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## **Women's Participation in Agriculture in Bangladesh: Trends, Determinants and Impact on Livelihoods<sup>1</sup>**

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### **Abstract:**

In Bangladesh, being a traditional Muslim society, women's participation in economic activities in general and in agriculture in particular has remained low. But recent labor force surveys conducted by the Bureau of Statistics show rapidly increasing participation of women in economic activities. The progress is attributed to poverty, empowerment of women by NGOs, and migration of male members from agriculture to non-farm occupation. With the absence of male members, women's role is changing from unpaid family worker to farm managers, a phenomenon termed as "feminization of agriculture". This paper uses unpublished longitudinal panel data from a nationally representative sample survey in 62 villages conducted in 2000 and 2008 that covered the same households to assess the trend and determinants of women's involvement in agricultural activities. It uses a module on time budget for all adult members for the last four days preceding the survey. The second author was the Principal Investigator in all three surveys. The results show that 66 percent of women participated in agricultural activities in 2008, an increase from 58 percent in 2000. The allocation of time has also increased from 1.11 to 1.28 hours per day although this was less than 1987 level. But the participation was limited to mostly livestock and poultry farming which is a marginal economic activity with allocation of only 0.91 hour of labor per day. The participation in crop farming was low. Only 3.85 percent of the female workers participated in crop farming in 2008, compared to 53 percent for men. But crop farming is a relatively full time activity for them with allocation of 2.92 hours per day in 2008 which has reduced from 4.30 hours per day in 1987. Only about 1 percent of the women participated in the agricultural labor market in 2000 and 2008. Women's participation in agricultural labor market remains insignificant at 1.07 percent of agricultural workers compared to 23% for male workers in 2008. A regression analysis show that women's participation is negatively related with landholding, age after some limit, village level electricity, education of household head, distance of bus stop from village and wage rate in non-agriculture, but

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positively related with age of female workers, irrigated area of female workers' households, NGO membership of women, remoteness of village and agricultural wage rate in village. Changes in income of the participating and non-participating women laborers' households in agricultural activities, and the determinants of the changes in income are also reported in the paper.

**Keywords:** *Longitudinal survey, panel data, time budget, women's participation in agriculture, feminization of agriculture*

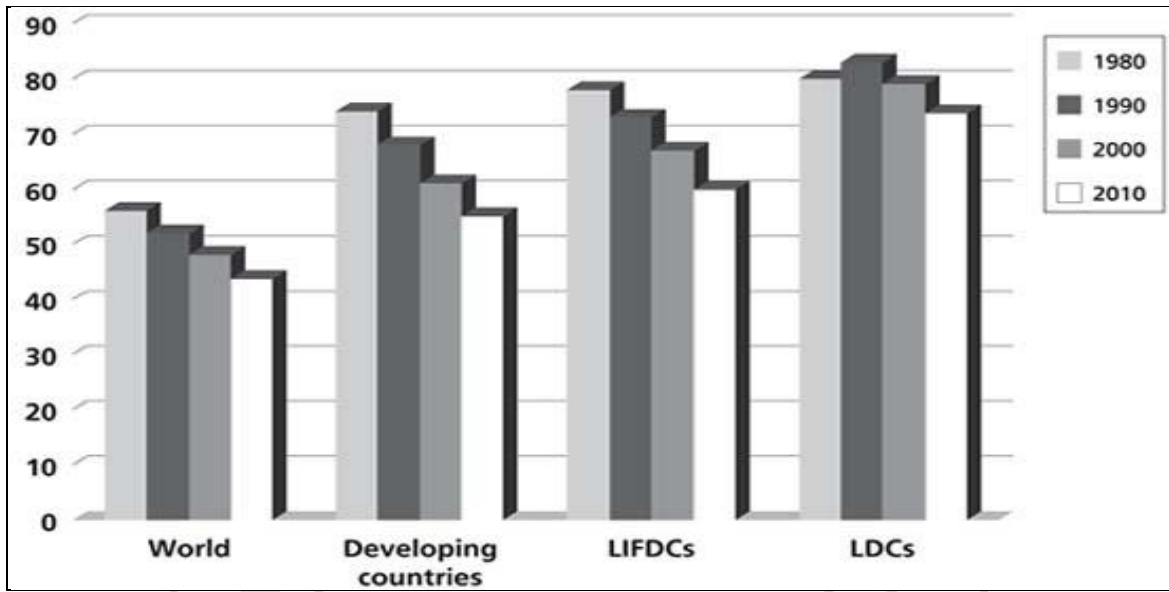


## 1. Introduction

The female contribution to the overall economy, particularly in agriculture is high throughout Asia. Bangladesh, Bhutan, Cambodia, China, India, Myanmar, Nepal, Pakistan and Vietnam have particularly high percentages of women employed in the agricultural sector, with estimates ranging between 60 and 98 percent (FAO, 2003). Among the neighboring countries, only 59 per cent of Bangladeshi women, as compared to over 74 per cent of Indian, 64 per cent Pakistani and 85 per cent Nepali women, are employed in agriculture. Indeed, in most Asian countries the number of women employed in agriculture as a percentage of the economically active population is higher than that of men. However, women's contribution to agriculture, which is considered as unpaid family labor, is grossly underestimated. In fact, if unpaid work were included, the figures for female employment in agriculture would be even higher (FAO, 2003).

FAO has noted that while the overall proportion of the economically active population (EAP) working in agriculture declined during the 1990s, the percentage of economically active women working in agriculture at the global level remained nearly 50 percent through 2000, with an even higher percentage in developing countries (61 percent) and in LDCs (79 percent). Furthermore, although FAO projections to 2010 indicate a continued reduction in the overall female participation in agriculture globally, the percentage of economically active women working in agriculture in LDCs is projected to remain above 70 percent. The chart below compares FAO estimates of the proportions of the female economically active population working in agriculture, first at the global level, and then for developing countries, low-income food deficit countries (LIFDCs) and the Least Developed Countries (LDCs).

Figure – 1 Percentage of economically active women working in agriculture, 1980-2010 (projected)



Source: FAO (2003)

In Bangladesh, being a traditional Muslim society, women in Bangladesh hardly participate in agricultural activities outside home (Hossain and Bayes, 2009; Abdullah and Zeidenstein, 1982). Women's agricultural activities were confined to homestead production and post-harvest operations; however, in recent years they are mostly involved in livestock and poultry rearing activities besides crop production activities. A number of studies were conducted on women's activities during 1980s (Abdullah and Zeidenstein, 1982; Ahsan, et.al, 1986; Begum, 1983; Chowdhury, 1986; Farouk, 1979 and 1983; Halim and McCarrthy, 1985; Westergaard, 1983, Jaim and Rahman, 1988). These studies found that women's contribution to socio-economic development were not visible, perhaps due to a set of social norms that enabled men to dominate women (Bose, et. al., 2009).

There has been scarcity of rural agricultural labor force in recent years and farm technologies have not yet sufficiently developed to cope with this scarcity. Therefore, women participation, particularly in agriculture as entrepreneurs is increasing in Bangladesh (Hossain and Jaim 2011; Birner, R., A. Quisumbing, and N. Ahmed 2010; etc). The progress is attributed to poverty, empowerment of women by NGOs, and migration of male members from agriculture to non-farm occupation. In the absence of male members,

women's role is changing from unpaid family worker to farm managers, a phenomenon termed as "feminization of agriculture".

With the above background, the present paper aims at:

- i) Investigating trend of female labor participation in agriculture in Bangladesh.
- ii) Assessing nature and extent of female participation in agriculture.
- iii) Examining determinants of women participation in agriculture.
- iv) Assessing changes in household income as a result of participation of women in agriculture and
- v) Exploring determinants of changes in income.

## **2. Data and Methodology**

In order to estimate the trends of female labor participation at the national level, data from Labor Force Surveys (LFS) conducted by the Bangladesh Bureau of Statistics (BBS) in 1995-96, 1999-2000, 2002-2003 and 2005-2006 were used. Further, at the household level, to assess the trend and determinants of women's involvement in agricultural activities longitudinal panel data collected through conducting a nationally representative sample survey were used.

Two-period national rural representative household sample survey was carried out in 1987 and 2000, with data collected from 62 villages in 57 districts jointly conducted by the International Rice Research Institute (IRRI), Los Banos, Laguna, the Philippines and the Bangladesh Institute of Development Studies (BIDS), Agargaon, Dhaka, Bangladesh (referred as IRRI-BIDS 62 village household surveys 1987 and 2000). The sample was drawn using a multi-state (districts-unions-villages-households) random sampling method in 1987, with the same sample revisited in 2000. In 2000, the random sample was drawn on the basis of "wealth-ranking", including households selected in the 1987 benchmark survey by stratifying households by landownership and tenure characteristics (Hossain et al., 2004). The same households were surveyed again in 2008.

The data were collected from 1,238 households in 1987; 1,888 households in 2000 and 2010 households in 2008 using a structured questionnaire. The sample size increased in 2000 and 2008 due to households splitting. We have used these three periods' primary household-level panel data. In addition to member level socio-demographic and socio-economic information, detailed activity time budgeting for all working members was recorded separately for four days preceding interview. The second author was the Principal Investigator in all these three surveys. Descriptive statistics along with some statistical test like T-test and multiple regression analysis as well as Probit Model were used for analyzing data.

### 3. Results and Discussions

#### 3.1 Trends of Labor Force Growth and Participation of Women in Agriculture: Bangladesh

Size of adult labor force (15 years and above) during the periods from 1995-96 to 1999-2000 has increased from 36.1 million to 40.7 million implying growth rate of 3.2%. However, growth of female labor force compared to male was found to be very high. During the period, the growth of female labor force was 14.4% compared to only 1.2% for male. The same trend was observed as revealed from Labor Force Surveys (LFS) in 2002-2003 and 2005-2006 (Table- 1).

Table- 1 Annual average labor force growth rate over time by gender: Bangladesh

Periods	Both sexes	Male	Female
1995-96 to 1999-2000	3.2	1.2	14.4
1999-2000 to 2002-2003	4.4	3.8	6.5
2002-2003 to 2005-2006	2.21	1.23	5.45

Sources: BBS (2002), BBS (2004) and BBS (2008)

Again, participation of female labor in agriculture compared to male also increased over time. During the period from 1999-2000 to 2005-2006 adult labor force has increased from 39.0 million to 47.4 million (Figure – 1) an increase by 21.53%. During the same period, while female labor force has increased by 43%, male labor force has increased by 16%. Particularly, for agriculture, there had been absolute decrease in male labor force.

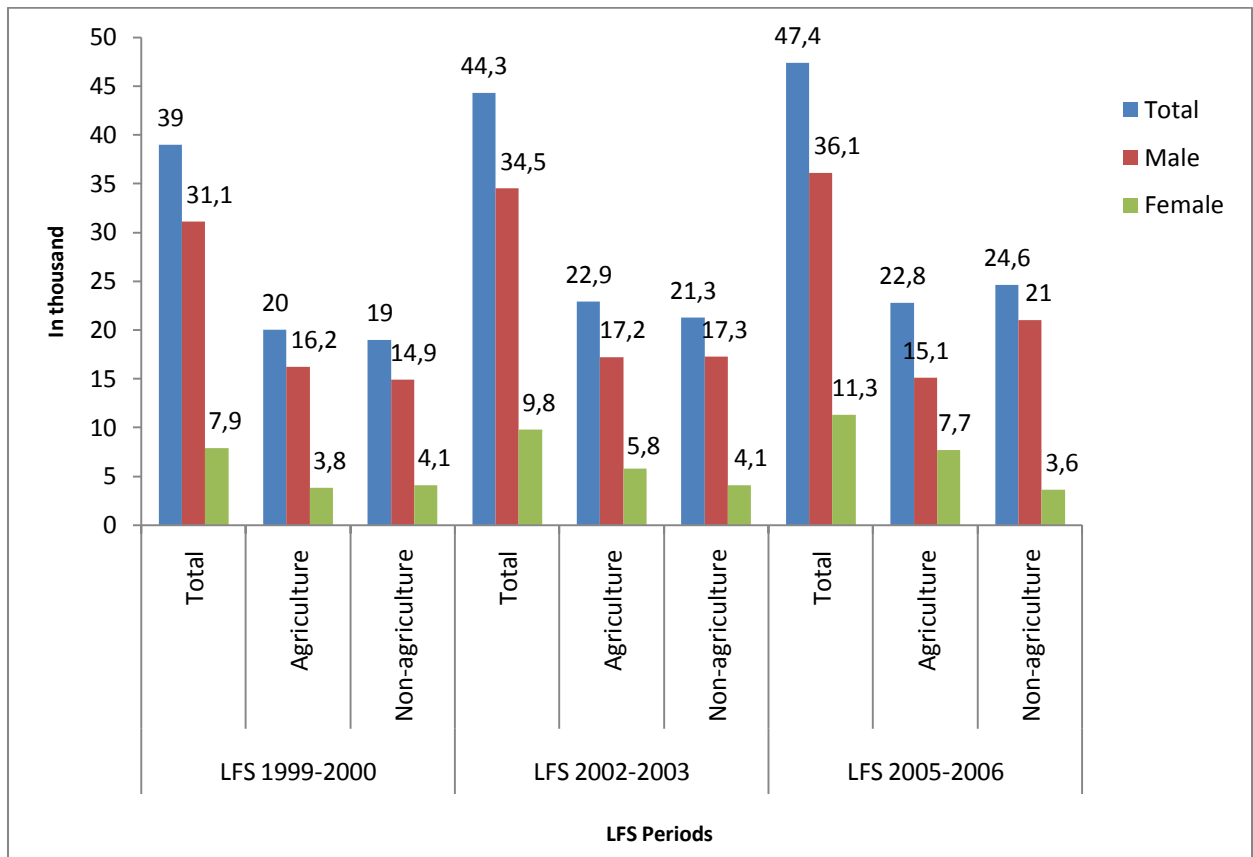
Agricultural male labor force decreased from 16.2 million to 15.1 million during the period from 1999-2000 to 2005-2006, a decrease by about 7%. On the other hand, during the same period, female labor force in agriculture has increased from 3.8 million to 7.7 million, an increase by about 103%. Comparative positions of men and women participation in agriculture in recent past can be seen more clearly from Figure – 2.

Participation of male labor force in non-agricultural activities, on the other hand, has increased from 14.9 million to 21.0 million from 1999-2000 to 2005-2006 which means an increase of about 41% while female participation in non-agricultural activities has decreased by 12% during the same period. Shifting of participation of male laborers from agriculture to non-farm activities has created a tremendous labor shortage in the agricultural sector of Bangladesh which largely explains gradual increase of female participation in agriculture. Further, the findings also indicate that in the non-farm sector the opportunities for employment for the male labor force has increased over time while for female labor force it has decreased to some extent.

Percentage of adult male participation has decreased over time while this has been increased for women. For men the percentage of adult male participation in agriculture has decreased from 51.9%, to 41.4% and 31.9% according to the LFS of 1999-2000, 2002-2003 and 2005-2006 respectively. On the other hand percentages of women in agriculture increased gradually from 48.1% to 68.1% according to LFS of 1999-2000 and 2005-2006 respectively (Figure – 3).



Figure 1 Trend of labor force participation in agricultural and non-agricultural activities by gender overtime: Bangladesh



Source: Labor Force Survey (LFS) 1999-2000, 2002-2003 and 2005-2006.

Figure - 2 Trend of female participation in agriculture compared to male: Bangladesh

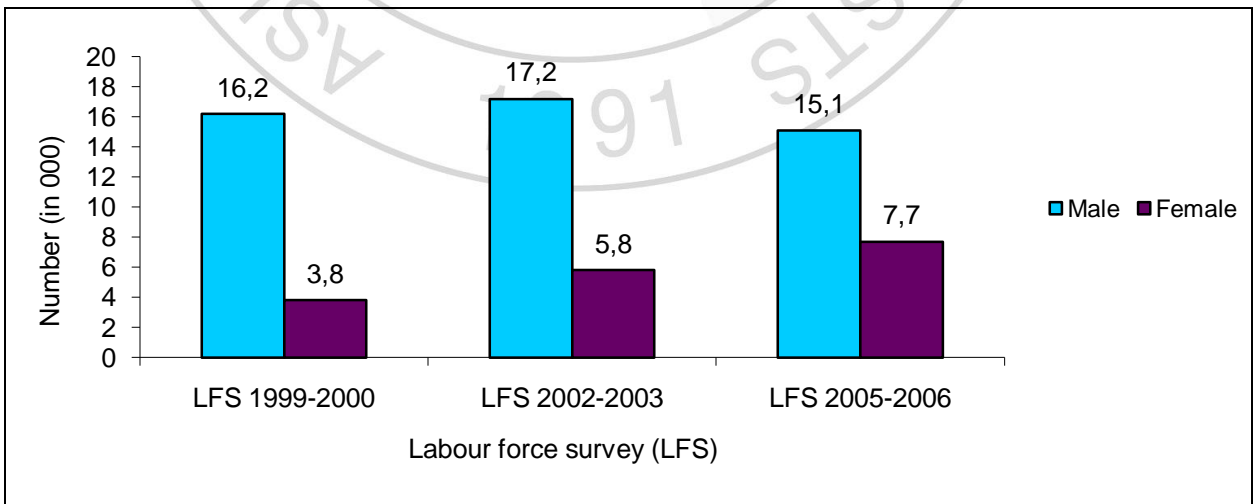
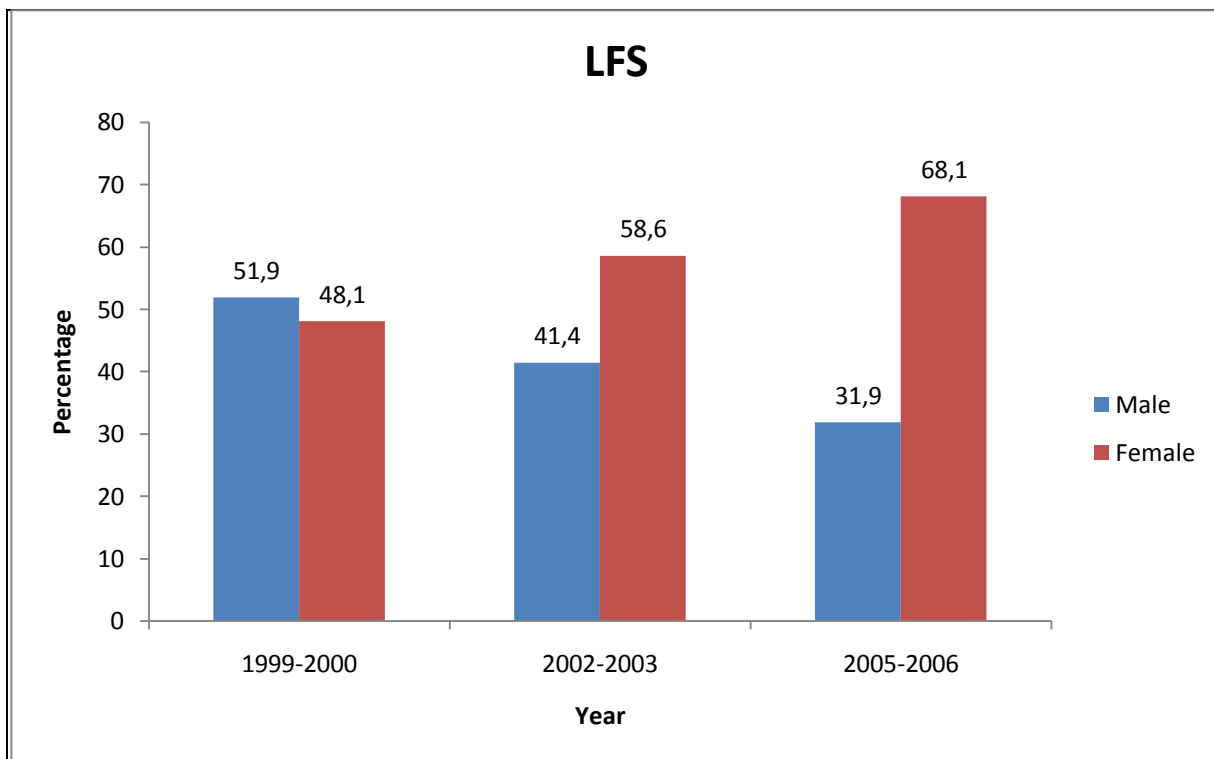


Figure- 3 Percentage of adult male and female participation in agriculture overtime: Bangladesh



Source: Labor Force Survey (LFS) 1999-2000, 2002-2003 and 2005-2006.

### 3.2 Nature and Extent of Women Participation in Agriculture: Household Data

Household panel data collected from 62 villages showed that adult male participation in agriculture has sharply declined from 83% in 1987 to 56% in 2000, a decrease by 27%; this has however, increased to some extent to a level of 65% in 2008. Participation of women in agriculture on the other hand remained almost the same in 1987 and 2000 (59% and 58% respectively); but compared to 2000, in 2008 women participation has increased by about 8%. Findings indicated that decrease in agricultural activities by adult male was due to less involvement in crop cultivation in recent years. About 79% adult males were engaged in crop cultivation in 1987 which has dropped to only about 42% in the year 2000; however, there had been some increase in male participation in crop cultivation in 2008 (53%). Involvement of male labor in crop cultivation has reduced in recent years as many of the

farm operations (i.e. tillage, irrigation, threshing of paddy, etc.) are now fully or partially mechanized.

Women involvement in crop cultivation has also sharply declined from about 23% in 1987 to about 3% in 2000 and 4% in 2008. This is mainly because of the fact that involvement of women in post-harvest operations, particularly for rice processing (i.e. winnowing, drying, parboiling, husking /milling, etc.) have been largely mechanized. At present, women are being involved mostly in livestock and poultry production activities rather than crop production activities. Participation of adult women in livestock and poultry production activities increased from 43% in 1987 to 51% in 2000 which further increased to 69% in 2008. Involvement of women in homestead gardening in recent years has also increased in recent years. Findings showed that in 2008, 18% of adult women household members took part in homestead gardening compared to about 9 to 10 percent in the years of 2000 and 1987 respectively. Credit support from NGOs (sometimes supported by training) has largely facilitated involvement of women in livestock and poultry rearing as well as in homestead gardening in rural Bangladesh. Participation of women in fisheries activities was found to be negligible in 2008 (less than one 1%) compared to 1987 (1%). For men also, participation in fisheries activities was only 5 to 6 % in 1987 and 2000 which further decreased to about 4% in 2008 as water bodies in Bangladesh in general are drying up.

Decrease in agricultural activities by men has been compensated by increase in participation in the non-agricultural / non-farm activities. Participation of adult male in non-agricultural activities has increased from 34% in 1987 to 46% in 2000 which was almost remained the same (44%) in 2008. Participation of adult women in non-farm activities, on the other hand decreased over time. In 1987, about 14% adult female family members were involved in non-agricultural activities which has decreased to only 7% in 2000 and 8% in 2008 implying that opportunities for rural women in non-farm activities has decreased over time. Participation of women in non-farm activities has also decreased over time in the cases of industry / processing, construction works, business and trade; while there had been slight improvement in service sector (Table- 2). For adult males, involvement has increased over

time particularly in services, transport operations as well as in business / trade. Their participation however, has decreased particularly in construction works as revealed from household survey in 2008.

**Table 2: Employment of adult men and women in agriculture and non-agriculture over time**

Activity	Percent of Adult Employed in the Activity					
	1987		2000		2008	
	Men	Women	Men	Women	Men	Women
<b>Agriculture</b>	<b>83.16</b>	<b>58.90</b>	<b>56.26</b>	<b>57.57</b>	<b>65.31</b>	<b>66.39</b>
Crop cultivation	79.17	22.66	42.21	2.79	52.63	3.85
Livestock and poultry	28.70	43.18	25.09	50.77	34.52	68.93
Homestead gardening	1.53	9.72	2.67	9.24	2.36	18.00
Fisheries	5.16	1.01	5.74	0.39	3.68	0.48
<b>Non agriculture</b>	<b>34.21</b>	<b>14.20</b>	<b>45.88</b>	<b>7.09</b>	<b>43.68</b>	<b>8.42</b>
Industry/processing	2.93	7.95	3.85	1.46	3.17	1.07
Transport operation	2.99	0.00	5.39	0.00	5.91	0.00
Construction work	9.86	3.79	3.81	1.12	4.20	1.55
Business/ trade	12.38	0.82	16.86	0.34	14.82	0.40
Services	9.33	3.28	17.78	4.34	16.87	5.68
<b>Total employed</b>	<b>94.37</b>	<b>65.09</b>	<b>90.37</b>	<b>61.95</b>	<b>94.52</b>	<b>71.39</b>
<b>Total of multiple responses</b>	<b>117.37</b>	<b>73.11</b>	<b>102.15</b>	<b>64.66</b>	<b>108.99</b>	<b>74.81</b>

Considering all adult men and women (whether worked or not) and all activities (both economic and domestic), it was found that total working hours has reduced to some extent since 1987. In 1987, average working hours per day was about 8 hours for male while it was about 9 hours per day for women. Average working hours for both men and women have reduced somewhat in recent years as revealed from 2000 and 2008 surveys. For women, this was due to allocation of less time in domestic activities than before. This implies that both men and women enjoy a bit more leisure than before.

The findings also showed that while men devoted more time for economic activities, women devoted more time for domestic activities. On the average, men allocated about 6- 7 hours per day for economic activities, allocation of time for women on the other hand, ranged between 1.47 to 1.75 hours per day during the period from 1987 to 2008.

Allocation of time for men in agriculture was mainly for crop production activities while for women it was for livestock and poultry rearing activities as revealed from all the surveys in 1987, 2000 and 2008. However, allocation of time for crop production activities for men has reduced from 4.30 hours per day in 1987 to 2.27 hours per day in 2000 and 2.92 hours per day in 2008. On the other hand, allocation of time per day for women in livestock and poultry rearing activities has increased from 0.64 hours in 1987 to 0.84 and 0.91 hours respectively in 2000 and 2008. Allocation of time for women has also slightly increased in recent years for homestead gardening.

For non-agricultural activities, in the case of men allocation of time has increased from 1.97 hours per day in 1987 to 3.06 hours per day in 2000. This implies that opportunities for non-farm activities for men have substantially increased. However, in 2008, allocation of time for non-farm activities for men decreased to 2.47 hours per day implying existing opportunities have fully exhausted. On the other hand, in the case of women, allocation of time for non-agricultural activities was only 0.42 hour per day in 1987 which gradually decreased to 0.37 hour in 2000 and 0.22 hour in 2008. This implies that while opportunities for men in non-agricultural activities have increased, for women these have been rather decreased over time. The findings also indicated that while for men allocation of time in business and services has increased to a considerable extent, for women this has particularly increased only in the case of service.

Table - 3 Average time allocation of adult men and women in agricultural and non-agricultural activities

Activity	Duration (Hours/Day/Worker) of Work for those Employed					
	Men			Women		
	1987 (N = 1756)	2000 (N=2464)	2008 (N=2472)	1987 (N=1563)	2000 (N=2419)	2008 (N=2614)
<b>Agriculture</b>	<b>5.02</b>	<b>2.94</b>	<b>3.65</b>	<b>1.33</b>	<b>1.11</b>	<b>1.28</b>
Crop cultivation	4.30	2.27	2.92	0.57	0.11	0.16
Livestock and poultry	0.56	0.48	0.55	0.64	0.84	0.91

Homestead gardening	0.02	0.04	0.03	0.11	0.14	0.19
Fisheries	0.14	0.15	0.15	0.01	0.02	0.02
<b>Non agriculture</b>	<b>1.97</b>	<b>3.06</b>	<b>2.47</b>	<b>0.42</b>	<b>0.36</b>	<b>0.22</b>
Industry/processing	0.15	0.26	0.21	0.21	0.07	0.04
Transport operation	0.20	0.36	0.44	0.00	0.00	0.00
Construction work	0.42	0.19	0.21	0.08	0.03	0.02
Business/ trade	0.74	1.10	1.05	0.02	0.02	0.03
Services	0.47	1.15	1.13	0.10	0.24	0.30
<b>Economic activities</b>	<b>6.99</b>	<b>6.00</b>	<b>6.69</b>	<b>1.75</b>	<b>1.47</b>	<b>1.67</b>
<b>Domestic activities</b>	<b>1.27</b>	<b>1.25</b>	<b>1.14</b>	<b>7.16</b>	<b>5.84</b>	<b>5.87</b>
<b>Total</b>	<b>8.26</b>	<b>7.24</b>	<b>7.83</b>	<b>8.91</b>	<b>7.30</b>	<b>7.54</b>

The analysis showed that only 2.45% of the women participated as wage labor compared to 24.63% for men in 1987. Participation of women in agricultural activities as wage labor has further decreased to about 1% in 2000 and 2008. On the other hand, participation of male wage laborer has also decreased to some extent from about 25% in 1987 to about 22% in 2000 and 23% in 2008. The analysis also showed that agricultural wage rate for both men and women increased overtime. However, wage of women was always low compared to men throughout all the periods since 1987 (Table - 4). Moreover, the disparity has increased more in the recent years than in the past. In 1987, compared to men, women wage in agriculture was 26% less while in 2000 and in 2008 it was less by 42% and 39% respectively.

Table- 4 Participation of wage laborer by gender in agriculture and wage rate over time

Gender	1987		2000		2008	
	% of labor	Wage Rate / day (USD)	% of labor	Wage Rate / day (USD)	% of labor	Wage Rate / day (USD)
Female	2.45	0.54	1.02	0.59	1.08	1.07
Male	24.63	0.73	22.26	1.02	23.08	1.76

Number of days employed in agriculture per year per woman was found to gradually increase from 1987 to recent years as revealed from repeat surveys in 2000 and 2008. Number of employed days in agriculture per woman in 1987 varied across different farm

sizes within the range of 56 to 67 while in 2000 and 2008 it varied between the ranges of 80 to 90 and 80 to 103 respectively. The tendency was increasing number of working days per year with the increase of farm size.

### 3.3 Determinants of Women Participation in Agriculture

Logit regression analysis has been used to analyze factors influencing women's participation in agriculture. The latest survey data of 2008 were considered for this analysis. The dependent variable was measured by a dummy variable with value = 0 for those allocated less than 1 hour per day (considered as not participated) and value = 1 for those allocated more than one hour per day (considered as participated). The explanatory variables ( $X_1$  -----  $X_{11}$ ) which were considered for the model can be seen from Table 5.

Table – 5 Determinants of women participation in agriculture: Estimates of Logit Function: 2008

Determinants / Independent Variables	Coefficients.	Std. Err.	Significance level
(X <sub>1</sub> ) Age of female workers (years)	0.24312*	0.01830	0.00000
(X <sub>2</sub> ) Square of age	-0.00271*	0.00021	0.00000
(X <sub>3</sub> ) Own land of female worker's HH (ha.)	-0.03265 <sup>ns</sup>	0.06051	0.59000
(X <sub>4</sub> ) Irrigated area of female worker's HH (ha)	0.27645**	0.11687	0.01800
(X <sub>5</sub> ) Education of female workers (years)	-0.05805*	0.01549	0.00000
(X <sub>6</sub> ) Village level electricity (dummy: Having electricity = 1, No electricity = 0)	1.48139*	0.37774	0.00000
(X <sub>7</sub> ) NGO membership (dummy: Membership = 1, No membership = 0)	0.36544*	0.11869	0.00200
(X <sub>8</sub> ) Distance of bus stop from village (Km.)	-1.03192*	0.08743	0.00000
(X <sub>9</sub> ) Square of bus distance from village	0.06046*	0.00367	0.00000
(X <sub>10</sub> ) Agricultural wage rate in village (Taka/day)	0.02921*	0.00251	0.00000
(X <sub>11</sub> ) Non-agriculture wage rate in village (Taka/day)	-0.10264*	0.00117	0.00000
Degrees of freedom: 2603			

Notes:

HH = Households

\*Significant at 1% level, \*\*Significant at 5% level, ns=not significant

Estimates of coefficients using Logit Function showed that women participation in agriculture was significantly related to age of female workers, irrigated area of female workers' households, NGO membership of women, remoteness of village (square of bus distance from village) and agricultural wage rate in village. On the other hand, the estimates of the model indicated that women participation in agriculture had significant negative relationship with education of female workers, village level electricity, distance of bus stop from village, non-agriculture wage rate in village as well as square of age (i.e. participation decreases after some age limit). Participation of women in agriculture is also negatively related to area of own land; however, the coefficient was not found to be significant.

### 3.4 Women Participation in Agriculture and Changes in Income

In order to assess the impact of women participation in agriculture on changes in income, the selected households were at first categorized into three groups depending on allocation of their time in agriculture in either or in both the years of 2000 and 2008. The three groups were:

- i) Those who were not involved in agricultural activities (zero hours per day)
- ii) Those who were not substantially involved in agricultural activities (less than 4 hours per day)
- iii) Those who were substantially involved in agricultural activities (more than 4 hours per day)

Table- 6 Distribution of households according to time allocation in agriculture by the female family members

Extent of female participation	Number of households	Percentage of households
Not substantially involved in agriculture (<4 hours per day)	1223	76.5
Substantially involved in agriculture (>4 hours per day)	212	13.3
Not involved in agricultural (0 hour per day)	164	10.3
All	1599	100.0



It was found that there was no participation of women in agriculture for 10.3% households while 13.3% had substantial participation (> 4 hours per day per worker). These two groups (no participation and substantial participation) were compared in relation to income changes between the periods of 2000 and 2008.

The analysis showed that in the case of households with substantial participation of women in agriculture, household income in real price had increased from Tk. 91,250 in 2000 to 1,01,386 in 2008; an increase by 11%. On the other hand, during the same period for the households with no participation of women in agriculture, this has decreased from Tk. 1,62,431 to Tk. 1,30,768; a decrease by about 20% (Table – 7). The analysis also showed that in real price, there had been increase in per capita income by about 22% for the households with substantial participation of women in agriculture during 2000 and 2008 while for the households with no participation in agriculture by the women there had been decrease in per capita income by about 20%.

Mean differences of income between the two groups showed that during the period from 2000 to 2008, there had been significant positive changes in household income as well as per capita income for the households with substantial participation of women in agriculture compared to non participants.

Table- 7 Changes in income for the households (HHs) with substantial participation and no participation of women in agriculture in 2008 compared to 2000

Particulars	Year 2000				Year 2008	
	Income in nominal price (2000)		Income in real price (at 2008 price level)			
	HHs with substantial participation by women	HHs with no participation by women	HHs with substantial participation by women	HHs with no participation by women	HHs with substantial participation by women	HHs with no participation by women
Household income (in Tk.)	45635	77658	91250	162431	101386	130768
Per capita	9422	15302	18833	31870	22982	25316

income (in Tk.)						
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Table - 8 Mean differences in changes in income of female households with substantial and no participation in agriculture during the periods from 2000 and 2008

Particulars	Mean differences within group		Mean difference between groups.	t-value	Level of significance
	Substantial participation in agriculture	No Participation in agriculture			
	(1)	(2)	(3=1-2)		
Household income	10136	-31663	41799	2.425	0.016
Income per capita	4149	-6554	10703	2.851	0.005

### 3.5 Determinants of Changes in Income

A multiple regression model was run to assess the determinants of changes in income in 2008 compared to 2000. Change in income had been considered as dependent variable (Y) while 10 independent variables were considered as can be seen from Table- 9.

The estimated regression coefficients are presented in Table – 9 with their level of significance. The  $R^2$  value was found to be 0.567 implying that about 57% of the changes in income of the female households with substantial and no participation in agriculture during the period from 2000 to 2008 have been explained by the explanatory variables considered for the model. The results show that area of land owned in 2000, education of adult members in 2000, value of capital items in 2000, change in education of adult members, change in number of male workers, change in number of female workers, change in area of cultivated land and change in value of capital items had significant positive effect on changes in household income. On the other hand, change in area of rented out land had significant negative impact on changes in income as the income of the household is likely to decrease with area of land rented out.

Significant negative coefficient for household income in the base year of 2000 implies that compared to better-off households, the poorer households did well in improving their income level over time.

Table- 9 Determinants of changes in income of the female labor households: Estimates of Multiple Regression Model

(X <sub>n</sub> ) Factors / Determinants	Coefficients		t-value	Sig.
	$\beta$	Std. Error		
Constant term ( <i>a</i> )	13494	3513	3.841	0.0001
(X <sub>1</sub> ): Household income (in Taka) in 2000	-0.708	0.021	-34.244	0.0000
(X <sub>2</sub> ): Total own land of the household (ha) in 2000	21154	2898	7.299	0.0000
(X <sub>3</sub> ): Education of members age 15 and above years in 2000	2425	195	12.414	0.0000
(X <sub>4</sub> ): Value (in Taka) of capital items in 2000	0.132	0.019	6.872	0.0000
(X <sub>5</sub> ): Change in education of adult(15+) members	1539	227	6.774	0.0000
(X <sub>6</sub> ): Change in number of male workers	12294	2872	4.281	0.0000
(X <sub>7</sub> ): Change in number of female workers	17716	5746	3.083	0.0021
(X <sub>8</sub> ): Change in area of cultivated land (in ha)	30716	4586	6.698	0.0000
(X <sub>9</sub> ): Change in area of rented out land ( in ha)	-34639	5115	-6.773	0.0000
(X <sub>10</sub> ): Change in value (in Taka) of capital items	0.257	0.021	12.542	0.0000
<b>R<sup>2</sup></b>	<b>0.5670</b>			
<b>Dependent Variable (Y) = Changes in income of the female labor household</b>				

Notes:  $\beta$  = Coefficient

N=1599

#### 4. Summary and Conclusions

##### 4.1 Summary

Household level survey data showed that percentage of adult women participation in agriculture remained almost the same in 1987 and 2000 (59% and 58% respectively), but compared to 2000 this has increased in 2008 (66%). Over the years, women involvement related to crop production has decreased which has been substantially compensated by involvement in livestock and poultry production activities. At the same time, involvement of women in homestead gardening has increased over time and has been doubled in 2008 compared to 2000 (from 9% in 2000 to 18% in 2008).

Allocation of time per day showed that in 1987 women spent 0.57 hours per day in crop production activities which has reduced to 0.16 hours per day per labor in 2008. Reduction of women involvement in crop related activities (particularly, rice) is due to the fact that many of the post-harvest operations in which women were traditionally involved are now partially done mechanically (i.e. winnowing, parboiling, drying, milling, etc.).

Allocation of time for women in livestock and poultry production activities has increased from 0.64 hours in 1987 to 0.91 hours per day in 2008. Along with government, the income generating programs of the NGOs have significant contribution in involving women in livestock and poultry production as well as homestead gardening activities.

Estimates of Logit function showed that age of female workers, irrigated area of female workers' households, NGO membership of women, remoteness of village and agricultural wage rate in village have significant influence on participation of women in agricultural activities. Women also contributed to household income as wage labor. However, participation of women as wage labor was very low (about 1% compared to 23% of male in 2008) and their wage rate was also much lower than men (about 40% less).

In the case of men, the involvement in agriculture has sharply decreased in 2000 compared to 1987. This was mainly because of the fact that many of the farm operations in which male farmers are usually involved have been mechanized. This was the period when farmers took the benefit of the privatization and import liberalization policies of farm machineries. Almost all land is now cultivated by power tiller (replacing man as well as bullock), other post-harvest operations like carrying paddy from field, threshing of paddy, etc. in which men workers were involved are now partially or fully mechanized. However, in recent years (survey in 2008) participation of male in agriculture has again increased. This was mainly because of intensification of crop production activities as well as livestock production activities. Although per day allocation of time for crop production activities for male decreased from 4.30 hours per day in 1987 to 2.27 hours in 2000; this has again increased to

2.92 hours in 2008. Similarly, in 2008 allocation of time of men in livestock and poultry production activities has increased a little bit from 0.48 hours to 0.55 hours per day.

The analysis also showed that while non-farm involvement for men has increased over time, the involvement of women has reduced. In the non-farm sector, women involvement has increased to some extent only in service sector (from 3.28% in 1987 to 5.68% in 2008) while for male adults, involvement in non-farm activities has increased substantially both in service as well as in trade/business sectors.

It was also found that changes in land owned, education of adult members, value of capital items, education of adult members, number of male workers, number of female workers and area of cultivated land had significant positive effect on overtime changes in household income. On the other hand, change in area of rented out land had significant negative impact on changes in income. It was also found that the households with low income in the base year had significant increase in income over time.

#### **4.2 Conclusions:**

Less involvement of male members with increased production than in the past indicates increased labor productivity in agriculture in recent years. Adoption of more farm mechanization in future and expansion of remunerative non-farm job opportunities for male indicate labor crisis for agricultural operations in the rural areas will aggravate which will demand participation of more women in agriculture.

In the face of male labor crisis, increased women involvement in crop production activities is mostly related to managerial activities. Most of the technologies developed for agriculture are related to pre-harvest crop production activities in which male farmers are mostly involved. Women friendly pre-harvest as well as post-harvest technologies for crop production and processing technologies need to be developed for effective participation of women in agriculture. This needs attention from both the researchers and planners.

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