Project ID: 647

Competitive Research Grant

Sub-Project Completion Report

on

Floating bed fodder cultivation in submerged and flooded areas in Sylhet district: A tool for climate resilient livestock production

Project Duration

April 2017 to September 2018

Department of Biochemistry and Chemistry
Faculty of Biotechnology and Genetic Engineering
Sylhet Agricultural University, Sylhet 3100

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

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Floating bed fodder cultivation in submerged and flooded areas in Sylhet district: A tool for climate resilient livestock production
Project Implementation Unit
National Agricultural Technology Program-Phase II Project (NATP-2)
Bangladesh Agricultural Research Council (BARC)
New Airport Road, Farmgate, Dhaka – 1215
Bangladesh

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Project Implementation Unit
National Agricultural Technology Program-Phase II Project (NATP-2)
Bangladesh Agricultural Research Council (BARC)
New Airport Road, Farmgate, Dhaka – 1215
Bangladesh

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Acronyms

BOD	:	Biological oxygen demand	ft	:	Feet
CP	:	Crude Protein	IVD	:	In Vitro Degradability
DM	:	Dry Matter	Kg	:	Kilogram
DO	:	Dissolved oxygen	LAB	:	Lactic Acid Bacteria
EE	:	Ether Extract	MR	:	Methyl Red
F	:	Far	MRS	:	De Man, Rogosa & Sharpe
FB	:	Floating Bed	MRVP	:	Methyl Red Voges-Proskauer test
FBF	:	Floating Bed fodder	N	:	Near
FBGS	:	Floating Bed German at SAU	RF	:	Rumen fluid
FBDF	:	Floating bed Dal in Field	sqft	:	Square feet
FBDS	:	Floating bed Dal at SAU	VP	:	Voges-Proskauer test
LGS	:	Land German at SAU	SAU	:	Sylhet Agricultural University

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Executive Summary

To solve the problems of fodder crisis in the haor areas the project was taken to introduce the low cost floating bed fodder cultivation technology to the farmers. For conducting this study the water logged areas of Jaintapur and Kanaighat upazilas of Sylhet district were selected. A total of forty interested contract farmers were selected from the two upazilas (twenty from each). The frame of the floating was made using bamboo that was covered with plastic net. Four pieces of mature banana plants were fixed beneath the bamboo frame for floating management. Sufficient amount of dried water hyacinth were stacked on the floating bamboo frame with at least one feet height to make the first layer of the floating bed. The top layer of floating bed was prepared with 3 inches dried cow dung mixed soil. German (*Echinochloapolystachya*) and Dal grasses (*Hymenachneamplexicaulis*) were used for floating bed fodder cultivation study. Samples of floating bed fodder were collected from the contract farmers for the study of yield, microbial and nutritional evaluation of the grasses.

German grass was found to be suitable for floating bed cultivation. Production of German grass on the floating bed was higher both at the field (about 100 ton/ha) and at the university campus (about 160 ton/ha) compared to local (18 ton/ha) and Dal grasses (80 ton/ha). Rainy season was found to be suitable for floating bed fodder cultivation in the haor areas. Maturity of floating bed grasses planted in winter took longer time (90 days) compared to the grasses planted during July to September (60 days); consequently, the yield at 1st cutting was also lower (120 ton/ha) than the floating beds constructed during January compared to the beds constructed during July to September (150 ton/ha). Production of green fodder on floating bed was higher (100 ton/ha at the field and 160 ton/ha at the university campus) compared to growing on land (85 ton/ha at the university campus). DM (%) of German grass that was produced during winter or dry season was higher (14.83%) than the rainy season grasses (13.02%). In vitro degradability (IVD) of fodders produced in rainy season was lower (195.16 g/kg) compared to fodders produced in winter (216.03 g/kg).

Biochemical and microbial test confirmed the presence of *lactobacillus* in silage. Proximate analysis study revealed that silage had higher nutritional value than the green German grasses.The percentages of Ash (4.88%), EE (3.93%), DM (30.5%) and CP (12.37%) were higher in silage than in the green German grasses that were 3.5%, 3.49%, 16.7% and 10.15% respectively. In vitro degradability study showed that silage also makes the fodder more digestible than the green grasses. IVD of DM differed significantly ($P<0.001$) among the silage and green German grasses. German grass silage showed higher IVD (45.66%) than the green German grasses (36.56%) after 48 hours of incubation. Good quality silage can be used as an alternative source of fodder materials to feed animals during lean period to increase feed security for livestock in the haor areas.

There was a positive correlation between IVD of floating bed grasses and DO of water ($r=0.746$) holding the floating beds. The floating bed fodder samples those had a less IVD value (195.17 g/kg) had also low DO value (1.81 mg/L) of water. Likewise, fodder samples from the floating beds with the highest IVD value (255.3 g/kg) had also maximum DO value (4.20 mg/L) of the water. There was no significant difference for DO, BOD, alkalinity, chlorides, hardness and pH of the water between the 1st through to the 5th week of fodder cultivation. From these results it can be concluded that there is no significant difference in water quality after constructing floating bed in haor areas and there will be no harmful effect on fish production.

Average milk production of the cows fed with floating fodder was increased by 0.2L/cow/day which was 50L/cow/lactation. Milk from the cows fed with floating bed German grass had significantly higher fat% (4.42) compared to control (2.69). Cost benefit ratio was higher (5.6) to the farmers who fed floating bed fodder to their cows compared to control (0.96).

CRG Sub-Project Completion Report (PCR)

A. Sub-project Description

1. **Title of the CRG sub-project:**
   Floating bed fodder cultivation in submerged and flooded areas in Sylhet district: A tool for climate resilient livestock production.

2. **Implementing organization:**
   Sylhet Agricultural University, Sylhet

3. **Name and full address with phone, cell and E-mail of PI/Co-PI (s):**

Principal Investigator:
Dr. Mohammad Mehedi Hasan Khan
Professor and Chairman, Department of Biochemistry and Chemistry
Faculty of Biotechnology and Genetic Engineering
Sylhet Agricultural University, Sylhet 3100
Cell: 01680592166
E-mail: mehedi2001bdbd@gmail.com

Co-Principal Investigator(s):
Dr. Md. Jasim Uddin
Professor, Dept. of Animal Nutrition
Faculty of Veterinary and Animal Science
Sylhet Agricultural University, Sylhet
Cell: +8801911720221
E-mail: jasimsau@gmail.com

4. **Sub-project budget (Tk):**
   4.1 Total: Tk 20,00,000.00.
   4.2 Revised (if any):

5. **Duration of the sub-project:**
   5.1 Start date (based on LoA signed): 11 July 2017
   5.2 End date : 30 September 2018

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

Sylhet Division consists of some hilly areas and hundreds of haors and beels varing in size from a few hectares to several thousand hectares. During monsoon these haor basins remain full of flood water but during winter the haors become dry and remain bare, consequently there is scarcity of quality feeds and fodder for the ruminants during the monsoon and winter seasons. As a result, overall livestock production is very poor in the haor areas as the animals suffer from malnutrition. To overcome the problems livestock farmers in the haor areas need alternative techniques to grow fodder. Earlier research by our group observed that floating bed fodders can be used to feed ruminants during the rainy and even winter season. Therefore, the present study was undertaken to produce floating bed fodders and observe the adaptability by farmers, subsequently, to improve the production performances of ruminants and socio-economical status of the farmers from the two poor upazilas of Sylhet like Jaintapur and Kanaighat.

7. Sub-project goal:
To ensure climate resilient fodder production in water logged areas.

8. Sub-project objective (s):

- To introduce the low cost floating bed fodder cultivation technique to the farmers of haor areas
- To ensure year round availability of fodder through silage production
- To increase the production performances of cows through feeding floating bed fodder

9. Implementing location (s):
Jaintapur, Kanaighat upazila of Sylhet district and Sylhet Agricultural University, Sylhet, Bangladesh

10. Methodology in brief:

10.1. Introducing floating bed fodder cultivation technique in the haor areas

Survey and selection of farmers
A baseline survey was carried out to identify the water logged areas of Jaintapur and Kanaighat, upazila of Sylhet suitable for floating bed fodder production practice. During the selection of experimental sites emphasis was given to select fodder crisis areas. Twenty interested contract farmers from each upazila were selected. Cultural and intercultural agronomical practices and animal production system details were recorded.

Training of the contract farmers
A day long training program was organized at Jingabari and Darbast union parishad complex of Kanaighat and Jaintapur upazila respectively (Figure 1).

Figure 1: Farmers training at Darbast Union of Jaintapur upazila on floating bed fodder production

Construction of floating bed and cultivation of fodder
A bamboo frame was prepared and covered with plastic net. The size was near about 30ft x 5ft. Four pieces of mature banana plants were fixed beneath the bamboo frame for floating management of the bamboo frame. In some cases empty waste plastic bottles were used instead of banana plant. Sufficient amount of dried water hyacinth were stacked on the floating bamboo frame, with at least one feet height, to make the first layer of the floating bed. In few cases where water hyacinth was not enough decomposed rice straw was used. The top layer of floating bed was prepared with 3 inches dried cow dung mixed soil. The platforms were made movable so that the farmer can choose suitable locations for better management. After selecting a good location, the platforms were fixed with bamboo poles

keeping a suitable distance from the bank. According to the suggestion of reviewers two large floating bed (60 x5 sqft) beds were also constructed at Jaintapur upazila at deep bill area. Different stages of floating bed construction are show in Figure 2.

a): Construction of floating bed frame/platform

b): Placement of floating bed frame/platform in water body

c): Preparation of bed through layering with water hyacinth and cow dung

Figure 2: Pictures showing different stages of construction of floating bed

a): Cuttings of grass for floating bed

b): Fodder plantation on floating bed

c): Complete floating bed with planted fodder

Figure 3: Pictures showing cutting of grass and plantation on the bed

Fodder plantation on floating bed

Based on the findings of Islam *et al*. (2018) and Kanak *et al*. (2013) cuttings of German (*Echinochloapolystachya*) and Dal grasses (*Hymenachneamplexicaulis*) were used for floating bed (FB) fodder cultivation. Cuttings were prepared with each cutting containing three complete internodes with four nodes. The cuttings were planted on row by row. Distance of one row to another was about 0.25m. Cuttings of two grasses, either German or Dal were planted in line sowing keeping a distance of

6-12 inches from plant to plant and row to row. Figure 3 shows the cutting of grass and plantation on the floating bed. German grasses were planted on seventeen floating beds and Dal grasses were planted on three floating beds at Jaintapur. Among the seventeen floating beds with German grass four were fitted with empty plastic bottles instead of Banana plants. The floating beds at Jaintapur were constructed during July to September (Table 1), when there was flood water available in this area. On the basis of production performances of two grasses, in Kanaighat, only German grass was planted. Among the floating beds eighteen were constructed during November to January (Table 2), in the dry season due to availability of fund and also to check the production differences due to variation of season. Rest two floating beds were constructed during March and April, 2018. Four floating beds were constructed at SAU campus. Of the four floating beds one was cultivated with German grass and another one with Dal grass in July, 2017; another one with German grass in February, 2018 and the rest one was cultivated with Dal grass in February, 2018.

German grasses were planted in land at SAU campus in November, 2017 and also in the field of farmers land to compare the production performance, nutritive value and for economical evaluation.

Care and management of floating bed fodder cultivation

There was regular check-up of the bamboo frames that was supporting the structure of a floating bed and replaced by pushing Banana plants under the floating beds to maintain the floating activity of the bed if required. There were chances to intake the grasses by free grazing cattle or goat. The beds were always kept sufficiently away from the pond bank to secure the beds from cattle attack. Fodder was harvested after 60 to 65 days in the first cutting and 40 to 45 days after 2^{nd} or more cutting. The harvesting time depended on season. In summer it took shorter time and in winter it took longer time. No fertilizer was added up to 7^{th} cutting. After that one inch cow dung with soil was added with previous floating bed

Determination of water quality of the floating bed

Water samples (minimum 1 liter) were collected in the morning hours between 8 to11am from near of floating bed (N) and far from floating bed (F). Collection of water samples were carried out once in a week for five weeks. After collecting, water samples were transferred to the laboratory of the Department of Biochemistry and Chemistry, Faculty of Biotechnology and Genetic Engineering, Sylhet Agricultural University, Sylhet for analysis. The water quality parameters such as dissolved oxygen (DO), biological oxygen demand (BOD), alkalinity, chlorides, hardness and pH were monitored weekly throughout the experimental period. To determine DO and BOD, the collected water samples in BOD bottles were fixed inside according to azide modification of Winkler (1988). Alkalinity was determined by titrimetric method. Chlorides was measured by Mohr Method according to IS: 3025 (part-32) - reaffirmed 2003. Hardness was measured by titrimetric method. A pH meter (Jenway, model 3020, UK) was used to measure the pH of water.

Sample collection for yield and nutritional quality evaluation of fodder

Fodder samples from floating beds were collected from the different cuts for the study of yield, microbial and nutritional quality evaluation. Similarly, three local grasses namely Durba, Binna and Katu that were grown naturally were also collected. All the German and Dal grasses were harvested by cutting at fourth node (between fourth and fifth internodes) from the base/root. For local grasses only the areal part was collected. Fodders produced on 1sqm area were harvested and weighed to determine the yields of different fodder. Spring balance of 20kg was used for this purpose. All the collected fodders were shifted to Biochemistry laboratory of SAU for nutritional analysis

Evaluation of nutritional quality of the floating bed fodders

Sample preparation

For nutritional analysis, the whole grass samples were cut in to pieces of less than l cm size with knife. After taking samples for dry matter and ash test, rest of the samples were dried at 105°C for overnight, grinded with blender machine and kept separately in air tight sample bottles.

Proximate analysis

The proximate analysis including DM, Ash, CP, EE of the fodder samples were performed according to AOAC (2010) and Khan (2012).

a): Fodder production on floating bed, 30th day

b): Comparative study of fodder production on floating bed (Left- dal grass, right- German grass), 45th day

c): Fodder production on floating bed, 45th day

d): Fodder production on floating bed, 55th day

e): Fodder production on floating bed, 60th day (ready to harvest)

Figure 4: Pictures showing the growth of floating bed fodder at different days

In vitro evaluation of the fodders

Collection of rumen fluid from Cattle

Rumen fluid (RF) was collected from healthy slaughtered cattle and transported to the laboratory in the insulated flasks under anaerobic conditions that was preheated at 39°C with water. The RF was strained through a porous cloth into the pre-warmed McDougall buffer at the ratio of 1:4 to prepare the inoculums (Khan and Chaudhry, 2010). The flasks were then screw capped and kept at 39^0C in a water bath until use.

Measurement of in vitro DM degradability of grass by rumen fluid

In vitro degradability (IVD) was performed according to Khan and Chaudhry (2010). For the IVD test, 0.3g of grass sample was taken to a 50 ml falcon tube to which 40 ml of buffered inoculum was added. The tube was screw capped, shaken by up and down movement and incubated for 24 hours at 39^0C in a water bath. Sample from each tube were then filtered by suction pumping. The filter paper with the residue was then dried up in an oven and the dry matter was calculated.

10.2. Ensuring year round availability of fodder through silage production

Silage production from fodder

Construction of silo

To ensure year round availability of fodder, silage was prepared and their nutritional quality evaluated. For silage preparation, two cylinder shaped brick built silos were constructed at Sylhet Agricultural University campus (Figure 5). The height of the silo was 3ft with the diameter of 2ft. The bottom of the silo was 1ft above the ground. Silo 1 contained the German grass from SAU field for silage and Silo 2 contained German grass of Floating Bed Fodder from SAU (FBS) pond. Another silo was constructed in Jaintapur under the earth. The length of the underground silo was 5ft with the width of 3ft and depth 2.5 ft. The silo thus prepared was capable of holding 40 kg of silage. Large polythene was used to warp the silo. Floating bed German grass of Jaintapur region was used for silage production in this silo.

Production of silage

Silage was produced by using German grass grown both on land and on floating bed. For the preparation of silage, German grass was harvested after 60 days of plantation. The fully matured fodder was cut from the 2 cm upper part. About 65-70% moisture level in green fodder was maintained ideally for silage making (in case of high moisture level wilting was required). The harvested German grass was then chopped to short length (1-3 cm). The grass was made shorter to easily tightening and compressing to the maximum when filling, which was more conducive to eliminate air. However, the aerobic activities of microorganism during the silage process were shortened to ensure the formation of an anaerobic environment.

Figure 5: Brick built silo a) External view b) Internal view

About 60 kg chopped fodder materials were uniformly mixed with 1 kg Molasses. After the chopped grass was mixed with the molasses the material was filled into the silo. The grass material was then compacted by pressing with heavy object like bricks. The function of compaction was to exhaust air and create the fermentation conditions for anaerobic *Lactobacillus* for silage. The tighter the silage materials are filled, the more thoroughly the air is removed, and it increases the quality of silage. The filling and compaction was completed taking shortest possible time. The silage material was covered

with a layer of plastic film. Then it was covered and compacted with the help of bricks which was then fully covered by mud. The mouth of the silo was then sealed with large polythene so that no air can enter into the silo and ensure a completely anaerobic condition for fermentation. The silo was kept covered for 28 days for the silage to be ready for feeding cattle. Figure 6 shows the different stages of preparation of fodder for silage production.

Proximate analysis and in vitro degradability test of silage

The proximate analysis including DM, Ash, CP, EE of silage and in vitro degradability of silage were done according to the methods described earlier.

Determination of pH

To determine pH a 100 gram sample of silage was thoroughly mixed with 100 ml of water and the liquid was poured into a test vial. The pH meter was simply dipped into the liquid sample to determine the pH of the silage.

Figure 6: Silage Production: **a)** Chopping of grass; **b)** Preparation of silo; **c)** Mixing with urea molasses; **d), e), f)** Preservation of grass in the silo.

Evaluation of the quality of silage

Screening and confirmation of Lactic Acid Bacteria (*Lactobacillus spp*.) from silage

Culture of silage sample on nutrient agar

From the 28 days old silage few chopped materials were taken out. Five (5) gram of the silage sample was then added to 100 ml of water and shaken vigorously. From the water and silage mixture 100 microgram of the sample was added in petridishes containing warm nutrient agar. The sample was then spread over the nutrient agar using a sterile cotton bud. The petridishes were covered with aluminum foil and incubated at 37^0C for 24 hours.

Culture of Lactobacillus spp. on MRS media and confirmation by biochemical tests

The microorganisms grown on Nutrient agar were cultured on MRS media for cultivating specifically the *Lacobacillus* spp. (deMan *et al.,* 2009). *Lactobacillus* spp. grown on MRS media was then sub-cultured to produce pure culture. Presence of *Lactobacillus* spp. was then confirmed using catalase test, indole test, MRVP test, oxidase test and glucose fermentation test following the standard methods for the tests.

10.3. Production performances of cows after feeding floating bed fodder

Production performance of cows

Twelve indigenous cows were selected for the observation of milk production in Jaintapur region in July, 2018. Initially, for two weeks, the cows were fed with locally available grass and milk production was recorded. After that six cows were fed with floating bed German grass for four weeks and the rest six cows remained as control. Milk production of these cows was recorded.

Evaluation of milk composition

Milk sample of 200 ml was collected from each cow, transported to the lab and composition was checked by an automatic milk analyzer (Funke Gerber, Germany). Data were analyzed by Minitab 17.

11. Results and discussion:

11.1 Introducing floating bed fodder cultivation technique to the farmers of haor areas

Fodder yield from floating bed

Fodder yield from different floating beds after different cut in Jaintapur and Kanaighat are given in Tables 1 and 2. The tables show that maturity of floating bed grasses planted in winter took longer time (90 days) compared to the grasses planted during July to September (60 days); consequently, the yield at 1^{st} cutting was also lower (120 ton/ha) than the floating beds constructed during January compared to the beds constructed during July to September (150 ton/ha). Islam *et al*., (2018) was also reported similar seasonal variation of the production of floating bed fodders. Production of floating bed German grass was higher both at the field (about 100 ton/ha) and at the university campus (about 160 ton/ha) compared to the floating bed Dal (80 ton/ha) and local grasses (18 ton/ha), as shown in Tables 1 and 2 and Figures 7 and 8. It is also evidenced from Figure 7 and 8 that production of green fodder on floating bed was higher (the yield at the field was about 100 ton/ha and at the university campus about 160 ton/ha) compared to growing on land (the yield at the university campus was about 85 ton/ha). Yield of grasses, as shown in Figure 9, at 1^{st} cut during July to August and 6^{th} cut during April to May was found to be higher (150 ton/ha from each cut) compared to the subsequent cuts in between (yield at 2^{nd}, 3^{rd}, 4^{th} and 5^{th} cut was 140, 130, 120 and 110 ton/ha, respectively). These findings indicate that floating bed cultivation of fodder technique in the haor areas is suitable for the rainy season. So far as maintaining the integrity of floating bed is concerned plastic bottles performed better than the banana tree as it was found that banana trees are susceptible to rotting, requiring frequent restoration. Therefore, it

was suggested to use plastic bottles instead of banana trees for keeping the beds floating for a prolong period of time.

Proximate analysis and IVD of forages

Local grasses had a slightly higher average DM (%) compared to the floating bed fodder as local grasses were grown naturally in soil ($P<0.05$). The DM (%) was lowest in German grass from Jaintapur region than other grasses. DM (%) of German grass that was produced during winter or dry season was higher (14.83%) than the rainy season grasses (13.02%). IVD (24 hours incubation) of fodders produced in rainy season was lower (195.16 g/kg) compared to fodders produced in winter (216.03 g/kg). Proximate composition and IVD of different FB fodder is shown in Table 3.

Table 1: Summary of floating bed fodder production in Jaintapur upazila

Number of beds	Materials used to float the bed	Name of fodder	1st Cutting		2nd Cutting		3rd Cutting		4th Cutting		5th Cutting		6th Cutting	
			Maturity (Days)	Production (T/ha.)	Maturity (Days)	Production (T/ha.)	Maturity (Days)	Production (T/ha.)	Maturity (Days)	Production (T/ha.)	Maturity (Days)	Production (T/ha.)	Maturity (Days)	Production (T/ha.)
13	Banana plant	German	60±3	150±20	45±3	140±20	45±3	130±20	45±3	120±30	45±3	110±30	45±3	150±30
			Comments: The beds were constructed during July to September. Two beds were destroyed by fish– one after the first cutting and the other one after second cutting. Water was dried in 6 beds after second cutting											
04	Plastic bottle	German	60±3	160±20	45±3	145±20	45±3	140±20	45±3	130±30	45±3	120±30	45±3	150±30
03	Banana plant	Dal	60±3	80±10	45±3	80±10	Farmers were discouraged due to the lower production of Dal grass and that's why they have chosen German over Dal							

Note: T/ha= Metric ton /hectare

Table 2: Summary of floating bed fodder production in Kanaighat upazila

Number of bed	Time of Construction	Name of fodder	1st Cutting		2nd Cutting		3rd Cutting		4th Cutting		Comments
			Maturity (Days)	Production (T/ha.)	Maturity (Days)	Production (T/ha.)	Maturity (Days)	Production (T/ha.)	Maturity (Days)	Production (T/ha.)	
10	November	German	70±5	130±20	50±5	130±20	45±5	130±20	45±5	140±20	
8	January	German	90±5	120±20	45±5	130±20	45±5	140±20	45±5	140±20	One bed was destroyed during second cutting
2	March- April	German	65±5	140±20	45±5	140±20	45±5	140±20	45±5	140±20	

Table 3: Variation in proximate composition and IVD from different grasses

Origin of sample		Dry matter (%)	Ash (%)	Crude protein (%)	Ether extract (%)	IVD 24 hours (g/kg)
Jaintapur (German), rainy season		13.02±1.99	2.15±0.08	12.93±1.74	3.32±0.3	195.16±24.45
Kanaighat (German), winter season		14.83±2.18	2.38±0.07	13.94±0.69	3.37±0.31	216.03±52.33
Jaintapur (Dal)		17.32±4.40	2.12±0.06	14.49±2.43	3.23±0.24	216.89±11.6
Local Grasses	Durba	18.68±1.34	1.63±0.03	8.40±0.24	1.48±0.12	206.50±5.2
	Katu	17.87±2.1	1.78±0.02	8.92±0.13	1.61±0.11	206.66±4.73
	Binna	19.35±2.35	1.59±0.03	7.80±0.2	1.29±0.16	212.16±4.85
P >		0.12	0.005	0.005	0.005	0.05

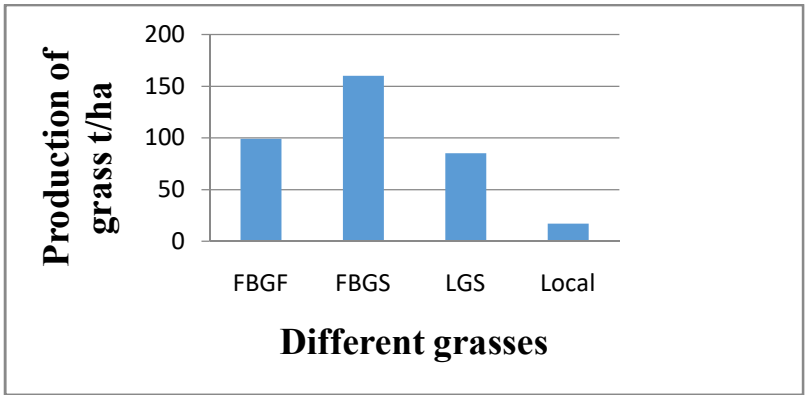

Figure 7: Production of different forages (t/ha) at Jaintapur and on campus

Note: FBGF= Floating bed German in Field; FBGS= Floating bed German at SAU; LGS= Land German at SAU; Local= Local grasses (Durba, Katu, Binna)

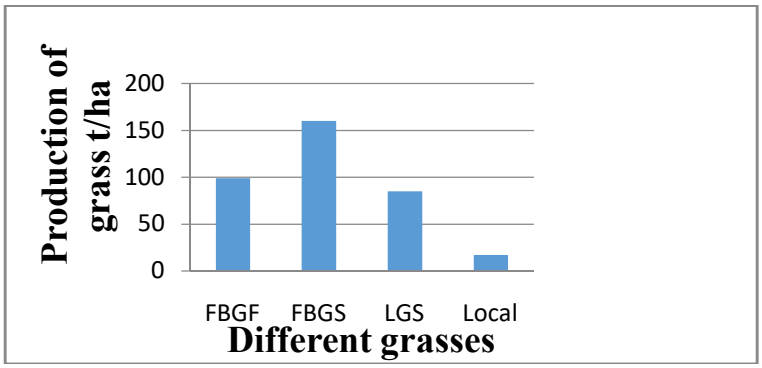

Figure 8: Production of different forages at Kanaighat and on campus

Note: FBGF= Floating bed German in Field; FBGS= Floating bed German at SAU; LGS= Land German at SAU; Local= Local grasses (Durba, Katu, Binna)

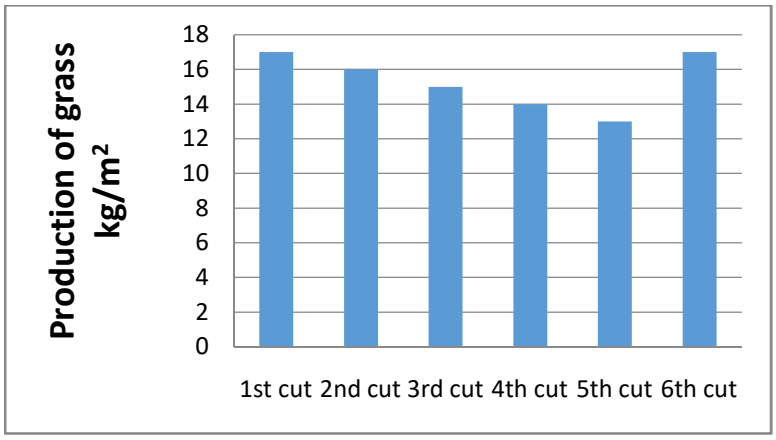

Figure 9: Production of German grass on floating bed at different cut in Jaintapur

Note: 1st cut= July-Aug; 2nd cut= Sep-Oct, 3rd cut= Nov-Dec; 4th cut =Dec-Jan; 5th cut=Feb-March; 6th cut= Apr-May.

ss

Figure 10: Silage gra

11.2. Ensuring year round availability of fodder through silage production:

Production of Silage

After 28 days of ensiling the quality of good silage was ensured by observing the characteristics of the silage of greenish brown appearance, absence of mould (Figure 10), smell of lactic and acetic acid (like dahi and vinegar), etc. Moreover, when the silage was squeezed it broke slowly into pieces, also indicated good quality. The quality silage can be a good alternative for storing fodder to be used during lean period in order to increase feed security for livestock.

Proximate composition and in vitro degradability (IVD) of silage

There were significant differences (P<0.001) in proximate composition (DM, Ash, CP and EE) among the silage and fresh green German grasses. The DM, Ash, CP and EE were in acceptable range. As shown in Table 4, the percentages of Ash (4.88%), EE (3.93%), DM (30.5%) and CP (12.37%) were higher in silage than in the green German grasses that were 3.5%, 3.49%, 16.7% and 10.15% respectively. IVD of DM differed significantly (P<0.001) among the silage and green German grass. German grass silage showed higher IVD (45.66%) than the green German grasses (36.56%) after 48 hours of incubation. IVD of silage and German grass at 0, 24 and 48h is shown in Table 5. The pH was lower in presence of silage than the German grass at different incubation time.

Table 4: Proximate composition of different silage

Sample Name with source	DM (%)	ASH (%)	EE (%)	CP (%)	NDF (%)
Silage from University Silo 1 German grass from floating bed	30.5±0.50	4.88±0.22	3.93±0.002	12.37±0.10	69.30±0.50
Silage from University Silo 2 German grass from floating bed	20.3±0.45	4.2±0.26	3.92±0.001	12.54±0.33	67.55±0.32
Silage from Silo of Jaintapur German grass from floating bed	21.5±0.50	4.52±0.22	3.93±0.003	12.37±0.02	68.00±0.34
Green grass German	16.7±0.30	3.5±0.24	3.49±0.002	10.15±0.03	62.44±0.40
P value	<0.001	<0.001	<0.001	<0.001	<0.001

Table 5: In vitro degradability and pH of different silage and grass in different hour of incubation

Sample Name with source	0 hour		24 hour		48 hour	
Sources of grass	IVD (%)	pH	IVD (%)	pH	IVD (%)	pH
Silage from University Silo 1 German grass from floating bed	10.5± 0.5	6.47± 0.002	22.5± 0.45	6.06± 0.01	40.2± 0.48	5.88± 0.020
Silage from University Silo 2 German grass from floating bed	11.2± 0.45	6.82± 0.001	24.56± 0.34	6.00± 0.02	45.66± 0.46	5.45± 0.003
Silage from Silo of Jaintapur German grass from floating bed	10.56± 0.35	6.88± 0.003	22.88± 0.04	6.11± 0.012	44.54± 0.34	5.78± 0.040
Green grass German	5.56± 0.4	6.8± 0.050	18.99± 0.43	7.04± 0.04	36.56± 0.55	7.45± 0.023

Figure 11: Growth of bacteria on Nutrient Agar from silage and *Lactobaccillus* spp. on MRS medium.

Confirmation of lactic acid bacteria (*Lactobacillus* spp.*)* from silage

Whitish small and big colonies on the nutrient agar indicate preliminarily the presence of *Lactobacillus* spp. in the silage sample which on MRS media appeared as small, white creamy colonies (Figure 11).

Biochemical tests

Gram's staining

On Gram's staining the organisms appeared as violet and purple colored (Gram positive) and rod shaped bacilli under microscope (100 X magnifications) which is the characteristic of *Lactobacillus* spp. (Figure 12).

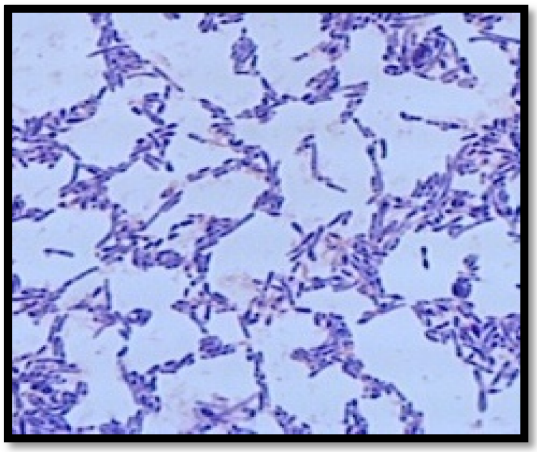

Figure 12: Gram positive rodshape *Lactobacillus* spp.

Catalase test

No bubbles were produced after inoculation indicated the test was Catalase negative. The *Lactobacillus* shows negative results in catalase reaction (Figure 13).

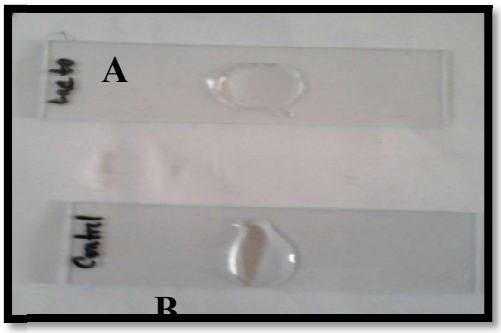

Figure 13: Catalse test; no bubbles indicating *Lactobacillus* spp. in slide A) and bubbles in slide B) Control.

Oxidase test

There was no change in color after addition of bacteria in the filter paper indicated the test was Oxidase negative. This strain might be *Lactobacillus* spp. (Figure 14).

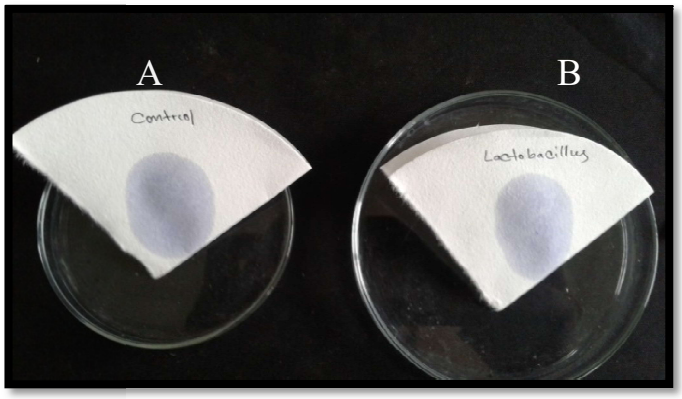

Figure 14: Negative Oxidase test A) control B) Inoculum

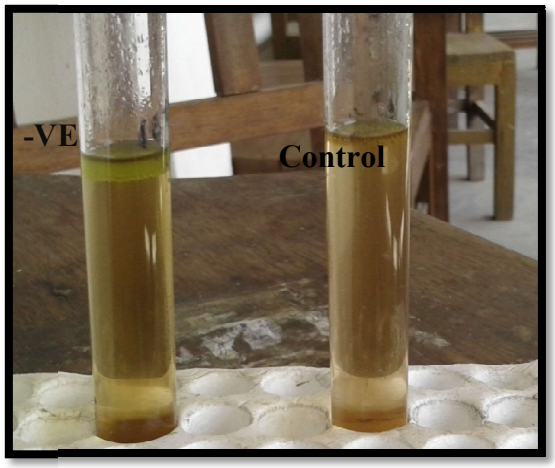

Figure 15: Indole test (Negative result).

Indole test

No pink or red colored ring appeared at the top indicated the test was Indole negative (Figure 15) which is an indication of *Lactobacillus* spp.

Methyl Red test

There was a distinct red color layer indicated the test was MR positive (Figure 16). The positive result in methyl red is an indication of *Lactobacillus* spp.

Voges–Proskauer (VP) test

No pink-red color development indicated the test was VP negative (Figure 17) which is the characteristic of *Lactobacillus* spp.

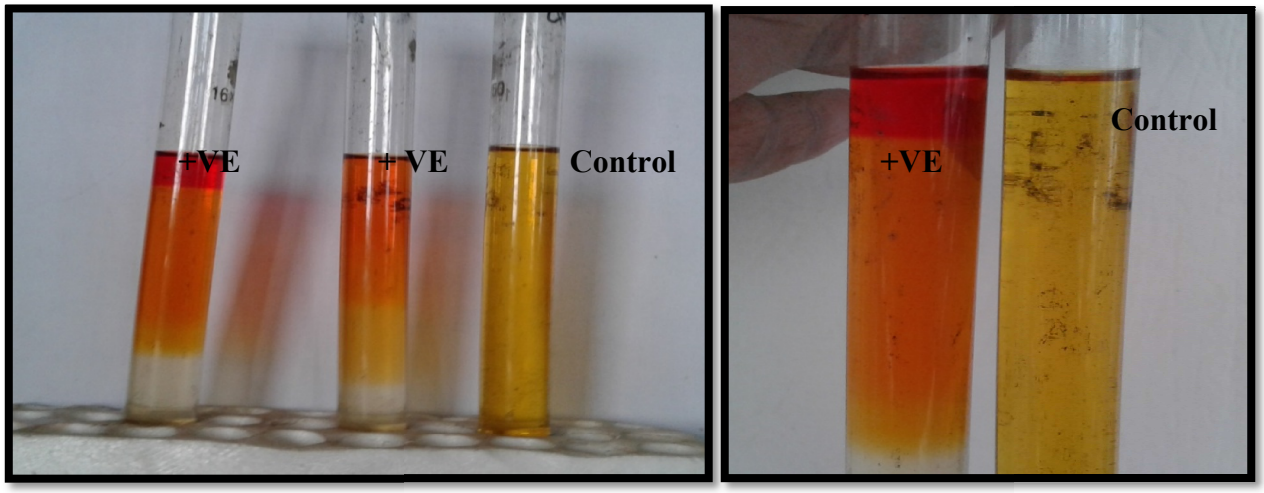

Figure 16: Methyl red test (positive result).

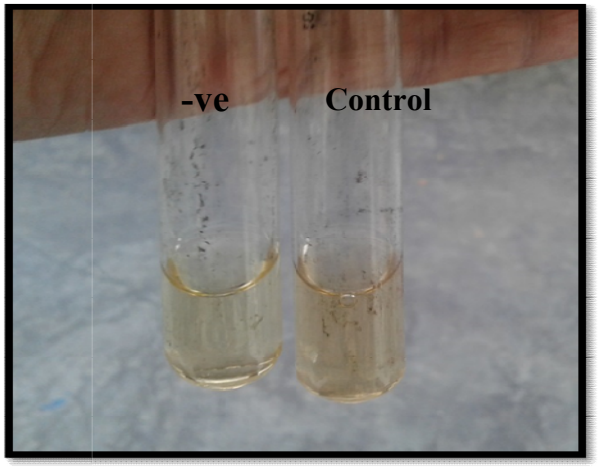

Figure 17: VP test (Negative Result).

Glucose Fermentation test

The medium was changed into orange color indicated that the test was positive. Gas production was detected by the presence of small bubbles in the tubes (Figure 18).

After all those biochemical tests it was confirmed that the bacteria in the silage were mainly the *Lactobacillus* spp.

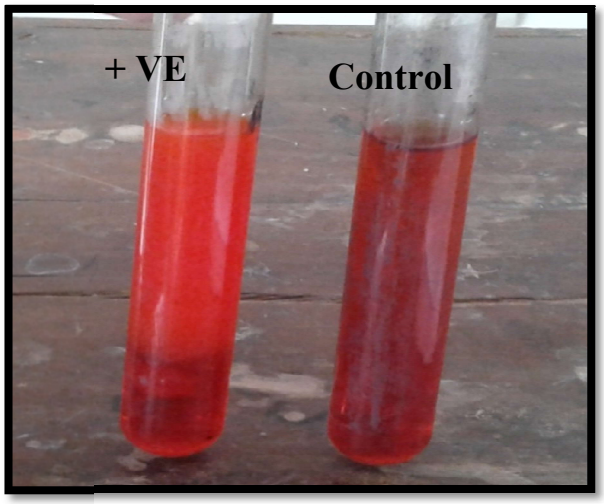

Figure 18: Positive Glucose fermentation test.

Determination of water quality

Abandoned ponds/water bodies were utilized for floating bed fodder production. Quality of water in water bodies where floating bed fodder cultivation was practiced is shown in Table 6. Present study revealed that there is a positive correlation between in vitro degradability (IVD) of fodder and dissolved oxygen (DO) of water (r=.746) of floating bed. The floating fodder samples those had a less IVD value (195.17 g/kg) had also low DO value (1.81 mg/L) of water. Fodder samples from the FBS water body had the highest IVD value (255.3 g/kg) with a maximum DO value (4.20 mg/L).

Table 6: The relation between water quality and IVD

Origin of Sample	DO (mg/L)	BOD (mg/L)	pH	IVD g/kg
Kanaighat (German)	1.81±0.22	0.76±0.10	7.12±0.35	195.17±52.3
Jaintapur (German)	2.10±0.30	1.06±0.43	7.35±0.53	216.03±24.5
Jaintapur (Dal)	1.97±0.83	0.76±0.03	7.40±0.62	216.89±11.6
FBS (German)	4.20±0.20	1.30±0.02	7.20±0.02	255.30±3.5

DO= Dissolved oxygen, BOD= Biological oxygen demand, IVD= In vitro degradability

There was significant value difference ($P<0.01$) of water for DO (3.78 vs 3.57), BOD (2.87 vs 2.37), alkalinity (14.21 vs 17.99), chlorides (8.5 vs 9.8), hardness (30.33 vs 18.58 and pH (6.64 vs 6.51) between Jaintapur and Kanaighat (Table 7). However there was no significant difference for DO, BOD, alkalinity, chlorides, hardness and pH of the water close to the floating bed and far from the floating bed (Table 7). There was no significant difference for DO, BOD, alkalinity, chlorides, hardness and pH of water between the 1st through to the 5th week of fodder cultivation (Table 8). After collection of water sample from

close and far distance of floating bed water bodies, colony counting was completed with different dilution of water sample. Average result of colony counting is shown in Table 9. The value for microbial count was higher in water near to floating bed (6.15 X 10^{10}) compared to the water sample far to bed (1.03 X 10^{10}) though the values were non-significant. From these results it can be concluded that there is no significant difference in water quality after constructing floating bed in haor areas and there will be no harmful effect on fish production.

Table 7: Variation of Dissolve oxygen, Biological oxygen demand, Alkalinity, Chlorides, Hardness and pH on location basis of floating bed fodder

Location	Water Parameters					
	Dissolve oxygen	**Biological oxygen demand**	**Alkalinity**	**Chlorides**	**Hardness**	**pH**
Jaintapur near to bed	3.78^{a}±0.07	2.87^{a}±0.06	14.21^{a}±0.85	8.5^{c}±0.31	30.33^{a}±1.24	6.64^{a}±0.03
Jaintapur far to bed	3.74^{a}±0.07	2.42^{a}±0.06	16.12^{b}±0.85	9.07^{bc}±0.31	29.98^{a}±1.24	6.64^{a}±0.03
Kanaighat near to bed	3.57^{b}±0.08	2.37^{b}±0.07	17.99^{ab}±1.00	9.8^{ab}±0.36	18.58^{b}±1.47	6.51^{b}±0.04
Kanaighat far to bed	3.52^{b}±0.08	2.42^{b}±0.07	18.53^{ab}±1.00	10.34^{a}±0.36	17.95^{b}±1.47	6.52^{b}±0.04
P value	P=0.01	P<0.001	P<0.01	P<0.01	P<0.01	P<0.01

Table 8: Variation of water parameters of stagnant water of floating bed areas on duration

Weeks	Water Parameters					
	DO	**BOD**	**Alkalinity**	**Chlorides**	**Hardness**	**pH**
1^{st}	3.76±0.08	2.73±0.07	17.80±1.23	8.98^{b}±0.37	25.57^{a}±1.51	6.51^{b}±0.03
2^{nd}	3.70±0.10	2.61±0.06	19.02±1.51	9.48^{b}±0.47	23.36^{c}±1.51	6.58^{ab}±0.03
3^{rd}	3.66±0.15	2.64±0.08	18.15±1.26	10.75^{a}±0.85	24.30^{b}±1.51	6.53^{b}±0.03
4^{th}	3.61±0.20	2.63±0.10	17.19±1.15	9.12^{b}±0.52	22.77^{c}±1.51	6.67^{a}±0.03
5^{th}	3.61±0.16	2.61±0.07	17.64±1.28	8.92^{b}±0.37	25.06^{a}±1.51	6.60^{ab}±0.03
P value	P=0.14	P=0.1	P=0.27	P<0.001	P=0.01	P=0.001

Table 9: Average microbial number of the water samples

Sample Name	**(CFU/ml)**
Close Water	6.15×10^{10}
Far Water	1.03×10^{10}
P value	0.281

Table 10: Average milk production (L)

Group of cows	Before treatment	After treatment	Milk production increased /cow/day	Milk production increased /cow/lactation
Control	1	1	0	0
Feeding floating bed German grass	1.2	1.4	0.2	50

Table 11: Composition of milk (%)

Group of cows	Protein	Fat	Lactose	Solid Not Fat	Mineral
Control	**3.40±0.16**	**2.69±0.70**	**5.10±0.24**	**9.27±0.43**	**0.76±.04**
Feeding floating bed German grass	3.16±0.14	4.42±1.07	4.73±0.21	8.60±0.39	0.72±.03
P value	0.11	0.04	0.11	0.11	0.21

11. 3. Production performance of cows after feeding floating bed fodder:

Milk production performance of cows between control and feeding floating bed German grass is shown in Table 10. On average milk production was increased by 0.2L/cow/day which was 50L/cow/lactation. Composition of milk (Table 11) showed that milk from the cows fed with floating bed German grass had significantly higher fat% (4.42) compared to control (2.69). Table 12 shows the Cost benefit analysis of feeding floating bed fodder to milking cows. Cost benefit ratio was higher (5.6) to the farmers who fed floating bed fodder to their cows compared to control (0.96).

Table 12: Cost benefit analysis of feeding floating bed fodder to milking cows

	For conventional feeding with local grass	For floating bed German grass feeding
Total cost	Expenditure to collect grass for 1 cow/ day= 100 Tk So Expenditure to collect grass for 1 cow for 365 days = (100x365)= 36500 Tk	(i) Bed cost= 6000 Tk (ii) Seed cost= 1300 Tk Total cost= 7300 Tk
Total Return	1Lmilk= 80 Tk 1.2 L milk= (1.2x 80)= 96 Tk	1 L milk= 80 Tk 1.4 L milk= (1.4x 80)= 112 Tk
Income from milk/day	1day= 96 Tk So Income from milk for 365days = (96x365)= 35040 Tk	1day= 112 Tk So income from milk/year = (112x365)= 40880 Tk
Loss/ Profit	Loss= Total Return-Total cost = (35040-36500)= -1460 Tk	Profit= Total Return-Total cost = (40880-7300)= 33580 Tk
Benefit cost nation (BCR) = Grass Return/Total cost	$=\frac{35040}{36500}=0.96$	$=\frac{40880}{7300}=5.6$

12. Research highlight/findings:

- Production of green fodder on floating bed was higher (100 and 160 ton/ha at the field and at the university campus respectively) compared to growing on land (85 ton/ha).
- Floating bed cultivation of fodder technique in the haor areas was found to be suitable for the rainy season. Maturity of floating bed grasses planted in winter took longer time (90 days) compared to the grasses planted during July to September (60 days). Again, the yield at 1st cutting was also lower (120 ton/ha) from the floating beds constructed during January compared to the beds constructed during July to September (150 ton/ha)
- In vitro degradability (IVD) of fodders produced in rainy season was lower (195.16) compared to fodders produced in winter (216.03).
- Fodder quality had a positive correlation (r=0.746) with dissolved oxygen of water.
- In vitro degradability of silage was higher than fresh fodder.
- Nutritive value of silage was higher than fresh fodder, so this technique can be used during winter season or lean period.
- Floating bed fodder production had no adverse effect on water quality.
- Floating bed fodder production does not need any fencing, land preparation or inorganic fertilizer. It can be constructed in the fallow water bodies. Therefore, floating bed fodder production is less expensive than the conventional way of fodder production.
- Milk production was higher in the animals fed with floating bed fodder (50 L more milk was produced /cow/lactation) than the control cows.
- Cost benefit ratio was higher (5.6) to the farmers who fed floating bed fodder to their cows compared to control (0.96).

B. Implementation Position

1. Procurement:

Description of equipment and capital items	PP Target		Achievement		Remarks
	Phy (#)	Fin (Tk)	Phy (#)	Fin (Tk)	
(a) Office equipment	**Furniture**	**134,500**	**Office equipment** a)Furniture b)Computer& accessories c)Digital Camera	**134,500** 49500.00 55000.00 30000.00	
(b) Lab &field equipment	**Lab Equipments**	**2,00,000.00**	**Lab Equipments** a)Oven b)Colorimeters, Spectroquant® Picco	**1,99,500.00** 89,500.00 1,10,000.00	
(c) Other capital items	**Bicycle**	**16000**	**Bicycle** Bicycle	**16000** 16000	

2. Establishment/renovation facilities:

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	
Renovation of lab			√	√	Renovation was carried out at Biochemistry lab

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

Description	Number of participant			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training	✓		40	Two days 28-10-2017 & 13-01-2018	
(b) Workshop					Workshop was planned in September, it was expected that project tenure would extended, as it was not extended workshop could not be arranged.

C. Financial and physical progress

Fig in Tk

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
A. Contractual staff salary	623460	621409	621409	0	100%	
B. Field research/lab expenses and supplies	628000	562821	562821	0	100%	
C. Operating expenses	124000	133774	135344	-1570	100%	
D. Vehicle hire and fuel, oil & maintenance	45000	39100	39100	0	100%	
E. Training/workshop/ seminar, etc.	125000	116649	42032	74617	40%	Workshop could not be arranged due to time.
F. Publications and printing	80000	32922	10000	22922	30%	
G. Miscellaneous	24040	25985	21000	4985	80%	
H. Capital expenses	350500	349000	349000	0	100%	

D. Achievement of Sub-project by objectives: (Tangible form)

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 introduce the low cost floating bed fodder cultivation technique to the farmers of haor areas	Training was given to the farmers. Floating beds constructed at farmers field and at SAU campus. Different types of fodder (German, Dal, etc.) encompassing different seasons of the year were cultivated on the floating beds. Yield and nutritional values of the fodders were determined. Water quality of the floating bed water bodies was determined.	Production of green fodder on floating bed was higher (100 and 160 ton/ha at the field and at the university campus respectively) compared to growing on land (85 ton/ha). Floating bed fodder production in the haor areas was found to be suitable for the rainy season. Maturity of floating bed grasses planted in winter took longer time (90 days) compared to the grasses planted during July to September (60 days). In vitro degradability (IVD) of fodders produced in rainy season was lower (195.16) compared to fodders produced in winter (216.03). Floating bed fodder production had no adverse effect on water quality.	It is expected that the farmers in the haor areas will adopt the floating bed production technique to feed their animals.
To ensure year round availability of fodder through silage production	Silage was produced, so that farmer can feed their animal even in winter.	Nutritive value of silage was higher than fresh fodder. Farmers fed grass to ruminants from floating bed in rainy season and silage to cattle in winter season.	Silage production using floating bed fodder would increase the availability of fodder throughout the year in the haor areas.
To increase the production performances of cows through feeding floating bed fodder	Milk production of the cows fed with floating bed fodder was compared with cows fed with conventional grass. Cost benefit ratio was determined for the cows fed with floating bed fodder	Milk production was higher in the animals fed with floating bed fodder (50 L more milk was produced /cow/lactation) than the control cows Cost benefit ratio was higher (5.6) to the farmers who fed floating bed fodder compared to control (0.96)	Higher milk production will help increasing the income of farmers that in turn will help reducing poverty in the haor areas.

E. Materials Development/Publication made under the Sub-project:

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet/flyer etc.			
Journal publication	3 manuscripts		Production and Nutritive Value of Floating Bed Fodder (German and Dhal Grasses)
Information development			
Youtube			A Documentary on Floating Bed Fodder Cultivation

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

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

Floating bed fodder production technology for haor areas

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

Production of green fodder on floating bed was higher compared to growing on land.
Floating bed fodder production in the haor areas was found to be suitable for the rainy season.
Floating bed fodder production had no adverse effect on water quality.

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

Floating bed fodder production technology was found to be well accepted by the farmers of the haor areas that will help increasing fodder production in the areas that in turn will reduce fodder crisis and will help increasing animal production thereby increasing farmers' income.

iv. Policy Support

Knowledge generated from this project regarding floating bed fodder production in the haor areas will help policy makers to take decision in relation to transferring this technology to the farmers through extension departments and agencies.

G. Information regarding Desk and Field Monitoring

i) Desk Monitoring:

ii) Field Monitoring (time& No. of visit, Team visit and output):

Monitoring team	**Date(s) of visit**	Output
Technical Division/ Unit, BARC	05-04-18	Technical division suggested to prepare a big floating bed and also suggested to include monitoring of water quality
PIU-BARC, NATP-2	07-04-18	This team suggested to include economic analysis of floating bed fodder production.
Internal Monitoring	28-06-18	This team suggested preparing a video documentary for social media like, youtube for farmers to share the technology among each other.

H. Lesson Learned (if any)

i) The pond that has big fish or Grass carp is not suitable for floating bed fodder cultivation as the fishes can destroy the floating system of the beds.
ii) Floating bed fodder cultivation technology is not suitable for Dal grass and local grass
iii) The technology is also not suitable for the dry winter season

I. Challenges (if any)

Heavy flash flood that can destroy the bed was found to be challenging for floating bed fodder production.

Signature of the Principal Investigator
Date …….
Seal

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

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