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PJBS

ISSN 1028-8880

# Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 7 (8): 1322-1326, 2004
ISSN 1028-8880


# Salinity on Cultivable Land and Its Effects on Crops

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**Abstract:** This study was conducted during the period of May to December 2001 in four thanas under three southwestern districts of Bangladesh. In the present study structured interview schedule was used as data collection tool. In the surveyed area most of the farmers (45%) having above 4 acres of land and only 23% farmers had 2 acres of land. The major field crop of the study area was rice (aman/boro). Other crops like jute, sesame, groundnut, potato, mustard, vegetables (especially winter vegetables) were also grown in limited areas. About 41% farmers mentioned the salinity intrusion as a major barrier for crop cultivation and 23% farmers mentioned that the increase of salinity in river water is another major cause for salinity increase in cropland. Different farmers described the consequences of salinity in various dimensions, the major effect was the reduction in crop yield (34% farmers). The increasing trend of salinity in southwest region of Bangladesh is reducing the farmers' interest to cultivate various agricultural crops. In the study area, the fruit trees like mango, bettle nut, coconut, sapota, date palm, giant taro, jack fruit, black berry, wax jambu etc are disappearing gradually. The effect of salinity is not only functional on crops but its impact on environment is now well recognized. Declining tree species, reducing soil fertility, increasing disease and insect infestation in field crops, increasing human and animal diseases are the major impact of increasing salinity. Native fish species in open and fresh water bodies are also disappearing gradually.

**Key words:** Salinity, cultivable land, crop

## INTRODUCTION

The accumulation of excess soluble salts in the crop root zone affects plant growth adversely. Soils, which contain sufficient neutral salts in the root zone, are termed as saline soils. Plant growth in these soils is either restricted or entirely prevented depending on the kind and amount of soluble salts, the plants grown and environmental factors.

Inundation of arable lands by saline water to cultivate shrimp has created salinity problems in south west of Bangladesh. Vast area of tidal land previously used for rice cultivation in Khulna and Bagerhat districts has been changed to Shrimp farms[1]. It has been also reported that upstream withdrawal of the Ganges water in Farraka (built in 1976) beyond the border of Bangladesh has reduced fresh water discharge causing intrusion of salinity into main land[2]. The saline aquifer has penetrated about 151 km and 46.5 km from the coast towards Khulna and Barisal, respectively. Minimum salinity of 0.5 $dSm^{-1}$ was recorded at some places in the month of October at the end of monsoon while maximum salinity of 68.2 $dSm^{-1}$ was recorded at the end of dry season[3].

Plant growth and development are largely affected by salinity. During rabi season salinity increases as the ground water goes down. As a result vast land areas in salt affected areas remains fallow owing to inadequate supply of irrigation water and also lack of salt tolerant crop varieties. This leads to the decrease in cropping intensity with increased environmental hazards. Thus one might expect that the use of salinity tolerant crop varieties as well as acclimatized with saline cropping pattern would increase the net return from per unit area. Nevertheless, data regarding the detailed information focusing salinity effect on cropping intensity, cropping pattern and season wise fallow land distribution pattern etc. are lacking in general. So the overall objective of the present study was to obtained an overview of the cultivation pattern on saline area of southwest region of Bangladesh.

## MATERIALS AND METHODS

This study was conducted during the period of May to December 2001 in four thanas under three southwestern districts of Bangladesh. In the present study structured interview schedule was used as data collection tool. Relevant literatures were collected to prepare the questionnaire and report as well. Four thanas under three districts of southwest Bangladesh namely Tala in Satkhira, Dumuria and Batiaghata in Khulna and Fakirhat in Bagerhat were surveyed for this study. The salt affected areas were 15,620, 30,660, 16,890 and 6,900 ha

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Table 1: Salinity affected land distribution in surveyed areas

| Upazilla | Total land (ha) | Salinity affected land (ha) | Cultivable land (ha) | Uncultivable land (ha) |
|---|---|---|---|---|
| Tala | 33,713 | 15,620 | 26,724 | 1,365 |
| Dumuria | 44,797 | 30,660 | 36,566 | 1,099 |
| Batiaghata | 24,605 | 16,890 | 17,891 | 1,725 |
| Fakirhat | 15,883 | 6,900 | 10,076 | 1,104 |

Source: Upazilla Bhumi O Mrittika Bhabohar Nirdesika (Tala, Dumuria, Batiaghata and Fakirhat upazilla), SRDI: 1989-91

of total area of 33,713, 44,797, 24,605 and 15,883 ha in Tala, Dumuria, Batiaghata and Fakirhat thanas, respectively (Table 1). In surveyed area, farming system is mainly prawn/shrimp culture based.

An up to date list of all the farmers of selected villages were prepared. Total number of farm families were 90, selected from Tala, Dumuria, Batiaghata and Fakirhat thanas for data collection. Among which 11 from Tala, 33 from Dumuria, 40 from Batiaghata and 6 from Fakirhat were interviewed. A structured and open-ended interview schedule was prepared for data collection in Bengali version where the view of the study was ensured properly. The schedule was pre-tested before final collection of data. After pre-test, necessary correction, addition, alteration and rearrangements were made. The interview schedule was then finalized for collection of data. Data were collected from the field randomly according to the sample design. Interviews were conducted with the respondents at their homes. Most of the questions were asked to them in a qualitative form. In some cases, the researches failed to meet the sample farmers at their homes for interview. Then the researches visited them repeatedly and in few cases conducted interview with reserve farmers. After completion of field survey, all the interview schedules were grouped and interpreted according to the objective of the study. At the beginning of the data processing, all the qualitative data were converted into quantitative form and local units into standard units. The data obtained through interview schedule were coded and tabulated in a data sheet.

## RESULTS AND DISCUSSION

It was revealed from the present study that the salinity intrusion problem effects existing cropping system in different ways. The analysis was done considering only those issues that were directly related with the cultural practices and accordingly described below.

Table 2: Land ownership status in surveyed area

| Cultivable land (Ac) (including gher) | Respondent (No.) | Respondent (%) |
|---|---|---|
| 0-2.0 | 21 | 23 |
| 2.1-4.0 | 29 | 32 |
| 4.1- above | 40 | 45 |

Table 3: Other crops cultivated by farmers

| Name of crops | Respondent (No.) | Participants (%) |
|---|---|---|
| Sesame | 13 | 62 |
| Jute | 3 | 14 |
| Vegetables | 5 | 24 |

**Land status:** In the surveyed area most of the farmer (45%) having above 4 acres of land whereas below 2 acres land owned by only 23% of total respondents (Table 2). Both owned and leased land was calculated. It was observed that net return of unit area from field crop is not satisfactory (Data not presented).

**Cropping system in the study area:** Cropping pattern of Tala, Dumuria, Batiaghata and Fakirhat thanas, represent the general cropping pattern of Southwest region. The farming system of this area was generally shrimp/prawn based. The major field crop of the study area was rice (aman/boro). Generally farmers did not cultivate aus in this area. During aus growing season the salinity intensity becomes higher and they have less opportunity to use the land for aus cultivation. Other crops like jute, sesame, groundnut, potato, mustard, vegetables (especially winter vegetables) are also grown in limited areas (Table 3). The varieties of different rice growing seasons cultivated by the farmers in the study area are shown in Table 4.

In boro season most of the rice land remain fallow specially in surveyed areas. Only 18% farmers cultivated rice in boro season and rest 82% cultivate aman rice. Farmers use both HYV and local variety in aman and boro season. In boro season 76.19% farmers used HYV which covered 70% of total boro area and 23.81% farmers use local variety which covered 30% of total boro area (Table 4). BR 28 was the most popular HYV rice variety compared with BR 11, BR 23, BR 26 and BR 29. Baroi ratna, Vajan, etc. are the local varieties that also cultivated in this area. The average yields of local varieties and HYV were 2.6 and 4.4 ton $ha^{-1}$, respectively (Table 4).

In aman season farmers planted both local and HYV varieties but local varieties are more popular compared with HYV. Around 59.13% farmers used local variety in aman season that covered 66.67% of total area used in that season and rest 40.87% farmers used HYV which covered 33.3% of total aman area (Table 5). Among those varieties Jati, Ghunsi, Hoglapata, Hogla, Chapal, Moynamati etc. of local varieties and BR 11, BR 23 of HYV performed better. Though the yield performance of local variety was less (1.9 ton $ha^{-1}$) than the HYV (2.5 ton $ha^{-1}$) (Table 5), farmers preferred to cultivate local variety in aman season for its indigenous characters like taller plant height, insect, disease, water logging and salt tolerance capacity, more tasty as well as less production cost.

Table 4: Variety wise rice cultivation in different rice season

| Participant (No.) | Season | Varieties | Total cultivated variety | Average yield (ton ha$^{-1}$) |
|---|---|---|---|---|
| 68 (Local) | Aman | BR – 10, BR –11,BR – 21, BR – 22, | 9 (HYV) | 1.9 (Local) |
| 47 (HYV) | | BR – 23 , BR – 26, | 18 (Local) | 2.5 (HYV) |
| | | BR – 28, BR – 29,BR – 30, Jotai, | | |
| | | Ghunsi, Chapal,Hoglapata, Hogla, | | |
| | | Cachra, Benapol,Gotail, Chini atap, | | |
| | | Mohini, Chaplash,Jotaieu, Ghute salute, | | |
| | | Bamon balam,Moynamoti, Patibalam, | | |
| | | Balam Patni | | |
| 5 (Local) | Boro | IT, BR – 11,BR – 23, BR – 26, | 7 (HYV) | 2.6 (Local) |
| 16 (HYV) | | BR – 28, BR – 29,BR-1, | 3 (Local) | 4.4 (HYV) |
| | | Vajan, Bare ratna, Chinese | | |

Table 5: Different rice variety cultivated by farmers

| | Participant (No.) | | Participant (%) | | Variety (No.) | | Variety (%) | |
|---|---|---|---|---|---|---|---|---|
| Variety | Aman | Boro | Aman | Boro | Aman | Boro | Aman | Boro |
| Local | 68 | 5 | 59.13 | 23.81 | 18 | 3 | 66.67 | 30 |
| HYV | 47 | 16 | 40.87 | 76.19 | 9 | 7 | 33.33 | 70 |

Table 6: Related problems of crop cultivation

| Types of Problem | Respondent (No.) | Respondent (%) |
|---|---|---|
| Saline intrusion | 49 | 41 |
| Draught/ Lack of irrigation facility | 28 | 24 |
| Water Logging | 18 | 15 |
| Lack of proper cultivation practices | 11 | 9 |
| Insect infestation | 8 | 7 |
| Do not follow proper planting time | 2 | 2 |
| Disease infection | 1 | 1 |
| Pressure of powerful man for Bagda cultivation | 1 | 1 |

Table 7: Major causes for increasing salinity

| Major causes of increasing salinity | Respondent (No.) | Respondent (%) |
|---|---|---|
| Unplanned gher expansion | 70 | 63 |
| Increasing salinity in river water | 25 | 23 |
| Unplanned embankment construction | 5 | 5 |
| Influence of powerful man for bagda cultivation | 4 | 4 |
| Water logging | 3 | 3 |
| Natural saline soil | 1 | 1 |
| Blockage of canal/river | 1 | 1 |

Table 8: Consequences of Salinity in crop production

| Consequences of Salinity | Respondent (No.) | Respondent (%) |
|---|---|---|
| Yield reduction | 38 | 34 |
| Less scope for diversified crop cultivation | 15 | 13 |
| Reduce soil fertility | 12 | 11 |
| Increase insect infestation | 10 | 9 |
| Increase crop damage | 9 | 8 |
| Create problems for boro cultivation | 9 | 8 |
| Create problems for irrigation | 6 | 6 |
| Hampering plant growth | 3 | 3 |
| Delay cultivation | 3 | 3 |
| Effect on rice plant (showing red color) | 2 | 2 |
| Effect on livelihood status | 1 | 1 |
| Unidentified problems | 1 | 1 |

Table 9: Effect of salinity on soils

| Effects of soil salinity | Respondent (No.) | Respondent (%) |
|---|---|---|
| Reducing soil fertility | 86 | 81 |
| Demolishing beneficial organisms | 5 | 5 |
| Disturbing soil structure | 2 | 2 |
| Increasing fellow land | 3 | 3 |
| Soil surface covered with red layer | 1 | 1 |
| Facing no problems | 8 | 8 |

According to the farmers opinion due to salinity the average yield of rice was decreased by 1 to 2.2 ton ha$^{-1}$ and other crops yield also decreasing day by day. Compared to the national average, yield reduction of aman local (1.9 ton ha$^{-1}$), aman HYV(2.5 ton ha$^{-1}$), boro local (2.6 ton ha$^{-1}$) and boro HYV(4.4 ton ha$^{-1}$) was 24, 35, 16 and 12%, respectively. (The average yield of Transplanted aman local, Transplanted aman HYV, Boro local and boro HYV is 2.5, 3.9, 3.1, 5 ton ha$^{-1}$, respectively[4].

In the study areas it was also found that farmers cultivate jute, sesame, different vegetables (especially winter vegetables) in minimum scale. Most of the farmers grow these vegetables in their homestead for their own consumption. In Batiaghata thana, farmers grow sesame in little commercial purposes after aman harvesting, but they get less profit from this crop. They mainly cultivate local variety whose average yield was 0.23 ton ha$^{-1}$. Introducing salinity tolerant or high yielding variety of sesame in this area might be an opportunity for the farmers to increase their production. Considering the cultivation practices of other crops, it was found that 62, 14 and 24% farmers cultivated sesame, jute and vegetables in their field, respectively.

**Problems related with crop cultivation:** During crop cultivation farmers were facing a lot of problems that ultimately reduce their crop production as well as their livelihood standard. About 41% farmers mentioned that the salinity intrusion as a major barrier for crop cultivation. Along with this, lack of irrigation facility during the cultivation time is another important problem, which was indicated by 24% of the total respondent and about 15% farmers suffered by water logging problems during crop cultivation. Other highlighted problems were improper cultivation practices (9%) and insect infestation (7%) with other problems like not maintaining appropriate planting time, disease infection and pressure of powerful man for Bagda cultivation (Table 6).

**Major causes of salinity intrusion and its trend:** A series of causes are responsible for salinity intrusion problem in southwest of Bangladesh. Some are natural and some are man made (Table 7). Around 63% respondents said that unplanned gher expansions have key roles in increasing the salinity problem. Due to unplanned gher expansion especially for Bagda (Shrimp) cultivation, farmers were compelled to use saline water into their gher, which makes both the water and soil saline. About 23% farmers mentioned that the increase of salinity in river water is another major cause for salinity increase in cropland. Gher also creates the blockage of canals and rivers which reduces the flow of fresh water. Unplanned construction of embankment is another cause for increasing salinity. Moreover, the farmers of southwest region were also facing problem of pressure from influential people, because the bagda ghers are prepared large in size and mainly the ghers are controlled by the influential farmers. Thus in some cases small farmers were compelled to cultivate shrimp in their crop land. The farmers in particular the older ones opined out that the increasing salinity might cause no land for crop cultivation in coming decades.

**Consequences of Salinity:** Different farmers described the consequences of salinity in various dimensions, the major effect was the reduction in crop yield, which was mentioned by 34% farmers (Table 8). Salinity intrusion problem also reduces the scope of diversified crop cultivation that was mentioned by 13% farmers. About 11% said that soil fertility reduction is also related with salinity intrusion problem which ultimately damages crop (8%). Farmers also described the salinity effect on boro cultivation (8%), less scope for irrigation by fresh water (6%), suppressing plant growth (3%) etc. Few farmers explained the consequence of salinity as the reducing livelihood status of the farmers.

**Effects salinity on soil:** Soil salinity is most important for agricultural crops as its effects are reflected on crop production (Table 9).About 81% farmers think the effect of salinity that reduces soil fertility, whereas 5% clearly mentioned the problems of destroying beneficial organism (earthworm's etc). Around 2% farmers could not clearly explain the problem but they assumed that problems were related with destruction of soil structure. However, 3% respondent said that soil salinity creates fallow land, 8% respondent said that they face no severe problems.

**Present farming practices in saline areas:** The increasing trend of salinity in southwest region of Bangladesh is reducing the farmers' interest to cultivate various agricultural crops. But they need to continue their cultivation practices, as the farmers have no alternative to livelihood. In the study areas, it was found that due to salinity most of the farmers were not able to cultivate crops round the year. The salinity intrusion is highest in the months of March to June and lowest in the month of August to October. Transplant aman rice is the major crop for farmers with boro as the minor one.

Generally, in saline areas most of the crops loss their yield capacity due to their intolerance to salinity. In surveyed areas, it was observed that few rice varieties BR 11, BR 28, BR 29, BR 30 and some local varieties like Patnai, Hogla, Baroi ratna, Ghonsi, Jotai, etc. show good results. On the contrary, the farmers for cultivation especially in winter season mostly choose succulent vegetables.

Different farmers followed different farming practices to reduce salinity effect on the lands and increase crop production. Based on crop type, some of them adopted special type of farming practices like mulching with water hyacinth, straw, ash etc to keep the evaporation at minimum level. Several farmers also suggested to use no fertilizer, for salinity mitigation or crop cultivation on saline land. Few of them also used different fertilizers like gypsum, urea, Triple super phosphate (TSP), Di ammonium phosphate (DAP), compost to mitigate salinity induced soil problems.

Before salinity intrusion, in this region farmers cultivated a wide spectrum of crop varieties. They planted jute, pulses, wheat, sugarcane, sesame, mustard, watermelon etc. round the year. But at present most of the crop fields have been converted into golda and bagda gher and thus the scope of various crop cultivation becomes limited and some acclimatized local varieties are also disappearing day by day.

With regard to cropping patterns in the surveyed areas, the authors as well as Kalam *et al.*[5] reported that following are the major cropping pattern –

- Fallow – Fallow – Transplanted aman
- Fallow/rabi crops – Mixed aus and aman
- Fallow – Broadcast aus – Transplanted aman
- Boro – Fallow – Shrimp/prawn

In surveyed areas, water scarcity was found as a serious problem. Water is essential input for proper growth and development of plants. Due to increasing salinity farmers are facing problem for fresh irrigation water. They mainly use river water to irrigate their crop land, while some of them used canal and pond as irrigation water sources. Any alternatives like conservation of rain water or drip irrigation etc were not

practiced by the farmers of this region. Water pump is used for irrigating crop field but it is costly. In surveyed areas maximum farmers have no fallow land and they mainly follow shrimp based farming system instead of rice based farming. In most of the areas two times rice production is not possible because of different degrees of salinity.

**Salinity impact on tree production:** In Tala, Dumuria, Batiaghata and Fakirhat areas of southwest region, tree production (both fruit and forest trees) are also being hampered due to salinity. In the surveyed area, the fruit trees like mango, bettle nut, coconut, sapota, date palm, giant taro, jack fruit, black berry, wax jambu etc are disappearing gradually. Drastic reduce growth of bettle nut, papaya and banana was also noticed. However some exotic quick growing trees like babla, rain tree, eucalyptus are growing satisfactorily.

During the survey farmer expressed their opinion that at the beginning, growth remains satisfactory, but ones the tap roots reach at the saline layer, the trees start dying due to shortage of pure soil water (introduced salinity) via nutrient depletion leading to physiological disturbance. Plant growth varied from area to area depending on degree of salinity.

**Environmental effect of salinity:** It was evident from the study the effect of salinity was not only functional on crops but its impact on environment is now well recognized. Due to salinity the physiographic structure of saline areas are changing rapidly. In this region climatic change becomes a vital point for future generation. Declining tree species production, reducing soil fertility, increasing disease and etc infestation in field crops, increasing human and animal diseases are the major impact of increasing salinity. Native fish species in open and fresh water bodies are also disappearing gradually. Salinity hazards destroy green belts or plant of coastal zone and thus causes different disasters like increasing temperature, heavy showers, drought etc. So, salinity will be a major hazardous issue for future generation of the south west region of Bangladesh.

In the study areas, grazing lands are also decreasing due to salinity. For that reason, the number of livestock is also decreasing due to shortage of feed e.g. forage, straw with a shortage of both fresh and irrigation water.

Changing the physiographic structure of this region is the collective result of a series of factors, of which the salinity referred as to the prime factor. A lot of problems of cultivation and environmental changes occur for the salinity intrusion in crop land. It was found that in the surveyed area rice farming system changed to prawn/shrimp farming. In some areas this salinity also creates opportunity for shrimp (bagda) cultivation which helps to increase the socio economic standard. However, it also might be a threat for sustainable agriculture, shrimp production and also environment if we are not be more conscious about environmentally and socially sound cultivation practices.

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