Household fish consumption in relation to fishing practices and fish production in flood plains of Bangladesh

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ABSTRACT

A monthly survey of daily household fish consumption was conducted from August 1991 to July 1992 in the Chanda, BSKB and Halxi beels of Bangladesh. Annual averages of daily household fish consumption of the 3 flood plains were, respectively, 0.19, 0.16 and 0.19 kg/household a day, equivalent to the average daily fish consumption per caput of 31, 29 and 33 g/person a day. The consumption was higher for fishing households and in the monsoon season, and lower for non-fishing households and in the dry season. The fish harvested from the flood plains made up for 77.37, 48.78 and 74.21%, respectively, of the local fish consumption in these 3 flood plains.

Situated in the Ganges River Delta, Bangladesh has one of the richest and largest flood-plain systems in the world (Rahman 1989). Its total area was estimated to be 2,946,953 ha, occupying 72.81% of the inland water area, and producing about 50% of the total fish production of inland open water capture fisheries (Bangladesh Fisheries Resources Survey System 1988). In the flood-plain fisheries, fish caught by fishermen are either sold for cash or kept for household consumption. The latter is as important as the former and more important in the case of subsistence fishermen. Also, non-fishing households usually purchase fish at local bazaars, where fish from flood-plain are one of the major supply sources. Traditionally, fish provide 80% of the animal protein in the diet of local inhabitants (Bangladesh Center for Advanced Study (BCAS) 1989, Nuruzzaman 1989). The daily fish consumption per caput in Bangladesh was reported on average 33 g in the 1960’s and 21 g in 1988 (BCAS 1989).

The objectives of this study were to estimate the amount of fish consumed by households, and to determine the relationship of consumption to fishing practices and flood-plain fish production.

STUDY AREAS

The 3 flood plains studied were the Chanda beel in the Gopalganji District, the BSKB beel in the Khulna District, and the Halxi beel in the Natore District. The flood plain areas, population sizes, numbers of villages and households, and average household sizes are shown in Table 1. The 3 flood plains are
so-called seasonal beels, which are inundated in the summer monsoon and dry up in the winter (Tsai and Ali 1985). In 1992 flooding began in May and ended in December in the Chanda beel. It occurred about 1 month later in the BSKB and Halti beels.

The Chanda beel is an open flood plain that is inundated by water from nearby rivers. Local residents are engaged primarily in fishing in the monsoon season and farming in the dry season. The BSKB beel is a closed flood plain. It is surrounded by embankments and is inundated primarily by rain water in the monsoon season. Its water level is regulated by sluice gates. Local residents are engaged primarily in agriculture in both monsoon and dry seasons. The Halti beel is a semi-open flood plain. It is surrounded by embankments but with many breaches that connect it to adjacent rivers. Many local residents fish in the monsoon season and practice agriculture in the dry season.

MATERIALS AND METHODS

For each flood plain, the 2-stage random sampling method (Cochran 1977) was used to select study households. Villages in flood plains were the primary sampling units and households in study villages were the secondary sampling units. There were 21 study villages in the Chanda beel, 23 in the BSKB beel and 40 in the Halti beel. They comprised, respectively, 48, 18 and 29% of the total number of villages (Table 1). These sample sizes are for estimating the average number of households in the villages at 20% sampling error (d-value = 0.20). Because of the multi-domain sampling, 400 households (the maximum number) in each flood plain allowed by the budget was used. The households were allocated to the study villages in proportion to their numbers.

A monthly household survey was conducted from August 1991 to July 1992. All 400 study households in each flood plain were visited each month. For each study household, data on the amount of fish consumed and fishing practices (whether household member(s) engaged in fishing) were collected for each of the 3 days (today, yesterday and day before yesterday). This assumed that the memory of the interviewees is reliable perhaps only for the 3 days. A total of about 1200 samples (400 households x 3 days) on daily household fish consumption (kg/household a day, simplified as kg) and fishing practices were collected.

According to the fishing practices, each household was assigned to one of the two categories for each day: non-fishing household or fishing household. The non-fishing

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Chanda</th>
<th>BSKB</th>
<th>Halti</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood-plain area (ha)</td>
<td>10,872</td>
<td>26,040</td>
<td>16,770</td>
</tr>
<tr>
<td>Number of villages</td>
<td>44</td>
<td>127</td>
<td>140</td>
</tr>
<tr>
<td>Population</td>
<td>54,103</td>
<td>111,802</td>
<td>104,359</td>
</tr>
<tr>
<td>Number of households</td>
<td>8,896</td>
<td>20,552</td>
<td>17,924</td>
</tr>
<tr>
<td>Average household size (number of</td>
<td>6.12</td>
<td>5.44</td>
<td>5.81</td>
</tr>
<tr>
<td>residents/household)</td>
<td></td>
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</tr>
</tbody>
</table>

Table 1. Areas, populations, numbers of households and household sizes in Chanda, BSKB and Halti beels: August 1991 to July 1992
household had no members engaged in fishing on that day. When there was at least one member engaged in fishing on that day, the household was regarded as a fishing household.

The mean daily number of households and mean daily fish consumption were estimated for each month for each of the two categories of households by the following equations:

\[ N = nN_0/3n_0 \]  

(1)

where \( N \) is the mean daily number of households in a given month; \( n \) is the number of samples obtained; \( n_0 \) is the total number of samples obtained; \( N_0 = 400 \); and \( N_0 \) is the total number of households in floodplain

\[ \bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i \]  

(2)

where \( \bar{x} \) is the mean daily household fish consumption; and \( x_i \) is the daily fish consumption of study household \( i \).

The annual average of household numbers and of daily household fish consumption are the averages of the monthly means for the 12-month study period.

The monthly means of daily fish consumption for each of the two categories of households were plotted against monthly fish production of the flood plains to establish the consumption-production relationships. The fish production data were obtained from the fish production monitoring programme (Tsai et al. 1992) conducted concurrently with this study. The relationships are expressed by the following asymptotic function equation:

\[ \bar{x} = \bar{x}_\infty \left(1 - e^{-k(t - p_0)}\right) \]  

(3)

where \( p \) is monthly fish production (tons = 1000 kg) from flood plain; \( p_0 \) is \( p \) at monthly mean daily household fish consumption; \( \bar{x} \) equal to zero; \( k \) is the consumption rate; \( \bar{x}_\infty \) is the maximum at \( p \) infinite, the asymptotic level that predicts the maximum level reached under the present socio-economic conditions, when the fish supply from the flood plains increases to a level no long affecting the consumption.

RESULTS AND DISCUSSION

Fishing practice

The involvement of local residents in the floodplain fisheries in the Chanda beel was about twice than in the other two flood plains (Table 2).

In each flood plain, the monthly averages of daily numbers of the two category of households showed drastic seasonal changes corresponding to the monsoon cycle: high for fishing households and low for non-fishing households in the monsoon season and the reverse in the dry season (Table 2). The maximum number of fishing households occurred in August for the Chanda beel, October for the BAKB beel and November for the Halti beel; the minimum numbers were in April, May and June respectively. The percentage reduction in the numbers of fishing households from the month of peak fishing to the month of least fishing was fairly similar among the 3 flood plains, viz. 79% for the Chanda beel, 84% for the BAKB beel and 73% for the Halti beel.

Fish consumption

Table 3 shows the monthly and annual averages of daily fish consumption by the two categories of households and all households (2 categories combined) in the 3 flood plains. For the non-fishing households, the annual averages of daily fish consumption were equivalent to a daily fish consumption per caput of 23, 24 and 21 g respectively. For the fishing households the consumption was 0.25, 0.20 and 0.26 kg, equivalent to a daily fish consumption per caput of 41, 37 and 47 g respectively. The consumption by the fishing households was 1.60 and 2.24 fold higher
than that of non-fishing households. For all households, the consumption was 0.19, 0.16 and 0.19 kg, which were equivalent to a daily fish consumption per caput of 31, 29 and 33 kg respectively. This is higher than 21 g estimated for the average of the country in 1988 (BCAS 1989).

The results of 2-way ANOVA indicated that annual mean daily household fish consumption of the fishing households was significantly higher than that of the non-fishing households in each flood plain (F-value 58.53, P < 0.001), but there was no significant difference among the 3 flood plains (F-value =
When the one-way ANOVA was conducted for the non-fishing and fishing households, respectively, the annual averages of the monthly mean daily fish consumption were not significantly different among the 3 flood plains for the non-fishing household (F-value = 0.34, P > 0.05), but significantly different for the fishing households (F-value = 3.45, P < 0.05).

The lack of differences in fish consumption among the 3 flood plains when tested by the two-way ANOVA was because when the two categories were combined, the similarity in the consumption of the non-fishing households, which were majority of households, smoothened the differences in the consumption of the fishing households. This lack of geographical difference suggested that the low daily household consumption observed in this study was perhaps a general phenomenon under the present socio-economic conditions (low purchasing power for non-fishing households and high cash demands for fishing households) and market conditions (low supply and high price) in most of the rural communities in the country.

At each flood plain, the monthly averages of daily fish consumption of fishing households showed drastic seasonal changes: high in the monsoon season and low in the dry season (Table 3), corresponding to the seasonal patterns of the number of households (Table 2). The monthly average peaked in August in the Chanda beel, October in the BSKB beel and November in the Halti beel. The lowest consumption occurred in April in the Chanda beel and in June in the BSKB and Halti beels. The percentage reductions from the month of peak consumption to the month of lowest consumption were greater for the non-fishing households than the fishing households and for Chanda and Halti beels than the BSKB beel: 84% for the Chanda beel, 67% for the BSKB beel and 74% for the Halti beel for the non-fishing households; and 56%, 26% and 57%, respectively, for the fishing households.

The fishing households depend on catches by households' members (fishermen) from flood plains as the sole source of fish. On the other hand, the non-fishing households depend on local markets (bazars) as the primary source. Apparently, the seasonal changes in the market conditions (supply, demand and price) that affect the amounts of fish consumed by non-fishing households are greater than the changes of individual fishermen that affect the amounts consumed by their households.

Consumption-production relationship

The relationships between monthly mean daily household fish consumption and monthly fish production for the non-fishing households (\(x_0\)) and for fishing households (\(x_f\)) in the 3 flood plains are shown in Fig. 2. Their equations (3) are:

For Chanda beel

\[
\bar{x}_0 = 0.358 (1 - e^{-0.004(p + 32.48)})
\]

\(R^2 = 0.92, df = 11\)

\[
\bar{x}_f = 0.314 (1 - e^{-0.019 (p + 24.55)})
\]

\(R^2 = 0.96, df = 11\)

For BSKB beel

\[
\bar{x}_0 = 0.215 (1 - e^{-0.004(p + 120)})
\]

\(R^2 = 0.55, df = 11\)

\[
\bar{x}_f = 0.211 (1 - e^{-0.031 (p + 14.90)})
\]

\(R^2 = 0.81, df = 11\)

For Halti beel

\[
\bar{x}_0 = 0.327 (1 - e^{-0.003 (p + 55.19)})
\]

\(R^2 = 0.49, df = 11\)

\[
\bar{x}_f = 0.373 (1 - e^{-0.007 (p + 64.88)})
\]

\(R^2 = 0.73, df = 11\)
Table 3. Monthly and annual averages of daily fish consumption (mean ± SD, kg/household a day) of non-fishing household (N), fishing household (F) and all households (A), Chanda, BSKB and Halti beels, August 1991 to July 1992

<table>
<thead>
<tr>
<th>Month</th>
<th>Chanda</th>
<th></th>
<th></th>
<th>BSKB</th>
<th></th>
<th></th>
<th>Halti</th>
<th></th>
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</thead>
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<tr>
<td></td>
<td>N</td>
<td>F</td>
<td>A</td>
<td>N</td>
<td>F</td>
<td>A</td>
<td>N</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>(50)</td>
<td>(351)</td>
<td>(401)</td>
<td>(377)</td>
<td>(24)</td>
<td>(401)</td>
<td>(298)</td>
<td>(93)</td>
<td>(391)</td>
</tr>
<tr>
<td>Avg</td>
<td>0.31 ± 0.13</td>
<td>0.34 ± 0.10</td>
<td>0.33 ± 0.11</td>
<td>0.14 ± 0.13</td>
<td>0.15 ± 0.12</td>
<td>0.14 ± 0.13</td>
<td>0.16 ± 0.18</td>
<td>0.20 ± 0.16</td>
<td>0.17 ± 0.17</td>
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<tr>
<td>Sept</td>
<td>0.23 ± 0.11</td>
<td>0.29 ± 0.09</td>
<td>0.27 ± 0.10</td>
<td>0.17 ± 0.12</td>
<td>0.22 ± 0.09</td>
<td>0.19 ± 0.11</td>
<td>0.17 ± 0.17</td>
<td>0.24 ± 0.28</td>
<td>0.19 ± 0.21</td>
</tr>
<tr>
<td></td>
<td>(158)</td>
<td>(242)</td>
<td>(400)</td>
<td>(222)</td>
<td>(177)</td>
<td>(394)</td>
<td>(301)</td>
<td>(100)</td>
<td>(401)</td>
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<tr>
<td>Oct</td>
<td>0.21 ± 0.09</td>
<td>0.30 ± 0.08</td>
<td>0.27 ± 0.09</td>
<td>0.18 ± 0.16</td>
<td>0.23 ± 0.09</td>
<td>0.21 ± 0.14</td>
<td>0.20 ± 0.21</td>
<td>0.31 ± 0.24</td>
<td>0.25 ± 0.23</td>
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<tr>
<td></td>
<td>(253)</td>
<td>(397)</td>
<td>(191)</td>
<td>(197)</td>
<td>(400)</td>
<td>(284)</td>
<td>(313)</td>
<td>(114)</td>
<td>(403)</td>
</tr>
<tr>
<td>Nov</td>
<td>0.20 ± 0.09</td>
<td>0.30 ± 0.09</td>
<td>0.27 ± 0.10</td>
<td>0.14 ± 0.13</td>
<td>0.20 ± 0.09</td>
<td>0.17 ± 0.12</td>
<td>0.23 ± 0.22</td>
<td>0.35 ± 0.28</td>
<td>0.27 ± 0.25</td>
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<tr>
<td></td>
<td>(128)</td>
<td>(270)</td>
<td>(398)</td>
<td>(225)</td>
<td>(150)</td>
<td>(397)</td>
<td>(271)</td>
<td>(131)</td>
<td>(402)</td>
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<tr>
<td>Dec</td>
<td>0.19 ± 0.17</td>
<td>0.32 ± 0.12</td>
<td>0.26 ± 0.16</td>
<td>0.13 ± 0.14</td>
<td>0.23 ± 0.14</td>
<td>0.16 ± 0.15</td>
<td>0.10 ± 0.16</td>
<td>0.29 ± 0.27</td>
<td>0.15 ± 0.21</td>
</tr>
<tr>
<td></td>
<td>(191)</td>
<td>(200)</td>
<td>(391)</td>
<td>(272)</td>
<td>(176)</td>
<td>(398)</td>
<td>(305)</td>
<td>(98)</td>
<td>(403)</td>
</tr>
<tr>
<td>Jan</td>
<td>0.11 ± 0.14</td>
<td>0.25 ± 0.13</td>
<td>0.16 ± 0.15</td>
<td>0.14 ± 0.14</td>
<td>0.21 ± 0.08</td>
<td>0.16 ± 0.13</td>
<td>0.14 ± 0.20</td>
<td>0.37 ± 0.29</td>
<td>0.18 ± 0.24</td>
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<tr>
<td></td>
<td>(240)</td>
<td>(152)</td>
<td>(392)</td>
<td>(285)</td>
<td>(115)</td>
<td>(400)</td>
<td>(322)</td>
<td>(79)</td>
<td>(401)</td>
</tr>
<tr>
<td>Feb</td>
<td>0.08 ± 0.09</td>
<td>0.19 ± 0.11</td>
<td>0.11 ± 0.11</td>
<td>0.12 ± 0.12</td>
<td>0.20 ± 0.10</td>
<td>0.14 ± 0.12</td>
<td>0.08 ± 0.01</td>
<td>0.30 ± 0.24</td>
<td>0.12 ± 0.17</td>
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<tr>
<td></td>
<td>(270)</td>
<td>(272)</td>
<td>(392)</td>
<td>(314)</td>
<td>(83)</td>
<td>(397)</td>
<td>(322)</td>
<td>(74)</td>
<td>(396)</td>
</tr>
<tr>
<td>Mar</td>
<td>0.07 ± 0.11</td>
<td>0.20 ± 0.10</td>
<td>0.11 ± 0.11</td>
<td>0.13 ± 0.15</td>
<td>0.22 ± 0.12</td>
<td>0.14 ± 0.15</td>
<td>0.09 ± 0.12</td>
<td>0.31 ± 0.31</td>
<td>0.14 ± 0.21</td>
</tr>
<tr>
<td></td>
<td>(273)</td>
<td>(171)</td>
<td>(390)</td>
<td>(316)</td>
<td>(73)</td>
<td>(389)</td>
<td>(306)</td>
<td>(73)</td>
<td>(399)</td>
</tr>
<tr>
<td>Apr</td>
<td>0.06 ± 0.07</td>
<td>0.15 ± 0.07</td>
<td>0.08 ± 0.08</td>
<td>0.13 ± 0.26</td>
<td>0.20 ± 0.26</td>
<td>0.15 ± 0.27</td>
<td>0.06 ± 0.12</td>
<td>0.29 ± 0.28</td>
<td>0.13 ± 0.21</td>
</tr>
<tr>
<td></td>
<td>(318)</td>
<td>(73)</td>
<td>(381)</td>
<td>(316)</td>
<td>(52)</td>
<td>(368)</td>
<td>(285)</td>
<td>(71)</td>
<td>(399)</td>
</tr>
<tr>
<td>May</td>
<td>0.05 ± 0.08</td>
<td>0.16 ± 0.09</td>
<td>0.09 ± 0.10</td>
<td>0.08 ± 0.23</td>
<td>0.18 ± 0.12</td>
<td>0.09 ± 0.22</td>
<td>0.06 ± 0.11</td>
<td>0.19 ± 0.16</td>
<td>0.07 ± 0.12</td>
</tr>
<tr>
<td></td>
<td>(272)</td>
<td>(122)</td>
<td>(365)</td>
<td>(365)</td>
<td>(31)</td>
<td>(384)</td>
<td>(353)</td>
<td>(43)</td>
<td>(396)</td>
</tr>
<tr>
<td>June</td>
<td>0.06 ± 0.09</td>
<td>0.19 ± 0.10</td>
<td>0.11 ± 0.11</td>
<td>0.06 ± 0.14</td>
<td>0.17 ± 0.21</td>
<td>0.07 ± 0.15</td>
<td>0.06 ± 0.12</td>
<td>0.15 ± 0.17</td>
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</tr>
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<td>(246)</td>
<td>(145)</td>
<td>(391)</td>
<td>(382)</td>
<td>(56)</td>
<td>(398)</td>
<td>(358)</td>
<td>(35)</td>
<td>(393)</td>
</tr>
<tr>
<td>July</td>
<td>0.10 ± 0.13</td>
<td>0.25 ± 0.13</td>
<td>0.17 ± 0.15</td>
<td>0.08 ± 0.11</td>
<td>0.17 ± 0.25</td>
<td>0.09 ± 0.15</td>
<td>0.07 ± 0.13</td>
<td>0.18 ± 0.12</td>
<td>0.08 ± 0.3</td>
</tr>
<tr>
<td></td>
<td>(221)</td>
<td>(171)</td>
<td>(392)</td>
<td>(339)</td>
<td>(60)</td>
<td>(399)</td>
<td>(355)</td>
<td>(30)</td>
<td>(394)</td>
</tr>
<tr>
<td>Annual</td>
<td>0.14 ± 0.09</td>
<td>0.25 ± 0.07</td>
<td>0.19 ± 0.09</td>
<td>0.13 ± 0.03</td>
<td>0.20 ± 0.03</td>
<td>0.16 ± 0.04</td>
<td>0.11 ± 0.06</td>
<td>0.26 ± 0.07</td>
<td>0.19 ± 0.06</td>
</tr>
</tbody>
</table>

The $R^2$-values of equations (4) and (5) suggest that 92% of the variability in the monthly mean daily fish consumption of non-fishing households and 96% of that of fishing households in the Chanda beel is explainable by the variability of the monthly fish production from the flood plain. In the BSKB and Halti beels, the percentages were lower, 55% and 49%, respectively, for the non-fishing households (equations 6 and 8) and 81% and 73% for the fishing households in each flood plain. These suggest that the fish production from the flood plains strongly affects the daily fish consumption of both fishing and non-fishing households, with a greater effect on the fishing households than on the non-fishing households, and for the Chanda beel than BSKB and Halti beels.

When the $k$-values and $x_\text{av}$-values of relationship equations (4) and (9) were com-
**Contribution of flood-plain fish**

When the monthly fish production in the flood plains decreases to zero (no-fish production), there would be no fishing households and thus, all households in the flood plains would become non-fishing households. Therefore, in Fig. 1 the intercept of the consumption-production relationship line for the fishing households should coincide with that of the non-fishing households in each plain. Accordingly, in Fig. 2 a dotted line expressing this theoretical relationship for the fishing households was drawn for each flood plain.

The intercepts of equations (4), (6) and (8) for the non-fishing households occurred at 0.043 kg for the Chanda beel, 0.082 kg for the BSKB beel, and 0.049 kg for the Halti beel. These are the predicted monthly averages of daily household fish consumption when no fish were caught from the flood plains. These amounts may also be regarded as the monthly averages of daily household consumption of fish imported from outside or produced from culture ponds inside the flood plains. Based on this assumption, the percentages of these amounts contributing to the annual mean daily fish consumption of all households (Table 3) were 22.63% for the Chanda beel, 51.25% for the BSKB beel, and 25.79% for the Halti beel. In other words, fish from the flood plains contributed 77.37% of the fish consumed by local residents in the Chanda beel, 48.78% in the BSKB beel and 74.21% in the Halti beel. The consumption by residents in the Chanda and Halti beels depends mostly on fish produced from the flood plains, while the residents in the BSKB beel depends more on fish imported or cultured than production from the flood plain.

**Flood control and irrigation project**

Of the 3 flood plains studied, the BSKB beel is surrounded by embankments and its
water level is regulated by sluice gates. The entire flood plain is cultivated with amon paddy (rice growing in flood plain) in the monsoon season. Apparently, the flood control and irrigation project has changed the flood-plain hydrology and fish habitats, causing a decrease in fish productivity; it was 42 kg/ha a year for the BSKB beel, about one-third of 124 kg/ha a year of the Chanda beel and one half of 86 kg/ha a year of the Halti beel (Tsai et al. 1992). Consequently, the catches of fishermen in the BSKB beel have decreased and so has the daily fish consumption of the fishing households (Table 3). Apparently, the decrease in fish supply from the flood-plain at markets was compensated by increased imports of fish from outside and by pond cultures inside the flood plains.

ACKNOWLEDGEMENTS

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REFERENCES


