farm level (US $54 million) comes from lower costs to farm a hectare of rice with *Guti* vs. prilled urea (using total costs, including family labor valued at market wage rates). Most costs are the same; the differences are found in the amount of urea used and in labor. Farmers using *Guti* vs. prilled urea used US $40/ha less urea (or US $19/ha less at subsidized prices); this was partially offset by the higher cost for *Guti* vs. prilled urea (US $25 per ton of *Guti*, or US $4 for the average 143 kg of *Guti* used per hectare).

The data used in these calculations, which come from AAPI's crop cut surveys, show marginally less labor required with *Guti* vs. prilled urea. Comparing rice production with *Guti* vs. prilled urea, the labor required differs for three tasks: applying urea, weeding (buried *Guti* urea is less accessible to new weeds; and rice with *Guti* grows faster and thicker, blocking weeds) and harvest and post-harvest tasks (*Guti* produces more rice, taking more labor to harvest and thresh). Combining data from crop cut surveys for *Aus* and *Aman* 2012 and *Boro* 2013, the 6.1 additional days/ha required to apply *Guti* urea and the 5.8 additional days/ha required to harvest and process more rice are more than offset by the 12.3 fewer days/ha required to weed fields with *Guti* urea, leading to a net decrease of 0.5 days/ha (Table 4 and Appendix 5).

Other surveys report more labor with *Guti*; for example, the final evaluation survey for the ILSAFARM project found a net increase of 12 days/ha. Most of the difference between these estimates is due to weeding, which may be due in part to differences in weather; some of the difference may be due to unreliable data. In any case, these and other surveys agree on the additional labor required to apply *Guti* vs. prilled urea: approximately 6 days/ha. These 6 days were worth US $24 at market wage rates in 2012/13; thus, the additional labor to apply *Guti* urea to a hectare costs less than the US $40 of urea saved (but not less than the US $19 farmers save when they buy urea at subsidized prices).

Less than 1 percent of the AAPI project's impact on GDP comes from value added in small business producing *Guti* urea. More than 1,000 small businesses throughout the AAPI project area produced an estimated 192,000 tons of *Guti* (143 kg/ha for 1,346,000 ha). Based on information from an AAPI survey of 150 *Guti* producers in early 2013, these businesses generated an average value added (returns less costs) of $10.62 per ton, or US $2,050,000 for 192,000 tons (Table 4 and Appendix 6).

Table 4: Impact of AAPI Interventions on GDP, 2012/13

Item	Units and Prices		HYV and Hybrid Rice						Costs and Returns for 1,346,000 ha with *Guti* Urea (US $)
			With *Guti* Urea		With Broadcast Urea		Difference		
	Units	US $/ unit	Units/ ha	US $/ ha	Units/ ha	US $/ ha	Units/ ha	US $/ ha	
AAPI impact on GDP, of which	US $								**251,000,000**
Value added at farm level (with rice price at export parity and unsubsidized urea price)	US $								**249,000,000**
Gross income, of which:	US $			1,234	0	1,089	0	145	195,000,000
Rice (export parity farm-gate price for *Aus* and *Aman*, farm-gate price for *Boro*; see text)	tons	300	3.95	1180	3.49	1042	0.46	139	187,000,000
Note: at import parity farm-gate price	tons	369					0.46	[170]	[229,000,000]
Note: at reported farm-gate price	tons						0.36	[127]	[171,000,000]
Straw	tons	9	5.90	53	5.21	47	0.70	6	8,000,000
Costs that differ between fields with *Guti* vs. broadcast urea, of which:	$			404		440		-38	-51,000,000
Urea (*Guti* or prilled urea)	kg	0.511	143	73	220	112	-78	-40	-54,000,000
Note: urea at farmers' subsidized price	kg	0.249					-78	[-19]	[-26,000,000]
Higher retail price for briquettes	kg	0.025	143	4	0	0	143	4	5,000,000
Labor differences, of which:	days	4.04	80.0	327	80.5	328	-0.5	-2	-2,000,000
Urea application	days		10.1	-	4.0	-	6.1		
Weeding	days		16.3	-	28.7	-	-12.4		
Harvest and post-harvest tasks	days		53.5	-	47.7	-	5.8		
Value added by urea briquette producers (with 0% subsidy for briquetting machine)	tons	**10.62**	**0.143**	**1.52**	**0**	**0**	**0.143**	**1.52**	**2,050,000**
Gross income	tons	25.70	0.143				0.143	3.68	4,950,000
Costs	tons	15.08	0.143				0.143	2.16	2,910,000

Sources: Additional area with *Guti* urea from Table 3; farm production and expenses and tons of *Guti* urea use by season from Appendix 5; prices from Appendices 4 and 5; benefits and costs for *Guti* producers from Appendix 6.

3.2 Benefit-Cost Calculations for USAID/GOB, Farmers and *Guti* Urea Producers

From September 2010 through June 2013, USAID invested US $14.66 million in AAPI, while GOB contributed an estimated US $7.95 million through the DAE (Table 5). These investments (totaling US $22.6 million) increased Bangladesh's GDP by US $251 million in 2012/13. However, the *Guti* urea use stimulated by the project will likely extend beyond 2012/13, so that future benefits should be considered as well. Assuming the level of *Guti* urea use achieved in 2012/13 continues through 2021/22, the present value of US $251 million per year for 10 years, with a discount rate of 13 percent per year, is US $1.54 billion. With these estimates, the benefit-cost ratio for USAID and GOB investments in AAPI through June 2013 is 68 (US $1.54 billion/US $22.6 million).

A benefit-cost ratio for farmers' investments in *Guti* urea over all seasons in 2012/13 is undefined, because estimated costs per ha are less with *Guti* vs. prilled urea. Even if cost estimates are somewhat off (e.g., assuming smaller differences in weeding days with *Guti* vs. prilled urea), farmers' benefits far exceed costs. The final evaluation for the ILSAFARM project estimated a benefit-cost ratio of 5.7 for farmers shifting from prilled urea to *Guti* urea; this estimate included 12 more labor days/ha with *Guti* urea and valued urea at subsidized prices.

For the 2012/13 *Boro* season, the benefit-cost ratios for all farms (Appendix 10, Table 9) were 2.04 for *Guti* and 1.83 for prilled urea and the differential benefit-cost ratio of *Guti* over prilled was 5.83.

Table 5: Project, Government, Farmer and Briquette Producers' Costs vs. Impact on Value Added for Farmers and for Bangladesh

Item	Returns and Costs (US $)	Benefit-Cost Ratio
Benefit-cost ratio for USAID and GOB investments in AAPI		68
Benefits: present value over 2012-2013–2021-2022 assuming benefits continue as in 2012-2013, discounting future gains at 13%/year	1,540,000,000	
Note: Impact on GDP in 2012-2013 (from Table 4)	251,000,000	
Costs: USAID and GOB investments in AAPI through June 2013	22,600,000	
USAID grant to IFDC	14,660,000	
GOB support through DAE (20% of salaries and expenses for staff in AAPI districts and involved central staff)	7,950,000	
Benefit-cost ratio for farmers (returns and costs in Table 4 and Appendix 5)		Undefined, costs <0
Benefit-cost ratio for urea briquette producers (see benefits and costs in Appendix 6)		1.7

Source: Table 4; Appendices 4, 5 and 6.

Guti producers also have a favorable benefit-cost ratio. Throughout the AAPI project area, *Guti* urea sells at Tk 22/kg vs. Tk 20/kg for prilled urea. Revenue of Tk 2/kg (or US $25.70/ton) from sale of *Guti* urea multiplies to US $4.95 million for 192,000 tons. Against this revenue, producers have average total costs of US $15.08/ton, yielding a benefit-cost ratio of 1.7 (see details in Appendix 6).

3.3 Rice Self-Sufficiency

In 2012/13, Bangladesh was self-sufficient in rice, importing only 29,000 tons, while also exporting some high value rice. AAPI's extension of *Guti* urea to an additional 1,346,000 ha in 2012/13 (compared to baseline) increased Bangladesh's rice production by 624,000 tons (Table 6). This additional 624,000 tons made the difference between import dependence and self-sufficiency in 2012/13. Approximately half of this increase was achieved in 2011/12 (based on area with *Guti* urea in 2011/12 from AAPI's quarterly reports).

Table 6: Additional Rice Production Due to AAPI's Extension of Area with *Guti* Urea

Rice Crops(s)	Additional Area with *Guti* Due to AAPI Interventions (ha) A	Higher Yield with *Guti* Urea vs. Prilled Urea (ton/ha) B	Additional Rice Production Due to AAPI Interventions (ton) A x B
Total for 2012/13	1,346,000	0.46	624,360
Aus 2012	106,000	0.38	40,280
Aman 2012	506,000	0.40	202,400
Boro 2013	734,000	0.52	381,680

Source: Table 3 and Appendix 5.

The 624,000 tons of additional rice production in 2012/13 due to the AAPI project exceeds annual imports in three of the previous five years (Table 7). Other factors have contributed to Bangladesh's achievement of rice self-sufficiency in 2012/13 including: a 5 percent reduction in rice consumption per capita per year from 160 kg in 2005 to 152 kg in 2010 (BBS, 2011b); and increased use of phosphate and potash fertilizers due to increased subsidies on triple superphosphate (TSP), diammonium phosphate (DAP) and muriate of potash (MOP).

Table 7: Rice Imports Into Bangladesh, 2003/04 to 2012/13 ('000 tons)

Fiscal Year (1/7 – 30/6)	Food Aid Arrival	GOB Commercial	Total GOB Import	Private Commercial	Total National Imports
2007/08	82	292	292	1,681	2,055
2008/09	30	386	386	187	603
2009/10	4	52	4	37	87
2010/11	6	1,264	1,270	291	1,561
2011/12	9	455	464	59	523
2012/13	4	1	5	24	29

Source: Director General of Food, 2013; Food Project Monitoring Unit, 2013.

Over the next three to five years, further expansion of *Guti* urea use to an additional 1-3 million ha through AAPI as well as other projects and programs could be expected to boost Bangladesh's rice production by another 0.4 to 1.5 million tons (estimating *Guti* use increases rice yields per ha by 400-500 kg). Other factors, including new varieties, hybrids and changes in agronomic practices could also contribute to higher yields.

At the farm level, higher rice yields with *Guti* urea motivate farmers to plant more land to rice. In the survey for this evaluation, 80 percent of farmers who had ever used *Guti* urea said that higher yields with *Guti* urea encouraged them to plant more rice; 20 percent expected no change in cropping pattern, while only one percent expected to reduce rice area (Table 8). This suggests that most farmers think of additional rice produced with *Guti* urea as a cash crop rather than something to feed the household.

Table 8: Cropping Pattern Response to Higher Rice Yield with *Guti* Urea (% of Farmers Who Used *Guti* Urea on Any Crop in 2012/13)

	Plant More Land to Paddy, to Grow More Rice (%)	Plant Less Land to Paddy, to Grow More Other Crops (%)	No Change (%)
Marginal farms (0.02-0.19 ha)	77%	3%	20%
Small farms (0.2-0.99 ha)	81%	1%	19%
Medium and large farms (≥1 ha)	80%	2%	18%
Total	80%	1%	18%

Source: AAPI Mid-term Evaluation and *Boro* 2013 Gross Margin Survey, May-June 2013.

Although *Guti* has significantly increased Bangladesh's rice production over the past several years and could prompt further large increases over the next five years as well, future surpluses are not assured. The fly in the ointment is that rice production can fall if low prices (due to GOB policies blocking rice exports) discourage farmers from planting rice or investing in fertilizers and other inputs. During much of 2012/13, rice prices in Bangladesh were below export parity (estimated from the Vietnam five percent white rice price; see Appendix 4). Although prices rose after the *Boro* harvest, as of June 2013, Bangladesh's Ministry of Food reported relatively low prices in Bangladesh: "In the week ending June 14th…Thai 5% parboiled, Pakistan 5% parboiled and Kolkata wholesale prices … [were] 540 USD/MT [US $ per metric ton], 490 USD/MT and 396 USD/MT, respectively. Dhaka city wholesale rice price stood at 332 USD/MT on the same date" (National Food Policy Capacity Strengthening Program [NFPCSP], 2013a; see also NFPCSP, 2013b).

3.4 Fertilizer Subsidies

Farmers using *Guti* urea rather than prilled urea on 1,346,000 ha in 2012-2013 used a weighted average of 78 kg/ha less urea, reducing urea purchases by a total of 105,000 tons. Because GOB subsidizes urea fertilizer, lower urea sales reduce GOB subsidies. Total GOB savings on subsidies for 105,000 tons of urea saved in 2012/13 was US $27.3 million (Table 9). These savings in 2012/13 alone notably exceed USAID and GOB support to the AAPI project from September 2010 through June 2013.

Although Bangladesh produces some urea, it also imports. The Bangladesh Chemicals Industry Corporation (BCIC) imports and distributes urea to warehouses, where fertilizer dealers accept delivery for further distribution. The urea subsidy to farmers can be estimated as the difference between the world price of urea (FOB Black Sea) plus transport to Bangladesh plus transport and storage within Bangladesh less BCIC's price to dealers (Appendix 4). The weighted average urea subsidy for 2012/13 is US $260/ton (considering urea subsidies in the second quarter [Q2] of 2012] for *Aus* 2012, Q3 2012 for *Aman* 2012 and Q1 2013 for *Boro* 2013). Savings of $260/ton multiply to US $27.3 million for 105,000 tons.

Table 9: AAPI Impact on GOB Fertilizer Subsidies

Item	Per Hectare Change in Fertilizer Use (kg/ha)	Additional Area with USG (ha)	Total Change in Fertilizer Use (tons)	Subsidy ($/ton)	Change in GOB's Expenditures on Subsidies ($)
	A	B	C=AxB	D	E=CxD
Total for 2012/13	-78	1,346,000	-105,000	260	-27,300,000
Aus 2012	-48	106,000	-5,088	347	-1,800,000
Aman 2012	-52	506,000	-26,312	249	-6,600,000
Boro 2013	-100	734,000	-73,400	258	-18,900,000

Sources: Table 3 and Appendices 4 and 5.

From 2007/08 through 2012/13, urea sales in Bangladesh have trended down even though farmers are producing more rice. At least part of the explanation for these conflicting trends may be expansion in rice area fertilized with *Guti* urea. The decline in urea use was more evident through 2011/12 in the eight districts where the ILSAFARM project began in late 2008 than in the rest of Bangladesh (Table 10). However, by 2012/13, the decline was equally strong across all 22 AAPI districts as in the eight districts in the former ILSAFARM project that are now part of the AAPI project area.

This evaluation has no information on changes in *Guti* urea use in non-AAPI districts; if *Guti* use is increasing, that could help to explain declining urea use in Bangladesh. (Considering that farmers in other Asian countries with high ratios of people per arable hectare get higher rice yields and apply more N compared to farmers in Bangladesh, the recent trend toward less urea use in Bangladesh is not necessarily a good thing.)

Table 10: Urea Sales After 2007/08 as a Percentage of 2007/08 Sales

Region	Fertilizer Sales in 2007/08 (tons)	Fertilizer Sales as a Percent of 2007/8 Sales				
		2008/09	2009/10	2010/11	2011/12	2012/13
ILSAFARM	155,496	93%	86%	88%	79%	76%
AAPI districts	721,043	92%	90%	96%	83%	76%
Non-AAPI districts	2,041,740	92%	106%	96%	83%	83%
Bangladesh	2,762,783	92%	102%	96%	83%	81%

Source: BCIC.

Eventually, the higher agronomic N efficiencies (kg of paddy per kg of applied N) that farmers realize with *Guti* vs. prilled urea may make it easier for the GOB to allow higher urea prices without threatening rice production. With the higher N efficiencies with *Guti* urea, farmers could double what they currently pay for urea and still realize a better return per kilogram of urea with *Guti* than with prilled urea.

3.5 Foreign Exchange

AAPI improved Bangladesh's foreign exchange current account in 2012/13 by an estimated US $335 million (Table 11). Two items – rice and urea fertilizers – must be considered to evaluate the project's impact on Bangladesh's balance of payments. Farmers shifting from prilled to *Guti* urea used 105,000 tons less urea, allowing GOB to reduce urea imports by US $44 million. Because Bangladesh imported a modest amount of rice in 2012/13 (29,000 tons [see Table 7]), the 624,000 additional tons produced due to AAPI interventions allowed an equivalent reduction in rice imports, saving US $291 million in foreign exchange.

Table 11: AAPI Impact on Bangladesh's Balance of Payments in 2012/13

Item	Cost and Freight (C&F) (US $/ton)	Estimated Reduction in Imports (tons)	Savings on Foreign Exchange (US $ millions)
Rice	466	624,000	290.8
Urea	423	105,000	44.4
Total			335.2

Sources for urea: Urea savings per season are from Table 10; C&F prices for fertilizer are from Appendix 4, using the Q2 2012 price for urea imported for the *Aus* 2012 season, the Q3 2012 price for the *Aman* season and the Q1 2013 price for the 2013 *Boro* season; the table shows the weighted average C&F price for the three seasons.

Sources for rice: Reduction in rice imports is from Table 6; the C&F price for rice for 2012/13 is from Appendix 4.

4 Economic Impact on Farm Households, Rural Businesses and the Labor Market

4.1 Impact on Rice Production and Household Rice Self-Sufficiency

The random sample survey for this evaluation provides a basis to analyze the economic impact of the AAPI project by farm size. The percentage of farmers who used *Guti* urea to fertilize at least one rice crop in 2012/13 increases by farm size class from 47 percent of marginal farms (owning 0.02 to 0.19 ha) to 90 percent of large farms (owning ≥ 3 ha). Similarly, in the ILSAFARM final evaluation survey, the percentage of farms using *Guti* urea doubled from 25 percent of marginal farms to 50 percent of medium-large farms.

Seventy percent of all sampled farmers (69 percent in FTF districts) used *Guti* urea on at least one rice crop in 2012/13. Among women farmers, 61 percent used *Guti* urea on at least one rice crop in 2012/13. Although the percentage of farms using *Guti* urea increases with farm size, because there are so many more marginal and small vs. medium and large farms, marginal and small farms account for 68 percent (59/87) of users and 59 percent (160/273) of rice area fertilized with *Guti* urea in 2012-2013. Because marginal farmers may be under-represented in this survey (see Appendix 2), the percentage of *Guti* users and *Guti* area in marginal and small farms may be somewhat higher than reported in Table 12.

Table 12: *Guti* Urea Use in 2012/13 by Farm Size, Region and Gender

Farm Category	Number of Households Surveyed	Number (%) Using *Guti* on Rice in any Season	Number (%) Using *Guti* on Any Non-Rice Crop	Average Rice Area with *Guti* Urea Among Households Using *Guti* on Rice in Any Season (ha)				Total Annual Rice Area with *Guti* by Farm Size (ha)
				Aus 2012	*Aman* 2012	*Boro* 2013	Total for 3 Seasons	
Marginal (0.02-0.19 ha)	62	29 (47%)	2 (3%)	0	0.07	0.13	0.20	6
Small (0.2-0.99 ha)	719	490 (68%)	57 (8%)	0.02	0.12	0.18	0.31	154
Medium (1.0-2.99 ha)	209	166 (79%)	26 (13%)	0.03	0.23	0.37	0.63	105
Large (≥3 ha)	10	9 (90%)	2 (20%)	0.02	0.32	0.61	0.96	9
All farms	1,000	694 (69%)	87 (9%)	0.02	0.15	0.23	0.39	273
All farmers in FTF districts	840	589 (70%)	79 (9%)	0.02	0.15	0.22	0.40	234
Women farmers	36	22 (61%)	2 (6%)	0	0.06	0.14	0.20	4

Source: AAPI Mid-Term Evaluation and *Boro* 2013 Gross Margin Survey, May-June 2013.

The average *Guti* user in the AAPI project area in 2012/13 cultivated a total of 0.39 ha of paddy with *Guti* urea over three seasons, producing 288 kg more rice than he or she would have produced with prilled urea (Tables 12 and 13). Among households in FTF districts, average additional production of 297 kg was slightly higher than the AAPI average.

The area fertilized with *Guti* urea was highest in the *Boro* season: 617 sample farmers used *Guti* urea on a total of 157 ha, averaging 0.25 ha per farm (Appendix 10). Notably, this average is less than average of 0.34 ha for all farmers in the AAPI project area (from comprehensive lists of all farmers compiled by Sub-Assistant Agricultural Officers [SAAOs]). Thus, while the survey sample may not be accurate in terms of the percentage of marginal farmers and *Guti* users, there appears to be no bias in favor of farmers using *Guti* on more area; hence, any biases in the sample likely do not affect differences in yields and incomes between farmers who did and did not use *Guti* urea.

Average annual additional rice production per household was 135 kg in marginal farms, 219 kg in small farms and over 500 kg in medium and large farms. Average additional rice production among women farmers was 139 kg, similar to the increase among marginal farmers.

Table 13: Impact of *Guti* Urea Use on Rice Production by Farm Size and Gender

Farm Category	Difference in Rice Yields Between Fields with *Guti* vs. Prilled Urea (tons/ha)			Average Impact of *Guti* Urea Use on Annual Rice Production per Farm (kg)[a]
	Aus 2012	*Aman* 2012	*Boro* 2013	
Marginal (0.02-0.19 ha)	0.47	0.70	0.66	135
Small (0.2-0.99 ha)			0.70	219
Medium (1.0-2.99 ha)	0.65	0.92	0.77	517
Large (≥3 ha)	0.51	0.78	0.69	678
All farms	0.52	0.76	0.71	288
All farms in FTF districts	0.52	0.81	0.72	297
Women farmers	0.49	0.87	0.62	139

a. The average is calculated from area with each rice crop by farm size (Table 12) multiplied by the difference in yields for each farm size and season.

Source: AAPI Mid-term Evaluation and *Boro* 2013 Gross Margin Survey, May-June 2013; gross margin surveys for *Aus* 2012 and *Aman* 2012.

Marginal farms' average 135 kg of additional rice production with *Guti* urea was sufficient to feed the average marginal household (with 5.8 members in the survey sample) for an additional 1.7 months (Table 13). Virtually all additional rice produced by medium and large farms using *Guti* urea goes to the market because pre-*Guti* production far exceeds household rice consumption. This applies as well to most small farms owning at least 0.2 ha (given Bangladesh's average cropping intensity of 1.91, with 77 percent of gross cropped area in rice, and average yields of 2.9 tons/ha [BBS, 2011a], the average household owning 0.2 ha plants rice on 0.29 ha per year and harvests 840 kg of rice, sufficient to feed 5.8 members of an average family for more than 11 months). Some farm households will eat at least some of the additional rice produced with *Guti* urea (averaging 219 kg/year for small farms), but most will sell all of it.

The 2011-2012 Bangladesh Integrated Household Survey (BIHS) reported the average farm produced 1,527 kg of rice, selling half of that production for cash and services (Ahmed et al., 2013). This would leave about 760 kg for household consumption, which agrees with average household size of consumption of 13.4 kg/person/month (with 4.7 persons per household in the BIHS survey).

Table 14: Impact of Additional Rice Production with *Guti* Urea on Rice Self-Sufficiency or Surplus for Sales by Farm Size, 2012/13

Item		Marginal Farms	Small Farms	Medium and Large Farms
A	Average additional rice production with *Guti* urea (kg)	135	219	525
B	Average size of households using *Guti* urea[a]	5.8	5.8	6.0
C = B x 13.4 kg/month	Average rice consumed per month per household (kg)[b]	78	78	80
D = A/C	Average months that additional own-produced rice with *Guti* urea use is able to feed the family (months)	1.7	2.8 but rarely relevant	Not relevant

a. Average household sizes are from the AAPI Mid-Term Evaluation and *Boro* 2013 Gross Margin Survey, May-June 2013.
b. Calculating 13.4 kg/person/month from rural consumption of 441.6 grams/person/day x 30.4 days/month for rural residents (BBS, 2011b).

Source: Table 12 and Appendix 6.

4.2 Impact on Farm Household Income and Welfare

One measure of the impact of *Guti* urea use on farm income is the difference between the farmer's gross margin per hectare from fields fertilized with *Guti* urea vs. fields fertilized with prilled urea. According to the definition of gross margin recommended by USAID for AAPI and other FTF projects in Bangladesh and elsewhere, the gross margin values all output at market prices but considers only major purchased inputs (ignoring inputs accounting for less than five percent of total costs and ignoring all inputs such as labor, seed and land supplied by the farm family. This definition of gross margin approximates farmers' income; the difference in gross margins between fields farmed with *Guti* and prilled urea approximates the increase in farm income due to *Guti* urea

Average marginal and small farms that used *Guti* urea on rice realized additional incomes of US $41 and US $54 per household, respectively, in 2012/13. Women farmers shifting from prilled to *Guti* urea realized average additional income of US $55 per household. Among all farms using *Guti* urea, the average additional income from rice fertilized with *Guti* urea was US $78 per household from an average of 0.39 ha (Tables 13 and 15). In FTF districts, the average household's gain in income was similar at US $77.

Table 15: Impact of *Guti* Urea Use on Gross Margin in Rice Production by Farm-Size Class

Farm-Size Class	Difference in Gross Margins Between Fields with *Guti* vs. Prilled Urea (Tk/ha)			Average Annual Impact on Gross Margin[a]	
	Aus 2012	*Aman* 2012	*Boro* 2013	(US $/ha)	US $ Household
Marginal (0.02-0.19 ha)	10,161	16,975	15,850	206	41
Small (0.2-0.99 ha)			12,068	174	54
Medium (1.0-2.99 ha)	11,944	22,855	18,572	250	158
Large (≥ 3 ha)	11,784	5,817	11,816	125	120
All farms	11,459	16,344	14,352	189	74
All farms in FTF districts	12,035	16,625	15,483	199	77
Women farmers	8,668	22,667	21,131	274	55

a. These averages are weighted by the area with *Guti* urea in each season (Table 12), using the exchange rate for each season (see Appendix 4).

Source: Gross Margin Surveys for *Aus* 2012, *Aman* 2012 and *Boro* 2013.

Among farmers who ever used *Guti* urea, the most commonly reported use of income from *Guti* urea among all farm categories was to improve food. Other uses common among all farm categories were to buy new clothes and educate children (Table 16). Marginal farms were more likely to invest in household furnishings, while medium-large farms were more likely to increase savings.

Table 16: Farmers' Use of Additional Income from Use of *Guti* Urea, July 2011-June 2013 (percent of farmers reporting each use)

	Marginal	Small	Medium-Large
Improve food	70%	73%	77%
Buy household furnishings	70%	13%	17%
Buy new clothes	53%	72%	74%
Children's education	50%	63%	72%
Increase savings	23%	20%	37%
Renovate house or build a new house	13%	8%	17%
Pay debt	13%	4%	1%
Buy livestock	3%	10%	10%
Buy agricultural equipment	0%	6%	8%
Buy land	0%	1%	1%

Source: AAPI Mid-Term Evaluation and *Boro* 2013 Gross Margin Survey, May-June 2013.

According to some measures of economic and social welfare, marginal farm households using *Guti* urea appeared on average to be somewhat better off than farmers not using *Guti* (Table 17). For example, marginal farms using *Guti* vs. prilled urea were more likely to send their children to school, less likely to have mortgaged land out and more likely to have invested in household

improvements, consumer durables, agricultural equipment and livestock. However, among small farms and medium-large farms, differences between farms that ever and never used *Guti* urea were more random.

Table 17: Differences in Selected Social and Economic Measures Between Households That Ever and Never Used *Guti* Urea, Stratified Farm Size

Item	Marginal Farms: Situation for 32 *Guti* Users vs. 30 Non-Users	Small Farms: Situation for 489 *Guti* Users vs. 230 Non-Users	Medium/Large Farms: Situation for 178 *Guti* Users vs. 41 Non-Users
Percentage of children aged 6-15 in school	6%	8%	-7%
Households' reported additional income from *Guti* during June 2011-May 2013 (US $)	23	45	94
Households' total reported non-rice income during June 2012-May 2012[a] (US $)	-53	-132	-110
Land			
Buy any land last 2 years? (% yes)	-3%	-2%	0%
Sell any land last 2 years? (% yes)	0%	-1%	2%
Mortgage land out last 2 years? (% yes)	-7%	-2%	-3%
Repaid a mortgage last 2 years? (% yes)	3%	-1%	0%
Build any pond last 2 years? (% yes)	-3%	5%	4%
Investments last 2 years (% reporting)			
Household investments(cement floor, tin roof, tin walls, new room/house)	8%	3%	7%
Purchase of consumer durables (bicycle, motorcycle, radio, television, mobile phone)	20%	-5%	-5%
Purchase of agricultural machinery (power tiller, sprayer, irrigation pump or well, weeding machine, paddy thresher)	5%	8%	-2%
Purchase of farm animals (cow, bull, water buffalo, goat, poultry to raise for meat or eggs	8%	-3%	0%
Number of times per week eating high value foods (average reported)			
Chicken	0.68	-0.03	-0.05
Mutton	0.20	0.08	0.08
Beef	0.02	-0.09	-0.65
Fish or shrimp	0.89	-0.22	0.61
Eggs	0.74	0.02	-0.27

a. This includes income from farm labor for others, crop sale, vegetable or fruit sale, milk, eggs or livestock sale, fish or shrimp sale and business income; see details in Appendix 7.

Source: AAPI Mid-term Evaluation and *Boro* 2013 Gross Margin Survey, May-June 2013.

Among marginal farms, households that ever used *Guti* urea reported eating high value foods more often during the week compared to households that never used *Guti*. However, this difference also does not carry through for small and medium-large farms, for which *Guti* use appears to have no favorable impact on diet (Table 17, last lines).

In the ILSAFARM final impact survey, among all farm size classes, households using *Guti* urea reported lower average non-rice incomes compared to households not using *Guti* urea. This mid-term evaluation found the same situation. Marginal, small and medium-large farms that had ever

used *Guti* urea reported lower annual non-rice incomes by US $53, US $132 and US $110, respectively, compared to farms that never used *Guti* urea. Notably, these higher non-rice incomes exceed estimated incomes from *Guti* urea. Lower non-rice income among *Guti* users may be due to unreliable data; on the other hand it might be showing that households busy with non-rice production are less likely to pay attention to yield gains available with *Guti* use on rice.

4.3 Impact of Expanded *Guti* Urea Use on Rural Businesses

From September 2010 through June 2013, the AAPI project expanded annual demand for *Guti* urea by 192,000 tons and assisted approximately 900 rural entrepreneurs to invest to meet that demand. These 900 businesses invested an average of US $700 per business, or US $600,000 across all businesses. To help new businesses get started, AAPI paid 75 percent of the cost for *Guti* machines (i.e., machines to compress prilled urea into *Guti*), or about US $1.3 million for 900 machines; in 2013, AAPI reduced the subsidy to 50 percent. These investments support annual production of *Guti* worth almost US $5 million.

Although *Guti* production is essential to support *Guti* use, the income that rural businesses earn by producing *Guti* urea is dwarfed by the overall impact of expanded *Guti* use on all rural businesses. The additional 624,000 tons of rice produced due to AAPI's extension of *Guti* use to 1,346,000 ha generates downstream jobs and incomes to trade and process rice as well as jobs and incomes when farmers spend their additional earnings.

At local farm-gate prices, the additional 624,000 tons of rice are worth US $171 million (see Table 4). From farm-gate to urban wholesale markets, the value of this rice increases by an estimated 15-20 percent, generating $25-35 million in wages and incomes for traders, processors and transporters. Farmers spending their additional US $171 million income on food, clothes, children's education, consumer durables, housing improvements, etc. (Table 16) increase demand for goods and services from rural businesses and laborers.

Table 18: Estimated AAPI Impact on Rural Businesses

Business	Estimated Impact, 2012/13 (US $)		Basis for the Estimate
	Income	Investments[a] (US $)	
Direct impact			
Guti producers	5,000,000	250,000[b]	AAPI monitoring
Indirect impact			
Rice traders, processors and transporters	25,000,000-35,000,000	1,200,000 1,800,000	Annual income estimated as 15-20% of the farm-gate value of rice
Businesses selling goods and services to farmers	171,000,000	9,000,000	Sales to farmers estimated as 100% of farmers' additional income

a. Estimated as 5 percent of income.
b. Sales of *Guti* machines varied over AAPI's 39 months from September 2010; with total investments of US $600,000 over 39 months, the average annual investment was US $250,000.

Source: Consultant's estimates.

Thus, AAPI's total impact on rural business incomes far exceeds *Guti* producers US $5 million in annual sales. Similarly, private investments in rural businesses stimulated by the AAPI project far exceed the US $600,000 invested by 900 new *Guti* producers over 30 months. If businesses invest an average of 5 percent of their revenue, AAPI in 2012/13 alone stimulated estimated private investments by rice traders, transporters and processors of US $1.2-1.8 million and by rural businesses selling goods and services to farmers of US $9 million (Table 18).

4.4 Impact of Expanded Use of *Guti* Urea on Labor Demand

Information from AAPI's crop cut surveys during 2012/13 shows that fertilizing rice with *Guti* urea reduces labor use by 0.5 days/ha due to much less time required to weed rice fields. Some other surveys show that fields fertilized with *Guti* vs. prilled urea use more labor. For example, ILSAFARM's final evaluation survey reported that *Guti* use increased labor demand by 12 days/ha (including 1.4 days for family women and 0.9 days for hired women); most of the additional labor was needed to harvest and process the larger yield. To put these different results into perspective, at the 2012/13 market wage rate of $4/day, a 0.5 day/ha reduction in labor use would cut labor costs by $3 million, while an increase of 12 days/ha would be worth $64 million.

Aside from what happens on farms using *Guti*, the AAPI project generates jobs directly by assisting entrepreneurs to get into *Guti* production. AAPI estimates 1.67 jobs created with each new *Guti* producer for a total of 1,500 new jobs through March 2013.

However, AAPI's indirect impact on the labor market dwarfs its direct impact on farm labor and on jobs in businesses producing *Guti* urea. Indirectly, AAPI generates jobs in businesses that trade, transport and process the additional 624,000 tons of rice produced with *Guti* urea as well as in businesses that service farmers with more money to spend.

5 Gender

5.1 Assessing Women's Empowerment in Agriculture

During 2011-2012, USAID with International Food Policy Research Institute (IFPRI) and the Oxford Policy and Human Development Initiative designed an index of women's empowerment in agriculture (WEAI) (Sraboni et al., 2013). The index is a weighted sum of two indices: An index of five domains of empowerment (5DE) in agriculture, which weights responses to questions dealing with production, resources, income, leadership and time (the five domains in this index are further sub-divided into 10 "domain indicators"); and a gender parity index (GPI), which weights responses to questions dealing with intra-familial gender parity.

The information for these indices is solicited from men and women during one-on-one interviews via mostly subjective questions (Alkire et al., 2012), such as: "How much input did you have in making decisions about food crop farming, cash crop farming, livestock raising and fish culture?" A small minority of the information going into these indices is based on objective measures and questions, such as: "Are you a member of any agricultural/livestock/fisheries producer/market group; water, forest users', credit or microfinance group…?"

Bangladesh is the first country to measure women's empowerment through the WEAI using information collected in 2011-2012 through the Bangladesh Integrated Household Survey, a national survey of 6,500 households. Because this is the first use of the WEAI index, there are no cross-country comparisons or time-trends to give a sense of reality to what is reported. According to the survey, 22-24 percent of rural women in Bangladesh or in FTF districts are considered to be empowered (vs. 43-50 percent of men) while 36-39 percent of women are considered to have gender parity within their household (p. 9 in Sraboni et al., 2013).

The survey identified specific deficits in women's empowerment, including (pp. 11-12 in Sraboni et al., 2013): "lack of participation in groups ([contributing] 16.2 percent [to women's disempowerment] in the FTF zone and 17.3 percent in Bangladesh), lack of control over income (16.1 percent in the FTF zone and 15.0 percent in Bangladesh) and discomfort in speaking in public (16.3 percent in the FTF zone and 16.5 in Bangladesh)."

5.2 AAPI Project Empowering Women in Agriculture

During 2010-2013, the AAPI project has progressively increased women's participation in project activities from the initial target of 20 percent to 50 percent in the *Boro* season of 2013. Targets that were considered ambitious several years ago have been exceeded. The AAPI project involves women in project activities in ways that impact directly on many of WEAI's 10 "domain indicators" (Table 19). Women's participation in project activities has been achieved through persuasion and cooperation, with goodwill and without confrontation.

Table 19: Selected AAPI Activities Empowering Women According to WEAI's Domain Indicators

WEAI Domain Indicator	Contribution to Disempowerment in FTF Zone	Involvement of Women in FTF Districts in AAPI Activities (% of participants, latest quarter)
Input in productive decisions	10.1%	Farmers' training on FDP (47%) Motivational field visits (43%) Motivational meeting with experienced farmers (39%)
Autonomy in production	4.6%	Field demonstrations for rice (49%) and vegetables (91%) AWD demonstration (40%) Field trials for rice (50%) and vegetables (100%)
Ownership of assets	5.9%	Sale of briquette machines (46%, Oct-Dec 2012)
Purchase, sale or transfer of assets	7.4%	See sale of briquette machines
Access to and decisions on credit	9.1%	Business management training (14%)
Control over use of income	16.1%	
Group member	16.2%	
Speaking in public	16.3%	See demonstrations and trials
Workload	7.3%	
Leisure	7.2%	Open sky shows

Among the 1,000 farmers surveyed for this mid-term evaluation, 36 were women (cf.: in the 2008 Agricultural Census, women headed 3 percent of farm households [BBS, 2011c]). The farm size distribution for these 36 farms was similar to the distribution in the total sample (two marginal farms, 32 small farms and two medium-large farms).

Sixty-one percent of farms headed by women used *Guti* urea on any rice crop in 2012/13 compared to 69 percent of all farms (Table 12). The average woman-led farm used *Guti* urea on only 0.2 ha in the year, compared to 0.39 ha for all farms. On the other hand, women shifting from prilled to *Guti* urea realized relatively large gains in gross margins per hectare (Table 15); hence, their average gain in income per family from using *Guti* urea (US $55) was not far below the average for all farms (US $74). Women-headed households using *Guti* urea gained an average 139 kg in rice production, sufficient to feed an average family for almost 2 months (Tables 13 and 14).

6 Environment

The AAPI project has multiple favorable impacts on the environment. Shifting from prilled to *Guti* urea: (a) improves the local environment by reducing nitrogen runoff from rice paddies into

local water bodies; (b) improves the regional environment by reducing nitrogen volatization from rice paddies as ammonia and nitric oxide (NO) and subsequent return to earth with rain or acid rain and by reducing nitrogen runoff from rice paddies into regional water bodies; and (c) improves the global environment by reducing carbon dioxide (CO_2) emissions during production of urea, with an unknown impact on emissions of methane and nitrous oxide (N_2O) from rice paddies.

With support from USAID through a Global Climate Change Initiative award, AAPI in 2012 initiated research through the Bangladesh Agricultural University (BAU) and the Bangladesh Rice Research Institute (BRRI) to measure paddy field emissions of NO (which contributes to regional acid rain and global ozone depletion) and N_2O (a greenhouse gas, with an effect 300 times stronger than CO_2). This research is significant on a world scale, because little is currently known about emissions of these two gases from paddy fields – the scale of emissions and the factors that increase or decrease emissions. Under the current agreement, funding for this research ends in 2014 (hopefully arrangements can be made to continue this important research, taking advantage of investments in equipment and training).

During 2011 through 2013 and continuing, AAPI has also funded research to measured N in standing water in paddy fields fertilized with prilled urea, *Guti* urea and NPK briquettes. Findings from this research are repeated and predictable: application of prilled urea boosts levels of ammonia in standing water for one to seven days, whereas application of *Guti* urea has little or no impact on ammonia in standing water.

One measure of AAPI's impact on greenhouse gas emissions can be calculated directly from the project's impact on farmers' use of urea. As noted above (Table 9), farmers shifting from prilled to *Guti* urea on 1,346,000 ha reduced urea use by 105,000 tons. Producing a ton of urea releases an estimated 1.8 ton of CO_2 (Wood and Cowie, 2004). Thus, in addition to whatever happens to greenhouse gas emissions at the field level, the project has reduced CO_2 emissions by 189,000 tons through reduced demand and the production of urea.

7 Activities Contributing to the Success of the Project

The project's success depends crucially on parallel promotion of demand and supply. AAPI's large-scale extension activities among farmers – most of which are coordinated with DAE – generate demand for *Guti* urea. At the same time, AAPI assists local entrepreneurs to produce *Guti* urea to meet local demand.

Without parallel promotion of demand and supply, problems on one or the other side of the market can prevent or stop *Guti* urea use. If production of *Guti* urea runs ahead of demand, fertilizer dealers are left with unsold stocks that deteriorate over time; this is almost assured if *Guti* production is initially organized through factories or other large scale producers not in day-to-day contact with farmers who must buy the product. On the other hand, programs to extend *Guti* use will not succeed if farmers who are persuaded to use it are unable to buy it.

By cooperating with DAE, AAPI is able to generate and supervise a massive extension program. For example, in the 2013 *Boro* season alone, AAPI organized one-day training for 90,000 farmers in 3,000 batches and established 487 demonstration plots in rice, along with other demonstrations on vegetables, trials on rice and vegetables and other project activities.

In the survey for this mid-term evaluation, 850 of 1,000 farmers said they had heard of *Guti* urea. Eighty-four percent of these farmers reported information from government extension agents, while 61 percent mentioned demonstration plots. Aside from AAPI's extension efforts, farmers also learned about *Guti* urea from other farmers (42 percent), neighbors (32 percent) and *Guti* producers (33 percent). The frequent mention of these non-project sources of information suggests that *Guti* use can spread once it is established in a farming community.

Table 20: Sources of Information About *Guti* Urea (% of Respondents Reporting Each Source)

Sources of Information	ILSAFARM Mid-Term Survey	ILSAFARM Final Impact Evaluation Survey		AAPI Mid-Term Evaluation Survey (850 Farmers Who Had Ever Heard of *Guti* Urea)
		544 Farmers Who Never Used *Guti*	354 Farmers Who First used *Guti* in 2009-10	
DAE extension agents	59	0.6	77	84
Demonstration plot	17	0	30	61
IFDC/USAID	60	0.2	47	52
Billboard/banner	16	0.4	21	46
Other farmers	40	60	55	42
Farmers' meeting	13	0.2	20	42
Guti producer	17	0	34	33
Neighbors	-	-	-	32
Field day	-	-	-	17
Leaflet	-	-	-	11
Television	28	0.2	26	6
Video	-	0	1.6	3

Sources: ILSAFARM final evaluation; AAPI Mid-Term Evaluation and *Boro* 2013 Gross Margin Survey, May-June 2013.

8 Medium-Term Sustainability of *Guti* Urea Use in Bangladesh

With current rice yields and agronomic practices in Bangladesh, farmers shifting from prilled to *Guti* urea have been getting approximately 15 percent higher yields. Higher farm income from higher yields motivates farmers to apply *Guti* urea despite the extra days required to do so. This situation can be expected to continue for the medium term, as discussed in this Section.

In the medium term, the one fly in the ointment that could restrain or even suppress *Guti* urea use in Bangladesh is that government control of urea trade could channel urea to local dealers with

no interest to produce and sell *Guti* urea. If so, farmers interested to buy and use *Guti* might not be able to find it in their local markets.

8.1 Farmers' Demand – Is It Sustainable?

Both the ILSAFARM and AAPI projects found that high percentages of farmers who use *Guti* once will use it again (Table 21). For example, 97 percent of farmers in the AAPI project area who used *Guti* urea on *Boro* rice in 2012 repeated use on *Boro* rice in 2013. In the survey for this mid-term evaluation, 697 out of 1,000 farmers reported ever using *Guti*, of which 694 (99.6 percent reported using *Guti* urea on one or more rice crops in 2012/13).

Because benefits from *Guti* urea vary according soil conditions and no doubt other local factors, it is reasonable that reuse is less than 100 percent. For example, during field visits for this evaluation, this consultant met a farmer in a village in Harinakunda Upazila of Jhenaidah District who reported no impact on yields when he used *Guti* urea four to five years ago. Notably, the area has permeable soils; irrigation water does not remain on the fields for more than a day. Under such conditions, water percolation leaches N from *Guti* urea into groundwater. None of 20 farmers surveyed in that village used *Guti* urea, which is reasonable behavior considering their own and their neighbors' experiences.

Table 21: Repeat Users of *Guti* Urea, ILSAFARM and AAPI Projects

Years, Season	Base Year		Later Year		% of Users Repeating From Base to Later Year
	Number of Users	Average Area with *Guti* Urea (ha)	Repeat Users	Average Area with *Guti* Urea (ha)	
2009 *Aus* to 2010 *Aus*	77,932	0.17	64,508	0.20	83%
2009 *Aman* to 2010 *Aman*	117,597	0.18	105,885	0.27	90%
2011 *Aman* to 2012 *Aman*	596,124	0.28	575,558	0.32[a]	97%
Ever previous use to use on any rice crop 2012/13					99.6%

a. Average for all users.

Sources: ILSAFARM Final Evaluation; AAPI Quarterly Reports; AAPI Mid-Term Evaluation and AAPI Mid-Term Evaluation and *Boro* 2013 Gross Margin Survey, May-June 2013.

During the survey for this mid-term evaluation, farmers who had ever used *Guti* urea reported multiple benefits with *Guti* urea (Table 22), including increased yield (mentioned by 96 percent of users), less urea use (91 percent), more profit (78 percent), one-time urea application (76 percent) and less weeds (72 percent).

Table 22: Farmers' Perceptions of Benefits with *Guti* Urea

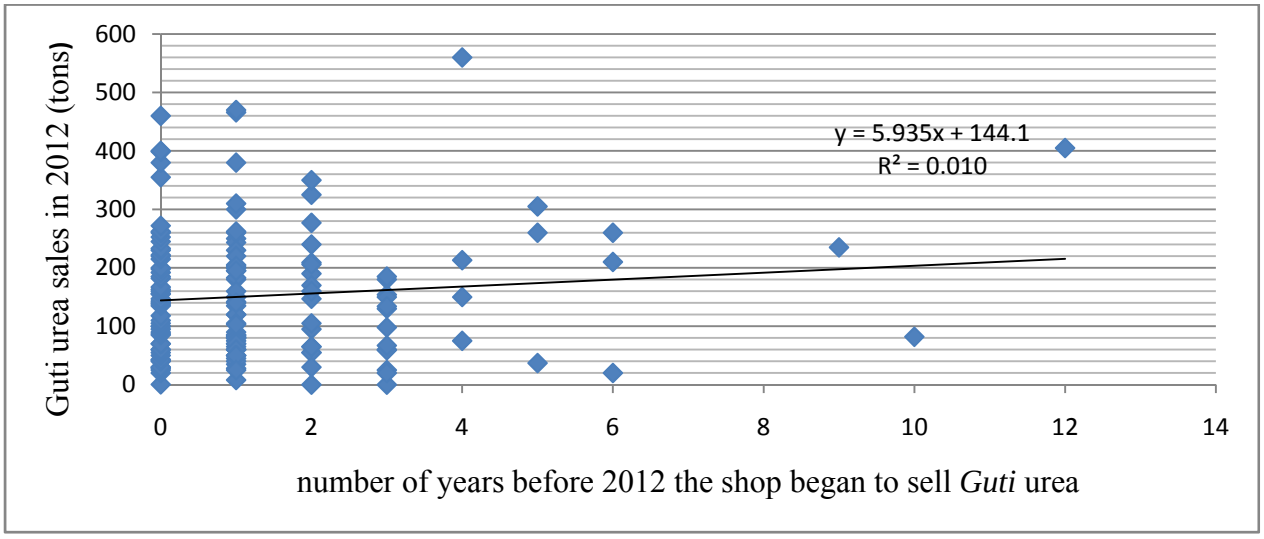
Perceived Benefit	Frequency of Mention by Farmers Who Ever Used *Guti* Urea (%)
Increase yield	96%
Saving urea	91%
More profit	78%
One-time urea application	76%
Less weeds	72%
Less disease	42%

Source: AAPI Mid-Term Evaluation and *Boro* 2013 Gross Margin Survey, May-June 2013.

Nevertheless, despite knowing about benefits with *Guti* urea, many farmers who used *Guti* urea on one or more plots of *Boro* rice in 2013 had one or more other rice plots which they fertilized with prilled urea. Why farmers familiar with *Guti* urea do not use it on all their rice plots is a question that is relevant to AAPI efforts to expand use, and to projections of spread or retreat over time, when the AAPI project ends.

8.2 Small-Scale Production of *Guti* Urea – Is It Sustainable?

In the AAPI project area, most *Guti* urea is produced by businesses selling 100-200 tons per year; such shops operate their *Guti*-producing machines only 225-450 hours per year (producing 450 kg per hour). In a January 2013 survey of 150 randomly selected *Guti* producers, the average business produced 152 tons of *Guti* urea in 2012. Moreover, there was only a small trend to greater production according to years in the business: sales increased an average of only 6 tons per year. Only one of 150 producers sold more than 500 tons in 2012, operating his or her machine more than 1,000 hours.



Source: AAPI 2013 survey of 150 randomly selected businesses that bought *Guti* machines through AAPI.

Figure 1: *Guti* Urea Sales in 2012 vs. Years in the Business

Even so, most *Guti* producers in the AAPI project area see a good return on their investment due to the Tk 2/kg premium that farmers pay for *Guti* vs. prilled urea. This mark-up exceeds what *Guti* producers need to charge to cover costs. With a 15 percent annual rate of discount on future sales and with AAPI's current 50 percent subsidy on the briquetting machine, the average business selling 152 tons per year has a 4.1 benefit-cost ratio (Table 23; see also Appendix 6).

Table 23: Benefit-Cost for Investing in *Guti* Production: Three Cases Varying by Subsidy on *Guti* Machine and *Guti* Urea Sales per Year

	Case 1	Case 2
	50% Subsidy on *Guti* Machine, Sales of 152 tons/year	0% Subsidy on *Guti* Machine, Sales of 500 tons/year
Investment[a] ($)	-1,226	-2,323
Present value of 5 years' sales less variable costs[b] ($)	6,605	21,726
Note: Undiscounted annual sales less variable cost ($)	1,970	6,481
Benefit/cost ratio	4.1	9.35

a. Including cost of urea briquette machine (with or without subsidy), electric motor, diesel engine, electric line installation, change of pressing roller, land purchase, room construction and other miscellaneous investments costs.
b. Discounted at 15 percent per year.

What will happen to small-scale producers over time? Will they expand production along with local demand? Will production gravitate to medium-scale businesses that operate several machines, producing and selling *Guti* wholesale to fertilizer sub-dealers? In 2012/13, farmers in an average upazila in the AAPI project area used 1,500 tons of *Guti* urea; this amount could be produced by two machines operating 1,600 hours per year. Something like this has developed in Tangail and Comilla Districts, where *Guti* production and use has continued for more than 10-20 years after projects ended: production concentrates in businesses that distribute *Guti* to fertilizer dealers, and the markup from prilled to *Guti* urea is less than Tk 1/kg.

In the AAPI area, more efficient production in medium-scale businesses may develop over time. One factor that can delay this development is government controls on fertilizer trade at the local level. In any case, shifting to more efficient medium-scale – wholesale – production at the upazila or even district level maintains essential links between *Guti* supply and demand.

Large-scale production in factories could cuts costs, but could also bring other problems, Even with cheap *Guti* available at the factory, farmers could lose access if fertilizer dealers with local monopolies enforced by GOB decide not to carry *Guti* urea (because it reduces demand for prilled urea). If production runs ahead of demand, factories may be left with unsold stocks that deteriorate over time. Small-scale production (as in the AAPI project area) and medium-scale production (as has developed in Comilla and Tangail districts) avoid these problems.

9 Long-Term Sustainability and Global Dissemination

If and when Bangladesh's farmers achieve much higher rice yields (with new hybrids or varieties, more fertilizers, etc.), use of *Guti* vs. prilled urea might have less impact on yields. Thus, beyond the medium term, farmers' incentives to use *Guti* urea might depend more on urea savings with *Guti* vs. higher costs to apply *Guti* vs. prilled urea. At the same time, wage rate increases might influence farmers' decisions to use *Guti* urea.

Throughout Asia and Africa, farmers growing transplanted paddy could reduce N losses by shifting from broadcasting prilled urea to UDP. Whether they could realize yield gains by shifting to UDP depends on other factors, including varieties, agronomic practices, whether plants are getting enough N, etc. UDP has not caught on outside Bangladesh. Factors include the failure to develop supply and demand together, time and expense to apply briquettes by hand and lack of an acceptable applicator.

To ensure that UDP is sustainable in Bangladesh in the long-term and to facilitate spread of UDP to other countries, the promotion of UDP should focus on N savings, without relying on yield increases. IFDC's promotion of *Guti* urea in Bangladesh has shown how to develop supply and demand together – coupling extension among farmers with small-scale private and local production of briquettes. However, the current range of agronomic practices with *Guti* urea in Bangladesh (two *Guti* sizes, one recommendation for plant and row spacing) are not necessarily suitable for farmers in other countries or even for long-term use in Bangladesh over time.

The factors that allow for global dissemination of the use of urea briquettes in Asian and African rice paddies are similar to the factors that establish long-term sustainability of *Guti* urea use in Bangladesh. These factors are two: (a) developing strategies for briquette use that allow farmers to apply as much or as little urea as they wish to suit yield targets, field conditions and personal (even irrational) preferences; and (b) developing one or more applicators that reduce the farmer's time and expense to apply urea briquettes. These two factors are linked. The challenge to develop better applicator(s) depends on relaxing and revising existing advice about plant spacing and *Guti* application.

9.1 Allowing Flexibility in Field Architecture, Plant Density and N Use

IFDC and DAE advise farmers to plant rice in rows 20 cm apart, spacing plants 20 cm apart along rows. This leads to 250,000 (500 x 500) hills of rice. IFDC and DAE further advise farmers to place one *Guti* between four hills, applying 62,500 (=250,000/4) *Guti* per hectare. Further, farmers are advised to use *Guti* weighing 1.8 g in *Aus* and *Aman* seasons (applying 113 kg/ha of urea, with 52 kg/ha of N) and 2.7 g in the *Boro* season (applying 168 kg/ha of urea, with 78 kg/ha of N). These recommendations are reinforced by IFDC advice and assistance to *Guti* producers to supply *Guti* weighing 1.8 g when farmers are buying urea for *Aus* and *Aman* rice and 2.7 g when farmers are buying urea for *Boro* rice.

In effect, these recommendations put farmers in a strait-jacket. Farmers who use *Guti* urea cannot adjust N application to suit soil conditions or yield targets. It may be fortuitous that agronomic practices in Bangladesh have been such that most farmers using *Guti* urea realize significant yield gains – this seems to be due to common pre-*Guti* practices giving plants less N

than they need. However, there is no reason to believe that farmers in China, India, Nigeria or other countries with different varieties, soils and yields would realize similar gains or that Bangladeshi farmers in the future would realize similar yield gains with *Guti* urea.

Flexibility in N application is desirable to extend *Guti* use (IFDC, 2011). Flexibility in N application – as well as in plant density per hectare – with *Guti* urea could be achieved by increasing the row-to-row distance to 25 cm and allowing farmers to vary plant spacing along rows. For example, the plant density achieved with current recommendations (20 x 20) could be similarly achieved by spacing plants 16 cm apart along rows 25 cm apart (25 x 16). Recent research at Bangladesh Rice Research Institute (BRRI) sponsored by IFDC reports higher yields during *Boro* 2012 from fields with plants spaced 25 cm x 15 cm (yielding 6.63 t/ha) than from fields with plants spaced 20 cm x 20 cm (yielding 6.20 t/ha) (p. 58, AAPI Quarterly Report for April-June 2012).

With wider rows, *Guti* urea could be applied along alternate rows, without having to aim strictly to place one *Guti* between 4 plants. If 1.8 g *Guti* is used, application of 52 kg/ha of N could be achieved by spacing each *Guti* 32 cm apart along alternate rows. To apply 78 kg/ha of N, farmers could apply 1.8 g *Guti* every 21 cm along alternate rows. But, of course, any other rate of N application could be achieved with different spacing of 1.8 g *Guti*.

Developing flexibility is a challenge for AAPI research, not for AAPI extension. No one can know what will come out of research until it is done (see Recommendations in Section 10, below). Because AAPI and DAE have invested a lot of time and effort extending current recommendations (one *Guti* per four plants, 20 cm x 20 cm spacing between plants), it is reasonable for AAPI to continue these messages in its extension activities through 2015.

9.2 Developing Applicators(s)

During the early 1980s, scientists at the International Rice Research Institute (IRRI) in the Philippines were developing and testing several applicators (Khan et al., 1984). Despite almost 30 years of effort, no one has come to AAPI staff with a reliable mechanism able to apply *Guti* faster than hand placement.

The development and popularization of a workable applicator in Bangladesh may have been held back by insistence that applicators place one *Guti* every 40 cm, without missing or slipping, so that each *Guti* ends up between 4 plants. This is further complicated by the narrow rows, only 20 cm wide, making it difficult to push an applicator without damaging rice plants.

The wider 25 cm rows that would allow flexibility in plant density and urea use would also make it easier to develop a workable push-type applicator. An applicator that applies smaller *Guti* urea more often along a wider row does not have to be so exact to place *Guti* between plants. Furthermore, with wider rows, damage to rice plants is less.

Research as well as surveys report time and expense for *Guti* application by hand and by various applicators under development (Table 24). Research also reports small differences in yields depending on mode of application – often higher yields with manual application, with modestly (usually <5 percent) lower yields with single and double row applicators. The injector applicator

currently being distributed is slower than hand placement and so does not change farmers' calculations of benefits and costs with *Guti* urea.

Table 24: Time to Apply *Guti* Urea by Hand and by Applicators (per hectare)

Study or Survey	Hand Application	Single-Row Applicator	Double-Row Applicator(s)	Injector Applicator
Survey for ILSAFARM final evaluation, 2010	10.1 days			
AAPI crop cuts in farmers' fields, *Aus* and *Aman* 2012, *Boro* 2013	9.2-10.7 days			
AAPI field performance trials, *Aus* 2012 (comparing 4 methods)	33.3 hours	16.7 hours	11.1 hours	
AAPI field performance trials, *Aus* 2012 (comparing 3 methods)	33.3 hours	14.3 hours	9-11.1 hours	
AAPI field performance trials, *Aman* 2012 (comparing 4 methods)	25 hours	16.7 hours	12.5 hours	50 hours
AAPI field performance trials, *Aman* 2012 (comparing 3 methods)	25 hours	16.7 hours	11.1 hours	50 hours
AAPI field performance trials, *Boro* 2013 (15 sites)	31.0 hours	15.2 hours	9.5 hours	35.3 hours

Source: ILSAFARM Final Evaluation; Appendix 5 in this report; AAPI Quarterly Reports, July-September 2012 and April-June 2013.

10 Recommendations

Recommendation 1: Keep doing what you're doing. AAPI has been a tremendously successful project.

Recommendation 2: Look for funding and strategies to extend *Guti* urea into Rajshahi Division as soon as possible, preferably beginning *Boro* 2014. GOB could help to solicit grant funds from USAID or other bilateral donor or low interest loans from World Bank or Asian Development Bank. Considering potential savings on urea subsidies, GOB might be interested to contribute its own funds. Concurrently or alternately, IFDC could train and advise other organizations (NGOs, other donor-funded projects) to extend UDP.

Recommendation 3: Alert officials in USAID and GOB that *Guti* use has had a big impact on rice production and that more can be expected from further expansion of *Guti* use. This realization is important for GOB and for concerned donors, who have decisions to make about food policies and food policy advice. Bangladesh has attained rice self-sufficiency – the country imported a minimal 29,000 tons in 2012/13. Expanded *Guti* use can be expected to push beyond current marginal self-sufficiency to consistent and increasing surpluses in normal years. This favorable situation could collapse back into import dependence if Government does not allow and encourage exports of all qualities of rice. Allowing exports puts a floor under local prices. With an option to export, higher production feeding into a sated national market can drive rice prices so low that farmers will get a clear message – the government doesn't want you to

produce so much rice. Farmers facing low rice prices could cut production, throwing Bangladesh back into import dependence – and back to higher import parity prices.

Recommendations 4-6: Advocate and assist institutional and policy changes to strengthen the position of *Guti* producers in urea trade.

Recommendation 4: Support *Guti* urea producers to establish an association. Having an association gives them a voice at the national level (e.g., to advocate for access to fertilizers) and makes them more easily accessible for financial and other support through future projects. In a 2013 AAPI survey, 99 (66 percent) of a random sample of 150 *Guti* producers were members of BFA, while 61 percent were interested to join a *Guti* producers' association. An association of *Guti* producers could be established as a sub-group within BFA. To bring this to pass, AAPI could negotiate a memorandum of understanding with BFA, committing AAPI to channel some training and other support for *Guti* producers through BFA and committing BFA to establish a *Guti* producers sub-group. To ensure that *Guti* producers have a voice, leadership of the sub-group within BFA should be elected by members of the sub-group.

Recommendation 5: Ask GOB to allow an extra Tk 1/kg subsidy on urea sold to dealers and sub-dealers for *Guti* production. This could be administered by asking dealers and sub-dealers to collect receipts from each sale of *Guti* urea, showing the amount sold. When dealers next buy urea, BCIC could allow dealers Tk 1 credit for each kilogram of *Guti* urea sold, as demonstrated by the receipts. The challenge in these arrangements is to ensure that receipts are accurate; GOB could ask that each receipt be signed by the relevant SAAO. SAAO's should know which farmers use *Guti* urea.

Recommendation 6: Ask Government to withdraw the demand for a Tk 30,000 security deposit for fertilizer sub-dealers who buy *Guti* machines. Purchase of a *Guti* machine is equivalent to a security deposit – it demonstrates that the entrepreneur is intends to stay in the business, and it exposes him or her to losses if the upazila fertilizer committee, finding fault with the dealer, cuts off his or her access to fertilizer.

Recommendations 7-8: Fund and otherwise promote research required to adapt UDP technology for long-term sustainability and international dissemination.

Recommendation 7: Fund and promote research to demonstrate use of *Guti* urea in maximum yield trials. To do so, researchers have to adopt plant spacing and methods of *Guti* application that can accommodate varied and especially high rates of N application per hectare. This can be achieved by planting rice in rows 25 cm wide, with variable distances between plants, and depositing urea briquettes weighing 1.8 g at specified frequencies along alternate rows (as discussed in Section 9).

Recommendation 8: To reduce cost to apply *Guti* urea, fund and promote research to develop push-style applicators able to deposit *Guti* at various specified distances along rows at least 25 cm wide.

Recommendation 9: Introduce NPK granules in a way that allows farmers to determine the relative proportion of each nutrient in a granule. From the 1970s, Bangladeshi farmers have

enjoyed a fertilizer market that offers high analysis, single-nutrient products. Given variations in soil fertility, yield targets and personal opinion, farmers buy and apply what they think is best. Introduction of NPK granules can be done in a way that preserves farmers' freedom to decide what mix of nutrients to buy and use. This could be done by introducing the concept of "custom blend" NPK granules that contain what a specific farmer wants and may not match any of the formulas that AAPI recommends.

With this strategy, A *Guti* producer could have bags for NPK granules labeled according to AAPI's recommendations (x percent N, y percent P, z percent K); when he or she produces granules according to specified formulas and puts them in labeled bags, AAPI or others could at any time test the granules to see if they match the label. To preserve flexibility to give farmers whatever they want, AAPI could also introduce bags labeled "Custom Blend." The granules in those bags would not be subject to testing; the content of those granules would be a matter to be decided between the farmer and the *Guti* producer. Farmers could watch the mixing or could operate on trust.

In general, agronomic soils and conditions vary from plot to plot and over time. What is a good recommendation in one place and time does not fit elsewhere. Because the challenge is to help farmers know what to apply, giving everyone the same standard recommendations can be a step backwards. This does not happen if NPK granules become a form of custom blending. This also fits the adage, "The customer is always right."

Recommendation 10: Consider minor adjustments to project monitoring to improve information on project impacts, as follows:

- **Shift the source of information for gross margin calculations from seasonal post-harvest surveys to AAPI's Crop Cut Surveys.** To do so, revise AAPI's crop cut forms and procedures (see proposed changes in Appendix 8) to collect information not only on yield also on all costs of production and on sales. Yield data from crop cuts are more reliable than from farmers' recall.
- **Consider analyzing household data according to marginal (owning 0.02 to 0.2 ha), small but not marginal, medium and large farms.** In analyzing data from the 2008 agricultural census (BBS, 2011c), BBS classifies farms as small (holdings from 0.05 to 2.49 acres [circa 0.02-0.99 ha]), medium (2-7.49 acres [1-2.99 ha]) and large (≥ 7.5 acres [≥ 3 ha]). Unfortunately, with those categories, small farms with holdings up to 0.99 ha account for 84 percent of all farms. Such a large category does allow a focus on relatively poor farm households. A category of marginal farms with holdings 0.02-0.2 ha would focus on the 28 percent smallest farms. Focusing on marginal farms would agree with the 2011-2012 BIHS survey, which analyzed farms according to categories as follows: marginal (<0.5 acres), small (0.5-1.49 acres), medium (1.5-2.49 acres) and large (≥2.5 acres) (Ahmed et al., 2013).

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Appendix 1: Terms of Reference for Mid-term Performance Evaluation of AAPI Project

Background: The USAID-funded Accelerating Agriculture [Productivity] Improvement Project (AAPI) project in Bangladesh is a five-year intervention. The AAPI project goal is *to improve food security and accelerate income growth in rural areas by increasing agricultural productivity on a sustainable basis*. Project goal achievement is based upon rapid farmer adoption of fertilizer deep placement (FDP) technology which allows farmers to increase crop yields by 15-20 percent per hectare with 1/3 less use of high cost urea fertilizer. FDP technology is a resource efficient technology that promotes improved crop uptake of plant nutrients. It is highly suited for use in flooded rice systems wherein nutrient loss (in the case of applied nitrogen) can be up to 2/3's of the applied nitrogen. It is particularly suited for small scale rice production with transplanted rice – the conditions which prevail in the major production season in Bangladesh.

The AAPI project began in October, 2010 and enjoyed a two month overlap with the Improved Livelihood for Sidr-Affected Farmers (ILSAFARM) project. ILSAFARM targeted the Barisal region. That same area, plus additional areas, is targeted under AAPI. Building upon the relationships established and systems developed under ILSAFARM, AAPI has achieved rapid progress in FDP technology diffusion by addressing both supply (assuring there is ready farmer access to FDP products) and demand side issues concurrently.

Based upon progress achieved in year 1 of AAPI, USAID under the Feed the Future (FTF) program requested IFDC to scale up AAPI to 124 upazilas (107 in 20 FTF districts and 17 in Mymensingh and Sherpur districts). The scale up started with the *Aman* 2011 season and ends in *Boro* 2013. The results achieved since scale-up are high relative to target. The year 3 work plan has been developed and approved by USAID. It contains a series of detailed performance and impact targets. The project monitoring and evaluation (M&E) system tracks performance against target. Progress reports, which provide quantitative results, are submitted to USAID on a weekly and quarterly basis.

Performance Evaluation of AAPI: In order to assess the performance of the project following completion of the first 30 months of implementation, the final season of AAPI scale up plan and to establish a basis for assessing impact over the remaining life of the project, AAPI will conduct a performance evaluation of the project at of the end of the *Boro* 2013 season. The study will include at a minimum the following:

1. Review project documents including the technical proposal, project work plans and performance reports to understand activities and targets;
2. Assess the result achievements of the project using indicators [listed and explained in Appendix].
3. Assess the labor requirement for deep placement of *Guti* urea per hectare.
4. Assess contributions of various interventions in realizing the project objectives.
5. Assess the participation of women in project activities and gender equity/equality in distribution of project benefits.
6. Assess sustainability of the activities and achievements under alternative scenarios of presence and absence of project support.
7. Translate project benefits to show the extent of national level savings through such areas as fertilizer subsidy, reduction in burden because of food grain import and fertilizer import.

8. Assess the strength of the small business model to maintain supply to meet demand growth.
9. Identify trends in cropping patterns as farmers increase rice yield
10. Lessons learned; and
11. Make recommendations on possible future actions, within the mandate of the project – to increase agricultural production in the project area for increased food security and for livelihood improvement.
12. Make recommendations for future monitoring of project performance that will facilitate future impact assessments.
13. Assess return on investment with a focus on economic analyses.

Composition of the Team: The team will consist of an economist. The Economist will be responsible for preparing the report, generating information from secondary and primary sources. The economist will work with the AAPI M&E Specialist and the Data Management Team.

Methodology: The study methodology will include the following:
1. Survey of farmers (to assess performance in using *Guti* urea such as yield increase, urea use efficiency, increase in income, key challenges).
2. Review project documents
3. Assess the result achievements of the project using indicators attached in Appendix 1.
4. Assess the labor requirement for deep placement of *Guti* urea per hectare.
5. Assess contributions of various interventions in realizing the project objectives.
6. Assess the participation of women in project activities and gender equity/equality in distribution of project benefits.
7. Assess sustainability of the activities and achievements under alternative scenarios of presence and absence of project support.
8. Translate project benefits to show the extent of national level savings through such areas as fertilizer subsidy, reduction in burden because of food grain import and fertilizer import.

The consultant will:
- Design questionnaire for farmers survey, field testing and finalize the same and finalize sample size (3-5 days)
- Train interviewers and field testing through them (2-3 days)
- Review project documents (continuous)
- Travel 15-20 days outside Dhaka to supervise field survey through interviewers and supervising interview in the field
- Guide AAPI Data Management unit for data entry and analyses (10 days)
- Meet the Ministry of Agriculture, DAE and BFA officials to understand the current situation and GOB's future plan on expansion of UDP technology (2 days).
- Report writing (10 days).

Duration of the Study: The duration of the study will be for two months starting from mid-May to mid-July 2013. The Economist will submit an inception report that includes a methodology and work plan within two weeks of start of the assignment.

[Appendix 1 to the Terms of Reference lists indicators to be used in the analysis. This list is reorganized and presented as Appendix 2 in this evaluation.]

Appendix 2: FTF Indicators, AAPI Project Custom Indicators and Additional Indicators Assigned for This Evaluation

Appendix 1 to the TORs for this evaluation lists indicators for this evaluation. The list provided does not exactly follow AAPI's list of FTF and custom indicators. Accordingly, the list below includes all FTF and AAPI custom indicators along with additional indicators in the TORs for this evaluation.

The AAPI project's monitoring and reporting on its achievements and activities is extraordinarily thorough. This mid-term evaluation agrees with AAPI's reporting. For various reasons – e.g., because this evaluation focuses on economic impacts in a fiscal year and uses world prices for rice – there are some differences in specific numbers between what is in this report and what AAPI reports. This is not a criticism of AAPI's reporting. AAPI has been clear about its assumptions and sources, providing a solid basis for this evaluation and for an expected final evaluation.

Appendix Table 2.1: AAPI achievements according to FTF Indicators

Indicators		Comments
FTF indicators		
	4.5-2: Number of jobs attributed to FTF implementation	USAID's indicator does not recognize indirect impacts, which are huge (see section 4.4).
	4.5-4: Gross margin of rice farmers (total) – US $ per hectare	The average gross margin per ha for *Boro* 2013 is $185, while the average annual gross margin for a household is $74 (Table 15)
	4.5.2-2: Area under FDP technology – rice	The project has extended UDP to an additional 1,346,000 ha (after subtracting baseline use)
	4.5.2-2: Area under FDP technology – vegetables	Not estimated. 9 percent of all farmers interviewed used UDP on some non-rice crop in 2012/13
	4.5.2-5: Number of farmers adopting FDP technology	The project reports this number based on comprehensive lists prepared by Sub-Assistant Agricultural Officers. In the survey for this evaluation, 62 percent of farmers used *Guti* on *Boro* rice in 2013, while 69 percent used it on at least one rice crop in 2012/13.
	4.5.2-7: Number of individuals who have received USG supported short-term agricultural sector productivity or food security training	The project reports this information.
	4.5.2-13: Number of rural households benefitting directly from US government interventions	The project reports this information.
	4.5.2-23: Value of incremental sales of rice (million US $)	This evaluation estimated incremental production of $195 million in 2012/13, of which roughly 90 percent would be surplus to what is required for household consumption.

AAPI Custom Indicators	
Increased yield of rice	Weighted average across 3 seasons: 460 kg/ha
Incremental rice production	624,000 tons in 2012/13
Increased value of rice	$195,000,000 in 2012/13
Urea saving (mt)	105,000 tons in 2012/13
Value of urea saved	$44 million at the port, $54 million at retail level (unsubsidized) in 2012/13
GOB saving on urea subsidy	$27,300,000 during 2012/13
Average incremental value per hectare	$145
Farmers trained	The project reports this information.
Fertilizer briquette machines sold	The project reports this information.

Additional Indicators in My TORs	
Employment increased: Changes in farm labor by hired and family men, women	AAPI's crop cut surveys in farmers' field reported fewer days/ha to farm a field with *Guti* urea, largely due to fewer days to weed fields fertilized with *Guti* urea.
Changes in income indirectly related to use of *Guti* urea: change in (a) use of chemical fertilizers (except urea); (b) use of organic fertilizers; (c) off-farm employment and wages	Farmers who used *Guti* used an average of 78 kg/ha less urea (weighted average over 3 seasons) worth $40 at unsubsidized prices or $19 with subsidy. There were only minor and inconsistent differences in use of other chemical fertilizers, organic fertilizers and hired labor.
Change in family welfare related to use of *Guti* urea: (a) increased holdings by farmers of household items, farm equipment, animals and other assets; (b) housing improvements	Marginal farmers using *Guti* urea reported more investments and housing improvements, but this did not carry over for small, medium and large farms (see Section 4.2).
Improved environment: cleaner air and water due to improved N use efficiency	*Guti* use reduced carbon dioxide emissions by 189,000 tons by reducing urea use and thereby energy used to make it.
UDP technology expanded: amount of private investment increased	UDP use expanded to 1,346,000 ha. From 2010-2013, new *Guti* producers invested an estimated $600,000 in their businesses.

Appendix 3: Farmers' Mid-Term Performance Evaluation and Gross Margin Survey

Survey Design

The evaluation surveyed 1,000 farmers (20 farmers in each of 50 blocks). Among 1,000 randomly sampled farmers we estimated that at least 420 would have used *Guti* urea on *Boro* paddy 2013; AAPI's block surveys report that 2.46 million (42 percent) of 5.83 million total farmers used *Guti* urea in *Boro* 2013 (Quarterly reports for October-December 2012 and January-March 2013).

We selected the 50 blocks from each district, using the random order of blocks from the 2012 *Aman* paddy block survey. The number of blocks selected from each district was based on the number of farmers in that district (appendix table 2.1): 1 block from each district with <150,000 farmers; 2 from each district with 150,000-300,000 farmers, 3 blocks from districts with 300,000-450,000 farmers, 4 blocks from Jessore District (522,000 farmers) and six blocks from Mymensingh District (just over 900,000 farmers).

For each selected block, we collected lists of all farmers in the block – generally more than 1,000 – from DAE. We photocopied the first 20 pages of each list, gave these pages to interviewers and instructed them to interview the first farmer listed on each page. If the first farmer was not available, they were allowed to interview the second and so on.

Some collected data suggest some bias in our sample away from marginal farms (6 percent in our sample vs. 24 percent in the 2008 Agricultural Census (BBS, 2011c). Our survey classifies farms according to owned land, whereas BBS classifies them according to holdings, which includes rented land; this might account for some of the difference. There may also be some bias in favor of *Guti* use: 62 percent of the sample used *Guti* on *Boro* paddy vs. 42 percent of farmers in AAPI's block surveys (which are comprehensive reports of farmers using *Guti* prepared by Sub-Assistant Agricultural Officers of the Department of Agricultural Extension). On the other hand, sampled farmers who used *Guti* urea in *Boro* 2013 used it on average of 0.25 ha (617 sampled farmers used *Guti* on 157 ha of *Boro* paddy); whereas among all farmers in the AAPI project area, the average was 0.34 ha (2,4 million farmers used *Guti* on 828,000 ha of *Boro* paddy).

The source of the bias to sample too few marginal farmers may have come from the way we selected farmers from lists of farmers in each block. In choosing the first farmer on each of the first 20 pages, we neglected farmers further down the list (e.g., on pages 21 through 50). If SAAOs tended to list marginal farmers at the end of the list, that could explain a bias in our sample. The text will consider how any bias might be influencing conclusions from survey data.

Appendix Table 2.1: Selection of Random Blocks by District for Farmers' Survey

District	Number of Farmers	Upazila	Union	Block
< 150,000, one block selected per district				
Meherpur	138,178	Mujibnagar	Mahajanpur	Komorpur
Barguna	138,120	Betagi	Bibichini	Bibichini
Jhalokati	109,512	Kathalia	Chacrirampur	Mohiskandi
Narail	122,662	Lohagara	Kashipur	Bahirpara
150,000 to <300,000, two blocks selected per district				
Bagerhat	164,277	Kachua	Gopalpur	Gopalpur
		Morrelganj	Taligati	Taligati
Chuadanga	208,170	Jiban Nagar	Utholi	Utholi
		Alamdanga	Vangbaria	Vangbaria
Gopalganj	221,866	Muksudpur	Kasalia	Bedgram
		Tungipara	Dumuria	Bashbaria
Khulna	215,708	Phultala	Atra Giltola	Seromony
		Terokhada	Terokhada	Atlia
Madaripur	204,194	Shibchar	Shibchar Pourosova	Pourosova
		Madaripur Sadar	Shirkhara	Srinodi
Magura	188,986	Mohammadpur	Binodpur	Binodpur
		Sreepur	Goashpur	Juka
Patuakhali	252,057	Kala Para	Tiakhali	Paschim Tiakhali
		Dashmina	Bashbaria	Char Hosnabad
Pirojpur	171,686	Kawkhali	1 No Soyna Ragunathpur	1 No Soyna
		Nesarabad	Boldia	1 No Boldia
Rajbari	152,979	Pangsha	Babupara	Babupara 1
		Kalokhali	Boialia	Boialia-1
Satkhira	289,339	Debhata	Sakhipur	Sakhipur
		Tala	Tetulia	Shuvachini
Shariatpur	189,149	Naria	Noshshon	Shawra
		Bhedarganj	Charvanga	Bakaulkandi
Sherpur	278,025	Nalitabari	Noyabil	Noyabil
		Sreebardi	Singabaruna	Singabaruna
300,000 to <450,000, three blocks selected per district				
Barisal	306,876	Barisal Sadar	Roypasha Karapur	Karapur
		Agailjhara	Bagdha	Bagdha
		Muladi	Batamara	Selimpur
Bhola	381,673	Daulatkhan	Modonpur	Modonpur
		Burhanuddin	Gongapur	Daria
		Lalmohan	Bodorpur	Debirchar
Faridpur	312,871	Alfadanga	Gopalpur	Gopalpur
		Sadarpur	5 No. Vasan Char	12 No. Vasan Char
		Saltha	Bollovdi	Bollovdi-1
Jhenaidah	343,942	Kotchandpur	Safderpur	Joydia
		Harinakunda	Taharhuda	Taharhuda
		Maheshpur	S.B.K	Khalishpur
450,000 to <600,000, four block selected				
Jessore	522,267	Bagherpara	Bandabila	Mathurapur
		Abhaynagar	Shuvarara	Isamati
		Jhikargachha	Hajirbag	Barunhal
		Jessore Sadar	Churamankati	Churamankati

~900,000, six blocks selected				
Mymensingh	927,788	Nandail	Betagoir	Betagoir
		Trishal	Kanihari	Kustia
		Haluaghat	Amtel	Amtoil
		Mymensingh Sadar	Asthadhar	Asthadhar
		Gaffargaon	Rasulpur	Bor Bhora
		Ishwarganj	Ishwrganj	Dattapara

Questionnaire for Farmers

NOTE TO INTERVIEWER: WHEN MEETING THE FARMER, AFTER INTRODUCING YOURSELF, ASK IF HE/SHE GREW PADDY DURING THE LAST YEAR (IN AT LEAST ONE SEASON, *AUS* OR *AMAN* 2012 OR *BORO* 2013). IF NOT, END THE INTERVIEW AND GO TO THE NEXT SAMPLED FARMER.

Questionnaire No. _____

Interviewer's Name: _____ Date: _____

1. Please let us know some of the relevant personal information about you.
   Name _____ Gender: M – F
   Marriage status: Unmarried_____ married _____ widowed _____
   Father/Husband Name _____
   Village _____ Block _____ Union _____
   Upazila _____ District _____
   Tel: _____

2. How many family members do you have in your household (please put the number):
   a. Male:_____ b. Female:_____

3. How many family members are children aged 6 through 15 years old? ☐
   How many of these children are attending school? ☐

4. How much land do you own, in decimals (including ponds) _____

5. What is the distance from the house to a marketplace where inputs are purchased? ____ km

6. Have you heard about *Guti* urea? Y/N _____
   If yes, what is the distance from your house to a store that sells *Guti* urea? _____km

NOTE TO INTERVIEWER: IF THEY HAVE NOT HEARD OF *GUTI* UREA, SKIP TO QUESTION 18. IF THEY HAVE HEARD OF *GUTI* UREA CONTINUE WITH THE FOLLOWING QUESTIONS.

7. What are your sources of information about *Guti* urea (check all that apply):

Discussions with other farmers		Distribution of handbill in the mosques by IFDC staff		Television		*Guti* urea producer		NGO	
Government extension agent (DAE)		Distribution of handbill in the school by IFDC staff		Farmers Meetings		fertilizer dealer		Video	
Demonstration or trial Site		Newspaper		Wall Painting		IFDC training			
Field Day		Other printed Information		Billboard		Any other IFDC activity			
Bazar miking		Observing neighbors' fields with *Guti* urea		Banner		Radio		Other	

8. Have you ever used *Guti* urea on rice or any other crop? Yes_____ No_____

NOTE TO INTERVIEWER: IF THE FARMER HAS NEVER USED *GUTI* UREA, ASK QUESTION 9 AND THEN SKIP TO QUESTION 18. IF THE FARMER HAS USED *GUTI* UREA, SKIP TO QUESTION 10 AND CONTINUE.

9. Are there any particular reasons why you have not tried *Guti* urea? (check all that apply).

No reason	
Not enough information or knowledge about *Guti* urea	
Guti urea not available	
Long distance of the *Guti* urea shop	
Price of *Guti* urea is high	
Guti urea application requires more labor	
Guti urea application is physically difficult	
Guti urea requires paddy transplanting in lines	
Any other (please specify)	
Any other (please specify)	

10. When did you first use *Guti* urea on paddy (what year)? _____

11. Please tell us how many decimals of paddy you planted in the 3 previous seasons, what rice variety or hybrid you planted and if you used *Guti* urea or prilled urea:

Season	Total decimals with paddy	with *Guti* urea		with prilled urea	
		Variety name	decimals	Variety name	Decimals
Aus 2012					
Aman 2012					
Boro 2013					

12. During the last 12 months (from June 2012 to today) have you used *Guti* urea on crops other than paddy? Yes ____ No _____
    If Yes, how many number decimals of the following crops did you fertilize with *Guti* urea?
    (a) Vegetables_____
    (b) Maize_____
    (c) Potatoes_____
    (d) Bananas_____
    (e) Other crops (names and decimals)_____

13. Have you seen the injector-style *Guti* urea applicator [show a picture]? Yes_____ No ____
    If yes, do you know anyone who uses the machine in their field? Yes_____ No_____

14. Have you seen the push-style *Guti* urea applicator? [show a picture]? Yes_____ No_____
    If yes, do you know anyone who uses the machine in their field? Yes_____ No_____

15. From your experience, what do you think are the benefits with *Guti* urea? (please check all that apply)
    a. Increase yield ___ b. Saving urea ___ c. One-time urea application ___ d. Less weeds ___
    e. More profit _____ f. Less disease ___ g. No benefit _____ h. Any other (specify) _____

16. Has your use of *Guti* urea influenced any of your neighbors to use it on their paddy fields?

Yes_____ No_____

NOTE TO INTERVIEWER: QUESTION 17 IS FOR ALL FARMERS WHO HAVE EVER USED *GUTI* UREA, BUT DID NOT USE IT ON THEIR LAST PADDY CROP (ON *BORO*, IF THEY PLANTED *BORO*; OR *AMAN* IF THAT WAS THEIR LAST PADDY CROP]

17. Why did you not use *Guti* urea on your last paddy crop (check all reasons)?

Not happy with results from previous *Guti* urea use	
Guti urea not available	
Long distance of the *Guti* urea shop	
Price of *Guti* urea is high	
Guti urea requires more labor	
Guti application is physically difficult	
Guti requires line sowing	
Any other (please specify)	
Any other (please specify)	

NOTE TO INTERVIEWER: QUESTIONS 18-27 ARE FOR ALL FARMERS, INCLUDING THOSE WHO HAVE EVER OR CURRENTLY USE *GUTI* UREA AND THOSE WHO HAVE NEVER HEARD OF OR NEVER USED *GUTI* UREA.

18. Please request the farmer to provide the following information (in the table) on *Boro* 2013 paddy with *Guti* urea and with prilled urea.

Details	2013 *Boro* paddy with *Guti* urea	2013 *Boro* paddy with broadcast urea
Decimals planted for 2013 *Boro* paddy, of which		
Hybrid (variety name, decimals)	Name:	Name:
	Decimals:	Decimals:
HYV (variety name, decimals)	Name:	Name:
	Decimals:	Decimals:
Costs (what you paid out to others only, do not count family labor or own-provided inputs)		
Did you rent any of the land (yes, no)		
If yes, how much did you pay in rent (if paid in-kind or rented for a full year, enter the Tk value for the *Boro* season only)		
Tk paid for land preparation by power tiller or cattle? If used own power tiller, what was the diesel cost?		
How much Tk did you pay for seed (if used own seed or donated seed, write Tk 0)		
Prilled urea, kg		
Total cost in Tk		
Guti urea, kg		
Total cost in Tk		
Tk for all other chemical fertilizers (TSP, MOP,		

	DAP, Zn, gypsum, others) total cost in Tk		
	Tk paid for organic fertilizers such as cow dung, etc. (do not include use of own cow dung, etc.)		
	Tk paid for irrigation cost (if they irrigate with their own machine, then electricity or diesel costs only)		
	Tk paid for pesticides		
	Tk paid to hired labor, total for transporting fertilizers, seed-bed preparation, land preparation, transplanting, fertilizer application, pesticide application, weeding, harvesting, post-harvest processing, etc. (do not include household labor)		
Paddy produced (maund)			
Paddy sold (maund)			
	Price received per kg of paddy		
Straw sold (maund)			
	Price received per kg of straw		

19. What is the daily wage rate in your community for farm laborers?
    For men in the peak labor season: Tk_____ During the slack labor season: Tk_____
    For women in the peak labor season? Tk _____During the slack labor season: Tk ____

20. Aside from paddy, what other sources of income has your family had in the last 12 months (from June 2012 through May 2013)?

Source	**Income in the last 12 months from June 2012 (Tk)**
Off-farm labor, short-term	
Sale of jute	
Sale of vegetables	
Sale of fruits	
Sale of other crops (beans, pulses, oilseeds, etc.)	
Sale of fish or shrimp	
Sale of milk	
Sale of chicken, ducks or eggs	
Sale of other livestock	
Salary of the family member(s)	
Remittance of the family member(s)	
Business	
Any other (Please specify)	

21. Have you bought any land in the last 2 years (from June 2011)? Yes____ No_____
    If yes, how many decimals?_____
    Have you sold any land in the last 2 years (from June 2011)? Yes____ No_____
    If yes, how many decimals? _____

Have you mortgaged any land out to others to borrow money in the last 2 years (from June 2011)? Yes____ No____
Have you repaid/cleared any mortgages in the last 2 years (from June 2011)? Yes___ No___

22. Have you excavated any pond in the last 2 years (from June 2011)? Yes____ No_____

23. In the last 2 years (from June 2011), have you invested in any improvements to your house:

Housing Improvements	**Yes**	**No**
Added a cement floor to your home?		
Added a tin roof to your home?		
Added a tin wall to your home?		
Added a brick or cement wall to your home?		
Installed a well for drinking water?		
Added a room or other building to your home?		

24. Have you bought any of the following items for the home and family in the last 2 years (from June 2011)?

Consumer Durables	**Yes**	**No**
Motorcycle		
Bicycle		
Mobile phone		
Television		
Radio		

25. Have you bought any agricultural equipment in the last 2 years (from June 2011)?

Agricultural Equipment	**Yes**	**No**
Power tiller		
Sprayer		
Irrigation pump		
Weeding machine		
Paddy thresher		

26. Have you bought any of the following livestock in the last 2 years (from June 2011)?

Livestock	**Yes**	**No**
Cows		
Bulls		
Water buffalo		
Goats		
Poultry to raise for meat or eggs		

27. During the past 7 days, in how many meals has your family eaten the following foods:
Chicken_____ Mutton_____ Beef_____
Fish or shrimp_____ Eggs_____

NOTE TO INTERVIEWER: THE LAST THREE QUESTIONS ARE FOR FARMERS WHO USED *GUTI* UREA AT ANY TIME IN THE LAST 2 YEARS (FROM JUNE 2011):

28. About how much additional income has your family realized in the last 2 years (from June 2011) from the use of *Guti* urea? Please make an estimate: Tk _____

29. How did you use the additional income you got from using *Guti* urea [check all that apply]?
    Education of children_____
    Purchase new clothes_____
    Improved diet/food_____
    Bought new household furnishings_____
    Purchased agricultural equipment_____
    Increased saving_____
    Paid debt_____
    Purchased animals_____
    Renovated or built new home_____
    Bought land_____
    Other (specify)_____

30. When you get higher paddy yield with *Guti* urea (check one):
    (a) plant more land with paddy, to grow more rice_____
    (b) plant less land with paddy, to grow other crops _____
    (c) no change; plant the same amount of land with paddy_____

Appendix 4: Prices Used in the Economic Analysis

Appendix Table 4. Prices Used in the Economic Analysis

Item	Sept 2010 (at project signing)	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013
Exchange rate (BDT/$)	69.7	81.9	81.7	81.1	79.0	77.8
Urea ($/ton)						
Subsidy ($/ton), calculated as (A+50+B)-C	**252**	**347**	**249**	**259**	**258**	**204**
A FOB, Black Sea, (from World Bank Pink Sheet)	315	470	381	383	396	353
Note: MOA's reported FOB						
C&F, Bangladesh (estimated as FOB +$50/ton)	365	520	431	433	446	403
Note: MOA's reported C&F						
B Cost to move urea from ship to BCIC warehouse (estimated as 10% of CIF)	37	52	43	43	45	40
Note: MOA's reported local costs						
C BCIC's price to wholesalers	150	225	225	227	233	239
Trading margin allowed wholesalers and retailers (Tk 1.6, weighted average of Tk 2/kg from BCIC factories and Tk 1.3 from warehouses)	23	19	19	20	20	21
Retail price to farmers (Tk 12/kg at project signing; Tk 20/kg during 2012-13)	172	244	244	247	253	257
Full cost price at farm level (retail price + subsidy)	**424**	**591**	**493**	**506**	**511**	**461**
Rice prices						
Vietnam 5%, FOB (from World Bank Pink Sheet)	458	429	434	439	402	389
Import parity (based on Vietnam)						
Dhaka wholesale (Vietnam + $50)	508	479	484	489	452	439
Unweighted average for 2012/13			466			
Southwest farm-gate (Dhaka wholesale less 20%)	406	383	387	391	361	351
Weighted price for *Aus, Aman, Boro* 2012/13			369			
Export parity (based on Vietnam)						
Southwest farm-gate (Vietnam less 30%)	321	300	304	307	281	272
Weighted price for *Aus, Aman, Boro* 2012/13			288			

Sources for the exchange rate: Bangladesh Bank (2013) and ADB (2012).

Sources for urea prices: FOB prices for Black Sea urea are from World Bank Pink Sheet (World Bank, 2013a and 2013b). Based on discussions with Bangladesh Fertilizer Association, urea C&F is estimated as FOB + $50/ton and cost to move urea from ship to warehouse estimated at 10 percent of urea C&F. Subsidies based on these costs (see Table) are less than the subsidies that MoA reports; MoA's reported subsidies are based on payments to private importers (see Notes in the above table) and may include inflated costs, so they do not accurately show the subsidy reaching farmers.

Sources for rice prices: FOB prices for Vietnam 5 percent are from World Bank Pink Sheet (World Bank, 2013a and 2013b). Based on discussions with staff of the Department of Food and others, Vietnam is a preferred source for price rice imports into Bangladesh and is also the closest competitor for rice from Bangladesh in international markets (e.g., exports to African countries). Based on expert opinion, private imports from Vietnam could reach the Dhaka wholesale price with a $50 markup above Vietnam's FOB price. Based on Minten at al. (2010) and expert opinion, farm-gate prices in the southwest are 20 percent below Dhaka wholesale prices. Based, similarly, on expert opinion, Bangladeshi rice traders could export rice from Bangladesh when farm-gate prices in Bangladesh are 30 percent below the Vietnam FOB price.

Appendix 5: Differential Costs and Returns per Hectare with *Guti* Urea and with Prilled Urea, 2012-13

Appendix Table 5.1: Differential Costs and Returns per Hectare with *Guti* vs. Prilled Urea, *Aus* Rice 2012

Item	Units and Prices		HYV and Hybrid *Aus*					
			With *Guti* Urea		With Broadcast Urea		Difference	
	(units)	($/unit)	(units/ha)	($/ha)	(units/ha)	($/ha)	(units/ha)	($/ha)
Gross income, of which:	$			919		801		118
Rice (export parity price)	ton	304	2.89	879	2.52	766	0.37	113
Rice (from farm-gate price)	ton	179						
Paddy (reported farm-gate price)	ton	120	4.32	517	3.76	451	[0.56]	[67]
Straw	ton	9	4.32	40	3.76	35	0.560	5
Costs that differ between fields with *Guti* vs. prilled urea, of which:	$							-4
Urea (*Guti* or prilled)	kg	0.591	111	66	159	94	-48	-28
Note: subsidized retail price	kg	0.244					-48	[-12]
Higher price for *Guti* urea	kg	0.024	111	3	0	0	111	3
Labor days that differ between *Guti* vs. prilled urea, of which:	days	4.24	75.0	318	70.0	297	5.0	21
Urea application, *Guti* or broadcast urea	days		10.7		3.8		6.9	
Family men	days		6.4		3.4		3.0	
Family women	days		0.0		0.0		0.0	
Hired men	days		4.3		0.4		3.9	
Hired women	days		0.0		0.0		0.0	
Weeding	days		15.4		27.3		-11.9	
Family men	days		7.2		12.3		-5.1	
Family women	days		0.2		0.3		-0.1	
Hired men	days		7.9		14.6		-6.7	
Hired women	days		0.1		0.1		0.0	
Harvest and post-harvest tasks	days		48.9		38.9		10.0	
Family men	days		11.7		9.3		2.4	
Family women	days		11.7		9.3		2.4	
Hired men	days		21.0		16.7		4.3	
Hired women	days		4.4		3.5		0.9	

Sources: Rice price is export parity price for Q3 2012 from Appendix 3. Paddy yields, urea use and labor days for fertilizer application and weeding are from AAPI's crop cut survey in farmers' fields (416 plots with *Guti* urea and 416 with prilled urea). Labor days for harvest and post-harvest tasks are from the ILSAFARM final evaluation survey and the AAPI gross margins survey for *Aman* 2012. Urea price is full cost, without subsidy, for Q2 2012 from Appendix 3. The reported farm-level rice price and wage rate are from the *Aus* 2012 gross margins survey. The paddy to rice ratio (1:0.67) is standard. The 1:1 ratio of straw to paddy production and price of straw (Tk 0.75/kg) are from DAE, no date.

Appendix Table 5.2: Differential Costs and Returns per Hectare with *Guti* vs. Prilled Urea, *Aman* Rice 2012

Item	Units and Prices		HYV and Hybrid *Aus*					
			With *Guti* Urea		With Broadcast Urea		Difference	
	(units)	($/unit)	(units/ha)	($/ha)	(units/ha)	($/ha)	(units/ha)	($/ha)
Gross income, of which	$			1,055		927		129
Rice (export parity price)	ton	307	3.29	1,010	2.89	887	0.40	123
Rice (from farm-gate price)	ton	254						
Paddy (reported farm-gate price)	ton	170	4.91	836	4.32	734	0.60	[102]
Straw	ton	9	4.91	45	4.32	40	0.60	6
Costs that differ between fields with *Guti* vs. prilled urea, of which:	$							-29
Urea (*Guti* or prilled)	kg	0.493	113	56	163	80	-52	-26
Note: subsidized retail price	kg	0.244					-52	[-13]
Higher price for *Guti* urea	kg	0.024	113	3	0	0	113	3
Labor days that differ between *Guti* vs. prilled urea, of which:	days	3.64	64.6	235	66.2	241	-1.6	-6
Urea application, *Guti* or broadcast urea	days		9.2		4.2		5.0	
Family men	days		4.4		2.6		1.8	
Family women	days		0.1		0.0		0.1	
Hired men	days		4.7		1.6		3.1	
Hired women	days		0.0		0.0		0.0	
Weeding	days		12.2		22.0		-9.8	
Family men	days		4.5		7.5		-3.0	
Family women	days		0.1		0.1		0.0	
Hired men	days		7.4		14.0		-6.6	
Hired women	days		0.2		0.3		-0.1	
Harvest and post-harvest tasks	days		43.2		40.0		3.2	
Family men	days		10.1		9.8		0.3	
Family women	days		10.6		9.1		1.5	
Hired men	days		19.3		16.8		2.5	
Hired women	days		3.2		4.3		-1.1	

Sources: Because the export parity price for rice is less than the farm-gate price (1.5 times the farm-gate price of paddy), there is no opportunity to export, so the farm-gate price is used to calculate benefits. Paddy yields, urea use and labor days for fertilizer application and weeding are from AAPI's crop cut survey in farmers' fields (868 plots with *Guti* urea and 868 with prilled urea). Labor days for harvest and post-harvest tasks are from AAPI's gross margins survey for *Aman* 2012. Urea price is full cost, without subsidy, for Q3 2012 from Appendix 3. The reported farm-level rice price and wage rate are from the *Aman* 2012 gross margins survey. The paddy to rice ratio (1:0.67) is standard. The 1:1 ratio of straw to paddy production and price of straw (Tk 0.75/kg) are from DAE, no date.

Appendix Table 5.3: Differential Costs and Returns per Hectare with *Guti* vs. Prilled Urea, *Boro* Rice 2013

Item	Units and Prices		HYV and Hybrid *Aus*					
			With *Guti* Urea		With Broadcast Urea		Difference	
	(units)	($/unit)	(units/ha)	($/ha)	(units/ha)	($/ha)	(units/ha)	($/ha)
Gross income, of which:	$			1,402		1,242		160
Rice (export parity price)	ton	272						[141]
Rice (from farm-gate price)	ton	294	4.56	1,341	4.04	1,188	0.52	153
Paddy (reported farm-gate price)	ton	197	6.81	1,341	6.03	1,188	0.78	153
Straw	ton	9	6.81	61	6.03	54	0.78	7
Costs that differ between fields with *Guti* vs. prilled urea, of which:	$							
Urea (*Guti* or prilled)	kg	0.511	168	86	268	137	-100	-51
Note: subsidized retail price	kg	0.253					-100	[-25]
Higher price for *Guti* urea	kg	0.0025	168	4	0	0	168	4
Labor days that differ between *Guti* vs. prilled urea, of which:	days	4.28	91.3	391	91.8	393	-0.5	-2
Urea application, *Guti* or broadcast urea	days		10.7		3.9		6.8	
Family men	days		4.5		3.4		1.1	
Family women	days		0.1		0.0		0.1	
Hired men	days		6.0		0.5		5.5	
Hired women	days		0.1		0.0		0.1	
Weeding	days		19.3		33.6		-14.3	
Family men	days		6.5		10.2		-3.7	
Family women	days		0.3		0.6		-0.3	
Hired men	days		11.2		20.2		-9.0	
Hired women	days		1.3		2.6		-1.3	
Harvest and post-harvest tasks	days		61.3		54.3		7.0	
Family men	days		14.7		13.0		1.7	
Family women	days		14.7		13.0		1.7	
Hired men	days		26.4		23.3		3.1	
Hired women	days		5.5		4.9		0.6	

Sources: Rice price is export parity price for Q2 2013 from Appendix 3. Paddy yields, urea use and labor days for fertilizer application and weeding are from AAPI's crop cut survey in farmers' fields (998 plots with *Guti* urea and 998 with prilled urea). Labor days for harvest and post-harvest tasks is estimated at 9 person-days per ton of paddy, with percentages of family and hired and men and women extrapolated from the ILSAFARM final evaluation survey and the AAPI gross margins survey for *Aman* 2012. Urea price is full cost, without subsidy, for Q1 2013 from Appendix 3. The reported farm-level rice price and wage rate are from the *Boro* 2013 gross margins survey. The paddy to rice ratio (1:0.67) is standard. The 1:1 ratio of straw to paddy production and price of straw (Tk 0.75/kg) are from DAE, no date.

Appendix Table 5.4: Weighted Average Differential Costs and Returns per Hectare with *Guti* vs. Prilled urea, *Aus* and *Aman* Rice 2012 and *Boro* Rice 2013

Item	Units and Prices		HYV and Hybrid *Aus*					
			With *Guti* Urea		With Broadcast Urea		Difference	
	(units)	($/unit)	(units/ha)	($/ha)	(units/ha)	($/ha)	(units/ha)	($/ha)
Gross income, of which:	$			1,234	0	1,089	0	145
Rice (export parity prices for *Aus* and *Aman*, farm-gate for *Boro*)	ton	300	3.95	1,180	3.49	1042	0.46	139
Rice (reported farm-gate price)	ton	270					0.46	[127]
Straw	ton	9	5.90	53	5.21	47	0.70	6
Costs that differ between fields with *Guti* vs. prilled urea, of which:	$							-38
Urea (*Guti* or prilled)	kg	0.511	143	73	220	112	-78	-40
Note: subsidized retail price	kg	0.249					-78	[-19]
Higher price for *Guti* urea	kg	0.025	143	4	0	0	143	4
Labor days that differ between *Guti* vs. prilled urea, of which:	days	4.04	80.0	327	80.5	328	-0.5	-2
Urea application, *Guti* or broadcast urea	days		10.1		4.0		6.1	
Family men	days		4.6		3.1		1.5	
Family women	days		0.1		0.0		0.1	
Hired men	days		5.4		0.9		4.5	
Hired women	days		0.1		0.0		0.1	
Weeding	days		16.3		28.7		-12.4	
Family men	days		5.8		9.4		-3.6	
Family women	days		0.2		0.4		-0.2	
Hired men	days		9.5		17.4		-7.9	
Hired women	days		0.8		1.5		-0.7	
Harvest and post-harvest tasks	days		53.5		47.7		5.8	
Family men	days		12.7		11.5		1.2	
Family women	days		12.9		11.2		1.7	
Hired men	days		23.3		20.3		3.0	
Hired women	days		4.6		4.6		0.0	

Sources: Appendix tables 5.1-5.3, with weights determined by additional area per season from Table 3.1a.

Appendix 6: Revenues and Costs for Urea Briquette Production for an Average Urea Briquette Producer

During 2010-2012, the AAPI project subsidized 75 percent of the cost to purchase a *Guti* machine, or about $1,500 out of $2,000. In 2013, AAPI reduced this subsidy to 50 percent. However, for a *Guti* produce considering to stay in the business for the long term, the initial subsidy is less important than the cost to replace the machine. Assuming producers replace machines at full cost in five years, their annual investment costs can be estimated as the annual set-aside required to do so. Assuming that money set aside earns 5 percent per year and that all investments (the machine plus building, etc.) are replaced every five years, the annual set aside can be estimated at $411 per year (see Table below).

Appendix Table 6: Revenues and Costs for an Average Urea Briquette Producer Selling 152 tons per year, 2012

Item			Revenues, Expenses in $ (Tk)	
			Per Ton	Per Year
A	Gross income from sale of urea briquettes (differential income from selling briquettes vs. a similar weight of prilled urea)		25.70 (2,000)	3,906 (304,000)
B=C+D	Costs to produce briquettes, of which		15.08 (1,174)	2,292 (178,376)
C		Variable costs[a]	12.38 (963)	1,881 (146,376)
		Investment cost[b] (the annual set-aside, S, required to replace investment, I, after 5 years, assuming a 5% real annual return[c] on funds; $I = S \times [1.05] + \ldots + S \times [1.05]^5$)		
D		Investment costs, with full cost for the briquetting machine (Tk 185,855)	2.70 (211)	411 (32,000)
E = A-B	Net annual income with investments at full cost		10.62	1,614
Benefit-cost ratio (differential income vs. differential costs): 1.7 = 25.70/15.08				

a. Labor, diesel, electricity, packaging, transport, office, factory and warehouse rent, factory and machine maintenance, distribution and promotion, training, entertainment and miscellaneous costs.
b. Cost of urea briquette machine at 100 percent subsidy, electric motor and electric line installation or diesel engine, change of pressing roller, land purchase, room construction and other investments costs.
c. The 5 percent real annual return on funds set aside exceeds what is available from bank deposits; this assumes local entrepreneurs can invest set-aside funds safely for modest 5 percent returns.

Source: Revenue, variable costs, average annual sales and investment costs are from AAPI's January 2013 survey of 150 briquetting workshops.

Appendix 7: Indicators for Changes in Family Welfare With and Without *Guti* Urea

Appendix Table 7.1: Selected Social and Economic Differences Between Households Who Have Ever vs. Never Used *Guti* Urea, Stratified by Farm Size

Item	62 Marginal Farms		719 Small Farms		219 Medium-Large Farms	
	Guti User	Non-User	*Guti* User	Non-User	*Guti* User	Non-User
Number of households	30	32	489	230	178	41
Size of family (average)	5.8	6.0	5.8	5.6	6.0	6.2
Number of children aged 6-15	1.2	1.3	1.3	1.3	1.3	1.2
Number of children aged 6-15 in school	1.0	1.0	1.2	1.1	1.1	1.1
Other incomes, June 2012-May 2013 (average across all households in Tk)						
Off-farm labor income	14,844	23,497	10,125	13,973	6,433	6,341
Salary income	10,281	2,333	5,721	7,597	9,624	11,366
Vegetable or fruit sale	2,917	883	2,087	2,195	8,650	7,532
Jute or other crop sale	3,556	873	4,535	2,538	11,771	7,122
Fish or shrimp sales	156	-	1,805	4,951	11,611	16,761
Milk, egg or other livestock sales	2,223	2,740	5,990	7,204	7,733	8,480
Business income	5,469	13,367	13,316	15,678	26,565	33,561
Total other incomes	39,446	43,693	43,579	54,136	82,385	91,163
Land						
Buy any land last 2 years? (% yes)	0%	3%	7%	9%	12%	12%
Sell any land last 2 years? (% yes)	0%	0%	1%	2%	2%	0%
Mortgages land out last 2 years? (% yes)	0%	7%	3%	6%	2%	5%
Repaid a mortgage last 2 years? (% yes)	6%	3%	5%	6%	3%	2%
Build any pond last 2 years? (% yes)	0%	3%	9%	4%	12%	7%
Investments last 2 years (% reporting)						
Household investments(cement floor, tin roof, tin walls, new room/house)	31%	23%	56%	53%	68%	61%
Purchase of consumer durables (bicycle, motorcycle, radio, television, mobile phone)	53%	33%	70%	75%	78%	83%
Purchase of agricultural machinery (power tiller, sprayer, irrigation pump or well, weeding machine, paddy thresher)	28%	23%	29%	22%	34%	37%
Purchase of farm animals (cow, bull, water buffalo, goat, poultry to raise for meat or eggs	78%	70%	83%	87%	74%	73%
Number of times per week eating high value foods (average reported)						
Chicken	1.27	0.59	1.79	1.82	2.08	2.13
Mutton	0.23	0.03	0.23	0.15	0.43	0.35
Beef	0.43	0.41	0.89	0.98	1.38	2.03
Fish or shrimp	3.83	2.94	3.71	3.93	4.32	3.70
Eggs	2.8	2.06	3.07	3.05	2.76	3.02

Source: Data in this table are from the AAPI Mid-Term Evaluation and *Boro* 2013 Gross Margins Survey, May-June 2013

Appendix 8: Revising AAPI's the Crop Cut Process to Collect Information to Calculate Gross Margins

AAPI's Field Monitoring supervise and report from hundreds to more than 1,000 crop cuts each season. For each crop cut, FMOs select at random one plot with *Guti* urea and a nearby plot with prilled urea (planted to HYV or hybrid rice), cut and weigh a portion of the plots to determine yields and collect and report information on yields, production practices, inputs and labor in a Crop Cut Report.

With some minor adjustments, AAPI's crop cut procedures can be revised to collect information to calculate gross margins with *Guti* urea and prilled urea. The crop cuts collect unbiased information on yields. Because crop cuts take time and farmers are focused on what they have accomplished, the event offers a good opportunity to collect accurate information on labor and inputs. With some minor changes, the Crop Cut Report (see below: CROP CUT REPORT) can be revised to collect information on cash costs of production, except hired harvest and post-harvest labor.

To complete data for gross margin calculations, the FMO can return to 350 crop cut venues (each venue involves a farmer and plot using *Guti* urea and another with prilled urea) to ask several additional questions (see below: ADDITIONAL CROP CUT REPORT).

CROP CUT REPORT

Date:_____

Farmer:_____ (Man/Woman) SAAO:_____
Block:_____ Union:_____
Upazila:_____ District_____

LAND OWNERSHIP
How much land does the farmer own (including fields, ponds, houselot)? _____decimals

SEASON, VARIETY, SEED SOURCE
Season [check one]: *Aman*_____; *Boro*_____; *Aus*_____
Variety name: _____ [check one]: Hybrid____ or HYV____
Seed source [check one]: own saved seed_____; bought seeds_____: bought seedlings_____
If he/she bought seeds or seedlings, from where did he/she buy them?_____

PLOT (a plot is the area surrounded by a bund and planted to a single variety)
Plot size (in decimals):_____; plot dimensions _____meters x _____meters

YIELD
Size of cut:_____square meters
Weight of grain_____kg Moisture content of grain_____%
Calculated yield at 14% moisture:_____kg/ha

LAND PREPARATION
How much did you pay for land preparation (to hire a power tiller or oxen, pay for fuel)_____Tk

USE OF INORGANIC FERTILIZERS (kg/plot):
Guti urea applied_____kg; Price Tk/kg. Total spent on *Guti* urea_____Tk
Urea (except *Guti* urea)_____kg. Price_____Tk/kg. Total spent on prilled urea_____Tk.
Did you apply any topdressing of urea? Yes_____No____
If yes, how much applied: 1st topdressing_____kg; 2nd_____kg; 3rd_____kg

NPK granules_____kg Size of granules: _____g
Composition: urea____%, DAP ____%, MOP____%, other (specify)_____%

TSP_____kg DAP_____kg SSP_____kg
MOP_____kg Gypsum____kg Zinc_____kg
Other (specify)_____kg

Total spent on all inorganic fertilizers (except *Guti* and prilled urea): _____Tk.

USE OF ORGANIC FERTILIZERS (kg/plot)

Animal manure_____kg Green manure_____kg
Burned straw_____kg Unburned straw_____kg
Burned rice hulls_____kg Unburned rice hulls_____kg
Compost_____kg
Total spent on organic fertilizers bought from others (exclude value of manure, etc.):_____Tk

PESTS, DISEASES, PESTICIDES

Was your crop badly or very badly affected by pests or disease? Yes_____No_____
If yes, name of pest or disease_____
Did you use (check all that apply): insecticides_____herbicides_____fungicides_____?
If yes, total cost _____BDT

IRRIGATION

Did you irrigate the crop? Yes_____No__ If yes, number of times irrigated_____
Did you irrigate from your own machine? Yes___No_____ If yes, cost of irrigation from own machine Tk/season:_____
Did you buy irrigation services from another machine? Yes_____No_____ If yes, cost of irrigation from another's machine: Tk/season_____

LABOR DAYS AND LABOR COSTS

Tasks, Labor Days and Cost (Taka)	**Household labor**		**Hired labor**	
	Men	Women	Men	Women
What is the usual wage for agricultural labor (Tk/day)?				
How many days of household and hired labor did you use for the following tasks on this plot?				
Transportation of inputs				
Transplanting				
Guti urea or NPK granule application				
Broadcast urea application				
Other Fertilizer Application				
Weeding				

How much did you pay to hire labor for all tasks in farming this plot, including the above, but also seedbed preparation, irrigation, etc:_____Tk.

ADDITIONAL COMMENTS

Does the farmer consider this yield to be [check one]: normal_____high_____low_____
Did the crop suffer any unusual conditions? Yes____No_____. If yes, explain:_____
_____
Additional comments:_____

CROP CUT SUPERVISED AND REPORT SUBMITED BY:

Signature:_____
Name:_____
AAPI staff designation:_____

ADDITIONAL CROP CUT REPORT Date:_____

Farmer:_____ (Man/Woman) SAAO:_____
Block:_____ Union:_____
Upazila:_____ District_____

SEASON, VARIETY, SEED SOURCE
Season [check one]: *Aman*_____; *Boro*_____; *Aus*_____
Variety name: _____ [check one]: Hybrid____ or HYV____

LABOR DAYS AND LABOR COSTS

Tasks, Labor Days and Cost (Taka)	Household Labor		Hired Labor	
	Men	Women	Men	Women
How many days of household and hired labor did you use for the following tasks on this plot?				
Harvesting				
Post-harvest tasks				

How much did you pay to hire labor for harvesting and post-harvest tasks? :_____Tk.

SALE OF PADDY AND STRAW
How much paddy have you sold from this harvest? _____kg
How much did you receive from these sales (total received)_____Tk
What was the average price received per kg of paddy? _____Tk/kg

How much straw have you sold from this harvest? _____kg
How much did you receive from these sales (total received)_____Tk
What was the average price received per kg of straw? _____Tk/kg

Additional comments:_____

ADDITIONAL CROP CUT SUPERVISED AND REPORT SUBMITED BY:

Signature:_____
Name:_____
AAPI staff designation:_____

Appendix 9: Consultant David Gisselquist's Activities and Persons Met Consultant's Schedule of Activities

12 May	Arrive Bangladesh
12-24 May	Review project documents, work with IFDC staff, visit offices in Dhaka
12-23 May	With IFDC staff and USAID advice, design the mid-term evaluation and *Boro* 2013 gross margins survey
24-28 May	Travel to Mymensingh. Train enumerators, test the questionnaire and take part in the survey. Visit BAU to discuss research on greenhouse gases.
30 May-8 June	Travel to Barisal, Patuakhali, Satkhira, Jessore and Jhenaidah to take part in the survey. Visit Model Villages. Meet project and government staff.
9 June-9 July	Work in Dhaka analyzing survey findings, meeting relevant experts, writing reports.
7 July	Circulate draft report
8-9 July	Revise based on comments and submit to IFDC

Persons Met

Name	Designation, Organization	Contact Information
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Sydur Rahman	Water Management Specialist, FAO, Khulna	01711230937
Timothy Krupnik	CIMMYT, Dhaka	01755568938
Mahesh Kumar Gathala	Cropping Systems Agronomist, CIMMYT, Dhaka	01755577390
Darrell Deppart	Chief of Party, Climate-Resilient Ecosystems and Livelihoods, Winrock, Dhaka	01755587445
Forrest Cookson	Economist, Dhaka	01911-337-755
Md Mohafez Ali	Ex-Director, Directorate General of Food	01715068337
Wais Kabir	Chairman, Bangladesh Agricultural Research Council	01715-036-732
Samina Yasmin	Cropping Systems Agronomist, CIMMYT, Barisal	01711808828
Kaikus Ahmad	Deputy Chief of Party, Bangladesh Policy Research and Strategy Support Program, IFPRI, Dhaka	01760946614
Badrul Hasan	Director, Procurement Division, Directorate General of Food	02-9550261
M Syeduzzaman	Trustee, Center for Policy Dialogue	02-9141734
Ousmane Seck	World Bank	

Appendix 10: Survey on Gross Margin of Farmers for *Boro* 2013

Introduction

Calculation of the Gross Margin for resource-poor farmers is a new results indicator for AAPI project as required under Feed the Future (FTF) upscale program of USAID. AAPI started to conduct sample surveys to determine gross margin after the *Aman* 2011 season. The AAPI project is promoting farmer use of urea deep placement (UDP) technology to improve resource efficiency in rice production in 22 selected districts of the country in the South, Southwest and Northeast. *Guti* urea (UDP) is a resource efficient technology that allows farmers to realize significant increases in yields (commonly about 15 percent) while reducing use of nitrogen fertilizer by approximately one-third. AAPI has been promoting UDP technology through training and creating awareness among farmers. Through the first 36 months of AAPI, from September 2010 through the *Boro* rice season in 2013, a total of 2.56 million hectares (ha) of rice planted area has come under UDP technology (counting fields each time they use UDP).

This report estimates the Gross Margins realized by farmers producing paddy with UDP during the *Boro* 2013 season and compares the same with paddy being produced with prilled urea. The difference between the total value of production (whether sold or consumed at home) and "purchased input costs…that are at least 5 percent of total costs."[1] The gross margin is used to analyze how efficiently a farm is using its inputs – raw materials, labor and production-related fixed assets -- to generate profit. Improving the gross margin for farm products contributes to increasing agriculture gross domestic product (GDP) and reducing poverty.

Objective

The major objectives of the study are to calculate the productivity, gross margin and cost-benefit ratio (excluding family labor, rental value of own land and other inputs provided by the household) of sample farmers using UDP compared to farmers broadcasting prilled urea.

Methodology

This gross margin analysis is based on a survey carried out in all the 20 FTF districts and two north-central districts – Mymensingh and Sherpur (M&S) – under AAPI intervention. The survey interviewed 1,000 farmers (20 farmers in each of 50 blocks) randomly selected from lists of farmers in each block (Appendix 2 in the mid-term evaluation lists block chosen for the survey). Among the 1,000 farmers we estimated that at least 420 would have used *Guti* urea on *Boro* paddy 2013, based on comprehensive reports from local Department of Agricultural Extension through AAPI field staff (block survey reports) that 42 percent (2,463,000 out of 5,827,000) of farmers in the project area used *Guti* urea on *Boro*. These block surveys also reported that 66 percent of HYV/hybrid *Boro* (828,000 of 1,257,000 hectares [ha]) was fertilized with *Guti* (data from AAPI Quarterly Reports). From these data, we estimated that more than

[1]Quoted from page 24 of: USAID, 2013. Feed the Future Indicator Handbook: Definition Sheets, updated 4 April 2013.

210 farmers would have used prilled urea on 2013 *Boro* paddy. This was sufficient to identify a difference in gross margins with 95 percent confidence if the underlying ratio of gross margins is 2.0.[2] Primary data was collected from the respondent farmers through personal interviews by independent enumerators using a structured questionnaire. All the local measurements were converted into standard unit and final analysis was done using Microsoft Excel and Microsoft Access.

Cost of Production: Following FTF guidelines, gross margin calculations consider only purchased inputs that represent at least 5 percent of total costs. Costs included, for example, rent paid but not imputed rent on own land. If a farmer owned the pump that irrigated his or her land, the fuel cost was considered. In the gross margin survey for *Aman* rice 2012, only 17 of 383 farmers (4 percent) borrowed money, and total interest paid was only 0.3 percent of total expenses (Tk 48,500 vs. Tk 15 million); therefore this survey did not ask about credit.

Total Revenue: The revenue earned was calculated as the total production of paddy multiplied by the price received by farmers for selling a portion of their production. In addition, the value of straw was added to total revenue, using a standard ratio of straw to paddy (1:1) and a standard value of straw (Tk 0.75 per kilogram.[3]

Gross Margin Analysis: Gross margin per ha is the difference between the gross return per ha and the total input cost incurred per ha, as per FTF definitions. Because farmers in Bangladesh do not pay tax; gross margin equates to farm income.

Benefit-Cost Ratio Analysis: The benefit-cost ratio (BCR) assesses the return on investment. It is calculated as gross return divided by the total costs, with costs defined according to FTF's definition (i.e., excluding purchased inputs representing less than 5 percent of total costs).

Results

***Sampled Farmers by Farm Size, Region and Gender*:** The Bangladesh Bureau of Statistics (BBS) categorizes farms as marginal (0.05 to 0.49 acres, equivalent to 0.02-0.19 ha), small but not marginal (0.5 to 2.49 acres, equivalent to 0.2-0.99 ha), medium (2.5 to 7.49 acres, or 1 to 2.99 ha) and large (at least 7.5 acres or 3 ha). Of the 1,000 sampled farmers, 96 percent are men, while 3.6 percent are women. Of the total sample, 6.2 percent have marginal farms, 72 percent have small but not marginal farms, 21 percent have medium farms and 1 percent have large farms (Table 1).

Table 1: Number of Farmers Interviewed by Farm Category, Gender and Region

Farm Size	Men (percent of sampled farmers by	Women (percent of sampled farmers by	Total (percent of all sampled

[2] Wikipedia. 2013. Sample Size Determination. Available at: http://en.wikipedia.org/wiki/Sample_size_determination (accessed 17 May 2013).
[3] Department of Agricultural Extension. No date. Cost of production. Available at: http://www.dae.gov.bd/cost-of-production/ (accessed 27 June 2013).

	farm size)	farm size)	farmers)
Marginal (up to 0.199 ha)	60 (97)	2 (3.2)	62 (6.2)
Small (0. to 0.99 ha)	687 (96)	32 (4.5)	719 (71.9)
Medium (above 1.00 to 2.99 ha)	208 (99.5)	1 (0.5)	209 (20.9)
Large (≥ 3.0 ha)	9 (91)	1 (9)	10 (1.0)
Total	964 (96)	36 (3.6)	1,000 (100)
20 Feed the Future Districts			840
Mymensingh and Sherpur			160

Source: Field Survey *Boro* 2013

***Adoption of Guti Urea by Farm Size, Region and Gender*:** Nine hundred and eight of 1,000 sample farmers planted a total of 414 ha of *Boro* paddy in 2013, planting an average of 0.45 ha per farm (908 farmers planting 414 ha). Marginal farms planted an average of 0.16 ha each, small farms averaged 0.36 ha, while women averaged 0.27 ha (33 farmers planting 9 ha). Forty-four percent of marginal farmers who grew *Boro* in 2013 used *Guti* urea. The percentage of farmers using *Guti* urea increased by farm size up to 80 percent among medium and large farms.

Table 2: Adoption of UDP by Farm Size, Region and Gender

	Farmers Planting *Boro* Paddy			*Boro* Area		
	Number Planting *Boro* Paddy 2013	Number Using UDP	Percent Using UDP	Area with *Boro* Paddy (ha)	*Boro* Area with UDP (ha)	Percent of Area with UDP
Marginal (up to 0.199 ha)	61	27	44	9.7	3.9	40
Small (0. to 0.99 ha)	648	431	66	232.5	86.4	37
Medium (above 1.00 to 2.99 ha)	189	151	80	158.6	60.9	38
Large (≥ 3.0 ha)	10	8	80	12.6	5.7	45
Total	908	617	68	413.8	157.0	38
FTF districts	748	513	69	331	131	40
Mymensingh and Sherpur	160	104	65	81	25	31
Women farmers	33	21	64	9	3	50

Source: Field Survey *Boro* 2013

***Yield*:** Paddy yields with UDP averaged 7.34 tons per hectare (mt/ha) and were similar across all farm sizes, regions and genders. The lowest average yield (7.15 t/ha among women) was only 3 percent less than the highest average yield (7.35 t/ha among small and medium farmers and men). Paddy yields with prilled urea averaged 6.26 t/ha. The lowest average yield (6.12 t/ha in Mymensingh and Sherpur) was only 3 percent less than the highest average yield (6.3 t/ha among small farms, large farms and in FTF). The difference in yields between fields with UDP and

prilled urea averaged 1.08 t/ha. This difference was smallest among women farmers (0.93 t/ha) and largest among medium farmers (1.16 t/ha).

Table 3: Yields and Yield Differences by Farm Size, Region and Gender (mt/ha)

Farmers' Category		UDP	Broadcast Urea	Incremental
All farmers		7.34	6.26	1.08
Farm size				
	Marginal (up to 0.199 ha)	7.22	6.23	0.99
	Small (0. to 0.99 ha)	7.35	6.30	1.05
	Medium (above 1.00 to 2.99 ha)	7.35	6.19	1.16
	Large (≥ 3.0 ha)	7.33	6.30	1.03
Farm size				
	Feed the Future districts	7.30	6.30	1.00
	Mymensingh and Sherpur	7.16	6.12	1.04
Gender				
	Men farmers	7.35	6.26	1.09
	Women farmers	7.15	6.26	0.93

Source: Field Survey *Boro* 2013.

Gross Margin: The average total returns/ha from paddy fields fertilized with *Guti* urea (value of paddy plus straw) was 17 percent higher than the average total returns from fields fertilized by broadcasting prilled urea. The average gross margin/ha with UDP was Tk 59,916 ($778) per ha while the average gross margin with prilled urea was TK 45,592 ($592) per ha. The income from fields with UDP was greater by $186 per hectare due primarily to higher paddy yields with UDP. The BCR with UDP was 2.03 vs. 1.83 with prilled urea.

Table 4: Gross Margin and Benefit-Cost Ratio for All Sample Farmers

Item	UDP	Broadcast Urea	Difference	P value of Difference[a]
Total Return (Tk/ha)	117,513	100,223	17,291	0.0000
Total Cost (Tk/ha)	57,597	54,631	2,966	0.92
Gross Margin (Tk/ha)	59,916	45,592	14,325	0.0000
Gross Margin (US $/ha)	778	592	186	
Benefit-Cost Ratio (BCR)	2.04	1.83		

a. 2-tailed, equal variances not assumed.

Source: Field Survey *Boro* 2013.

The t-test (of statistical significance) shows that there is no significant difference between the average cost per hectare to grow paddy with *Guti* urea vs. prilled urea (P values near 1); but the

difference between average returns per hectare and gross margins per hectare with *Guti* urea vs. broadcast urea are highly significant, with P values less than 0.001.

Gross Margin by Farm Size: With UDP, gross margin was similar for small, medium and large farms, ranging from Tk 58,000 to Tk 61,000. Gross margin for marginal farmers was less because many marginal farms planted *Boro* on rented or share-cropped land (which was therefore a purchased input). With broadcast urea, marginal farmers similarly had the highest costs and the lowest gross margin.

The benefit-cost ratio with UDP ranged from 1.85 to 2.08 across farm sizes; with prilled urea, the benefit-cost ratio ranged from 1.58 to 1.95. The average gross margin and benefit-cost ratios are higher with UDP than with prilled urea for all four farm sizes (Table 5).

Table 5: Gross Margin and Benefit-Cost Ratio by Farm Size

Item	UDP Area				Broadcast Urea Area			
	Marginal	Small	Medium	Large	Marginal	Small	Medium	Large
Total Return (Tk/ha)	115,592	117,674	117,674	117,353	99,742	100,863	99,102	100,863
Total Cost (Tk/ha)	62,649	56,950	59,185	56,364	63,310	52,507	58,610	51,690
Gross Margin (Tk/ha)	52,943	60,724	58,489	60,989	36,432	48,656	40,492	49,173
Gross Margin (US $/ha)	688	789	760	792	473	632	526	639
Benefit-Cost Ratio	1.85	2.07	1.99	2.08	1.58	1.93	1.69	1.95

Source: Field Survey *Boro* 2013.

Gross Margin by Zone: Average gross margin is higher in UDP plots for both the FTF and M&S districts (Table 6). Comparing the two zones, average returns with both UDP and prilled urea are significantly higher in FTF districts than in Mymensingh and Sherpur. On the other hand average costs with both UDP and prilled urea are higher in FTF districts than in M&S districts. Most of this difference is due to higher labor costs in FTF districts.

Because returns and costs are both higher in FTF districts, there is little difference between the regions in terms of gross margins for fields with either UDP or prilled urea. However, farmers in Mymensingh and Sherpur, with lower costs, have higher benefit-cost ratios than farmers in FTF districts.

Table 6: Gross Margin and Benefit-Cost Ratio by Zone

Item	UDP		Broadcasted Urea	
	FTF Districts	M&S Districts	FTF Districts	M&S Districts
Total Return (Tk/ha)	119,630	109,691	102,123	93,758
Total Cost (Tk/ha)	59,112	49,773	57,088	47,724
Gross Margin (Tk/ha)	60,518	59,918	45,035	46,034
Gross Margin (US $/ha)	786	778	505	598
Benefit-Cost Ratio (BCR)	2.02	2.20	1.79	1.96

Note: Percentages are rounded to the nearest one.US $1=BDT 77.

Source: Field Survey *Boro* 2013.

Gross Margin by Gender: For both men and women, the average gross margin is higher in plots fertilized with *Guti* urea compared to plots with broadcast urea (Table 7). Among farmers using *Guti* urea, women have higher gross margins and higher benefit-cost rations compared to men. On the other hand, among farmers using prilled urea, men have higher gross margins and benefit-cost ratios.

Table 7: Gross Margin by Gender

Item	Men		Women	
	UDP	Broadcast Urea	UDP	Broadcast Urea
Total Return (Tk/ha)	117,674	100,223	114,472	99,582
Total Cost (Tk/ha)	57,676	54,488	54,079	60,321
Gross Margin (Tk/ha)	59,998	45,735	60,393	39,261
Gross Margin (US $/ha)	779	594	784	510
Benefit-Cost Ratio	2.04	1.84	2.12	1.65

Source: Field Survey *Boro* 2013

Sales of Product: The sample farmers were asked to provide information sale of *Boro* paddy in order to get actual farm-gate values for paddy. Farmers in FTF districts reported selling 696 tons for a total of Tk 10,760,000, showing an average farm-gate paddy price of Tk 15.46/kg. Farmers in Mymensingh and Sherpur reported selling 160 tons of paddy for a total of Tk 2,330,000, showing an average price of Tk 14.57/kg. The average across all districts was Tk 15.26 per kg. These prices apply to paddy produced with either *Guti* urea or prilled urea.

Across all districts, farmers using *Guti* urea produced a total of 1,149 tons, from which they reported selling 357 tons. These are not net sales; many farmers will sell more paddy later, while some who sold paddy will later buy rice to feed their family.

Table 8: Prices Received for Paddy by Region

Zone	Number of Farmers Who Sold Paddy	Total Sale of Paddy (mt)	Total Payment Received (Tk)	Price of Paddy (Tk/mt)
FTF Districts	499	696	10,760,000	15,460
M&S Districts	118	160	2,330,000	14,570
Total	617	856	13,060,000	15,260

Note: Figures in parentheses are percentages of total in that category and rounded to the nearest one.

Source: Field Survey *Aman* 2012.

Conclusion

Farmers who fertilized *Boro* paddy with *Guti* urea in 2013 harvested an average of 7.34 t/ha of paddy compared to 6.26 t/ha for farmers who used prilled urea. This difference in yields led to high gross margins with UDP across farm sizes, regions and gender.

The average gross margin per hectare of paddy for farmers using UDP was $778 (Tk 59,916), whereas from paddy fields fertilized with prilled urea, the average gross was $592 (Tk 45,592).

Detailed Tables on Costs and Returns

Table 9: Gross Margin per Hectare with *Guti* Urea and Prilled Urea, HYV and Hybrid *Boro* Rice 2013 (all farmers, FTF and MS)

Item	Unit	Unit Price (Tk)	*Guti* Urea (617 farmers, 157 ha)		Broadcast Urea (763 farmers, 257 ha)		Difference	
			Units/ha	Tk/ha	Units/ha	Tk/ha	Units/ha	Tk/ha
Total return, of which	Tk			117,513		100,223		17,291
Paddy	Mt	15,260	7.34	112,208	6.26	95,528	1.07	16,481
Straw	Mt	750	7.34	5,505	6.26	4,695	1.07	810
Total cost	Tk			60,409		58,342		2,067
Total cost (omitting items <5%)				57,597		54,631		2,966
Human labor	Tk			34,230		30,025		4,205
Power tiller	Tk			5,289		5,494		-205
Seed	Tk			927		1,081		-154
Urea	Kg	20	170	3403	272	5,435	-102	-2,032
Higher price for *Guti*	Kg	2	170	340	0	0	170	340
Other chemical fertilizers	Tk			5,143		5,408		-265
Organic fertilizers	Tk			727		722		5
Pesticides	Tk			642		905		-263
Irrigation cost	Tk			9,192		8,269		923
Land rent for the season	Tk			516		1,003		-487
Gross Margin (return-cost)	**Tk**			**59,916**		**45,592**		**14,325**
Benefit-Cost Ratio (return/cost)	**ratio**			**2.04**		**1.83**		

Note: "Total cost" sums all costs in the table. "Total cost (omitting items <5%)" sums costs for human labor, power tiller, urea plus higher price for *Guti*, other chemical fertilizers and irrigation (and land rent for marginal farmers only). The gross margin is the difference between total return and total cost (omitting items <5%). The benefit-cost ratio is total return divided by total cost (omitting items <5%).

Source: AAPI mid-term evaluation and *Boro* 2013 gross margins survey, May-June 2013.

Table 10: Gross Margin per Hectare with *Guti* Urea and Prilled Urea, HYV and Hybrid *Boro* Rice 2013 (marginal farmers, owning 0-0.199 ha, FTF and MS)

Item	Unit	Unit Price (Tk)	*Guti* Urea (27 farmers, 4 ha)		Broadcast Urea (46 farmers, 6 ha)		Difference	
			Units/ha	Tk/ha	Units/ha	Tk/ha	Units/ha	Tk/ha
Total return, of which	Tk			115,592		99,742		15,850
Paddy	mt	15,260	7.22	110,177	6.23	95,070	0.99	15,107
Straw	mt	750	7.22	5415	6.23	4,673	0.99	743
Total cost	Tk			64,652		65,540		-888
Total cost (omitting items <5%)				62,649		63,310		-661
Human labor	Tk			31,848		26,533		5,315
Power tiller	Tk			4,729		4,489		-60
Seed	Tk			896		1,127		-231
Urea	kg	20	166	3322	289	5,788	-123	-2,466
Higher price for *Guti*	kg	2	166	332	0	0	166	332
Other chemical fertilizers	Tk			5,132		5,472		-340
Organic fertilizers	Tk			435		347		88
Pesticides	Tk			672		756		-84
Irrigation cost	Tk			10,582		9,438		1,144
Land rent for the season	Tk			6,704		11,290		-4,586
Gross Margin (return-cost)	**Tk**			**52,943**		**36,432**		**15,850**
Benefit-Cost Ratio (return/cost)	**ratio**			**1.85**		**1.58**		

Source: AAPI mid-term evaluation and *Boro* 2013 gross margins survey, May-June 2013.

Table 11: Gross Margin per Hectare with *Guti* Urea and Prilled Urea, HYV and Hybrid *Boro* Rice 2013 (small farmers, owning 0.2-0.99 ha, FTF and MS)

Item	Unit	Unit Price (Tk)	*Guti* Urea (431 farmers, 86 ha)		Broadcast Urea (542 farmers, 146 ha)		Difference	
			Units/ha	Tk/ha	Units/ha	Tk/ha	Units/ha	Tk/ha
Total return, of which	Tk			117,674		100,863		16,811
Paddy	mt	15,260	7.35	112,161	6.30	96,138	1.05	16,023
Straw	mt	750	7.35	5513	6.30	4,725	1.05	788
Total cost	Tk			59,849		56,199		3,650
Total cost (omitting items <5%)				56,950		52,207		4,743
Human labor	Tk			32,557		27,365		5,192
Power tiller	Tk			5,230		5,484		-254
Seed	kg			1,006		1,250		-244
Urea	kg	20	172	3,735	275	5,489	-82	-1,754
Higher price for *Guti*	kg	2	172	344	0	0	172	344
Other chemical fertilizers	Tk			5,499		5,716		-217
Organic fertilizers	Tk			715		828		-113
Pesticides	Tk			718		1,045		-327
Irrigation cost	Tk			9,585		8,153		1,432
Land rent for the season	Tk			460		869		-409
Gross Margin (return-cost)	**Tk**			**60,724**		**48,656**		**12,068**
Benefit-Cost Ratio (return/cost)	**ratio**			**2.07**		**1.93**		

Source: AAPI mid-term evaluation and *Boro* 2013 gross margins survey, May-June 2013.

Table 12: Gross Margin per Hectare with *Guti* Urea and Prilled Urea, HYV and Hybrid *Boro* rice 2013 (medium farmers, owning 1-2.99 ha, FTF and MS)

Item	Unit	Unit Price (Tk)	*Guti* Urea (151 farmers, 61 ha)		Broadcast Urea (166 farmers, 98 ha)		Difference	
			Units/ha	Tk/ha	Units/ha	Tk/ha	Units/ha	Tk/ha
Total return, of which	Tk			117,674		99,102		18,572
Paddy	mt	15,260	7.35	112,161	6.19	94,459	1.16	17,702
Straw	mt	750	7.35	5,513	6.19	4,643	1.16	870
Total cost	Tk			61,561		61,560		1
Total cost (omitting items <5%)				59,185		58,610		575
Human labor	Tk			36,586		34,339		2,247
Power tiller	Tk			5,441		5,560		-119
Seed	kg			809		827		-18
Urea	kg	20	169	3,389	266	5,325	97	-1936
Higher price for *Guti*	kg	2	169	338	0	0	169	338
Other chemical fertilizers	Tk			4,723		4,996		-273
Organic fertilizers	Tk			771		742		29
Pesticides	Tk			546		718		-172
Irrigation cost	Tk			8,708		8,390		318
Land rent for the season	Tk			250		663		-413
Gross Margin (return-cost)	**Tk**			**58,489**		**40,492**		**18,572**
Benefit-Cost Ratio (return/cost)	**ratio**			**1.99**		**1.69**		

Source: AAPI mid-term evaluation and *Boro* 2013 gross margins survey, May-June 2013.

Table 13: Gross Margin per Hectare with *Guti* Urea and Prilled Urea, HYV and Hybrid *Boro* Rice 2013 (large farmers, owning ≥3 ha, FTF and MS)

Item	Unit	Unit Price (Tk)	*Guti* Urea (9 farmers, 6 ha)		Broadcast Urea (9 farmers, 7 ha)		Difference	
			Units/ha	Tk/ha	Units/ha	Tk/ha	Units/ha	Tk/ha
Total return, of which	Tk			117,353		100,863		16,490
Paddy	mt	15,260	7.33	111,856	6.30	96,138	1.03	15,718
Straw	mt		7.33	5,498	6.30	4,725	1.03	773
Total cost	Tk			58,509		53,810		4,699
Total cost (omitting items <5%)				56.364		51,690		4,674
Human labor	Tk			36,052		28,162		7,890
Power tiller	Tk			4,929		5,299		-370
Seed	kg			1,014		1,048		-34
Urea	kg	20	165	3,369	277	5,541	-112	-2,172
Higher price for *Guti*	kg	2	165	330		0	165	-330
Other chemical fertilizers	Tk			4,224		4,659		-435
Organic fertilizers	Tk			624		359		265
Pesticides	Tk			507		713		-206
Irrigation cost	Tk			7,460		8,029		-569
Land rent for the season	Tk			0		0		0
Gross Margin (return-cost)	**Tk**			**60,989**		**49,173**		**11,816**
Benefit-Cost Ratio (return/cost)	**ratio**			**2.08**		**1.95**		

Source: AAPI mid-term evaluation and *Boro* 2013 gross margins survey, May-June 2013.

Table 14: Gross Margin per Hectare with *Guti* Urea and Prilled Urea, HYV and Hybrid *Boro* Rice 2013 (FTF districts)

Item	Unit	Unit Price (Tk)	*Guti* Urea (513 farmers, 131 ha)		Broadcast Urea (616 farmers, 200 ha)		Difference	
			Units/ha	Tk/ha	Units/ha	Tk/ha	Units/ha	Tk/ha
Total return, of which	Tk			119,630		102,123		17,507
Paddy	mt	15,460	7.38	114,095	6.30	97,398	1.08	16,697
Straw	mt		7.38	5,535	6.30	4,725	1.08	810
Total cost	Tk			61,889		60,804		1,085
Total cost (omitting items <5%)				59,112		57,088		2,024
Human labor	Tk			35,542		32,330		3,212
Power tiller	Tk			5,213		5,285		-72
Seed	kg			877		957		-80
Urea	kg	20	171	3,413	273	5,466	102	-2,053
Higher price for *Guti*	kg	2	171	342		0	171	342
Other chemical fertilizers	Tk			5,181		5,325		-144
Organic fertilizers	Tk			779		805		-26
Pesticides	Tk			613		790		-177
Irrigation cost	Tk			9,421		8,682		739
Land rent for the season	Tk			508		1,164		-656
Gross Margin (return-cost)	**Tk**			**60,518**		**45,035**		**15,483**
Benefit-Cost Ratio (return/cost)	**ratio**			**2.02**		**1.79**		

Source: AAPI mid-term evaluation and *Boro* 2013 gross margins survey, May-June 2013.

Table 15: Gross Margin per Hectare with *Guti* Urea and Prilled Urea, HYV and Hybrid *Boro* Rice 2013 (Mymensingh and Sherpur Districts)

Item	Unit	Unit Price (Tk)	*Guti* Urea (104 farmers, 25 ha)		Broadcast Urea (147 farmers, 56 ha)		Difference	
			Units/ha	Tk/ha	Units/ha	Tk/ha	Units/ha	Tk/ha
Total return, of which	Tk			109,691		93,758		15,993
Paddy	mt	14,570	7.16	104,321	6.12	89,168	1.04	15,153
Straw	mt	750	7.16	5,370	6.12	4590	1.04	780
Total cost	Tk			52,768		51,642		1,126
Total cost (omitting items <5%)				49,773		47,724		2,049
Human labor	Tk			27,416		21,856		5,560
Power tiller	Tk			5,682		6,236		-554
Seed	kg			1,189		1,519		-330
Urea	kg	20	170	3,390	266	5,323	96	-1,933
Higher price for *Guti*	kg	2	170	340	0	0	170	340
Other chemical fertilizers	Tk			4,942		5,703		-761
Organic fertilizers	Tk			453		656		-203
Pesticides	Tk			792		1,312		-520
Irrigation cost	Tk			8,003		8,606		-603
Land rent for the season	Tk			561		431		130
Gross Margin (return-cost)	**Tk**	**59,918**			**46,034**		**13,884**	
Benefit-Cost Ratio (return/cost)	**ratio**	**2.20**			**1.96**			

Source: AAPI mid-term evaluation and *Boro* 2013 gross margins survey, May-June 2013.

Table 16: Gross Margin per Hectare with *Guti* Urea and Prilled Urea, HYV and Hybrid *Boro* Rice 2013 (men farmers)

Item	Unit	Unit Price (Tk)	*Guti* Urea (596 farmers, 154 ha)		Broadcast Urea (738 farmers, 250 ha)		Difference	
			Units/ha	Tk/ha	Units/ha	Tk/ha	Units/ha	Tk/ha
Total return, of which	Tk			117,674		100,223		17,451
Paddy	mt	15,260	7.35	112,161	6.26	95,528	1.09	16,633
Straw	mt	750	7.35	5,513	6.26	4,695	1.09	818
Total cost	Tk			60,451		58,256		2,195
Total cost (omitting items <5%)				57,676		54,488		3,188
Human labor	Tk			34,347		29,988		4,359
Power tiller	Tk			5,299		5,478		-179
Seed	kg			924		1,076		-152
Urea	kg	20	171	3,409	271	5,421	-100	-2012
Higher price for *Guti*	kg	2	171	342	0	0	171	342
Other chemical fertilizers	Tk			5,129		5,397		-268
Organic fertilizers	Tk			738		781		-43
Pesticides	Tk			638		901		-263
Irrigation cost	Tk			9,150		8,204		946
Land rent for the season	Tk			475		1,010		-535
Gross Margin (return-cost)	**Tk**			**59,998**		**45,735**		**14,263**
Benefit-Cost Ratio (return/cost)	**ratio**			**2.04**		**1.84**		

Source: AAPI mid-term evaluation and *Boro* 2013 gross margins survey, May-June 2013.

Table 17: Gross Margin per Hectare with *Guti* Urea and Prilled Urea, HYV and Hybrid *Boro* Rice 2013 (women farmers)

Item	Unit	Unit Price (Tk)	*Guti* Urea (21 farmers, 3 ha)		Broadcast Urea (25 farmers, 6 ha)		Difference	
			Units/ha	Tk/ha	Units/ha	Tk/ha	Units/ha	Tk/ha
Total return, of which	Tk			114,472		99,582		14,889
Paddy	mt	15,260	7.15	109,109	6.22	94,917	0.93	14,192
Straw	mt	750	7.15	5,363	6.22	4,665	0.93	698
Total cost	Tk			58,761		63,788		-5,027
Total cost (omitting items <5%)				54,079		60,321		-6,242
Human labor	Tk			28,406		31,507		-3,101
Power tiller	Tk			4,788		6,318		-1,350
Seed	kg			1,078		1,285		-207
Urea	kg	20	171	3,415	298	5,995	-127	-2,580
Higher price for *Guti*	kg	2	171	342	0	0	171	342
Other chemical fertilizers	Tk			5,854		5,822		32
Organic fertilizers	Tk			146		400		-254
Pesticides	Tk			868		1,068		-200
Irrigation cost	Tk			11,274		10,859		415
Land rent for the season	Tk			2,590		714		1,876
Gross Margin (return-cost)	**Tk**			**60,393**		**39,261**		**21,131**
Benefit-Cost Ratio (return/cost)	**ratio**			**2.12**		**1.65**		

Source: AAPI mid-term evaluation and *Boro* 2013 gross margins survey, May-June 2013.