Agro-Ecological Change And Crop Production: Grass-Root Experiences from Rural Farmer’s Perspectives

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Abstract : The aim of this study is to explore the changing nature of agro-ecological system and its impact on crop production in the rural areas of Bangladesh. Both quantitative and qualitative methodologies were employed. Primary data were collected through the tools and techniques of social survey and Participatory Rural Appraisal (PRA) methods. Data of three generations of the respondents were considered in this study to understand the changing pattern. Statistically significant (p<0.05) changes in agricultural occupation was recorded along with literacy level. Soil quality has been deteriorated in the study area that led to fertility reduction, loss of useful insects and birds. Complete dependency on groundwater for irrigation was also recorded that was almost entirely dependent on surface waters in past.

Key Words: Agro-ecology; agricultural production; Irrigation

1. Introduction

Bangladesh is predominantly an agricultural country. According to Rahman (1993), “Agriculture continues to remain the most important sector in Bangladesh. Though, its share in total GDP has declined to around 40% in 1990/91, it still employs 55% of the total labor forces[1] Virtually no “open” land existed for agricultural expansion (Hossain, 1988)[2] and arable lands were lost to settlement. Agricultural growth, therefore, focused on increasing land productivity-intensification achieved primarily through increased irrigation, which facilitated double and triple cropping and the use of “green revolution” inputs (i.e., crops, fertilizer, pesticides). Agriculture was developed at least 10,000 years ago, and it has undergone significant developments since the time of the earliest cultivation...Agricultural practices such as irrigation, crop rotation, fertilizers, and pesticides were developed long ago but have made great strides in the past century (Binford, 1968)[3].

Soil is the most basic of all resources and the primary substrate for growing crops (Pal et al., 2009)[4]. Soil degradation is a narrower term for declining soil quality, encompassing the deterioration in physical, chemical, and biological attributes of the soil (Enters, 1998)[5]. Rapid decline of soil fertility is a problem of crop production in Bangladesh. The organic matter in croplands has been decreasing. Over uses of fertilizers, unplanned cultivation and improper management of soil have already caused not only stagnation but also decline in productivity of modern varieties (Kashem et al., 2007)[6]. Lal et al. (1989) defined soil degradation as 'Diminution of soil quality (and thereby its current and potential productivity) and/or a reduction in its ability to be a multipurpose resource due to both natural and man-induced causes'[7]. Evidences have shown that the status of soil fertility can be improved through inclusion of green manuring crops and their biomass incorporation in the rice-rice cropping pattern (Choudhury et al., 2004; Rahman et al., 2005; BRRI, 2006)[8-10]. Climate change is expected to have a wide range of direct and indirect impacts on human health, ecological systems, and socio-economic sectors. The ultimate effects of climate change on socio-economic or ecological systems will depend on three broad factors: the characteristics of the change in climate, the sensitivity of the system to a given change, and the capacity of the system to adapt to climate change (O’Neill et al., 2001)[11]. Indirect effects of global climate change on rice production will also occur via ecosystem responses (Barnes et al., 1989; Bazzaz et al, 1985; Oechel and Allen, 1985)[12-14].

Agro ecology refers to the study of the relation of agricultural crops and environment (Chhatwal, 1996)[15]. There are thirty (30) Agro-Ecological Zones (AEZ) in Bangladesh. The study area belongs in AEZ-5 and AEZ-12. AEZ-5 indicates lower Atrai Basin. This region comprises the low lying area in between the Barind tract and the Ganges river flood plain. Smooth low lying basin land occupies most of the region and the dominating features include dark grey, heavy, acidic clays. Seven general soil types are found in the region but non calcareous Dark Grey Floodplain soil covers most of the area with moderate organic matter and fertility status.
Locations of this zone are Naogan and Natore districts and parts of Rajshahi, Bogra and Sirajgonj districts. AEZ-12 is Low Ganges River Floodplain. This region comprises the eastern half of the Ganges river floodplain which is low lying, having a typical meander floodplain landscape of ridges and basins. Nature of the soil of the region includes silt loams and silty clay loams on the ridges where as silty clay loams to heavy clays are found on the lower sites. General soil types predominantly include calcareous Dark Grey and Calcareous Brown Floodplain soils. Organic matter content is low in ridges and moderate in the basins. Soils are calcareous in nature having neutral to slightly alkaline reaction. General fertility level is medium. Locations of this zone are Natore, Pabna, Goalanda, Faridpur, Madaripur, Gopalgonj and Sariatpur, eastern part of kustia, Magura, and Narail, northern Barisal, and South-Western part of Manikgonj (BBS, 2004) [16]. No prior relevant research was found to be conducted in the study area.; secondly, it will help to know, how they are facing troubles in terms of agro-ecology as a remote area; thirdly, this area like demographic, physical and agro-ecological are more relevant to understand the change; and finally, the study area is well known to all as an agricultural production zone which help to explore new ideas in rural areas of Bangladesh. The objective of the study is to explore the nature of agro-ecological system and its impact on crop production.

2. Research Methodology

The study was conducted at Bilsha village of Gurudaspur Upazilla under the district of Natore, Bangladesh. This area is situated in the middle of the Chalan Beel, the largest wetland in Bangladesh. The total area of Bilsha village is 1891 acre and total households are 797 (BBS, 2001) [17]. After stratifying all the households on the basis of occupation of the head (Figure 1), 33% from each stratum were randomly selected for present study. This study was carried out for a period of two years from April 2014 to March 2016.

Quantitative and qualitative methodological applications were made to secure cross checked data. Primary data were collected using social survey from the selected head of the households through face to face interview using a questionnaire as part of social survey. Data were also collected from the key respondents- those were experienced enough and skilled at agriculture through Focus Group Discussion (FGD) as a PRA tool. For better understanding of the agricultural change, data were also collected from the Upazilla Agriculture Office of Gurudaspur under the district of Natore. For analysis, data were subjected to simple descriptive analysis and other statistical tests (e.g. t-test). Computer software SPSS (version 15.00) was used to serve this purpose.

3. Results and Discussion

3.1. Changes in pattern of occupation

Changes in occupation over generations were recorded in the study area. A total of 10 occupations of the respondents were found during the study period which was only half (5) among their father’s and grandfather’s time (Table 1). Agriculture was the dominant occupation throughout the three generations though the proportion of involvement has been reduced to a considerable extent (from 86.79% to 75.09%; statistically significantly different among generations, \( p<0.05 \)). Involvement in agriculture was statistically significantly lower than the population normal agricultural involvement, \( t=21.639, \ p=0.022 \). An increasing trend of involvement in service was recorded over this period (from 1.51% to 7.92%, statistically significantly different among generations, \( p<0.05 \)).

Table 1: Changing pattern of primary occupation over three generations of the respondents

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Respondents</th>
<th>Father of the respondents</th>
<th>Grandfather of the respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>75.09</td>
<td>76.60</td>
<td>86.79</td>
</tr>
<tr>
<td>Fisherman</td>
<td>08.30</td>
<td>08.30</td>
<td>08.30</td>
</tr>
<tr>
<td>Service</td>
<td>07.92</td>
<td>3.77</td>
<td>1.51</td>
</tr>
<tr>
<td>Business</td>
<td>05.28</td>
<td>10.95</td>
<td>01.51</td>
</tr>
<tr>
<td>Laborer</td>
<td>01.51</td>
<td>0.38</td>
<td>01.89</td>
</tr>
<tr>
<td>Imam</td>
<td>00.38</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Moazzzen</td>
<td>00.38</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tailor</td>
<td>00.38</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rural Doctor</td>
<td>00.38</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Carpenter</td>
<td>00.38</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

3.2. Changes in literacy level

A dramatic change in education over generations was revealed from the present study. Over one-fifth (86.79%) of the respondent’s grandfathers were illiterate which was reduced to only 6.04% in case of respondents (Table 2). Tendency to complete secondary and tertiary education was also recorded among newer generations.
Table 2: Educational status over three generations of the respondents

<table>
<thead>
<tr>
<th>Types of Education</th>
<th>Respondents (%)</th>
<th>Father of the respondents (%)</th>
<th>Grandfather of the respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiterate</td>
<td>06.04</td>
<td>29.81</td>
<td>86.79</td>
</tr>
<tr>
<td>Primary</td>
<td>39.24</td>
<td>43.78</td>
<td>10.94</td>
</tr>
<tr>
<td>Secondary</td>
<td>38.11</td>
<td>20.75</td>
<td>01.89</td>
</tr>
<tr>
<td>Higher Secondary</td>
<td>03.78</td>
<td>01.89</td>
<td>0.38</td>
</tr>
<tr>
<td>Graduate/Honours</td>
<td>06.79</td>
<td>02.64</td>
<td>-</td>
</tr>
<tr>
<td>Kamel</td>
<td>04.53</td>
<td>0.75</td>
<td>-</td>
</tr>
<tr>
<td>Higher (B.Ed/M.Ed)</td>
<td>01.13</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

3.3. Experiences of the respondents regarding qualities of soil

Almost all the respondents (93.58%) believed that the quality of soil has been degraded to a great extent over time. Only a small portion (1.13%) of the respondents mentioned that they do not understand any change. However, remaining part of respondents (5.29%) stated that the fertility of soil has been increased.

All of the respondents (100%) were interested to know the status of soil quality of their land. But, this was not possible because of lack of appropriate technical knowledge and equipments required. However, no initiative from the authorized body was also reported regarding this issue.

3.4. Status of useful invertebrates

Four species of useful biota for agriculture were reported to be present in the agricultural fields (Figure 1). All the respondents (100%) have reported that the abundance of helpful invertebrates have been decreased in agricultural lands and adjacent areas. Three causes of declining were recorded from the respondents: use of inorganic fertilizers, use of pesticides and poaching of birds- reported by 92.08%, 95.47% and 91.7% of the total respondents respectively.

3.5. Changes in the pattern of cultivation

Remarkable change in the cropping pattern in the study area was recorded from this research (Table 3). Research findings revealed that eight indigenous varieties of agricultural crops were cultivated in the past (around 1990); of which only three were continually being planted to date. However, two new crops, Boro rice and maize/corn, were found to be cultivated in the study area. It was also recorded that all the cultivated agricultural crops were high yield varieties (HYVs) and no native varieties were recorded to be planted nowadays.

Different factors were highlighted by the respondents for this shifting in cropping pattern (Table 3). The prime factors found to be responsible for this change was high mass production and profit of crops reported by all the respondents in the study area.

Table 3: Status of cropping pattern in the study area

<table>
<thead>
<tr>
<th>Status of cropping (Past around 1990)</th>
<th>Present</th>
<th>Factors affecting changes in cropping pattern</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice (Aman), Rice (Aush), Wheat, Barley, Mustard, Sesame, Jute, Kaon (a small cereal grain)</td>
<td>Rice (Aman), rice (Boro: BRRI 28, 29, 39; Hira; Teg, Zira and Minicate), Maize, Wheat, and Jute</td>
<td>High production, More profit than native variety, Easy availability of seeds</td>
<td>100</td>
</tr>
</tbody>
</table>

3.6. Changing pattern of irrigation

A conspicuous change in the irrigation pattern in the study area was revealed in this research (Table 4). Use of deep tube-well was very common in the study area whose use was not reported by the respondents in past. The irrigation system of the study area was found fully dependent on ground water, though surface water was the key source for irrigation in the past (Table 4). Lack of sufficient surface water in open water bodies of the study area in recent time was the key factor responsible for this change. Insufficient water in rivers and other surface water bodies became a common problem in Bangladesh (Galib et al., 2016). However, declined of ground water level, resulted from complete dependency on it, was a crucial problem of irrigation system in the study area especially during the month of March to mid of the May.

Figure 1: Presence of some useful invertebrates in the agricultural fields of the respondents
### Table 4: Status of irrigation in the study area

<table>
<thead>
<tr>
<th>Irrigation System</th>
<th>Past (around 1990) (%)</th>
<th>At Present (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Water + Doan</td>
<td>44.91</td>
<td>-</td>
</tr>
<tr>
<td>River Water + Shewti</td>
<td>51.32</td>
<td>-</td>
</tr>
<tr>
<td>River + Power Pump</td>
<td>55.85</td>
<td>-</td>
</tr>
<tr>
<td>Open Water + Shallow Machine</td>
<td>70.19</td>
<td>-</td>
</tr>
<tr>
<td>River + Shallow Machine</td>
<td>64.91</td>
<td>10.19</td>
</tr>
<tr>
<td>Deep Tube-well + Shallow Machine</td>
<td>-</td>
<td>72.84</td>
</tr>
<tr>
<td>Deep Tube-well + Electric Mortar</td>
<td>-</td>
<td>16.98</td>
</tr>
</tbody>
</table>

### 3.7. Impact of ground water based irrigation on agro-ecology

A range of adverse impacts of ground water dependent irrigation were reported by the respondents (Figure 2). Declining of ground water level due to extensive use of it was reported by almost all the respondents (98.87%). In the starting period of Boro (local name of a rice variety) rice season, the ground water existed within 10 to 15 feet depth of soil that further downed to 30 to 35 feet during the dry months of April to May. However, 20 to 50 years ago the water level retained within 15 to 20 feet depth during these dry months. Over half of the respondents (61.89%) have reported that the fertility of their lands was deteriorated because of over use of ground water.

### 3.8. Causes of decreasing useful birds in the agricultural fields

All the respondents (100%) reported that diversity and abundance of useful birds were decreased in the study area. A number of factors were reported by the respondents those were responsible for the declining of birds (Figure 3). Decreased food availability, use of toxic substances in the agricultural lands and illegal trapping for meat were the most important factors led to the current situation.

![Figure 3: Different causes of decreasing birds in the agricultural fields of study area](image)

### 4. Conclusion

This study revealed a change in all the areas regarding traditional agro-ecological system and its interaction with crop production. Most of the points, producers are experiencing these changes in a negative way due to lack of proper scientific participatory interventions except the high production rate of the cultivated crops. Further multidisciplinary research is needed to investigate the issue in a holistic way and to aid the improvement of the situation.

### 5. References


