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The Social Performance of an Innovative Method of Rice Fertilization in Southern Asia

An International Center for Soil Fertility and Agricultural Development

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by

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August 2007

Library of Congress Cataloging-in-Publication Data

Thompson, Thomas P., 1947-
The social performance of an innovative method of rice fertilization in Southern Asia / by Thomas P. Thompson.
p. cm.
Includes bibliographical references.
ISBN-13: 978-0-88090-160-4
1. Rice--Fertilizers--South Asia. 2. Urea as fertilizer--South Asia. I. International Center for Soil Fertility and Agricultural Development. II. Title.
S667.R5T46 2007
633.1'8890954--dc22

2007028095

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IFDC publications are listed in *IFDC Publications*, General Publication IFDC–G-1; the publications catalog is free of charge.

Foreword

Through participatory research, monitoring, evaluation, and information dissemination, the IFAD-funded "Adapting Nutrient Management Technologies" (ANMAT) Project has demonstrated that farmers in Bangladesh have successfully adopted urea deep placement (UDP), an improved nutrient management practice for rice production.

The nature of the socioeconomic research is unique because increased rice yield has not been viewed as an end but a means to reduce poverty, increase household food security, and improve standards of living among those who practice fertilizer deep placement. The adoption of new technologies by farmers, even those that appear to offer great benefits, takes time, effort, and persistence. The baseline (pre-intervention) socioeconomic surveys, followed by similar surveys of the same farmers, have allowed the impacts, benefits, and consequences as well as characteristics that influence use and adoption to be determined and documented in Bangladesh.

This paper, "The Social Performance of an Innovative Method of Rice Fertilization in Southern Asia," documents benefits of UDP that are agricultural in nature and those that are not agricultural per se. The latter includes standards of living, household property, new employment opportunities, and housing characteristics. An innovative feature of the socioeconomic surveys is to ask farmers to state "life wishes" as baseline qualitative data and determine realization of those wishes in subsequent surveys. Thus ANMAT does not establish a priori goals or benefits for farmers but seeks to document benefits reported by farmers on the basis of their own definitions of needs and aspirations.

Amit Roy
IFDC President and
Chief Executive Officer

Preface

With funding and support from the International Fund for Agricultural Development (IFAD), IFDC (An International Center for Soil Fertility and Agricultural Development) implemented the Adapting Nutrient Management Technologies (ANMAT) Project in South Asia. The 3-year project was designed for participatory research and evaluation of the use of urea supergranules and other nutrient management practices in paddy production. The practice of urea deep placement (UDP) offers small and marginal farmers an opportunity to increase paddy yield and thereby improve their income and standard of living. The research reported here describes the impact of the UDP practice on the socioeconomic and agricultural characteristics of small-scale paddy producers. The survey compares pre- and post-intervention data to be used to evaluate socioeconomic and agricultural change among a sample of farmers who were introduced to the practice of UDP during the 1999-2000 cropping season. The impact assessment was conducted in 2002.

The ANMAT staff—Ray B. Diamond, Resident Project Coordinator; Kh. Makbul Elahi, Project Officer; Syed Afzal Hossain, Data Analyst; and Mofizul Islam, Senior Agriculturalist—all contributed to the data collection and analyses. Ray Diamond offered extremely useful insights, provided conceptual clarification of the measurements and data, and offered a critical evaluation that greatly benefited this report. His contributions and support are appreciated and gratefully acknowledged. Makbul Elahi arranged field trips, assisted in interviewing and selecting enumerators, and otherwise contributed to making the fieldwork proceed smoothly. Syed Afzal Hossain demonstrated his superior skills at data input and analysis. His patience and attention to detail greatly benefited the work in general and the report in particular. His contributions are gratefully acknowledged.

The support of four NGOs is gratefully acknowledged: People's Oriented Program Implementation (POPI), Kishoreganj; Development Organization for the Rural Poor (DORP), Chandur; International Development Enterprises (IDE), Bogra; and Padakhep Manabik Unnayan Kendra (PMUK) in Jessore.

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List of Acronyms and Abbreviations

ANMAT	Adapting Nutrient Management Technologies
DORP	Development Organization for the Rural Poor
ha	hectare
IDE	International Development Enterprises
IFAD	International Fund for Agricultural Development
IFDC	International Fertilizer Development Center (An International Center for Soil Fertility and Agricultural Development)
KCal	kilocalorie
kg	kilogram
NGO	non-governmental organization
PMUK	Padakhep Manabik Unnayan Kendra
POPI	People's Oriented Program Implementation
UDP	urea deep placement
USG	urea supergranules

Cropping Seasons

Aman	Rice transplanted in July-August and harvested in November-December
Rabi/Boro	Rice transplanted in January-February and harvested in May-June

The Social Performance of an Innovative Method of Rice Fertilization in Southern Asia

Background

Rice is a staple food crop for over 2 billion people and directly or indirectly provides employment for about 1 billion people in southern and southeastern Asia. More than 90% of the rice in the world is grown in Asia where one-half of the world's population and 80% of the world's poor are concentrated. Demand for rice driven by population growth is such that 80–100 million new consumers of rice are added to the world population annually. To satisfy the increasing demand for rice, production must increase by 60% to 760 million tons by the year 2020. Only 4% of world rice production is marketed internationally, and 96% or about 460 million tons is consumed in the country where it is harvested. The importance of small-scale farmers in producing rice is evident because about one-half of the rice grown in Asia is consumed by producers. Rice is more than a food crop—it is a facet of life in many developing countries [4]. This paper explores the social performance of an innovative method of rice fertilization in Bangladesh.

The most prevalent method of applying nitrogenous fertilizer to rice is a basal application with or without incorporation before transplanting. This is followed by one or more topdressings in the floodwater within 3–4 weeks after transplanting up to near the flowering stage. Numerous research reports, however, have shown that such practices are inefficient because generally only about one-third of the fertilizer N is used by plants and the remainder is lost through volatilization, denitrification, runoff, and leaching or is immobilized in the soil [6].

An innovative means to reduce N losses and improve fertilizer efficiency is to deep place fertilizer N as urea supergranules (USG) of compacted prilled urea that may be produced by a village-level briquetting machine. The basic method of USG application is to place USG by hand between alternate four hills of rice at a depth of 7–10 cm about 3–7 days after transplanting. Although this method of N application increases labor time compared with broadcasting urea, urea deep placement (UDP) can ensure modest yield increases of 0.5 to 1.0 ton/ha over traditional methods of N rates of 40–60 kg/ha [6]. The potential yield increases through the use of USG have prompted the interest of national and international organizations to demonstrate this fertilizer technology on the fields of farmers in developing countries [1,2,3,5,7]. The agricultural technology of USG and the nitrogen management practice of deep placement hold promise for those farmers cultivating rice on small plots in developing countries where increased yields are of critical importance [6,8].

Through funding from the International Fund for Agricultural Development (IFAD), the pre-intervention baseline data presented and discussed in this report were collected in January and February of 2000, specifically, in Bangladesh in the districts of Chandpur, Kishoreganj, and Bogra. In Jessore, interviews were conducted in April 2000. The sample is comprised of 1,026 farmers with 300 in Matlab Thana, Chandpur; 300 in Bajitpur and Bhairab Thanas, Kishoreganj; 125 in Sherpur Thana, Bogra; and 301 in Jhikorgacha and Sharsha Thanas, Jessore. All data pertain to the 1999 calendar year. These areas were chosen because entrepreneurs purchased briquetting machines and were offering the innovative urea briquettes in the market. Figure 1 shows the geographical locations of the pre- and post-UDP intervention districts in Bangladesh.

During January and February of 2002, the post-intervention impact data were collected from a stratified random sample of 560 farmers or about a 55% sample of the pre-intervention baseline sample of 1,026 farmers. The sample was stratified on farm size and household type. The sample of 560 farmers was then divided into two groups of users and nonusers of the UDP practice.

The baseline and impact sample sizes by farm type and district are shown in Table 1. These data show that all baseline districts and farm types defined by size of holdings are represented in the

Figure 1. Pre- and Post-UDP Intervention Areas in Bangladesh

Table 1. Baseline and Impact Sample Farm Sizes by District

District	Type I (.001–.399 ha)		Type II (.400–.600 ha)		Type III (.601–1.000 ha)		Type IV (1.001–2.000 ha)		Type V (>=2.001 ha)		Total	
	Baseline Sample	Impact Sample	Baseline Sample	Impact Sample	Baseline Sample	Impact Sample	Baseline Sample	Impact Sample	Baseline Sample	Impact Sample	Baseline Sample	Impact Sample
	Number (Percent)	Number (Percent)	Number (Percent)	Number (Percent)	Number (Percent)	Number (Percent)	Number (Percent)	Number (Percent)	Number (Percent)	Number (Percent)	Number (Percent)	Number (Percent)
Chandpur	130 (43.0)	75 (43.1)	80 (32.0)	30 (23.6)	61 (26.2)	26 (19.7)	24 (13.9)	19 (20.9)	5 (7.4)	3 (8.3)	300 (29.3)	153 (27.3)
Kishoreganj	99 (32.8)	44 (25.3)	78 (31.2)	46 (36.2)	60 (25.8)	41 (31.1)	52 (30.1)	19 (20.9)	11 (16.2)	3 (8.3)	300 (29.2)	153 (27.3)
Bogra	38 (12.6)	19 (10.9)	30 (12.0)	21 (16.5)	20 (8.6)	28 (21.2)	23 (13.3)	19 (20.9)	14 (20.6)	13 (36.1)	125 (12.2)	100 (17.9)
Jessore	35 (11.6)	36 (20.7)	62 (24.8)	30 (23.6)	92 (39.5)	37 (28.0)	74 (42.8)	34 (37.4)	38 (55.9)	17 (47.2)	301 (29.3)	154 (27.5)
Total	302 (29.4)	174 (31.1)	250 (24.4)	127 (22.7)	233 (22.7)	132 (23.6)	173 (16.9)	91 (16.3)	68 (6.6)	36 (6.4)	1026 (100.0)	560 (100.0)

impact sample. Intentional over-sampling is evident only for the district of Bogra, where the baseline sample was significantly smaller than that of the other sample districts. These data show clearly that the impact analysis reported here is based on a representative, random, and stratified sample of the baseline farmers [9,10].

The questionnaire was initially developed at IFDC headquarters and tested and modified in Bangladesh. The survey instrument was divided into two major sections. One section sought general socioeconomic and the other agronomic data. Specifically, the following variables are covered:

- Socioeconomic data about the farmer.
- Socioeconomic data on household composition.
- Type of household structure.
- Household furnishings.
- Area cultivated by season.
- Land tenure.
- Fertilizer use.
- Agricultural credit.
- Use of hired labor.
- Irrigation.
- Land preparation.
- Transplanting.
- Gender disaggregated labor data.
- UDP and broadcast yields.
- Child labor.
- Ownership of agricultural equipment.
- Ownership of household furnishings.
- Investment in agricultural equipment.
- House and roof type.
- Animal ownership.
- Household income.
- Crop and animal income.
- Off-farm employment.
- Benefits of UDP use.
- Life wishes.
- Planned UDP use in 2002.

Summary of Salient Findings

- The practice of UDP was introduced to 1,026 farmers in Chandpur, Kishoreganj, Bogra, and Jessore (Table 1).
- UDP farmers significantly reduced the use of broadcast urea, most notably in the Rabi/Boro season (Tables 2 and 3).
- UDP farmers also significantly increased paddy yields by an average 37.6% in the Rabi/Boro season and 45.6% in the Aman season (Table 4).
- On average, improved rice production among UDP users provided the annual rice requirement for an additional 3.2 persons (Table 5).
- Radio ownership among UDP users increased significantly by 19.1% during the period between the baseline and impact surveys (Table 6).
- Compared with nonusers, television ownership significantly increased among UDP users (Table 7).
- Compared with nonusers, UDP farmers substantially increased bicycle ownership from 64.0% in the pre-intervention period to 83.0% in the post-intervention period (Table 8).
- The ownership of traction animals among UDP users remained rather constant compared with a 22.6% decrease among nonusers. UDP users were less compelled to dispose of traction animals (Table 9). This is also the case for ownership of fowl (Table 10).
- Compared with nonusers, UDP farmers were far more likely to make investments in agricultural equipment and on average increased that investment by 12.2% (Table 12).
- On average UDP users increased income from paddy sales by 10.6% compared with a decrease of 15.6% among nonusers (Table 13).
- UDP users provided opportunities for rural employment in fertilizer application by substantially increasing expenditures for hired labor on UDP plots. Those expenditures increased by 251.4% in the Rabi/Boro season and 222.5% in the Aman season on average (Table 14).
- UDP users reported having significantly less labor for weeding. Specifically, mean expenditures for hired weeding labor decreased on average by 35.9% in the Rabi/Boro season and 26.1% in the Aman season (Table 15).
- Compared with nonusers, UDP farmers reduced the percentage of mud floors in their houses by 7.6% on average.
- The five greatest benefits of UDP use reported by farmers are increased rice storage, payment of school expenses, improved houses, improved finances, and purchase of animals (Table 19).

Analytical Approach

The analyses presented and discussed here are based on a paired comparison of 560 pairs of farmers from the pre-intervention survey who were also interviewed in the post-intervention survey. That sample of 560 pairs is divided into two groups of 295 pairs of UDP users and 265 pairs of nonusers. Nonusers never used the practice of UDP, and users practiced broadcast and UDP paddy cultivation only in the post-intervention period but were nonusers in the pre-intervention period. It is on this basis that users and nonusers of UDP are compared, and the consequences of UDP use are evaluated by a two-tailed paired t-test.

The following hypothesis is tested uniformly throughout the analysis:

$$H_o : \mu_{t_1} - \mu_{t_2} = O$$

where t_1 = pre-intervention population mean and t_2 = post-intervention population mean.

Thus, the null hypothesis of no difference between the pre- and post-intervention means of *x* variable is tested for paired farmers who are users and nonusers of UDP in each district and for each user category in total. Throughout this report, a finding of not significant (NS) indicates that the hypothesis of no difference in means cannot be rejected and a statistically significant difference in means indicates the hypothesis of no difference may be rejected at the reported level of statistical significance. Each mean or percentage difference is tested at the 0.10, 0.05, 0.02, 0.01, and 0.001 levels of statistical significance. NS means nonsignificant at $\alpha = 0.1$.

Research Findings

Urea Use

One of the attractive aspects of UDP is that users may expect to reasonably reduce the quantity of urea applied and thus reduce monetary expenditures for that nutrient. The data in Table 2 show a comparison of pre- and post-intervention mean broadcast urea applied by users and nonusers of UDP by district and season.

Indeed these data for UDP users showed that statistically significant decreases in mean broadcast urea applied were reported in the districts of Kishoreganj (–12.4%), Jessore (–16.9%), and for the total user sample in the Rabi/Boro season (–8.2%). A decrease (–3.0%) was reported by the Bogra sample and is without significance. Among UDP users in the Rabi/Boro season, only the district of Chandpur reported a significant increase in mean broadcast applied urea (12.4%).

Although mean broadcast urea applied decreased significantly among nonusers for the Rabi/Boro season in Kishoreganj (–16.6%) and Jessore (–8.5%), it increased significantly in Chandpur (24.9%). Insignificant increases were reported by Bogra (6.8%) and for the total nonuser sample (0.4%). On average, the total figures for users and nonusers of UDP in the Rabi/Boro season show that users applied significantly less broadcast urea than nonusers.

In the Aman season, users of UDP by district and in the aggregate reported no significant changes in mean broadcast urea applied in the post-intervention period compared with the pre-intervention period.

Among nonusers in the Aman season, Table 2 shows no significant change in applied broadcast urea in Kishoreganj (3.0%) and the total nonuser sample (–2.1%). Significant decreases among nonusers were reported by the samples in Bogra (–27.2%) and Jessore (–11.3%). The only district to report a significant increase was Chandpur (18.9%).

Expenditures for Fertilizer

Since the introduction of USG in Bangladesh, farmers have been informed by brochures, videos, field days, radio and television announcements, and by extension services that the practice of UDP and the use of USG have the potential to increase yields and reduce monetary expenditures for urea. The data in Table 3 confirm that benefit was realized well among users of UDP during the pre-and post-intervention period.

Table 2. A Comparison of Pre- and Post-Intervention Mean Broadcast Urea Applied (kg/ha) by Users and Nonusers of UDP by Season and District

District	Current UDP Users			Percentage Increase/ (Decrease)	Level of Statistical Significance	Current UDP Nonusers			Percentage Increase/ (Decrease)	Level of Statistical Significance
	Number of Paired Farmers	Mean Broadcast Urea Applied kg/ha				Number of Paired Farmers	Mean Broadcast Urea Applied kg/ha			
		Pre-Intervention	Post-Intervention				Pre-Intervention	Post-Intervention		
	Rabi/Boro Season									
Chandpur	38	254.4	285.9	12.4	.10	49	235.2	293.7	24.9	.001
Kishoreganj	93	286.3	250.7	(12.4)	.01	22	266.0	221.8	(16.6)	.01
Bogra	30	274.7	266.4	(3.0)	NS	67	257.1	274.6	6.8	NS
Jessore	41	357.9	297.4	(16.9)	.01	91	356.6	326.2	(8.5)	.01
Total	202	293.1	269.1	(8.2)	.01	229	292.8	294.1	0.4	NS
	Aman Season									
Chandpur	53	214.1	233.1	8.9	NS	79	195.1	232.0	18.9	.001
Kishoreganj	40	218.2	187.6	(14.0)	NS	11	179.1	184.4	3.0	NS
Bogra	27	112.2	137.1	22.2	NS	64	169.0	123.0	(27.2)	.01
Jessore	39	262.2	252.8	(3.6)	NS	80	303.1	268.7	(11.3)	.05
Total	159	209.7	210.2	0.2	NS	234	235.1	230.1	(2.1)	NS

NS: Not statistically significant at $\alpha = 0.1$.
Only farmers cultivating broadcast paddy in the pre- and post-intervention periods are considered.

Table 3. A Comparison of Mean Expenditures (US $/ha) for Broadcast Urea and USG by Season and District

District	Current UDP Users			Percentage Increase/ (Decrease)	Level of Statistical Significance
	Number of Paired Farmers	Mean Urea Expenditure (US $/ha)			
		Broadcast Area	UDP Area		
	Rabi/Boro Season				
Chandpur	51	30.60	22.80	(25.5)	.001
Kishoreganj	90	26.00	16.10	(38.1)	.001
Bogra	15	26.60	18.30	(31.2)	.001
Jessore	42	32.40	22.80	(29.6)	.001
Total	198	28.60	19.40	(32.2)	.001
	Aman Season				
Chandpur	16	23.50	15.80	(32.8)	.001
Kishoreganj	41	19.40	14.00	(27.8)	.001
Bogra	4	15.50	11.40	(26.5)	.05
Jessore	40	27.30	22.50	(17.6)	NS
Total	101	23.00	17.60	(23.5)	.01

US $1 = Tk 57.40.
NS: Not statistically significant at $\alpha = 0.1$.
Only farmers cultivating broadcast and UDP paddy areas in the post-intervention period are considered.

During the Rabi/Boro season and on average, those who practiced UDP experienced a 32.2% decrease in expenditures for urea on the UDP area compared with the broadcast paddy area. The greatest saving was reported by the Adapting Nutrient Management Technologies (ANMAT) project sample in Kishoreganj (38.1%) followed by Bogra (31.2%), Jessore (29.6%), and Chandpur (25.5%). Each of these changes is statistically significant and is within the expected range.

A very similar pattern is evident in Table 3 for the Aman season where on average the sample of UDP users decreased expenditures for urea by 23.5%. The greatest saving was reported by the sample in Chandpur (32.8%), followed by Kishoreganj (27.8%), Bogra (26.5%), and Jessore (17.6%); with the exception of Jessore, all saving is statistically significant.

Comparison of Broadcast and UDP Yields

The data on paddy yields shown in Table 4 are instructive per se and provide a lesson on agricultural survey work in developing countries in general and Bangladesh in particular. It appears that the paddy yield data for Chandpur and Kishoreganj are well above reasonable agronomic expectations. The over-estimation of yields may be attributed to at least two factors. First, farmers in Bangladesh are polite and cooperative to field interviews, but it is virtually impossible to interview a particular farmer without others present. This is far less than ideal because interviews intended for a single farmer become “public events” complete with observers, especially when a “foreigner” is present. Succinctly, interviews are a “village event” in Bangladesh that give farmers an opportunity to embellish yields to impress others. Second, the livelihoods of non-governmental organization (NGO) personnel who conduct interviews are dependent on “good” project results. That dependency creates an incentive to embellish paddy yields because those yields are the “essence of everything” in rural Bangladesh. Yields are status, prestige, economic security, and the very fabric of social life and subsistence.

Every effort and full attention was given to the potential problem of yield data during the training sessions for interviewers. Various ANMAT staff members monitored interviews to check the quality and reasonableness of yield data. Despite that effort, it appears that in some cases embellished UDP yields were reported in the districts of Chandpur and Kishoreganj. Specifically, the problems are limited to Chandpur in the Rabi/Boro season where UDP is

Table 4. A Comparison of Pre-Intervention Mean Broadcast Paddy Yields with Post-Intervention Yields Among Users of UDP and Pre- and Post-Intervention Mean Broadcast Paddy Yields Among Nonusers of UDP by Season and District (kg/ha)

District	Current UDP Users			Percentage Increase/ (Decrease)	Level of Statistical Significance	Current UDP Nonusers			Percentage Increase/ (Decrease)	Level of Statistical Significance
	Number of Paired Farmers	Mean Paddy Yield				Number of Paired Farmers	Mean Paddy Yield			
		Pre-Intervention	Post-Intervention				Pre-Intervention	Post-Intervention		
	Rabi/Boro Season									
Chandpur	47	3,951	6,572	66.3	.001	49	3,847	5,307	38.0	.001
Kishoreganj	117	4,971	6,862	38.0	.001	22	4,649	5,064	8.9	NS
Bogra	17	4,484	4,764	6.2	NS	67	4,585	4,682	2.1	NS
Jessore	56	5,476	6,962	27.1	.001	91	5,631	5,840	3.7	.02
Total	237	4,853	6,678	37.6	.001	229	4,849	5,313	9.6	.001
	Aman Season									
Chandpur	36	3,710	5,297	42.8	.001	78	3,332	4,179	25.4	.001
Kishoreganj	84	3,615	5,773	59.7	.001	11	2,999	4,601	53.4	.01
Bogra	5	4,004	4,673	16.7	NS	64	3,787	3,260	(13.9)	.001
Jessore	47	4,273	5,508	28.9	.001	80	4,362	4,465	2.4	NS
Total	172	3,826	5,569	45.6	.001	233	3,795	4,044	6.6	.01

NS: Not statistically significant at $\alpha = 0.1$.

Only farmers cultivating in both the pre- and post-intervention periods are considered.

In Chandpur during the baseline period, feeder canals for the irrigation system were not fully completed and the irrigation water was not supplied in a timely manner. Between the baseline and impact survey, substantial improvement in the irrigation system with a timely water supply was established. At the time of writing the impact report, the irrigation system in the Chandpur UDP area was virtually completed.

reported to have increased paddy yields by 66.3% above broadcast yields and for Kishoreganj in the Aman season where that reported yield increase averaged 59.7%. Finally, in this regard the sample in Chandpur reported an average increased UDP yield of 42.8% compared with broadcast paddy. That is also above expectation but possible because of a low pre-intervention yield and significant improvements in the irrigation system during the project period.

With these caveats, the data in Table 4 show a comparison of pre-intervention mean broadcast urea paddy yields with post-intervention UDP yields among UDP users and pre- and post-intervention mean broadcast paddy yields among nonusers of UDP by season and district. The reader should note that, based on demonstration data, paddy yields from UDP may be reasonably expected to increase by about 18%–35% over broadcast yields.

Among users of UDP, very significant increases in UDP paddy yields compared with broadcast yields were reported for all districts except Bogra, where an increase of 6.2% is not statistically significant. Statistically significant paddy yield increases were reported by UDP users in Chandpur (66.3%), Kishoreganj (38.0%), Jessore (27.1%), and for the total sample of UDP users (37.6%) in the Rabi/Boro season.

Yield increases were also reported by nonusers of UDP for broadcast paddy between the pre- and post-intervention period. However, the percentage change is not nearly of the magnitude of the UDP increases, even compared with those that are probably embellished. As a background note, during the past 2 years paddy yields in Bangladesh have been higher than in nearly a decade.

That said, nonusers in the districts of Chandpur (38.0%), Jessore (3.7%), and the total sample of nonusers in the Rabi/Boro season (9.6%) reported statistically significant increases in broadcast yield during the pre- and post-intervention period. Increases without statistical significance were reported by nonusers in Kishoreganj (8.9%) and Bogra (2.1%) in the Rabi/Boro season.

Among users of UDP in the Aman season, all sample districts reported percentage increases in UDP paddy production compared with the practice of broadcasting urea, and the increases (except Bogra with 16.7%) are statistically significant. Users in Chandpur (42.8%), Kishoreganj (59.7%), Jessore (28.9%), and the total sample of users in the Aman season reported increases with statistical significance.

Among nonusers of UDP, all districts reported increases in broadcasted paddy yields in the Aman season and only in Jessore is that increase without statistical significance (2.4%), Chandpur (25.4%), Kishoreganj (53.4%), and the total nonuser sample (6.6%) reported a statistically significant increase. Among all districts and seasons, only Bogra (–13.9%) reported a statistically significant decrease in broadcast paddy yields during the pre- and post-intervention surveys.

Household Food Security

The incremental rice yield attributable to the use of USG and the UDP practice may be sold or placed in storage. If storage is chosen rather than sale, then household food security is improved. It appears that storage is the modal option among farm households where UDP is practiced (see Table 14).

One method to compare the poverty alleviation value of additional rice production attributable to the practice of UDP is base pre-intervention production on the UDP area as a focused and refined point of comparison. The data in Table 5 show a comparison of annual food security provided by pre- and post-intervention rice production on that basis.

The mean additional persons provided the annual rice requirement above the poverty level is statistically significant in Chandpur (2.8), Kishoreganj (3.1), Bogra (0.6), Jessore (4.5), and among all UDP farmers (3.2). Thus, the UDP practice contributes significantly to poverty alleviation in Bangladesh.

Household Property

Radio Ownership

Compared with nonusers (8.2%), users (19.1%) of UDP significantly increased radio ownership during the pre- and post-intervention period. By

Table 5. A Comparision of Annual Food Security Provided by Pre-Intervention and Post-Intervention Rice Production

District	Mean Rice Production Based on UDP Area			Mean Persons Provided Annual Rice Requirement				Level of Statistical Significance
	Number of Paired Farmers	Pre-Intervention	Post-Intervention	Pre-Intervention	Post-Intervention	Additional Persons	Percentage Increase/ (Decrease)	
Chandpur	61	678	1,303	3.0	5.8	2.8	93.3	.001
Kishoreganj	130	1,232	1,932	5.5	8.6	3.1	56.4	.001
Bogra	20	1,036	1,172	4.6	5.2	0.6	13.0	.05
Jessore	58	2,384	3,401	10.7	15.2	4.5	42.1	.001
Total	269	1,340	2,050	6.0	9.2	3.2	53.3	.001

Annual rice requirement per person = 223.5 kg.
Only farmers cultivating in both the pre- and post-intervention periods are considered.
The data include Rabi/Boro and Aman seasons.
Pre-intervention broadcast paddy area is assumed equal to post-intervention UDP area.

district radio ownership among users increased significantly in Chandpur (22.4%) and Kishoreganj (49.2%). Ownership decreased in Bogra (–6.3%) and Jessore (–15.9%).

Among nonusers the data in Table 6 show that radio ownership increased substantially in the district of Chandpur (56.4%). Ownership also increased in Kishoreganj (17.4%) and Bogra (7.0%). A decrease in radio ownership was reported in Jessore (–12.6%).

Television Ownership

The data in Table 7 show that in the aggregate, television ownership among users (109.3%) and nonusers (54.0%) increased greatly during the period. By district, users reported increases in television ownership in Chandpur (172.7%), Kishoreganj (151.4%), and Jessore (77.4%). There was no change in television ownership during the pre- and post-intervention period in Bogra.

Among nonusers, increases in ownership were reported in Chandpur (287.5%) and Kishoreganj (614.3%). Ownership increased by 23.9% in Bogra and remained constant in Jessore. Radio and television are means of social integration through access to information and news, especially agricultural news. These data show that the practice of UDP is a means to develop social integration in rural Bangladesh.

Bicycle Ownership

Geographical mobility is important but sometimes limited in rural Bangladesh. Personal transportation by bicycle is favored over "hired rickshaws" and carries a measure of status and freedom. For these reasons bicycle ownership is desirable and an indicator of "standard of living."

The data in Table 8 show clearly that UDP users in Chandpur (148.4%), Kishoreganj (58.8%), Jessore (11.4%), and the total sample of users

Table 6. A Comparison of Pre- and Post-Intervention Mean Radio Ownership of Users and Nonusers of UDP by District

District	Current UDP Users			Percentage Increase/ (Decrease)	Current UDP Nonusers			Percentage Increase/ (Decrease)
	Number of Paired Farmers	Percent Radio Ownership			Number of Paired Farmers	Percent Radio Ownership		
		Pre-Intervention	Post-Intervention			Pre-Intervention	Post-Intervention	
Chandpur	66	0.67	0.82	22.4	65	0.55	0.86	56.4
Kishoreganj	107	0.59	0.88	49.2	16	0.69	0.81	17.4
Bogra	20	0.80	0.75	(6.3)	42	0.71	0.76	7.0
Jessore	55	0.82	0.69	(15.9)	86	0.87	0.76	(12.6)
Total	248	0.68	0.81	19.1	209	0.73	0.79	8.2

Table 7. A Comparison of Pre- and Post-Intervention Mean Television Ownership of Users and Nonusers of UDP by District

District	Current UDP Users			Percentage Increase/ (Decrease)	Current UDP Nonusers			Percentage Increase/ (Decrease)
	Number of Paired Farmers	Percent Television Ownership			Number of Paired Farmers	Percent Television Ownership		
		Pre-Intervention	Post-Intervention			Pre-Intervention	Post-Intervention	
Chandpur	39	33.0	90.0	172.7	29	24.0	93.0	287.5
Kishoreganj	52	35.0	88.0	151.4	7	14.0	100.0	614.3
Bogra	11	82.0	82.0	0.0	24	67.0	83.0	23.9
Jessore	36	53.0	94.0	77.4	51	63.0	63.0	0.0
Total	138	43.0	90.0	109.3	111	50.0	77.0	54.0

Table 8. A Comparison of Pre- and Post-Intervention Mean Bicycle Ownership of Users and Nonusers of UDP by District

District	Current UDP Users			Percentage Increase/ (Decrease)	Current UDP Nonusers			Percentage Increase/ (Decrease)
	Number of Paired Farmers	Percent Bicycle Ownership			Number of Paired Farmers	Percent Bicycle Ownership		
		Pre-Intervention	Post-Intervention			Pre-Intervention	Post-Intervention	
Chandpur	26	31	77	148.4	23	43	65	51.2
Kishoreganj	86	51	81	58.8	7	29	100	244.8
Bogra	23	91	78	(14.3)	34	68	71	4.4
Jessore	58	88	98	11.4	95	89	95	6.7
Total	193	64	83	29.7	159	75	86	14.7

increased bicycle ownership. Only users in Bogra reported a decrease in ownership (14.3%). Overall, UDP users clearly increased bicycle ownership in the period between the baseline and impact surveys (29.7%).

Among nonusers, only Kishoreganj (244.8%) of the total sample (14.7%) reported significant increases in bicycle ownership. Increases were also reported in the districts of Chandpur (51.2%), Bogra (4.4%), and Jessore (6.7%).

Clearly, the use of UDP provided resources for farmers and household members to improve means of personal transportation beyond that of nonusers. The ease of mobility in Bangladesh is valued and desirable among rural populations because it enhances ease of access to markets and transportation of goods.

Traction Animal Ownership

A comparison of pre- and post-intervention traction animal ownership among users and nonusers of UDP by district is shown in Table 9. Depending on circumstances, there is a general trend in Bangladesh to divest ownership of traction animals. Leather prices were favorable during the pre- and post-intervention period and prompted farmers to sell animals. Second, during interviews many complained of the expense and burden of owning traction animals. Third, preparation of land by machine is relatively quicker and less expensive.

Given these considerations, the ownership of traction animals among users decreased significantly in Jessore (–23.4%). Decreases were also reported in Bogra (–4.9%), and for all users (–0.8%) but without statistical significance. Increases in traction animal ownership among users were reported in Chandpur (1.8%) and Kishoreganj (13.4%) but were not statistically significant. The substantial decrease in Jessore may be attributable to the flood during the project period.

Among nonusers, significant decreases in traction animal ownership were reported in Jessore (–45.7%) and for all nonusers (–22.6%). Chandpur also reported a decrease of 20.3% without statistical significance. An increase was reported in Bogra (15.1%) without significance. The only statistically significant increase in ownership of animal traction among nonusers of UDP was reported in Kishoreganj (52.9%).

Animal Ownership

Fowl Ownership—Table 10 shows a comparison of pre- and post-intervention mean fowl ownership among users and nonusers of UDP by district. Fowl (chickens, ducks, and pigeons) are a form of "walking capital" and a food source in Bangladesh.

In the aggregate, nonusers of UDP reported a statistically significant decrease in fowl ownership (–11.9%), considerably greater than that among UDP users (–1.4%). That is not statistically significant. In the aggregate these data suggest that compared with nonusers, UDP users were less compelled to sell or consume fowl during the pre- and post-intervention period. Thus, users may benefit from expanding fowl ownership because the base for reproduction is better preserved. Among users, Chandpur is the only district that reported a statistically significant

Table 9. A Comparison of Pre- and Post-Intervention Mean Traction Animal Ownership Among Users and Nonusers of UDP by District

District	Current UDP Users			Percentage Increase/ (Decrease)	Level of Statistical Significance	Current UDP Nonusers			Percentage Increase/ (Decrease)	Level of Statistical Significance
	Number of Paired Farmers	Mean Traction Animals Owned				Number of Paired Farmers	Mean Traction Animals Owned			
		Pre-Intervention	Post-Intervention				Pre-Intervention	Post-Intervention		
Chandpur	71	1.63	1.66	1.8	NS	73	1.58	1.26	(20.3)	NS
Kishoreganj	123	2.32	2.63	13.4	NS	19	1.89	2.89	52.9	.10
Bogra	27	3.89	3.70	(4.9)	NS	57	2.12	2.44	15.1	NS
Jessore	55	3.42	2.62	(23.4)	.02	94	3.52	1.91	(45.7)	.001
Total	276	2.51	2.49	(0.8)	NS	243	2.48	1.92	(22.6)	.001

NS: Not statistically significant at $\alpha = 0.1$.

Table 10. A Comparison of Pre- and Post-Intervention Mean Fowl Ownership Among Users and Nonusers of UDP by District

District	Current UDP Users			Percentage Increase/ (Decrease)	Level of Statistical Significance	Current UDP Nonusers			Percentage Increase/ (Decrease)	Level of Statistical Significance
	Number of Paired Farmers	Mean Fowl Ownership				Number of Paired Farmers	Mean Fowl Ownership			
		Pre-Intervention	Post-Intervention				Pre-Intervention	Post-Intervention		
Chandpur	74	13.3	16.9	27.1	.05	79	11.7	12.6	7.7	NS
Kishoreganj	130	13.1	10.7	(18.3)	.02	22	12.4	8.8	(29.0)	.02
Bogra	32	18.5	21.3	15.1	NS	67	17.5	16.3	(6.9)	NS
Jessore	58	16.8	15.0	(10.7)	NS	94	14.7	10.9	(25.9)	.02
Total	294	14.5	14.3	(1.4)	NS	262	14.3	12.6	(11.9)	.10

NS: Not statistically significant at $\alpha = 0.1$.

increase in fowl ownership (27.1%). Only Kishoreganj reported a statistically significant decrease in fowl ownership among users (–18.3%). Bogra reported an increase (15.1%) and Jessore a decrease in fowl ownership (–10.7%); however, both these latter changes are without significance statistically.

Among nonusers the districts of Kishoreganj (–29.0%), Bogra (–6.9%), and Jessore (–25.9%) reported decreases in fowl ownership. However, the decrease in Bogra is not statistically significant. Chandpur reported an increase of 7.7% also without statistical significance. Clearly, nonusers consumed or sold fowl more than users during the pre- and post-intervention period.

Small Ruminant Ownership—Among users of UDP, the data in Table 11 show that mean ownership of small ruminants decreased in Kishoreganj (–47.4%), Jessore (–11.1%), and for total users (–18.2%). That change was only statistically significant in Kishoreganj. Ownership increased in Chandpur (85.7%) and Bogra (19.0%) but is without statistical significance.

Among UDP nonusers, mean small ruminant ownership decreased during the pre- and post-intervention period in Chandpur (–50.0%), Kishoreganj (–18.8%), Jessore (–20.8%), and for all nonusers (–13.6%). With the exception of Jessore, these decreases are without statistical significance.

It may be concluded that the method of N application does not significantly influence the ownership of small ruminants in general. The notable exceptions are Kishoreganj among UDP users and Jessore among nonusers.

Investment in Agricultural Equipment

Regardless of UDP use, no district in the ANMAT sample reported a statistically significant mean increase in investment in agricultural equipment during the pre- and post-intervention period (Table 12).

On a percentage basis, increased investments in agricultural equipment were reported among UDP users in the districts of Kishoreganj (11.9%), Bogra (28.7%), Jessore (23.1%), and for all users (12.2%). Only Chandpur (–40.1%) reported a decrease in mean investment in agricultural equipment.

Among nonusers, percentage decreases in investment in agricultural equipment were reported in the districts of Chandpur (–54.6%), Kishoreganj (–100.0%), Jessore (–27.7%), and for all nonusers (–12.6%). Only Bogra reported an increase (20.4%), which is not statistically significant.

It may be concluded that users improved mean investment in agricultural equipment by 12.2%. In contrast, that investment among nonusers decreased by 12.6%. Albeit without statistical significance, these changes should not be ignored entirely. Note that the direction of change among users and nonusers is opposite.

Paddy Sales Income

Depending on circumstance and need, paddy may be sold or stored, and the latter evokes the concept of food security. The data in Table 13 provide a comparison of pre- and post-intervention mean paddy income among users and nonusers of UDP and by deduction a view of paddy storage.

Among UDP users, mean income from sales of paddy increased in Chandpur (462.7%), Kishoreganj (2.3%), Bogra (10.7%), and for the sample of users (10.6%). Only the change in Chandpur is statistically significant where the small base sales in the pre-intervention period should be noted. Among nonusers, income from paddy sales also increased significantly in Chandpur (665.2%), again from a small pre-intervention base; Kishoreganj (10.7%) was without significance.

Such income decreased in Bogra (–12.7%), Jessore (–60.7%), and for the total sample of nonusers (–15.6%). Both decreases are statistically significant. The decrease in Jessore is undoubtedly explained by the severe floods in that district during the pre- and post-intervention period. Note that sales increased among users (10.6%) and decreased among nonusers (–15.6%) in the aggregate. The

Table 11. A Comparison of Pre- and Post-Intervention Mean Small Ruminant Ownership Among Users and Nonusers of UDP by District

District	Current UDP Users			Percentage Increase/ (Decrease)	Level of Statistical Significance	Current UDP Nonusers			Percentage Increase/ (Decrease)	Level of Statistical Significance
	Number of Paired Farmers	Mean Small Ruminants				Number of Paired Farmers	Mean Small Ruminants			
		Pre-Intervention	Post-Intervention				Pre-Intervention	Post-Intervention		
Chandpur	6	0.7	1.3	85.7	NS	4	1.0	0.5	(50.0)	NS
Kishoreganj	50	1.9	1.0	(47.4)	.02	9	1.6	1.3	(18.8)	NS
Bogra	15	2.1	2.5	19.0	NS	26	2.1	2.2	4.8	NS
Jessore	51	2.7	2.4	(11.1)	NS	81	2.4	1.9	(20.8)	.10
Total	122	2.2	1.8	(18.2)	NS	120	2.2	1.9	(13.6)	NS

NS: Not statistically significant at $\alpha = 0.1$.

Table 12. A Comparison of Pre- and Post-Intervention Mean Investment (US $) in Agricultural Equipment Among Users and Nonusers of UDP by District

District	Current UDP Users			Percentage Increase/ (Decrease)	Current UDP Nonusers			Percentage Increase/ (Decrease)
	Number of Paired Farmers	Mean Investmentent			Number of Paired Farmers	Mean Investmentent		
		Pre-Intervention	Post-Intervention			Pre-Intervention	Post-Intervention	
Chandpur	48	285.46	170.94	(40.1)	44	115.66	52.5	(54.6)
Kishoreganj	101	299.66	335.3	11.9	22	121.05	0	(100.0)
Bogra	26	1,004.62	1,292.58	28.7	48	1,068.06	1,285.54	20.4
Jessore	50	788.32	970.74	23.1	73	876.88	634.07	(27.7)
Total	225	486.68	545.95	12.2	187	687.32	600.85	(12.6)

US $1 = Tk 51.00.

Agricultural equipment includes power tiller, sprayer, irrigation pump, weeding machine, and paddy thresher.

Table 13. A Comparison of Pre- and Post-Intervention Mean Paddy Income (US $) of Users and Nonusers of UDP by District

District	Current UDP Users			Percentage Increase/ (Decrease)	Current UDP Nonusers			Percentage Increase/ (Decrease)
	Number of Paired Farmers	Mean Paddy Income			Number of Paired Farmers	Mean Paddy Income		
		Pre-Intervention	Post-Intervention			Pre-Intervention	Post-Intervention	
Chandpur	65	31.51	177.32	462.7	62	25.23	193.07	665.2
Kishoreganj	131	553.63	566.14	2.3	22	284.14	314.44	10.7
Bogra	32	685.23	758.61	10.7	68	625.12	545.5	(12.7)
Jessore	56	253.82	222.58	(12.3)	89	337.78	132.87	(60.7)
Total	284	389.84	431.09	10.6	241	333.55	281.36	(15.6)

US $1 = Tk 51.00.

opposite directions of change should not be ignored entirely.

Expenditures for Hired Labor[1]

Fertilizer Application

The data in Table 14 compare mean expenditures for hired labor for fertilizer application on broadcast and UDP areas among UDP users by season and district.

These data for the Rabi/Boro season show substantial and statistically significant greater expenditures for the UDP area compared with the broadcast area. In Chandpur that increase is $8.70/ha, Bogra ($13.10/ha), Jessore ($10.90/ha), and for the overall sample in the Rabi/Boro season ($8.80/ha). An increase in such expenditures was also reported in Kishoreganj ($3.10/ha) without statistical significance.

[1]All $ values are U.S. dollars.

Table 14. A Comparison of Mean Expenditures for Hired Labor Days Per Hectare for Fertilizer Application on Broadcast and UDP Areas by Season and District

District	Current UDP Users			Mean Difference US $	Percentage Increase/ (Decrease)	Level of Statistical Significance
	Number of Paired Farmers	Mean Expenditures for Fertilizer Application (US $)				
		Broadcast Area	UDP Area			
	Rabi/Boro Season					
Chandpur	3	1.70	10.40	8.70	511.8	0.05
Kishoreganj	5	5.70	8.80	3.10	54.4	NS
Bogra	4	1.60	14.70	13.10	818.8	0.1
Jessore	5	4.00	14.90	10.90	272.5	0.001
Total	17	3.50	12.30	8.80	251.4	0.001
	Aman Season					
Chandpur	2	1.30	11.30	10.00	769.2	0.1
Kishoreganj	2	7.90	11.40	3.50	44.3	NS
Jessore	5	3.90	14.90	11.00	282.1	0.01
Total	9	4.00	12.90	8.90	222.5	0.001

US $1 = Tk 57.40.
NS: Not statistically significant at $\alpha = 0.1$.
Insufficient cases (1) for analysis in Bogra.

A similar pattern in expenditures for hired labor for fertilizer application is evident for the Aman season where statistically significant increases are reported in Chandpur ($10.00/ha), Jessore ($11.00/ha), and all the total sample users ($8.90/ha). That increase in Kishoreganj ($3.50/ha) is not significant statistically.

These data show the contributions of UDP in providing employment opportunities for day wage labor and thus alleviation of poverty. One way to view the value of aggregate expenditure here is to convert the mean increase in aggregate expenditures for labor ($8.80/ha) in the Rabi/Boro season to equivalent days of rice. To wit, $8.80 x 57.4 Tk = 505 Tk ÷ the average retail of 1 kg of rice (12.5 Tk) = 40 kg of rice. The daily rice consumption required to be above the poverty level is 0.61 kg. Thus, 40.0 kg of rice ÷ 0.61 = 65.6 days of food security above the poverty level for hired labor is attributable to the practice of UDP.

Weeding

As noted earlier, a decrease in required weeding of UDP paddy compared with broadcast paddy is a reasonable agronomic expectation. The data in Table 15 confirm that expectation and show substantial and significant decreases in mean expenditures for hired labor per weeding in the Rabi/Boro and Aman seasons in every district in the ANMAT sample.

In the Rabi/Boro season, the districts of Chandpur (–$21.60), Kishoreganj (–$11.00), and the total sample of users (–$11.50) reported statistically significant decreases in mean expenditures for weeding. Bogra (–$4.80) and Jessore (–$3.00) also reported decreases in such expenditures compared with the broadcast paddy area, but these changes are not statistically significant.

Mean expenditures for hired labor for weeding UDP paddy compared with broadcast paddy also decreased with statistical significance in Chandpur (–$18.00/ha), Kishoreganj (–$10.00/ha), and for the total sample of users who cultivated paddy in the Aman season (–$7.20/ha). The decreases in Bogra (–$0.40/ha) and Jessore (–$1.90/ha) are not significant.

When compared with broadcast paddy, these data show that UDP farmers realize significant saving in expenditures for weeding by hired labor-

Table 15. A Comparison of Mean Expenditures for Hired Labor Days Per Hectare for Weeding on Broadcast and UDP Areas by Season and District

	Current UDP Users			Mean Difference US $	Percentage Increase/ (Decrease)	Level of Statistical Significance
District	Number of Paired Farmers	Mean Expenditures for Weeding (US $)				
		Broadcast Area	UDP Area			
	Rabi/Boro Season					
Chandpur	35	48.30	26.70	21.60	(44.7)	0.001
Kishoreganj	46	24.20	13.20	11.00	(45.5)	0.001
Bogra	12	36.00	31.20	4.80	(13.3)	NS
Jessore	29	23.20	20.20	3.00	(12.9)	NS
Total	122	32.00	20.50	11.50	(35.9)	0.001
	Aman Season					
Chandpur	11	40.30	22.30	18.00	(44.7)	0.01
Kishoreganj	22	22.90	12.90	10.00	(43.7)	0.001
Bogra	4	29.90	29.50	0.40	(1.3)	NS
Jessore	29	26.10	24.20	1.90	(7.3)	NS
Total	66	27.60	20.40	7.20	(26.1)	0.001

US $1 = Tk 57.40.
NS: Not statistically significant at $\alpha = 0.1$.
Only farmers who cultivated broadcast and UDP areas and employed hired labor for weeding are considered.

ers. This saving is an attractive feature of the UDP practice that is a significant factor in adoption.

Housing Characteristics

Houses in rural Bangladesh are typically constructed of straw, mud, bamboo, tin, or cement. Because the ANMAT baseline data indicated that improved housing was a wish of farmers, particularly in Jessore, the post-intervention survey included a number of questions about housing characteristics.

Mud Houses

The data in Table 16 show a comparison of the mean occupancy of mud houses in the pre- and post-intervention period among users and nonusers of UDP by district under normal circumstances. One would not expect digression in the "quality" of housing from cement to straw, but use of UDP may provide finances to improve housing quality. The frequency of straw, bamboo, and cement houses are minimal in the ANMAT sample and mud and tin are modal types.

Among users of UDP, the frequency of mud houses in Chandpur and Bogra remained constant during the pre- and post-intervention period. However, the occupancy of mud houses decreased on a percentage basis in Jessore (–81.4%) and for the total sample of users (–42.0%).

Among nonusers, the occupancy of mud houses also decreased significantly in Bogra (–13.8%), Jessore (–37.3%), and for the total sample of nonusers (–23.3%). An increase of 34.0% in mud houses was reported in Chandpur.

Overall, the data in Table 16 show that users of UDP decreased the occupancy of mud houses by –42.0% compared with –23.3% among nonusers. Therefore, UDP users realized resources to improve their standard of living through improved housing.

Tin Houses

During the pre- and post-intervention period, the data in Table 17 show that on average, users of UDP in Chandpur (9.1%), Kishoreganj (29.6%), Jessore (150.0%), and the total sample of users (22.4%) increased occupancy of tin houses. There was no change in the mean occupancy of tin houses in Bogra. The very significant change in Jessore is explained by pervasive rebuilding, government loans of cash, and distribution of USG following floods in the period between the ANMAT pre- and post-intervention surveys.

The mean occupancy of tin houses also increased significantly among nonusers of UDP in Chandpur (16.9%), Kishoreganj (53.8%), and for the total sample of nonusers (28.0%).

Although users and nonusers of UDP increased the mean occupancy of tin houses during the pre-

Table 16. A Comparison of Pre- and Post-Intervention Mean Occupancy of Mud Houses by Users and Nonusers of UDP by District

District	Current UDP Users			Percentage Increase/ (Decrease)	Current UDP Nonusers			Percentage Increase/ (Decrease)
	Number of Paired Farmers	Percent Mud Houses			Number of Paired Farmers	Percent Mud Houses		
		Pre-Intervention	Post-Intervention			Pre-Intervention	Post-Intervention	
Chandpur	6	50	50	0.0	6	50	67	34.0
Bogra	30	87	87	0.0	62	94	81	(13.8)
Jessore	33	97	18	(81.4)	63	83	52	(37.3)
Total	69	88	51	(42.0)	131	86	66	(23.3)

There are insufficient cases for analysis in Kishoreganj (2).

Table 17. A Comparison of Pre- and Post-Intervention Mean Occupancy of Tin Houses by Users and Nonusers of UDP by District

District	Current UDP Users			Percentage Increase/ (Decrease)	Current UDP Nonusers			Percentage Increase/ (Decrease)
	Number of Paired Farmers	Percent Tin Houses			Number of Paired Farmers	Percent Tin Houses		
		Pre-Intervention	Post-Intervention			Pre-Intervention	Post-Intervention	
Chandpur	74	88	96	9.1	76	83	97	16.9
Kishoreganj	121	71	92	29.6	20	65	100	53.8
Bogra	6	67	67	0.0	8	25	75	200.0
Jessore	5	40	100	150.0				
Total	206	76	93	22.4	104	75	96	28.0

There are insufficient cases for analysis among nonusers in Jessore (3).

and post-intervention period, the increases in Jessore and Kishoreganj among users are more significant than that among nonusers. Increases in mean occupancy of tin houses among total users and nonusers are significant, although the percentage increase among users (22.4%) is somewhat less than that among nonusers (28.0%).

House Flooring

Cement floors are preferable to mud floors in Bangladesh. The data in Table 18 compare mean mud floors in houses of users and nonusers of UDP by district. Decreases in the frequency of mud floors are assumed to be replaced by cement and represent improvement in housing quality.

The percentage of houses with mud floors decreased among UDP users in Chandpur (–2.1%), Kishoreganj (–8.8%), Bogra (–9.3%), Jessore (–8.0%), and among total users (–7.6%). However, only the decreases in Kishoreganj and for total users are substantial.

These data are less uniform among nonusers; a single district, Bogra, reported a significant decrease in mean mud floors (–12.1%). Chandpur also reported a decrease of (–4.0%). Nonusers in Kishoreganj and the total sample of nonusers reported no changes in mean mud floors.

The significant percentage increase in mud floors among nonusers in Jessore (16.5%) is an anomaly (Table 18) especially compared with a –8.0% decrease among users in that district. Overall, users compared with nonusers significantly reduced the mean number of houses with mud floors and very likely replaced such floors with cement. The practice of UDP may have well provided resources for that improvement.

Table 18. A Comparison of Pre- and Post-Intervention Mean Mud Floors in Houses Among Users and Nonusers of UDP by District

	Current UDP Users			Percentage Increase/ (Decrease)	Current UDP Nonusers			Percentage Increase/ (Decrease)
	Number of Paired Farmers	Percent Mud Floors			Number of Paired Farmers	Percent Mud Floors		
		Pre-Intervention	Post-Intervention			Pre-Intervention	Post-Intervention	
Chandpur	72	94	92	(2.1)	78	99	95	(4.0)
Kishoreganj	117	91	83	(8.8)	22	95	95	0.0
Bogra	32	97	88	(9.3)	67	99	87	(12.1)
Jessore	46	87	80	(8.0)	84	79	92	16.5
Total	267	92	85	(7.6)	251	92	92	0.0

Qualitative Benefits of UDP Use

The sample of 295 UDP users was asked to state one to three benefits of that practice and each user expressed at least one. The data in Table 19 show that the sample UDP users expressed 29 types of benefits, an average of 1.8. The relative ranks of each benefit are shown in bold numbers by district and for the total sample of users.

For the total sample, increased rice storage, thus food security, represented the greatest percentage of all 542 benefits expressed (16.2%), followed by payment of educational expenses (12.9%), improved housing (11.8%), improved finances (10.0%), purchased animals (8.5%), purchased agricultural equipment (6.5%), purchased new clothing (5.9%), started or improved small business (4.1%), purchased household appliances (3.3%), improved household furnishings (3.0%), and installation of a tube well (3.0%). These benefits, ranked 1–10 in Table 19, represent 85.0% of all qualitative benefits expressed by UDP users in the post-intervention period.

The modal benefit reported in Chandpur is an "improved house" (19.5%). Such improvements are most often floors, roofs, or earthen barriers for high water. The modal benefit in Kishoreganj is increased rice storage (24.8%). Rice storage means "food security" and was often expressed as "improved diet." Such storage also means having to purchase less rice and thus makes limited cash available for other purchases and living expenses. The sample in Bogra expressed most frequently the purchase of household appliances as a benefit of the UDP practice. Such appliances include radios, electric fans, lanterns, rice cookers, sewing machines, and, least often, a television. In Jessore new clothing was the modal reported benefit (16.0%). Perhaps clothing was lost or destroyed by the flood in the area that occurred between the pre- and post-intervention period.

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Table 19. Qualitative Benefits of UDP Reported by Users by District and Rank

Benefit[a]	District												*Total*		
	Chandpur			Kishoreganj			Bogra			Jessore					
	Number of Responses	Percent	Rank	Number of Responses	Percent	Rank	Number of Responses	Percent	Rank	Number of Responses	Percent	Rank	Number of Responses	Percent	Rank
Increased rice storage	29	15.7	**3**	41	24.8	**1**	1	2.1	**10**	17	11.8	**4**	88	16.2	**1**
Paid educational expenses	32	17.3	**2**	12	7.3	**5**	6	12.5	**2**	20	13.9	**2**	70	12.9	**2**
Improved house	36	19.5	**1**	9	5.5	**6**	1	2.1	**10**	18	12.5	**3**	64	11.8	**3**
Improved financial condition	16	8.6	**4**	24	14.5	**3**	5	10.4	**4**	9	6.3	**7**	54	10.0	**4**
Purchased animals	7	3.8	**8**	27	16.4	**2**	2	4.2	**7**	10	6.9	**6**	46	8.5	**5**
Purchased agricultural equipment	14	7.6	**5**	6	3.6	**8**	2	4.2	**7**	13	9.0	**5**	35	6.5	**6**
Purchased new clothing	0	0.0	19	8	4.8	**7**	1	2.1	**10**	23	16.0	**1**	32	5.9	**7**
Started or improved a small business	7	3.8	**8**	4	2.4	**10**	6	12.5	**2**	5	3.5	**10**	22	4.1	**8**
Purchased household appliances	2	1.1	14	1	0.6	15	7	14.6	**1**	8	5.6	**8**	18	3.3	**9**
Improved household furnishings	11	5.9	**6**	2	1.2	13	2	4.2	**7**	1	0.7	15	16	3.0	**10**
Installed a tube well	0	0.0	19	13	7.9	**4**	0	0.0	22	3	2.1	12	16	3.0	**10**
Purchased fowl	8	4.3	**7**	0	0.0	21	0	0.0	22	7	4.9	**9**	15	2.8	12
Rented-in additional land	2	1.1	14	1	0.6	15	3	6.3	**5**	4	2.8	11	10	1.8	13
Constructed latrine	3	1.6	12	5	3.0	**9**	1	2.1	**10**	0	0.0	16	9	1.7	14
Improved transportation	0	0.0	19	3	1.8	11	3	6.3	**5**	3	2.1	12	9	1.7	14
Purchased medication	4	2.2	11	0	0.0	21	0	0.0	22	3	2.1	12	7	1.3	16
Invested in fish cultivation	6	3.2	**10**	0	0.0	21	1	2.1	**10**	0	0.0	16	7	1.3	16
Investment in agricultural inputs	2	1.1	14	3	1.8	11	1	2.1	**10**	0	0.0	16	6	1.1	18
Purchased a timber tree	2	1.1	14	1	0.6	15	0	0.0	22	0	0.0	16	3	0.6	19
Repaired agricultural equipment	3	1.6	12	0	0.0	21	0	0.0	22	0	0.0	16	3	0.6	19
Improved animal husbandry	0	0.0	19	2	1.2	13	0	0.0	22	0	0.0	16	2	0.4	21
Established a pond	0	0.0	19	1	0.6	15	1	2.1	**10**	0	0.0	16	2	0.4	21
Purchased additional agriculture land	0	0.0	19	1	0.6	15	1	2.1	**10**	0	0.0	16	2	0.4	21
Built a new house	0	0.0	19	0	0.0	21	1	2.1	**10**	0	0.0	16	1	0.2	24
Paid for marriage	0	0.0	19	1	0.6	15	0	0.0	22	0	0.0	16	1	0.2	24
Increased paddy sales	0	0.0	19	0	0.0	21	1	2.1	**10**	0	0.0	16	1	0.2	24
Purchased watch	0	0.0	19	0	0.0	21	1	2.1	**10**	0	0.0	16	1	0.2	24
Purchased an irrigation pump	0	0.0	19	0	0.0	21	1	2.1	**10**	0	0.0	16	1	0.2	24
Purchased wood fuel	1	0.5	18	0	0.0	21	0	0.0	22	0	0.0	16	1	0.2	24
Total Responses	185	100.0		165	100.0		48	100.0		144	100.0		542	100.0	

a. Farmers expressed one to three benefits.

Paper Series IFDC—P-38
August 2007
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Muscle Shoals, Alabama 35662 (U.S.A.)

ISBN-13: 978-0-88090-160-4