

Project ID: 382

# Competitive Research Grant

## Sub-Project Completion Report

on

Development of existing maize based cropping  
patterns for sustaining soil fertility in south-  
western region of Bangladesh

**Project Duration**

**May 2017 to September 2018**

**Bangladesh Agricultural Research Institute  
Regional Agricultural Research Station, Jessore**

**Submitted to**

**Project Implementation Unit-BARC, NATP 2  
Bangladesh Agricultural Research Council  
Farmgate, Dhaka-1215**



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## Acronyms

AEZ	:	Agro-ecological zone
BARC	:	Bangladesh Agricultural Research Council
BARI	:	Bangladesh Agricultural Research Institute
DAE	:	Department of Agriculture Extension
FRG	:	Fertilizer Recommendation Guide
TSP	:	Triple Super Phosphate
MoP	:	Muriate of Potash
N		Nitrogen
P	:	Phosphorus
K	:	Potassium
Zn	:	Zinc
OC	:	Organic Carbon
t	:	Ton
ha	:	Hectare
kg	:	Kilo Gram
NATP	:	National Agricultural Technology Program
Tk.	:	Taka

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## Executive Summary

Soil fertility in the south western part of the country, namely Jhenidah, Chuadanga and Meherpur districts are affecting by continuous maize cultivation using higher chemical fertilizers. Usually farmers follow the cropping pattern Maize - Fallow - T. aus / T. aman. Incorporation of a pulse crop in the pattern can improve the soil fertility leading to use less chemical fertilizers (AEZ - 11). Considering these, four maize based cropping systems including farmers practice are selected for test. The systems are a) Maize - Mungbean - T. aman, b) Maize - Mungbean - T.aus, c) Maize - Blackgram - T. aus and d) Maize - Fallow - T.Aus (Farmers practice). The trial were conducted following randomized complete block (RCB) design with 5 dispersed replications of each pattern in four upazillas of Jhenidah and Chuadanga districts namely, Jhenidah Sadar, Kaliganj, Jibonnagar and Damurhuda. The first crop of the pattern was T.aus and T. aman rice (BARI Annual Report, 2015). Fifteen and five plots were under T.aus and T. aman rice respectively in each upazilla. The plot size was 33 decimal. In each crop, trials were covered 10 hectares land area. Soil samples were collected before sowing of 1<sup>st</sup> crop and after harvest of last crop and chemically analysed in Soil Science Laboratory of Soil Science Division of BARI. Chemical analysis of grain and straw were done for nutrient balance study. Results of chemical analysis of initial soil showed that nitrogen was very low and S, B, Zn and OM were also low (FRG, 2011), but P and K were medium to very high. In T.aus, the highest grain yield was found in Damurhuda upazilla (4.03 t ha<sup>-1</sup>) and the yield ranged from 3.89 to 4.03 t ha<sup>-1</sup>. Grain yield of T.aman rice is highest in Jibonnagar upazilla (5.19 t ha<sup>-1</sup>). The highest grain yield of maize (11.27 t ha<sup>-1</sup>) was found from Maize-Blackgram-T.aus cropping pattern and grain yield ranged from 10.89 to 11.27 t ha<sup>-1</sup> and straw yield ranged from 7.88 to 8.12t ha<sup>-1</sup>. In third crops Mungbean and Blackgram, grain yield ranged from 0.95 to 1.02 t ha<sup>-1</sup> and green biomass and dry stover yield ranged from 9.40 to 10.63 t ha<sup>-1</sup> and 1.63 to 1.89 t ha<sup>-1</sup>, respectively. The highest gross return and gross benefit was from Maize-Mungbean-T.aman cropping pattern and rice equivalent yield increased by 26%. The highest amount of nitrogen and potassium recycled from mungbean / blackgram biomass ranged from 67.76 to 72.38 kg ha<sup>-1</sup> and 42.24 to 45.12 kg ha<sup>-1</sup>. The highest nutrition depletion was observed in nitrogen (197.12 kg ha<sup>-1</sup>) and potassium (195.65 kg ha<sup>-1</sup>) and lowest in phosphorus (2.37 kg ha<sup>-1</sup>) and sulphur (24.61 kg ha<sup>-1</sup>).

## CRG Sub-Project Completion Report (PCR)

### A. Sub-Project Description

- 1. Title of the CRG sub-project: Development of existing maize based cropping patterns for sustaining soil fertility in south-western region of Bangladesh**
- 2. Implementing organization:** Bangladesh Agricultural Research Institute, Regional Agricultural Research Station, Jashore
- 3. Name and full address with phone, cell and E-mail of PI/Co-PI (s):**

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**4. Sub-project budget (Tk):**

4.1 Total: 22, 85,169.00

4.2 Revised (if any): 20, 24,500.00

**5. Duration of the sub-project:**

5.1 Start date (based on LoA signed): 09 May 2016

5.2 End date: 30 September 2018

**6. Justification of undertaking the sub-project:**

Maize is the third most important cereal after wheat and rice and plays a significant role in human and livestock nutrition worldwide. Recent expansion of the maize area under rice-maize systems is very rapid in Bangladesh. In 2014-15 season, the area and production of maize was 3.55 lakh ha and 23.61 lakh ton, respectively (AIS, 2016). Maize is known as an exhaustive crop. It could uptake 287, 50, 168, 26, 8 and 1.5 kg NPKSZnB from soil per hectare per crop, respectively (Bender *et al.*, 2013). Due to huge amount of nutrient uptake and tropic and sub tropic climate, soil fertility is deteriorating day by day. In Bangladesh, maize growing area is drought prone where organic matter decomposition rate is high. Diversification to maize could also be a good strategy for climate change adaptation. Maize is more tolerant to high temperature and per kg of grain needs less than one third of water consumed

by the rice plant. Maize yields tend to decline in fields where it has been cultivated as a dry season crop for five or more years. Soil nitrogen as well as organic matter can be replenished by growing legumes after maize. Planting short duration rice varieties would allow farmers to plant maize earlier. Maize farming in Bangladesh is still new territory for many farmers, and time required for them to fully integrate it into cropping systems that optimize production and improve soil health (BARI Annual Report, 2015). Now the annual demand is about 2.5 million tons of which about 90% is fulfilled and in 2030 the estimated demand will be 3.5 million tones. To fulfill the demand, maize based cropping systems would be developed with improved and sustained soil fertility.

**7. Sub-project goal:** Development of maize based cropping patterns for improving and sustaining soil fertility.

**8. Sub-project objective (s):**

- i) To develop present maize based cropping patterns for sustaining soil fertility
- ii) To improve and maintain soil fertility through better nutrient management
- iii) To adapt improved maize based cropping systems for increasing farmer's income
- iv) To increase productivity and profitability for attaining food and nutrition security

**9. Implementing location (s):**

- i) Sadar upazilla, Jhenidah district
- ii) Kaliganj upazilla, Jhenidah district
- iii) Sadar upazilla, Chuadanga district
- iv) Jibonnagar upazilla, Chuadanga district

**10. Methodology in brief:**

In the recent years, intensive crop cultivation using high yielding varieties of crop with imbalanced fertilization has led to mining out the inherent plant nutrients from the soils thereby fertility status of the soils severely declined in Bangladesh. Maize is the third important cereal crop but second in both area and production in Bangladesh. Jhenaidah, Chuadanga and Meherpur districts (AEZ -11) are the major maize growing area (BARI Annual Report, 2011). According DAE report has covered about 72,000 hectares of land in these three districts maize cultivation (DAE). Now the village economics of this area are mostly maize based. About 3 lakh farmers are directly or indirectly involved in maize cultivation. The soil fertility in the area is affecting by continuous maize cultivation using higher chemical fertilizers. Mono crop based fertilizer recommendations are proving to be costly to the poor farmers. On the other hand, rich farmers are using high dose of chemical fertilizer especially urea for some crops which creates imbalance in soil nutrients. Usually the farmers follow the pattern Maize-Fallow-T.aus/T.aman. Inclusion of a pulse crop in the cropping pattern would reduce the requirement of chemical fertilizers in the next crop maintaining a good health of soils through biological nitrogen fixation and addition of organic matter to soil. Farmers of the area will also be financially benefitted from the pulse crops in the

pattern. Considering these four maize based cropping systems including farmers practice are selected. The systems are-

- a) Maize-Mungbean-T.aman
- b) Maize-Mungbean-T.aus
- c) Maize-Blackgram-T.aus
- d) Maize –Fallow-T.Aus ( Farmers practice)

The field trials were conducted in randomized complete block (RCB) design with 5 dispersed replications of each pattern in four Upazilla of Jhenidah and Chuadanga districts namely, Jhenidah Sadar, Kaliganj, Jibonnagar and Damurhuda. The initial soil samples, collected from depth of 0-15 cm were analysed in the laboratory of Soil Science Division of Bangladesh Agricultural Research Institute (BARI) following standard methods. Initial values of some important soil physical and chemical parameters of the experimental soil are presented in Table 1. The first crop of the pattern was T.aus (BRRI dhan-48 ) and T.aman (BRRI dhan-49) rice. Fifteen and five plots were under T.aus (BRRI dhan-48) and T.aman rice (BRRI dhan-57), respectively in each Upazilla. The plot size was 33 decimal. In each year, trials were covered 10 hectares land area. Before conducting trials, co-operative farmers were trained about the modern production technologies of the crops included in the patterns. Soil samples were collected before sowing and harvest of each crop. The rice variety used in T.aus season is BRRI dhan-48 and in T.aman season is BRRI dhan-49 used in Jhenidah district and BRRI dhan-57 in Chuadanga district. Chemical analysis of soil, grain and straw has done for nutrient balance study. Fertilizers were applied at the rate of 70-26-45-7 kg of N-P-K-S per hectare in T.aus and 75-45-35-10 kg of N-P-K-S per hectare in T.aman from urea, TSP, MoP and gypsum, respectively. Twenty five to thirty days aged seedlings of T.aus rice were transplanted from June 20 to July 10, 2017 with 20 X 15 cm spacing. Similarly, thirty to thirty five days old T.aman rice (BRRI dhan-49) seedlings were transplanted from July 15-28, 2017 with the same spacing. The second crop maize was sown from November 6-24, 2017. Due to unavailability of BARI Maize variety exotic hybrid maize variety 981 was used as test crop. Fertilizers were used at the rate of 175-45-95-30-3-2 kg of N-P-K-S-Zn-B per hectare from urea, TSP, MoP, gypsum, zinc sulphate and boric acid, respectively. Maize seeds were sown in line with 60 cm row to row and 20 cm seed to seed spacing. Maize was harvested from April 4-22, 2018. Mungbean (BARI Mug-6) and Blackgram (BARI Mash-3), the third crop in the pattern were sown from April 10-25, 2018 and varieties used. Fertilizers were used at the rate of 17-12-20 kg of N-P-K per hectare from urea, TSP and MoP, respectively. After two picking of the grains the green biomass of mungbean and blackgram was ploughed down into the soil and left for decomposition until the T.aman/T.aus was transplanted. Intercultural operations and plant protection measures were taken against insects and diseases as and when necessary.

## 11. Results and discussion:

Results of chemical analysis of initial soil sample collected before sowing of 1<sup>st</sup> crop are presented in Table-1. The soil samples were collected from 0-15 and 15-30 cm depth from all the plots. Different chemical component were analysed. Nitrogen was found very low and S, B, Zn and OM were low. But P and K were medium to very high. The grain and straw yield of T. aus and T. aman rice by upazilla are presented in Table-2. In T. aus, the highest grain yield was found in Damurhuda upazilla (4.03 t ha<sup>-1</sup>) followed by Jibonnagar upazilla (4.01 t ha<sup>-1</sup>) and the yield ranged from 3.89 to 4.01 t ha<sup>-1</sup> and straw yield ranged from 4.91 to 5.67 t/ha. Grain yield of T. aman rice was highest in Jibonnagar upazilla (5.19 t/ha) and lowest in Jhenidah sadar upazilla (4.58 t/ha) and the highest straw yield was in Jibonnagar upazilla (6.28 t ha<sup>-1</sup>). Results of chemical analysis of soil sample collected after harvest of 1<sup>st</sup> crop are presented in Table-3. The soil samples were also collected from 0-15 and 15-30 cm depth from all the plots. Different chemical component were analysed in the Soil Science Laboratory of Soil Science Division of BARI. Nitrogen was found very low and S, B, Zn and OM were low- very low. But P and K were medium to very high. The grain and straw yield and yield contributing characters of maize like number of plants per 10 sq. metre and number of cobs per 10 sq. metres are presented in Table-4, 5 & 6. Upazilla wise yield and yield contributing characters of maize are presented in Table-4. The

**Table: 1. Average initial soil sample data in the research area**

District	Upazilla	Soil Depth (cm)	pH	OC (%)	OM (%)	N (%)	K (meq 100g <sup>-1</sup> )	P (µg g <sup>-1</sup> )	S (µg g <sup>-1</sup> )	B (µg g <sup>-1</sup> )	Zn (µg g <sup>-1</sup> )
Jhenaidah	Sadar	0-15	6.94	0.69	1.19	0.07	0.29	20.78	21.54	0.22	0.99
		15-30	6.95	0.59	1.76	0.06	0.23	11.18	11.79	0.11	0.79
	Remarks	-	Opt.	-	Low	Very low	Opt.	Medium	Low	Low	Low
	Kaligonj	0-15	7.14	0.69	1.08	0.06	0.39	27.19	20.37	0.24	1.03
		15-30	7.20	0.52	0.89	0.05	0.28	24.78	11.06	0.09	0.75
	Remarks	-	Opt.	-	Low	Very Low	High	Very High	Low	Low	Low

District	Upazilla	Soil Depth (cm)	pH	OC (%)	OM (%)	N (%)	K (meq 100g <sup>-1</sup> )	P (µg g <sup>-1</sup> )	S (µg g <sup>-1</sup> )	B (µg g <sup>-1</sup> )	Zn (µg g <sup>-1</sup> )
Chuadanga	Jibonnagar	0-15	7.36	0.74	1.27	0.07	0.45	28.03	23.26	0.32	1.08
		15-30	7.32	0.61	1.05	0.06	0.35	17.72	13.53	0.15	0.76
	Remarks	-	Opt.	-	Low	Very Low	Very High	Opt.	Medium	Low	Medium
	Damurhuda	0-15	7.57	0.83	1.30	0.07	0.36	22.05	24.06	0.23	1.16
		15-30	7.50	0.64	1.10	0.06	0.28	17.25	12.70	0.10	0.80
	Remarks	-	Opt.	-	Low	Very Low	High	Very High	Medium	Low	Medium

highest grain yield of maize (11.71 t ha<sup>-1</sup>) was found Jhenidah sadar upazilla under T. aus-Maize pattern followed by same pattern (11.58 t ha<sup>-1</sup>) in Jibonnagar upazilla. Number of plants per 10 sq. metres were ranged from 86 to 91 and number of cobs per 10 sq. metre from 88 to 94. In Jhenaidah district the highest grain yield of maize (11.70 t ha<sup>-1</sup>) was found from T.aus- Maize cropping pattern. Similarly in Chuadanga district the same pattern produced the highest grain yield if maize (11.45 t ha<sup>-1</sup>). On an average the highest grain and straw yield of both the districts was found in Maize-Blackgram-T.aus cropping pattern (11.27 t ha<sup>-1</sup>) and (8.12 t ha<sup>-1</sup>), respectively and the grain yield ranged from 10.89 to 11.27 t ha<sup>-1</sup> and straw yield from 7.88 to 8.12 t ha<sup>-1</sup>. Similarly, this cropping pattern produced the highest number of plants and cobs per unit area. Table -7 and 8 showed the grain and stover yield of mungbean and blackgram. The highest grain yield of mungbean (1.02 t ha<sup>-1</sup>) was observed from Maize-Mungbean-T.aman cropping pattern which was followed by Maize-Blackgram-T.aus (0.98 t ha<sup>-1</sup>). Maize-Blackgram-T.aus also produced the highest stover yield (1.89 t ha<sup>-1</sup>). These findings are in agreement with the findings of BARI Annual Report (2015).

**Table: 2. Average grain and straw yield of 15 farmers of T.aus and 5 farmers of T.aman for each upazilla**

District	Upazilla	T.aus		T.aman	
		Grain Yield (t ha <sup>-1</sup> )	Straw yield (t ha <sup>-1</sup> )	Grain Yield (t ha <sup>-1</sup> )	Straw yield (t ha <sup>-1</sup> )
Jhenaidah	Sadar	4.00	5.11	4.58	6.09
	Kaligonj	3.89	4.91	4.59	5.68
Chuadanga	Jibonnagar	4.01	5.67	5.19	6.28
	Damurhuda	4.03	5.49	4.61	6.00

**Table. 3. Average grain and straw yield of maize of 5 farmers for each pattern**

District	Upazilla	Cropping Pattern	No. of plants (10 m <sup>-2</sup> )	No. of cobs (10 m <sup>-2</sup> )	Grain Yield (t/ha <sup>-1</sup> )	Straw Yield (t ha <sup>-1</sup> )
Jhenaidah	Sadar	Maize-Mungbean-T.aman	90	92	11.08	7.87
		Maize-Mungbean-T.aus	85	87	10.33	7.28
		Maize-Blackgram-T.aus	89	93	11.71	7.77
		Maize-Fallow-T.aus	86	88	10.99	7.25
	Kaligonj	Maize-Mungbean-T.aman	87	90	11.16	7.38
		Maize-Mungbean-T.aus	87	91	10.79	7.46
		Maize-Blackgram-T.aus	90	94	11.69	7.40
		Maize-Fallow-T.aus	88	94	11.58	7.66
Chuadanga	Jibonnagar	Maize-Mungbean-T.aman	90	90	11.27	8.36
		Maize-Mungbean-T.aus	89	89	11.17	8.34
		Maize-Blackgram-T.aus	90	91	11.58	8.55
		Maize-Fallow-T.aus	91	91	11.33	8.71
	Damurhuda	Maize-Mungbean-T.aman	88	88	10.62	8.21
		Maize-Mungbean-T.aus	90	90	10.86	8.44
		Maize-Blackgram-T.aus	91	91	11.31	8.78
		Maize-Fallow-T.aus	90	90	11.06	8.19

**Table. 4. Average grain and straw yield of maize of 10 farmers for each patter**

District	Upazilla	Cropping Pattern	No. of plants (10 m <sup>-2</sup> )	No. of cobs (10 m <sup>-2</sup> )	Grain Yield (t/ha <sup>-1</sup> )	Straw Yield (t ha <sup>-1</sup> )
Jhenaidah	Sadar & Kaligonj	Maize-Mungbean-T.aman	89	91	11.12	7.63
		Maize-Mungbean-T.aus	86	89	10.56	7.37
		Maize-Blackgram-T.aus	90	94	11.70	7.58
		Maize-Fallow-T.aus	87	91	11.28	7.45
Mean			<b>88.00</b>	<b>91.25</b>	<b>11.17</b>	<b>7.51</b>
Chuadanga	Jibonnagar & Damurhuda	Maize-Mungbean-T.aman	89	91	10.95	8.28
		Maize-Mungbean-T.aus	90	93	11.02	8.39
		Maize-Blackgram-T.aus	91	94	11.45	8.67
		Maize-Fallow-T.aus	91	91	11.19	8.45
Mean			<b>90.25</b>	<b>92.25</b>	<b>11.15</b>	<b>8.45</b>

**Table: 5. Average grain yield and straw yield of maize for each pattern**

Cropping Pattern	No. of plants (10 m <sup>-2</sup> )	No. of cobs (10 m <sup>-2</sup> )	Grain Yield (t ha <sup>-1</sup> )	Straw Yield (t ha <sup>-1</sup> )
Maize-Mungbean-T.aman	89	90	11.04	7.95
Maize-Mungbean-T.aus	88	90	10.89	7.88
Maize-Blackgram-T.aus	91	93	11.27	8.12
Maize-Fallow-T.aus	89	91	11.23	7.95

**Table: 6. Average grain yield and stover yield of Mungbean (BARI Mung-6) and Blackgram (BARI Mash-3) for each patter**

District	Upazilla	Cropping Pattern	Grain Yield (t ha <sup>-1</sup> )	Stover Yield (t ha <sup>-1</sup> )
Jhenaidah	Sadar & Kaligonj	Maize-Mungbean-T.aman	1.00	1.90
		Maize-Mungbean-T.aus	0.95	1.85
		Maize-Blackgram-T.aus	0.96	1.89
		Maize-Fallow-T.aus	-	-
Chuadanga	Jibonnagar & Damurhuda	Maize-Mungbean-T.aman	1.04	1.86
		Maize-Mungbean-T.aus	1.02	1.50
		Maize-Blackgram-T.aus	0.94	1.46
		Maize-Fallow-T.aus	-	-

**Table: 7. Average grain yield and stover yield of Mungbean (BARI Mung-6) and Blackgram (BARI Mash-3) for each pattern**

Cropping Pattern	Grain Yield (t ha <sup>-1</sup> )	Green biomass yield (t ha <sup>-1</sup> )	Dry Stover Yield (t ha <sup>-1</sup> )
Maize-Mungbean-T.aman	1.02	10.23	1.88
Maize-Mungbean-T.aus	0.98	10.63	1.89
Maize-Blackgram-T.aus	0.95	9.40	1.63
Maize-Fallow-T.aus	-	-	-

**Total rice (system) yield and economics**

Total rice (system) yield influenced by different cropping patterns are presented in Table-8. Highest total rice system yield was obtained from Maize-Mungbean-T.aman cropping pattern (20.63 t ha<sup>-1</sup>) followed by Maize-Blackgram-T.aus pattern (19.91 t ha<sup>-1</sup>). The lowest rice system yield was in

Maize-Fallow-T. aus pattern (16.36 t ha<sup>-1</sup>). The gross return and marginal gross return was also highest in Maize-Mungbean-T. aman cropping pattern (Tk. 412600 and Tk. 85400). The gross benefit was also highest in the same pattern (Tk. 261410) and lowest from Maize-Fallow-T. aus pattern (Tk. 211525). The highest marginal benefit cost ratio (MBCR) 2.40 was in Maize-Mungbean-T. aman pattern followed by Maize-Blackgram-T. aus. The highest relative yield increase (26%) was in Maize-Mungbean-T. aman followed by Maize-Blackgram-T. aus (22%). These findings are in agreement with the findings of BARI Annual Report (2015).

**Table: 8. Benefit cost ratio of different pattern**

<b>Cropping Pattern</b>	Total REY (Tkha <sup>-1</sup> )	Gross return (Tkha <sup>-1</sup> )	Marginal gross return Tk ha <sup>-1</sup> )	Total variable cost (Tk ha <sup>-1</sup> )	Marginal variable cost (Tk ha <sup>-1</sup> )	Gross benefit (Tkt ha <sup>-1</sup> )	MBCR	% REY increased over existing pattern
Maize-Mungbean-T. aman	20.63	412600	85400	151190	35515	261410	2.40	26
Maize-Mungbean-T. aus	19.45	389000	61800	146120	30445	242880	2.03	19
Maize-Blackgram-T. aus	19.91	398200	71000	146120	30445	252080	2.33	22
Maize-Fallow-T. aus	16.36	327200	0	115675	0	211525	0	-

Rice = 20 Tk kg<sup>-1</sup>, Mungbean = 60 Tk kg<sup>-1</sup>, Maize = 17.50 Tk kg<sup>-1</sup>, Urea = 16 Tk kg<sup>-1</sup>, TSP = 22 Tk kg<sup>-1</sup>, MoP = 15 Tk kg<sup>-1</sup>, Gypsum = 8 Tk kg<sup>-1</sup>, ZnSO<sub>4</sub> = 150 Tk kg<sup>-1</sup>, Boric acid = 150 Tk kg<sup>-1</sup>, Labour = 350 Tk/8 hr/person

#### **Nutrient uptake and nutrient balance by different cropping pattern**

Table-9 revealed the nutrient uptake by T. aus rice. The mean uptake of N, P, K, S and Zn was 120.13, 25.00, 151.69, 21.08 and 0.97 kg ha<sup>-1</sup> respectively. Table-10 showed the nutrient uptake by T. aman rice. The mean uptake of N, P, K, S and Zn was 142.48, 29.37, 177.23, 24.81 and 1.01 kg ha<sup>-1</sup> respectively. Table-11 and 12 showed the nutrient uptake of maize grain and straw, respectively. Total nutrient uptake by maize under different cropping pattern is presented in Table-13. The highest N uptake (348.70 kg ha<sup>-1</sup>) by maize was in Maize-Blackgram-T. aus cropping pattern and ranged from 329.03 kg ha<sup>-1</sup> to 348.70 kg ha<sup>-1</sup>. Total P uptake by different pattern ranged from 57.97 to 61.73 kg ha<sup>-1</sup> and K ranged from 197.49 to 208.58 kg ha<sup>-1</sup>. Uptake of S ranged from 39.30 to 41.53 kg ha<sup>-1</sup> and Zn 0.88 to 0.94 kg ha<sup>-1</sup>.

Table-14 indicated that the total nutrient uptake by mungbean grain. N uptake by mungbean under different cropping pattern ranged from 42.75 to 45.90 kg ha<sup>-1</sup>, P uptake from 4.28 to 4.60 kg ha<sup>-1</sup>, K uptake from 11.88 to 12.75 kg ha<sup>-1</sup>, S uptake from 2.02 to 2.20 kg ha<sup>-1</sup> and Zn from 0.035 to 0.038 kg ha<sup>-1</sup>. Nutrient recycled by mungbean biomass was studied and presented in Table-15. The total

amount of N recycled under different pattern ranged from 67.76 to 72.38 kg ha<sup>-1</sup>, P from 5.63 to 6.20 kg ha<sup>-1</sup>, K from 42.24 to 45.12 kg ha<sup>-1</sup>, S from 3.26 to 3.74 kg ha<sup>-1</sup> and Zn from 0.122 to 0.131 kg ha<sup>-1</sup>.

Table-16 showed the total nutrient uptake by the full pattern. The uptake of Maize-Mungbean-T.aman cropping pattern was 523.34, 93.09, 390.77, 66.97 and 1.925 kg ha<sup>-1</sup> from N, P, K, S and Zn, respectively. Similarly, Maize-Mungbean-T. aus cropping pattern uptake was 493.26, 87.38, 361.43, 62.48 and 1.930 kg ha<sup>-1</sup> from N, P, K, S and Zn, respectively. However, Maize-Fallow-T. aus cropping pattern uptake was 459.12, 85.00, 354.78, 61.61 and 1.870 from N, P, K, S and Zn kg ha<sup>-1</sup>, respectively.

Table-17 indicated the apparent nutrient balance in soil under different cropping pattern. Apparent nutrient balance of major nutrients calculated after complete of cropping cycle indicated that the balance for most of the nutrients is negative. The highest negative balance was observed in N and K. Maize - Fallow- T. Aus pattern showed the highest negative balance of nitrogen (197.12 kg ha<sup>-1</sup>) and sulphur (24.61 kg ha<sup>-1</sup>) but potassium in Maize - Mungbean -T. Aman cropping pattern was 195.65 kg ha<sup>-1</sup>. All these parameters are in consistent with the research findings of BARI Annual Report (2011).

**Table: 9. Nutrient uptake by T. aus rice**

Upazilla	Nutrient uptake by T. aus rice (kg ha <sup>-1</sup> )				
	N	P	K	S	Zn
Jhenidah sadar	118.72	24.60	148.06	20.74	0.92
Kaliganj	114.90	23.78	142.77	20.40	0.96
Jibonnagar	124.11	26.00	159.71	22.05	1.02
Damurhuda	122.79	25.62	156.21	21.14	0.98
<b>Mean</b>	<b>120.13</b>	<b>25.00</b>	<b>151.69</b>	<b>21.08</b>	<b>0.97</b>

**Table: 10. Nutrient uptake by T.aman rice**

Upazilla	Nutrient uptake by T.aman rice (kg ha <sup>-1</sup> )				
	N	P	K	S	Zn
Jhenidah sadar	140.30	29.07	177.05	24.62	1.00
Kaliganj	136.58	28.08	168.64	23.72	0.97
Jibonnagar	153.08	31.4	187.71	26.44	1.04
Damurhuda	139.98	28.94	175.51	24.47	1.03
<b>Mean</b>	<b>142.48</b>	<b>29.37</b>	<b>177.23</b>	<b>24.81</b>	<b>1.01</b>

**Table: 11. Nutrient uptake by maize grain by cropping pattern basis in two districts**

Districts	Cropping pattern	Nutrient uptake by maize (kg ha <sup>-1</sup> )				
		N	P	K	S	Zn
Jhenidah	Maize-Mungbean-T.aman	233.52	48.37	122.32	24.91	0.88
	Maize-Mungbean-T. aus	221.76	45.94	116.16	23.65	0.85
	Maize-Blackgram-T. aus	245.70	50.90	128.70	26.21	0.92
	Maize-Fallow-T. aus	236.88	49.07	124.08	25.27	0.90
Chuadanga	Maize-Mungbean-T.aman	229.95	47.63	120.45	24.53	0.95
	Maize-Mungbean-T. aus	231.42	47.94	121.22	24.68	0.85
	Maize-Blackgram-T. aus	240.45	49.81	125.95	25.65	0.98
	Maize-Fallow-T. aus	235.00	48.68	123.10	25.07	0.89

**Table: 12. Nutrient uptake by maize straw by cropping pattern basis in two districts**

Districts	Cropping pattern	Nutrient uptake by maize (kg ha <sup>-1</sup> )				
		N	P	K	S	Zn
Jhenidah	Maize-Mungbean-T.aman	98.8	10.64	76.00	14.60	
	Maize-Mungbean-T. aus	95.81	10.32	73.70	14.15	
	Maize-Blackgram-T. aus	98.54	10.61	75.80	14.55	
	Maize-Fallow-T. aus	96.85	10.43	74.50	14.30	
Chuadanga	Maize-Mungbean-T.aman	107.64	11.60	82.80	15.90	
	Maize-Mungbean-T. aus	109.07	11.75	83.90	16.11	
	Maize-Blackgram-T. aus	112.70	12.14	86.70	16.65	
	Maize-Fallow-T. aus	109.85	11.83	84.50	16.22	

**Table: 13. Total nutrient uptake by maize crop in cropping pattern basis (kg ha<sup>-1</sup>)**

Cropping pattern	N	P	K	S	Zn
Maize-Mungbean-T.aman	334.96	59.12	200.79	39.96	0.88
Maize-Mungbean-T.aus	329.03	57.97	197.49	39.30	0.92
Maize-Blackgram-T.aus	348.70	61.73	208.58	41.53	0.94
Maize-Fallow-T.aus	339.29	60.00	203.09	40.43	0.90

**Table: 14. Nutrient uptake by mungbean grain (kg ha<sup>-1</sup>)**

Cropping Pattern	N	P	K	S	Zn
Maize-Mungbean-T.aman	45.90	4.60	12.75	2.20	0.035
Maize-Mungbean-T.aus	44.10	4.41	12.25	2.11	0.038
Maize-Blackgram-T.aus	42.75	4.28	11.88	2.04	0.036
Maize-Fallow-T.aus	-	-	-	-	-

**Table: 15. Nutrient recycled by mungbean biomass (kg ha<sup>-1</sup>)**

Cropping Pattern	N	P	K	S	Zn
Maize-Mungbean-T.aman	72.38	6.20	45.12	3.26	0.124
Maize-Mungbean-T.aus	72.0	5.98	44.88	3.74	0.131
Maize-Blackgram-T.aus	67.76	5.63	42.24	3.52	0.122
Maize-Fallow-T.aus	-	-	-	-	-

**Table: 16. Total Nutrient uptake by the whole pattern (kg ha<sup>-1</sup>)**

Cropping Pattern	N	P	K	S	Zn
Maize-Mungbean-T.aman	523.34	93.09	390.77	66.97	1.925
Maize-Mungbean-T.aus	493.26	87.38	361.43	62.48	1.930
Maize-Blackgram-T.aus	511.58	91.00	372.25	64.86	1.864
Maize-Fallow-T.aus	459.12	85.00	354.78	61.61	1.870

**Table: 17. Apparent nutrient balance in soil under different cropping pattern (kg ha<sup>-1</sup>)**

Cropping Pattern	N	P	K	S
Maize-Mungbean-T.aman	-183.96	18.11	-195.65	-23.71
Maize-Mungbean-T.aus	-159.26	1.62	-156.55	-21.74
Maize-Blackgram-T.aus	-181.82	-2.37	-170.00	-24.34
Maize-Fallow-T.aus	-197.12	-2.00	-194.78	-24.61

**Table: 18. Chemical properties of soil after completion of cropping cycle**

Cropping Pattern	Soil Depth (cm)	pH	OM (%)	N (%)	K (meq 100g <sup>-1</sup> )	P (µg g <sup>-1</sup> )	S (µg g <sup>-1</sup> )	B (µg g <sup>-1</sup> )	Zn (µg g <sup>-1</sup> )
Maize-Mungbean-T.aman	0-15	6.95	1.32	0.11	0.32	22.65	21.65	0.25	1.00
	15-30	7.00	1.16	0.07	0.24	12.10	12.72	0.11	0.82
Remarks	-	Opt.	Low	Very low	Opt.	Medium	Low	Low	Low
Maize-Mungbean-T.aus	0-15	7.10	1.18	0.10	0.39	27.25	22.38	0.27	1.15
	15-30	7.20	0.95	0.06	0.29	24.65	15.18	0.09	0.78
Remarks	-	Opt.	Low	Very Low	High	Very High	Low	Low	Low
Maize-Blackgram-T.aus	0-15	7.16	1.29	0.09	0.45	28.54	25.23	0.32	1.15
	15-30	7.30	1.05	0.06	0.36	18.72	13.63	0.15	0.86
Remarks	-	Opt.	Low	Very Low	Very High	Opt.	Medium	Low	Medium
Maize-Fallow-T.aus	0-15	7.17	1.30	0.07	0.36	22.05	24.16	0.21	1.17
	15-30	7.45	1.10	0.06	0.29	17.26	12.60	0.09	0.81
Remarks	-	Opt.	Low	Very Low	High	Very High	Medium	Low	Medium

**12. Research highlight / findings:**

- In the existing Maize-Fallow-T.aus cropping pattern Mungbean/Blackgram can be grown successfully.
- Maize-Mungbean-T.aman/T.aus cropping pattern produced 19-26% higher rice equivalent yield compared to existing Maize-Fallow-T.aus pattern.
- Farmers income increased 15-24% by adopting the improved Maize-Mungbean-T.aman/T.aus cropping pattern.
- Soil nutrient mining can be minimized by growing mungbean/blackgram in Maize-Fallow - T.aman cropping pattern.

**13. References:**

1. AIS, 2016. Agricultural Information Services, KhamarBari, Farmgate, Dhaka 1215.
2. BARI Annual Report. 2011. Bangladesh Agricultural Research Institute, Soil Science Annual Report, 2011, Joydebpur, Gazipur
3. BARI Annual Report. 2015. Bangladesh Agricultural Research Institute, On-Farm Research Division Annual Report, 2015, Joydebpur, Gazipur
4. Bender, J. K. , Hans, R.Y. and Smith, J. 2013. Nutrient balance study in maize based dropping system in New Castle, American J. Environment. Col. 56(3). P. 113.
5. BARC, 12. Fertilizer Recommendation Guide. 2012. Bangladesh Agricultural Research Council, Farmgate, New Airport Road, Dhaka-1215.





## **B. Implementation Position**

### **1. Procurement:**

Description of equipment and capital items	PP Target		Achievement		Remarks
	Phy (no.)	Fin (Tk)	Phy (no.)	Fin (Tk)	
(a) Office equipment	--	--	--	--	--
(b) Lab & field equipment	01.Knapsack sprayer	7,500/-	02	15,000/-	--
	02.Bicycle	10,500/-	02	21,000/-	--
(c) Other capital items	--	--	--	--	--

### **2. Establishment/renovation facilities: Not applicable**

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	

### **3. Training/study tour/seminar/workshop/conference organized:**

Description	Number of participant			Duration (Days/weeks/months)	Remarks
	Male	Female	Total		
(a) Training	262	18	280	9 batch (Day long)	--
(b) Workshop	--	--	--	--	--

### **C. Financial and physical progress**

Sl. No	Major Head	Total approved budget (Tk.)	Fund received (Tk.)	Actual expenditure (Tk.)	Balance/ unspent	Physical progress (%)	Reasons for deviation
1	Contractual Staff Salary	584979	654169	576902	77267	88.19	
2	Field Research / Lab expenses and supplies	744175	822402	653272	169130	79.43	
3	Operating Expenses	225122	228000	218594	9406	95.87	
4	Vehicle Hire and Fuel, Oil & Maintenance	76224	82731	70223	12508	84.88	
5	Training/Workshop/ Seminar etc.	238000	198000	199197	-1197	100.60	
6	Publications and printing	80000	80000	0	80000	0.00	
7	Miscellaneous	40000	50000	50306	-306	100.61	
8	Capital Expenses	36000	37800	37800	0	100.00	
	<b>Grand Total</b>	<b>2024500</b>	<b>2153102</b>	<b>1806294</b>	<b>346808</b>	<b>83.89</b>	

Note.01. Tk.329,745 RPA fund has refund to Project Unit Office, BARC, Dhaka

02. Tk. 17063 GOB fund in the bank account

### **D. Achievement of Sub-project by objectives:**

Specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output (i.e. product obtained, visible, measurable)	Outcome (short term effect of the research)
To develop present maize based cropping patterns for sustaining soil fertility	Set up of field experiments of maize based cropping pattern including mungbean / blackgram	15-20% higher yield has obtained than farmers practice	Soil health friendly maize based cropping pattern has developed.
To improve and maintain soil fertility through better nutrient management	Soil sample collection before and after the pattern completion. Chemical analysis of soil and plant samples for nutrients. Preparation of nutrient balance sheet	Soil nutrient status especially organic matter has improved	Soil fertility has improved through incorporation of legumes biomass to the soil
To adapt improved maize based cropping systems for increasing farmer's income	Farmers income has increased due to legume crops included in the pattern	Maize based cropping systems will be adapted by farmers at least 40-60%	Gross benefit of the pattern has increased and Rice Equivalent Yield increased by 26%
To increase productivity and profitability for	Application of balance fertilizer and legume crops incorporation.	Knowledge and skill of the farmers has increased about green	Profitable maize based cropping pattern has

attaining food and nutrition security	Provide training and field day for the farmers on intensive cropping systems	manuring after maize cultivation	developed and MBCR increased up to 2.40.
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**E. Materials Development/Publication made under the sub-project: None**

Publication	Number of publication		Remarks (e.g. paper title name of journal, conference name, etc)
	Under preparation	Completed and publication	

**F. Technology/Knowledge generation/Policy Support (as applied):**

i) Generation of technology (Commodity & Non-commodity)

- a) In the existing Maize-Fallow-T.aus cropping pattern Mungbean / Blackgram can be grown successfully.
- b) Maize-Mungbean-T.aman/T.aus cropping pattern produced 19-26% higher rice equivalent yield compared to existing Maize-Fallow-T.aus pattern.

ii) Generation of new knowledge that help in developing more technology in future

iii) Technology transferred that help increased agricultural productivity and farmers' income

- a) Nine farmers training and two field days were organized in the project period to transfer the technology that will help to increase agricultural productivity and farmers' income.

iv) Policy Support

**G. Information regarding Desk and Field Monitoring**

- i) Desk Monitoring (description & output of consultation meeting, monitoring workshops / seminars etc.):
- ii) Field Monitoring (time & No. of visit, Team visit and output):

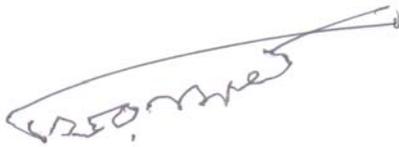
Monitoring team	Date(s) of visit	Total visit (No.)	Remarks
Technical Division/ Unit, BARC	Desk monitoring	01	-
PIU-BARC, NATP-2	Director 29 April 2018	01	-
Internal Monitoring	-	-	-
Others Visitors	RARS scientist	07	10 person

**I. Lesson Learned**

- i. In the existing Maize-Fallow-T. aus cropping pattern Mungbean / Blackgram can be grown successfully.
- ii. Maize-Mungbean-T. aman/T. aus cropping pattern produced 19-26% higher rice equivalent yield compared to existing Maize-Fallow-T. aus pattern.
- iii. Farmers income increased 15-24% by adopting the improved Maize-Mungbean - T. aman / T. aus cropping pattern.
- iv. Soil nutrient mining can be minimized by growing Mungbean / Blackgram in Maize- Fallow - T. aman cropping pattern.

**J. Challenges**

- i) High rainfall during sowing time of mungbean/blackgram
- ii) Unavailability of mungbean/blackgram seed
- iii) Unavailability of short duration rice seed



Signature of the Principal Investigator

Date. 30/01/2019  
Seal

Counter signature of the Head of the  
organization/authorized representative  
Date.....  
Seal

Appendix-i

List of farmers participated in the research work

μ bs	K...l#Ki bvg	wVKvbv	dmj aviv
1	‡gvt Avwib wgqv	MÖvgt Gjv½x, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`n	‡ivcv Avgb-f~Æv-gyMWvj
2	‡gvt wZZvm Av³vi	MÖvgt Gjv½x, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`n	‡ivcv Avgb-f~Æv-gyMWvj
3	‡gvt gwbiæj Bmjvg	MÖvgt Gjv½x, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`n	‡ivcv Avgb-f~Æv-gyMWvj
4	‡gvt e³vi Avjx	MÖvgt Gjv½x, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`n	‡ivcv Avgb-f~Æv-gyMWvj
5	‡gvt w`byR wgqv	MÖvgt Gjv½x, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`n	‡ivcv Avgb-f~Æv-gyMWvj
6	‡gvt Avwidyj Bmjvg	MÖvgt Gjv½x, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-gyMWvj
7	‡gvt Bgivb †nv‡mb	MÖvgt Gjv½x, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-gyMWvj
8	‡gvt iwKe wgqv	MÖvgt Gjv½x, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-gyMWvj
9	‡gvt nwwdRyj gÛj	MÖvgt Gjv½x, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-gyMWvj
10	‡gvt im~j wgqv	MÖvgt Gjv½x, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-gyMWvj
11	‡gvt Rqbjwgqv	MÖvgt Kwv`iKzj, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-gvmKjvB
12	‡gvt bv‡qe Avjx	MÖvgt Kwv`iKzj, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`vn	‡ivcv AvDk-f~Æv-gvmKjvB
13	‡gvt Qvgv` wgqv	MÖvgt Kwv`iKzj, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`vn	‡ivcv AvDk-f~Æv-gvmKjvB
14	‡gvt iRe Avjx gÛj	MÖvgt Kwv`iKzj Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`vn	‡ivcv AvDk-f~Æv-gvmKjvB
15	‡gvt Avãyi iwng	MÖvgt Kwv`iKzj, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`vn	‡ivcv AvDk-f~Æv-gvmKjvB
16	‡gv t`m`i Avjx	MÖvgt Gjv½x, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-cwZZ
17	‡gvt †Mvjvg im~j wgqv	MÖvgt Gjv½x, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-cwZZ
18	‡gvt gvgyb wgqv	MÖvgt Gjv½x, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-cwZZ
19	‡gvt †Mvjvg AvRg	MÖvgt Gjv½x, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-cwZZ
20	‡gvt kwdDwİb	MÖvgt Gjv½x, Dc‡Rjvt KvjxMÄ, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-cwZZ

21	‡gvt †ZvZv wek'vm	MÖvgt jÿxcyi, Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv Avgb-f~Æv-gyMWvj
22	‡gvt Avãym mvgv` wgqv	MÖvgt jÿxcyi Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv Avgb-f~Æv-gyMWvj
23	‡gvt †Kvievb gÛj	MÖvgt jÿxcyi Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv Avgb-f~Æv-gyMWvj
24	‡gvt Qd`yj wgqv	MÖvgt jÿxcyi, Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv Avgb-f~Æv-gyMWvj
25	‡gvt Avmv`yj Bmjvg	MÖvgt jÿxcyi Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv Avgb-f~Æv-gyMWvj
26	‡gvt Aveyj Kvjvg gÛj	MÖvgt jÿxcyi, Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv- gyMWvj
27	‡gvt Avj-Avwgb	MÖvgt jÿxcyi, Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-gyMWvj
28	‡gvt Avãyjðvn	MÖvgt jÿxcyi, Dc‡Rjvt m`i, †Rjvt wSbvB`vn	‡ivcv AvDk-f~Æv-gyMWvj
29	‡gvt AKzj Luv	MÖvgt jÿxcyi, Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-gyMWvj
30	‡gvt bvwn` nvmvb	MÖvgt jÿxcyi, Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-gyMWvj
31	‡gvt †`vwLi Dwílb	MÖvgt Mvbœv, Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-gvmKjvB
32	‡gvt Avãym Qvjvg	MÖvgt Mvbœv, Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-gvmKjvB
33	‡gvt gvwbK wgqv	MÖvgt Mvbœv, Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-gvmKjvB
34	‡gvt gwdRyj nK	MÖvgt Mvbœv, Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-gvmKjvB
35	‡gvt iweDj Bmjvg	MÖvgt Mvbœv, Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-gvmKjvB
36	‡gvt Qvgv` wgqv	MÖvgt jÿxcyi, Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-cwZZ
37	‡gvt Avãym Qvjvg	MÖvgt jÿxcyi, Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-cwZZ
38	‡gvt †gvKv‡ím Avjx	MÖvgt jÿxcyi Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-cwZZ
39	Wv. †gvt Avãyi iwK`	MÖvgt jÿxcyi Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-cwZZ
40	‡gvt Puv` Avjx	MÖvgt jÿxcyi, Dc‡Rjvt m`i, †Rjvt wSbvB`n	‡ivcv AvDk-f~Æv-cwZZ

$\mu$ bs	<b>K...l#Ki bvg</b>	<b>wVKvbv</b>	<b>dmj aviv</b>
41	‡gvt AvwZqvi ingvb	MÖvgt Kwv`cyi Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv Avgb-f~Æv-gyMWvj
42	‡gvt Kwdj Dīxb	MÖvgt Kwv`cyi, Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv Avgb-f~Æv-gyMWvj
43	‡gvt mv‡R`yi ingvb	MÖvgt Kwv`cyi Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv Avgb-f~Æv-gyMWvj
44	‡gvt GKivgyj nK	MÖvgt Kwv`cyi, Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv Avgb-f~Æv-gyMWvj
45	‡gvt kvnvbyRyj nK	MÖvgt ‡jvKbv_cyi Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv Avgb-f~Æv-gyMWvj
46	‡gvt iweDj Avjg	MÖvgt e`bcyi, Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gyMWvj
47	‡gvt ûgvqb †nv‡mb	MÖvgt e`bcyi, Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gyMWvj
48	‡gvt myjZvb wek vm	MÖvgt e`bcyi, Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gyMWvj
49	‡gvt mvBdzj †nv‡mb	MÖvgt e`bcyi, Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gyMWvj
50	‡gvt †mvnvM Avjx	MÖvgt e`bcyi, Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gyMWvj
51	‡gvt Avt Lv‡jK wgqv	MÖvgt Kwv`cyi Mvs cvov, Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gvmKjvB
52	‡gvt AvwRR wgqv	MÖvgt Kwv`cyi Mvs cvov, Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gvmKjvB
53	‡gvt Avey e°i wgqv	MÖvgt Kwv`cyi Mvs cvov, Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gvmKjvB
54	‡gvt nv‡mg Avjx	MÖvgt Kwv`cyi Mvs cvov, Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gvmKjvB
55	‡gvt mvRvnb Avjx	MÖvgt Kwv`cyi Mvs cvov, Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gvmKjvB
56	‡gvt gyKzj †nv‡mb	MÖvgt `vgyoû`v, Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-cwZZ
57	‡gvt iwdKzj wgqv	MÖvgt `vgyoû`v, Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-cwZZ
58	‡gvt AvwbQzi ingvb	MÖvgt `vgyoû`v Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-cwZZ
59	‡gvt gBbīxb wgqv	MÖvgt `vgyoû`v Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-cwZZ
60	‡gvt mvjvDīxb	MÖvgt `vgyoû`v, Dc‡Rjvt `vgyoû`v, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-cwZZ

$\mu$ bs	K...l#Ki bvg	wVKvbv	dmj aviv
61	‡gvt jvjPvb wgqv	MÖvgt GKZvicyi, Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gvmKjvB
62	‡gvt wejøvj wgqv	MÖvgt GKZvicyi, Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gvmKjvB
63	‡gvt Ave`yjøvn wgqv	MÖvgt GKZvicyi, Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gvmKjvB
64	‡gvt †Mvjvg wek!vm	MÖvgt GKZvicyi, Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gvmKjvB
65	‡gvt Qv‡bvqvi †nv‡mb	MÖvgt GKZvicyi, Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gvmKjvB
66	‡gvt gwKDi ingvb	MÖvgt GKZvicyi Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-cwZZ
67	‡gvt igRvb Avjx	MÖvgt GKZvicyi Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-cwZZ
68	‡gvt mg‡mi Avjx	MÖvgt GKZvicyi Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-cwZZ
69	‡gvt wgbviæj Bmjvg	MÖvgt GKZvicyi Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-cwZZ
70	‡gvt gwn`yj nK	MÖvgt GKZvicyi, Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-cwZZ
71	‡gvt wjUb wgqv	MÖvgt m‡šlvcy, Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gyMWvj
72	‡gvt †mvnvM Avjx	MÖvgt m‡šlvcy, Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gyMWvj
73	‡gvt gvnvej †nv‡mb	MÖvgt m‡šlvcy Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gyMWvj
74	‡gvt eRjy †gvjøv	MÖvgt m‡šlvcy, Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gyMWvj
75	‡gvt mvivg wgqv	MÖvgt m‡šlvcy, Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv AvDk-f~Æv-gyMWvj
76	‡gvt Rqbjv wgqv	MÖvgt Kwkcyl, Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv Avgb-f~Æv-gyMWvj
77	‡gvt Avwidzj nK	MÖvgt Kwkcyl, Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv Avgb-f~Æv-gyMWvj
78	‡gvt mvBdzj nK	MÖvgt Kwkcyl, Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv Avgb-f~Æv-gyMWvj
79	‡gvt bvRgyj nK	MÖvgt Kwkcyl, Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv Avgb-f~Æv-gyMWvj
80	‡gvt AvwkKzi ingvb	MÖvgt Kwkcyl, Dc‡Rjvt Rxeb bMi, †Rjvt PzqvWv½v	‡ivcv Avgb-f~Æv-gyMWvj