# FOOD CONSUMPTION AND NUTRITIONAL STATUS OF VULNERABLE PEOPLE REARING LIVESTOCK IN BANGLADESH

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## ABSTRACT

This study was carried out in farm households rearing livestock in three vulnerable districts, Sirajganj, Bogra and Jamalpur of Bangladesh. Based on primary data on 210 households in 2010, the study aimed at assessing the impact of rearing livestock on food consumption and nutrition of farm households. The study carried out both descriptive and functional analyses and observed that livestock alone contributed 41 percent of total income, family food cost was 58 percent of total cost and 43 percent of total income. Daily per capita food, calorie and protein intakes were respectively 1101.02g, 2230 kcal and 69g. Rice alone contributed 68 percent of total calorie intake. Farm households of Jamalpur district consumed significantly less amount of food, calorie and protein. Daily per capita food consumption was influenced by farm size, family size and district but not by income. The overall absolute and hard core poverty indices on the basis of DCI were respectively 48 percent and 29 percent and they were respectively 48 percent and 32 percent on the basis of poverty line. Poverty incidence was the highest in Jamalpur district. As a policy option, livestock rearing should be intensified and strengthened by offering different government support programmes in Jamalpur district since livestock rearing and food consumption and nutritional security was positively related.

## I. INTRODUCTION

Livestock rearing in Bangladesh is an integral agricultural activity among most rural households, particularly landless, marginal and small landholders. It has significant positive impact on equity in terms of income, employment and poverty reduction in rural areas as distribution of livestock is more egalitarian as compared to land. Apart from its multi-faceted roles in socio-economic development, the livestock sector constitutes about 17 percent of agricultural gross domestic product and provides nutritionally rich food to many people in both rural and urban areas (BBS, 2010). Small animals like sheep, goat and poultry are largely kept by the land scarce poor households for commercial purposes due to their low initial investment and operational costs required. Demand for animal based products such as milk, meat and eggs has significantly increased due to sustained growth in income, urbanisation, change in food preferences and increased awareness on nutritional food intake. In order to meet the emerging demand for livestock based products both in domestic and global markets, there is a renewed need to enhance livestock production and productivity. The major challenge before the Bangladesh livestock sector is sufficient supply of livestock inputs that is

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feed, fodder and concentrate. As land-scarce poor households face feed and fodder scarcity, they tend to give up livestock rearing, particularly that of large ruminants (Rao et al., 2003). With the emergence of the market economy, the livestock sector is now moving towards specialisation with increasing involvement of big farmers and investors. Small dairy herds are turning into big dairy farms with capital-intensive production technologies. Likewise, backyard poultry is converging itself into integrated capital-intensive poultry farms. This phase of livestock sector development does not favour landless and smallholder producers.

Land and livestock are the major assets of rural households for livelihood support in general and landless, marginal and small households in particular. As distribution of land holdings in rural Bangladesh is highly skewed towards medium and large farmers, rearing of livestock is considered to be a potential option for poor landless and small farming households to earn their livelihoods on a sustainable basis. Empirical evidence shows that livestock rearing has a positive impact on equity of income and employment for resource-poor rural households (Ali, 2007; Birthal & Ali, 2005; Birthal & Singh, 1995; Rao et al., 2003; Singh & Hazell, 1993).

The ongoing global climate change and erratic nature of rainfall had often affected crop production in the immediate past few years. Hence, livestock has become a source of dependable income for poor farmers. In years of drought the livestock population faces severe shortage of feed and fodder. Livestock sector is likely to emerge as an engine for agricultural growth in the coming decades. It is also considered as a potential sector for export earnings.

Household food security is defined as access by all people at all times to enough food to ensure an active and healthy life (Maxwell *et al.,* 2000). Achieving food security requires that the aggregate availability of physical supplies of food is sufficient, that households have adequate access to those food supplies through their own production, through the market or through other sources, and that the utilisation of those food supplies is appropriate and socioculturally acceptable to meet the specific dietary needs of individuals (Riely *et al.,* 1999: Rahman and Schmitz, 2007). Poverty, food insecurity and malnutrition are the usual phenomena for the rural Bangladesh. Poverty is the root cause of food insecurity.

The above three phenomena can be improved by increasing the domestic food production and by reforming the market. Increase of domestic food production is indispensable to improve the present food security condition of the people. Uses of appropriate livestock enterprises can help increase the domestic production, which in turn can increase income or increase access to food of the households. Labour intensive sustainable livestock enterprises would also increase the income of landless labourers and marginal farmers, thus increasing the food security of the people of rural Bangladesh. Animal rearing is a common activity in backyards . of rural communities of Bangladesh. Animal meat is an important source of protein. Considering the above issues, this study has been undertaken to assess the impact of livestock rearing on food consumption, nutritional status and poverty of the people living in vulnerable districts in Bangladesh.

## II. METHODOLOGY

This study was based on primary data collected from farmers with pre-tested questionnaires through field survey. The districts Shirajgonj, Bogra and Jamalpur districts were selected as

study areas since poor people of these districts face food shortages due to flood and river erosion in some months in a year, thus living in food insecurity and malnutrition conditions. Two hundred ten poor and marginal farmers practicing livestock enterprises commercially had been selected through simple random sampling technique from the above three districts from the population of 1200 farmers. This 1200 population or sampling frame was constituted with help of elected members of Union Parishad and village leaders. From each district 70 farmers rearing livestock and poultry for livelihoods had been selected and data on various food security indicators or variables were collected through direct interview method.

Farmers were found to rear different livestock based enterprises such as livestock farm for meat production, dairy farm, goat farm, broiler farm, layer farm and mixed farms. But the majority of farms were the dairy farms followed by broiler farms. Some farmers were found to rear more than one enterprise. Sirajganj and Jamalpur districts were dominated by cattle (meat + dairy) farms and Bogra district was dominated by poultry (broiler + layer) farms. But different enterprises varied significantly across districts ($\chi^2 = 141.35^{**}$). Average land used for livestock enterprises was 5.77 decimals with significant variations among districts (F= $13.55^{**}$) (Table 1).

For the analysis of data, both partial and functional analyses have been carried out and appropriate statistical tools and techniques were used, such as descriptive statistics, econometric models, t-test, F-test, $\chi^2$-test, etc. Different models both linear and double-log have been fitted well on daily per capita consumption. Share of livestock income in total income and food security level attained from livestock enterprises have been assessed. For the measurement of poverty, poverty line has been estimated functionally. For the measurement of nutritional status and poverty the Direct Calorie Intake (DCI), and Cost of Basic Needs (CBN) methods have been used. In the past, DCI method was used to calculate the incidence of poverty where population or household falling below a threshold calorie intake was considered as poor. The threshold per capita per day calorie intake is 2122 kcal. A person, whose daily calorie intake is less than 2122 kcal, is considered to be in the 'Absolute Poverty'. Similarly, a person having daily calorie intake less than 1805 kcal, is considered to be in the 'Hard Core Poverty'. The Bangladesh Bureau of Statistics (BBS) used the following semi-log or exponential model to estimate the poverty line:

$\ln Y = \beta_0 + \beta_1 X + U$

Where Y = per capita monthly expenditure (food and non-food)

      X = per capita per day calorie intake

      U = disturbance term

**Table 1. Description of livestock farms surveyed in the study**

| District | Name of livestock farm | | | | | | | Land area used for livestock farm |
|---|---|---|---|---|---|---|---|---|
| | Livestock farm for meat | Dairy farm | Goat farm | Broiler farm | Layer farm | Others (mixed) farm | Total | |
| Sirajganj | 1 | 54 | 0 | 15 | 0 | 0 | 70 | 6.90 (6.27) |
| Bogra | 2 | 0 | 0 | 62 | 3 | 3 | 70 | 7.71 (8.41) |
| Jamalpur | 9 | 52 | 1 | 4 | 1 | 3 | 70 | 2.71 (1.37) |
| Total | 12 | 106 | 1 | 81 | 4 | 6 | 210 | 5.77 (6.46) |
| $\chi^2$ | 141.35** | | | | | | | F= 13.55** |

Note: Figures in the parentheses indicate standard deviations. ** indicates significance at 0.01 probability level.

## III.    RESULTS AND DISCUSSION

### Household Profile

Younger farmers were engaged in livestock enterprises to earn an affordable income in different districts. Most of the farmers were middle aged and they were found to be enthusiastic about the performance of their works. Average age of farmers at the aggregate level was 44.69 years with significant variations (F = 55.16**) among districts (Table 2). Farmers rearing livestock in Bogra were found to be younger than that of other districts. Farmers of Bogra were mostly involved in poultry enterprises.

Most of the farmers were educated and average education was 8.41 years of schooling. Farmers of Jamalpur district have significantly (F =6.98**) higher education (9.97 years of schooling) than that of other districts. All farmers had own land and some cultivable land. Overall own and total cultivable lands were observed to be 149.47 decimals and 152.60 decimals respectively with significant variations among districts. All farmers had homestead and some of them had also pond. But pond areas varied significantly among districts (F= 12.36**). Average homestead and pond area was respectively 16.94 decimals and 6.91 decimals. About 79 percent farmers had previous experience of rearing livestock and poultry but previous experiences of farmers were higher in Sirajganj district (40.36 percent) (Table 2).

**Table 2. Socio economic and demographic characteristics of farm households**

| District | Age of farm operator (year) | Education of farm operator (year of schooling) | Area of own land (decimal) | Area of homestead (decimal) | Area of pond (decimal) | Total land (decimal) | No. of household having previous experience |
|----------|------|------|------|------|------|------|------|
| Sirajganj | 47.74 (13.28) | 6.01 (3.98) | 198.35 (279.35) | 14.04 (14.75) | 0.47 (3.94) | 200.35 (266.83) | 67 (40.36)* |
| Bogra | 33.19 (11.54) | 9.24 (3.48) | 128.69 (117.94) | 20.23 (14.71) | 11.50 (21.64) | 134.08 (116.10) | 66 (39.76)* |
| Jamalpur | 53.13 (9.79) | 9.97 (10.27) | 121.39 (118.03) | 16.55 (10.26) | 8.77 (8.76) | 123.37 (92.74) | 33 (19.88)* |
| All districts | 44.69 (14.32) | 8.41 (6.86) | 149.47 (190.17) | 16.94 (13.59) | 6.91 (14.39) | 152.60 (178.77)3 | 166 (100.00)* |
| F-values | 55.16** | 6.98** | 3.58* | 3.77* | 12.36** | 3.91* | $\chi^2 = 64.58$** |

Note: Figures in the asterisk parentheses indicate percentages. Figures in the parentheses indicate standard deviations. ** and * indicate significance at 0.01 and 0.05 probability level, respectively

Family size was 5 persons, which varied significantly among districts (F=7.70**). The number of earning member was 1.74 persons. Dependency ratio was 0.64 with significant variations (F=16.03**) among districts. Overall literacy ratio was 0.66 where it was significantly higher in Jamalpur district (0.82). Literacy ratio of female to male was 0.87 and thus literacy rate of male was higher compared to female. Family composition was 1 male: 1.09 female. That is, number of female was more than that of male (Table 3).

**Table 3. Demographic profiles of farm households: family information**

| District | Family size | Number of earning member | Dependency ratio | Literacy ratio of female to male | Overall literacy ratio | Family composition (ratio of female to male) |
|----------|------|------|------|------|------|------|
| Sirajganj | 5.77 (2.76) | 1.59 (0.93) | 0.72 (0.12) | 0.84 (0.73) | 0.58 (0.29) | 1.09 (0.87) |
| Bogra | 4.53 (1.61) | 1.77 (0.76) | 0.58 (0.19) | 0.72 (0.56) | 0.56 (0.27) | 0.96 (0.60) |
| Jamalpur | 4.86 (1.04) | 1.87 (0.70) | 0.62 (0.12) | 1.05 (0.56) | 0.82 (0.18) | 1.24 (0.75) |
| All districts | 5.05 (2.00) | 1.74 (0.81) | 0.64 (0.15) | 0.87 (0.64) | 0.66 (0.28) | 1.09 (0.75) |
| F-values | 7.70** | 2.29 | 16.03** | 5.17** | 23.65** | 2.44 |

Note: Figures in the parentheses indicate standard deviations. ** indicates significance at 0.01 probability level.

**Household Income and Expenditure**

Study of income of the people living in vulnerable districts showed that farmers earned income from eight sectors. These were livestock, agriculture (crop), business, service, Foreign Service, selling of labour, fishing and other sources. The livestock was the largest contributor to total income followed by agriculture, business, service, Foreign Service, other sources, fishing and selling of labour respectively at the aggregate level. The overall share of livestock sector in total income was 41 percent with the highest share observed in Bogra district (52 %) and the lowest share observed in Jamalpur district (14 percent). Total income per farm was the highest in Sirajganj district (Tk.307133.23) followed by that in Jamalpur district (Tk.169098.37) and Bogra district (Tk.131117.33) respectively whereas the total income per farm at the aggregate level was Tk.202449.65. But there were significant differences of income from business, service, Foreign Service, fishing and other sources among the districts (Table 4).

**Table 4. Income of farm households from all sectors (BDT) in 2010**

| Sectors | Districts | | | | F-values |
|---|---|---|---|---|---|
| | Sirajganj | Bogra | Jamalpur | All | |
| Livestock | 155903.93 (216250.67) | 68243.85 (1187316.77) | 23555.57 (90371.45) | 82567.78 (697759.87) | 0.65 |
| Agriculture | 50879.31 (50043.87) | 44387.77 (38001.92) | 34085.66 (39924.46) | 43117.58 (43334.28) | 2.72 |
| Business | 59614.29 (91170.69) | 13785.71 (46566.42) | 35985.71 (52775.57) | 36461.91 (68785.51) | $8.32^{**}$ |
| Service | 28900.00 (58243.90) | 2071.43 (14608.24) | 44414.29 (60405.51) | 25128.57 (51985.07) | $13.28^{**}$ |
| Foreign service | 7000.00 (57366.10) | - | 18571.43 (53953.43) | 8523.81 (45895.78) | $2.98^{*}$ |
| Selling of labour | 1857.14 (8894.37) | 285.71 (2390.46) | 2171.43 (10837.36) | 1438.09 (8213.57) | 1.06 |
| Fishing | 71.43 (597.61) | 2342.86 (9803.70) | 4571.43 (14288.51) | 2328.57 (10131.27) | $3.54^{*}$ |
| Other sources | 2907.14 (16515.54) | - | 5742.86 (17846.11) | 2883.33 (14167.55) | $2.93^{*}$ |
| Total from all sources | 307133.23 (246218.13) | 131117.33 (1193094.03) | 169098.37 (130624.28) | 202449.65 (708057.35) | 1.20 |
| Ratio of livestock income to total income | 0.51 | 0.52 | 0.14 | 0.41 | |

Note: Figures in the parentheses indicate standard deviations, $^{**}$ and $^{*}$ indicate significance at 0.01 and 0.05 probability level, respectively.

Table 5 presents yearly households' expenditure per farm in 10 different cost items. The cost items were food, clothing, education, treatment, land purchase, house repairing or purchase, purchase of savings certificate, vehicle purchase, cattle

purchase and others. Food cost was the largest cost component followed by cost of land purchase, cost of house purchase or repairing, cost of education, cost of clothing, cost of cattle purchase, cost of vehicle purchase, cost of treatment, cost of savings certificate purchase and cost of others, respectively at the aggregate level. But all the cost items varied significantly among districts except the cost of land purchase, cost of purchase of savings certificate and cost of vehicle purchase. The overall share of food cost to total cost was 58 percent. That is, food was the most important cost item of the people living in vulnerable districts. This result was consistent with the results of PMS (2004) and HIES (2004) of Bangladesh. The food cost was 43 percent of total income (Table 4). This result was also consistent with the literature of various findings which stated that people in developing countries were spending about 50 percent of total income for food.

**Table 5. Yearly households' expenditure in different items (BDT) in 2010**

| Cost items | Districts | | | | F-values |
|---|---|---|---|---|---|
| | Sirajganj | Bogra | Jamalpur | All | |
| Food | 111873.03 (48096.27) | 85882.85 (34898.22) | 62088.34 (13407.26) | - 86614.74 (40502.57) | 35.09** |
| Clothing | 8192.86 (5615.27) | 6237.14 (5057.62) | 6364.29 (4505.97) | 6931.43 (5134.20) | 3.25* |
| Education | 17878.57 (34421.74) | 6481.43 (8689.05) | 3185.71 (3687.20) | 9181.90 (21456.99) | 9.80** |
| Treatment | 6507.15 (9270.29) | 3497.14 (2984.79) | 1822.86 (1523.84) | 3942.38 (5987.83) | 12.18** |
| Land purchase | 41114.29 (171310.68) | 9971.43 (60959.71) | 4285.71 (16468.80) | 18457.14 (106153.36) | 2.48 |
| Purchase/ repairing house | 9257.14 (36570.63) | 4655.71 (12210.34) | 20521.43 (48843.47) | 11478.09 (36373.21) | 3.61 * |
| Savings certificate | 2857.14 (23904.57) | 428.57 (3585.69) | - | 1095.24 (13945.91) | 0.85 |
| Vehicle purchase | 3654.29 (21443.18) | 7228.57 (41739.76) | 3836.43 (13570.02) | 4906.43 (28115.67) | 0.36 |
| Cattle purchase | 7557.14 (28093.34) | 1414.29 (6586.09) | 10621.43 (10677.90) | 6530.95 (18090.03) | 4.88** |
| Others | - | 140.00 (316.07) | 14.29 (119.52) | 51.43 (204.14) | 10.92** |
| Total | 208891.60 (248825.02) | 125937.14 (100751.99) | 112740.49 (64341.38) | 149189.74 (164250.80) | 7.49** |
| Share of food cost to total cost | 0.54 | 0.68 | 0.55 | 0.58 | |

Note: Figures in the parentheses indicate standard errors, ** and * indicate significance at 0.01 and 0.05 probability level, respectively.

**Food and Nutrition Intake**

Table 6 presents monthly households' consumption of different food items in kg. Household consumed 17 food items where rice was the most important staple food followed by potato and vegetables. The overall monthly per household consumptions of rice, potato and vegetables were respectively 69.22 kg, 18.19 kg and 18.18 kg. Other important food items in terms of volume of monthly consumptions were respectively milk (16.43 kg), fish (10.38 kg), onion (6.38 kg), meat (4.74 kg), soybean oil (3.09 kg), wheat (2.79 kg), chilli (2.77 kg), egg (2.47 kg), sugar (2.08 kg), lentil (1.77 kg), mustard oil (1.13 kg), garlic (0.92 kg), ginger (0.49 kg) and other spices (0.36 kg) at the aggregate level. Consumptions of all the above food items varied significantly among districts except wheat and ginger as suggested by F-values.

Statistics on daily per capita food intake on 17 food items have been presented in Table 7. Rice was the most important staple food in term of the highest per capita daily consumption. Daily per capita consumption of rice was 469.33g whereas daily per capita consumption of vegetables was 125.89g at the aggregate level. Other important food items in terms of higher amounts of daily per capita consumptions were respectively potato (124.53g), milk (110.1 lg), fish (70.21g), onion (44.24g), meat (33.57g), soybean oil (21.57g), chilli (19.97g), egg (17.36g), wheat (17.18g), sugar (14.81g), lentil (12.14g), mustard oil (7.30g), garlic (6.57g), ginger (3.55g) and other spices (2.70g) at the aggregate level. Daily per capita consumption of all the food items varied significantly among districts except wheat and other spices. Daily per capita consumption of all food items was the highest in Bogra district (1233.14g) followed by that in Sirajganj district (1213.61g) and Jamalpur district (856.30g), respectively. The overall daily per capita food intake was about 1101g. This result was consistent with the result of Islam et al (2007), which showed that overall daily per capita consumption of all food items was 1182g for the people using 14 land use patterns in Bangladesh. F-value suggested that people in Jamalpur district exhibited significantly the lowest amount of daily per capita consumption of overall all food items except milk (Table 7).

To identify which factors were affecting or influencing daily per capita consumptions of food, two different models such as linear and double-log were estimated using some conventional factors, socio-demographic factors and district factors. The conventional factors which normally influence daily per capita consumption of food were income from livestock and other income, the socio-demographic or farm-specific factors were education of farm operator, experience of farm operator, farm size and family size. The district factors were three districts such as Sirajganj, Bogra and Jamalpur.

**Table 6. Monthly households' consumption of different food items (kg.)**

| Food items | Districts | | | | F-values |
|---|---|---|---|---|---|
| | Sirajganj | Bogra | Jamalpur | All | |
| Rice | 83.58 (33.42) | 65.17 (24.44) | 58.93 (8.37) | 69.22 (26.44) | 19.32** |
| Wheat | 3.89 (9.43) | 1.59 (10.26) | 2.90 (4.28) | 2.79 (8.43) | 1.32 |
| Potato | 21.26 (15.60) | 25.91 (12.89) | 7.40 (3.28) | 18.19 (14.18) | 46.31** |
| Vegetables | 17.94 (11.93) | 21.50 (14.58) | 15.10 (4.85) | 18.18 (11.48) | 5.71** |
| Lentil | 2.14 (1.97) | 2.03 (1.20) | 1.15 (1.17) | 1.77 (1.55) | 9.38** |
| Mustard oil | 1.71 (2.88) | 0.96 (0.82) | 0.74 (0.53) | 1.13 (1.78) | 5.86** |
| Soybean oil | 3.99 (1.93) | 3.21 (1.50) | 2.08 (0.75) | 3.09 (1.67) | 29.47** |
| Sugar | 2.66 (1.74) | 2.08 (1.01) | 1.51 (0.72) | 2.08 (1.32) | 15.20** |
| Fish | 15.49 (8.92) | 10.46 (6.74) | 5.20 (1.98) | 10.38 (7.76) | 43.13** |
| Meat | 5.56 (3.64) | 5.97 (3.44) | 2.69 (2.33) | 4.74 (3.49) | 22.07** |
| Milk | 23.06 (18.11) | 10.90 (9.56) | 15.34 (5.99) | 16.43 (13.25) | 17.46** |
| Egg | 2.88 (2.45) | 3.39 (1.82) | 1.15 (0.99) | 2.47 (2.08) | 25.62** |
| Onion | 9.00 (4.79) | 6.84 (4.95) | 3.29 (1.35) | 6.38 (4.67) | 35.44** |
| Garlic | 1.04 (0.74) | 0.93 (0.24) | 0.80 (0.41) | 0.92 (0.51) | 4.18** |
| Ginger | 0.52 (0.34) | 0.53 (0.28) | 0.44 (0.38) | 0.49 (0.34) | 1.44 |
| Chilli | 3.37 (1.21) | 3.36 (1.34) | 1.59 (0.63) | 2.77 (1.38) | 59.97** |
| Other spices | 0.44 (0.43) | 0.29 (0.23) | 0.35 (0.18) | 0.36 (0.31) | 4.84** |

Note: Figures in the parentheses indicate standard deviations, ** and * indicate significance at 0.01 and 0.05 probability level, respectively.

**Table 7. Daily per capita consumption of different food items (gram)**

| Food items | Districts | | | | F-values |
|---|---|---|---|---|---|
| | Sirajganj | Bogra | Jamalpur | All | |
| Rice | 506.52 (152.57) | 483.31 (95.39) | 418.15 (88.69) | 469.33 (121.21) | 10.95** |
| Wheat | 21.35 (53.20) | 9.07 (46.02) | 21.13 (30.74) | 17.18 (44.48) | 1.76 |
| Potato | 128.68 (78.12) | 192.07 (80.13) | 52.85 (28.63) | 124.53 (87.52) | 96.47** |
| Vegetables | 111.53 (56.73) | 158.40 (85.99) | 107.74 (41.37) | 125.89 (67.84) | 13.57** |
| Lentil | 13.18 (11.69) | 14.96 (6.34) | 8.28 (10.76) | 12.14 (10.23) | 8.58** |
| Mustard oil | 9.40 (13.35) | 7.11 (5.02) | 5.38 (3.99) | 7.30 (8.66) | 3.89* |
| Soybean oil | 24.98 (11.27) | 25.11 (12.38) | 14.63 (5.14) | 21.57 (11.20) | 24.77** |
| Sugar | 17.14 (10.64) | 16.32 (8.18) | 10.96 (5.88) | 14.81 (8.85) | 11.02** |
| Fish | 95.07 (39.66) | 79.11 (46.43) | 36.44 (12.54) | 70.21 (43.57) | 49.67** |
| Meat | 35.38 (23.26) | 46.14 (25.21) | 19.18 (18.02) | 33.57 (24.88) | 25.76** |
| Milk | 142.25 (97.85) | 80.15 (54.06) | 107.93 (41.95) | 110.11 (73.18) | 14.25** |
| Egg | 17.81 (10.55) | 26.26 (12.71) | 7.99 (7.05) | 17.36 (12.75) | 54.37** |
| Onion | 55.77 (27.42) | 53.92 (33.40) | 23.02 (8.93) | 44.24 (29.49) | 36.50** |
| Garlic | 6.50 (4.39) | 7.47 (2.65) | 5.74 (3.12) | 6.57 (3.52) | 4.38** |
| Ginger | 3.23 (1.54) | 4.23 (2.60) | 3.21 (2.84) | 3.55 (2.43) | 4.12* |
| Chilli | 21.58 (8.22) | 27.14 (13.84) | 11.19 (4.48) | 19.97 (11.67) | 49.29** |
| Other spices | 3.23 (4.11) | 2.37 (2.61) | 2.48 (1.38) | 2.70 (2.93) | 1.80 |
| Total | 1213.61 (335.08) | 1233.14 (305.97) | 856.30 (190.31) | 1101.02 (331.79) | 39.04** |

Note: Figures in the parentheses indicate standard deviations, ** and * indicate significance at 0.01 and 0.05 probability level, respectively.

These three districts were well depicted using two dummy variables (Table 8). Both the models suggested that as the farm size increased, the daily per capita consumption was also increased. That is, there was positive relationship with farm size and per capita food consumption. In other words, per capita food consumption was higher in the larger farms whereas it was lower in the smaller farms. The result also showed that per capita consumption was significantly larger in smaller family than the larger family. In other words, as the family size increased, the daily per capita food consumption decreased significantly. The districtal dummies indicated that daily per capita food consumption was significantly higher in Sirajgonj and Bogra districts than that in Jamalpur district. But livestock income and other income did not have any influence on food consumption. F-values suggested that both the models were well fitted to data (Table 8).

**Table 8 Factors influencing per capita per day consumption of food**

| Factors | Regression coefficients of linear model | Regression coefficients of double-log model |
|---|---|---|
| Intercept | 1081.92758** (70.09723) | 6.76034** (0.21576) |
| Education of farmer | 2.13129 (2.78432) | 0.03977 (0.02480) |
| Experience of farmer | 53.49351 (54.42454) | 0.05814 (0.04799) |
| Farm size | 0.27836** (0.12277) | 0.02947** (0.01226) |
| Family size | -65.20616** (10.34761) | -0.33419** (0.05027) |
| Income from livestock | 0.00003 (0.00005) | 0.00283 (0.00529) |
| Other income | 0.00005 (0.00020) | 0.02137 (0.01822) |
| District dummy (1 for Sirajganj and zero otherwise) | 372.27093** (55.27097) | 0.36220** (0.04864) |
| District dummy (1 for Bogra and zero otherwise) | 327.68513** (54.67238) | 0.31291** (0.04788) |
| Adj. $R^2$ | 0.38 | 0.41 |
| F-value | 16.75** | 19.18** |

Note: Figures in the parentheses indicate standard errors, ** indicates significance at 0.01 probability level.

Table 9 presents daily per capita calorie intake from 17 food items. The result showed that daily per capita calorie intake from rice was about 1525 kcal, which was 68 percent of total calorie intake at the aggregate level with a little variation among districts. This result was consistent with the result of BBS (2010), which stated that people of Bangladesh were getting more than 70 percent calorie from rice alone. Other important food items which offered higher calorie at the aggregate level were respectively potato (114.6 kcal), soybean oil (92.1 kcal), fish (74.4 kcal), milk (72.7 kcal), wheat (55.7 kcal), sugar (55.2 kcal), chilli (47.3 kcal),

meat (45.7 kcal), lentil (39.9 kcal), vegetables (37.8 kcal), egg (30.6 kcal), onion (20.6 kcal), garlic (9 kcal), other spices (3.5 kcal), ginger (3.3 kcal) and mustard oil (2.4 kcal). The total daily per capita calorie intake from all food items was about 2230 kcal at the aggregate level. These results were consistent with the results of Islam et al (2007). Islam et al (2007) observed that daily per capita calorie intake was 2439 kcal for the farm households practicing 14 land use patterns in Bangladesh. The daily per capita calorie intake was the highest in Sirajganj district (about 2452 kcal) followed by that in Bogra district (about 2396 kcal) and Jamalpur district (1842 kcal), respectively.

**Table 9. Daily per capita calorie intake (kcal)**

| Food items | Sirajganj | Bogra | Jamalpur | All |
|---|---|---|---|---|
| Rice | 1646.2 | 1570.8 | 1359.0 | 1525.3 |
| Wheat | 69.2 | 29.4 | 68.5 | 55.7 |
| Potato | 118.4 | 176.7 | 48.6 | 114.6 |
| Vegetables | 33.5 | 47.5 | 32.3 | 37.8 |
| Lentil | 43.4 | 49.2 | 27.2 | 39.9 |
| Mustard oil | 3.1 | 2.3 | 1.8 | 2.4 |
| Soybean oil | 106.7 | 107.2 | 62.5 | 92.1 |
| Sugar | 63.9 | 60.9 | 40.9 | 55.2 |
| Fish | 100.8 | 83.9 | 38.6 | 74.4 |
| Meat | 48.1 | 62.8 | 26.1 | 45.7 |
| Milk | 93.9 | 52.9 | 71.2 | 72.7 |
| Egg | 31.3 | 46.2 | 14.1 | 30.6 |
| Onion | 25.9 | 25.1 | 10.7 | 20.6 |
| Garlic | 8.9 | 10.2 | 7.9 | 9.0 |
| Ginger | 3.0 | 3.9 | 3.0 | 3.3 |
| Chilli | 51.1 | 64.3 | 26.5 | 47.3 |
| Other spices | 4.1 | 3.0 | 3.2 | 3.5 |
| Total | 2451.5 | 2396.3 | 1842.0 | 2229.9 |
| Share of calorie from rice In total calorie | 0.67 | 0.66 | 0.74 | 0.68 |

Protein is an important nutrient of food which is essential to maintain a good health. Maintaining good health is an indicator of food security. In the food security arena, food means nutritious food. Overall daily per capita protein intake was about 69g, which has the conformity with the findings of Islam et al (2007), which observed that overall daily per capita protein intake by farm households was about 65g. The daily per capita protein intake was the highest in Bogra district (about 78g) followed by that in Sirajganj district (about 76g) and Jamalpur district (about 52g), respectively (Table 10). The most important protein offering food items were rice, vegetables, fish, meat, soybean oil, lentil, milk, egg, wheat and potato, respectively.

**Table 10. Daily per capita protein intake (gram)**

| Food items | Sirajganj | Bogra | Jamalpur | All |
|---|---|---|---|---|
| Rice | 25.33 | 24.17 | 20.91 | 23.47 |
| Wheat | 2.58 | 1.10 | 2.56 | 2.08 |
| Potato | 2.06 | 3.07 | 0.85 | 1.99 |
| Vegetables | 9.48 | 13.46 | 9.16 | 10.70 |
| Lentil | 2.64 | 2.99 | 1.66 | 2.43 |
| Mustard oil | 2.07 | 1.56 | 1.18 | 1.61 |
| Soybean oil | 6.25 | 6.28 | 3.66 | 5.39 |
| Sugar | 0.00 | 0.00 | 0.00 | 0.00 |
| Fish | 11.41 | 9.49 | 4.37 | 8.43 |
| Meat | 7.08 | 9.23 | 3.84 | 6.71 |
| Milk | 2.85 | 1.60 | 2.16 | 2.20 |
| Egg | 2.14 | 3.15 | 0.96 | 2.08 |
| Onion | 0.67 | 0.65 | 0.28 | 0.53 |
| Garlic | 0.34 | 0.40 | 0.30 | 0.35 |
| Ginger | 0.17 | 0.22 | 0.17 | 0.19 |
| Chilli | 0.35 | 0.43 | 0.18 | 0.32 |
| Other spices | 0.10 | 0.07 | 0.07 | 0.08 |
| Total | 75.5 | 77.9 | 52.3 | 68.6 |

**Poverty and Food Security**

The Bangladesh Bureau of Statistics (BBS) used the following semi-log or exponential model to estimate the poverty line:

$$\ln Y = \beta_0 + \beta_1 X + U$$

Where Y = per capita monthly expenditure (food and non-food)

X = per capita per day calorie intake

U = disturbance term

$\ln Y = 6.341084^{**} + 0.000484^{**}X$, where X is the threshold per capita per day calorie intake.

(0.063123)    (0.0000273)

$R^2 = 0.60$  and  $F = 314.07^{**}$.

**Absolute poverty line:**

$\ln Y = 6.341084 + 0.000484X$

$\ln Y = 6.341084 + 0.000484 \times (2122)$

$\ln Y = 7.368132$

Hence, Y = EXP (7.368132) = Tk. 1584.67 (**absolute poverty line**)

**Hard core poverty line:**

$\ln Y = 6.341084 + 0.000484X$

$\ln Y = 6.341084 + 0.000484 \times (1805)$

$\ln Y = 7.214704$

Hence, Y = EXP (7.214704) = Tk. 1359.27 (**hard core poverty line**)

The absolute and hard core poverty estimated using exponential models are respectively Tk.1584.67 and Tk.1359.27. On the bases of DCI and poverty line, the incidence of poverty has been measured for different districts and presented in Table 11. The overall absolute and hard core poverty indices on the basis of DCI were respectively 48 percent and 29 percent. The above estimated poverty was relatively higher than PMS (2004) and Rahman and Schmitz (2007), which observed that the absolute and hard core poverty were respectively 41 percent and 19 percent. The recent price spirals of essentials caused increase of poverty incidence in developing countries including Bangladesh. Poverty indices estimated with poverty lines are similar with that of estimated using DCI. The overall absolute and hard core poverty indices based on poverty line were respectively 48 percent and 32 percent. It was clear that poverty incidence in Jamalpur district was significantly higher than that of Sirajganj and Bogra districts as evidenced by both the methods. Overall observations suggested that poverty incidence was the lowest in Sirajganj district whereas it was the highest in Jamalpur district.

**Table 11. Poverty incidence of farm households rearing livestock**

| Districts | Direct calorie intake (DCI) method | | Cost of basic needs (CBN) (poverty line) method | |
|---|---|---|---|---|
|  | Absolute poverty (%) | Hard core poverty (%) | Absolute poverty (%) | Hard core poverty (%) |
| Sirajganj | 33 | 17 | 21 | 13 |
| Bogra | 31 | 17 | 36 | 24 |
| Jamalpur | 80 | 51 | 87 | 60 |
| All | 48 | 29 | 48 | 32 |

Livestock enterprises ameliorated some food security and economic indicators as opined by the farm households. About 92 percent farm households replied that they had increased income from rearing livestock and livestock based enterprises. After having involved in livestock enterprises they had gradually increased savings, food intake, expenditure on education, permanent assets, ornaments for women, housing, employment opportunity, women employment opportunity, poultry and farm implements over the past few years. But the number of cattle and goat decreased compared to previous some years. People were opted to rearing high yielding breed (HYB) instead of indigenous breed and also opted to more intensified livestock rearing. Although the number cattle and goat decreased over time, they had increased income due to increased in productivity of livestock (Table 12).

**Table 12 Change of the various food security and economic indicators**

| Indicators | Change of indicators | | |
|---|---|---|---|
| | Increase (%) | Decrease (%) | Unchanged (%) |
| Income | 92.4 | - | 7.6 |
| Savings | 81.2 | - | 18.8 |
| Food intake | 79.6 | - | 20.4 |
| Expenditure on education | 71.5 | 15.2 | 13.3 |
| Permanent asset | 48.6 | 6.2 | 45.2 |
| Ornaments | 59.0 | 6.7 | 34.3 |
| Housing | 58.0 | 5.5 | 36.5 |
| Employment opportunity (overall) | 66.2 | 6.2 | 27.6 |
| Women employment opportunity | 95.7 | 0.5 | 3.8 |
| Cattle | 37.1 | 43.4 | 19.5 |
| Goat | 25.6 | 53.9 | 20.5 |
| Buffalo | 30.4 | 29.6 | 40.0 |
| Poultry | 70.5 | 6.0 | 23.5 |
| Farm implements | 60.7 | 5.5 | 33.8 |

## IV. CONCLUSIONS AND POLICY IMPLICATIONS

The livestock sector was the largest contributor to total income. Improved food consumption, calorie and protein intake were directly related to rearing of livestock especially in the vulnerable districts. In addition, rearing of livestock helped improve some other food security and economic indicators of farm households. These indicators were income, savings, expenditure on education, permanent assets, ornaments, housing, employment opportunity, number of poultry and farm implements.

Farmers reared livestock and poultry more intensively in Sirajganj and Bogra districts but Jamalpur district lagged far behind the above two districts in terms rearing of livestock, consumptions of food, protein, calorie and high incidence of poverty. As the food consumption and nutritional status were influenced by rearing of livestock, it should be intensified and strengthened in Jamalpur district with a view to getting more calorie, protein and also to reduce poverty. Government intervention is needed to expedite livestock development programmes in Jamalpur district to attract more farmers by offering various government support programmes.

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