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Government input support on *Aus* rice production in Bangladesh: impact on farmers' food security and poverty situation

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Abstract

Background: *Aus* rice began to lose its importance as farmers slowly started shifting to cultivation of irrigated *Boro* rice encouraged by its higher yields. The government of Bangladesh has launched an incentive programme for small and marginal farmers with an attempt to rejuvenate *Aus* rice cultivation. The aim of this study is to assess the impact of government input support on *Aus* rice production in Bangladesh and its impact on food security and farmers' poverty situation. A total of 120 (i.e., 60 supported and 60 non-supported) farmers from two upazilas of Mymensingh district were selected. Data were analysed with a combination of descriptive statistics, mathematical and statistical techniques.

Results: The results show that rice cultivation occupied the major portion of farmers' total cropped area. The government of Bangladesh had provided with input (both cash and kind) support in order to boost *Aus* rice (UFSHI and NERICA variety) production. Cropping intensity of supported farmers' was increased by 39.7%, whereas it was increased by only 1.4% for non-supported farmers. Productivity of *Aus* rice was 138.0 and 100.0% in stare of supported and non-supported farmers, respectively. Average per capita daily calorie intake of the households was still below the national average level of 2122 kcal. Poverty in terms of deprivation of health education, employment, housing, mobility and income was decreased, and overall livelihood circumstances were improved through government input support on *Aus* rice production.

Conclusions: The study concludes that the motivation provided with by the government through input support on *Aus* rice production was highly appreciated by the farmers. Though per capita daily calorie intake by the farmers was still under the national average level, supported farmers were more food secure than non-supported farmers. Several dimensions of poverty were decreased, and overall socioeconomic status was improved. The study recommended that scientific and technical training programmes should be arranged to raise farmers' awareness about Aus rice production for enhancing their livelihood.

Keywords: Government, Input support, *Aus* rice, Food security, Poverty

Background

Bangladesh is the 4th largest country in the world with respect to rice area and production [1]. At present, the net cultivable area is about 8.50 M ha and net cultivated area is 7.45 M ha [2]. Rice is the staple food for the people of Bangladesh. It grows in all the three crop growing seasons of the year and occupies about 77% (11.42 M ha) of the total cropped area of about 14.94 M ha. Rice alone constitutes about 93% of the total food grains produced annually in the country [3]. *Aus* rice has been contributing to food production in addition to other two rice crops (*Aman* and *Boro*) until mid-1980s. The production seasons of *Aus*, *Aman* and *Boro* rice are *Kharif*—I (April–July), *Kharif*—II (July–November) and *Rabi* (November–April), respectively. *Aus* rice began to lose its importance as farmers slowly started shifting to

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cultivation of irrigated *Boro* rice encouraged by its higher yields. The acreage during the *Aus* season dwindled below 10 lakh ha now, from 30 lakh ha in early 1980s. Rice output during the *Aus* season slumped to almost half at 17 lakh tonnes from over 30 lakh tonnes in early 1980s. At the same time, the acreage and production of *Boro* rice shot up several folds. One of the reasons behind the falling of *Aus* rice production is non-availability of land as its seed sowing or transplanting period falls during the March and April months when *Boro* rice still remains in the field. Farmers are not getting enough time and land to grow *Aus* rice [4].

Increased production of rice during the *Boro* season has also dampened farmers' interest to stay in the cultivation of *Aus* rice, which grows on an upland situation and requires less irrigation because of monsoon during its growth period. Farmers do not like to grow *Aus* rice as they get higher output from *Boro* rice. The government wants to use the advantage of less irrigation requirement of *Aus* rice with an objective to cut dependency on the underground water for irrigation and arrest the fall in the water level in the aquifer. *Aus* rice can create new scope by scaling up production and shed dependency on the underground water [5].

Governments in both developed and developing countries intervene in agriculture with a view to achieving a wide range of economic and social objectives. Incentives on agricultural production are a common element in agricultural development, the aim of which is to promote adoption of new technologies and thus increase agricultural productivity [6]. The reasons for government intervention include self-sufficiency, employment creation, support small-scale producers for adopting modern technologies and inputs, reduce price instability and improve the income of farm households. This intervention can take a number of forms such as price support programmes, direct payments and input support to influence the cost and availability of farm inputs like credit, fertilizers, seeds, irrigation water, etc. Of all domestic support instruments in agriculture, input support is the most common. The provision of input support is linked to the achievement of self-sufficiency in food production and food security. Input support can bring economic benefits to society but can also be a major cause of negative environmental externalities when they promote excessive use of fertilizers, agrochemicals and irrigation water.

However, the government of Bangladesh has launched an incentive programme with a cost of Tk. 336.2 million for small and marginal farmers in the country with an attempt to rejuvenate the cultivation of *Aus* rice. Besides, the government has allocated Tk. 19.6 million for enhancing sweet pumpkin and *dhaincha* production. Under the programme, a total of 231,363 small and marginal farmers will get necessary seed and chemical fertilizers at the free of cost for cultivating local high yielding variety (HYV) and NERICA (a stress tolerant African variety) of *Aus* rice in 49 drought prone districts across the country. These necessary inputs have already been moved to different stations across the country, and the farmers are getting these inputs for cultivating the *Aus* rice.

Importance of such modality has been portrayed in a good number of studies. A taciturn effort has been made here to appraise the previous research studies which are: Salam et al. [7] assessed the strategic plan for increasing *Aus* and *Aman* rice cultivation in Bangladesh and identified *Aus*- and *Aman*-based cropping pattern appears to be quite prospective; Parvin [8] focused on cash subsidy support to the farmers by the government for increasing farm level production in Bangladesh and found that marginal farmers have enjoyed more advantages in terms of cash benefits (12.0% surplus) than small and medium farmers; Barkat [9] conducted a quantitative analysis of fertilizer demand and subsidy policy in Bangladesh and found that fertilizer distribution switched from market mechanism to government machinery apparently without any rigorous evaluation study of the system; Chirwa et al. [10] identified the factors influencing access to agricultural input subsidy coupons in Malawi and showed that poor and elderly-headed households were less likely to receive fertilizer coupons and receive less of the subsidized fertilizers, whereas households with larger land parcels and semi-commercialized farmers were more likely to receive coupons and acquire more subsidized fertilizers; Sharma and Thaker [11] examined trends in fertilizer subsidy and its distribution system between farmers and fertilizer industry across different farm sizes in India and highlighted that reduction in fertilizer subsidy has adverse impact on farm production and income of small and marginal farmers as they do not get benefit from higher output prices but do benefit from lower input prices.

It is evident from the above discussion that no empirical study has been conducted yet in Bangladesh on impact of government incentives like input support on *Aus* rice production. Thus, there exists a scope to identify the impact of government input support on increasing *Aus* rice production in Bangladesh. The research will present an updated status of the distribution system of government input support in producing *Aus* rice with its intensification and productivity, and evaluate the impact of government input support on food security and poverty reduction of the *Aus* paddy producing farmers, and hence improve livelihood status of the small and marginal farmers. The specific objectives are: (1) to identify

the farmers' socioeconomic status and distribution system of government input support for producing *Aus* rice; (2) to analyse the crop intensification and productivity of *Aus* rice through government input support; (3) to address the factors affecting adoption of cultivating *Aus* rice with government support; and (4) to evaluate the impact of government input support on *Aus* rice farmers' food security and poverty reduction.

Methods

Study areas and sample size

The study was conducted at different villages of two upazilas (Mymensingh Sadar and Trishal) of Mymensingh district. For investigation, two categories of farmers were targeted: supported farmers (who received input support from the government) and non-supported farmers (who did not receive input support from the government). Following purposive sampling technique, 30 supported farmers and following stratified random sampling technique, more 30 non-supported farmers (i.e., a total of 60 farmers) were selected from each of the study areas. Thus, a total of 120 farmers were interviewed for this study to collect field level data. Questionnaire survey, focus group discussions (FGD) and key informant interviews (KII) were also performed for collecting the primary data. The questionnaire was concerned with farmers' socioeconomic profile, distribution system of government input support, information on crop intensification, profitability and productivity of *Aus* rice production, food security status and poverty indicators of the farm households, and problems and suggestions regarding *Aus* rice production. Secondary data sources like reports, publications, handouts, etc., relevant with this study were also examined.

Analytical techniques

Descriptive statistics

Descriptive statistics like sum, averages and percentages were calculated to identify the farmers' socioeconomic status and distribution system of government input support for producing *Aus* rice.

Crop intensification index (CII)

Crop intensification index was constructed to measure the cropping intensity in a given cropland per year [12]. The following formula was used for calculation:

$$\text{Cropping intensity} = (\text{Area}_{GC} \div \text{Area}_{NC}) \times 100$$

where Area_{GC}, gross cropped area (ha); Area_{NC}, net cropped area (ha).

Profitability analysis

Profitability of *Aus* rice production was measured in terms of gross return, gross margin, net return, benefit–cost ratio (undiscounted) and profitability ratio. The formula needed for the calculation of profitability is discussed as follows.

Gross return (GR)

Gross return was calculated by multiplying the total volume of output by the price in the harvesting period [13]. The equation was as follows:

$$\text{GR} = X_{mp}P_{mp} + X_{bp}P_{bp}$$

where X_{mp}, yield of main product (kg/ha); P_{mp}, price of main product (Tk./kg); X_{bp}, yield of by-product (kg/ha); P_{bp}, price of by-product (Tk./kg).

Gross margin (GM)

Gross margin was calculated by the difference between gross return and total variable cost. The following equation was used to calculate GM:

$$\text{GM} = \text{GR} - \sum C_v$$

where GR, gross return (Tk./ha); $\sum C_v$, total variable cost (Tk./ha).

Net return (NR)

Net return was calculated by deducting all costs (variable and fixed) from the gross return. The following algebraic form of NR was used for estimation:

$$\text{NR} = \text{GR} - \sum C_v - \sum C_f$$

where GR, gross return (Tk./ha); $\sum C_v$, total variable cost (Tk./ha); $\sum C_f$, total fixed cost (Tk./ha).

Benefit–cost ratio (BCR)

Benefit–cost ratio (BCR) is a relative measure which is used to compare the return per unit of cost. BCR was estimated as a ratio of gross return to gross cost. The formula used for calculating BCR (undiscounted) was as follows:

$$\text{BCR} = \text{GR} \div \text{GC}$$

where GR, gross return (Tk./ha); GC, gross cost (i.e., $\sum C_v + \sum C_f$) (Tk./ha).

Profitability ratio

Profitability ratio was estimated by dividing supported farmers' net return by non-supported farmers' net return [14], the formula of which was as follows:

$$\text{Profitability ratio} = \text{NR}_S \div \text{NR}_{NS}$$

where NR_S, net return of supported farmers (Tk./ha); NR_{NS}, net return of non-supported farmers (Tk./ha).

Average productivity index (API)

Aus rice productivity was measured using average productivity index (API). The following formula was adopted from [15] for calculation:

$$\text{API} = \sum_{i=1}^{n} \left(\frac{X_i - \bar{X}_i}{\text{SD}(X_i)} \right)^2 \sum_{i=1}^{n} \left(\frac{Y_i - \bar{Y}_i}{\text{SD}\ (Y_i)} \right)^2$$

where X_i, average crop yield in the cropped area (quintal/ha); $\bar{X}_i$, average crop yield in the entire region (quintal/ha); SD (X_i), standard deviation of crop yield in the cropped area (quintal/ha); Y_i, average harvested extent in the cropped area (quintal/ha); $\bar{Y}_i$, average harvested extent in the entire region (quintal/ha); SD (Y_i), standard deviation of harvested extent in the cropped area (quintal/ha).

The productivity grade was determined from the productivity range which is represented in Table 1.

Logit model

In order to identify the factors influencing adoption of *Aus* rice cultivation by the farmers with government support, the following logistic regression analysis (i.e., logit model) was used [16]:

$$K_i = \ln [P_i \div (1 - P_i)] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + E_i$$

where P_i is the probability of adoption and non-adoption of *Aus* rice production with government support, $P_i = 1$ indicates adoption and $P_i = 0$ indicates non-adoption.

Dependent variable: K_i, probability of adoption of *Aus* rice production with government support.

Independent variables: X_1, household size (no.); X_2, educational level of household head (years of schooling); X_3, age of household head (years); X_4, farm size (ha); X_5, farm income (Tk.); X_6, non-farm income (Tk.); X_7, extension contact ($P_i = 1$ indicates having extension contact, and $P_i = 0$ indicates having no extension contact); X_8, farming experience (years of farming); β_0, intercept; β_1–β_8, regression coefficients of the dependent variables; E_i, error term.

The marginal probabilities of the key determinants of adopting *Aus* rice production with government support were estimated based on expressions derived from the marginal effect of the logit model given as follows:

$$\text{d}K/\text{d}X = \beta_i \{P_i(1 - P_i)\}$$

where β_i, estimated logit regression coefficient with respect to the ith factor; P_i, estimated probability of farmers' adoption status.

Table 1 Range and grade of productivity. *Source*: Adopted from Dharmasiri (2009)

Range of productivity	Grade of productivity
87.5% and above	Very high
62.5–87.5%	High
37.5–62.5%	Medium
12.5–37.5%	Low
Below 12.5%	Very low

Measurement of food security

To identify the food security status of the farmers, two stages of analyses were done. At first, a food security index (Z) was constructed and food security status of each household was determined based on the food security line using the recommended daily calorie intake [17]. Households whose daily per capita calorie intake amounted up to 2122 kcal were regarded as food secure and those below 2122 kcal were regarded as food insecure. The mathematical representations were as follows:

$$Z_i = Y_i \div R$$

where Z_i, food security index for ith households (1 = food secure households and 0 = food insecure households, i.e., $Z_i = 1$ for $Y_i \geq R$; and $Z_i = 0$ for $Y_i < R$); Y_i, daily per capita calorie intake of ith households; R, daily per capita calorie required for ith households; $i = 1, 2, 3, \ldots, 120$.

Based on the household food security index (Z), food shortfall/surplus index (P) and the head count ratio (H) were calculated. Food shortfall/surplus index was calculated as:

$$P = \frac{1}{M} \sum_{i=1}^{m} G_i$$

where P, food shortfall/surplus index; M, number of food secure households (for food surplus index) or food insecure households (for food shortfall index); G_i, per capita calorie intake deficiency (or surplus) faced by ith households where, $G_i = [(Y_i - R) \div R]$.

The head count ratio (H) measures the percentages of the households that are food secure or insecure which is defined as:

$$H = M \div N$$

where H, head count ratio; M, number of households that are food secure (for food surplus index) or food insecure (for food shortfall index); N, number of sample households.

German correlation sensitive poverty index (GCSPI)

The GCSPI is an index designed to measure the intensity of poverty [18]. It comprises six equally weighted poverty dimensions; health (weighted indicators: health condition and health impairments), education (weighted indicators:

schooling and graduation), employment (weighted indicators: activity status, minimum wage and time poverty), housing (weighted indicators: housing condition, amenities and living space), mobility (weighted indicators: transport and crime) and income (weighted indicators: households' monthly income). The following formula was used to address the intensity of poverty:

$$\text{Intensity of poverty} = \sum d(w) \times 100$$

where d, households deprived of the indicators; w, weighted score of the indicators.

Problem confrontation index (PCI)

The researcher identified the major problems faced by the farmers in producing *Aus* rice with government input support. An overall score of the problems faced by supported and non-supported farmers was computed by adding their scores of the problems in all 10 selected problems. Each farmer was asked to indicate the extent of difficulty caused by each of the problems by checking any of the four responses such as 'frequently', 'occasionally', 'rarely' and 'not at all', and weights were assigned to these responses as 3, 2, 1 and 0, respectively. The scores of problem confrontation index (PCI) for each selected problem were computed through using the subsequent formula [19]:

$$\text{PCI} = \left(P_{\text{frequently}} \times 3\right) + \left(P_{\text{occasionally}} \times 2\right) + \left(P_{\text{rarely}} \times 1\right) + \left(P_{\text{not at all}} \times 0\right)$$

where $P_{\text{frequently}}$, number of responses indicating the problem occurred frequently; $P_{\text{occasionally}}$, number of responses indicating the problem occurred occasionally; P_{rarely}, number of responses indicating the problem occurred rarely; $P_{\text{not at all}}$, number of responses indicating no problem at all.

The problems were ranked according to farmers' PCI score which denoted the severity of their responses.

Results and discussion

Demographic information of the farmers

The demographic information of the farmers is represented in Table 2. It is seen that average household size of the supported farmers was 5.0 (whereas 68.0% members were male and 32.0% were female) and non-supported farmers was 6.0 (whereas 65.0% members were male and 35.0% were female). In terms of farmers surveyed, 72.0 and 76.0% were male, and 28.0 and 24.0% were female in case of supported and non-supported farmers, respectively. Average farm size of the supported and non-supported farmers was 0.67 and 0.62 hectare, respectively. Majority of the farmers (62.8% supported and 59.1% non-supported) were under the age group of 15 to 55 years which is considered as active and working group. Most of the supported farmers (41.0%) in the study areas could put sign only, whereas majority of the non-supported farmers (45.0%) were illiterate. About 80.0% supported and 82.0% non-supported farmers were engaged in different agriculture, and other income generating activities (IGA) in the study areas (Table 2).

Land tenancy arrangements of the farmers

Table 3 reveals the land tenancy status of three types of farmers (i.e., small, medium and large) within supported and non-supported categories. It is seen that most of the supported and non-supported farmers were small farmers (76.0 and 68.0%, respectively). Average farm size of supported small and medium farmers was 0.26 and 1.08 ha, which was 0.21 and 1.03 ha in case of non-supported small and medium farmers, respectively. The major share of small and medium farmers' cultivable land was rented/leased-in (76.9 and 50.0%, and 52.4 and 49.1% for supported and non-supported farmers, respectively). Though 30.6 and 22.2% cultivable land was rented/leased-out by supported and non-supported medium farmers, respectively, neither supported nor non-supported small farmer rented/leased-out any cultivable land.

Table 2 Demographic information of the farmers. *Source*: Field survey, 2017

Particulars	Farmers' categories	
	Supported	Non-supported
Average household size (no.)	5.0 (male: 68.0%; female: 32.0%)	6.0 (male: 65.0%; female: 35.0%)
Average sex distribution (% of farmers)		
Male	72.0	76.0
Female	28.0	24.0
Average farm size (ha)	0.67	0.62
Average age (years)		
Below 15 years	12.8	14.3
15–55 years	62.8	59.1
Above 55 years	24.4	26.6
Literacy rate (% of farmers)		
Illiterate	32.0	45.0
Sign only	41.0	32.0
Primary and above	27.0	23.0
Occupational status (% of farmers)		
Agriculture only	20.0	18.0
Agriculture and others	80.0	82.0

Table 3 Farmers' land tenancy arrangements. *Source*: Field survey, 2017

Farmers' categories	% of farmers	Average farm size (ha)	Land tenancy arrangements (ha)		
			Own	Rented/leased-in	Rented/leased-out
Supported					
Small farmers (< 1.00 ha)	76.0	0.26	0.06 (23.1)	0.20 (76.9)	–
Medium farmers (1.01–3.00 ha)	24.0	1.08	0.21 (19.4)	0.54 (50.0)	0.33 (30.6)
Large farmers (above 3.01 ha)	–	–	–	–	–
Non-supported					
Small farmers (< 1.00 ha)	68.0	0.21	0.10 (47.6)	0.11 (52.4)	–
Medium farmers (1.01–3.00 ha)	32.0	1.03	0.26 (24.1)	0.53 (49.1)	0.24 (22.2)
Large farmers (above 3.01 ha)	–	–	–	–	–

Figures in the parentheses indicate percentages of average farm size

Farm area under crop production

Farm area under crop production picturises the total cropped area of supported and non-supported farmers which were 0.48 and 0.43 ha, respectively (Table 4). Rice cultivation constituted 68.8 and 69.8% of total cropped area of supported and non-supported farmers, respectively, where non-rice cultivation was 27.0 and 25.5%, respectively. It is also seen that fruits and agroforestry occupied 4.2% area in case of supported farmers and 4.7% area in case of non-supported farmers. *Boro* rice constituted the highest portion (29.2%) of total cropped area for supported farmers where *Aman* rice constituted the highest portion (27.9%) of total cropped area for non-supported farmers. Being less productive, farmers' attention over *Aus* rice production was less than *Aman* and *Boro* rice (16.7 and 16.3% in case of supported and non-supported farmers, respectively).

Distribution system of government input support

The government of Bangladesh has launched an input support programme in order to boost *Aus* rice cultivation and motivate the farmers towards *Aus* rice production. Under the programme, each farmer will get 5 kg seed, 20 kg urea, 10 kg DAP, 10 kg MoP and Tk. 400 in cash for cultivating UFSHI breed of *Aus* rice on 0.13 ha (1 bigha) of land. For NERICA cultivation, each farmer will get 10 kg seed, 20 kg urea, 10 kg DAP, 10 kg MoP and Tk. 800 in cash for cultivating NERICA breed of *Aus* rice on 0.13 ha (1 bigha) of land (Table 5).

Farmers' perceptions about government input support on *Aus* rice production

To appraise the government input support on *Aus* rice production, the researchers made discussion with the farmers of the study areas. Following the discussion, 10 (ten) statements were selected for this study. Each farmer was asked to indicate his/her opinion regarding the pros and cons of the input support. The percentages of farmers sharing their opinions on the selected statements are represented in Table 6.

It is reflected that 90.0% supported farmers were agreed with the statement that the support given by the government was not necessary to be paid back (Table 6). 85.0% supported farmers gave positive opinion about increase in income which was followed by 75.0% supported farmers' agreement with the statement that poor landless farmers could get support from the government. Disagreement of supported farmers for the statements that farmers might not be helped through this programme in short duration and field level GO-NGO motivational activities were found in case of 55.0 and 46.7% farmers, respectively.

For non-supported farmers, 86.7% were agreed with the statement that political affiliation was required to get input support from the government. 83.3% non-supported farmers were agreed with the statement that support given by the government is not necessary to be paid back which was followed by 81.7% non-supported farmers agreement with the statement that poor landless farmers could get support from the government. On the contrary, 40.0% non-supported farmers were disagreed with the statement that farmers might not be helped through this programme in short duration (Table 6).

Crop intensification analysis

Cropping intensity is explained as the number crops grown in a given cropland per year. It measures the productivity of per unit gross cropped area in a year (Bhaskar 2009). The whole process is named as crop intensification. Intensification of crop production in the study areas is demonstrated in Table 7. It is seen that before government input support, gross and net cropped area of supported and non-supported farmers were 0.36 and 0.22 ha; and 0.39 and 0.23 ha, respectively. Cropping intensity was found as 163.6 and 169.6% in case of supported and

Table 4 Farm area under crop production. *Source*: Field survey, 2017

Crops	Farmers' categories			
	Supported		Non-supported	
	Cultivated area (ha)	% of total cropped area	Cultivated area (ha)	% of total cropped area
Rice crops				
Aus	0.08	16.7	0.07	16.3
Aman	0.11	22.9	0.12	27.9
Boro	0.14	29.2	0.11	25.6
Total rice cropped area	0.33 (68.8)		0.30 (69.8)	
Non-rice crops				
Vegetables	0.03	6.2	0.03	6.9
Cash crops	0.02	4.2	0.01	2.3
Spices	0.02	4.2	0.02	4.7
Pulses	0.03	6.2	0.03	6.9
Oil seeds	0.03	6.2	0.02	4.7
Total non-rice cropped area	0.13 (27.0)		0.11 (25.5)	
Fruits and agroforestry	0.02	4.2	0.02	4.7
Total cropped area	0.48	100.0	0.43	100.0

Figures in the parentheses indicate percentages of total cropped area

non-supported farmers, respectively. On the contrary, after government input support, gross and net cropped area of supported and non-supported farmers were 0.48 and 0.21 ha, and 0.43 and 0.25 ha, respectively. Cropping intensity of supported and non-supported farmers was estimated at 228.6 and 172.0% after government input support. Supported farmers' cropping intensity was increased by 39.7%, whereas non-supported farmers' cropping intensity was increased by only 1.4%.

Table 5 Distribution system of government input support conditions per farmer. *Source*: Upazila Agriculture Office, 2017

Items	Amount	Conditions/remarks
Cash, Tk.	400	For UFSHI (local HYV) cultivation in 0.13 ha (1 bigha) of land
Kind, quantity		
Seed, kg	5	
Fertilizers, kg		
Urea	20	
DAP	10	
MoP	10	
Cash, Tk.	800	For NERICA (African variety) cultivation in 0.13 ha (1 bigha) of land
Kind, quantity		
Seed, kg	10	
Fertilizers, kg		
Urea	20	
DAP	10	
MoP	10	

The results implied that before government input support, supported and non-supported farmers could grow crops for nearly 1.6 and 1.7 times per year in a particular cropland whereas after government input support, supported farmers could grow crops for nearly 2.3 times per year in a particular cropland, but it was 1.7 times in case of non-supported farmers (Table 7). The result is quite similar with [20] where the authors found variability in crop intensity from one farming household to the next was higher among high-intensity households than those of low-intensity households.

Profitability of *Aus* rice production

Profitability of *Aus* rice production was measured in terms of gross return, gross margin, net return, benefit–cost ratio and profitability ratio. Variable and fixed costs were taken into deliberation to estimate the total cost of production. Variable costs included human labour, power tiller, seeds/seedlings, fertilizers, and herbicides and insecticides; and fixed cost included land use cost and interest on operating capital.

Total variable cost of supported and non-supported farmers was Tk. 21,605 and Tk. 31,426 per ha, respectively (Table 8). Total variable cost of supported farmers was lower than non-supported farmers because they were provided with essential seed/seedlings, fertilizers and cash for *Aus* rice cultivation by the government at free of cost. Total fixed cost was estimated at Tk. 8286 and Tk. 8876 per ha for supported and non-supported farmers, respectively. Total cost of *Aus* rice production in case of supported and non-supported

Table 6 Farmers' perceptions about government input support on *Aus* rice production (% of farmers). *Source*: Field survey, 2017

Statements	Farmers' categories					
	Supported ($n = 60$)			Non-supported ($n = 60$)		
	Agree	Neutral	Disagree	Agree	Neutral	Disagree
Diversified food production is increased	58.3	11.7	30.0	40.0	35.0	25.0
Nutritional security of the family members is assured	48.3	30.0	21.7	53.3	20.0	26.7
Farmers income can be increased	85.0	5.0	10.0	80.0	6.7	13.3
Farmers may not be helped through this programme in short duration	28.3	16.7	55.0	36.7	23.3	40.0
Poor landless farmers can get support from the government	75.0	3.3	21.7	81.7	10.0	8.3
Farmers can get quality seed from the government	45.0	18.3	36.7	51.7	28.3	20.0
Support given by the government is not necessary to be paid back	90.0	6.7	3.3	83.3	10.0	6.7
Political affiliation is required to get input support from the government	70.0	21.7	8.3	86.7	8.3	5.0
Income generation from non-farming activities is not included in the approach	48.3	26.7	25.0	48.3	20.0	31.7
Field level government and non-government organizations motivate the famers to adopt the programme	33.3	20.0	46.7	36.7	28.3	35.0

Table 7 Crop intensification index (CII). *Source*: Authors' estimation, 2017

Government input support stages	Farmers' categories					
	Supported			Non-supported		
	Gross cropped area (ha)	Net cropped area (ha)	Cropping intensity (%)	Gross cropped area (ha)	Net cropped area (ha)	Cropping intensity (%)
Before	0.36	0.22	163.6	0.39	0.23	169.6
After	0.48	0.21	228.6	0.43	0.25	172.0
Change in cropping intensity (%)	–	–	39.7	–	–	1.4

farmers was Tk. 29,891 and Tk. 40,302 per ha, respectively.

Table 8 represents that gross return from *Aus* rice cultivation was Tk. 49,920 and Tk. 51,220 per ha for supported and non-supported farmers, respectively. Gross margin and net return of supported and non-supported farmers were estimated at Tk. 28,315 and Tk. 19,794; and Tk. 20,029 and Tk. 10,918 per ha, respectively. BCR of *Aus* rice production was found as 1.67 and 1.27 in stare of supported and non-supported farmers, respectively, which means that by investing Tk. 100 per ha in *Aus* rice production, supported farmers received Tk. 167 in return, whereas non-supported farmers received Tk. 127. Profitability ratio of supported and non-supported farmers was 1.83 which was significant at 1% probability level and it demonstrated that while non-supported farmers earned Tk. 100 per ha from *Aus* rice production, supported farmers earned Tk. 183 per ha with the input support provided by the government.

Measurement of *Aus* rice productivity

Productivity of *Aus* rice in the study areas was estimated using average productivity index which is represented by Table 9. It is seen that average yield of supported and non-supported farmers in the cropped area was 27.8 and 27.5 quintal per ha, respectively, where average yield in the entire region was 28.2 quintal per ha. On the other hand, average harvested extent of supported and non-supported farmers was 27.6 and 27.2 quintal per ha, respectively, where average harvested extent in the entire region was 27.9 quintal per ha. Average *Aus* rice productivity was estimated at 138.0 and 100.0% in case of supported and non-supported farmers, respectively. Although productivity of *Aus* rice was high for both categories of farmers, supported farmers' one was 38.0% higher than non-supported farmers (Table 9). The results are relatively similar with [21] where the authors found improvement in smallholder maize profitability and productivity through input subsidy scheme.

Table 8 Profitability of *Aus* rice production (Tk./ha). *Source*: Authors' estimation, 2017

Particulars	Farmers' categories	
	Supported	Non-supported
Variable costs		
Human labour	17,700	17,340
Power tiller	3705	3705
Seed/seedlings	–	4940
Fertilizers		
Urea	–	2470
DAP	–	1383
MoP	–	988
Total	–	4841
Herbicides and insecticides	200	600
(1) Total variable cost	21,605	31,426
Fixed costs		
Land use cost	6990	6990
Interest on operating capital	1296	1886
(2) Total fixed cost	8286	8876
(3) Total cost	29,891	40,302
Return from *Aus* rice production		
(4) Gross return	49,920	51,220
(5) Gross margin (4 - 1)	28,315	19,794
(6) Net return (4 - 3)	20,029	10,918
(7) Benefit–cost ratio (BCR) (4 ÷ 3)	1.67	1.27
(8) Profitability ratio	1.83*** (0.007)	

Figure within the parenthesis indicates percentages of farmers; *** indicates significant at 1% probability level

Factors affecting adoption of *Aus* rice cultivation with government support

A logit model was used to identify the factors influencing adoption of *Aus* rice cultivation by the farmers in the study areas with government support. Eight independent variables were identified as major determinants of adopting *Aus* rice cultivation by the farmers in this study. The estimated equation was as follows:

$$K_i = 5.134 + 0.029X_1 + 1.103X_2 - 0.271X_3 + 0.660X_4 + 1.580X_5 + 0.004X_6 + 0.000X_7 - 0.001X_8$$

Three out of eight independent variables included in the model were found significant in explaining the variation in adopting *Aus* rice cultivation by the farmers with government input support. These variables were farm size, farm income and extension contact (Table 10).

Household size

The result of marginal effect shows that household size had a positive value of dK/dX and it was 0.002. It indicated that if household size is increased by 1 unit, the probability of adopting *Aus* rice cultivation with government support will be increased by 0.002 times.

Educational level of household head

Educational level of household head had a positive value of dK/dX which was 0.006, and it meant that if educational level of household head is increased by 1 unit, the probability of adopting *Aus* rice cultivation with government support will be increased by 0.006 times.

Age of household head

The result of marginal effect shows that age of household head had a negative value of dK/dX and it was 0.008. It implied that if the age of household head is increased by 1 unit, the probability of adopting *Aus* rice cultivation with government support will be decreased by 0.008 times.

Farm size

The result of marginal effect shows that farm size had a positive value of dK/dX and it was 0.016, which was statistically significant at 10% level of probability. It demonstrated that if farm size is increased by 1 unit, the probability of adopting *Aus* rice cultivation with government support will be increased by 0.016 times. The reason was that with a large farm size, farmers could

Table 9 Average productivity index (API). *Source*: Authors' estimation, 2017

Particulars	Farmers' categories	
	Supported	Non-supported
Average yield in the cropped area (quintal/ha)	27.8	27.5
Average yield in the entire region (quintal/ha)	28.2	28.2
Standard deviation of yield in the cropped area (quintal/ha)	0.5	1.0
Average harvested extent in the cropped area (quintal/ha)	27.6	27.2
Average harvested extent in the entire region (quintal/ha)	27.9	27.9
Standard deviation of harvested extent in the cropped area (quintal/ha)	0.2	0.5
Average productivity (%)	138.0	100.0

Table 10 Estimates of coefficients and marginal effects of logit model. *Source*: Authors' estimation, 2017

Variables	Coefficient (β)	SE	z	$P > \|z\|$	95% CI		dK/dX
Constant	5.134	2.967	1.730	0.084	0.690	10.942	–
Household size (X_1)	0.029	0.031	0.942	0.295	− 0.093	0.028	0.002
Educational level of household head (X_2)	0.103	0.079	1.293	0.175	− 0.263	0.048	0.006
Age of household head (X_3)	− 0.271	0.174	− 1.557	0.382	− 0.493	− 0.189	− 0.008
Farm size (X_4)	0.660*	0.367	1.801	0.091	1.008	0.430	0.016
Farm income (X_5)	1.580**	0.682	2.316	0.043	− 1.616	− 1.058	0.016
Non-farm income (X_6)	0.004	0.003	1.519	0.153	0.010	0.000	0.000
Extension contact (X_7)	0.000**	0.000	2.433	0.036	0.000	0.000	0.000
Farming experience (X_8)	− 0.001	0.002	− 0.618	0.579	− 0.005	0.003	− 0.000

**, *Significant at 5 and 10% probability level, respectively

cultivate less productive *Aus* rice in a noticeable amount of cropland keeping cultivation of *Aman* and *Boro* rice in other cropland.

Farm income

Farm income had a positive value of dK/dX which was 0.016, and it was statistically significant at 5% level of probability. It indicated that if farm income is increased by 1 unit, the probability of adopting *Aus* rice cultivation with government support will be increased by 0.016 times. The reason was that farmers earning a healthy amount of monetary income from other farming enterprises could take a risk of profit or loss from *Aus* rice cultivation.

Non-farm income

Non-farm income had a positive value of dK/dX, and it was 0.000. It meant that if non-farm income is increased by 1 unit, the probability of adopting *Aus* rice cultivation with government support will be increased by 0.000 times.

Extension contact

The result of marginal effect shows that extension contact had a positive value of dK/dX and it was 0.000, which was statistically significant at 5% level of probability. It implied that the probability of adopting *Aus* rice cultivation with government support for those farmers who have extension contact is 0.000 times higher compared to those farmers who do not have extension contact. The reason was that farmers got influenced and motivated by the extension agents to adopt *Aus* rice cultivation with government input support.

Farming experience

The result of marginal effect shows that farming experience had a negative value of dK/dX which was 0.000. It meant that if extension contact is increased by 1 unit, the probability of adopting *Aus* rice cultivation with government support will increase by 0.000 times.

Average annual income of the farmers

The money income earned by the farmers from different sources is depicted in Table 11. Mainly, there were two sources of money income in the study areas, namely farm income and non-farm income. Farm income included income from crop, livestock, poultry, homestead and agroforestry. Non-farm income included income from small business, wage labour, shopkeeping, van/rickshaw pulling and other sources. It is found that average annual income of supported and non-supported farmers was Tk. 92,092 and Tk. 87,459, respectively. In case of supported farmers, 59.4% income (Tk. 54,727) was from farming activities and 40.6% (Tk. 37,365) was from non-farming activities where these were 54.5% (Tk. 47,665) and 45.5% (Tk. 39,794) in terms of non-supported farmers, respectively. The result is supported by [22] where the authors found that crop farming was the largest source of farm income for the sampled farmers.

Food security status of the households

Food security was estimated from the viewpoint of three perspectives, such as availability of safe and nutritious food, access to food and utilization of food. It is evident from Table 12 that food security index value for food secure supported and non-supported households was 1.09 and 1.03, and for food insecure supported and non-supported households was 0.43 and 0.50, respectively.

Based on the recommended daily calorie intake of 2122 kcal, it is observed that 71.7 and 65.0% households were food secure supported and non-supported; and remaining 28.3 and 35.0% households were food insecure supported and non-supported, respectively. Average calorie intake of food secure supported and non-supported households was 2017.4 and 1984.2 kcal per day which was 1788.4 and 1940.1 kcal in case of food insecure supported and non-supported households, respectively, but these were still lower than the national average level (i.e., 2122 kcal) for both food

Table 11 Average annual income of the farmers

Sources of income	Farmers' categories			
	Supported		Non-supported	
	Tk./year	Percentage of total income	Tk./year	Percentage of total income
Farm income				
Crop	30,569 (55.8)[a]	59.4	26,629 (55.9)[a]	54.5
Livestock	12,357 (22.6)[a]		9749 (20.5)[a]	
Poultry	2551 (4.7)[a]		3017 (6.2)[a]	
Homestead and agroforestry	8000 (14.6)[a]		7420 (15.6)[a]	
Others	1250 (2.3)[a]		850 (1.8)[a]	
Total farm income	54,727 (100.0)[a]		47,665 (100.0)[a]	
Non-farm income				
Small business	12,575 (33.7)[b]	40.6	11,972 (30.1)[b]	45.5
Wage labour	8119 (21.7)[b]		10,041 (25.2)[b]	
Shopkeeping	8790 (23.5)[b]		7990 (20.1)[b]	
Van/rickshaw pulling	5044 (13.5)[b]		6796 (17.1)[b]	
Others	2837 (7.6)[b]		2995 (7.5)[b]	
Total non-farm income	37,365 (100.0)[b]		39,794 (100.0)[b]	
Total income	92,092	100.0	87,459	100.0

[a] Figures in the parentheses indicate percentages of total farm income; and

[b] Figures in the parentheses indicate percentages of total non-farm income

Table 12 Food security indices of the farm households. *Source*: Authors' estimation, 2017

Households' categories	Food security indices	Index values	
		Food secure households	Food insecure households
Supported	Food security index (*Z*)	1.09	0.43
	Head count index (*H*)	71.7	28.3
	Per capita daily calorie availability	2017.4	1788.4
	Food shortfall/surplus index (*P*)	0.21	− 0.16
Non-supported	Food security index (*Z*)	1.03	0.50
	Head count index (*H*)	65.0	35.0
	Per capita daily calorie availability	1984.2	1910.1
	Food shortfall/surplus index (*P*)	0.16	− 0.20

secure and insecure supported and non-supported households. The value of food surplus index in stare of food secure supported and non-supported households was 0.21 and 0.16, respectively, which indicated that households of both categories had superfluous food for crisis period, where the value of food shortfall index for food insecure supported and non-supported households was − 0.16 and − 0.20, respectively, indicating a situation of food shortage and no surplus food at the dilemma period for households of both categories (Table 12). The result is quite similar with [23] where the authors observed that average per capita daily calorie intake of the *char* dwellers was below the national average level of 2122 kcal.

German correlation sensitive poverty index (GCSPI)

To calculate GCSPI, poverty situation and livelihood condition of the farm households were evaluated on the basis of six poverty dimensions: health (weighted indicators: health condition and health impairments), education (weighted indicators: schooling and graduation), employment (weighted indicators: activity status, minimum wage and time poverty), housing (weighted indicators: housing condition, amenities and living space), mobility (weighted indicators: transport and crime) and income (weighted indicators: households' monthly income). The proportion of deprived supported and non-supported households was 29.0 and 34.8%, respectively; and the proportion of privileged supported and non-supported

Table 13 German correlation sensitive poverty index (GCSPI). *Source*: Authors' estimation, 2017 and HIES, 2010

Indicators	Households' categories				Weights
	Supported ($n = 60$)		Non-supported ($n = 60$)		
	No. of households deprived (√) or privileged (×) based on the indicators				
	√	×	√	×	
Health					
Subjective health condition, either poor or bad	22/60	38/60	27/60	33/60	1/12
Lack of physical and mental health condition due to health impairments	9/60	51/60	8/60	52/60	1/12
Education					
Less than 9 years of schooling	33/60	27/60	41/60	19/60	1/12
Neither graduation nor training qualification	45/60	15/60	54/60	6/60	1/12
Employment					
Unemployed status of activity	0/60	60/60	0/60	60/60	1/18
Working with below minimum wage	13/60	47/60	9/60	51/60	1/18
Working hour at least 8 h	28/60	32/60	36/60	24/60	1/18
Housing					
In urgent need of complete renovation to avoid the danger of breaking down	5/60	55/60	13/60	47/60	1/18
Lack of comfortable amenities	44/60	16/60	56/60	4/60	1/18
Living space below minimum requirement (45 sq. metre)	10/60	50/60	17/60	43/60	1/18
Mobility					
No personal vehicle available and public transport more than 20 min away	20/60	40/60	17/60	43/60	1/12
Insecure or dangerous neighbourhood	6/60	54/60	0/60	60/60	1/12
Income					
Monthly household income below breadline (11,479 Tk.)	3/60	57/60	8/60	52/60	1/6
Score of the households	0.290	0.710	0.348	0.652	–
Intensity of poverty (%)					
Deprived (√) households	29.0		34.8		
Privileged (×) households	71.0		65.2		

Score of deprived supported households = (22/60 × 1/12) + (9/60 × 1/12) + (33/60 × 1/12) + (45/60 × 1/12) + (0/60 × 1/18) + (13/60 × 1/18) + (28/60 × 1/18) + (5/60 × 1/18) + (44/60 × 1/18) + (10/60 × 1/18) + (20/60 × 1/12) + (6/60 × 1/12) + (3/60 × 1/6) = 0.290; score of privileged supported households = (38/60 × 1/12) + (51/60 × 1/12) + (27/60 × 1/12) + (15/60 × 1/12) + (60/60 × 1/18) + (47/60 × 1/18) + (32/60 × 1/18) + (55/60 × 1/18) + (16/60 × 1/18) + (50/60 × 1/18) + (40/60 × 1/12) + (54/60 × 1/12) + (57/60 × 1/6) = 0.710; scores of deprived or privileged non-supported households were calculated accordingly; percentage of deprived supported households = 0.290 × 100 = 29.0; percentage of privileged supported households = 0.710 × 100 = 71.0; percentages of deprived or privileged non-supported households were calculated accordingly

households was 71.0 and 65.2%, respectively (Table 13), the households were deprived or privileged based on all the indicators of a single dimension or at a combination of the indicators across dimensions. The reason for a better livelihood condition of supported farmers was that farmers could save money from irrigation and other energy inputs (i.e., the inputs provided with by the government) and further employ it in other income generating activities. This result is quite similar with [24] where the authors observed improved rural poverty status through agricultural input subsidy programmes.

Problem confrontation index (PCI)

Problem confrontation index (PCI) is a mathematically problem ranking index which is defined as a set of objects which must satisfy a number of problems or limitations. It represents the entities in a problem as a homogeneous collection of finite limitations over variables in a specific area. The farmers of the study areas were asked to give their opinion on 10 selected problems which were identified during data collection period and after computing the PCI scores, the problems were ranked according to their PCI score. The computed PCI scores of the 10 problems ranged from 93 to 139 (against a possible range from 0 to 180) for supported farmers and 98 to 119 (against a possible range from 0 to 180) for non-supported farmers which were arranged in rank order according to their PCI scores as shown in Table 14.

Majority of the farmers opined that the price of the output was very low in response to their production costs.

Table 14 Problem confrontation index including ten (10) selected problems. *Source*: Authors' estimation, 2017

Identified problems	Farmers' categories											
	Supported ($N = 60$)						Non-supported ($N = 60$)					
	Frequently (3)	Occasionally (2)	Rarely (1)	Not at all (0)	PCI	Rank order	Frequently (3)	Occasionally (2)	Rarely (1)	Not at all (0)	PCI	Rank order
Insufficient support	17	26	12	5	115	4	23	17	14	6	117	3
Lack of proper distribution	24	16	14	6	118	3	16	16	18	10	98	10
Lack of proper training	15	13	22	10	93	10	15	17	20	8	99	9
High price of seed and fertilizer in the market	28	21	8	3	134	2	22	19	15	4	119	1
Lack of good quality seed and fertilizer	19	19	17	5	112	5	17	16	21	6	104	8
Low price of output	34	16	5	5	139	1	23	17	15	5	118	2
Lack of storage of product during harvesting	16	22	15	7	109	8	25	14	13	8	116	4
Lack of transportation facility	20	17	17	6	111	6	19	18	13	10	106	7
Less technical support from different organizations	18	19	15	8	107	9	19	17	17	7	108	6
Lack of scientific knowledge and method	20	14	19	7	110	7	21	18	14	7	113	5

Calculation of PCI score for the problem of lack of insufficient support-PCI score of supported farmers = $(17 \times 3) + (26 \times 2) + (12 \times 1) + (5 \times 0) = 115$; PCI score of non-supported farmers = $(23 \times 3) + (17 \times 2) + (14 \times 1) + (6 \times 0) = 117$; PCI scores for rest of the problems were computed accordingly

The PCI score of this problem was 139 and 104 ranking by 1st and 2nd in terms of supported and non-supported farmers, respectively. High price of seed and fertilizer in the market was another major problem faced by the farmers in the study areas. The PCI score of this problem was calculated at 134 and 119, which was ranked as 2nd and 1st problem along with the statements of supported and non-supported farmers, respectively. Most of the farmers stated about lack of proper distribution as one of the major problems. With the statements of supported and non-supported farmers, the PCI score of this problem was marked as 118 and 113 which was ranked as 3rd and 5th, respectively. Other problems like insufficient support, lack of proper training, lack of good quality seed and fertilizer, lack of storage of product during harvesting, lack of transportation facility, less technical support from different organizations and lack of scientific knowledge and method were ranked as 4th (with PCI score 115), 10th (with PCI score 93), 5th (with PCI score 112), 8th (with PCI score 109), 6th (with PCI score 111), 9th (with PCI score 107) and 7th (with PCI score 110) in case of supported farmers; and 3rd (with PCI score 117), 9th (with PCI score 99), 8th (with PCI score 104), 4th (with PCI score 116), 7th (with PCI score 106), 6th (with PCI score 108) and 10th (with PCI score 98) in case of non-supported farmers (Table 14). The result is fairly comparable with [25] where the author found that lack of information on subsidy programmes was the major problem in Africa.

Conclusions

The study concludes that the motivation provided with by the government through input support on *Aus* rice production was highly appreciated by the farmers. The study exposed that cropping intensity as well as profitability and productivity of *Aus* rice was increased through this programme. It is also seen from the study that three out of eight independent variables had significant influence on adoption of *Aus* rice cultivation by the farmers with government support which were: farm size, farm income and extension contact. Though per capita daily calorie intake by the farmers was still under the national average level, supported farmers were more food secure than non-supported farmers. It is also revealed that farmers' income was increased as a result of minimized input cost. The study also indicates that poverty in terms of deprivation of health education, employment, housing, mobility and income was decreased, and overall livelihood circumstances were improved through government input support on *Aus* rice production. Majority of the farmers stated about low output price, high price of seed and fertilizer in the market and lack of proper distribution as major problems they faced. This study will help and motivate the researchers and policy makers to uncover the critical areas of government forthcoming supports' impact on crop production. Considering the findings of the study, some essential policy recommendations have been arisen which are: motivational and extension services of government should be strengthened and properly implemented to raise farmers' awareness about *Aus* rice production. Also, initiative for scientific and technical training programmes should be arranged by different government and non-government organizations to strengthen safety net programmes for enhancing farmers' food security and reduction in poverty.

Authors' contributions

MTU designed, collected and checked the analysed data; supervised and reviewed the draft manuscript and approved the final manuscript. ARD coordinated the study, collected and analysed the data and prepared the draft manuscript. Both authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

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