

Effect of *Dadon* on the Catch, Quality and Post-harvest Loss Reduction of Open Water Fisheries in Kishoreganj *Haor*

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Abstract

To assess the impact of *dadon* (interest-based loan) on catch, quality and post-harvest loss (PHL) reduction of open water fisheries, a 12-month study was carried out among the six fish landing centers (FLC) under 5 *haor upazilas* in Kishoreganj district of Bangladesh, viz. Chamra ghat *Matshaya Arat* in Karimganj *upazila*, Tarail *Matshaya Arat* in Tarail *upazila*, Chouganga *Matshaya Arat* in Itna *upazila*, Korgaon bazar *Matshaya Arat* in Kotiadi *upazila*, Rodar podda *Matshaya Arat* and Nikli *notun bazar Matshaya Arat* in Nikli *upazila*, from August 2018 to July 2019. Data were collected using pre-tested questionnaire interview and focus group discussion on *dadon* receiver (DR) and *dadon* non-receiver (DnR) fishermen and the data were verified and checked through key informant interviews (KII). One hundred twenty (120) interviewees (60 fishermen from each group of DR and DnR) were randomly selected from 6 landing centers to collect empirical data. The rate of commission taken by *araidar* was higher in DR (5.9%-8.5%) compared to DnR (3.9%-5.69%). Results indicated that, no icing practice (34.17%), poor hygienic condition during handling (15.83%) and use of inadequate ice in fish after harvest were the major reasons for post-harvest loss of wet fish. The estimated average PHL was 6.7% in fishers' custody from DR compared to DnR (12.4%), but the PHL was increased in the successive supply chain, the PHL of fish from boat to FLC and up to *arat* by DR was significantly lesser compared to DnR ($P < 0.05$). The fish handling status was comparatively better in DR fishermen ($p > 0.05$) compared to DnR, while DR washed their fish better than DnR ($p < 0.05$). Uses of ice box, steel drum, plastic drum and plastic crate were found to be dominant among the DR compared to DnR ($p < 0.05$). Ice-fish ratio was found to be inadequate ($p < 0.05$) by DnR fishermen (ice: fish = 1:2.99) compared to DR (ice: fish = 1:1.58). The catch size and sell/day of fish by DR fishermen were higher compared to that of DnR fishermen ($p > 0.05$). Therefore, the study revealed that DR fishermen were found to be comparatively able to catch and sell more fish, keep the quality of fish better and reduce the PHL more than DnR fishermen.

Keywords

Dadon, Post-harvest loss (PHL), Freshness quality, Kishoreganj *haor*

1. Introduction

Fisheries play an important role in food safety and nutrition, a means of securing the necessities of fisheries stakeholders, a source of income and social prosperity in developing countries [1] as well as providing main source of animal protein not only in Bangladesh, but globally. Almost 85% of the fishery produce in Bangladesh comes from freshwater source. Among them, open water fishery contributes about 28.45% of total fish production [2]. In spite of this fact, the development of artisanal fishery industry is regrettably threatened by post-harvest fish losses [3, 4].

The term post-harvest fish loss (PHFL) refers to fish that is either discarded or sold at a relatively low price because of quality deterioration. PHFL require a great concern because it is a loss of an essential nutrients that should be consumed or sold in a lower price. It causes an enormous economic loss to fishermen, and traders globally [5]. Post-harvest fish losses can be classified into four common categories: physical loss, quality loss, nutritional loss and market force loss [5, 6].

Fish is a very perishable product and are most susceptible to rapid deterioration of quality as well as high post-harvest loss due to their relatively small size and vulnerability of constituent proteins and lipids [7]. The loss of quality in fish is not revealed at least up to 50% of deterioration by common organoleptic means [8] and consumers normally purchase or take it without any charge on quality. It is noticed that high temperature in sub-tropical local climate spoils fish quickly while still in the boat, at landing, during storage or processing, on the way to the market and even while waiting to be sold [9]. Availability of ice and method of icing and handling, along with the types and methods of handling and preservation appliances and carrying containers used in fish were found to be key elements for quality loss in wet fish. If the poor handling practice continues, it will bring about huge loss in the protein as well as nutrition supply of the half-starved and nutrition-divested people as well as the health-conscious people who find the quality fish as a vital source of nutraceutical item for healthy living [10].

Freshwater fisheries suffer from huge post-harvest loss every year from harvest to retail distribution, due to lack of technical know-how and poor handling practice, preservation and distribution devices. Post-harvest quality loss in wet fish occurred, based on different species and seasons. The losses may encounter up to 28-30 % of the total fish production, where about 15.5% accounts for fresh fish quality loss [11]. Post-harvest losses are not only a great concern of food security and public health but also a massive economic loss that the fishermen and traders suffer year after year.

Fishers in *haor* areas are dependent on informal credit mechanisms, like *dadon* (interest-based loan) system in lieu of formal or institutional credit system (i.e., banks or NGOs). *Dadon* is a non-institutional financing system built upon a verbal agreement between the fishers and the *aratdars*, which is paid back by harvested fish at the beginning of next fishing season at predetermined lower price, along with 5%-10% cash interest. *Aratdars* are at the core of the fish marketing chain on *dadon* based fishery in *haor* areas, in that they finance both backward and forward linkages. By taking loan, the *dadon* receivers are bound to sell their harvested fish to *aratdar* who benefits in the form of 5% to 10% commission [12, 13]. In addition, *Aratdars* provide additional facilities to *dadon* receiver fishermen, including accommodation, entertainment and temporary storage of fish [14].

Kishoreganj is a low-lying 'Vati' district and provides highly popular "*haor*-fish". Being wild harvest, the "*haor*-fish" are considered to be the tastiest fish and highly relished by the affluent consumers in metropolitan cities country-wide. But the post-harvest handling situation is worst in Kishoreganj *haor* area, almost 30% in some cases [15]. Ames *et al.* [16] pointed out that the effective quantitative loss assessment in fish post-harvest should require at least three years or more. On the other hand, there is no any holistic research on the assessment of post-harvest quality loss of fresh fish and the handling practice of harvested fish from fishing ground to *arat* between *dadon* receiver and *dadon* non-receiver fishermen in Kishoreganj *haor*. Considering the above backdrop, the aims of this survey was to (1) compare and observe the status of handling and preservation practices of wet fish between *dadon* receiver (DR) and *dadon*-non receiver (DnR) fishermen; (2) list the major reasons that cause post-harvest loss of wet fish in Kishoreganj *haor*; (3) know the effect of *dadon* on post-harvest loss reduction in open water fishery, especially in Kishoreganj *haor*.

2. Materials and Methods

2.1. Description of study areas

The study was conducted at six (6) fish landing centers in 5 *haor upazila* of Kishoreganj *haor viz.* Chamra ghat *Matshaya Arat* in Karimganj *upazila* (24°28'48.6"N, 90°57'18.0"E), Tarail *Matshaya Arat* in Tarail *upazila* (24°32'53.860"N, 90°53'34.529"E), Chouganga *Matshaya Arat* in Itna *upazila*, (24°31'32.997"N, 90°57'15.059"E), Korgaon bazar *Matshaya Arat* in Kotiadi *upazila* (24°19'41.318"N, 90°53'27.141"E) Rodar podda *Matshaya Arat* (24°18'40.472"N, 90°55'00.025"E) and Nikli *notun* bazar *Matshaya Arat* in Nikli *upazila* (24°19'53.228"N, 90°56'16.307"E). The study areas are illustrated in Figure 1.

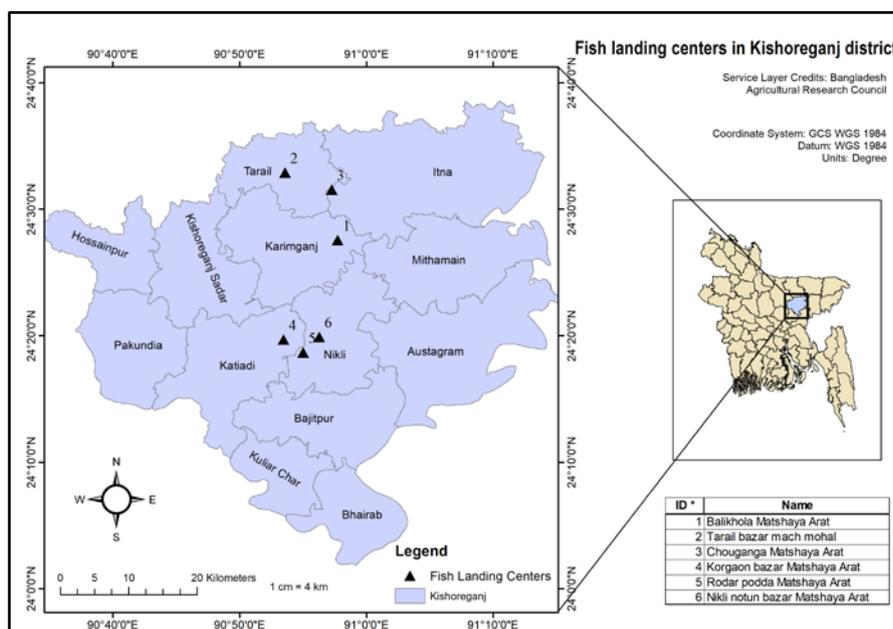


Figure 1. Map showing the location of the study area.

2.2. Sampling method, sampling period and sample size

Semi-structured questionnaire was prepared in accordance with the objective set for the study. The draft semi-structured baseline survey form was developed through rigorous process of drafting, editing, fine-tuning, expert-sharing, field testing and final field validation. The final well-structured questionnaires were administered to 60 *dadon* receiver (DR) fishermen and 60 *dadon* non-receiver (DnR) fishermen through face-to-face interview. Five (5) individual interviews of each stakeholder in 6 fish landing centers (a total of 120 individual interviews) were randomly selected. The field study was conducted from August, 2018 to July, 2019 while respondents were available at the time of the survey were interviewed.

2.3. Assessment of post-harvest quality loss of fish

During the BL survey, the quality conditions of *haor* fishes while landing or at boat were assessed using a sensory based *Fish Freshness Assessment Tool* [11, 17]. The qualitative loss was quantified in per cent by a regression model developed by [17]. The sensory indicators were adjusted based on physical conditions of local fish (Table 1 and Table 2). The assessments of quality loss were conducted in different steps of fish distribution channels from boat to *arat* during September to December, 2018. A total 18 fish species available during the study period at different steps of distribution channel were assessed. The assessed freshness quality in terms of defect points (DP) was used for the estimation of quality loss of fish. For the estimation of DP, at least five lots of same fish and 3 individual measurements for each lot were assessed.

2.4. Determination of post-harvest quality loss

In sensory Defect point (DP) analysis of wet fish (Table 2), quality breaking point lies within the DP range of > 3 to < 4 . The range is very wide. Therefore, the exact or near to actual sensory quality breaking point needs to be understood to calculate the ultimate percent quality loss. Based on a regression model analysis through correlating various biochemical and bacteriological quality parameters of fish with sensory defect qualities, the actual quality breaking point was determined to be 3.3 [11, 17]. Fish quality loss (%) was calculated from the number of assessed cases that crossed DP 3.3. The following formula was used to calculate percent quality loss of fish.

$$L (\%) = \frac{Di}{N} \times 100$$

L = Percent quality loss

N = Number of observed lots

Di = Total number of calculated DP those crossed DP 3.3

$$= \frac{d_1}{n_1} + \frac{d_2}{n_2} + \frac{d_3}{n_3} + \dots + \frac{d_i}{n_i}$$

where, 'd' is the number of DP crossed 3.3 in fishes in i^{th} lot and 'n' is the number of observations in i^{th} lot.

Table 1. Sensory defects and defect points (DP) for assessment of quality loss of fish in Kishoreganj haor

Characteristics	Defects	DP	Observations		
			1	2	3
Odor of broken neck	a. Natural fishy odor	1			
	b. Faint odor	3			
	c. Sour odor	5			
Odor of gills	a. Natural odor	1			
	b. Faint sour odor	2			
	c. Moderate sour odor	3			
	d. Strong sour odor	5			
Color of gills	a. Slight pinkish red	1			
	b. Pinkish red to brownish	2			
	c. Brown to grey	3			
	d. Bleached color	5			
Slime of gills	a. Thin colorless slime, filaments soft & separate	1			
	b. Sticky greenish slime, filaments separate	3			
	c. Yellowish slime, filaments attached	5			
Body slime	a. Clear, transparent, uniformly spread	1			
	b. Turbid, opaque	3			
	c. Thick, sticky, yellowish or greenish	5			
Eye	a. Bulging with protruding lens, transparent eye cap	1			
	b. Slight cloudy lens, sunken	2			
	c. Dull, sunken, cloudy, blood line/reddish cornea	3			
	d. Sunken eyes covered with yellow slime	5			
Consistency of flesh	a. Firm, elastic	1			
	b. Moderately soft & some loss of elasticity	2			
	c. Some softening of muscle	3			
	d. Limp or floppy	5			
General appearance	a. Full bloom, bright, shining, iridescent	1			
	b. Slight dullness, loss of bloom	2			
	c. Definite dullness and loss of bloom	3			
	d. Reddish lateral line and caudal region, dull, no bloom	5			

Average DP

Table 2. Quality grading of fish against DPs

Grade	DP	Grade Characteristics
A	< 2	Excellent, highly acceptable
B	2 to 3	Good, acceptable
C	> 3 to < 4	Deteriorating, not acceptable
D	4 to 5	Spoiled, rejected

2.5. Statistical analysis

All data generated in field were entered, coded, and filtered in Microsoft Excel[®] version 2016 software. From the excel sheet, data were further exported and analyzed using SPSS 20 software. The analysis was done using descriptive statistics like percentage, frequency distribution, mean, and standard error where necessary. A comparison of proportions and means across the intervention groups was carried out using the appropriate statistical tests including t-test at 5% significant level ($p < 0.05$). DMRT (Duncan's Multiple Range Test) method was used for comparing the significant differences of post-harvest loss of fish between *dadon* receiver fishermen and *dadon* non-receiver fishermen from different distribution channels by using SPSS 20 software.

3. Results

3.1. Demographic information

Table 3 shows the descriptive statistics information of *dadon* receiver and *dadon* non-receiver fishermen in the study area. Findings revealed that most of the *dadon* receiver (53.33%) and *dadon* non-receiver (48.33%) fishermen fall between 31 to 50 years while 28.33% *dadon* receiver and 35% *dadon* non-receiver fishermen fall between 11 to 30 years respectively. Result revealed that most of the household both in *dadon* receiver (51.67%) and *dadon* non-receiver fishermen (72.41%) had within 5-8 people in size. Survey carried out shows that majority of the *dadon* receiver (36.67%) and *dadon* non-receiver fishermen (33.33%) had primary education, 30% *dadon* receiver and 26.67% *dadon* non-receiver fishermen could sign only while 11.67% *dadon* receiver and 20% *dadon* non-receiver had no formal education. Findings revealed that 68.33% *dadon* receiver and 56.67% *dadon* non-receiver fishermen did not have any other source of income aside fishing while 18.33%, 8.33%, 5% *dadon* receiver and 26.67%, 13.33%, 3.33% *dadon* non-receiver fishermen involved with agricultural, business and manual labor aside fishing respectively. It was observed from the survey that minority of *dadon* receiver (28.33%) and *dadon* non-receiver (15%) had fish related training as well as 31.67% *dadon* receiver and 23.33% *dadon* non-receiver fishermen were member of fisher's association. Findings revealed that the demographic information of two types of fishermen was not statistically related ($p > 0.05$) with receiving *dadon* or not.

Table 3. Demographic information of the respondents (n = 120)

Variables	<i>Dadon</i> receiver (n = 60)		<i>Dadon</i> non-receiver (n = 60)	
	Frequency	%	Frequency	%
Age Structure (years)				
11-30	17	28.33	21	35
31-50	32	53.33	29	48.33
Above 50	11	18.33	10	16.67
Family size				
2-4	22	37.36	15	25.74
5-8	31	51.67	43	72.41
above 8	7	10.97	2	1.85
Educational status				
Illiterate	7	11.67	12	20
Can sign only	18	30	16	26.67
Primary education	22	36.67	20	33.33
Secondary education	8	13.33	10	16.67
Higher secondary education	3	5	2	3.33
Madrasah	2	3.33	0	0
Occupational status				
Only fishing	41	68.33	34	56.67
Fishing + Agriculture	11	18.33	16	26.67
Fishing + Small business	5	8.33	8	13.33
Fishing + Day labour	3	5	2	3.33
Boat ownership				
Own boat	27	45	12	20
Hired boat	12	20	31	51.67
Group boat	21	35	17	28.33
Any form of fish training				
Yes	17	28.33	9	15
No	43	71.67	51	85
Member of fish association group				
Yes	19	31.67	14	23.33
No	41	68.33	46	76.67

3.2. Rate of commission in *arat*

In Kishoreganj *haor* basin, *arat*der take commission from both *dadon* receiver and non-receiver fishermen are summarized in Figure 2. The commission was very high, as high as 5.9% to 8.5% taken from *dadon* receiver fishermen, while 3.9% to 5.8% from *dadon* non-receiver fishermen. Rate of commission in the same column *viz.* Nikli, Chouganga, Rodar podda and Tarail having different superscripts differ significantly ($p < 0.05$ in Chouganga and Tarail; $p < 0.001$ in Nikli and Rodar podda).

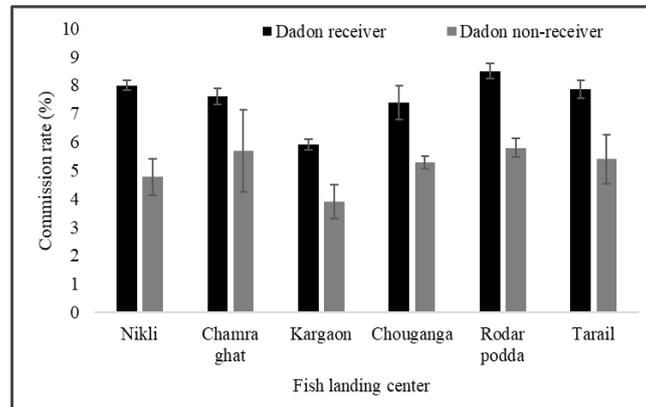


Figure 2. Rate of commission in *arat* (%) given by *dadon* receiver and non-receiver fishermen.

3.3. Extent of post-harvest loss (PHL) of wet fish

A total of 18 commercial fish species available during the study period was studied for PHL estimation (Figure 3 and Table 4). Average fish quality loss was 6.7% in fishers' custody from *dadon* receiver fishermen compared to *dadon* non-receiver fishers' custody (12.4%) (Table 4). About 2.36% quality loss of wet fish was observed in boats belong to fishes under *dadon* receiver fishermen while 3.36% in the fishes under *dadon* non-receiver fishermen. When fishes were transferred from boat to fish landing centers (FLC), PHL of fish was higher in *dadon* non-receiver fishers' custody (6.38%) compared to *dadon* receiver fishers' custody (4.63%). About 7.18% quality was lost in *arat* capturing *dadon* receiver fishermen while 10.3% quality was lost which were captured by *dadon* non-receiver fishermen (Figure 3).

Table 4 shows the descriptive results of extent of post-harvest loss of wet fish between two types of fishermen who receive *dadon* or not in the study area. Post-harvest loss in fish is a one-way chain reaction, which if once initiated, will continue till to a complete loss of quality is ensured. Findings revealed that jat punti, bele, boal, pabda, baim and calbshu lost more than 5% quality, while transferring to FLC from fishing in *dadon* receiver fishers' custody. All fishes except sar punti, carpio and guchi baim lost many of their qualities (more than 5%) while transferring to FLC from fishing in case of *dadon* non-receiver fishers' custody. Jat punti, sar punti, bele, kajoli, boal, kachki, gonia, ayer, baim and guchi baim really gone too bad in *arat*, which was captured by *dadon* non-receiver fishermen (about 12%). On the other hand, bele, kachki and guchi baim lost many of their quality (10.1%) in *arat*, which was captured by *dadon* receiver fishermen. The results revealed that, mean of PHL in the row having different superscripts differ significantly ($p < 0.05$) except tengra, batashi, pabda and tara baim while in *dadon* receiver fishers' custody. On the other hand, mean of PHL in the same row having different superscripts differ significantly ($p < 0.05$) except tengra, batashi, kachki, pabda and calbshu while in *dadon* non-receiver fishers' custody.

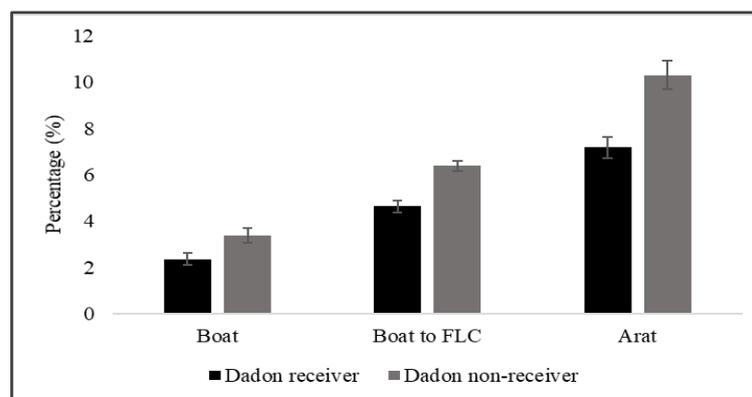


Figure 3. Post-harvest loss (%) of wet fish in DR and DnR fishers' custody.

Table 4. Post-harvest loss (%) of wet fish in Kishoreganj haor areas

Fish species	Month of assessment	% of PHFL							
		Dadon receiver				Dadon non-receiver			
		Boat	Boat to FLC	Arat	Av. PHL	Boat	Boat to FLC	Arat	Av. PHL
Jat punti	Sep-Nov	2.6±0.23 ^c	5.6±0.23 ^b	8±0.23 ^a		4±0.46 ^c	7.17±0.18 ^b	12.6±0.35 ^a	
Sar punti	Sep-Nov	2.1±0.35 ^c	3.6±0.26 ^b	7.5±0.35 ^a		3.3±0.17 ^c	4.57±0.15 ^b	11.7±0.35 ^a	
Tengra	Nov	3.1±0.17 ^b	4.83±0.23 ^a	4.5±0.29 ^a		3.9±0.58 ^b	6.33±0.34 ^a	6.63±0.35 ^a	
Gulsha	Sep-Nov	2.3±0.17 ^c	4.3±0.2 ^b	6.3±0.29 ^a		3.8±0.98 ^c	6.47±0.33 ^b	8.9±0.17 ^a	
Bele	Nov	2.5±0.29 ^c	5.13±0.14 ^b	10.1±0.4 ^a		2.7±0.4 ^c	5.83±0.35 ^b	13.3±0.75 ^a	
Carpio	Oct/Nov	0.2±0.0 ^c	2.8±0.7 ^b	4.1±1.1 ^a		0.2±0.0 ^c	4.9±1.4 ^b	5.5±1.7 ^a	
Batashi	Oct/Nov	2.1±0.35 ^a	4.27±0.14 ^b	5.6±0.29 ^a		2.9±0.5 ^b	5.5±1.53 ^a	5.6±1.4 ^a	
Kajoli	Oct/Nov	2±0 ^c	4.47±0.41 ^b	7.4±0.29 ^a		2.6±0.17 ^c	7.27±0.55 ^b	10.4±0.4 ^a	
Boal	Oct/Nov	3.1±0.4 ^c	5.33±0.15 ^b	8.7±0.23 ^a		4.5±0.69 ^c	6.87±0.44 ^b	13.7±0.34 ^a	
Kachki	Oct/Nov	3±0.52 ^c	4.3±0.17 ^b	10.2±0.12 ^a	6.7	5.1±0.23 ^a	5.97±0.44 ^a	10.6±0.12 ^b	12.4
Pabda	Nov	3.8±0.35 ^b	6.1±0.23 ^a	6.5±0.35 ^a		5.4±0.92 ^a	6.5±0.31 ^a	8.9±0.46 ^b	
Gonia	Sep-Nov	3±0.46 ^c	5.5±0.32 ^b	8.5±0.16 ^a		3.2±0.12 ^c	7.63±0.26 ^b	12.7±0.12 ^a	
Ayer	Oct/Nov	0.3±0.46 ^c	2.23±0.18 ^b	5.9±0.23 ^a		1.7±0.23 ^c	5.87±0.55 ^b	11.9±0.4 ^a	
Tara baim	Oct/Nov	2.73±0.84 ^b	4.3±0.1 ^{ab}	6±0.29 ^a		4.1±0.4 ^c	6.47±0.23 ^b	9.2±0.34 ^a	
Baim	Oct/Nov	4.2±0.46 ^c	6.23±0.35 ^b	8.6±0.17 ^a		4.6±0.29 ^c	7.63±0.24 ^b	13.8±0.23 ^a	
Guchi baim	Sep-Dec	1±0 ^c	3.37±0.64 ^b	10±0.46 ^a		1.4±0.23 ^c	4.97±0.67 ^b	10.8±0.4 ^a	
Calbashu	Nov	3.1±0.17 ^c	6.37±0.47 ^b	4.4±0.1 ^a		3.7±0.4 ^a	7.63±0.48 ^b	8.7±0.17 ^b	
Rui	Nov	1.3±0.17 ^c	4.63±0.35 ^b	7±0.23 ^a		3.5±0.12 ^c	7.3±0.44 ^b	10.4±0.17 ^a	

PHFL = Post-harvest fish loss, PHL = Post-harvest loss, FLC = Fish landing center, Av. = Average, Sep = September, Oct = October, Nov = November, Dec = December. Mean values with different superscripts in the same row differ significantly ($p < 0.05$).

3.4. Reasons for post-harvest loss of wet fish in Kishoreganj haor

Based on our observations and interviewed with the respondents, various reasons were compiled that contributed post-harvest losses of wet fish. Based on findings in Table 5, no icing practice (34.17%), poor hygienic condition (15.83%) and use of inadequate ice in fish after harvest were the major reasons for post-harvest loss of wet fish. In addition, post-harvest loss due to long times setting gear (5.83%), usage wounding gears that cause wounds and damage tissue (2.5%) and rough handling practice (7.5%) causes spoilage of fishes. Some of the reasons of fish post-harvest losses were natural, such as long time keeping of fish in boat or *arat* at higher temperature due to direct sunlight (10%) and distance and geographic difficulties (5%).

Table 5. Major reasons that cause post-harvest loss of wet fish in Kishoreganj haor

Variables (n = 120)	No. (%)
Use of harmful methods of fishing e.g. poison, dynamite	0 (0)
Entangling by fishing gears (nets, traps etc.)	5 (4.17)
Use of wounding gears	3 (2.5)
Setting gear for a long time	7 (5.83)
Distance and geographic difficulties	6 (5)
Poor hygienic condition	19 (15.83)
Rough handling while unloading (throwing fish, stand on fish etc.)	9 (7.5)
Inadequate use of ice	13 (10.83)
No icing	41 (34.17)
Delay in purchasing fish by traders	5 (4.17)
Long bargaining time while kept in ground due to sun at high temperature	12 (10)

3.5. Status of harvested, sold and consumed fish by fishermen

Figure 4 shows the daily catch, sell and consumption of fish between *dadon* receiver and *dadon* non-receiver fishermen. Findings revealed that *dadon* receiver fishermen could harvest, sell and consume comparatively more fish than *dadon* non-receiver fishermen ($p > 0.05$). The result showed that *dadon* receiver can harvest in an average of 6.98 ± 2.05 kg fish per day compared to *dadon* non-receiver fishermen (6.61 ± 1.36 kg) in Kishoreganj haor. The quantity of fish sold by *dadon* receiver fishermen was higher (6.4 ± 1.87 kg) than non-receiver fisherman (6.24 ± 1.38). Fisherman who receiver *dadon* keep in an average 0.55 ± 2 kg fish for their family needs before selling in *arat* which was comparatively higher than the fishermen who did not receive *dadon* (0.35 ± 0.06 kg).

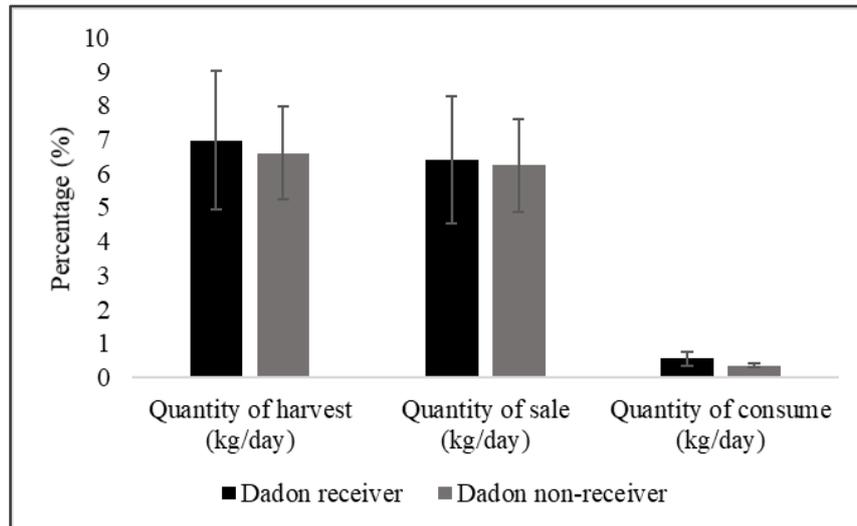


Figure 4. Quantity of harvested, sold and consumed fish (kg) per fisherman.

3.6. Handling status of fish by *dadon* receiver and non-receiver fishermen

The handling status of fish between *dadon* receiver and non-receiver fishermen is summarized in Figure 5 as encountered in the present study. The result revealed that 86.67% *dadon* receiver sorted captured fish based on species, size and quality which was comparatively higher than *dadon* non-receiver fisherman (83.33%) ($p > 0.05$). About 70.42% *dadon* receiver fishermen used water for washing captured fish and 38.33% *dadon* non-receiver fishermen used water before selling in *arat*. Mean in the same column (fish washed by water) having different superscripts differ significantly ($p < 0.05$). After harvesting, higher proportion of *dadon* receiver fishermen (55%) used fresh utensil to carry fish at *arat* compared to *dadon* non-receiver fishermen (22.5%) ($p > 0.05$). The fish handling condition of *dadon* non-receiver fishermen was comparatively worse than *dadon* receiver fishermen ($p > 0.05$).

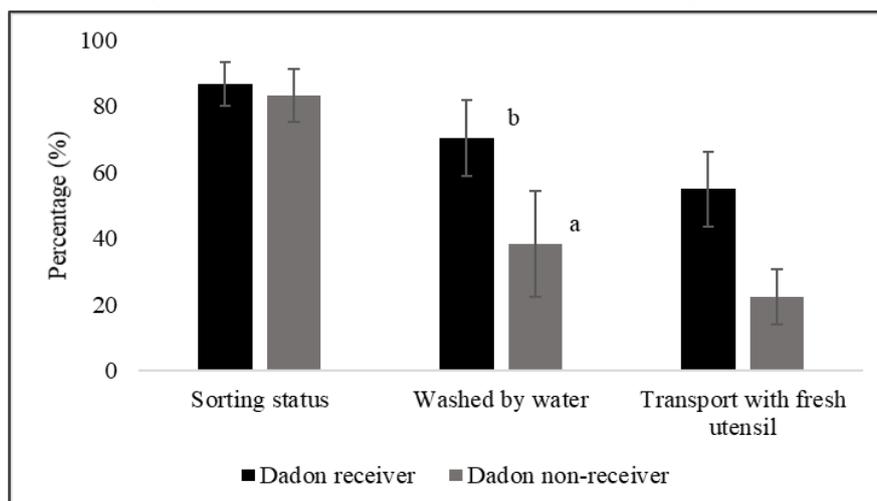


Figure 5. Handling condition of fish (%) by *dadon* receiver and *dadon* non-receiver fishermen. Values with different superscripts within same parameter in the same column differ significantly ($p < 0.05$).

3.7. Container used to keep/transport fish by *dadon* receiver and *dadon* non-receiver fishermen

After harvesting of fish from fishing in *haor*, various types of containers were used to carry fish in *arat*. About 50.75%, 27.9% and 10.83% *dadon* non-receiver fishermen used boat, bamboo made basket and gunny bag to carry fish in *arat* compared to *dadon* receiver fishermen (21.87%, 11.38% and 3.67% respectively). About 22.31% and 22.92% *dadon* receiver fishermen used plastic drum and plastic crate to carry fish in *arat* after harvest which was higher than *dadon* non receiver fishermen (5.6% and 4.92% respectively). About 5.56% and 12.3% *dadon* receiver fishermen used steel drum and ice box to carry fish in *arat* after harvest (Figure 6). On the other hand, *dadon* non-receiver did not use steel drum and ice box to carry fish in *arat*. The result revealed that significant differences was found ($p < 0.01$) using all types containers used to carry fish in *arat* after harvest between *dadon* receiver and *dadon* non-receiver fishermen.

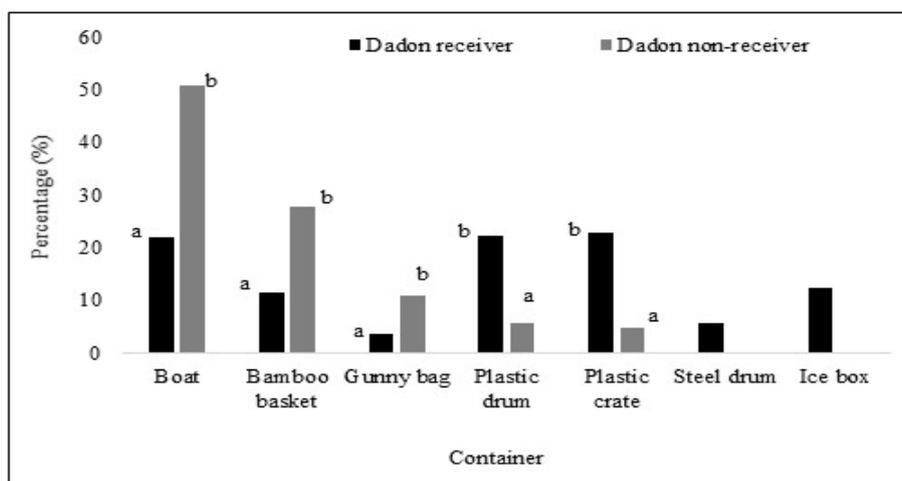


Figure 6. Container used to keep/transport fish from fishing ground to *arat* (%). Values with different superscripts within same parameter in the same column differ significantly ($p < 0.05$).

3.8. Status of ice used in fish during transportation

Figure 7 showed that icing practice by *dadon* non-receiver were hardly seen (76.91%) after harvesting in boat compared to *dadon* receiver (25.33%). About 74% *dadon* receiver used ice in fish, 22.5% of them used ice immediately just after the catch, 35% and 17.17% of them used ice within 1 and 3 hours respectively after harvesting. On the other hand, 23.09% *dadon* non-receiver fishermen used ice in fish, 8.7% of them used ice immediately just after the catch, 4.35% and 10.04% of them used ice within 1 and 3 hours respectively. About 77.78% *dadon* receiver claimed that ice used in fish was still present after arrival at *arat* compared to *dadon* non-receiver fishermen (23.33%).

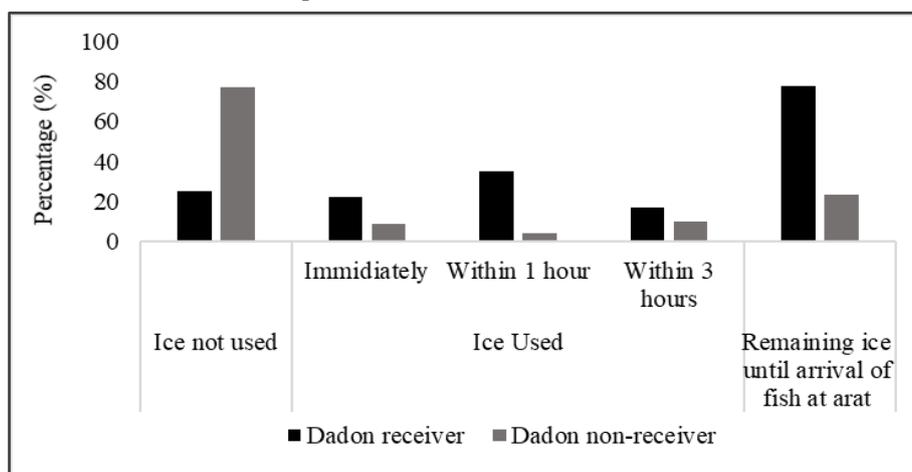


Figure 7. Icing of fish (%) during transportation at *arat* by *dadon* receiver and non-receiver fishermen.

3.9. Ratio of ice used in fish during transportation

Table 6 summarizes the comparison of ice used in fish during transportation by *dadon* receiver fishermen and non-receiver fishermen. Use of ice is necessary during transportation of fish but a very small quantity of ice was used in

fish during transportation. As a result, fish destined from *haor* areas often got deteriorated in quality. The present study revealed that *dadon* non-receiver fishermen used ice in lesser quantity (fish:ice = 2.99:1) compared to *dadon* receiver fishermen (fish:ice = 1.58:1). The *dadon* receiver used 1 kg ice in 1.16-2.04 kg fish during transportation at *arat* from the fishing ground, whereas *dadon* non-receiver used 1 kg ice in 2-4.56 kg fish.

Table 6. Ratio of ice used in boat after fish harvest by *dadon* receiver and *dadon* non-receiver fishermen.

Fish landing center	<i>Dadon</i> receiver			<i>Dadon</i> non-receiver		
	Fish (kg)	Ice (kg)	Ratio	Fish (kg)	Ice (kg)	Ratio
Nikli	10±3.45	6.06±2.4	1.65:1	16±5.03	4.83±3.66	3.31:1
Chamra ghat	8.6±3.43	7.38±3.1	1.16:1	10±3.54	4.63±2.59	2.16:1
Korgaon	40±10	28.67±8.51	1.4:1	38±31.05	8.33±6.01	4.56:1
Chouganga	19±1	9.33±1.33	2.04:1	14±3.06	7±2.52	2:1
Rodar podda	38.33±9.28	23.33±6.36	1.64:1	10.67±.67	5.33±1.45	2.1:1
Tarail	38.33±9.28	22.67±6.96	1.69:1	19.33±10.35	6±3.06	3.22:1
Total	25.71±6.08	16.24±3.98	1.58:1	18±4.24	6.02±.58	2.99:1

4. Discussion

Post-harvest loss (PHL) of wet fish is the highest for all the perishable products in the entire food production system [18] and a serious problem faced by the small-scale fisheries as well as threatening the progress of this sector [19]. Findings revealed that post-harvest loss was higher in fishers' custody from *dadon* non-receiver fishermen (12.4%) compared to *dadon* receiver fishermen (6.7%) due to poor handling practices during unloading of fish from boat to fish landing centers, lack of covering facilities for fresh fish at boat to prevent sunlight, use of inadequate ice after harvesting and failure to use appropriate containers during unloading result in poor quality fish. In this survey, fishes while in *dadon* receiver and non-receiver fishermen's custody in boat did not encounter much PHL. This view is supported by the findings of Nowsad *et al.* [17].

Post-harvest loss (PHL) of fish is a one-way chain reaction, which if once started, will continue till to a complete loss of quality is certified. The loss assessment study indicated that fish did not lose quality during handling by the fishermen at fish landing centers [17, 20]. This view was dissimilar with the present study. From observation carried out in the study area, it was discovered that almost all fish species encountered much PHL while transferring from boat to FLC and at *arat* in *dadon* non-receiver fishers' custody compared to *dadon* receiver's custody. This trend might be supplied of ice box by *aratder* to *dadon* receiver fishermen as well as use of ice in boat and appropriate containers by *dadon* receiver fishermen compared to *dadon* non-receiver fishermen.

During the study period, we tried to find out the possible reasons that caused much PHL of wet fish at selected fish landing centers in Kishoreganj *haor*. Findings of this study in line with the findings of Nowsad *et al.* [17, 21], Nowsad [11] and Hossain and Barman [22] conducted in Bangladesh in detecting causes of high PHL (inadequate icing, high temperature due to direct sunlight, delay before trading, careless handling and processing methods). These issues were also stated elsewhere as major reasons of massive PHL [23-27].

Findings showed that *dadon* receiver fishermen could harvest, sell and keep more fish in quantity than *dadon* non-receiver fishermen. This might be due to use own boat and net during fishing by *dadon* receiver fishermen. Assefa *et al.* [26] reported that fisherman had his own boat than a group boat, managing to reduce PHL which in agreement with our findings. Kabir [28] observed that fishermen worked as hired labor and ownership of net and boat was often beyond. This might be another reason for lower catch size and sell/day. Hossain *et al.* [29] observed that fishermen catch 35-80 kg fish per day by a group of fishermen of four (4) using a boat which was found to be higher compared to the present study.

Sorting and washing effort of fish were low in *dadon* non-receiver fishers' custody compared to *dadon* receiver fishermen during harvest to landing. *Dadon* receiver fishermen were more aware to use good practices of fish handling compared to *dadon* non-receiver fishermen. According to the respondent and our observation it was shown that *aratder* encouraged fishermen who were getting *dadon* to wash and sort their catch after harvest before the auction at *arat* because of getting a higher price from *paikers*. Alam [30] reported that *dadon* non-receiver fishermen had no permanent *dadondar* to sell their fish immediately after landing and sometimes they sold their catch directly to the consumer which may result in mishandling, improper, and uncertain payments.

Dadon non-receiver fishermen mostly used boat, bamboo made basket and gunny bag to transport and unload the

harvested fish compared to *dadon* receiver fishermen. Additionally, ice box and steel drum were not used during keeping/transportation of fish by *dadon* non-receiver fishermen accelerating quality loss of fish which in line with the findings of Nowsad [7, 11]. In our survey, most of the fishermen stated that, plastic drum or plastic crate, steel drum and sometimes ice-box were supplied from *arat* to *dadon* receiver fishermen to transport fish from fishing to fish landing centers. Hossain and Barman [22] reported that proper transportation with suitable accessories is required to retard spoilage, losses and improve the quality of wet fish.

In the present study, it was found that fish in *dadon* non-receiver fishers' custody was not significantly iced during transport to landing compared to *dadon* receiver fishermen. Additionally, icing practice *v.z.* immediately or within 1 or 3 hours after harvest as well as ice-fish ratio was higher by *dadon* receiver fishermen. This trend might be occurred using ice-box and more aware of keeping good quality fish by *dadon* receiver fishermen. The fish lost its quality due to lack of using suitable ice-box and careless handling and icing of fish [7].

5. Conclusion and recommendation

In Kishoregonj *haor*, huge quantity of open water fishes was captured by fishermen who were entrapped with *dadon*. However, post-harvest quality loss of fish was found significantly higher ($p < 0.05$) in *dadon* non-receiver fishermen compared to *dadon* receiver fishermen. *Dadon* is the most important way of financing in Kishoreganj *haor* basin, plays positive role in keeping good quality of fish by *dadon* receiver fishermen compared to *dadon* non-receiver fishermen. As fish is easily damaged and spoiled, careful handling, processing and preservation technique is paramount. Additionally, commission rate against *dadon* is high so many fishers are not interest to receive *dadon* and they do not take much attention to keep good quality fish. If we reduce the commission rate around 1%-2% and to encourage both types of fishers through implementing roles, regulations, workshop and training by GO and NGO, we will reduce post-harvest loss of fish from harvest to retail distribution.

Declaration of competing interest

The authors declare that they have no known contending interests or personal relations that could have appeared to influence the work stated in this paper.

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