ANNUAL REPORT

2023-2024

SOIL RESOURCE DEVELOPMENT INSTITUTE

MINISTRY OF AGRICULTURE

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2024

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Government of the people's Republic of Bangladesh

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Foreward

One of the vital activities of SRDI is to publish an annual report based on all activities performed during the fiscal year. Accordingly, this report covers the achievement against the target of Annual Performance Agreement (APA) for 2023-2024.

Being a NARS organization SRDI has the mandate to develop inventories on soil and land resources, ensure sustainable soil health management, and innovate technologies for problem soil management. All these ventures have a common goal- sustainable agricultural development.

 Conducting semi detailed soil survey and preparation of Upazilla Nirdheshika is one of the core works of SRDI. It is a unique tool developed for local level agricultural planning. The Nirdeshika comprises all land and soil related data, information including soil fertility and agro climatic features. It is prepared for developing local level agricultural planning by Upazila level DAE officials including SAAOs as it provides all sorts of local level land, soil and agro climatic data base. Upazila Nirdeshika has multiple uses. Among them, assessment of crop suitability, land use and recommendation of balanced fertilizer are of worth mentioning. Apart from Upazila Nirdeshika SRDI also prepares Union Sahayika as a tool for developing agricultural planning at grass root level. Except for its planning advantage, it is also used as a guiding tool for fertilizer recommendation. To popularize balanced fertilizer use practice among farmers SRDI has initiated and operating number of programmes, like conducting research trials and distribution of fertilizer recommendation cards and organizing discussion meetings on minimizing wastage of chemical fertilizers through farmers gathering.

Analysis of soil, fertilizer, plant & water is another vital activity of SRDI. These services are provided mainly by divisional and regional laboratories having permanent infrastructures. Beyond that another type of farmers' service is given through Mobile Soil Testing Laboratories (MSTL). It is mainly a motivational programme run with the objective of creating mass awareness among farmers on use of balanced fertilizer on the basis of soil test data.

Soil and water salinity monitoring is another prime activity of SRDI which is devoted to generating databases for improved management of saline soils and also for programme planning.

SRDI also conducts research through Soil Conservation and Watershed Management Centre (SCWMC) at Banderban and Salinity Management and Research Centre (SMRC) at Batiaghata, Khulna. Both the centres are devoted to conduct research and develop sustainable soil management technologies on problem soils, viz. hill soils and saline soils.

Aside from these, SRDI extends support services to DAE, NARS organizations, educational institutions and other GO and NGOs by providing data through its rich data base.
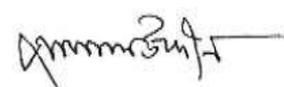
Divisions and sections of SRDI head office have significant contributions to achieve the annual APA targets in addition to their other valuable jobs.

I believe that the information and findings covered by this report will be helpful for all concerned.

I would like to extend my heartiest thanks and gratitude to all officers and staff of field offices, laboratories, research centers and head offices who are involved in implementing the annual programme 2023-2024 with sincere efforts.

My thanks also go for project directors and programme directors for their contribution in achieving the annual target.

Finally, members of the annual report preparation committee also deserve thanks for their valuable efforts to prepare the annual report.

(Md. Jalal Uddin)
Director General

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Executive Summary

Sustainable use of land resources and promoting soil health management are the two vital Sustainable Development Goals (SDG) relating to agricultural development in Bangladesh. Ensuring food security for the booming population through squeezing land and soil resources is the main challenge in achieving these goals. SRDI's all-out efforts and functions are concentrated to achieve the goals amidst harsh reality.

As a government and NARS organization under the Ministry of Agriculture (MoA) Soil Resource Development Institute (SRDI) is responsible for making inventory on land and soil resources, conducting research on hill soils and salinity affected areas. SRDI provides soil and fertilizer testing services through static laboratories. It also renders motivational soil testing services at grass root level through Mobile Soil Testing Laboratory (MSTL). The Institute is also liable to conduct research on crucial soil and environment related problems. Providing advisory services to divergent stakeholders is another salient job of SRDI.

Updating of "Upazila Nirdeshika" through semi-detailed soil survey is a core programme of SRDI. In the fiscal year 2023-24, updating soil survey programmes was carried out in 50 Upazilas. Field level information on significant changes in land use, land type, fertilizer use and other relevant data as well as composite soil samples were collected for each and every case. Inclusion of vegetables and fruits as a high value crop has been noticed in some places. A number of thirty-five (35) Upazila Nirdeshika were published in the year. The findings of published Upazila Nirdeshika reveal that there is significant increase in transformation of agricultural land into non-agricultural land due to urbanization, industrialization and rural settlements. Data also reveal that homestead forest covers a significant area under rural settlements of coastal areas. Change in land type classes has been observed in some cases. Soil pH as well as soil nutrient status have been decreasing or almost similar in different parts of the country. Reasons for declining soil pH or soil acidification are excessive and/ inappropriate use of nitrogenous fertilizers and removal of crop residues. Soils of intensive cropped area are found to be more exhausted in respect of soil fertility which is mainly due to unbalanced and less use of fertilizers along with minimum or without use of organic inputs.

Union based Land, Soil and Fertilizer Recommendation Guide (Union Sahayika) is being used as a local level tool for agricultural development planning and for advisory services. A number of 248 Union Sahayikas were prepared and published in the fiscal year 2023-24.
SRDI has launched Online Fertilizer Recommendation System (OFRS) since 2009. The system aims at providing faster and easier delivery of fertilizer recommendation service which is a part of sustainable soil management. In FY 2023-24, about 7,771 farmers/beneficiaries were served through OFRS software. Number of farmers served on the basis of Upazila Nirdheshika and soil tests are 5,793 and 1,870 respectively.

SRDI's activities also involve GIS based data processing and map preparation. This endeavor is employed for utilizing GIS in storage, retrieval as well as visualization of land and soil related maps. Under this programme, Proposed upazila for soil survey (semi-detailed soil survey of SRDI) maps were prepared in 2023-24 fiscal year.

SRDI initiated the Soil Test Based (STB) Fertilizer Recommendation System through Mobile Soil Testing Laboratories (MSTL) in 1996. At present, SRDI operates 10 MSTL for providing farmers service through soil analysis at the user's end in two seasons (Rabi & Kharif) of the year. In 2023-2024, 5081 farmers thoughout the country was given soil testing service and fertilizer recommendation cards through this programme.

SRDI is conducting salinity monitoring in coastal areas of the country to observe short term and long-term trends of salinity fluctuation. Data disclose that soil and water salinity was much higher in the south western part of the country than rest other parts. It is due to the non-functional river system because of reduced upstream flow. In Khulna division severe salinity affected districts are Bagerhat, Satkhira and Khulna. In Barishal Division mainly onshore areas are affected by salinity. Accordingly, higher degree of soil and water salinity was recorded in Barguna, Patuakhali, Bhola & Pirojpur Districts. Barishal Division is naturally more advantaged because of its active river network as well as affluent river flow. In recent years the Baleshwar River lost its upstream flow. Consequently, sea water intrusion occurs up to Pirojpur Sadar Upazila in dry season which means extension of saline area along the river Baleshwar and scarcity of irrigation water. In Bhola District, saline soils are easily managed because of its loamy texture. These coarse textured soils have low CEC. As a result, they can't hold salt elements with their poor electrostatic charge. This is the reason why desalination happens in these soils during monsoon through rain flashing if drainage provision is satisfactory. Soils of Hatiya and Swandip under Noakhali and Chittagong District as well as offshore part of Feni District also have the similar advantage. In Barishal Division saline soils could be more easily managed utilizing plentiful dry season river flow. Sweet water needs to be stored in October-November and utilized through a buried pipe irrigation network. This could be achieved through modern polder management. In Cox's Bazar District farmers use their lands as salt beds because of higher returns. This practice is detrimental to soil health and eventually may accelerate soil salinization. River water salinity of Noakhali and Bhola district is less than that of Khulna, Bagerhat and Satkhira districts. In Satkhira, river water salinity was found highest in May/June whereas in Noakhali and Barishal it was highest in April/May. River water remains saline during April-June as rainfall is low during this period. During the dry season most of the DTW and STW water remains saline. Generally, Barisal experiences lower rainfall during November to March. In Patuakhali, both soil and water salinity start to increase in January/February, attains its peak in March and starts to decrease in June/July at the onset of monsoon. In Chittagong and Cox's bazar soil salinity starts to increase in December, attains its peak in March and then gradually decreases at the start of monsoon. Water salinity starts to increase in January, attains its peak in April/May.

Salinity Management and Research Centre (SMRC), Batiaghata, Khulna has developed a number of technologies for saline soil management which have been found to be very effective in farmer's field. These technologies are: top soil carpeting technology for vegetable production on shrimp-gher bund, farm-pond technology, pitcher irrigation, dibbling and transplanting of maize under zero tillage, single and double layer mulching, flying bed culture for vegetable cultivation, and screening of suitable crop varieties for saline soils. Proper dissemination of these technologies is needed for crop intensification through optimum soil and water management in coastal areas of Bangladesh. Soil Conservation and Watershed

Management Centre (SCWMC), Meghla, Bandarban has developed some advanced technologies for hill soil management, among these hedge row technology, staggered trenching, half-moon trenching, slash and mulch system of agroforestry and Natural Vegetative Strips (NVS) for controlling soil erosion in hill slopes are noteworthy. These technologies need to be disseminated through DAE for sustainable soil management in hill areas.

Government has to pay a cosmic amount of money for subsidies on fertilizers. It is an extra pressure on our national economy. For proper utilization of government support or incentive it is necessary to use balanced fertilizers by farmers. Farmers should be motivated for rational and balanced use of fertilizers. Minimum wastage of fertilizers is expected with respect to economic and soil health and environmental perspective. With a view to fulfilling the objective, SRDI has initiated an adaptive trial programme to popularize balanced fertilizer use among farmers. Basis of the fertilizer recommendation was direct soil test value and soil fertility data of Upazila Nirdeshika. This programme has been implemented throughout the country to visualize superiority of balanced fertilization over farmers' assumed dose. Besides yield increase, balanced fertilization helps to maintain soil health and a good environment. Altogether 66 adaptive trials were set up in the year 2023-24. The yield data of Adaptive Trial plots revealed that farmers got 0.06%-33% higher yield in different crops and varieties in comparison to farmers' practices in different locations.

Chemical analysis of soil, fertilizer, plant and water samples is one of the core functions of SRDI. This programme has been aimed at evaluating soil fertility status for updating of soil chemical databases of SRDI's Upazila Nirdeshika and recommendation of balanced fertilizer doses for different crops. Another objective of the programme is to analyze fertilizer samples for the purpose of quality control and to analyze water and plant samples for research needs of SRDI and other Government and non-Government organizations. During 2023-24 Static Laboratories conducted soil analysis for both physical and chemical parameters, plant and water analysis for chemical parameters and fertilizer samples analysis under different programmes. In Static Laboratories (Central and Regional Laboratories) 33,070 soil samples, 519 water samples, 448 plant samples and 5,077 fertilizer samples were analyzed. Central Laboratory conducted research on various aspects of soil and fertilizer management, sludge management, nutrient management and so on. In addition, 5,081 soil samples were analyzed by 10 MSTLs.

Building up resourceful manpower to cope with upcoming challenges SRDI is implementing a good deal of training programmes throughout the year. As a part of this, training was imparted to the officers and scientists of SRDI, DAE on chemical analyses of soil and fertilizers, Identification of adulterated fertilizers at field level, Soil sample collection technique and use of balanced fertilizer. Training was given to the Officers of SRDI/DAE on the use of Upazila Nirdeshika along with various aspects of soil management/capacity building & skill development and the Officers of SRDI on application of GIS Technology in Preparing maps, skill development on remote sensing, innovation in public service, E-filing, laboratory equipment maintenance and methodology, use of computer and software; farmers/fertilizer dealers/ SAAO's/ entrepreneurs of Union Information Center on the use of Upazila

Nirdeshika/soil sample collection technique & use of balanced fertilizer/identification of adulterated fertilizer.

To mobilize field and laboratory activities SRDI has two projects and two programmes. The projects are "Construction of building and Capacity Building of SRDI (CCBS)" and "Gopalganj- Khulna- Bagerhat- Satkhira- Pirojpur Agricultural Development (GKBSP)". The programmes are "Acidic soil management and sustainable crop production & improvement of soil fertility by practicing climate smart agricultre in the Rajshahi & Rangpur Division including Madhupur Tract", and Strengthening of newly developed Potuakhali & Rangamati regional laboratories. Significant progress has been made with respect to yearly achievement of the institution. The activities performed by the projects and programmes have been included in this report precisely.

Chapter 1: SRDI at a glance

1.1 Brief Introduction of Soil Resource Development Institute (SRDI)

Soil Resource Development Institute (SRDI) is a designated organization for soil resource inventory as well as soil research for sustainable soil and land management with a view to ensuring food security. SRDI is an attached department to the Ministry of Agriculture which originated in 1961 as the East Wing Directorate of the Soil Survey Project of Pakistan with the assistance of FAO/UNDP. The institute aimed at quick inventory of soil and land resources to develop a sound database of soil and land especially for- Extension, Irrigation and drainage, Soil conservation and reclamation & soil fertility investigation and identification of problem soils.

After the emergence of Bangladesh, the then East wing office of the Central Soil Resource Institute started functioning as the Department of Soil Survey under the Ministry of Agriculture and Forest, Government of the People's Republic of Bangladesh. In 1983, Soil Resource Development Institute (SRDI) was established under the Ministry of Agriculture and Forest by reorganizing the then Department of Soil Survey. From 1986 onwards through successful completion of several projects the activities of SRDI have increased manifold. An important landmark in the development of the Institute was the recent creation of 33 regional offices as well as 16 regional laboratories to flourish soil management services up to grass root level. It is now prepared to face the challenges of the future to make breakthroughs in crop production through improved soil and nutrient management in Bangladesh.

1.1.1 Vision of SRDI:
SRDI has the vision to ensure judicious and profitable use of the land and soil resources of the country and to protect soil health.

1.1.2 Mission of SRDI:
The mission of SRDI is to make inventories of soil and land resources, classify them according to their potentiality, prepare user-friendly guidelines and manuals for their optimum utilization, investigate and manage problem soils and develop and implement sustainable plans for increased crop production in Bangladesh.

1.2 Functions of SRDI
The functions of the Soil Resource Development Institute are as follows:
a) Reconnaissance Soil Survey of the whole country based on aerial photo interpretation and field survey and laboratory investigation of soils;
b) Semi-detailed soil survey for the preparation of Upazila Nirdeshika;
c) Detailed/Semi-detailed soil surveys of development project areas and research farms for various beneficiary agencies;
c) Soil surveys to evaluate command areas for irrigation and for cropping potentials;
d) Soil surveys for locating areas of problem soils (e.g., saline, alkaline, acidic soil or peat soils) and polluted soils (contaminated by toxic elements and heavy metals), soil degradation and erosion (in watershed region) for planning reclamation or watershed management;

e)   Correlation of soils collected through various surveys;

f)   Conducting chemical, physical, mineralogical and microbiological study. Chemical analysis of soil, water and plant samples to verify and clarify the field observation;

g)   Analysis of chemical and organic fertilizers to ensure the quality of fertilizers for legal action and policy support.

h)   Interpretation of satellite imageries through GIS and remote sensing tools for soil and land use surveys;

i)   Preparation of various maps and reports on the above-mentioned surveys for publication;

j)   Providing services to the development agencies with the help of basic data on soils, land capability and crop suitability for preparation of both short and long-term agricultural development plans;

k)   Coordination with the beneficiary agencies at local, regional or national levels regarding planning and execution of land use development programmes;

l)   Guiding with respect to sustainable soil management and agricultural development possibilities for each upazila for agricultural extension and research workers;

m)   Provision of soil data for planning irrigation, drainage and reclamation projects;

n)   Identification of research need and selection of suitable sites for specific research/development activities;

o)   Imparting in-service training to the newly recruited technical officers on soil survey, land use planning, cropping potential, etc. and refreshers training to keep the technical officers of the department apprised and acquainted with the up-to date knowledge;

p)   Training of agricultural extension and research workers of various levels on proper utilization of soil survey information. Imparting basic training on various aspects of soils to the students of the agricultural institutions. (Source: Gazette Notification, October, 1983);

q)   Render services to farmers and others by analyzing soil, plant, water and fertilizer samples and recommend location specific fertilizer doses on the basis of soil testing and crop requirements;

r)   Provide assistance in regular monitoring of soil fertility and land productivity activities throughout the country;

s)   Study in soil moisture characteristics to ascertain irrigation needs of different crops;

t)   Launch a regular programme for the training of field level extension workers on the use of Upazila Nirdeshika to make them enable for preparing local level sustainable agricultural plan and to make recommendation of fertilizers on the basis of soil analytical data;

u)   Investigate soil fertility degradation problem, nutrient related problems of crops, soil moisture stress and constraints in crop production etc.

1.3 Organogram of SRDI

Soil Resource Development Institute (SRDI) is a government organization under the Ministry of Agriculture (MoA) which is working as a member of NARS system under the umbrella of Bangladesh Agricultural Research Council (BARC). The institute operates with 2 wings, 2 divisions and 11 sections. Field Services Field Services Wing consists of 7 divisional offices and 33 regional offices. Analytical Services Wing includes 7 divisional laboratories, 16

regional laboratories and central laboratory. Survey and land management division consists of 3 sections namely (i) soil survey and land classification section (ii) land use planning section (iii) land evaluation and soil correlation. Training & Communication Division consists of 3 sections namely (i) Cartography section (ii) DPS & ICT section (iii) Human resource development section and (iv) Publication and record section. Central Laboratory consists of 3 sections namely i) Soil physics and Mineralogy ii) Soil chemistry iii) Soil Microbiology and Biochemistry. SRDI's Two research centres namely (i) Soil Conservation and Watershed Management Center (SCWMC), Meghla, Bandarban and (ii) Salinity Management and Research Center (SMRC), Batiaghata, Khulna are controlled by central administration. Centrally controlled administration section includes: administrative branch, accounts branch and store branch. Besides, Upazila Nirdeshika Cell is directly controlled by the Director General's office.

Soil Resource Development Institute is headed by the Director General. Field Services Wing, Analytical Services Wing are headed by director. The divisions of head office, divisional offices, divisional laboratories and central laboratory are headed by Chief Scientific Office (CSO) and the sections of head office, regional offices, regional laboratories and research center are headed by Principal Scientific Officer (PSO). The Cartography Section is headed by a Senior Cartographer, Publication and Record Section is headed by Publication & Liaison Officer.

1.3.1 Functions of Survey and Land Management Division

Planning, coordination and supervision of all technical programmes and activities of the component sections. Review and/or editing of all technical reports prepared by the component sections. Coordination with allied Government, Autonomous/other agencies in national programmes on soil and land resource evaluation and land utilization planning. Correlation of soils and soil and land classification surveys at national level. Responsible for overall technical progress of the Division. Field investigation of soil problems. Assistance to the Director in general and technical administration of the division. This division has three sections.

1.3.1.1 Functions of Survey and Classification Section

Planning and supervision of soil surveys. Updating earlier surveys on soils, land use and land capability. Development of advanced methodology for soil surveys. Trials on adoption of latest global technology for soil survey, i.e., use of satellite image for preparing field maps through using remote sensing technique. Editing of soil survey reports.

1.3.1.2 Functions of Land use Planning Section

Planning, supervision and execution of soil survey data interpretation activities. Providing basic data on soils, land capability and crop suitability. Interpretation of soil data for locating areas suitable for extension and introduction of various crops. Processing of soil survey data for land use planning.

1.3.1.3 Functions of Land Evaluation and Soil Correlation Section

Planning and execution of an annual targeted programme. Managing correlation of soil series, organizing monoliths. Maintenance of uniform standard of methodology for soil survey. Development and maintenance of the Soil Museum with global experiences.

1.3.2 Functions of Training and Communication Division

Organizing all central training programmes and coordinating other training of field offices and laboratories. implementing other services through three component sections under this division. Coordination among the sections and administrative functions. Assisting Director General on various technical and administrative issues. This division comprises four sections.

1.3.2.1 Functions of Human Resource Development Section

Planning and execution of in-service training programmes. Organizing refresher courses. Organizing training programmes related to land, soil, water resources. Developing training modules. Preparation and collection of training materials. Planning, organizing and facilitating overseas training and higher Studies.

1.3.2.2 Functions of DPS and ICT Section

Planning and execution of an annual targeted programme. Review and/or edit all technical reports and maps prepared by using base materials and GIS technology. Storage, analyses and regular updating of soil and land resource databases. Maintenance and up scaling of Online Fertilizer Recommendation System (OFRS) and Website management. Responsible for overall technical progress of the division.

1.3.2.3 Functions of Cartography Section

Planning and execution of annual targeted cartographic activities. Procuring, managing and distributing all kinds of maps and aerial photographs. Liable for being a custodian of aerial photographs including base maps of different types.

1.3.2.4 Functions of Publication and Record Section

Collection of relevant books, journals, periodicals and management of SRDI library. Helping authority to conduct publication related activities is another responsibility of the section.

1.3.3 Functions of Nirdeshika cell

1.3.4 Functions of Field Services Wing

Planning, coordination and supervision of all technical programmes and activities of the divisional and Regional Offices under the wing. Assisting allied government and autonomous bodies and NGOs for implementing local and national level programmes on agricultural development. Assisting Director General on technical and administrative issues.

1.3.4.1 Divisional Offices

Implementation of the central technical programme through regular supervision and coordination with subordinate regional offices. Carry out administrative functions within the jurisdiction. Maintaining liaison with the partner agencies like NARS institutes, DAE, BADC etc. Contribute as a member of Regional Agricultural Technology Extension committee for developing agricultural development plans by providing soil and related data and information. Conducting training programmes for SAAOs, farmers, entrepreneurs, fertilizer dealers and NGOs' field workers. Providing advisory services to GOs/NGOs. Support also given to university and college students to fulfill their academic needs. Preparing reports on crop damage caused by, flood, cyclone, flash flood, drought etc.

1.3.4.2 Regional Offices

Implementing technical activities under the guidance and supervision of head office and divisional office. Preparation of updated Upazila Nirdeshika through semi detailed soil survey, providing useful information on land and soil resources which is a tool for local level agricultural development planning. Delivering farmers service through OFRS and Upazila Nirdeshika and soil test-based fertilizer recommendation. Technology transfer through block demonstration. Assisting beneficiary agencies like DAE, NARS institutes, BADC etc. by providing information and advisory services required for sustainable use of land and soil resources. Contribute as a member of District Agricultural Technology Extension Committee, District Agricultural Rehabilitation Committee and District Development Coordination Committee laying down information on soil and land resources for agricultural and other development planning. Conducting training programmes for SAAOs, farmers, entrepreneurs, fertilizer dealers and NGOs' field workers. Assistance given to university and college students to fulfill their educational needs. Preparing reports on crop damage caused by disasters like flood, cyclone, flash flood, drought etc.

1.3.5 Functions of Analytical Services Wing

Planning and implementation of annual programmes through central laboratory, divisional laboratories and regional laboratories. Coordinating and supervising the activities of all laboratories. Managing support services including instrument maintenance and supply of chemicals, glassware etc. Planning and execution and coordination of Mobile Soil Testing Laboratory (MSTL) programme. Fulfilling research needs of SRDI and other research organizations through central and other laboratories. Assisting Director General on various technical and administrative issues.

1.3.5.1 Function of Central Laboratory

Central laboratory of SRDI has been mandated to perform multiple functions under soil chemistry, soil physics and clay mineralogy and soil microbiology section. The activities performed by soil chemistry section includes, quality control of analytical work of different Laboratories of SRDI; quality testing of imported fertilizers, registration of new fertilizer brand, renewal of fertilizer registration; analysis of plant and water samples received from different organizations; helping DAE through analyzing fertilizer samples in order to control adulteration of fertilizers and conducting research on contemporary soil and environmental issues. Soil physics and clay mineralogy section has performed determination of physical characteristics of Barind Tract soils that underwent a natural soil degradation process named ferro lysis. Soil microbiology section has launched a programme to conduct benchmark study on microbial population under different agro ecological regions of Bangladesh. Under the assistance of the PARTNER project SRDI is going to establish a modern microbiological laboratory under the umbrella of the central laboratory.

1.3.5.2 Functions of Divisional Laboratory

Implementation of the annual targeted programme under the guidance and supervision of Analytical Services Wing. Analysis of soil, water and plant samples to evaluate soil fertility, diagnosis of salinity, acidity, nutrient mining for the purpose of providing services and research support. Analysis of fertilizer samples for the purpose of quality control. Distributing Fertilizer Recommendation Cards (FRC) among farmers on the basis of soil test results. Managing soil testing and fertilizer recommendation services by both static and Mobile Soil Testing

Laboratory (MSTL). Coordinating functions of regional laboratories and Mobile Soil Testing Laboratory (MSTL). Generating chemical data for updating Upazila Nirdeshika. Providing research support to research organizations and educational institutions. Conducting training programmes for farmers, entrepreneurs, fertilizer dealers, NGOs field workers.

1.3.5.3 Functions of Regional Laboratory

Analyses of soil samples and providing fertilizer recommendation cards among farmers. Soil analytical services are also given to different organizations like DAE, NARS organizations and educational institutions. Assisting divisional laboratories for achieving annual targets. Participate in execution of Mobile Soil Testing Laboratory programme. Supporting regional offices of SRDI through soil and water analysis. Conducting training programmes for farmers, entrepreneurs, fertilizer dealers, NGOs field workers.

1.3.6 Research Centers

1.3.6.1 Soil Conservation and Watershed Management Center (SCWMC):

Soil Conservation and Watershed Management Center is located at Meghla, Bandarban. SCWMC is responsible for generating technology on soil conservation and watershed management in sloping lands of Hilly areas through conducting research in hill areas. Organizing training programmes for SAAOs, farmers and NGOs field workers for technology dissemination. Providing support to university students fulfilling their academic needs.

1.3.6.2 Salinity Management and Research Center (SMRC):

Salinity Management and Research Center is located at Batiaghata, Khulna. SMRC is responsible for generating databases on soil and water salinity, identifying potential sources of irrigation water, screening of soil tolerant varieties of different crops, innovation and validation of saline soil and water management technologies. Conducting training of SAAOs, farmers and NGOs field workers for technology dissemination. Supporting research organizations and educational institutions fulfilling their research needs.

Chapter 2. Activities of Different Sections of Head Quarters

2.1 Soil Survey and Management Division

Soil Survey and Land Management Division consists of 3 (three) sections viz Soil Survey and Classification section, Land Use Planning Section, Land Evaluation and Correlation Section. The core function of the Soil Survey and Land Management Division is to plan, coordinate and supervise all technical programmes and activities of the component sections.

2.1.1 Soil Survey and Classification Section

Technical Work:

1. Updating survey.
   a) **Title of the Program**

   Updating Upazila Nirdeshika of Moulvibazar Sadar under Moulvibazar District & Rajarhat Upazila of Kurigrami district

   b) **Objectives**
   - To prepare a digital interpretative map of Moulvibazar Sadar and Rajarhat Upazila for conducting semi-detailed soil survey at field level.
   - To conduct semi-detailed survey to identify the changes in land and soil resources and changes in cropping pattern and crops grown over time in Moulvibazar sadar and Rajarhat Upazila.
   - Ground truthing and rectification of the draft digital map and preparing reports on the findings along with soil fertility status.

   c) **Methodology**

   Photo interpretation of Moulvibazar Sadar and Rajarhat Upazila:
   Areial photographs, topographic maps, existing upazila soil and landform maps as well as DLR map have been used as base materials. The draft interpretative map of Moulvibazar sadar and Rajarhat Upazila were preparaed using the ArcGIS technology. At first permanent features of the selected area such as roads, settlements, water bodies etc. were identified. Different land types were identified by analyzing Google images. During the updating soil survey program, changes of land type, land use, land cover, settlements, water bodies, roads, water recession, drainage class, soil and land degradation and GPS reading of sampling points have been recorded. By comparing land types and other visible features in the photo and relevant secondary data different soil mapping units were identified. Metaled and un-metaled roads were drawn from topographic maps. The interpretative soil and land form map is prepared at 1:50,000 scale.

   Composite soil samples were collected with GPS reading to compare the changes of nutrient status of soil due to intensive cultivation of modern varieties of different crops with imbalanced application of chemical fertilizers and climate changes.

   D) **Findings of Moulvibazar sadar upazila survey**
   - Area under settlements increased substantially

- Areas under medium highland, medium low land and low land have been changed to some extent due to changes in inundation depth
- People's livelihood changed positively with new agricultural activities
- Cropping patterns and diversification of crops positively changed
- Cropping Intensity increased due to expansion of irrigation facilities and crop diversification.
- Expansion of vegetable growing areas and production of vegetables were found to be increased substantially.

Changes in Land Type (Moulvibazar Sadar Upazila)

Land Type	Year, 2011		Year, 2023		Change %
	Area (ha)	%	Area (ha)	%	+/-
High land	3921	11.39	3745	10.88	-0.51
Medium high land	14972	43.5	14256	41.41	-2.09
Medium Low land	6147	17.86	6593	19.16	1.3
Low land	2569	7.47	2295	6.67	-0.8
Miscellaneous	792	2.3	620	1.8	-0.5
Total	6018	17.48	6910	20.08	2.6

Changes in Land use (Moulvibazar Sadar Upazila)

Land Use	Slope class/land type
1.Tea Garden	**Steep to Very Steep**
2. Forest	**Steep to Very Steep**
3. Bamboo and Bushy Areas	**Steep to Very Steep**
6.Rabi Veg.-Kharif Veg	**HL**
8. Fallow-B.Aus-T.Aman	**HL, MHL**
4.Rabi Veg-Fallow-T.Aman	**MHL**
5.Rabi Veg.-B.Aus-T.Aman	**MHL**
7. Fallow-T.Aus-T.Aman	**MHL**
9. Boro-Fallow-T.Aman	**MHL**
10. Boro-Fallow-B.Aman	**MLL**
11.Rabi Veg. -Fallow	**MHL**
12. Fallow-Fallow-T.Aman	**HL,MHL**
13. Fallow-Fallow-B.Aman	**MLL, LL**
14. Boro-Fallow-Fallow	**MLL,LL,VLL**
15. Fallow	-
16. Miscellaneous	
Total	

Updating soil Survey at Moulvibazar Sadar upazila

Updating soil Survey at Rajarhat Upazila
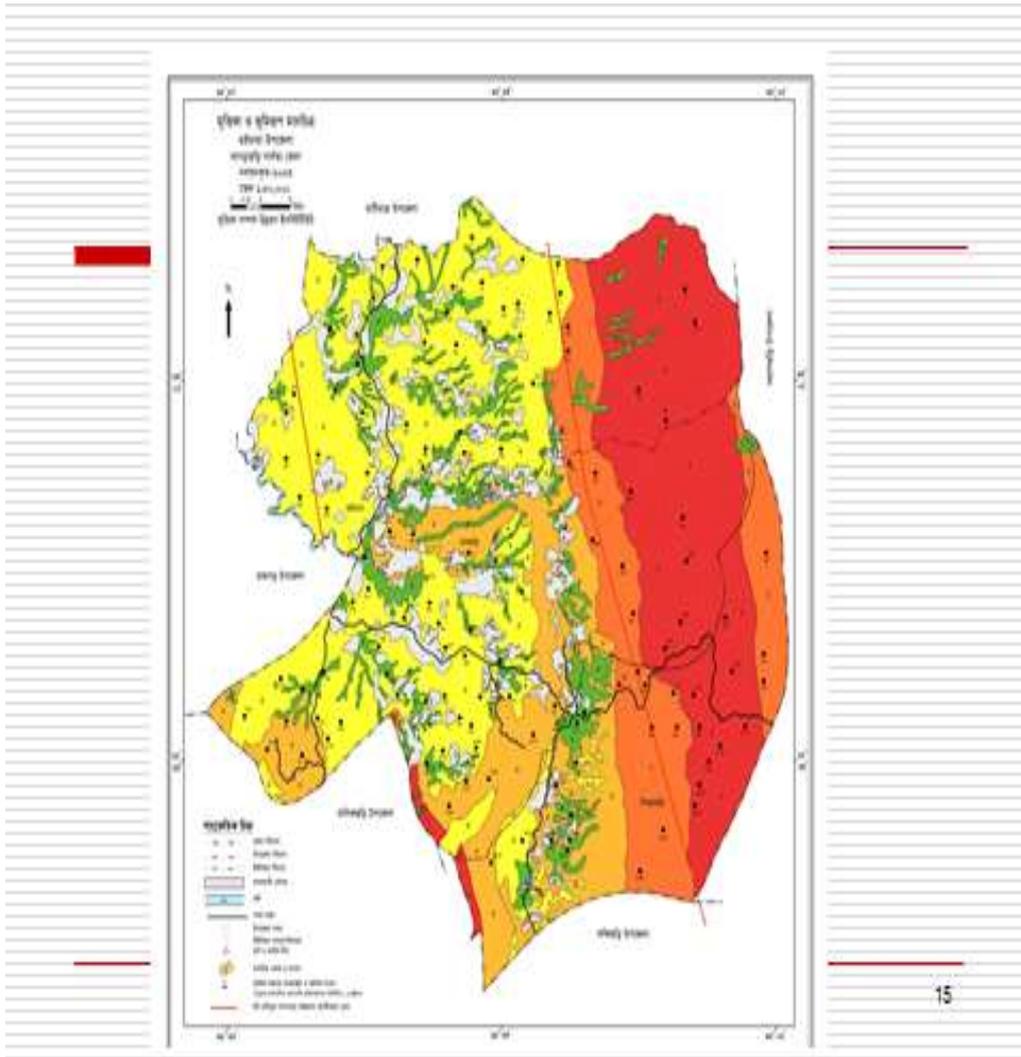
Fig: Soil and Landform Map of Guimara Upazila
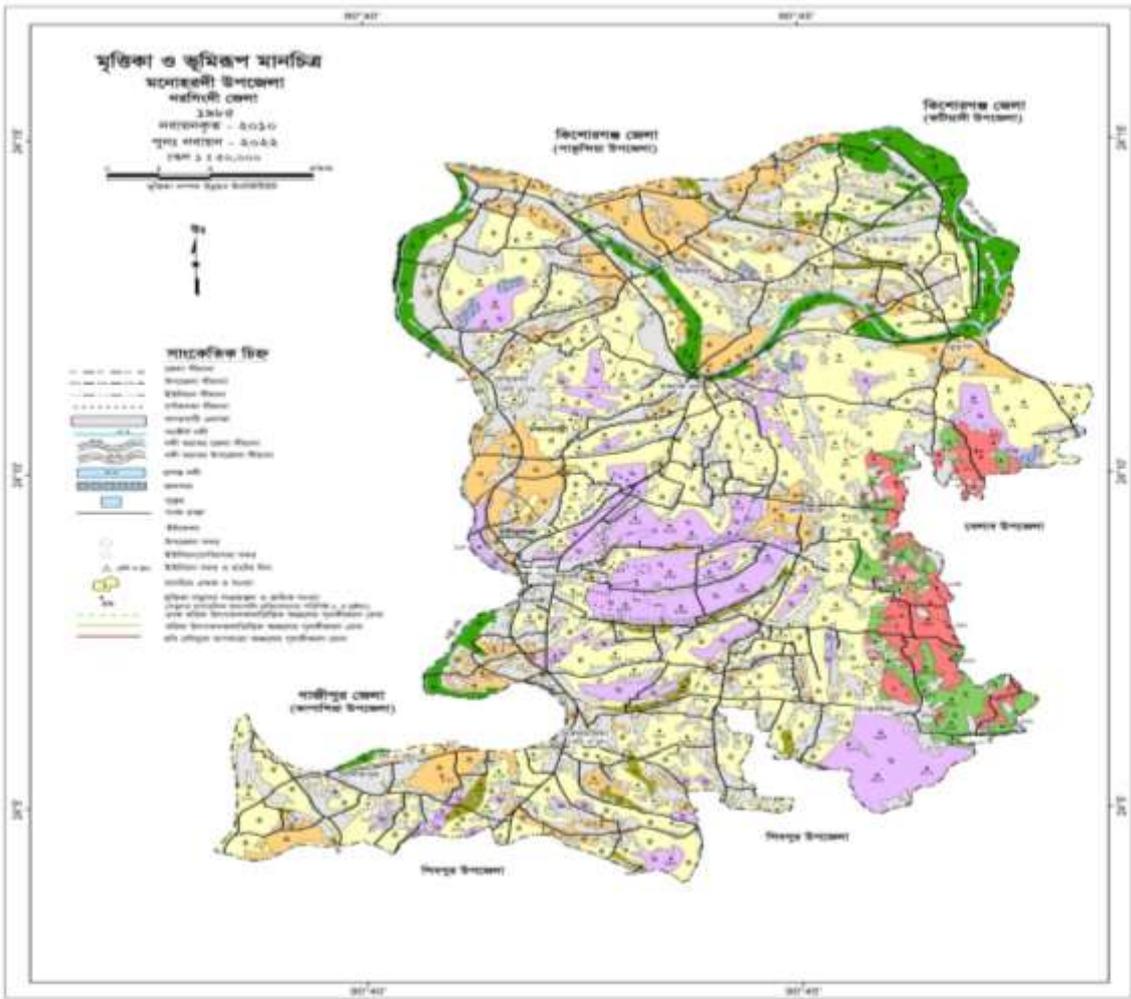
Soil and Landform Map of Monohardi Upazila
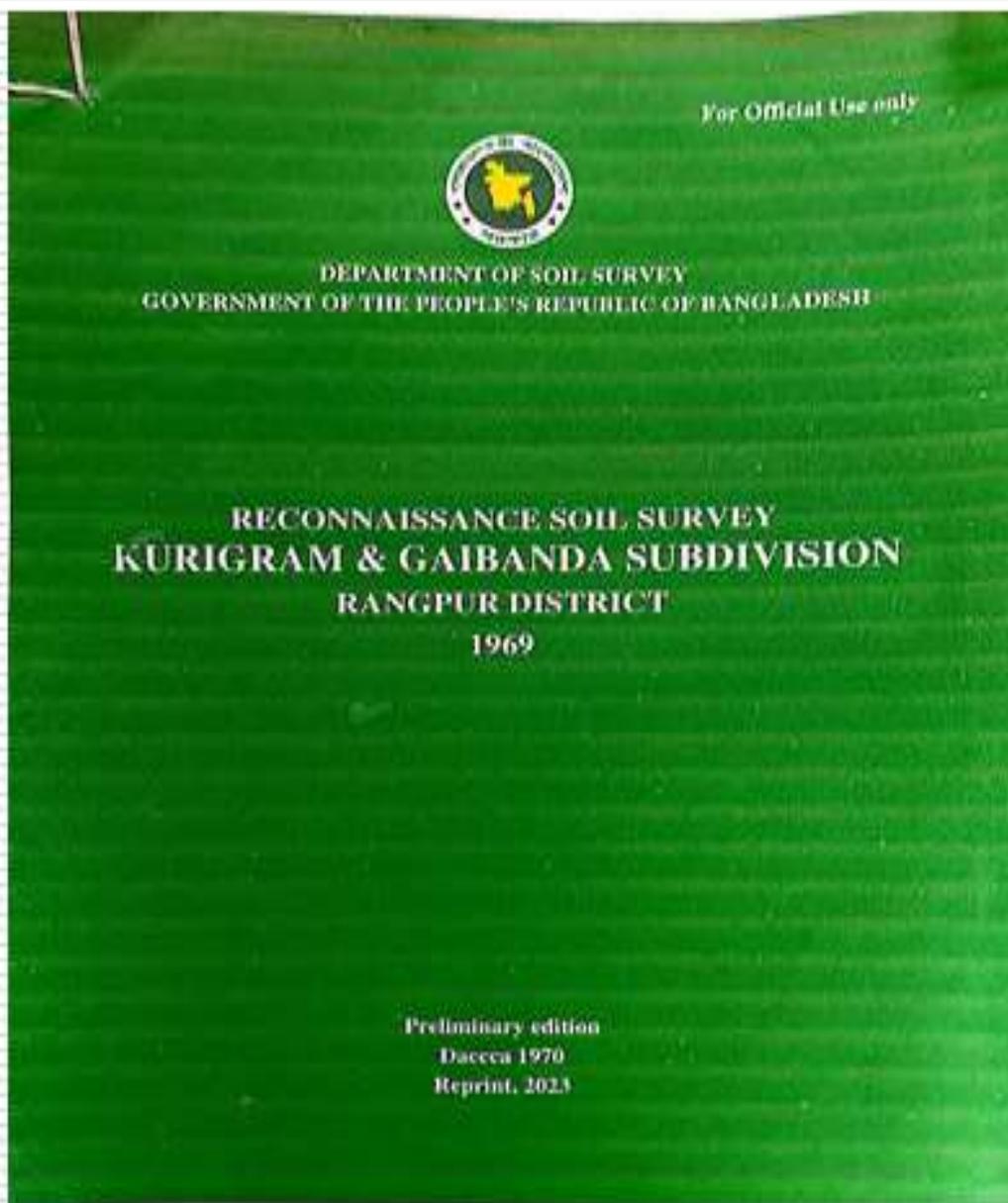
Fig: Editing RSS

Upazila Nirdeshika Proofing

1. Keshobpur	10. Agailjhara
2. Kushtia Sadar	11. Chauddagram
3. Atwari	12. Dumuria
4. Kotchandpur	13. Baniachang
5. Shaghata	14. Damurhuda
6. Borhanuddin	15. Derai
7. Bholahat	16. Faridganj
8. Kalia	17. Mehendiganj
9. Dighalia	18. Chauhali

Edited Union Shohaika for 2023-24

01. Indurkani Upazila, Pirojpur District.
a. Pattashi Union
b. Parerhat Union
c. Balipara Union

02. Rajapur Upazila, Jhalokati District
a. Motbari Union
b. Suktagor Union

03. Thakurgaon sadar, Thakurgaon District
a. Akhanagar Union
b. Baragaon union
c. Dholarhat Union

04. Khanshama upazila
a. Bherveri Union
b. Alokjhari Union

Motivational Training for preventing misuse of fertilizers

- Mothbaria
- Bhandaria
- Kaukhali
- Necharabad
- Pirojpur sadar
- Nazirpur
- Babuganj
- Ujirpur
- Charfashan
- Daulatkhan

Survey Monitoring

- Syedpur upazila, Nilphamari.
- Tajumuddin upazila , Bhola.
- Dasmina upazila, Patuakhali.
- Rajapur upazila, Jhalokati
- Bhandaria upazila, Pirojpur
- Gournadi upazila, Barisal

Other Activities

- ❑ Reporting monthly updated activities of PMO's instructions
- ❑ Corresponding Parliamentary affairs
- ❑ Compilation and Preparing monthly report for cabinet
- ❑ Reporting and/or comments on a number of Policy, guidelines, draft reports on different issues of Climate change, GAP, Environmental issues etc.

- ❑ GRS
- ❑ SMART case management system: Total automation of SRDI's Cases, Land Tax, land registration /Mutation
- ❑ PARTNER project activities

Comments on

"Preview Draft Report on Emirates Declaration on Resilient Food Systems, Sustainable Agriculture and Climate Action"

1. Reducing seasonal food loss and wastage may be achieved by promoting storage facilities and an effective trade off in country and abroad and establishing agro-based industries as well.
2. The most climate vulnerable countries like Bangladesh should need to give emphasis on hot spot based interventions as mentioned in our Delta Plan.
3. A huge monetary help and technological support are essential to implement climate initiatives in countries like Bangladesh.
4. More emphasis should be given on research and innovation in natural resource management which is neglected years together.
5. Programs on integrated management of food, agriculture and soil resources should be strengthen.
6. The time frame for implementation is only 2 years (by 2025), which we think is not sufficient to implement and achieve the objectives stated in the action plan. It should be better if it lasts for 4 years, at least.

Stating rethinking of the above points we appreciate the draft report and want to mention that **"Preview Draft Report on Emirates Declaration on Resilient Food Systems, Sustainable Agriculture and Climate Action"** is an important action plan with clear objectives and initiatives against climate change impact in agriculture and food sector. Integrating all of the possible adaptation and mitigation options to address climate change and focusing the specific need of women, children and youth, indigenous people, local communities and persons with disabilities etc. are very encouraging and justified. Soil Resource Development Institute (SRDI) firmly believes that this draft plan will definitely reduce harmful climate change impacts on agriculture and environment associated with food system and will enhance soil health and biodiversity as well. Our Government is committed to give top priority in addressing climate change to ensure green growth in our agriculture sector and converting our subsistence agriculture to a commercial one. We wish successful implementation of this action plan.

COMMENTS ON EXTENDED PRODUCER RESPONSIBILITY (EPR) GUIDELINES- SRDI

* There may be a '**List of abbreviation'** beginning to the EPR Guidelines

In 3.1: National Coordination Committee (NCC) of EPR Guidelines-

* There should be **a time frame** for NCC to accomplish the stated tasks/responsibilities.

* NCC should have the provision of formulating and providing guidelines for a robust **auditing system**

* Depending upon the necessities and conditions of a company, NCC should have the provision of **recommending Tax free/Tax reduction importation of machineries for recycling and processing plant**

* As one of the key responsibilities of NCC is giving award to obliged companies and PROs, NCC should have also provision for **imposing/approving penalties** to companies and PROs violating EPR guidelines.

* There should have provision of giving recognition by NCC as **GREEN COMPANY** depending upon their excellence in implementing EPR

* NCC may formulate a guideline for **mandatory investment** by the companies and PROs in research and **innovation to develop promising new technologies/management** procedures for effective implementation of EPR

In 3.2 : Department of Environment of EPR Guidelines-

* DoE should have a robust **framework for awareness building activities**, as well as capacity building through **training and motivational** activities.

* DoE should collect, publish and circulate **success stories** of effective EPR implementation.

* DoE should arrange **Public Opinion** (GONO SHUNANI) on quarterly basis to know the feedback about EPR implementation.

Comments on

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Project Activities
'Establishing Microbiology Laboratory in SRDI'-Part of PARTNER Program

Objective: Capacity building of SRDI in Microbiological analysis and activities by establishing Soil Microbiological Laboratory.

Specific objectives:
1. Identification of soil microbial population and their diversity
2. Generating Benchmark database of soil microbes in major soil series of Bangladesh
3. Isolation and identification of effective strains of inoculums
4. Preparation, printing and distribution of soil health cards

Major activities:
(i) Renovation and remodeling for establishing Microbiology Laboratory in SRDI head quarter, Dhaka;
(ii) Procuring and installing machineries/instruments/ equipment
(iii) Arranging survey to collect, prepare and analysis of different series based soil samples of different AEZs
(iv) Establishing 2 Lath house/Green house for isolation and growth of effective microbial strains
(v) Identification of soil microbial diversity and their population
(vi) Preparing, printing and distributing Soil Health Cards in a limited basis

Outcomes:
❑ Soil microbial population and their diversity identified
❑ 200 benchmark soil series wise database generated.
❑ 1000 Soil health Cards prepared, printed and distributed

Outputs:
❑ Laboratory established and functional.
❑ Soil series and cropping pattern based benchmark Microbiology database developed.
❑ Polynet/ Lath/ Greenhouse developed and some field and pot trials established (on the basis of further fund availability).
❑ Soil health cards were developed and distributed.

Achievements: (2023-24)

❑ Signing MoU with DG, DAE
❑ Formation of Project Establishment Committee for smooth functioning of the project and arranging meetings accordingly
❑ Procuring Office equipment
❑ Procuring Field and Laboratory equipment
❑ Arranging 2 batches (50 persons) training for officers and staffs on basic knowledge on soil microbiology and microbial analysis
❑ Preparing ToR for recruiting Computer Operator and Laboratory Technician through outsourcing
❑ Remodeling of Laboratory rooms for Microbiology laboratory is going on

2.2 Land Use Planning Section
2.2.1 Responsibilities
1. Land Use Planning Section is responsible for planning, supervision and execution of soil survey interpretation activities for various beneficiaries engaged in agricultural development.
2. Generating basic data on soils, land capability and crop suitability for preparation of short and long term agricultural development plans/projects.
3. Interpretation of soil database for location specific crop suitability assessment and processing of soil survey data for developing and updating GIS based data bank.

2.2.2 Achievements (2023-24) are shown under following heads
- Survey/Technical works
- Report writing
- Annual Performance agreement (APA) related activities
- National Integrity strategy (NIS) related activities
- E-governance and Innovation related activities
- National Social Security Strategy
- Other Activities

2.2.3 Annual Performance agreement (APA) activities:
Annual Performance Agreement provides a summary of the most important results that a ministry/division expects to achieve during the financial year. This document contains not only the agreed objectives, but also performance indicators and targets to measure progress in implementing them.

Stages of Annual Performance Agreement (APA):
1. Preparation
2. Work plan for action
3. Signing
4. Implementation
5. Monitoring
6. Reporting
7. Evaluation

Basis of Annual Performance Agreement (APA):
1. Allocation of business
2. 8th five year plan
3. SDG
4. Mid-term budgetary framework (MBF)
5. Election manifesto
6. Delta plan

Framework of Annual Performance Agreement (APA):
In order to facilitate the formulation of APA, a policy is formulated and software (APAMS) is prepared in the light of the policy. According to the policy the overall performance, preface, sections and attachments are mentioned below-

Section-1: Ministry/Division's Vision, Mission, Strategic Objectives and Functions.
Section-2: Final output/impact of different APA activities.
Section-3: Strategic Objectives, Priorities, Activities, Performance Indicators and Targets.

Annex-1: Abbreviation.
Annex-2: Description of Performance Indicators, Implementing Departments/Agencies and Measurement Methodology.
Annex-3: Dependence on other ministry /division's for achievement of APA target.

Major achievement (APA) of SRDI in 2023-24
fiscal year:
1. Field Survey for Updating Upazila Nirdeshika: 50 Upazila.
2. Preparation of union sahayika: 160 unions.
3. Soil sample analysis in static laboratory: 38,251 samples.
4. Fertilizer sample analysis: 4,998 samples.
5. Soil sample analysis through MSTL: 5,719 samples.
6. Soil and water sample analysis for salinity monitoring: 1188 samples.
7. Field trial establishment: 86
8. Online fertilizer recommendation system data updating: 50
9. Training on soil sample collection technique and fertilizer application: 8684
10. Distribution of Fertilizer Recommendation Card: 28,499

Annual Performance Agreement 2023-24 of SRDI was signed between Director General of SRDI and secretary, Ministry of Agriculture. Annual Performance Agreements are placed on the websites of SRDI.
Four (4) quarterly, one (1) half yearly Monitoring Progress report and final draft of Annual Performance Agreements for 2023-24 are submitted to Cabinet Division and Ministry of Agriculture. Appropriate evidence has been submitted against all performance indicators.
Draft APAs are reviewed by the Technical Committee (TC) headed by the Secretary (Coordination and Reforms), Cabinet Division. After the review by the TC. Cabinet Division provides feedback to the Ministries/ Divisions concerned. APAs are finalized by the Ministries/ Divisions incorporating suggestions given by the TC and sent back to the Cabinet Division. APAs are sent for approval of the National Committee on Government Performance (NCGP)
Actual achievements against performance targets are monitored by the Budget Management Committee (BMC) on a quarterly basis. BMC provides necessary guidance to ensure achievement of the targets.
At the end of the year, all Ministries/Divisions review and prepare a Performance Evaluation Report listing the achievements against the agreed results in the prescribed format. This report was finalized by June, 2024.

2.2.4 National Integrity Strategy (NIS) Activities:
The government of Bangladesh has taken the challenge of combatting corruption seriously as part of its election pledge implementation. Through a process of wide-ranging stakeholder consultations, the Government approved the National Integrity Strategy (NIS) October 2012. NIS has a in comprehensive set of goals, strategies and action plans aimed at increasing the level of independence, accountability, efficiency, transparency and effectiveness of the state and non state institutions to improve governance and reduce corruption in a holistic manner.

Standard Operational Procedures (SOPs) of Ethics Committee, formulated by Cabinet Division in January 2015 indicates, an implementation cycle of NIS is expected to be established consisting of the steps such as: adequate planning, proper implementation of the plan, regular

monitoring of the progress, effective countermeasures to the issues identified by monitoring, and revision of the plan.

Monitoring is conducted to measure progress of activities listed in the NIS work plan. The Integrity Focal Point of SRDI collected necessary information and filled out the monitoring sheet on regular basis. He placed the progress in the Ethics Committee meeting. The Ethics Committee members checked the gap between the plan and actual progress and took necessary decision. As part of effective follow-up, progress of NIS implementation and the monitoring results was discussed in the coordination meeting.
Four (4) Quarterly Monitoring Progress report of NIS 2023-24 submitted to MoA. Supporting documents such as report, letter, statement, photo, video etc. were preserved and submitted together with the monitoring sheet wherever possible.
Attended the meeting & training at MoA regularly as focal point of SRDI NIS Committee.

2.2.5 E-governance and Innovation related activities:
Government innovation is a broad term that includes the overall process of initiating new steps, changing existing conditions, and accelerating the development orientation of the government. It can be defined as the effort by a government to find an optimal solution to problems it faces by undergoing a change within itself. Government innovation is a multifaceted process that depends on both internal (organizational culture) and external factors (stakeholder interests).
Monitoring is conducted to measure progress of activities listed in the E-governance and innovation workplan.
Annual Progress report of E-governance and innovation workplan 2023-24 was submitted to MoA. Supporting documents such as report, letter, statement, photo, video etc. were preserved and submitted together with the monitoring sheet wherever possible.
*Innovate and prepare a software related to Upazila Nirdeshika report writing named "Climate Info".

2.2.6 National Social Security Strategy:
NSSS was approved in 2015 to tackle triple problems of poverty, vulnerability and marginalization. It is a roadmap for creating a lifecycle based comprehensive social protection system in Bangladesh. The role of Ministry of Agriculture is to Strengthen and consolidate programmes for assisting food availability and nutrition.

#Monthly reports on National Social Security Strategy action plan were submitted by SRDI to MoA. Though we have no National Social Security program in SRDI but SRDI has been playing a role on social security by arranging different farmer's training which is contributing to the increase in food production in the agricultural sector.

2.2.7 Other Technical Activities done in 2023-2024:
- Collected Climate Data from Bangladesh Meteorological Department and BARC for further studies in developing forecasting model.
- Prepared different saroni and graph of Nirdeshika with recent Climate data through software
- Participating in Digital Soil Mapping Training using R Software.
- Participated in different technical training and workshop.

Figure: Stakeholders meeting under NIS 2023-2024

Figure: Innovation showcasing under e-governance and innovation work plan (2023-2024)

2.1.3 Land Evaluation and Soil Correlation Section

1. Function of Land Evaluation & Soil Correlation Section

1) Planning, supervision & execution of soil series & other taxonomic units.
2) Maintenance of uniform methodology standards on soil survey works & keeping records of soil information.
3) Correlation of soil surveys done by other agencies/consultancy.
4) Development & maintenance of the soil museum.

2. Soil Information

1) 15 Physiography
2) 476 Soil Series (453 Soil series and 23 different river alluvium)
3) 50 Soil Monoliths (48 SRDI & 2 BARC)
4) 1178 Correlation Box
5) Recently collected 7 Soil Monoliths

3. Details of Officers/ Staff

Officer/ Staff name	Designation	Mobile No.	E-mail
Md. Altaf Hossain	PSO	01712-927102	altaf908@yahoo.com
Premangshu Majumder	SSO	01717-625278	Premangshu.bd@gmail.com
Md. Golam Muktadir	Audiovisual operator	**01613-177032**	
Md. Mustafizur Rahman	Fieldman	**01714-453868**	
Mst. Rokeya Begum	MLSS Cum Mali	**01970-800504**	

4. Achievements

4.1 Execution of different activities in Soil Museum

- Processing and Preservation of soil monoliths
- Technical Description and Labeling
- Display Collected Soil Monoliths in Soil Museum
- Processing and preservation of soil correlation boxes.
- Display correlation boxes in the Museum
- Welcome visitors and help them in seeing and learning about the displayed materials in the museum.

4.2 Virtual Soil Museum

- Assistance was given to the Strengthening of Soil Research and Research Facilities Project for building a Virtual Soil Museum.

4.3 Upazila Land and Soil Resource Utilization Guide updating (semi-detailed) survey

Sl	Upazila & district	Assigned Officer	Role of section	Date
1.	Kuliarchar Upazila, Kishoreganj	Md. Mamunur Rahman, CSO	Technical assistance given	Dec, 2023
2.	Jhenaigati Upazila, Sherpur	Premangshu Majumder, SSO	Co-Surveyor	Dec, 2023

4.4 Project / Program Plans Preparation

Sl	Title	Year	Contribution
1	Advancing agro-ecological zone (AEZ) monitoring and information system to improve adaptation to climate change and food security in Bangladesh" Project	SinceMay, 2024	Focal Person Md. Altaf Hossen, PSO

4.5 Workshop Presentation / Seminar

Sl.	Subject line	Responsibility	Assigned Officer	Organizer	Venue
1	Seminar on Citizens Charter	Delivered PPT presentation arranged by the authority	Md. Altaf Hossen, PSO	SRDI	SRDI, HQ, Dhaka

4.6 Miscellaneous

Sl	Work / Task / Program of action	Assigned Officer
1	18 Upazila Nirdeshika edit	Md. Mamunur Rahman, CSO
2	Land use survey monitoring	Md. Mamunur Rahman, CSO
3	Assistance with viewing and understanding the museum's exhibits provided to guests.	Md. Altaf Hossen, PSO
4	Assistance was given to 125 revenue post-recruitment	Premangshu Majumder, SSO
5	Assistance is given to developing the "Increase of Soil Fertility and Productivity Through Sustainable Soil and Land Management project"	Premangshu Majumder, SSO

4.7 Rendered Services in Different Committees

Sl	Work / Task / Program of action	Responsibility
1	**SDGs related activities** Arranged meetings, stakeholders' meetings, workshops, lectures in training classes, attended meetings arranged by MoA and other allied departments.	Focal point officer (PSO); Member (SSO)
2	**Citizen's Charter-related activities** Played a role in implementing and updating and monitoring of Citizen's Charter of the institute. Arranged quarterly meetings, stakeholders' meetings, learning sessions, monitoring activities, and reporting to the Ministry of Agriculture and attended meetings arranged by MoA and other allied departments.	Focal point officer (PSO); Alternative Focal point officer (SSO)
3	Market price assessment committee	Market price assessment committee
4	e-GP opening committee	Member Secretary (SSO)
5	Innovation committee	Member (SSO)
6	E-governance committee	Member (SSO)

5. Future program

5.1 Study on parent materials of Barind Tract, Madhupur Tract, Akhaura Terrace and Lalmai Hills to correlate the soils.

Physiography	Soils
Lalmai Hills	Khadimnagar, Lalmai, Salban and Kotbari
Akhaura Terrace	Pattan, Nidarabad, Sibna, Simrail and Rupa
Barind Tract	Kashimpur, Belabo, Tejgaon, Amnura, Nijhuri, Lauta, Gulta
Madhupur Tract	Kashimpur, Belabo, Tejgaon, Noadda, Chandra and Kalma

5.2 Renovation of Soil Museum in the new building.

5.3 Facilitating a Virtual Soil Museum Corner in Soil Museum.

Activities in photography

Pic: Kuliarchar Soil Survey

Picture: SDGs Meeting

Citizens charter meeting

Citizens charter meeting

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Jhenaigati Upazila Survey

2.2 Training & Communication Division

2.2.1 Human Resource Management section (HRD)

The functions of Human Resource Development Section are planning and organizing of in-service training for SRDI officers and staff. Imparting training on soil management issues to technical officers and field staff of DAE, BARI, BRRI, BJRI, BINA, BMDA, BADC and NGOs is the vital responsibility of the section. This section works on preparation and collection of training materials in terms of course syllabus such as audio-visual materials, soil monoliths, etc. The HRD section also works on the arrangement of theoretical and practical training for the students of different education institutions (e.g., BAU, DU, BSMRAU, SAU, KU, CU etc.) Research Centers & Academies, GO & NGOs on soil survey, soil classification and aerial photo interpretation, GPS, Upazila Nirdeshika as per their requirements and request. Arrangement of departmental training of newly recruited officers is another work of this section.

Activities pursuing through HRD Section

1. Arranging nomination for local and foreign training on fund availability and as per directives of the Ministries or other funding organizations or sponsors.
2. Arranging nomination for higher studies on fund availability & demand within the country & in abroad.
3. Nomination for training on different subjects and topics by the sponsoring/ executing agencies (Like BPATC, RPATC, BARD, BARC, Planning & Development academy, AIS, DAE,NATA etc.) and Ministries.
4. Arrangement of Seminar/ symposium / workshop/conference etc. on different subjects on requirement basis.
5. Arrangement of theoretical and practical training for the student of different educational institutions (Like BAU, DU, BSMRAU, SAU, KU, CU etc.), Research Centers & Academies, GO & NGO's on soil survey, soil classification and aerial photo interpretation, Upazila Nirdeshika as per their requirements and request.
6. Arrange departmental training of newly recruited officers (as & when required).
7. Collection and compilation of radio and television talk and sent to concern offices.
8. Provide technical & administrative support to the authorities.
9. Organize & attend
10. Searching scope for providing training on Soil survey and classification, analytical methodology etc. to different organizations in country and abroad.
11. As per direction of PMO, HRD Section of SRDI prepared In-house Training Plan for 2022-23
12. Sending Monthly progress on this plan summarizing that of all the field and regional offices including HQ and laboratories has been sending on cumulative achievement basis.

In-house Training Achievement-2024-25

Grade	No. of Officers & Staffs	Target Per person hr*	Total	Achieved (up to june'24)	% of Achievement against target (up to june '24)
10-12	8	55	440	440	99
13-17	64	55	3520	3520	99
18-20	65	55	3575	3575	99

Higher Education

Degree	No. of Officers					Remark
	On-going	Obtained Scholarship	Received permission	Requested for permission	Completed	*Joined-5 (But thesis not submitted) On going-6
PhD	7	-	21	-	1	

Workshop and Seminar attended by officers

Sl.	Topics	No.	Duration (Days)	Institute
1	Departmental Training (1st Batch)-ASW	25	1 Month	Soil Resource Development Institute, Dhaka
2	Departmental Training-FSW	23	1 Month	Soil Resource Development Institute, Dhaka
3	Departmental Training (2nd Batch)-ASW	31	1 Month	Soil Resource Development Institute, Dhaka
4	Workshop on what to do to meet the challenges of the 4th Industrial Revolution	9th and above grade officers working in SRDI Dhaka	1 Month	Soil Resource Development Institute, Dhaka
5	Training of officers on Right to	9th and above grade	1 Month	Soil Resource Development Institute, Dhaka
6	Training on Grievance Redressal Mechanism for Officers	9th and above grade officers working in SRDI Dhaka	1	Soil Resource Development Institute, Dhaka
7	Workshop on Public Awareness on Right to Information Act and Regulations	9th and above grade officers working in SRDI Dhaka	1	Soil Resource Development Institute, Dhaka
8	Training on the use of software on Integrated Digital Service Delivery Platform	9th and above grade officers working in SRDI Dhaka	1	Soil Resource Development Institute, Dhaka
9	Workshop on Public Awareness on Right to Information Act and Regulations	9th and above grade officers working in SRDI Dhaka	1	Soil Resource Development Institute, Dhaka
10	Workshop on what to do to meet the challenges of the 4th Industrial Revolution	9th and above grade officers working in SRDI Dhaka	1	Soil Resource Development Institute,Dhaka
11	Seminar on Service Commitment of Officers	9th and above grade officers working in SRDI Dhaka	1	Soil Resource Development Institute, Dhaka
12	Training of officers on Grievance Redressal Mechanism and GRS Software	9th and above grade officers working in SRDI Dhaka	1	Soil Resource Development Institute, Dhaka
13	SRDI's online workshop through MyGov platform	3th and above grade officers working in SRDI Dhaka	1	Soil Resource Development Institute, Dhaka
14	Workshop on Activities, Progress, Constraints and Prospects of National Agricultural Training Academy (NATA) in Implementation of Sustainable Development Goals (SDGs)	2	1	National Agricultural Training Academy (NATA)

15	English Language and Skills Development	2	1	National Agricultural Training Academy (NATA)
16	GIS Based Resourc Management System (GRM)	1	1	Ministry of Plaining
17	Training of Trainer (ToT) on Agricultural Practices (GAP) for safe Fruits and Vegetables Production	1	5	BARC
18	Geo-Spatial Data Integrating with Socio-Economic, and Environmental Data for Development Data for Developing web Application Seminer.	1	1	Bangladesh Bureau of Statistics (BBS)
19	Traning of trainer (ToT) on good agricultural practices (GAP) for safe foods & Vegetables production	1	5	BARC
20	Training on OMS under GEMS and creating a database of existing organogram	2	1	MoA
21	Seminar on Preparation of Large Scale Topographical Maps of Dhaka City and Surrounding Areas Using Aerial Photography	1	1	Survey of Banglades h (SoB)
22	Electronic-Project Management Information System (e-PMIS)-	6	2	MoA
23	Training of Officers on Citizen Charter	9th and above grade officers working in SRDI Dhaka	1	Soil Resource Development Institute, Dhaka
24	Induction Training" of newly recruited 41st BCS (Agriculture) Cadre Officers	6	3	Soil Resource Development Institute, Dhaka
25	Grievance redressal mechanism and training of officers on GRS software	9th and above grade officers working in SRDI Dhaka	1	Soil Resource Development Institute, Dhaka
26	Training of officers on Right to Information	9th and above grade officers working in SRDI Dhaka	1	Soil Resource Development Institute, Dhaka
27	Nata achievements and future plans	5	1	National Agricultural Training Academy (NATA)
28	Electronic-Project Management Information System (e-PMIS)	4	2	MOA
29	Smart Project Management	1	1	MOA
30	Audit Management and Monitoring System 2.0 (AMMS.2.0)	2	1	MOA
31	Commonwealth Multi-Stakeholder Dialogue on a "National Approach to	1	3	MOA

	Agricultural Data Infrastructure for Climate Decision			
32	Workshop aimed at finalizing priority areas of research in different periods in crop sub-sectors	3	1	BARC
33	Workshop on Higher Education (PhD) Program under PIU-BARC, NATP-II	4	1	
34	Regional workshop on selection of priority areas for agricultural research	6	1	
35	Climate Smart Agriculture Adaption	2	3	
36	Public Procurement Procedure	1	10	**NATA**
37	GIS and Remote Sensing in Smart Agriculture (2nd batch)	2	10	
38	In the seminar titled Achievements and Future Plans of Nata	1	5	
39	Public Procurement Procedure (2nd batch)	1	10	
40	"Induction Training" of newly recruited 41st BCS (Agriculture) Cadre Officers	6	3	**SRDI**

Attended by officers in local Training programmes

SL	Title/Courses	No.	Duration (Days)	Institute
1	GIS Based Resource Management System (GRM)	1	5	
2	Advanced ICT	1	10	
3	Public Procurement Procedure	1	10	
4	Modern Farm Mechanization	1	10	
5	Integrated Water Resources Management in Agriculture	1	5	
6	Project Appraisal and Formulation of DPP	1	10	
7	GIS and Remote Sensing in Smart Agriculture	1	10	NATA
8	Legal Issuses Related to International Trading of Agricultural Products	1	5	
9	Legal Issuses Related to International Trading of Agricultural Products	1	5	
10	English Language and Skills Development (2nd batch)"	1	10	
11	Modern Farm Mechanization	1	5	
12	Endeavour to Transform Smart Agriculture for Smart Bangladesh	2	1	

13	Safe Use of Pesticides & PGR in Fruits & Vegetables: Current Status, Challenges & way Forward	3	1	
14	Nutrition and Food Safety	2	5	
15	English Language and Skill Development	2	10	
16	Advanced ICT	1	10	
17	Public Financial Management	2	5	
18	Commercial Farm Management	1	5	
19	GIS and Remote Sensing for Smart Agriculture	2	10	
20	English Language and Skill Development	1	10	
21	Khamari" in a training workshop on mobile apps	1	7	CEGIS
22	iBAS++	2	1	Audit Complex, Dhaka
23	Green House Gas inventory and MRV System	2	3	DOE
24	iBAS++ Payment and Expenditure	14	1	Public Finance Bangladesh
25	Cyber security training	1	1	MoA
26	NIS Software includes training on RTI Software	3	1	MoA
27	Skill development training on implementation of use of D-Nothi	2	2	Department of Information and Communication Technology
28	Grievance redressal mechanism and training of officers on GRS software	9th and above grade officers working in SRDI Dhaka	1	Soil Resource Development Institute,Dhaka
29	e-GP system Tenders Training for Procuring Entity (PE) Users Training	1	5	MOA
30	Citizen Charter	9th and above grade officers working in SRDI Dhaka	1	Soil Resource Development Institute, Dhaka
31	IoT Based Precision Agriculture for Sustainable production	1	2	BARC
32	Technical Report Writing and Editing	2	3	
33	Training on Forestry and Agroforestry	1	2	
34	Excel Based Data Analysis for Early career Scientist	1	3	
35	Exploratory data analysis in agriculture Research with r Software	1	3	
36	Scientific Report Writing	2	5	
37	Integrated Digital Service Delivery platform	1	2	
38	Forestry and Agroforestry Technologies for Professionals"		2	
39	Khamari in a training workshop on mobile apps	4	1	
40	**GIS & Remote Sensing for Smart Agriculture**	3	5	
41	Implication of National Adaptation plan (NAP) of Bangladesh (2023-2050) to Crop-Agriculture Sub-Sector	4	1	BARC

42	Attending trainings organized to impart greater understanding on PPP related issues	1	1	
43	Training of Trainer (ToT) on Good Agricultural Practices (GAP) for safe Fruits and Vegetables Production	1	5	
44	Use of Fertilizer Inspection Manual	1	3	
45	"Technical Report Writing and Editing" (26th batch)	2	3	

Other Activities done by HRD Section

1. Preparing DPP and all corresponding works of the projects submitted to MoA
2. Website update and maintenance
3. Successful implementation of D-Nothi Program
4. APA & SDG Action Plan Activities
5. Preparing different Reports, Booklets, Directory etc.
6. Innovation activities of SRDI
7. Execution of PM's commitment
8. Various activities in association with a2i
9. Procurement work of SRDI
10. Organogram, recruitment rules, different cases etc.

Workplan:2024-25

1. Training for capacity building of officers and staff with relation to 4IR.
2. GIS related Training for officers.
3. Training will be arrange on advanced techniques of Laboratory analysis.
4. Workshop/Training will be arrange according to Government policy/demand.
5. Fundamental Training on newly appointed officers. 6. Training on Nirdeshika writing and Map Preparation.
7. Training on Capacity building of all officers. 8. Training on Capacity Building of all Staff.

2.2.2 Activities of DPS & ICT Section
Activities of DPSS

- Engaged in-Planning, organizing and execution of GIS related works
- Digitizing, preparation and printing of different types of thematic maps.
- DPSS is responsible for storage, maintenance and security of database on soil and land resources and other information's.

Major type of works done by DPS Section

1. GIS related
2. ICT related
3. Others

1. **GIS related**
   - Preparation of geo-referenced and geo-projected database
   - Map Preparation & Printing

2. **ICT related**
   Server & LAN management
   - Proper monitoring, maintence and trouble shooting of the server and internet related devices (server, router, bandwidth controller, switch etc.) of SRDI.
   - At present there are 102 internet connections in SRDI head office.

   Data Processing & Uploading
   - Soil Chemical data are generalized, processed and prepared for uploading
   - This uploaded data is used for Online Fertilizer Recommendation System (OFRS) software

3. **Others Technical Support**
a. **Updating of Online fertilizer Recommendation Software (OFRS)**
   - Updating the crop list for OFRS along with fertilizer application methods following Fertilizer Recommendation Guide 2018.

b.**Technical assistance for BBS**

   - Technical assistance and necessary support provided for sharing GIS meta data and developing the website (www.gis.gov.bd) for Bangladesh Geographical Information System Platform (BGISP) organized by BBS.
   - Technical assistance and necessary support provided to BBS for developing climate change and disaster statistics.

b. **UpazilaNirdeshika Survey**
   - Chandina Upazila Nirdeshika updating survey has been done and draft soil map has been prepared.

c. Hardware maintenance and troubleshooting for different computer of SRDI head office.
d. Updating the crop list for OFRS along with fertilizer application rate following Fertilizer Recommendation Guide 2018.
e. Technical assistance and necessary support provided to prepared different on demand report for MoA, BARC and others.
f. Involved in the innovation activities of SRDI.
g. Technical assistance provided to the students, scientists other visitors for research purpose.

h. **Programme implementation:**
   A promramme named "Assessment of Cultivated Land Area for Different Crops Using Remote Sensing and UpazilaNirdeshika"has been implementing with the help of DPS &ICT section.

Map Preparation & Printing

মৃত্তিকা ও ভূমিরূপ মানচিত্র
গাজীপুর সদর উপজেলা
গাজীপুর জেলা
১৯৯৭
নবায়নকৃত-২০২১
স্কেল ১:৫০,০০০

Data processing & uploading for OFRS.

48

Updating data base for FRG 2023

Data analysis of 30 AEZ for FRG 2023

Updating of SOLARIS software

Welcome to the SOLARIS-GIS (Version 2)

Soil Resource Development Institute (SRDI)

SOLARIS-GIS Version 2
Soil & Land Resource Information System

Developed by

C≋GIS Center for Environmental and Geographic Information Services
House 6, Road 23/C, Gulshan-1, Dhaka-1212, Bangladesh. Tel: 8817648-52, Fax: 880-2-8855935

Digital Map application
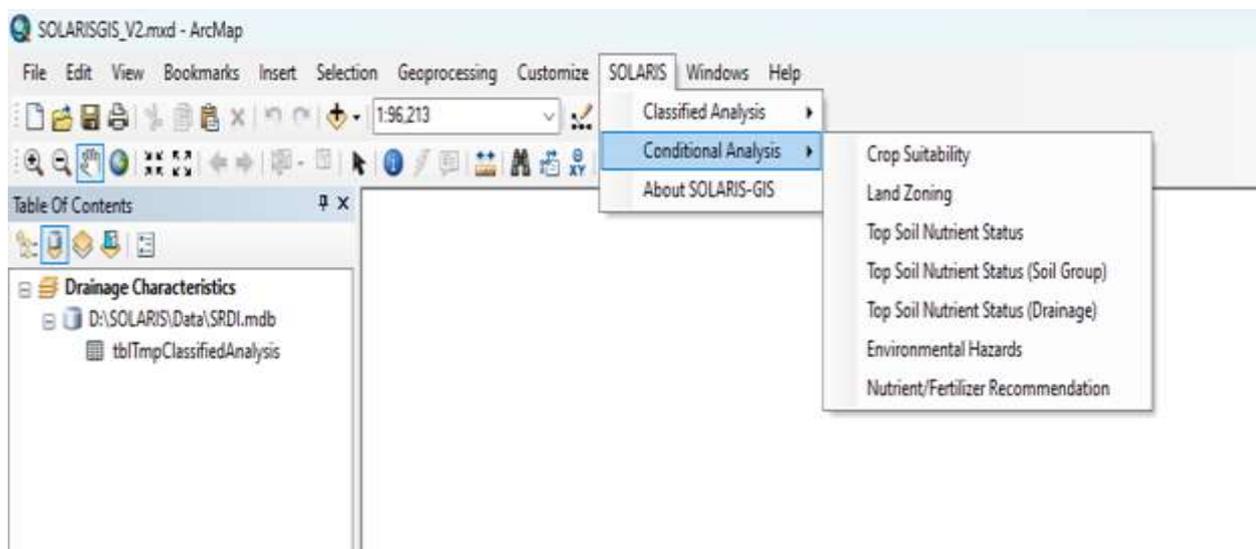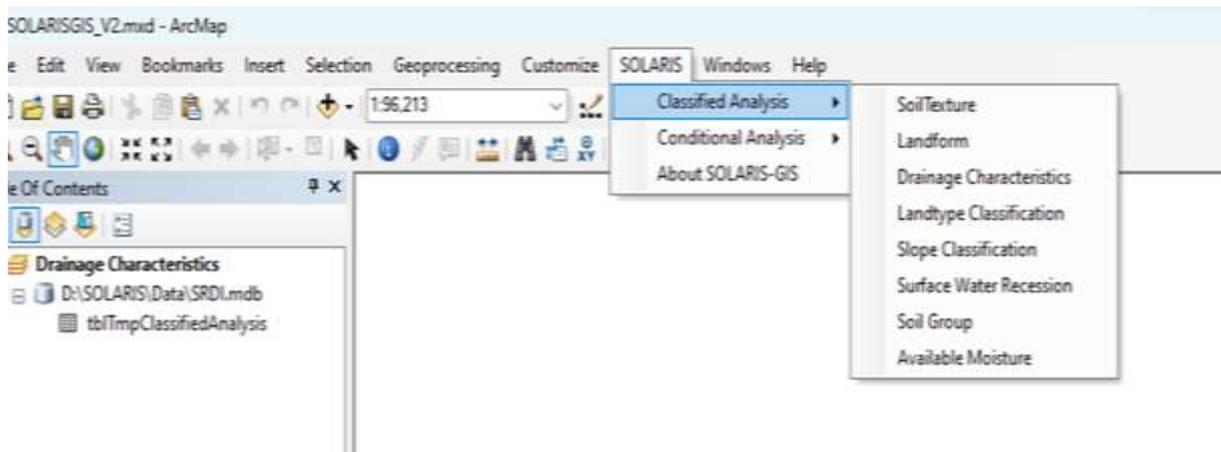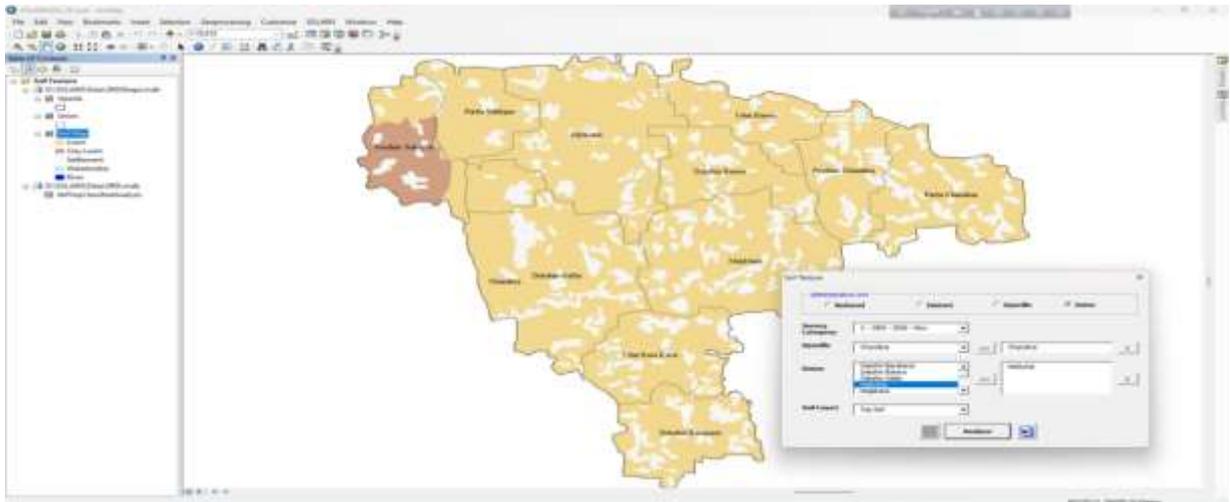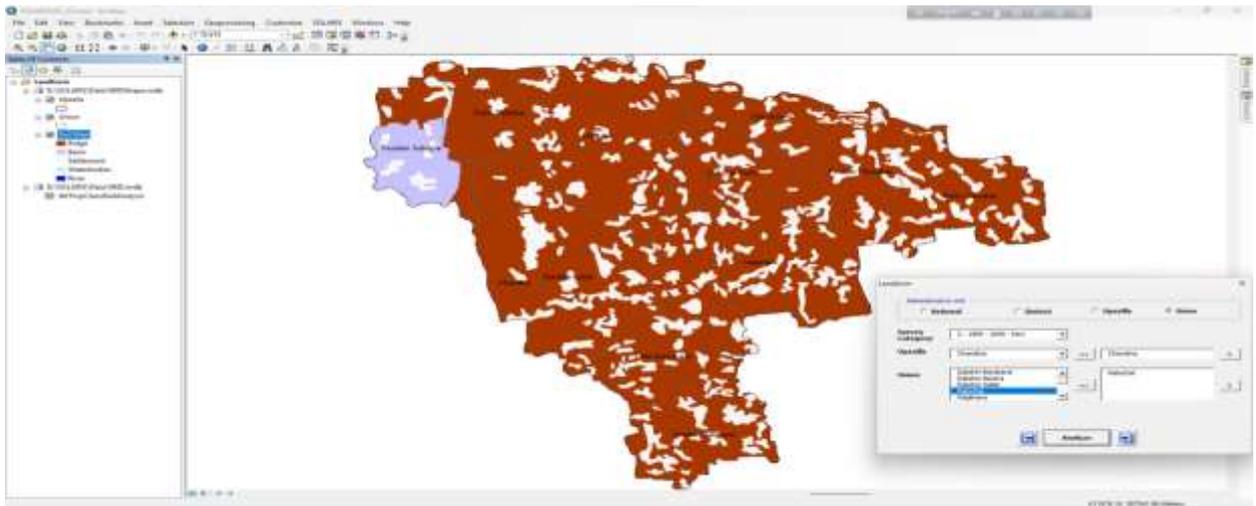
ডিজিটাল মানচিত্র সরবরাহের আবেদন(মানচিত্রে মৃত্তিকা তথ্য)

মৃত্তিকা সম্পদ উন্নয়ন ইনস্টিটিউট কর্তৃক প্রণীত ডিজিটাল মানচিত্র প্রাপ্তির জন্য নিম্নোক্ত তথ্যসমূহ পূরণ করে ট্রেজারি চালানের মাধ্যমে(মহাপরিচালক বরাবর) ফি প্রদানপূর্বক আবেদন করা যাবে। ট্রেজারি চালানের কোড: 1-4345-0000-2017
NB: যোগাযোগের ঠিকানা: প্রধান বৈজ্ঞানিক কর্মকর্তা, ডিপিএস এন্ড আইসিটি শাখা, মৃত্তিকা সম্পদ উন্নয়ন ইনস্টিটিউট, ফার্মগেট, ঢাকা।

dkarim2005@gmail.com Switch account ☁

The name, email, and photo associated with your Google account will be recorded when you upload files and submit this form

* Indicates required question

আবেদন ফরম
বরাবর
মহাপরিচালক
মৃত্তিকা সম্পদ উন্নয়ন ইনস্টিটিউট,
মৃত্তিকা ভবন,
কৃষি খামার সড়ক, ঢাকা-১২১৫।

আবেদনকারীর নাম : *

Your answer

পেশা: *

Your answer

ঠিকানা: *

2.2.3 Activities of Cartography Section

1. Map Digitizing:

Name of map	Name of Upazila	Map Scale	Nos.
A) Soil and Land type Map	Manda,Gafargaon,Netrokona,Muktagachha, Dighinala,Purbodhala,Nesarabad, Motbaria, Mehendiganj, Birol, Monohardi, Dimla, Domar, Hatibandha, Burungamari, Nandail, Kolmakanda, Niamatpur, Gopalpur	1:50000	19
B) Mouza Wise Upazila Map	Manda,Gafargaon,Netrokona,Muktagachha, Dighinala,Purbodhala,Nesarabad, Motbaria, Mehendiganj, Birol, Monohardi, Dimla, Domar, Hatibandha, Burungamari, Nandail, Kolmakanda, Niamatpur, Gopalpur,Paba		20
C) Union Map	Gongapur, kutba, Baromanik, Sachra, Deula, Padumshahar, Muktinagar, kachua, Ververy, Alokjhari, Angarpara,khamarpara,Bavoki, Vorotkhali, Bonarpara		15
D) Union Mauza Map	Gongapur, kutba, Baromanik, Sachra, Deula, Padumshahar, Muktinagar, kachua, Ververy, Alokjhari, Angarpara,khamarpara,Bavoki, Vorotkhali, Bonarpara		15
E) Physiography Map of Upazila	Burhanuddin , Khanshama, Shagata		3
F) Location Map	Meherpur Sadar, Jessore Sadar, Manda,Gafargaon,Netrokona,MuktagachhaDighinala,Purbodhala,Nechharabad, Motbaria, Mehendiganj, Birol, Monohardi, Dimla, Dumar, Hatibandha, Burungamari, Nandail, Kolmakanda, Niamotpur, Gopalpur	1:10,00000	21
G) Others Map	Soil Acidity Map of Bangladesh,Physiography Map of Sylhet, AEZ Map of Sylhet	1:10,00000	3

2. Map Drafting:

Name of map	Upazila Name	Map Scale	Nos.
a) Soil and Landtype Map	**Jhinaigati, Ramgati, Kalapara, Bhandaria**	1:50,000	4

3. Map Checking & Correction:

Name of map	Upazila/ Union	Map Scale	Nos.
Various Map	Various Upazila Map	1:50000	35
	Various Union Map	1:50000	12

4. Map Printing:

Name of map	Upazila/ Union	Map Scale	Nos.
Soil and Land form Map	Various Upazila and Union Map	1:50000	40

5. Area Calculation:

Name of map	Upazila Name	Map Scale	Nos.
a) Soil and Landtype Map	Various Upazila And Union Map	1:50000	19

6. Collection of base materials

Name of materials	Office Name	Districts	Nos.
Small Area Atlas Bangladesh	Collected from Bangladesh Bureau of Statistics (BBS)	64	64

7.Provide Cartographic Support to the SRDI activities, beneficiary Organization, Research Institute and Universities.

<center>**Work Plan for 2024-25**</center>

1. Collection of new base material as per demand of SRDI.
2. Ensure Cartographic Support as per demand of various section and divisions of SRDI.
3. Collaborating Work with SOB, LGED, BBS, and SPARRSO will be increase.

2.2.4 Publication and record section

Publication and Record Section of the Training and Communication Division is responsible for printing, publication and distribution of soil survey and other technical reports and their overall maintenance, to keep liaison with outside agencies for the above mentioned purpose and to assist the authority in technical & administrative support on different aspect.

Radio Talk

➢ A good number of officers participated at Radio talk in different agricultural aspects at Bangladesh Betar.

➢ Publication and Record Section communicated with Bangladesh Betar and proposed names of officers with titles of radio talk to be telecasted in collaboration with AIS.

Achievement

➢ **Collections :**

- Book/Journal/Report 20 copies

a) Prepared Proposal of Nomination for

- Bangabandhu National Agriculture Award

- Bangamata Begum Fazilatun Nesa Mujib Award

- Bangabandhu Public Administration Award

- Independent Award

- Ekushe Award

- UN Public Service Award

-Begum Rokeya Award etc.

b) Prepared Proposal of Nomination for Betar Kothika

c) Distribution :

- Poster 35 copies

d) Reader Services-Provided library services for 100 readers.

2.3 Upazila Nirdeshika Cell

Upazila Nirdeshika Cell

Three hundred and eighty reports of Upazila Nirdeshika have been updated till June 2023 with a series of coordinated efforts such as semi-detailed soil survey for updating of relevant maps, collection of land quality and soil characteristics data, soil sample collection for laboratory analysis followed by report writing with the processing of relevant updated data generated during field survey and laboratory analysis. SRDI scientists engaged in district offices usually conduct the soil survey and prepare draft report for respective surveyed Upazila. Editing of the report is done initially by divisional head (Chief Scientific Officer) who supervise survey based soil mapping and finally by the editorial board acting particularly as the approval authority of Upazila Niredeshika publication. The activities involved in the Upazila Nirdeshika updating system can be expressed as a flow-chart (Figure 1).

The entire activity is coordinated by Upazila Nirdeshika Cell of SRDI Head Office, Thirty-Five updated Nirdeshika has been published during the period of 2023-2024 under revenue budget of SRDI (Table 1).

Table 1. List of updated Land and Soil Utilization Guide (Nirdeshika) Published During the financial year 2023-2024

SL. No.	Name of Upazila of Updated Nirdeshika	Name of Respective District
1	Delduar	Tangail
2	Bhairob	Kishoreganj
3	Nikli	Kishoreganj
4	Austogram	Kishoreganj
5	Mohonganj	Netrokona
6	Gafargaon	Mymensingh
7	Sonaimuri	Noakhali
8	Mothbaria	Pirojpur
9	Doulatkhan	Bhola
10	Kulaura	Moulvibazar
11	Doarabazar	Sunamganj
12	Durgapur	Netrokona
13	Komolnagar	Laksmipur
14	Bhedorganj	Shariatpur
15	Titas	Cumilla
16	Bagharpara	Jessore
17	Abhoynagar	Jessore
18	Savar	Dhaka
19	Netrokona Sadar	Netrokona
20	Louhajang	Munshiganj
21	Nagarkanda	Faridpur
22	Faridpur Sadar	Faridpur
23	Shibpur	Narshingdi

24	Mirzapur	Tangail
25	Muksudpur	Gopalganj
26	Bondor	Narayanganj
27	Haziganj	Chandpur
28	Raninagar	Noagaon
29	Belkuchi	Sirajganj
30	Boraigram	Natore
31	Hatibandha	Lalmonirhat
32	Patgram	Lalmonirhat
33	Jessore Sadar	Jessore
34	Charghat	Faridpur
35	Faridpur	Pabna
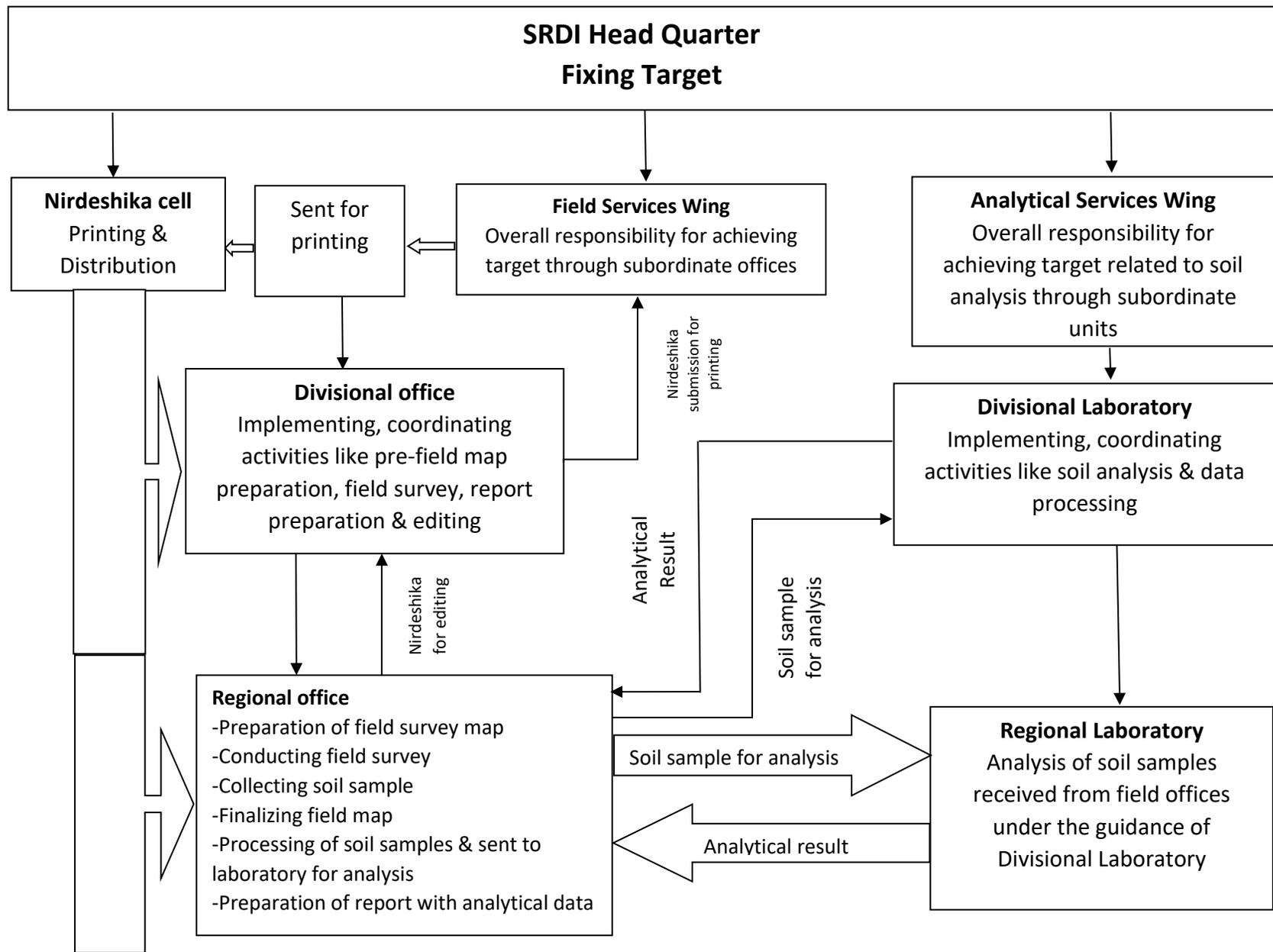
Figure 1: Flow chart of Nirdeshika Preparation

Chapter 3: Activities of Field Offices

3.1 Updating Upazilas Land and Soil Resource Utilization Guide (Upazilas Nirdeshika) through Semi-detailed Soil Survey

Introduction

Upazila Land and soil Resource Utilization Guide (Upazila Nirdeshika) developed through semi detailed soil survey is one of the basic tools used for local agricultural planning. Commencing from 1986, first round publication of all the 459 Upazila Nirdeshika was completed by June 2002. Following that updating programme of Upazila Nirdeshika has been taken and continued. The guide broadly comprises land and soil characteristics, land use, hydrological and agro climatic, soil fertility, agricultural constraints and potentialities of the concerned Upazila. As our agricultural lands are decreasing due to urbanization, industrialization and construction of new settlements, the need for planning and execution updating the Nirdeshika programme has arisen. As a result, SRDI carrying out a programme to update previous data for developing realistic agricultural planning. Other than resource-based planning tools, the Nirdeshika also guides the user to make fertilizer recommendations for crops. To mitigate upcoming challenges in agriculture, rational use of soil and land resources is of prime importance. Therefore, the programme has been launched with the following objectives.

Objectives

- To update the land, soil and land use database for local level agricultural development planning.
- To update the soil fertility database.
- To accommodate the changes due to infrastructure developments (roads, homestead, embankments etc.).

Methodology

Base Materials: Existing Upazila Soil and Landform Map (1:50,000), aerial photographs of approximate scale of 1:25,000 of 1:30,000, topographic maps (1:50,000), DLR maps (1: 63,360) were used as field base maps.

Methods: Based on recent aerial photo interpretation a photo interpretative Soil and Landform Map was prepared with help of existing one. The map consists of legend depicting soil mapping unit(s), land type, Mrittika Dal (Soil group), drainage class etc.

Ground truthing was done through validating mapping unit, land, soil information following regular traverse and grid as required by semi-detailed survey.
Soils were examined as often as necessary along traverse lines. For each 200 hectares of land, one composite soil sample was collected. The sampling intensity was increased as and when necessary, according to the complexity of the mapping unit.

Composite soil samples are collected from adjacent to or possibly nearer points of previous sampling sites with GPS reading so as to compare the changes of nutrient status due to intensive cultivation.

Mini pits were opened and described as and when necessary. Soil samples were also taken in correlation boxes (if necessary) from identified Mrittika Dal for use as reference for soil correlation. During soil sample collection, information on inundation depth, cropping pattern, constraints for agricultural development etc. were collected through conversation with farmers.

Collected composite soil samples were analyzed in the laboratory and updated Upazila Nirdeshika was prepared through assembling field information and laboratory data.

Table. Progress of Upazila Nirdeshika Updating

Field Survey		Map finalization		Draft Report Preparation		Final Report Preparation	
Target	Achievement	Target	Achievement	Target	Achievement	Target	Achievement
Divisional Office, Dhaka							
Goalanda	Goalanda	Shariatpur Sadar	Shariatpur Sadar	Companiganj		Nagarkanda	
Tungipara	Tungipara	Haimchar	Haimchar	Muksudpur	Muksudpur	Muksudpur	Muksudpur
Jhenaigati	Jhenaigati	Nakla	Nakla	Sherpur Sadar	Sherpur Sadar	Vedargonj	Vedargonj
Nikli	Nikli	Nikli	Nikli	Nikli	Nikli	Nikli	Nikli
Bhairob	Bhairob	Bhairob	Bhairob	-	-	-	-
Austagram	Austagram	Austagram	Austagram	-	-	-	-
Kuliarchar	Kuliarchar	Kuliarchar	Kuliarchar	Kuliarchar	Kuliarchar	-	-
Matiranga	Matiranga	Matiranga	Matiranga	-	-	-	-
Manikchari	Manikchari	Manikchari	Manikchari	-	-	-	-
Sarishabari	Sarishabari	Sarishabari	Sarishabari	-	-	-	-
Nesarabad	Nesarabad	Nesarabad	Nesarabad	Nesarabad	Nesarabad	Nesarabad	Nesarabad
Manikganj Sadar	Manikganj Sadar	Sreena-gar	Sreena-gar	Lauh-ajong	-	-	-
Iswarganj	Completed	Muktagacha	Completed	Goforgaon	Going on	Mohongonj	Completed
Nalitabari	Completed	Gouripur	Completed	Mymensingh sadar	Going on	Netrokona sadar	Completed
Narsingdi Sadar	Narsingdi Sadar	shibpur	Shibpur	shibpur	shibpur	Shibpur	Shibpur
Karimganj	Karimganj	As associate					-
Atpara	Completed	Purbadhala	Completed	Atpara	Going on	Purbadhala	Going on
Shakhipur, Melandah	Completed	Ghatail, Bashail	Draft completed (Digitization require)	Ghatail, Bashail	20% completed	Delduar, Mirjapur	Completed
Gouranadi	Compleated	-	-	Barishal Sadar	In process	-	-
Bhandaria	Compleated	-	-	-	-	Mathbaria	Compleated
Razapur	Compleated	-	-	-	-	-	-
Dasmina	Completed	Mirzaganj	Completed	Mirzaganj	Completed	-	-
Kalapara	Completed	-	-	Bauphal	In process	-	-
Tajumuddin	Completed	-	-	-	-	Borhanuddin	Compleated
		Doulatkhan	In process	-	-	Doulatkhan	In process
Divisional Office, Chattogram							
Sadar	Completed	Nabinagar	Completed	Nasirnagar	Completed	Derai	Editing
Adarsha Sadar	Completed	Sonaimuri	Completed	Sonaimuri	Completed	Sonaimuri	Completed
Chatkhil	Completed	Borkall	Ongoing				
Ranguniya	Completed	Mirsarai	Completed	Mirsarai	Completed	Mirsrai	Completed
Divisional Office, Khulna							
Rupsa	Rupsa	Avoynagar	Avoynagar	Rupsa	Rupsa	Avoynagar	Avoynagar
Fakirhat	Fakirhat	Dumuria	Dumuria	Fakirhat	Fakirhat	Dumuria	Dumuria
Ramgati	Ramgati	Sadarpur	Sadarpur	Sadarpur	Sadarpur	-	-
Rajbari Sadar	Rajbari Sadar	-	-	-	-	-	-
-	-	Damurhuda	Damurhuda	-	-	Damurhuda	Damurhuda
-	-			Baliakandi	Baliakandi		
Pangsha	Pangsha	Meherpur Sadar	Meherpur Sadar	Gangni	Gangni	Meherpur Sadar	Meherpur Sadar
Bhandaria	Bhandaria	PotuakhaliSadar	PotuakhaliSadar	Bhandaria	Bhandaria	Potuakhali Sadar	Potuakhali Sadar
Batiaghata	Batiaghata	Babugonj	Babugonj	Batiaghata	Batiaghata	Babugonj	Continued
Divisional Office, Rajshahi							
Godagari	completed	Paba	completed	Paba	Going On	-	-

Field Survey		Map finalization		Draft Report Preparation		Final Report Preparation	
Target	Achievement	Target	Achievement	Target	Achievement	Target	Achievement
		Godagari	completed	-	-	-	-
Chapai sadar	completed	Chapai sadar	completed	-	-	Volahat	Completed
-	-	-	-	-	-	Nachol	Sent to CSO
Sherpur,Khalu	completed	Sherpur, Khalu	Completed	Fulsori	Completed	Kosba	Completed
Charghat	Complete	Charghat	Complete	Charghat	Complete	Charghat	Complete
Faridpur	Complete	Faridpur	Complete	Faridpur	Complete	Faridpur	Complete
Tarash	Completed	Belkuci	Completed	Belkuci	Completed	Belkuci	Sent to PSO
Atrai	Completed	Atrai	Completed	Bagatipara	Completed	Bagatipara	Completed
Divisional Office, Rangpur							
Nawabganj	Nawabganj	Nawabganj	Nawabganj	Dinajpur Sadar	Dinajpur Sadar	Domar	Domar
Rajarhat	Rajarhat	Hatibandha	Hatibandha	Hatibandha	Hatibandha	Bhurungamari	Bhurungamari
Divisional Office, Sylhet							
Companiganj	Companiganj	Companiganj	Companiganj	-	-	-	-
Zakiganj	Zakiganj	Zakiganj	Zakiganj	Dharmapasha	Dharmapasha	Doarabazar	Doarabazar

Major findings of Goalanda Upazila, Rajbari

i) Total area-14987 ha

ii)Total sample colleted- 80

iii)Physiography& AEZ code- Active Ganges Floodplain (10)

iv)Major land type-Highland, Medium Highland, Medium Lowland, Lowland

v)Major soil group- Sara, Gopalpur, Rayna, Katra, Ishwardi, Muladi, Mehendiganj, Ganger Poli, Ganger Bele

Changes in Land Type (for floodplain, piedmont and terrace area)

Land type	Previous (1991)		Present (2023)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	1397	9.3	1132	7.6	-1.7	
Medium Highland	4609	30.8	3870	25.8	-5.0	
Medium Lowland	3430	22.9	3202	21.4	-1.5	
Lowland	764	5.1	732	4.8	-0.3	
Miscellaneous	4787	31.9	6051	40.4	+8.5	
Total	**14987**	**100**	**14987**	**100**		

Changes in Land Use

Land Use	Land type	Previous (1991)		Present (2023)		% increase/ decrease
		Area (ha)	%	Area (ha)	%	
1. Sarisha-jute-T.aman	-	-	-	1500	10	-
2. Sarisha-Till-T.aman	-	-	-	980	6.5	-
3.Gam-Jute-T. Aman	-	-	-	420	2.8	-
4. Peyaj-Jute-Felow	-	-	-	2350	15.7	-
5. Gam-Jute-Felow	-	-	-	480	3.2	-
6. Sarisha-Jute-Felow	-	-	-	1420	9.5	-
7. Peyaj-Boro-Felow	-	-	-	210	1.4	-
8. Boro- Falow- T Aman	-	-	-	46	0.6	-

9. Sarisha-Badam-Felow	-	-	-	280	1.9	-
10. Boro- Falow-Falow	-	-	-	60	0.4	-
11. Badam- Falow-Falow	-	-	-	350	2.3	-
12.R. vegetable-Kh.vegetable	-	-	-	225	1.5	-
13.Other(crop)	-	-	-	125	0.8	-
14. Misc	-	-	-	6501	43.4	-
Total				**14987**	**100.0**	-

Major findings of Tungipara Upazila, Gopalganj

i) Total area- 12,724 ha

ii)Total sample colleted- 94

iii)Physiography & AEZ code-

> Ganges Floodplain (12)

> Meghna Estuarine Floodplain (19)

> Gopalganj-Khulna Bils (14)

iv) Major land type- Highland, Medium Highland, Medium Lowland, Lowland, Very Lowland

v) Major soil group-Sara, Gopalpur, Ishward, Ghior, Ganges poly, Magra, Kotalipara, Rajoir, Harta, Satla

Changes in Land Type

Land type	Previous (2010)		Present (2024)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	935	7.35	1076	8.46	1.11 (+)	MHL converted to HL
Medium Highland	2678	21.05	1852	14.55	6.5 (-)	Due to landfill with soil/sand for making new orchard and settlement
Medium Lowland	2795	21.96	2857	22.45	0.49 (+)	MLL, LL, VLL increasing due to boro cultivation and fisheries
Lowland	2982	23.45	3084	24.24	0.79 (+)	
Very lowland	1577	12.38	1863	14.64	2.26 (+)	
Miscellaneous	1757	13.81	1992	15.66	1.85 (+)	Due to Increases settlement
Total	12724	100	12724	100		

Change in Land Use (for floodplain, piedmont and terrace area)

Land Use	2010 (year)		2024(year)		% increase(+)/ decrease(-)	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Boro (HYV) - F - F	5610	44.09	6682	52.51	8.42 (+)	2)Increases Boro rice cultivation
Rc - Mixed B Aus & Aman	881	6.92	302	2.37	4.55(-)	
Rc - J/B Aus - F	877	6.89	506	3.98	2.91(-)	
Rc - J -TA	802	6.30	947	7.44	1.14(+)	

Boro(HYV)-F-TA	780	6.13	856	6.73	0.60(+)	due to high yield
Boro (HYV) - B Aman - F	770	6.05	132	1.04	5.01(-)	
Rc - B Aman - F	283	2.23	225	1.77	0.46(-)	3)Increases fisheries and vegetables
RV - KV	266	2.09	483	3.80	1.71(+)	
Mustard - Boro - TA	480	3.77	517	4.06	0.29(+)	
Others Cropping Pattern	218	1.72	82	0.64	1.08(-)	
Miscellaneous	1757	13.81	1992	15.66	1.85(+)	
Total	12724	100	12724	100		

Foot note: Rc-Rabi Crops, F- Fallow land, B Aus-Broadcast Aus, J-Jute, HYV-High Yielding Variety, RV- Rabi Vegetables, KV- Kharif Vegetables

Changes in Settlement area increament:

Settlement Area	2010 (year)		2024 (year)		% increase(+)/ decrease(-)	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Settlement	979	7.69	1245	9.78	2.09 (+)	1) Over population growth

Major findings of Jhenaigati Upazila, Sherpur

i) Total area- 20,839 ha.
ii) Total sample collected- 133.
iii) Physiography & AEZ code- Northern and Eastern Hills (29), Northern and Eastern Piedmont Plain (22), Old Brahmaputra Flood plain (9).
iv) Major land type- High Land, Medium High Land, Medium Low Land, Low Land.
v) Major soil group- Kulaura, Borolekha, Ghushgao, Sreemongol, Gajni, Ratna, Marisi, Vugai, Ramnagar, Jhenaigati, Nanni, Pritimpasha, Monu, Nalitabari, Tajpur, Sonatola, Silmondi, Ghatail, Balina.

Changes in Land Type (for floodplain, piedmont terrace area)

Land type	Previous (2008)		Present (2023)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	8,888	42.62	7,844	37.64	-4.98	New Settlement, Infrastructure etc. occupied the high land, Top soil selling.
Medium Highland	8,101	38.87	8,350	40.07	+1.20	
Medium Lowland	2,137	10.25	2,049	9.83	-0.42	Decrease of inundation depth.
Lowland	294	1.41	250	1.20	-0.21	
Miscellaneous	1,419	6.85	2,346	11.26	+4.41	Increase of Settlement
Total	**20,839**	**100.00**	**20,839**	**100.00**		

Changes in Land Use in different Land type

Land Use	Land type	Previous (2008)		Present (2023)		% increase/ decrease	Possible Reasons
		Area (ha)	%	Area (ha)	%		
Natural Mixed Forest (Shal, Gojari, Mehoguni, Akashia etc.)	HL	2,397	11.5	1936	9.2	-2.2	
Annual (Pineapple, Sugarcane, Kasaba, Zinger, Termaric, Aroid, Lemon)	HL	158	0.76	175	0.8	+.04	
R. Vegetable - K. Vegetable:	HL	631	3.03	1,286	6.2	+3.17	
RC -F- T. Aman	HL, MHL	556	2.67				
F- T.Aus- T. Aman	HL, MHL	1,532	7.35				
RC -Boro-T. Aman	HL, MHL	152	0.73				
RC –T.Aus -T. Aman	HL, MHL	142	0.68				
Maize /Wheat -Aus-F	HL, MHL			190	0.9		
R. Vegetable –Boro-F-T.Aman	HL, MHL			1,143	5.5		
Boro- T.Aus - T. Aman	MHL	990	4.75				
Mustard- Boro- T. Aman	MHL			1,051	5.0		
Boro- F- T. Aman	MHL,MLL	10,420	50.0	11,416	54.7	+4.8	
F-F-T.Aman	MHL, LL			656	3.1		
Boro- F - F	MLL, LL	2,436	11.69	695	3.3	-8.39	
Others				345	2.0		
Miscellaneous		1,425	6.84	1,946	9.3		
Total		**20,839**	**100.0**	**20,839**	**100.0**		

Major findings of Kuliarchar Upazila, Kishoreganj

i) Total area – 10,252 ha

ii)Total sample colleted - 63

iii)Physiography & AEZ code
  - ➢ Brahmaputra Floodplain(9)
  - ➢ Meghna Floodplain(16)

iv)Major land type-
  - ➢ Highland
  - ➢ Medium Highland
  - ➢ Medium Lowland
  - ➢ Lowland
  - ➢ Very Lowland

v)Major soil group-

  - ➢ Sherpur
  - ➢ Sonatola
  - ➢ Silmondi
  - ➢ Dhamrai
  - ➢ Ghatail
  - ➢ Homna

- ➢ Fuldi
- ➢ Tengarchar

Change in Land Type

Land type	Previous (1992)		Present (2024)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	2060	20.09	2350	22.92	2.83 (+)	MHL converted to HL Due to landfill with soil/sand for making new orchard and settlement
Medium Highland	4322	42.16	3432	33.48	8.68(-)	
Medium Lowland	1366	13.32	1466	14.30	0.98(+)	MLL, LL, VLL increasing due to boro cultivation and fisheries
Lowland	397	3.87	497	4.85	0.98 (+)	
Very lowland	185	1.80	285	2.78	0.98 (+)	
Miscellaneous	1922	18.75	2222	21.67	2.92 (+)	Due to Increases settlement
Total	10252	100.00	10252	100.00		

Change in LandUse (for floodplain, piedmont and terrace area)

Land Use	2010 (year)		2024(year)		% increase(+)/ decrease(-)	Possible Reasons
	Area (ha)	%	Area (ha)	%		
T.Aman-F-Boro	2015	19.65	4835	47.16	27.51 (+)	2) Increases Boro rice cultivation due to high yield
Aus/Jute-Rabi crops	1466	14.30	800	7.80	6.5 (+)	
Boro-Fallow	1462	14.26	300	2.93	11.33 (-)	
Aus/Jute-T.Aman-Rabi crops	989	9.65	650	6.34	3.31(-)	
Aus-T.Aman-Fallow	741	7.23	250	2.44	4.79(+)	
T.Aus-T.Aman-Rabi crops	262	2.56	100	0.98	1.58(+)	3)Increases fisheries and vegetables
Others Cropping Pattern	1395	13.61	1095	10.68	(-)2.93	
Miscellaneous	1922	18.75	2222	21.67	2.92 (+)	
Total	10252	100.00	10252	100.00		

Changes in Settlement area increament: (Data should be provided both in MS Word & Excell sheet)

Settlement Area	2010 (year)		2024 (year)		% increase(+)/ decrease(-)	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Settlement	1486	14.49	1786	17.42	2.93 (+)	1) Over population growth
Total	10252		10252			

Major findings of Gournodi Upazila, Barishal

i) Total area-14,417 (ha)

ii)Total sample colleted- 82

iii)Physiography & AEZ code- Low Ganges River Floodplain (12), Old Meghna Estuarine Floodplain (19)

iv)Major land type- Highland, Medium Highland, Medium Lowland, Lowland

v)Major soil group- Sara, Gopalpur, Kalbadar, Hijla, Muladi, Mehendiganj, Batajor, Uzirpur, Magra.

Changes in Land Type

Land type	Previous Survey (2014)		Present Survey (2024)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	803	5.6	947	6.6	+1.0	Beetle leaf area increases because of high profit return, Cultivable land converted into homestead garden, orchard and settlement
Medium Highland	6,679	46.3	6,495	45.1	-1.2	
Medium Lowland	2,787	19.3	2,753	19.0	- 0.3	
Lowland	527	3.7	426	3.0	- 0.7	
Miscellaneous	3,621	25.1	3,796	26.3	+1.2	Gain of area due to homestead garden, orchard and settlement
Total	14,417	100	14,417	100		

Changes in Land Use

Land Use	Gournodi				% increase/ decrease	Possible reasons
	Previous Survey (2007)		Present Survey (2022)			
	Area (ha)	%	Area (ha)	%		
Boro- Fallow- T. Aman	5,786	40.1	6,545	45.4	+5.3	
Rabi Veg. – Kharif Veg.	337	2.4	547	3.8	+1.4	
Rc – Jute/Aus- T.Aman	893	6.2	1,024	7.1	+0.9	
Betel leaf	466	3.2	1,139	7.9	+4.7	
Boro- Fallow- Fallow	1,061	7.4	1,182	8.2	+0.8	
Others	2,253	15.6	184	1.3	-14.3	
Miscellaneous	3,621	25.1	3,796	26.3	+1.2	
	14,417	**100.0**		**100.0**		

Major findings of Manikganj Sadar Upazila, Manikganj

i) Total area- 21515 hectare

ii) Total sample colleted- 118

iii) Physiography & AEZ code- Brahmaputra Floodplain (7,8,9), Ganges River Floodplain (12)

iv) Major land type- Medium high land, medium low land, low land

v) Major soil group- Melandaha, Dhamrai, Savar Bazar, Sonatala, Silmondi, Sara, Gopalpur, Ishwardi, Ghior, Sandy alluvium of Brahmaputra, Silty alluvium of Brahmaputra

vi) Major land use- Mustard - Boro - Fallow, Lentil/Mustard/Wheat - T.Aman, Boro - Fallow - Fallow, Tobacco – Maize - Fallow, Rabi vegetables -Kharif vegetables, Black gram – Tobacco – Maize, Mustard / Maize -Boro, Boro – Fallow- T. Aman

Changes in Land Type:

Land type	2015 (Year)		2023 (Year)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
High land	589	2.8	699	3.2	0.4	
Medium high land	3599	16.7	3424	15.9	-0.8	

Medium low land	8866	41.2	8279	38.5	-2.7	
Low land	2861	13.3	2605	12.1	-1.2	Settlement area has been increased
Very low land	106	0.5	-			
Miscellaneous	5494	25.5	6508	30.2	4.7	
Total	21515		21515			
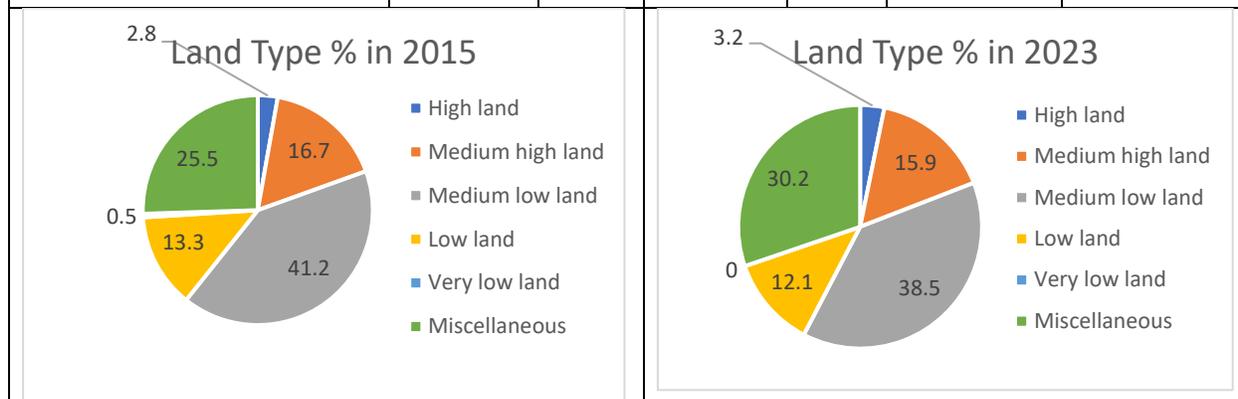
Changes in Land Use:

Land use	Land type	Previous (2015)		Present(2023)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
Mustard - Boro - Fallow	MHL	1779	8.3	1245	5.8	-2.5	Land use pattern has been changed due to change of socio-economic condition of the people
Mustard - Boro - Fallow	MLL	5454	25.3	4310	20.0	-5.3	
Mustard - Boro - Fallow	LL	966	4.5	735	3.4	-1.1	
Lentil/Mustard/Wheat - T.Aman	MHL	1676	7.8	1732	8.1	0.3	
Boro - Fallow - Fallow	MLL	3271	15.2	3145	14.6	-0.6	
Boro - Fallow - Fallow	LL	1895	8.8	1325	6.2	-2.6	
Boro - Fallow - Fallow	VLL	106	0.5	86	0.4	-0.1	
Tobacco – Maize - Fallow	MLL	141	0.7	135	0.6	-0.1	
Rabi vegetables -Kharif vegetables	HL	589	2.7	675	3.1	0.4	
Rabi vegetables - Kharif vegetables	MHL	95	0.4	135	0.6	0.2	
Black gram – Tobacco - Maize	MHL	49	0.2	58	0.3	0.1	
Mustard / Maize -Boro	MHL			744	3.5	3.5	
Mustard / Maize -Boro	MLL			785	3.7	3.7	
Boro – Fallow- T. Aman	MHL			460	2.1	2.1	
Miscellaneous		5494	25.6	5945	27.6	2.0	
		21515	100.0	21515	100.0		

Land Use % in 2015

- Mustard - Boro - Fallow
- Mustard - Boro - Fallow
- Mustard - Boro - Fallow
- Lentil/Mustard/Wheat - T.Aman
- Boro - Fallow - Fallow
- Boro - Fallow - Fallow
- Boro - Fallow - Fallow
- Tobacco – Maize - Fallow
- Rabi vegetables -Kharif vegetables
- Rabi vegetables - Kharif vegetables
- Black gram – Tobacco - Maize
- Mustard / Maize -Boro
- Mustard / Maize -Boro
- Boro – Fallow- T. Aman
- Miscellaneous

Values: 8.3, 25.3, 25.6, 0, 0, 0, 0.2, 0.4, 2.7, 0.7, 0.5, 8.8, 15.2, 7.8, 4.5

Land Use % in 2023

- Mustard - Boro - Fallow
- Mustard - Boro - Fallow
- Mustard - Boro - Fallow
- Lentil/Mustard/Wheat - T.Aman
- Boro - Fallow - Fallow
- Boro - Fallow - Fallow
- Boro - Fallow - Fallow
- Tobacco – Maize - Fallow
- Rabi vegetables -Kharif vegetables
- Rabi vegetables - Kharif vegetables
- Black gram – Tobacco - Maize
- Mustard / Maize -Boro
- Mustard / Maize -Boro

Values: 5.8, 20, 27.6, 2.1, 3.4, 8.1, 14.6, 6.2, 3.7, 3.5, 0.3, 0.6, 0.4, 0.6, 3.1

Major findings of Iswarganj Upazilla, Mymensingh

i) Total area-28,219

ii) Total sample collected-131

iii) Physiography & AEZ code- Brahmaputra Floodplain (7,9)

iv) Major land type- HL, MHL, MLL, LL and VLL

v) Major soil group- Sherpur, Sonatala, Tarakanda, Iswarganj, Silmandi, Lokdeo, Ghatail, Balina, Ghorargaon, Khalerchor, Silty Brahmaputra alluvium, Sandy Brahmaputra alluvium.

vi) Major land use- Rovi veg.- kharif veg., Boro-fellow-T-Aman, Boro-Aus-T.aman, Boro - Fellow-Fellow.

Changes in Land Type

Land type	Previous (2013)		Present (2023)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	11,175	39.6	11,102	39.34	-0.26	1. Increasing Trend Was found at sector of urbanization, settlement and highways overtime. 2. MLL area converted to MHL due to less inundation. 3.Increase of commercial fishing area.
Medium Highland	10,846	38.4	10,263	36.38	-2.03	
Medium Lowland	1,529	5.5	1,537	5.45	-0.05	
Lowland	467	1.6	449	1.59	-0.01	
VLL	483	1.7	483	1.7	00	
Miscellaneous	3,719	13.2	4385	15.54	+2.35	
Total	28,219	100	28,219	100		

Changes in Land Use:

Land Use	Land type	Previous (2013)		Present (2023)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
R.veg-K.veg	HL	1,072	3.8	1,410	5	+1.2	Farmers are Interested in rice cultivation for ensuring food security
Rabi crop -F-T.Aman	MHL, MLL	2,126	7.5	846	3	-4.5	
Boro-F-T.Aman	HL, MHL, MLL	11,285	40	15,520	55	+15	
Boro-Aus-T.Aman	HL, MHL	2,126	7.5	2,821	10	+2.5	
F-Aus/Jute-T.Aman	HL, MHL	1,552	5.5	705	2.5	-3	
Rabi crop -Aus/Jute-F	HL, MHL, MLL	2,126	7.5	1,122	4	-3.5	
Boro-F-F	MLL, LL, VLL	4,213	15	1,410	5	-10	
Miscellaneous		3,719	13.2	4,385	15.5	+2.3	
Total		28,219	100	28,219	100	-	

Previous (2013) Area (ha)

1,072 2,126
11,285
28,219 2,126
1,552
3,719 4,213 2,126

- R.veg- K.veg
- Rabi crop -F T.Aman
- Boro-F-T.Aman

Present (2023) Area (ha)

1,410 846
15,520
28,219 2,821
705
4,385 1,410 1,122

- R.veg- K.veg
- Rabi crop -F T.Aman
- Boro-F-T.Aman
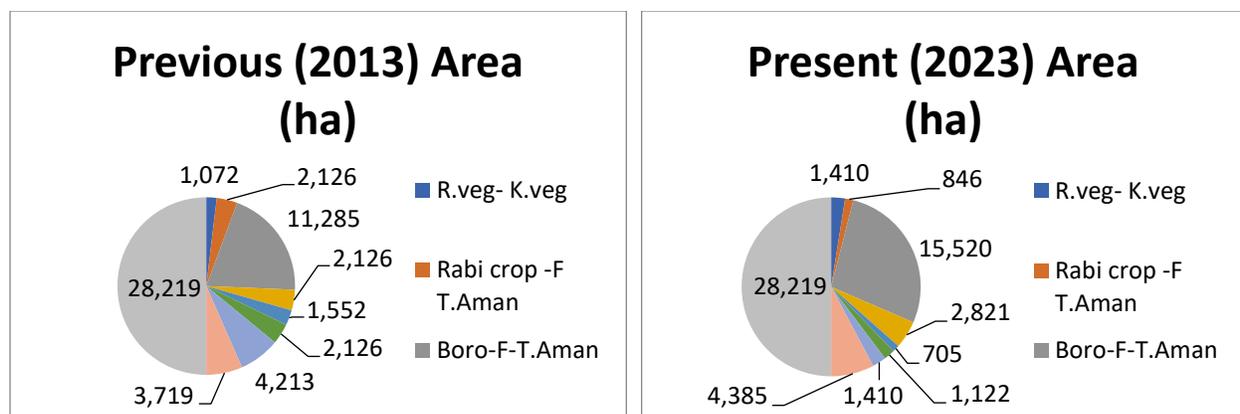
Major findings of Narshingdi Sadar upazila, Narshingdi

i) Total area- 21336 Ha
ii) Total sample collected- 202
iii) Physiography & AEZ code-　　　(a) Madhupur tract (28)
　　　　　　　　　　　　　　　(b) Old Brahmmaputra Flood Plains (9)
　　　　　　　　　　　　　　　(c) Meghna Flood Plain
iv) Major land type- High land, Medium High Land, Medium Low land, low land and very low land
v) Major soil group- Saik, Kalma, Payati, Khilgaon, Sonatala, Tengarchar, Silmondi, Shatnol, Nraibagh, Fuldi, Bararchar, Khalerchar, Ghorargaon

Change in Land Type

Slope class/Land type	Previous (2014)		Present (2024)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	1235	5.8	875	4.1	1.7(-)	
Medium Highland	3494	16.4	3030	14.2	2.2(-)	Settlement Increased due to industrialization and urbanization
Medium Lowland	4041	18.9	3690	17.3	1.6(-)	
Lowland	5854	27.4	5462	25.6	1.8(-)	
Very Low Land	1035	4.9	875	4.1	0.8(-)	
Miscellaneous	5677	26.6	7404	34.7	+8.1	
Total	21336	100	21336	100		

Change in Land Use

Land Use	Previous (2014)		Present (2024)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Fruit orchards (Jackfruit, Mango, lemon etc)	63	0.3	60	0.3	0	Agricultural land transform

	1086	5.09				into non-agricultural pupose
Rabi vegetables (bean, potato/cabbage/cauliflower/eeggplant) - Kharif vegetables (bitter gourd etc.)			1025	3.2	-1.89	
Banana orchard	317	1.5	290	1.4	-0.1	
Robi Crops-jute/aus- T Aman	587	2.75	350	1.2	-1.55	
Boro – fallow-T Amam	2910	13.63	3050	13.0	-0.63	
Mustard- Boro- fallow	4482	21	4600	20.9	-0.1	
Boro – F- F	5062	23.72	5550	23.9	-0.18	
Boro - B.Aman	1035	4.85	250	1.2	-3.65	
Others	117	0.55	63	0.3	-0.25	
Miscellaneous	5677	26.62	7404	34.7	-8.08	
Total	21336	100	7404	100.0		

Major findings of Atpara Upazila, Netrokona

i) Total area- 19,374 ha

ii) Total sample collected- 82

iii) Physiography & AEZ code- Old Brahmaputra Floodplain (AEZ 9)

Sylhet Basin (AEZ-21)

iv) Major land type- High land, Medium High land, Medium Low land & Low land.

v) Major soil group- Sunatola, Silmondi, Ghatail, Balina, Barhatta, Fagu, Terchibari.

v) Major land use- Boro-Fellow- Fellow, Boro-Fellow-Taman, Rabi vegetables- Fellow-Taman

Changes in Land Type

Land type	Previous (Year 1997)		Present (Year 2023)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	1570	8.1	1570	8.1	-	Land type calculation using digital mapping.
Medium Highland	7226	37.3	7250	37.4	+0.1	
Medium Lowland	4384	22.6	4108	21.2	-1.4	
Lowland	3434	17.7	3450	17.8	+0.1	
Miscellaneous	2760	14.3	2996	15.5	+1.2	
Total	19,374	100	19,374	100	0.0	

Change in Land Use

Land Use	Land type	Previous (Year 2009)		Present (Year 2023)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
1. Boro-Fellow-Taman	HL, MHL	5655	29.2	11296	58.3	+29.1	

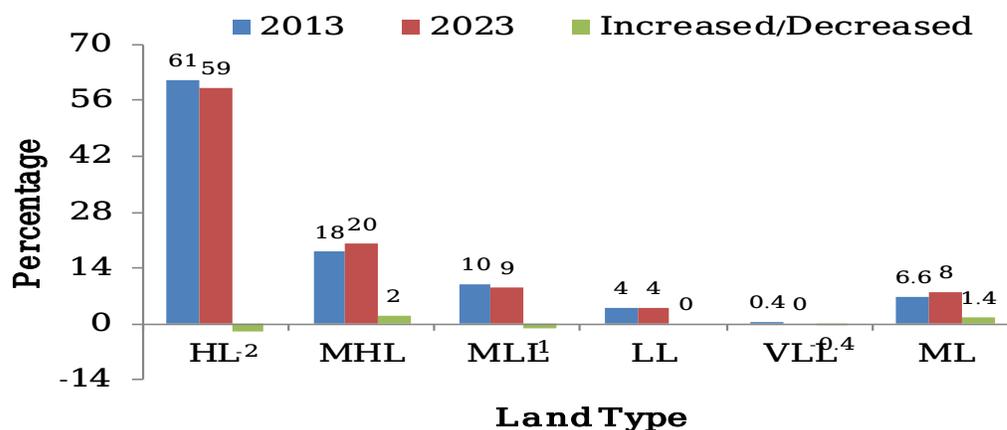|							
2. Boro-Fellow-Fellow	LL, MLL	6663	34.4	1493	7.7	-26.7	These overall changes in crop arrangement has been observed due to the changes in the socio economic status of the farmers.
3. Boro-Aus/Jute-Fellow	MHL, MLL	2652	13.7	1667	8.6	-5.1	
4. Fellow- Jute -T aman	MHL, MLL	580	3.0	660	3.4	+0.4	
5. Fellow- Aus/Jute-Taman	MLL,MHL	542	2.8	699	3.6	+0.8	
6. Rabi vegetables	HL	522	2.7	563	2.9	+0.2	
Miscellaneous	-	2760	14.2	2996	15.5	+1.3	
Total	**-**	**19374**	**100**	**19374**	**100**	**0**	

Major findings of Shakhipur Uazila, Tangail

i) Total area- 43,542 hectare

ii) Total sample colleted- 232

iii) Physiography & AEZ code- Madhupur tract (28) and Brhmaputra Floodplain (9)

iv) Major land type- High land, Medium high land, Medium low land and low land

v) Major soil group- Tejgoan, Belabo, Noadda, Gerua, Salna, Vatpara, Chandra, Siata, Kalma, Naga, Khilgoan, Karail, Sonatola, Shilmondi, Lokdeo, Hamidpur, Ghatail

vi) Major land use- Forest (Gajari, Akashmoni, Ukalyptus, Megium, Shal, Segun etc.), Natural Bush, Perennial Fruits Orchard (Jackfruit, Mango, Citrus, Guava, Boroi, Dragon fruits etc.), Annual Plants (Pineapple, Banana, Ginger, Turmeric etc.), Rabi vegetables – Kharif vegetables, Rabi crops-Aus/Jute-Fallow, Rabi crops-Aus/Jute-T. Aman, Fallow-Fallow- Kharif Vegetables, Fallow Aus/Jute-T. Aman, Boro-Fallow-T. Aman, Rabi crops-Fallow T.aman, Boro-Fallow-Fallow, Boro-Fallow-Deep water rice

Changes in Land Type

Land type	Previous (Year)		Present (Year)		% increase/	Possible reasons
	Area (ha)	%	Area (ha)	%	decrease	
High land	26,474	61	25,875	59	(-) 2	Homestead, industry and others infrastructure development, decreasing flooding depth and duration
Medium High land	8,001	18.1	8,620	20	(+) 2	
Medium Low land	4,361	10	4,032	9	(-) 1	
Low land	1,696	4	1,686	4	0	
Very Low land	151	0.3	0	0	(-)	
Miscellaneous	2,859	6.6	3,329	8	(+) 1.4	
Total	43,542	100	43,542	100		

2013 **2023** **Increased/Decreased**

Percentage

	HL	MHL	MLL	LL	VLL	ML
2013	61	18	10	4	0.4	6.6
2023	59	20	9	4	0	8
Increased/Decreased	-2	2	-1	0	-0.4	1.4

Land Type

Changes in Land Use in different Land type

Land Use	Land type	Previous (year)		Present (year)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
Forest	High land	1,495	3.4	1,342	3.1	(-) 0.3	Deforestation
Bush		3,783	8.7	2,520	5.8	(-) 2.9	Modern Cultivation (MC)
Orchard		2,155	4.9	3,850	8.8	(+) 1.9	High value
Annual fruits		3,039	7	4,564	10.5	(+) 1.2	High value
RV-KV	High land, Medium high land, Medium low land	4,360	10	5,582	12.8	(+) 1.5	High value
F-KV		982	2.3	120	0.3	(-) 2	Intensification
RC-aus/jute-F		2,535	5.8	2,103	4.8	(-) 1	Intensification
F-KV		982	2.3	542	1.2	(+) 1.1	Intensification
F-aus/jute-TA		2535	5.8	1,225	2.8	(+) 3	Intensification
B-F-TA		9246	21.2	7,567	17.4	(-) 3.8	Intensification
Must.-B-TA		0	0	5,241	12.0	(+) 12	Intensification
RC-F-TA		1,567	3.6	1,542	3.5	(-) 0.1	Intensification
B-F-F	Low land, VLL	5,047	11.6	1,267	2.9	(-) 8.7	Intensification
B-F-DWR		1,407	3.2	452	1.0	(-) 2.2	Intensification
Others	All	1,994	4.6	2,296	5.3	(+) 0.7	MC
Miscellaneous	Homestead	2,859	6.6	3,329	7.7	(+) 1.1	Infrastructures
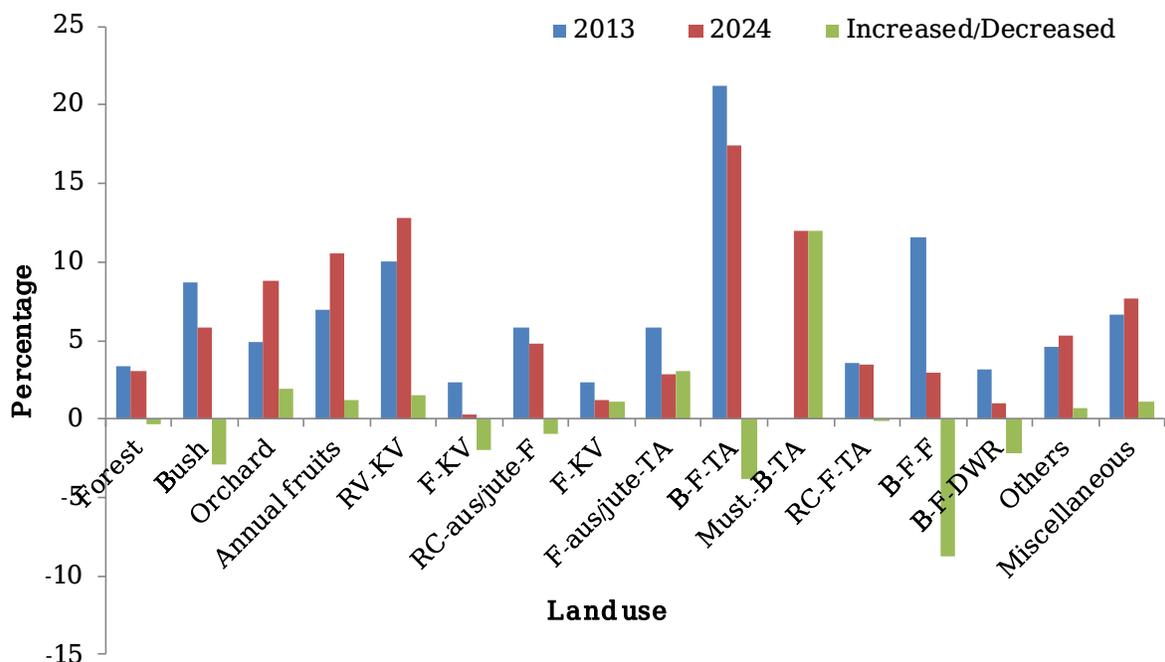
Major Findings Gournodi Upazila, Barishal

i) Total Area- 14,417 ha
ii) Total Sample Collected- 82
iii)Physiography & AEZ code-Ganges Floodplain (12) and Old Meghna Estuarine Floodplain (19)
iv) Major Land Type- HL, MHl, MLL, LL
v) Major Soil Group-Sara, Gopalpur, Kalbadar, Hijla, Muladi, Mehendigonj, Batajor, Uzirpur, Magra
vi) Major Land use- Boro- Fallow- T. Aman

Changes in Land Type

Land type	Previous Survey (2014)		Present Survey (2024)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	803	5.6	947	6.6	+1.0	Cultivable land converted into homestead garden, orchard and settlement
MediumHighland	6,679	46.3	6,495	45.1	-1.2	
Medium Lowland	2,787	19.3	2,753	19.0	- 0.3	
Lowland	527	3.7	426	3.0	- 0.7	
Miscellaneous	3,621	25.1	3,796	26.3	+1.2	Gain of area due to homestead garden, orchard and settlement
Total	14,417	100	14,417	100		

Changes in Land Use in different land type

Land Use	Previous Survey (2007)		Present Survey (2022)		% increase/ Decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Boro- Fallow- T. Aman	5,786	40.1	6,545	45.4	+5.3	-
Rabi Veg. – Kharif Veg.	337	2.4	547	3.8	+1.4	
Rc – Jute/Aus- T.Aman	893	6.2	1,024	7.1	+0.9	
Betel leaf	466	3.2	1,139	7.9	+4.7	
Boro- Fallow- Fallow	1,061	7.4	1,182	8.2	+0.8	
Others	2,253	15.6	184	1.3	-14.3	
Miscellaneous	3,621	25.1	3,796	26.3	+1.2	
	14,417	**100.0**		**100.0**		

Major Findings of Bhandaria Upazila, Pirojpur

i) Total Area- 15,443 ha
ii) Total Sample Collected- 67
iii) Physiography & AEZ code-Ganges Tital Floodplain (13)
iv) Major Land Type- HL, MHl, MLL
v) Major Soil Group- Jhalakathi, Ramgati, Barishal
vi) Major Land use- Boro- Fallow- T. Aman

Changes in Land Type

Land type	Prvious Survey (2007)		Present Survey (2024)		% increase/ Decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	423	2.7	450	2.9	+0.2	Cultivable land converted into homestead garden, orchard and settlement
Medium Highland	10,150	65.7	8233	53.4	+12.39	
Medium Lowland	158	1.1	150	1.0	+0.1	
Miscellaneous	4,712	30.5	6578	42.7	+12.09	
Total	15,443	100.0	15,433	100.0		

Major Findings Rajapur Upazila, Jhalakathi

i) Total Area- 16,433 ha
ii) Total Sample Collected- 72
iii) Physiography & AEZ code- Ganges Tidal Floodplain (13)
iv) Major Land Type- HL, MHl, MLL
v) Major Soil Group- Ramgati, Jhalakati, Barisal,Hogla, Betagi, Pirojpur,Polimati
vi) Major Land use- F – F – TA, F-T.Aus- TA

Changes in Land Type

Land type	Previous (2010)		Present (2024)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	320	1.9	195	1.2	-0.7	Cultivable land converted into homestead garden, orchard and settlement
Medium Highland	12049	73.3	10976	66.8	-6.5	
Medium Low land	173	1.1	120	0.8	-0.3	
Miscellaneous	3,891	23.7	5146	31.2	+7.5	Gain of area due to homestead garden, orchard and settlement
Total	16,433	**100.0**	16433	**100.0**	-	

Changes in Land Use in different land type

Land Use	Land type	Previous (2010)		Present (2024)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
1. RV-KV	HL/MHL	93	0.6	115	0.7	+0.1	
2. RC- T.Aus-TA	HL/MHL	147	0.9	351	2.1	+1.2	
3. F-T.Aus- TA	MHL	2335	14.2	2095	12.8	-1.4	
4. RC-F- TA	MHL	620	3.8	3220	19.6	+15.8	
5. F-F-TA	MHL	8843	53.8	5012	30.6	-23.2	Increased irrigation facility
6. B-F-TA	MHL	72	0.4	157	1.0	+0.6	
7. B-F-F	MHL	235	1.4	121	0.7	-0.7	
8.F-F-F	MHL/MLL	31	0.1	19	0.1	-	
9.Others	HL/MHL	166	1.1	197	1.2	+0.1	
***Miscellaneous	-	3,891	23.7	5146	31.2	+7.5	
Total	**-**	**16,433**	**100.0**	**16,433**	**100.0**	**-**	

Major findings of Dashmina Upazilla, Patuakhali

i) Total area- 30,287 ha
ii)Total sample colleted- 99
iii)Physiography & AEZ code- Ganges Tidal Floodplain (13) and Young Meghna Estuarine Floodplain (18)
iv)Major land type- Medium Highland
v)Major soil group- Bhola, Jhalakati, Barishal, Ramgati, Nilkamal, Polimati

Changes in Land Type

Land type	Previous (2014)		Present (2024)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	235	0.8	348	1.0	+0.2	Cultivable land (MHL) converted into homestead area
Medium Highland	14,303	47.2	14,353	47.4	+0.2	
Medium Lowland	852	2.8	810	2.7	-0.1	MLL are converted to MHL due to change in floding depth
Miscellaneous	14,897	49.2	14,776	48.8	-0.4	
Total	30,287	100.0	30,287	100.0	-	

Changes in Land Use in different land type

Land Use	Land type	Previous (2014)		Present (2024)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
1. RC- T.Aus- TA	MHL	5,361	17.7	590	1.9	-15.8	Aus production has declined due to cost of production, uneven seasonal rain and harvesting in monsoon
2. F- T.Aus- TA	MHL	2,141	7.1			-7.1	
3. RC(Chilli/Gnut/Potato/Grasspea/til/lentil)- T.Aus - TA	MHL	216	0.7			-0.7	
4. RC(Mung/Cowpea)-F-TA	MHL	4,157	13.7	6,148	20.3	+6.6	Improved land use & higher return
5.RC(Chilli/Gnut/Potato/Grasspea/til/lentil)-F-TA	MHL	3,072	10.1	3,409	11.3	+1.2	
6. Watermelon-F-TA	MHL	247	0.9	408	1.3	+0.4	
7. B-F-TA	MHL			2,476	8.2	+8.2	Increased irrigation facility
8. B-F- F	MHL			324	1.1	+1.1	
9. F-F-TA deep water	MHL			324	1.1	+1.1	Land use changed
10. Watermelon-F-F	MHL			162	0.5	+0.5	
11. Others	HL/MHL	196	0.6	1,670	5.5	+4.9	
Miscellaneous	-	14,897	49.2	14,776	48.8	-0.4	Erosion
Total		34,828	100.0	34,828	100.0		

∗RC (Mungbean/ Cowpea-55, Chilli-15, Groundnut-10, Grasspea-10, Mustard-5, Potato-5, Others-5)

Major Findings of Kalapara Upazila, Patuakhali

i) Total Area- 47,194 ha
ii) Total Sample Collected- 179
iii) Physiography & AEZ code- Ganges Tidal Floodplain (13)
iv) Major Land Type- MHL
v) Major Soil Group- Ramgati, Jhalakati, Barishal & Ganges Katal Polimati
vi) Major Land use- F-F- T. Aman, Robi crops- T. Aus- T. Aman, F- T. Aus – T. Aman, Robi crops- F- T. Aman

Changes in Land Type

Land type	Previous (2014)		Present (2024)		Changes (%)	Possible reasons
	Area (ha)	%	Area (ha)	%		
HL (Vitimati)	406	0.9	780.0	1.7	92.1	Increasing homestead, urbanization, development activities, orchard, garden etc.
MHL	33905	71.8	27684.0	58.7	-18.3	
Homestead	2298	4.9	4423.0	9.4	92.4	
Miscellaneous	10585	22.4	14307.0	30.3	35.16	
Total	47194	100	47194	100		

Changes in Land Use in different land type

Land use	Land type	Previous (2014)		Present (2024)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
1.Rabi Vegetables-Kharif vegetables	MHL		0.0	381	0.8	0.8	Price and demand of vegetables is higher. Availability of improved variety.
2. Rabi Crops - T. Aus - T. Aman	MHL	3715	7.9	2650	5.6	-2.3	Boro rice production increased due to availability of irrigation water and higher yield
3. Boro – T. Aus – T. Aman	MHL		0.0	1325	2.8	2.8	
4. Boro – F - T. Aman	MHL	1093	2.3	763	1.6	-0.7	
5. Rabi Crops – F - T. Aman	MHL	3121	6.6	1000	2.1	-4.5	
6. F – F - T. Aman	MHL	18603	39.4	4973	10.5	-28.9	
7. Boro – F - F	MHL	2756	5.8	3966	8.4	2.6	
8. Mug – F – T. Aman	MHL		0.0	10218	21.7	21.7	Production cost of mug bean is lower but production and price is satisfactory.
9. Water melon – F – T. Aman	MHL		0.0	1325	2.8	2.8	Economic return from water melon much more than other crop.
10. F – T. Aus – T. Aman	MHL	4464	9.5	944	2.0	-7.5	
11.Others	MHL	560	1.2	920	1.9	0.8	
12. Miscellaneous	HL/MHL	12883	27.3	18730	39.7	12.4	
Total		47195	100.0	47195	100.0		

Major findings of Tazumuddin Upazilla, Bhola

i) Total area- 34,828 ha
ii)Total sample colleted- 65
iii)Physiography & AEZ code- Ganges Tidal Floodplain (13) and Young Meghna Estuarine Floodplain (18)
iv)Major land type- Medium Highland
v)Major soil group- Bhola, Jhalakati, Ramgati, Nilkamal, Polimati

Changes in Land Type

Land type	Previous (2001)		Present (2024)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	311	1.0	1215	3.5	+2.5	Cultivable land (MHL) converted into homestead garden, orchard
Medium Highland	9,844	28.2	9,823	28.2	-+0	
Medium Lowland	341	1.0	828	2.4	+1.4	Due to siltation River area converted into new charland
Miscellaneous	24,332	69.8	22,962	65.9	-3.9	Due to siltation River area converted into new cultivable land

		34,828	100.0	34,828	100.0	-	

Changes in Land Use

Land Use	Land type	Previous (2001) Area (ha)	%	Present (2024) Area (ha)	%	% increase/ decrease	Possible reasons
1. RV-KV	HL/MHL			212	0.6	+0.6	Improved land use & higher return
2. RC- D.Aus- TA	MHL	3,921	11.3	713	2.0	-9.3	Aus production has declined due to cost of production, uneven seasonal rain and harvesting in monsoon
3. RC- B.Aus- TA	MHL	813	2.3			-2.3	
4. RC- T.Aus- TA	MHL	1,630	4.7	279	0.8	-3.9	
*5. RC-F- TA	MHL	3,130	9.0	6,488	18.6	+9.6	Improved land use & higher return
6. B-F-TA	MHL	277	0.8	1,377	4.0	+3.2	Increased irrigation facility
7. F-F-TA	MHL	73	0.2	414	1.2	+1.0	Land use changed
8. RC-F- F	MHL	341	1.0			-1.0	
9. Watermelon-F-TA	MHL			294	0.8	+0.8	Improved land use & higher return
10. Grass-F-TA	MHL			94	0.3	+0.3	
11. RC-F- Broadcast deep water aman	MLL			828	2.4	+2.4	
12. Others	HL/MHL		0.9	1,168	3.4	+2.5	Land use converted
Miscellaneous	-		69.8	22,962	65.9	-3.9	Erosion
Total	-	34,828	100.0	34,828	100.0		

*RC (Mustard-55%, Groundnut-20%, Potato-5%, Chilli-5%, Mungbean/Cowpea-10%, Others-5%)

Major findings of Brahmanbaria Sadar Upazila, Brahmanbaria

i) Total area	:	21,332 ha
ii) Total sample collected	:	120
iii) Physiography & AEZ code	:	a) Old Meghna Estuarine Floodplain (AEZ-19) b) Sylhet Basin (AEZ-21)
iv) Major land type	:	High Land, Medium High land (major), Medium Low land, Low land, Very Low land.
v) Major soil group	:	Chandina (major), Debidwar, Burichong, Homna, Fagu, Titas, Nasirnagar,Nabinagar.
vi) Major land type	:	Rabi Vegetables-F-F (major), Rabi Vegetables-Boro-T. Aman, Boro -F-F, Boro-T. Aus-T. Aman, Boro-F-T.Aman etc.

Changes in Land Type

Land type	Previous (2014)		Present (2024)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
High land	314	01.00	345	1.10	(+) 0.10	Gain of area due to homestead garden, orchard etc.
Medium High land	9,461	30.20	8,515	27.18	(-) 3.02	New infrastructure occupied Medium High land due to urbanization, over population.
Medium Low land	6,986	22.30	7,560	24.13	(+) 1.83	Changes of inundation depth.
Low land	5,947	18.98	6,542	20.88	(+) 1.9	
Very Low land	5,581	17.81	5,023	16.03	(-) 1.78	Accumulation of silt, increases sedimentation due to flood.
Miscellaneous	3,043	9.71	3,347	10.68	(+) 0.97	Increases of settlement.
Total	31,332	100.0	31,332	100.0	00.00	-

Changes in Land Use in different Land Type

Land Use	Land type	Previous (2014)		Present (2024)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
1.Homestead Vegetables	High Land	314	1.00	345	1.10	(+) 0.10	Due to increase of homestead garden, orchard etc.
2. Rabi Vegetables-Boro-T. Aman	Medium High land	4,731	15.10	4,258	13.59	(-) 1.51	Due to change of socio-economic condition of people.
3 Boro-T. Aus-T. Aman		2,838	9.06	2,554	8.15	(-) 0.91	
4. Boro (Modern)-F-T.Aman		1,892	6.04	1,703	5.43	(-) 0.61	
5. Boro-F-T.Aman	Medium Low land	2,096	6.69	2,268	7.24	(+) 0.55	1.Increases of Boro rice cultivation due to high yield. 2.Increases of high value profitable crops like Rabi vegetables.
6. Rabi Vegetables-F-T Aman		1,746	5.57	1,890	6.03	(+) 0.46	
7. Rabi Vegetables-F-B. Aman		1,397	4.46	1,512	4.83	(+) 0.37	
8. Boro (HYV) -F-F		1,048	3.34	1,134	3.62	(+) 0.28	
9.Boro (HYV) -F- B. Aman		699	2.23	756	2.41	(+) 0.18	
10.Rabi Vegetables-F-F	Low land	5,353	17.08	5,888	18.79	(+) 1.71	
11.Boro (Local)-F-F		594	1.90	654	2.09	(+) 0.19	
12.Boro -F-F	Very low land	4,465	14.25	4,018	12.82	(-) 1.43	Cultivation of HYV rice
13.Boro (Modern /Local) -F-B. Aman		1,116	3.56	1,005	3.21	(-) 0.35	
Miscellaneous	-	3,043	9.72	3,347	10.69	(+) 0.97	Increases of settlement
Total		31,332	100.0	31,332	100.0	00.00	-

Major findings of Cumilla Adarsha Sadar, Cumilla

i) Total area-	:	12,495 ha
ii) Total sample collected	:	78
iii) Physiography & AEZ code-	:	a) Northern and Eastern Hill (AEZ 29) b) Northern and Eastern Piedmont (AEZ 22) c) Meghna Eastuarine Floodplain (AEZ 19)
iv) Major land type	:	Highland, Medium Highland, Medium Lowland, Lowland.
v) Major soil group	:	Chandina, Pritimpasha, Monu, Chakala Debidwar, Burichang, Sonchochail, Olipur, Gomoti, Bigipur.

Change in Land Type

Land type	Previous (Year)		Present (Year)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	650	5.2	625	5.0	(-) 0.2	Due to new roads, homesteads and decrease of annual rainfall
Medium Highland	7918	63.4	6622	53.0	(-) 10.0	
Medium Lowland	332	2.6	250	2.0	(-) 0.6	
Miscellaneous	3595	28.8	4998	40.0	(+) 11.2	
Total	12495	100.00	12495	100.0		

Change in Land Use (for floodplain, piedmont and terrace area)

Land Use	Land type	Previous (year)		Present (year)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
Robi Veg. – Karif Veg.	High Land	200	1.6	225	1.8	(+) 0.2	Due to changes of land type and settlement
RC – T. Aush – T. Aman		300	2.4	275	2.2	(-) 0.2	
Boro(Modern) - T. Aush - T. Aman,		150	1.2	125	1.0	(-) 0.2	
Boro(Modern) - T. Aush - T. Aman,	Medium Highland	1249	10.0	1028	8.2	(-) 1.8	
Boro – F - T. Amam		4371	35.0	3753	30.1	(-) 4.9	
Rabi Vegetables-F-T Aman		450	3.6	351	2.8	(-) 0.8	
F – T. Aush – T Aman		525	4.2	465	3.7	(-) 0.5	
Rc –T. Aush – T Aman		736	5.9	538	4.3	(-) 1.6	
Rc. – F – T.Aman		587	4.7	487	3.9	(-) 0.8	
Boro (HYV) – F - DWTA	Medium Lowland	200	1.6	-	-	(-) .6	
Boro – F – F		132	1.0	125	1.0		
Boro – F – T. Aman		-	-	125	1.0		
Miscellaneous	-	3595	28.8	4998	40.0		
Total		12495	100.0	12495			

Major findings of Ranguniya Uazila, Chattogram

i) Total area-34,775 ha

ii)Total sample colleted- 202

iii)Physiography & AEZ code- Norther and eastern hill (29), Chittagpng coastal plain (23)

iv)Major land type- Highland, Medium Highland

v)Major soil group- Khadimnagar, Shalban, Lama, Nalua, Rangamati, Pahartoli, Mirsarai, Manu, Belonia, Rangunia

vi) Major land use- Boro- Fallow- T. Aman, Fallow-Fallow- T. Aman

Changes in Land Type

Land type	1998(Year)		2024(Year)		% increase(+)/ decrease(-)	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	13,669	39.3	13,669	39.3		
Medium Highland	16,863	48.5	15,538	44.7	-3.8	Due to Unplanned earth work
Medium Lowland	308	0.9	1,312	3.8	+2.9	
Lowland						
Very lowland						
Miscellaneous	3,935	11.3	4,256	12.2	0.9	Development
Total	34,775	100	34,775	100		

Changes in Land Use in different Land type

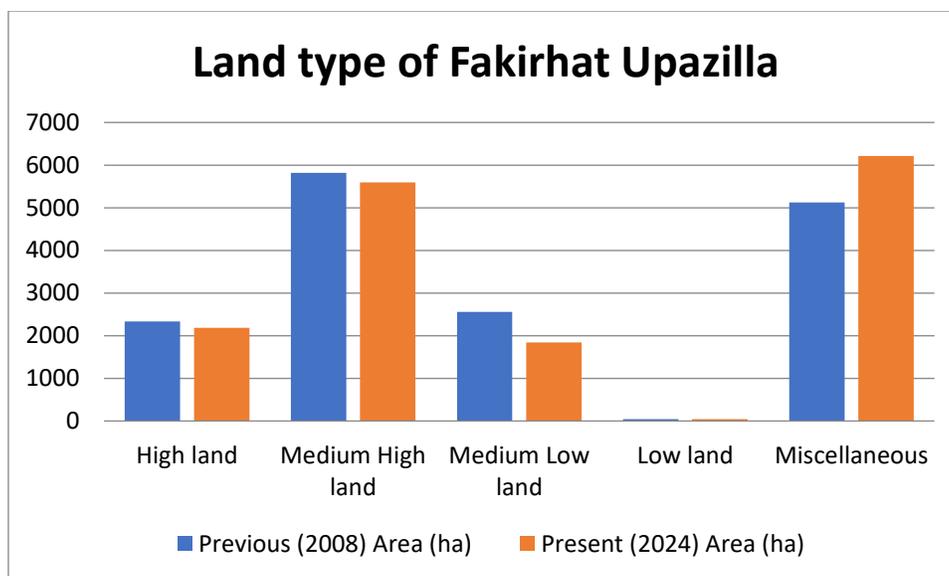| Land use	1998		2024		% increase(+)/ decrease(-)	Possible Reasons
	Area (Ha)	%	Area (Ha)	%		
Forest	4819	13.9	4819	13.9	0	
Fallow	6436	18.5	6867	19.7	+1.2	Brick field
Tea	725	2.1	725	2.1	0	
Boro-F-TA	11,535	33.3	7,900	22.7	-10.6	Converted to other cropping patterns
Rc- F - TA	1,460	4.2	2,510	7.2	+3	Irrigation coverage increase
F-F-TA	5,127	14.7	4,244	12.2	-2.5	Converted to other cropping patterns
F-TA-TA	251	0.7	0	0	-.0.7	
Rc-Kharif Veg-TA	0	0	545	1.6	+1.6	High value crop
Rc- TAus-F	150	0.4	0	0	-0.4	Converted to other cropping patterns
RC	37	0.1	0	0	-0.1	
RC-Kharif Veg	150	0.4	1285	3.4	+3	Irrigation coverage increase
Dal-F-TA	0	0	648	1.9	+1.9	Oilseed Project
Mustard-F-TA	0	0	200	0.6	+0.6	Oilseed Project
Betel leaf	150	0.4	150	0.4	0	
Spices	0	0	626	1.8	+1.8	Cash crop
Miscellaneous	3,935	11.3	4,256	12.2	+0.9	Development
Total	34,775	100	34,775	100		

Major findings of Rupsa Upazila, Khulna

i) Total area- 12,025 ha

ii) Total soil sample collected- 59

iii) Physiography & AEZ code- Ganges Floodplain and Ganges Tidal Floodplain, Gopalgonj Khulna bills & AEZ 11, AEZ 13 and AEZ 14

iv) Major land type- Highland, Medium Highland, Medium Lowland etc.

v) Major soil group- Gopalpur, Ishurdi, Ghior, Ramgoti, Bajoa, Borishal, Harta, Satla etc.

## Change in Land Type

Land type	Previous (2007)		Present (2024)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	1145	9.5	1015	8.5	-11.4	Settelement area increased
Medium Highland	4950	41.2	4341	36.1	-12.3	
Medium Lowland	2731	22.7	2744	22.8	0.5	
Lowland	-	-	-	-	-	
Very lowland	-	-	-	-	-	
Miscellaneous	3199	26.6	3925	32.6	+22.6	
Total		**100.0**		**100.0**		
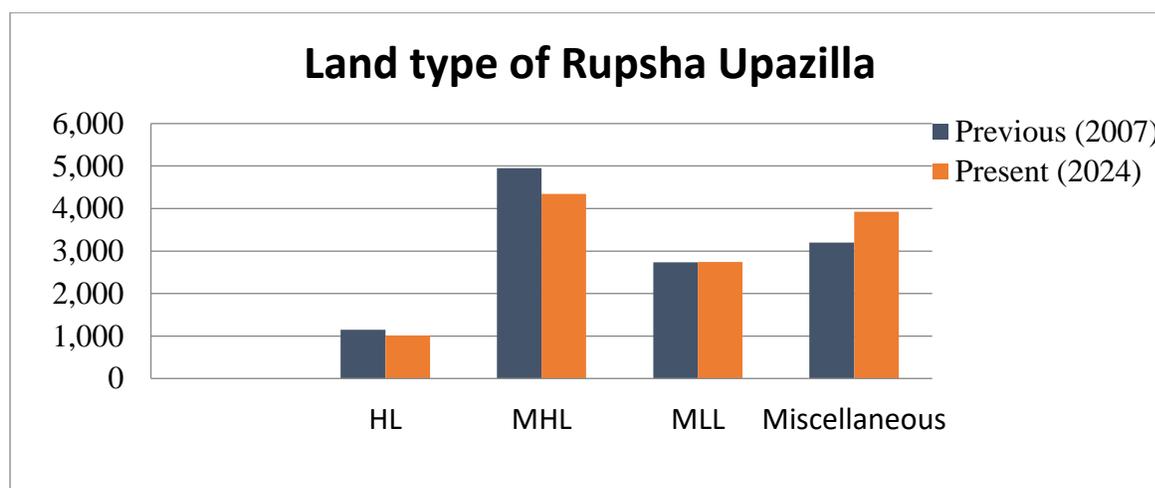
Changes in Land Use in different Land type

Land Use	Land type	Previous (2007)		Present (2024)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
Annual crops	HL	-	-	66	0.5	+100	
RV-KV	HL	147	1.2	51	0.4	-65.3	
F-KV-TA	HL	53	0.4	-	-	-100	
RC/RV-J/T.aus-TA	HL	70	0.6	-	-	-100	
RC/RV-J/T.aus-F	HL	173	1.4	35	0.3	-79.8	
RC/RV-F-TA	HL	87	0.7	-	-	-87	
Boro-F-TA	HL	260	2.2	208	1.7	-20.0	
RV-Til/J-F	MHL	52	0.4	-	-	-52	
F-Til/J/B.aus- TA	MHL	456	3.8	238	2.0	-47.8	
Boro-F-TA	MHL	2375	19.9	2260	18.8	-4.8	
F-F-TA	MHL	249	2.1	73	0.6	-70.9	
Boro-Shrimp	MHL	1232	10.2	1379	11.5	+11.9	
RC-F-TA	MHL	27	0.2	26	0.2	-3.7	
RV-F-TA	MHL	280	2.3	122	1.0	-56.4	
Shrimp-TA	MLL	279	2.3	-	-	-100	
F-Mixed aus & aman	MLL	533	4.4	-	-	-100	

Boro-F-F	MLL	532	4.4	302	2.5	-43.2
Boro-Shrimp	MLL	1665	13.8	2442	20.3	-46.7
Other		376	3.1	890	7.4	+136.7
Miscellaneous	-	3199	26.6	3925	32.6	+22.7
Total	-	12,025	100.0	12,025	100.0	
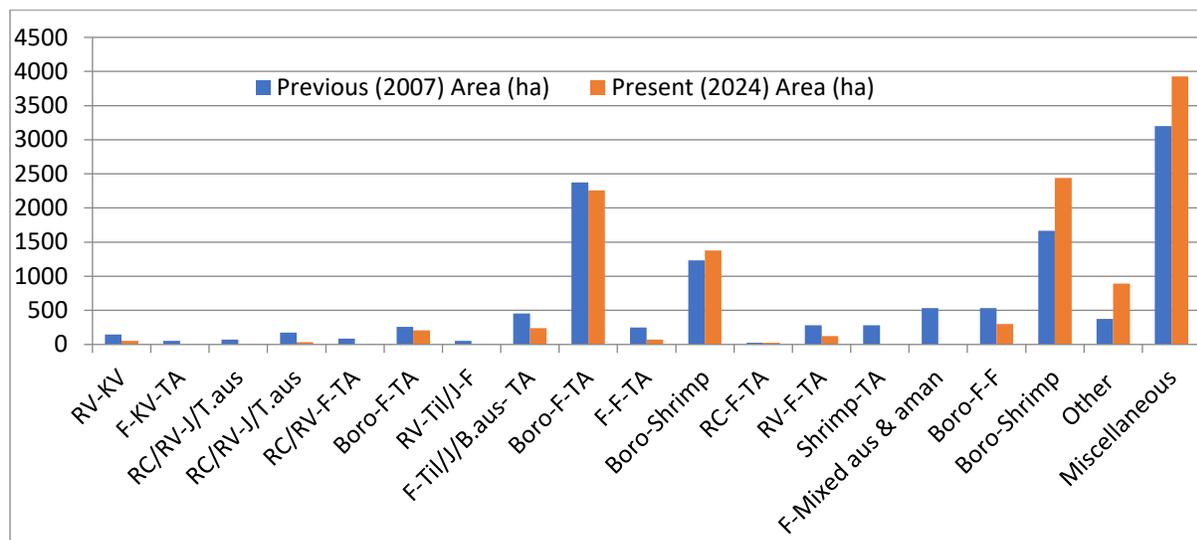
Major findings of Fakirhat Upazila, Bagerhat

i) Total area- 15,883 ha

ii) Total soil sample collected-98

iii) Physiography & AEZ code- Ganges Floodplain and Ganges Tidal Floodplain, Gopalgonj Khulna bills & AEZ 11, AEZ 13 and AEZ 14.

iv) Major land type- Highland, Medium Highland, Medium Lowland and Lowland etc.

v) Major soil group- Sara,Gopalpur, Ishurdi, Ghior, Bajoa, Barisal, Harta, Satla etc.

Change in Land Type

Land type	Previous (2008)		Present (2024)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
High land	2337	14.7	2186	13.8	-6.5	Due to improve drainage condition medium Low land decrease. And, Settlement area increased.
Medium High land	5822	36.7	5598	35.2	-3.8	
Medium Low land	2556	16.1	1843	11.6	-27.9	
Low land	44	0.3	40	0.3	-9.1	
Miscellaneous	5124	32.3	6216	39.1	+21.3	
Total	15883	100.0	15883	100.0	0.0	

Changes in Land Use in different Land type

Land Use	Land type	Previous (2008)		Present (2024)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
Perennial (Betel Vine)	HL	0	0.0	112	0.7	112.0	
Rabi Vegetable-Aus/Jute-Fallow	HL	521	3.3	225	1.4	-56.8	
Rabi Crops- fallow- TA	HL	454	2.9	216	1.4	-52.4	
Rabi Vegetable - Kharif Vegetable	HL	359	2.3	1,250	7.9	248.2	
Rabi vegetable -Fallow- TA	HL	160	1.0	214	1.3	33.8	
Fallow-Au/Jute- TA	HL	82	0.5	45	0.3	-45.1	
Uncultivated	HL	761	4.8	124	0.8	-83.7	Boro-falllow – TA pattern decreased and Boro-Shrimp+Fish pattern increased
Bo-Fallow-TA	MHL	2,770	17.4	1,458	9.2	-47.4	
Bo - Shrimp+Fish	MHL	1,620	10.2	3,424	21.6	111.4	
Falow -Falow - TA	MHL	586	3.7	258	1.6	-56.0	
Bo-Au-TA	MHL	316	2.0	0	0.0	-100.0	
Fallow-Sesame-TA	MHL	158	1.0	0	0.0	-100.0	
Rabi Crops- fallow- TA	MHL	119	0.7	405	2.5	240.3	
Falow -Falow - TA	MHL	40	0.3	53	0.3	32.5	
Water Body	MHL	199	1.3	0	0.0	-100.0	
Uncultivated	MHL	14	0.1	0	0.0	-100.0	
Bo - Shrimp+Fish	MLL	1,518	9.6	1,286	8.1	-15.3	
Bo - Fallow - Fallow	MLL	382	2.4	281	1.8	-26.4	
Fallow - Shrimp+Fish	MLL	613	3.9	236	1.5	-61.5	
Water Body	MLL	43	0.3	0	0.0	-100.0	
Fallow - Shrimp+Fish	LL	44	0.3	80	0.5	81.8	
Miscellaneous		5,124	32.3	6,216	39.1	21.3	
Total		15,883	100.0	15,883	100.0	0.0	
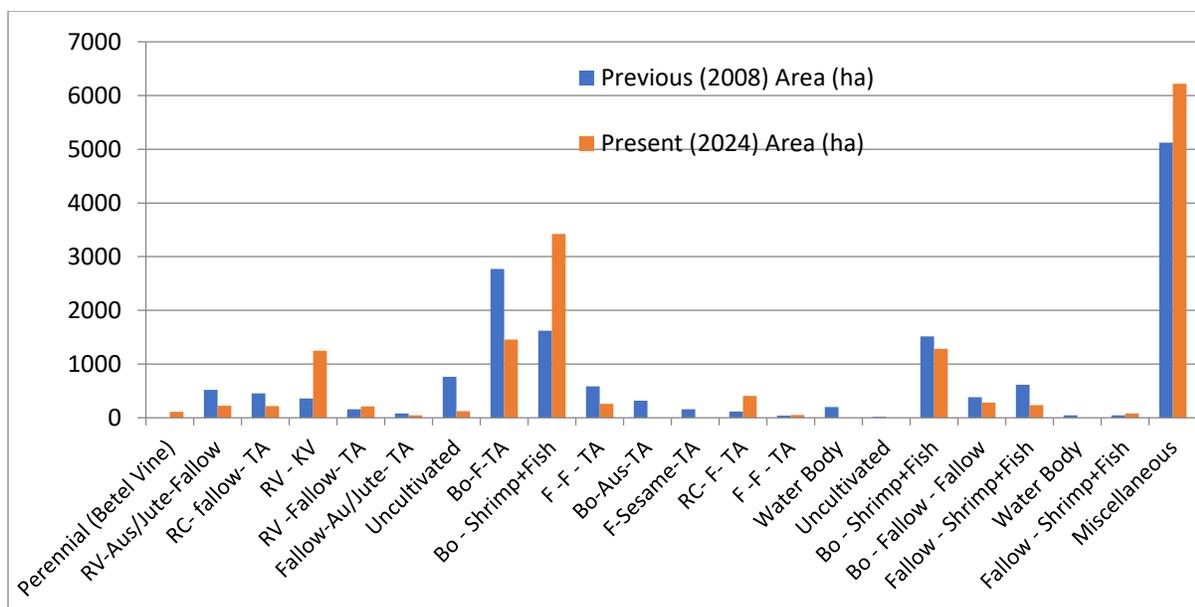
Major findings of Rajbari Sadar Upazilla, Rajbari

i) Total area-32387 ha

ii) Total sample colleted-145

iii) Physiography -Ganges Floodplain; AEZ code- Old Ganges Floodplain (12)

iv) Major land type- HL, MHL, MLL, LL

v) Major soil group-Sara, Gopalpur, Ishwardi, Ghior, Raina, Karra, Gangar Poli Mati and Ramdia

Changes in Land Type for Rajbari Sadar Upazila

Land type	Previous (2008)		Present (2023)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	5,935	18.3	6,214	19.2	(+) 0.9	
Medium Highland	13,088	40.4	11,023	34.0	(-) 6.4	
Medium Lowland	2,877	8.9	2,895	8.9	-	
Lowland	1530	4.7	1450	4.5	(-) 0.2	
Miscellaneous	8,957	27.7	10,805	33.4	(+) 5.7	
Total	32,387	100.0	32,387	100.0		
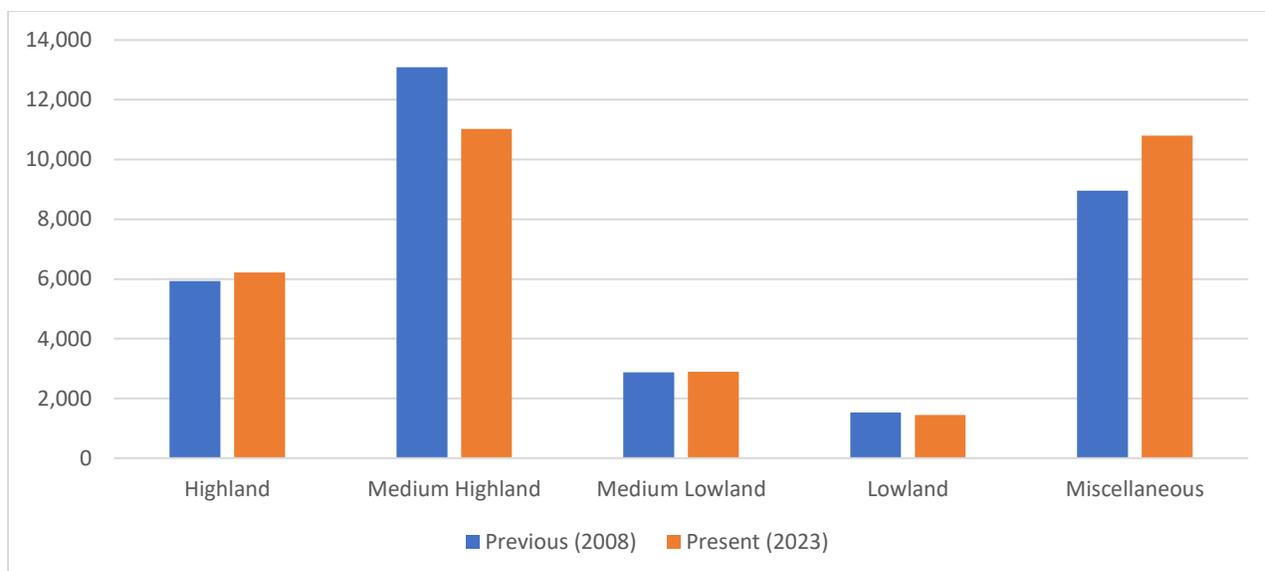
Area(ha)

Changes in Land Use for Rajbari Sadar Upazila

Land Use	Land type	Previous (year)		Present (year)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
Sugarcane + intercropping crops		1239	3.8	1287	4.0	+ (.2)	
RC-Jute-TA		6,459	19.9	7423	23.0	+ (3.1)	
RV-KV		1856	5.7	1720	5.3	- (0.4)	
RC-Jute-Fallow		18,27	5.7	1634	5.0	- (.7)	
RC-Broadcast Aus-Fallow		1230	3.8	547	1.7	- (2.1)	
RC-Mixed Broadcast Aush and Aman		1,112	3.4	-			
Boro -TA		5,599	17.3	5470	16.9	- (.4)	
Wheat-Jute-TA		-	-	956	3.0		
Masturd-Boro-TA		397	1.2	-			
Boro-Broadcast Aman		481	1,5	-			
Groundnut -Fallow-Fallow		438	1.4	335	1.0	- (.4)	
Boro -Fallow-Fallow		1,771	5.5	1225	3.7	- (1.8)	
others		1,021	3.1	985	3.0	- (.1)	
Miscellaneous (settlement/reservoir/river/pond etc.)		8,957	27.7	10,805	33.4	(+) 5.7	
Total		**32,387**	**100.0**	**32,387**	**100.0**		

Legend: ■ Previous (2008)Area(ha) ■ Present (2023)Area(ha)
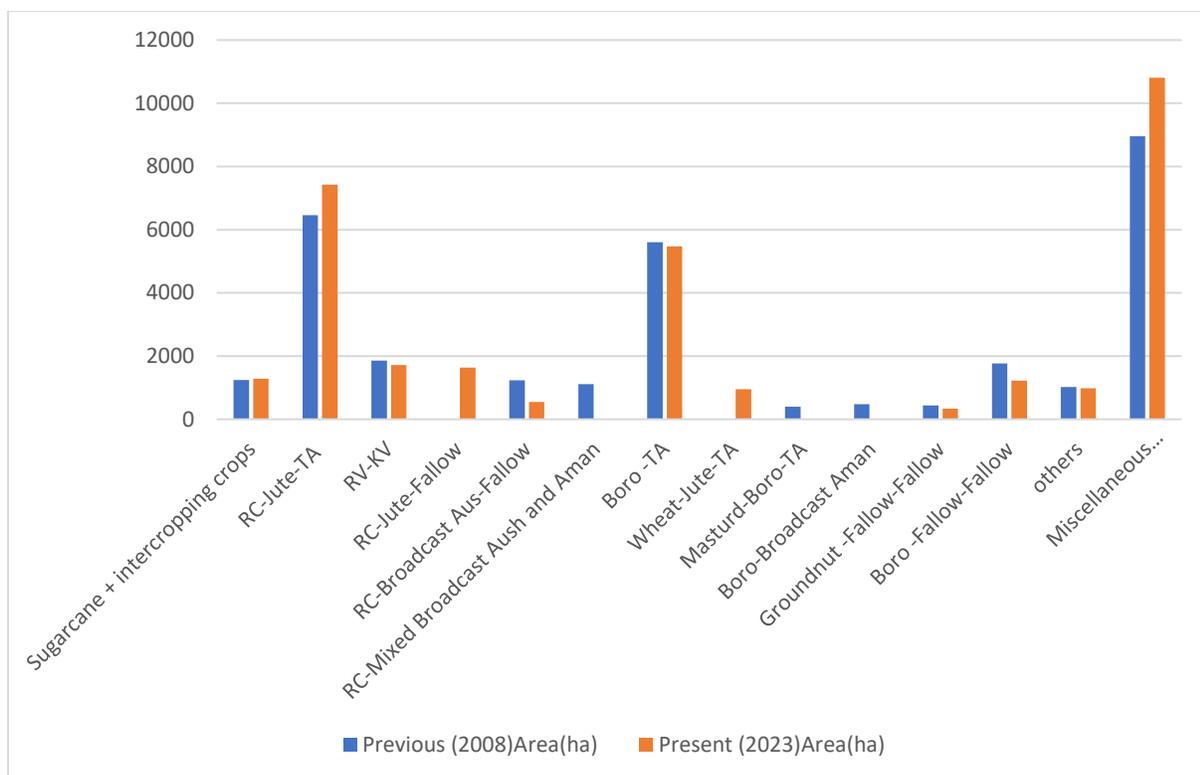
Major findings of Karimganj Upazilla, Kishoreganj

i) Total area-19575 ha
ii) Total sample colleted-123
iii) Physiography & AEZ code- Brahmaputra Floodplain & Surma Kushiara Fioodplain (9&21)
iv)Major land type- HL, MHL, MLL, LL
v) Major soil group-Sonatola,Silmondi,Lokdeo,Ghatail,
Balina,Balagonj,Goainghat,Kanaighat,Fagu,Sulla,Terchibari.

Major findings of Pangsha Upazila, Rajbari

i) Total area- 25,276 ha
ii) Total sample collected- 93
iii) Physiography & AEZ code- Old Ganges Floodplain and AEZ 12
iv) Major land type- Highland, Medium Highland, Medium Lowland, Lowland
v) Major soil group- Sara, Pangsha, Gopalpur, Ishurdi, Ghior, Ramdia, Raina, Katra Etc.
vi) Major land use- Onion-Jute-T. Aman, Rabi crops-Jute-T. Aman, Boro-Fallow-T. Aman.

Changes in Land Type

Land type	Previous (2008)		Present (2023)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	4,250	16.8	3,430	13.6	-19.3	
Medium Highland	12,167	48.1	9,317	36.9	-23.4	
Medium Lowland	3,021	12.0	2,110	8.3	-30.2	
Lowland	330	1.3	273	1.1	-17.3	
Miscellaneous	5,508	21.8	10,146	40.1	+84.2	
Total	**25,276**	**100**	**25,276**	**100**		
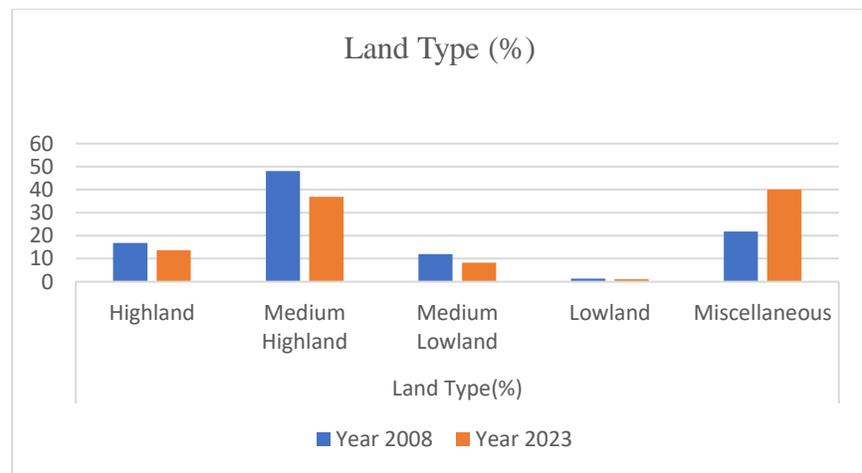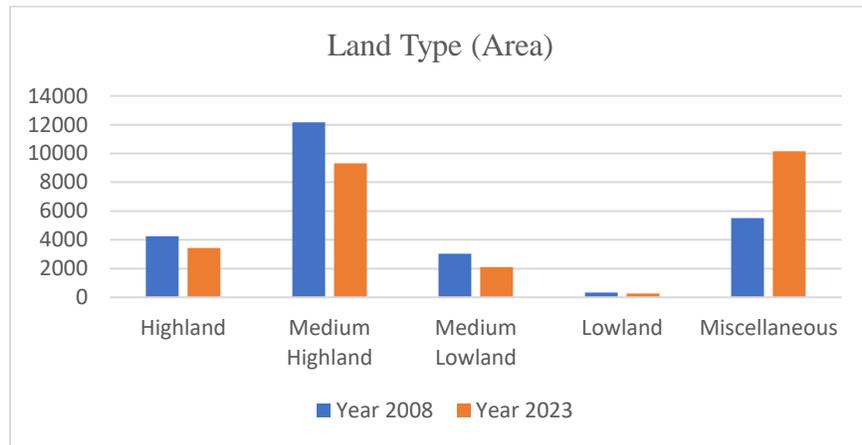
Changes in Land Use

Land Use	Previous (2008)		Present (2023)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Annual	859	3.4	986	3.9	+14.8	
Perennial	-	-	253	1.0	-	
Miscellaneous	5,508	21.8	10,136	40.1	+84.0	
Rabi vegetables-Kharif vegetables	556	2.2	505	2.0	-9.2	
Rabi crops- Mixed (Aus+Aman)	887	3.5	-	-	-	
Rabi crops-Jute-T. Aman	3,412	13.5	2,780	11.0	-18.5	
Rabi crops-Jute-Fallow	4,626	18.3	506	2.0	-89.1	
Boro-Fallow-T. Aman	5,814	23.0	2,275	9.0	-60.9	
Boro (Local/HYV)-Fallow-Fallow	1,466	5.8	506	2.0	-65.5	
Groundnut-Fallow-Fallow	379	1.5	758	3.0	+100.0	
Onion-Jute-T. Aman	-	-	5,308	21.0	-	
Mustard-Boro (Local/HYV)	404	1.6	505	2.0	+25.0	
Boro (Local/HYV)-B. Aman	935	3.7	-	-	-	
Others	430	1.7	758	3.0	+76.3	
Total	**25,276**	**100**	**25,276**	**100**		

Land Use(%)
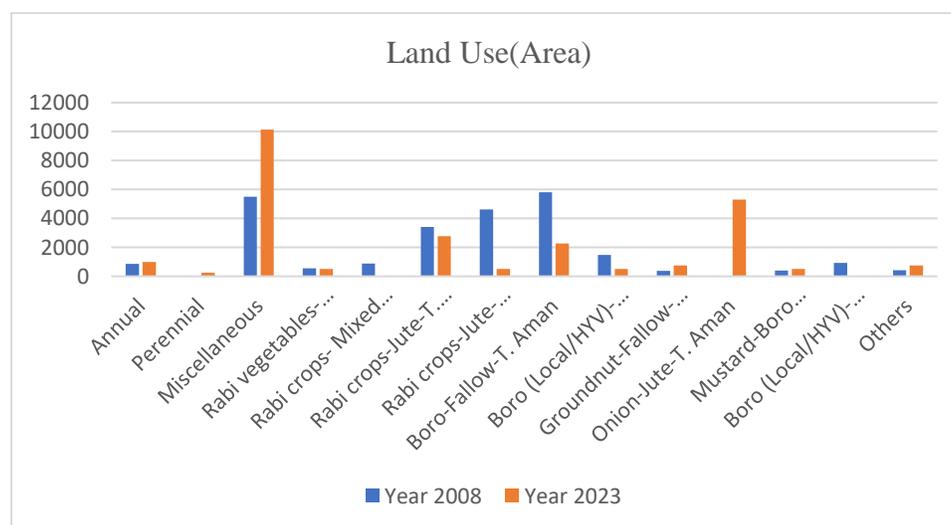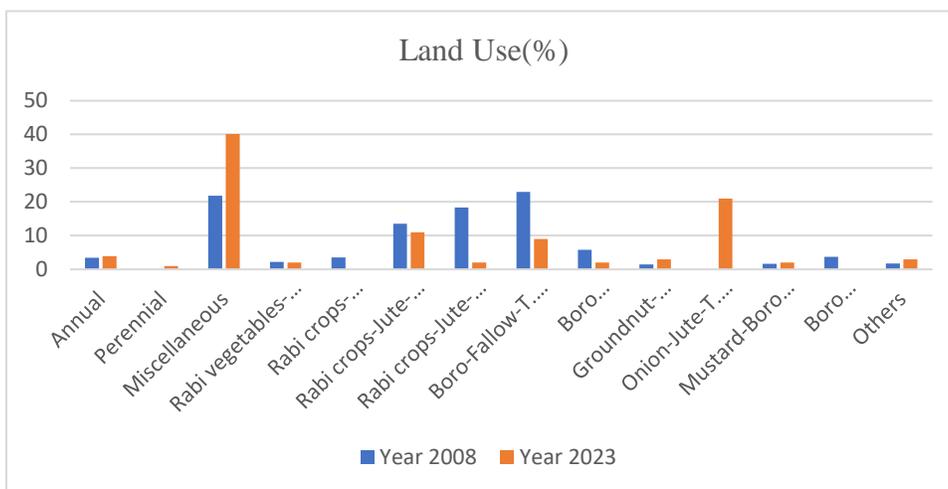
Major findings of BhandariaUpazila, Pirojpur

i) Total area- 15,443 ha
ii)Total soil sample collected- 67
iii)Physiography & AEZ code- Ganges Tidal Floodplain and AEZ 13
iv)Major land type-Highland, Medium Highland, Medium Lowland
v)Major soil group-Ramgoti, Jhalokati, Borishal, Hogla, Polimatietc.

Change in Land Type Bhandaria upazila

Land type	Previous (2014)		Present (2024)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	423	2.7	534	3.5	+1.7	
Medium Highland	10,150	65.7	7,931	51.4	-40.2	
Medium Lowland	158	1.1	174	1.1	+0.6	
Miscellaneous	4,712	30.5	6,808	44.1	+18.6	
Total	**15,443**	**100.0**	15,433	**100.0**		
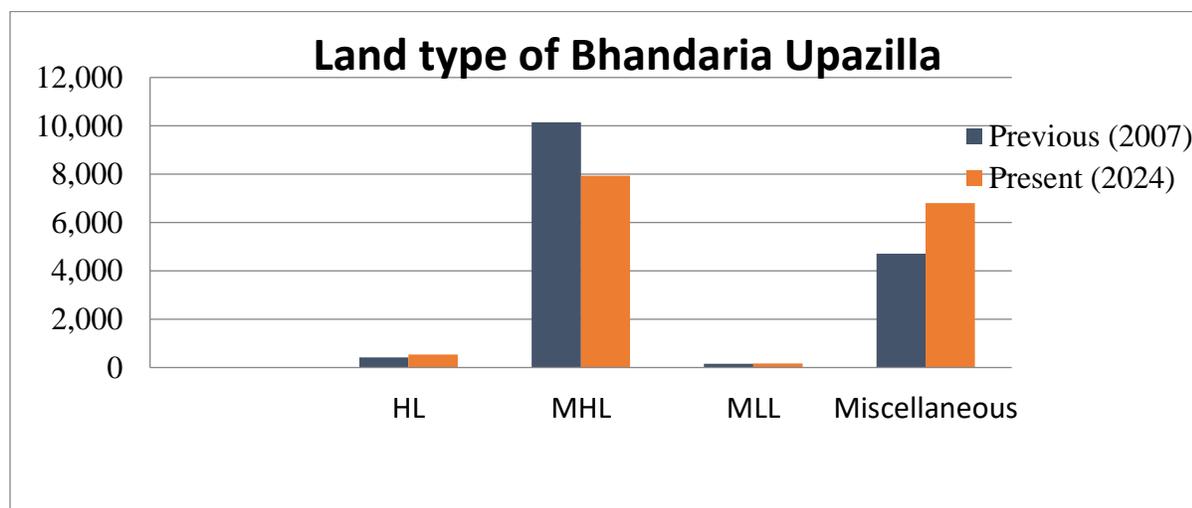
Land type of Bhandaria Upazilla

Change in Land Use

Land Use	Land type	Previous (2014)		Present (2024)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
Annual	HL	120	2.6	112	0.72	-6.7	
F-Aus-TA	MHL	5088	32.9	310	2.0	-93.9	
RC-F-TA	MHL	1270	8.2	2261	14.6	+78.0	
F-F-TA	MHL	3792	24.6	5113	33.1	34.8	
B- F-TA	MHL	0	0	247	1.5	+100	
RC-Aus-TA	MLL	158	0	174	1.1	+10.1	
Other	-	303	1.9	418	2.7	-9.1	
Miscellaneous	-	4712	30.5	6,808	44.1	+44.5	
Total		15,443	100.0	15,443	100.0		
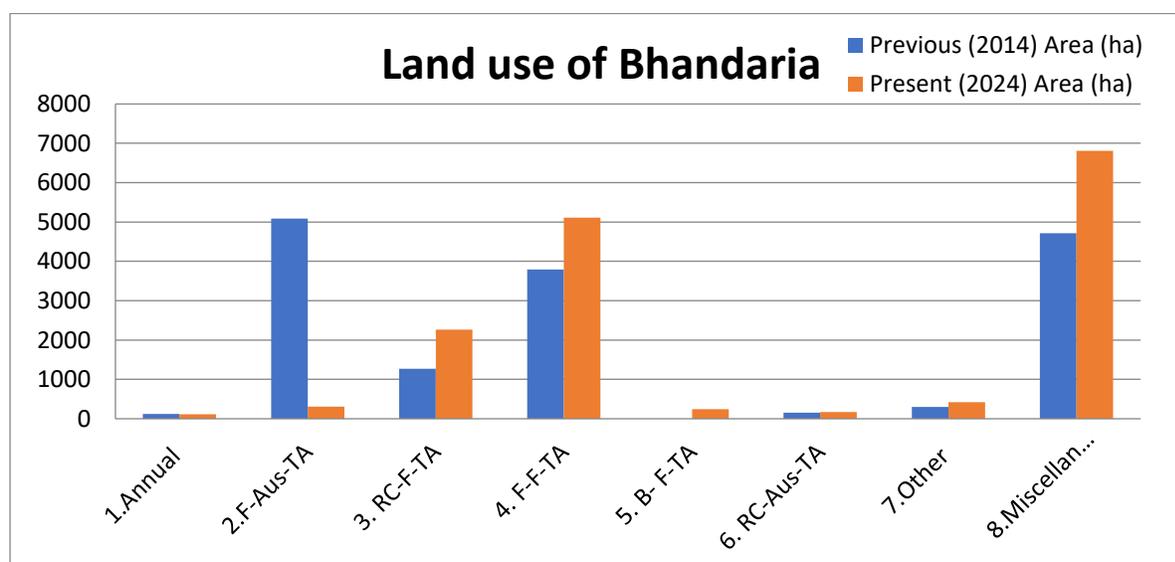
Major findings of BatiaghataUpazila, Khulna

i) Total area- 23,622 ha

ii)Total soil sample collected-128

iii)Physiography & AEZ code- Ganges Floodplain and Ganges Tidal Floodplain &AEZ 11 and AEZ 13

iv)Major land type-Highland, Medium Highland, Medium Lowland

v)Major soil group-Sara, Gopalpur, Ishurdi, Bajoa, Borishal etc.

Major findings of Godagari Upazila, Rajshahi

i) Total area- 47,563 ha

ii)Total sample colleted-344

iii)Physiography & AEZ code- Barind Tract (26), Ganges Floodplain (10, 11)

iv)Major land type- High Land

v) Major soil group-Amnura

vi) Major land use- Rabi crops (Wheat/ Mustard/ Potato/Pulse Crop/ Onion seeds-Fallow-T. Aman

Changes in Land Type

| Land type	Previous (Year 2016)		Present (Year 2023)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
High land	31,456	66	32,111	67	+1	Some low lands are converted to settlement
Medium High land	5,701	12	6,974	15	+3	
Medium Low land	2,399	5	2,212	5	No change	
Low land	3,259	7	1,162	2	-5	
Miscellaneous	4,748	10	5,104	11	+1	
Total	47,563	100	47,563	100		
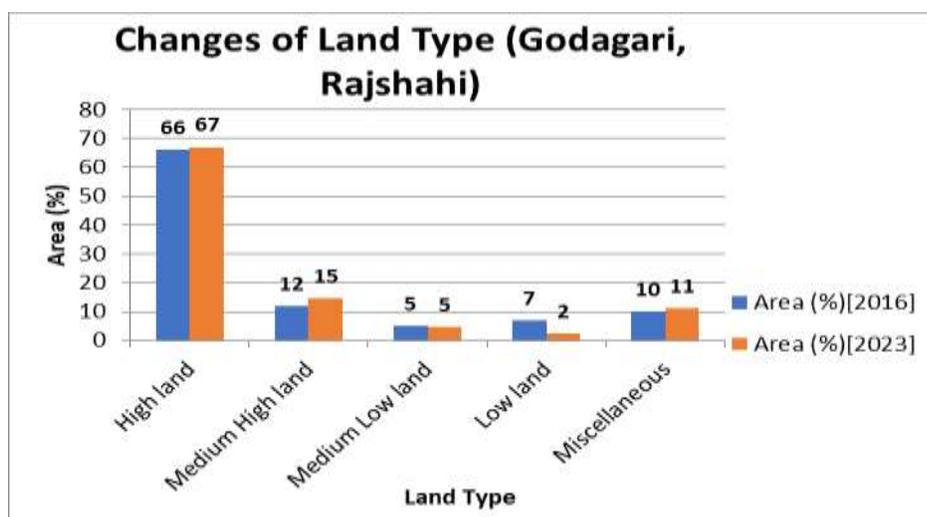
Changes in Land Use in different Land type

Cropping pattern (2016)	Cropping pattern (2023)	Land Type	Year 2016		Year 2023		% increase/ decrease	Possible reasons
			Area (Ha)	%	Area (Ha)	%		
Boro- Fallow- T.Aman	Boro- Fallow- T.Aman	HL+MHL	14,007	29.45	11,030	23.19	-6.26	Climate change, technological development, socio-economic condition of the farmers.
Rabi crops (Wheat/Maize)- Fallow-T.Aman	Robi crops (Wheat/ Mustard/ Potato/Pulse Crop/ Onion seeds-Fallow-T. Aman	HL+MHL	3,408	7.16	11,456	24.09	+ 16.93	
Mustard- Boro - Fallow	Rabi crops (Mustard- Boro/ Maize/Lentil/ Onion seed- Aus/ Maize- Fallow)	HL+MHL	3,495	7.35	1,730	3.64	-3.71	
Rabi crops (Potato/Mustard)- Boro- T.Aman	Rabi crops (Potato- Boro/Mustard/	HL+MHL	11,557	24.3	2,143	4.51	-19.79	

	Wheat/Onion/ Maize)- Boro- T.Aman						
Rabi vegetables (Cabbage/Cauliflower/Onion/Radish /Brinjal/Tomato/Bean/Carrot)- Kharif vegetables (Lady's finger/ Bottle gourd/Bitter gourd/Pointed gourd/Basil etc.)	Rabi vegetables (Cabbage/Cauliflower/Onion/Radish /Brinjal/Tomato/Bean/Carrot)- Kharif vegetables (Lady's finger/ Bottle gourd/Bitter gourd/Pointed gourd/Basil etc.)	HL+MHL	1485	3.12	795	1.67	-1.45
Fruit Orchard (Mango/Jackfruit/ Lichi/Lemon/Guava/ Papaya/Palm/ Dates etc.	Fruit Orchard Guava/ Mango/ Papaya etc)	HL+MHL	53	0.11	4550	9.57	+9.46
Boro- Fallow- Fallow	-	HL+MHL	918	1.93	-	-	-
Boro- Jute- T.Aman	-	HL+MHL	315	0.66	-	-	-
Boro- Deep water Aman	-	MHL+MLL	636	1.34	-	-	-
-	Rabi crops (Boro/Lentil-Aus-Tomato	HL+MHL	-	-	2388	5.02	-
-	Rabi crops (Mustard/Maize-Jute/ Aus/Maize-Mashkalai)	HL+MHL	-	-	2534	5.33	-
Rabi crops (Wheat/Maize/Potato/Mustard/Pulse crop)- T. Aus/ Jute-T.Aman	-	HL+MHL	5,660	11.9	-	-	-
Rabi crops (Wheat/Potato/Mustard/- Jute- T.Aman	-	HL+MHL	142	0.3	-	-	-
Rabi crops (Wheat/Maize/Potato/Mustard/Water melon/ Cucumber/ Fruiti/ Peanut) - Fallow- T.Aman	-	HL+MHL	117	0.25	-	-	-
Rabi crops (Watermelon/ Cucumber/ Fruiti/	-	HL+MHL+MLL	117	0.25	-	-	-

Peanut) - Fallow-Fallow								
Cucumber/ Fruiti/ Peanut - Fallow-Fallow	-	HL+M HL+M LL	587	1.23	-	-	-	
Sugarcane/ Banana/Zinger/ Turmeric/Colocasia/ Papaya etc.	-	HL+M HL	172	0.36	-	-	-	
Other cropping patterns	Other cropping patterns	HL+M HL+M LL+L L	146	0.31	200	.42	+.19	
Miscellaneous (Homestead, River, Pond, Waterbodies etc)	Miscellaneous (Homestead, River, Pond, Waterbodies etc)		4,748	9.98	10,737	22.57	-	
	Total		47,563	100	47,563	100	+12.59	

Changes of Cropping Pattern (Godagari, Rajshahi)
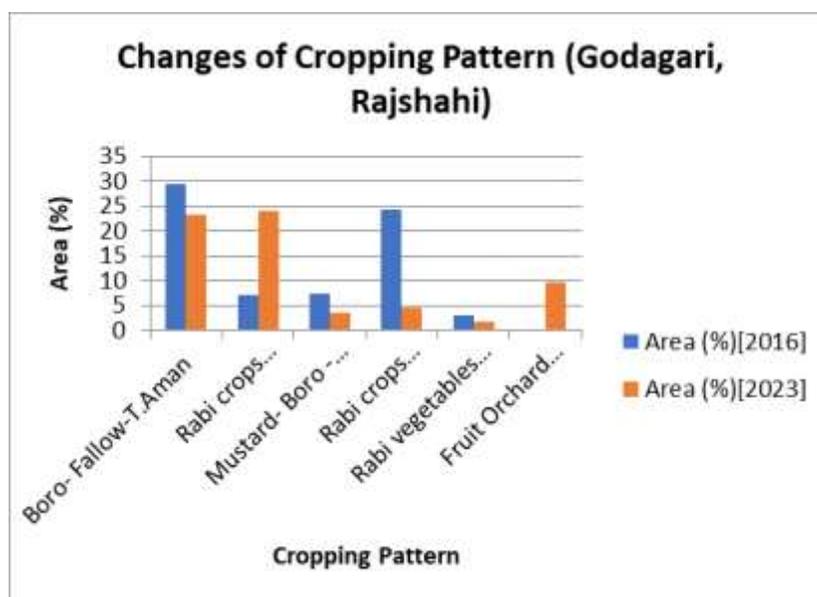
Major findings of Chapainawabganj Sadar Upazila, Chapainawabganj

i) Total area- 42,471 ha
ii)Total sample colleted-224
iii)Physiography & AEZ code- Barind Tract (26), Ganges Floodplain (10, 11),
iv)Major land type- High Land
v) Major soil group-Sara
vi) Major land use- Boro- Aus/Fallow-T.Aman

Changes in Land Type

Land type	Previous (Year 2018)		Present (Year 2023)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
High land	11,919	28.06	12,040	28.35	+0.29	Some low lands are converted to settlement
Medium High land	11,541	27.17	11,421	26.89	-0.28	
Medium Low land	2,587	6.10	2,600	6.12	+0.02	
Low land	158	0.37	110	0.26	-0.11	
Miscellaneous	16,266	38.30	16,300	38.38	+0.08	
Total	42,471	100	42,471	100		
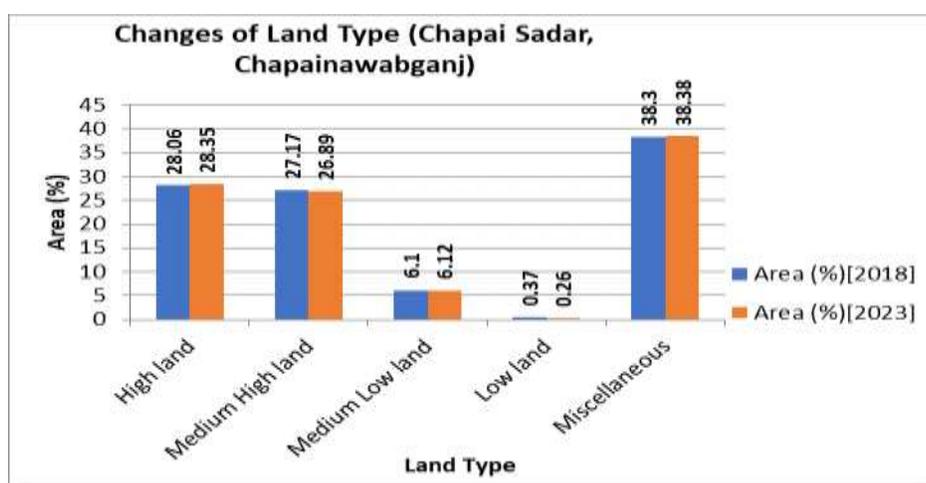
Changes in Land Use in different Land type

Cropping pattern (2016)	Cropping pattern (2023)	Land Type	Year 2018		Year 2023		% increase/ decrease	Possible reasons
			Area (Ha)	%	Area (Ha)	%		
Boro- Fallow- T.Aman	Boro- Fallow- T.Aman	HL+M HL	2,989	7.04	3,180	7.49	0.45	Climate change, technological development, socio-economic condition of the farmers.
Rabi crops (Wheat/Maize)- Fallow-T.Aman	Boro- Aus/Fallow- T.Aman	HL+M HL	2,187	5.15	6,360	14.97	9.82	
Mustard- Boro - Fallow	Mustard- Boro - Fallow	HL+M HL	1,513	3.56	310	0.73	-2.83	
Rabi crops (Potato/Mustard) - Boro- T.Aman	-	HL+M HL	2,868	6.75	-			

Rabi vegetables (Cabbage/Cauliflower/Onion/Radish/Brinjal/Tomato/Bean/Carrot)- Kharif vegetables (Lady's finger/ Bottle gourd/Bitter gourd/Pointed gourd/Basil etc.)	-	HL+M HL	2,126	5.01	-		
Fruit Orchard (Mango/Jackfruit/Lichi/Lemon/Guava/ Papaya/Palm/ Dates etc.	-	HL+M HL	2,003	4.72	-		
Sugarcane and mixed Rabi crops	Sugarcane-Sugarcane-Sugarcane	HL+M HL	581	1.37	460	1.08	-0.29
Fallow- Fallow-T.Aman	Fallow-Fallow-T.Aman	HL+M HL	441	1.04	5,150	12.13	11.09
Rabi crops (Mustard/ Potato/ Onion/ Mashkalai)-Jute-Fallow	Rabi vegetables-Aus-Fallow	MHL+ MLL	702	1.65	1250	2.94	1.29
Rabi crops (Wheat/Maize/Potato/Mustard/Pulse crop)- T. Aus/ Jute-T.Aman	Rabi crops (Boro/ Wheat)- Aus-Mashkalai	HL+M HL	6,363	14.98	9,860	25.02	8.24
Rabi crops (Wheat/Potato/Mustard- Jute-T.Aman	-	HL+M HL	486	1.14			
Rabi crops (Potato/Mustard) - Boro-Fallow	Boro/Mustard - Fallow - Fallow	HL+M HL	824	1.94	310	.73	-1.21
Rabi crops (Wheat/Mustard)	-	HL+M HL	151	0.36	-		

– Mixed Mango Orchard							
Rabi crops (Wheat/Mustard) – Boro- T. Aman	Rabi crops (Mustard/ Rabi vegetables)- Aus- Mashkalai	HL+M HL	2485	5.85	3070	7.23	1.38
Other cropping patterns	Other cropping patterns	HL+M HL+M LL+L L	486	1.14	150	.35	-0.79
Miscellaneous (Homestead, River, Pond, Waterbodies etc)	Miscellaneous (Homestead, River, Pond, Waterbodies etc)		16,266	38.30	12,371	29.13	-9.17
	Total		42,471	100	42,471	100	
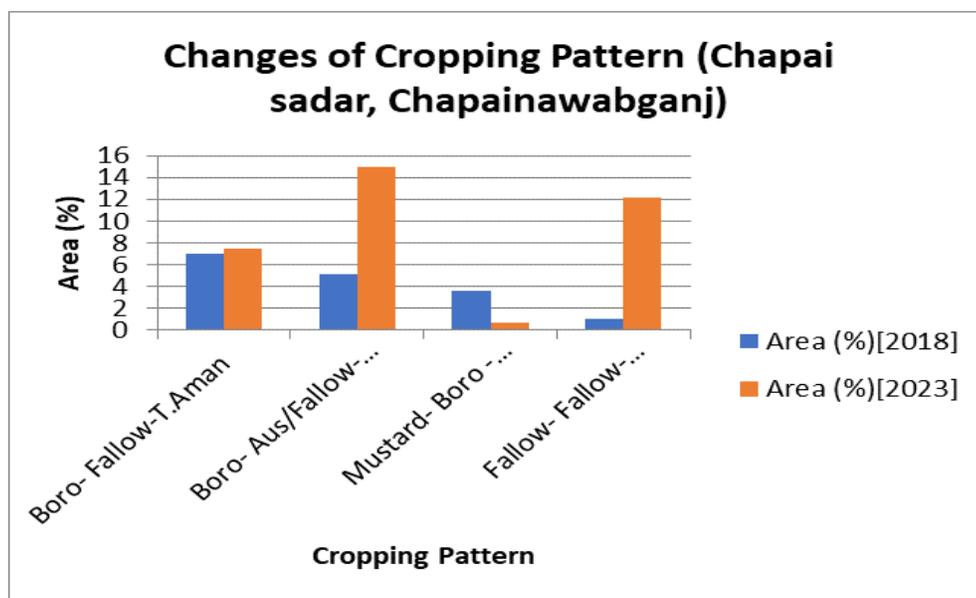
Major findings Kahalu upazila, Bogura

i) Total area-24,042 ha
ii)Total sample colleted-107
iii)Physiography & AEZ code-Barind Track (25), Tista Floodplain (3)
iv)Major land type-Highland, Medium highland
v)Major soil group-Amnura, Ekdala, Kahalu, Gangachara, Kaunia

Changes in Land Type

Land type	Previous (Year)1991		Present (Year) 2023		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	9,889	41.1	9,389	39.05	-2.05	Due to decrease of agricultural land and rapid urbanization
Medium Highland	11,538	48.8	11,038	45.91	-2.89	
Medium Lowland						
Lowland						
Miscellaneous	2,615	10.9	3,615	15.03	+4.13	Rapid urbanization
Total	24,042		24,042	100		
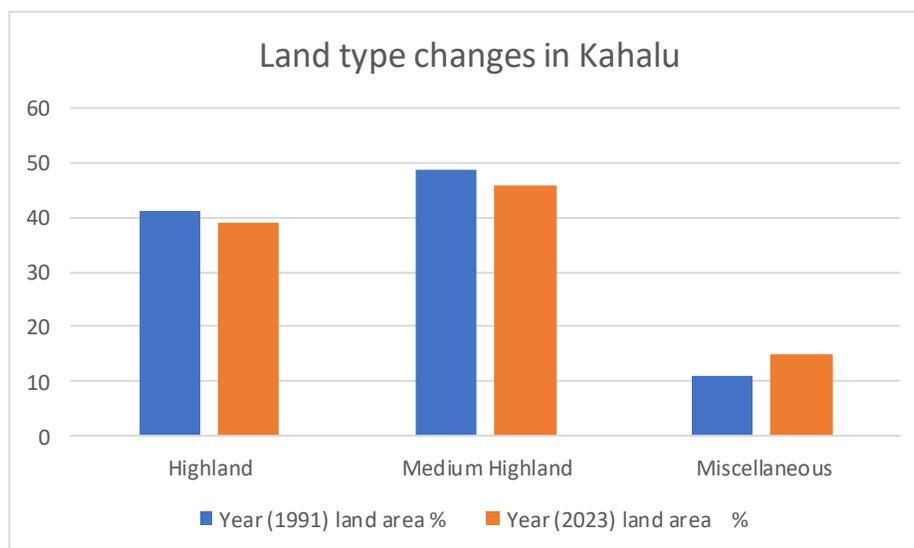
Changes in Land Use

Land Use	Land type	Previous (year)1991		Present (year)2023		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
FruitOrchard Mango/Jackfruit/Lichi/Ber	HL	121	0.5	240	1.0	+0.5	Due to changes in agricultural practices
Banana/Papaya/Ginger/Turmeric	HL	611	2.5	481	2.0	-0.5	
Rabi vegetables- Kharif vegetables	HL+MHL	776	3.2	1922	8.0	+4.8	
Maize-Fallow-T.Aman	HL+MHL	687	2.9	720	3.0	+0.1	
Potato/Mustard-Boro-T.Aman	HL+MHL	3,505	14.6	7212	30.0	+15.4	
Robi Crops-Jute/T.Aus-T. Aman	HL+MHL	3,759	15.6	2402	10.0	-5.6	
Boro-Fallow-T.Aman	HL+MHL	11,769	49.0	4807	20	-29	
Boro-Fallow-Fallow	HL+MHL			2402	10	+10	
Other cropping patterns	HL+MHL	199	0.8	241	1.0	+0.2	
Miscellaneous		2,615	10.9	3,615	15.03	+4.13	Rapid urbanization
Total		24,042	100	24,042	100		

Major findings of SherpurUpazila, Bogura

i) Total area-29,640
ii)Total sample colleted-142
iii)Physiography & AEZ code-Barind tract (25 and 27), Tista floodplain (3)
iv)Major land type-highland, medium highland, medium lowland
v)Major soil group-Noadda, Amnura, Ekdhala, Kahalu, Nachol, Polashbari, Jamun, Gangachara, Kaunia, Loshkara

Changes in Land Type

Land type	2014 (Year)		2024 (Year)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	8,216	27.7	7,716	26.0	+1.7	Rapid expansion of urban area
Medium Highland	14,095	47.6	14,595	49.2	-1.6	
Medium Lowland	2,375	8.0	1,875	6.3	+1.7	
Miscellaneous	4,954	16.7	5,454	18.4	-1.7	
Total	29,640	100	29,640	100		
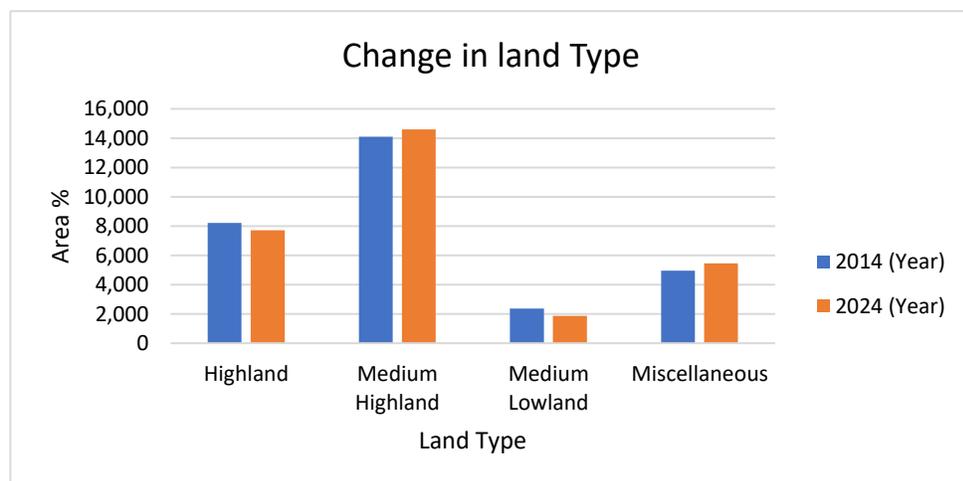
Changes in Land Use:

Land Use	Land type	…2014…(year) Area (ha)	%	…2024…...(year) Area (ha)	%	% increase/ decrease	Possible Reasons
Fruit garden (mango,litchi,guava,sugarcane, banana)		959	3.2	1000	3.3	+0.1	increase of fruit and vegetable cultivation
Wheat/maize-fellow-T-aman	HL	2290	7.7	3000	10.12	+2.42	
Robi vegetables- Kharif vegetables	HL	693	2.3	800	2.6	+0.3	
Robi crops-Jute/boro/aus	HL+MHL	4,417	14.9	4617	15.6	+0.7	
Potato/mustard-Boro-T-aman	HL+MHL	1,638	5.5	1838	6.2	+0.7	
Boro-fellow-t.aman	HL+MHL	1228	41.6	1528	5.1	+1	
Boro-fellow-fellow	HL+MHL	2,243	7.6	2043	6.8	-0.8	
Others crop	MHL+ MLL	148	0.5	1148	3.8	+3.3	
Miscellaneous	HL+MHL	4,954	16.7	5954	20.0	+3.3	
Total		29,640	100	29640	100		

Major findings of Pabna Sadar, Pabna

i) Total area- 44,391

ii)Total sample colleted- 189

iii)Physiography & AEZ code- Ganges River Floodplain; (AEZ 11,10)

iv)Major land type- Medium High Land

v)Major soil group- Sara Soil,Gopalpur Soil

vi)Major Land use- Rabi Crop- Jute- Fallow/ Rabi Crop- Jute- T.Aman, Boro- Fallow- T.Aman

Changes in Land Type

Land type	Previous (Year) Area (ha)	%	Present (Year) Area (ha)	%	% increase/ decrease	Possible reasons
Highland	14950	33.68	11216	25.27	-8.41	-
Medium Highland	14651	33	15448	34.79	1.79	
Medium Lowland	5179	11.67	7878	17.75	6.04	
Low land	425	0.96	-	-	-0.96	
Miscellaneous	9186	20.69	9849	22.19	1.5	
Total	44391	100	44391	100	-	
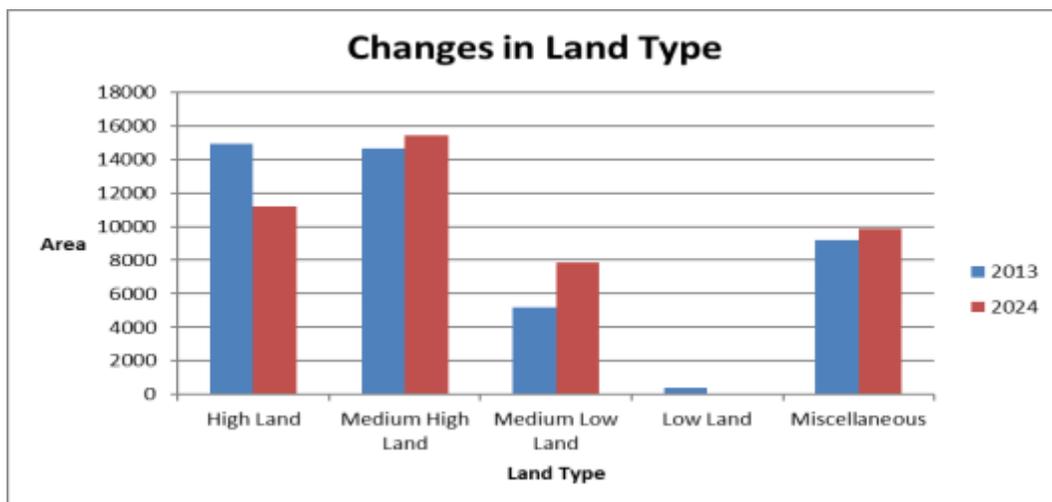
Major findings of Bera Upazila, Pabna

i) Total area- 24,871
ii)Total sample colleted- 105
iii)Physiography & AEZ code- Ganges River Floodplain, New Brahmaputra and Jamuna
Floodplan; (AEZ 7,10,12)
iv)Major land type- Low Land, Medium highland
v)Major soil group- Ghior Soil
vi)Major Land use- Rabi Crop- Jute- Fallow/ Rabi Crop- Jute- T.Aman, Boro- Fallow- T.Aman

Changes in Land Type

Land type	Previous (Year)		Present (Year)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	1487	5.98	2054	8.26	2.28	-
Medium Highland	2960	11.9	4720	18.98	7.08	
Medium Lowland	4065	16.34	3911	15.73	-0.61	
Low land	6474	26.03	6161	24.77	-1.26	
Very lowland	1440	5.79	2010	8.08	2.29	
Miscellaneous	8445	33.96	6015	24.18	-9.78	
Total	24871	100	24871	100	-	

Major findings of Tarash Upazila Sirajganj

i) Total area- 29,732
ii)Total sample colleted-135
iii)Physiography& AEZ code- Ganges (Floodplain)
iv)Major land type- Invarten Highland
v)Major soil group- Nijhuri,Amnura,Ekdala,Taradh, Jamun
vi)Major land use-

Changes in Land Type

Land type	Previous 2012		Present 2023		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	1,429	4.8	1,530	5.2	7	intensive cultivation,uplifting or Removal of top soil for Brick kleen
Medium Highland	9,909	33.3	10,106	34	1.9	
Medium Low land	8,549	28.8	8,765	29.5	2.5	
Low land	5,049	17.0	4,387	14.7	15	
Miscellaneous	4,796	16.1	4,944	16.6	3.0	
Total	29,732	100.0	29,732	100		

Land type changes in Tarash Upazila
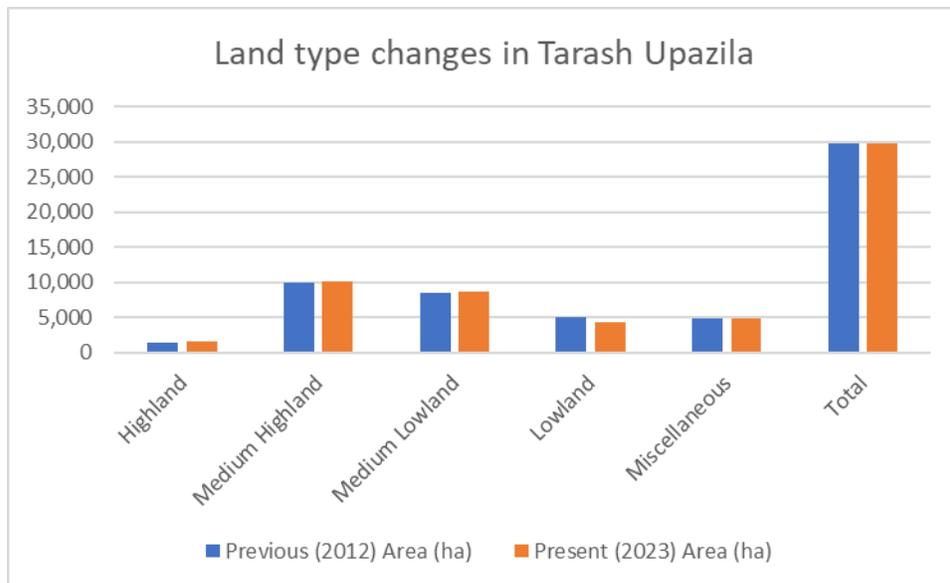
Major findings Atrai Uazila, Naogaon

i) Total area-28,300 ha
ii)Total sample colleted-140
iii)Physiography & AEZ code-Barind Track (25), Lowar Atrai Basin (5), Tista Floodplain (3), Ganga Flood plain (11)
iv)Major land type-Highland, Medium highland
v)Major soil group-Manda, Gongacora, Malonci, Amnura, Akdala, Hasnabad, Tarash, Kawnia, Gopalpur, Ghior, Batra.

Changes in Land Type

Land type	Previous (Year)1999		Present (Year) 2023		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	1189	4.20	1248	4.41	0.21	Rapid urbanization
Medium Highland	5378	19.00	5447	19.25	0.25	
Medium Lowland	17524	61.92	17629	62.29	0.37	
Lowland	457	1.614	-			
Miscellaneous	3752	13.24	3976	14.05	0.81	
Total	2,8300	100	28,300	100.00	0.03	
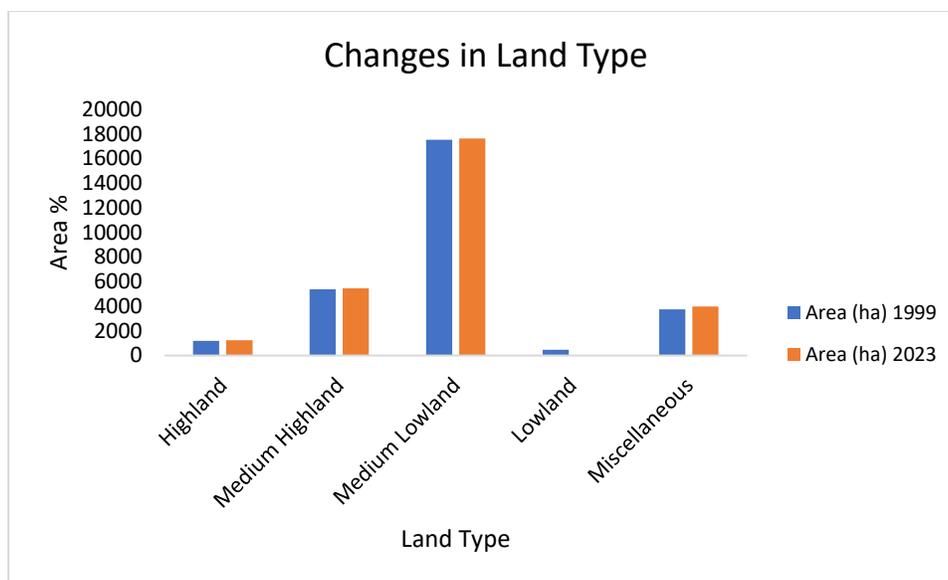
Changes in Land Use

Land Use	Land type	Atrai Upazila			
		Previous Survey (1999)		Present Survey (2023)	
		Area (ha)	%	Area (ha)	%
1. Potato/Boro-Aush-Fallow	HL	480	1.69	1205	4.25
2. Potatoes/Boro- Fallow -T. Aman	HL			725	2.56
3. Mustard/Boro- Fallow - Fallow	HL			3280	11.59
4. Corn- Fallow - Fallow	HL+MHL			3780	13.35
5. Boro- Fallow -T.Aman	HL+MHL	1546	5.46	3140	11.09
6. Boro- Fallow - Fallow	HL+MHL	4050	14.31	2470	8.72
7. Boro-Aush- Fallow	HL+MHL	3500	12.36	1450	5.12
8. Boro-B.Aman-T.Aman	HL+MHL			3600	12.72
9. Mustard/Boro- Fallow - T.Aman	HL+MHL			740	2.61
10. wheat-Aush- Fallow	HL+MHL			480	1.69
11. Corn-Aush- Fallow	HL+MHL			480	1.69
12. Vegetables/spice-vegetables/jute-vegetables/ Fallow	HL+MHL			720	2.54
13. Potato/Boro- Fallow - Fallow	HL+MHL			480	1.69
14. Potato/Boro-Sesame/Maize-Fallow	HL+MHL			400	1.42
15. Mustard/Boro-Aush- Fallow	MHL+MLL			480	1.69
16. Lentil-Aush- Fallow	MHL+MLL	480	1.69	400	1.42
17. other	HL+MHL	18244	64.49	270	0.95
Total		**28300**	**100**	**28300**	**100**

Major findings of Nawabganj upazila, Dinajpur

i) Total area- 35, 447 ha.
ii)Total sample colleted- 150
iii)Physiography & AEZ code- Old Himalayan Peidmont Plain (1), Barind Tract (25 & 27)
iv)Major land type- High Land, Medium High Land & Medium Low Land.
v)Major soil group- Belabo, Noadda, Amnura, Ekdala, Ranisankail, Pirgachha, Palasbari, Amgaon, Jamun, Gangachara, Srirampur, Kaunia.

Changes in Land Type

Land type	Previous (Year-2010)		Present (Year-2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	14,155	39.9	13,774	38.9	−1.00	Infrastructural Development, Top Soil Removal for Brick kiln, Riverbank Erosion etc.
Medium Highland	13,471	37.9	11,455	32.3	−5.6	
Medium Lowland	286	0.8	294	0.8	0.00	
Lowland	-	-	-	-	-	
Miscellaneous	-	-	-	-	-	
Total	7,589	21.4	9,924	28.0	+6.6	
	35,447	200.0	35,447	100.0		

Changes in Land Use

Land Use	Land type	Previous (year-2010)		Present (year-2022)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
Mango/Litchi/Banana/Jackfruit/Sugarcane	HL	1,008	2.8	1135	3.2	+0.4	Invention of High Yielding Variety, Modern Agricultural Technology, More Irrigation Facility, Increase of Awareness etc.
Rabi Crops (Mustard/Potato/Wheat/Maize/Vegetables)-Boro-T. Aman	MHL	1,783	5.0	3616	10.2	+5.2	
Rabi Crops (Mustard/Potato/Wheat/Maize/Aush/Jute)-T. Aman	HL			2977	8.4	+8.4	
Rabi Vegetables (Potato/Cauliflower/Cabbage/Onion/Brinjal/Bean/Tomato)-Kharip Vegetables (Bitter Gourd/Snake Gourd/Sponge Gourd/Parball/Pumpkin/Ladies Finger/Basil etc)	HL	1,112	3.1	2837	8.0	+4.9	
Rabi Crops (Mastard/Potato/Wheat/Maize/Vegetables)-F-T. Aman	MHL	9,520	26.9	6026	17.0	-9.9	
Boro (Modern)-Fallow-T. Aman (Modern)	MLL	14,099	39.8	8045	22.7	-17.8	
Other Patterns	-	336	1.0	887	2.5	+1.5	
Others (Settlement/Water body/Orchard etc,)	-	7589	21.4	9924	28.0	+6.6	
Total	-	35,447	100.0	35,447	100.0		

Major findings: Pirganj Upazila, Rangpur

i) Total area- 40932
ii)Total sample colleted-183
iii)Physiography & AEZ code-Barind Tract (27) and Tista Flood plain(3)
iv)Major land type- High land(20.5%),Medium high land (46.2%)
v)Major soil group- Belabo, Noadda, Chandra,Sahapur,Pirgacha,Polashbari, Gangachara, Kauniya, Loskora

Change in Land Type

Land type	2008		2024		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	13705	33.5	8390	20.5	-13	including household area
Medium Highland	22028	53.8	18910	46.2	-7.6	
Medium Lowland	970	2.4	4012	9.8	+7.4	developed drainage system
Miscellaneous	4229	10.3	9620	23.5	+13.2	
Total	**40932**	**100**	**40932**	**100**		
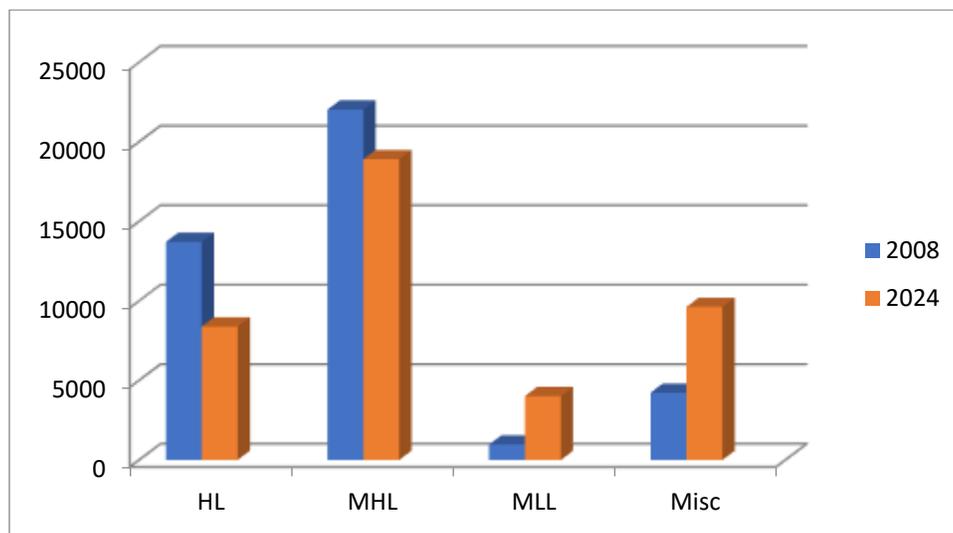
Fig: Graphical view of land type changes 2008-2024

Change in Land Use

Upazila	District	Physiography & AEZ	Major soil group	Major Land use	Major constraints	Remarks
Pirganj	Rangpur	Barind tract 27	belabo noadda chandra sahapur	1.potato/mustard-boro-t.aman 2.Rabi –kharip vegetable 3.boro-fallow-t.aman	scarcity of irrigation and labour	land occupied in settlement area
		Tista flood plain 3	Pirgacha polashbari gangachora kaunia loskora	1.potato/mustard-boro-t.aman 2.Rabi –kharip vegetable 3.boro-fallow-t.aman 4.wheat/jute-T.Aus-T.aman	slightly flood affected area	

Major Findings of Rajarhat Upazila of Kurigram

Change in Land Type

Land type	Previous (Year) 2000		Present (Year) 2023		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	6,686	28.3 %	5,175	22.7 %	5.6 % decrease	Due to increase of settlement, industries, change in river, pond, char land & exchange of Enclave (Seat Mahal).
Medium Highland	11,527	48.8 %	9,105	40.0 %	8.8 % decrease	
Medium Lowland	1958	8.3 %	1,340	5.9 %	2.4 % decrease	
Miscellaneous	3429	14.5 %	7,167	31.5 %	17 % increase	
Total	23600	100 %	22,787	100 %		
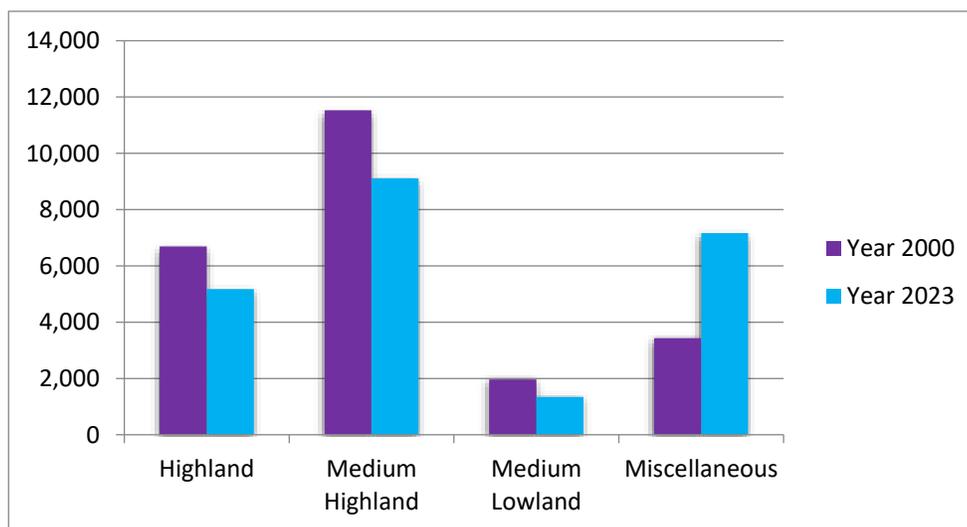
Fig: Graphical view of land type changes during 2000 to 2023 (Bhurungamari Upazila, Kurigram)

Change in Land Use

Land Use	2000 (year)		2023 (year)		% increase/ decrease	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Betel nut/banana/papaya/zinger/Turmeric/ Perennial crops	165	0.7 %	230	1.0 %	0.3 % increase	
Vegetable- Vegetable- Vegetable- Vegetable	-	-	62	0.3 %	new introduce	1.Due to increasing cropping intensity, new cropping pattern adapted

2. Due to increase of settlement, industries, change in river, pond, char land. |
Vegetable- Vegetable- Vegetable	-		230	1.0 %	new introduce	
Robi Vegetables -Kharif Vegetables	711	3.0 %	275	1.2 %	1.8 % decrease	
Potato-Maize-T. Aman	-		460	2.0 %	new introduce	
Maize-Jute- T. Aman	-		868	3.8 %	new introduce	
Wheat-Jute- T. Aman	553	2.3 %	398	1.7 %	0.6 % decrease	
Mustard-Boro- T. Aman	450	1.9 %	1959	8.6 %	6.7 % increase	
Potato- Boro- T. Aman	-		107	0.5 %	new introduce	
Boro-Fallow- T. Aman	7969	33.8 %	8163	35.8 %	2.0 % increase	
Boro-Fallow-Fallow	1263	5.4 %	597	2.6 %	2.8 % decrease	
Boro-Fallow-Black Gram	-	-	197	0.9 %	new introduce	
Peanut- Fallow-Black Gram	-	-	197	0.9 %	new introduce	
Peanut/ Black Gram/ pulse/Maize/Potato/chili	-	-	394	1.7 %	new introduce	
Fallow	1253	5.3 %	-	-		
Others	-	-	1483	6.5 %	-	
Miscellaneous	3429	14.5 %	7167	31.5 %	16 % increase	
Total	**23600**	0.7	**22787**	**100** %		

* Mustard-Jute- T. Aman, Foxtail Millet

Major findings of Taraganj Upazila, Rangpur

i) Total area-12,866
ii)Total sample colleted-80
iii)Physiography & AEZ code- Barind tract (25) and Tista floodplain (3)
iv)Major land type-Medium High land
v)Major soil group- Gangachara
vi) Major land use- Boro-Fallow-T.aman

Changes in Land Type

Land type	Previous (Year)		Present (Year)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
High land	3833	29.79	3641	28.30	-1.49	Due to decrease of agricultural land and rapid urbanization
Medium High land	7444	57.86	7072	54.97	-2.89	
Medium Low land	263	2.04	268	2.08	+.04	
Low land	-	-	-	-	-	
Miscellaneous	1326	10.31	1885	14.65	+4.34	Rapid urbanization
Total	12866	100	12866	100		
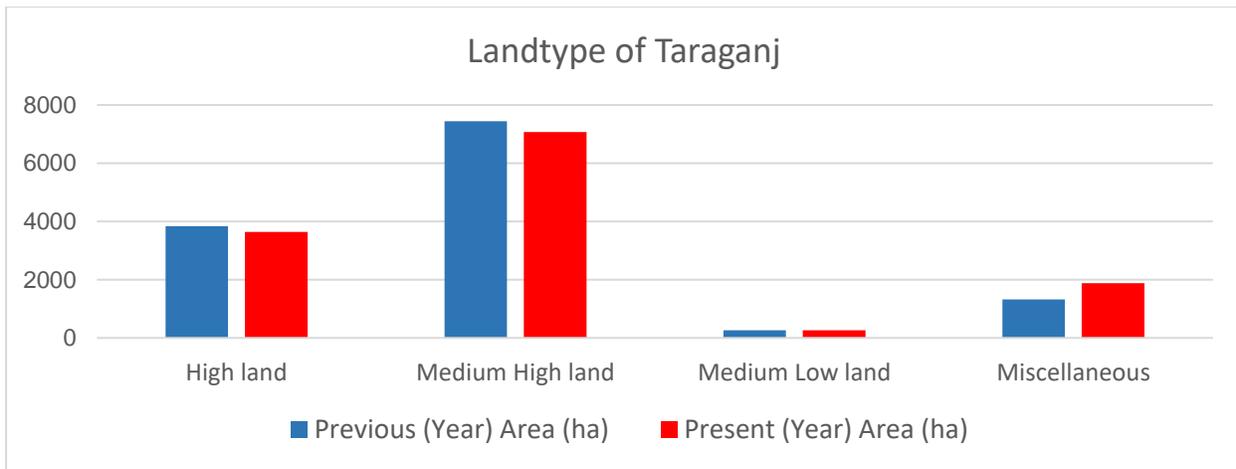
Changes in Land Use in different Land type

Land Use	Land type	Previous (year)		Present (year)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
FruitOrchard Mango/Jackfruit/Lichi/Ber	HL	155	1.20	220	1.71	+0.51	Due to changes in agricultural practices
Banana/Papaya/Ginger/Turmeric	HL	511	3.97	368	2.86	-1.11	
Tobacco-Jute/T.Aus-T.Aman	HL+MHL	676	5.25	889	6.91	+1.66	
Tobacco-Boro-T.Aman	HL+MHL	587	4.56	776	6.03	+1.47	
Rabi vegetables-Kharif vegetables	HL+MHL	687	5.34	483	3.75	-1.59	
Maize-Fallow-T.Aman	HL+MHL	659	5.12	346	2.69	-2.43	
Potato/Mustard-Boro-T.Aman	HL+MHL	1059	8.23	865	6.72	-1.51	
Robi Crops-Jute/T.Aus-T. Aman	HL+MHL	465	3.61	346	2.69	-0.92	
Boro-Fallow-T.Aman	HL+MHL	5901	45.87	5739	44.61	-1.26	
Boro-Fallow-Fallow	MHL+MLL	129	1.00	105	0.82	-0.18	
Other cropping patterns	HL+MHL+MLL	711	5.54	844	6.56	+1.02	
Miscellaneous	-	1326	10.31	1885	14.65	+4.34	
Total		12866	100	12866	100	-	

Land Use of Taraganj
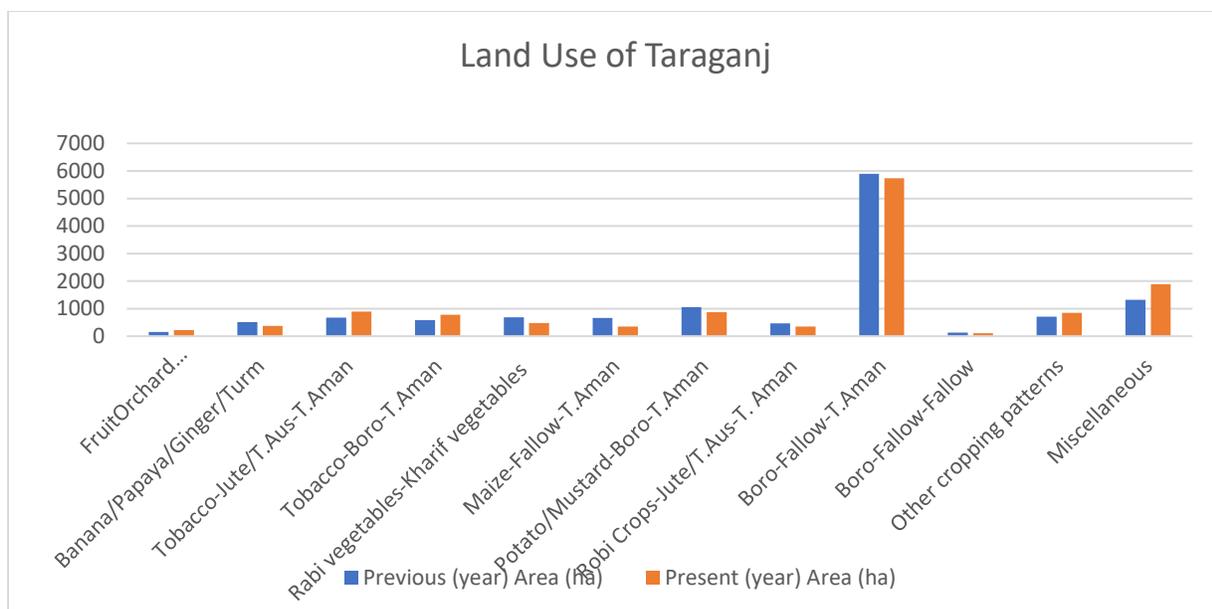
Major findings of Saidpur Upazila, Nilphamari

i) Total area-12167

ii)Total sample colleted-88

iii)Physiography & AEZ code-Barind tract (25) and Tista floodplain (3)

iv)Major land type-Medium High land

v)Major soil group-Gangachara

vi) Major land use- Boro-Fallow-T.aman

Changes in Land Type

Land type	Previous (Year)		Present (Year)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
High land	2751	22.6	2451	20.14	-2.46	Due to decrease of agricultural land and rapid urbanization
Medium High land	7534	61.9	7150	58.77	-3.13	
Medium Low land	55	0.5	63	0.52	0.02	
Miscellaneous	1827	15	2503	20.57	5.57	
Total	12167	100	12167	100.00	0.00	
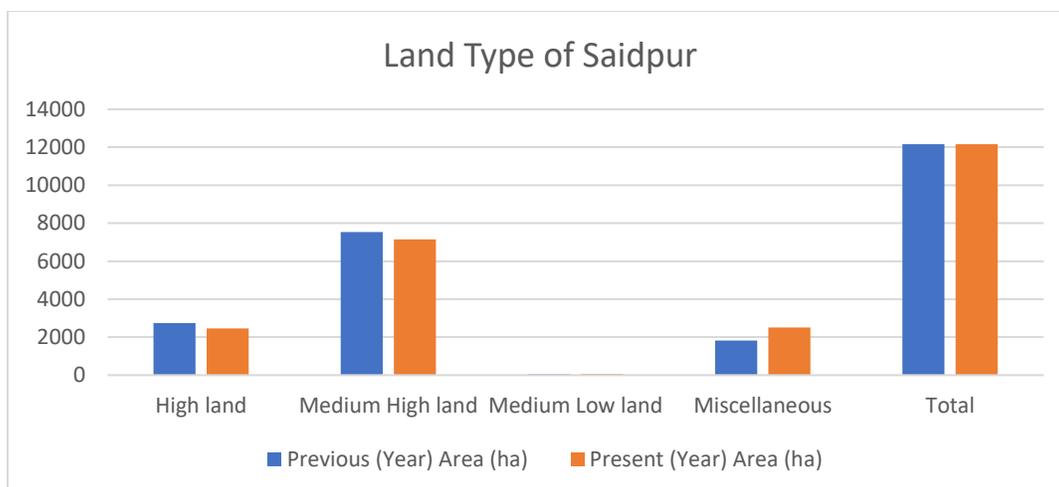
Land Type of Saidpur

Changes in Land Use in different Land type

Land Use	Land type	Previous (year)		Present (year)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
Orchard (Mango/Litchi/Jujube/Mahogany/Bamboo)	HL	372	3.06	393	3.23	0.17	Due to changes in agricultural practices
Sugarcane/Banana/Papaya/Ginger/Turmeric	HL	610	5.01	590	4.85	-0.16	
RabiCrops(Wheat/Potato/Mustard)-Jute/Maize- T. Aman	HL+MHL	1597	13.13	1613	13.26	0.13	
Rabi vegetables-Kharif vegetables	HL+MHL	719	5.91	710	5.84	-0.07	
Potato/Mustard-Boro-T.Aman	HL+MHL	2213	18.19	2340	19.23	1.04	
RabiCrops(Tobacco/Wheat/Maize/	HL+MHL	511	4.20	490	4.03	-0.17	
Boro-Fallow-T.Aman	HL+MHL	4090	33.62	3834	31.51	-2.10	
Boro-Fallow-B.Aman	HL+MHL	12	0.10	10	0.08	-0.02	
Boro-Fallow-Fallow	HL+MHL	40	0.33	35	0.29	-0.04	
Fallow-Fallow-B.Aman	MHL+MLL	3	0.02	2	0.02	-0.01	
Homestead	HL+MH+MLL	169	1.39	180	1.48	0.09	
Miscellaneous	-	1827	15.02	1970	16.19	1.18	
Total		12167	100.00	12167	100.00	-	

land use pattern in Saidpur
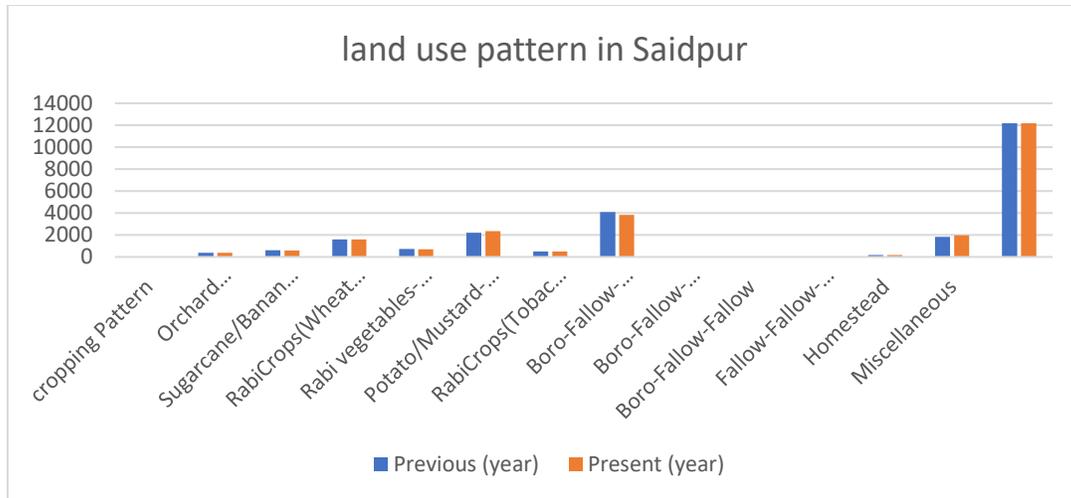
Major findings of Birampur Upazila, Dinajpur

i) Total area- 21,283 ha

ii) Total sample collected- 124

iii) Physiography & AEZ code- Teesta Floodplain (3), Barind Tract (25 & 27)

iv) Major land type- High Land, Medium High Land, Medium Low Land & Miscellaneous

v) Major soil group- Tejgaon, Belabo, Noadda, Amnura, Ekdala, Kahalu, Khilgaon, Manda, Gangachara, Kaunia, Lashkara.

vi) Major land use-Agriculture, Settlement and Orchard

Changes in Land Type

Land type	Previous (Year)		Present (Year)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
High land	7,000	32.9	4,799	22.5	-10.4	Infrastructural Development, Top Soil Removal for Brick Kiln etc.
Medium High land	11,027	51.8	12,004	56.4	+4.6	
Medium Low land	318	14.5	349	1.6	+0.1	
Miscellaneous	2,938	13.8	4,130	19.4	+5.6	
Total	21,283	100.00	21,283	100.00	0.0	
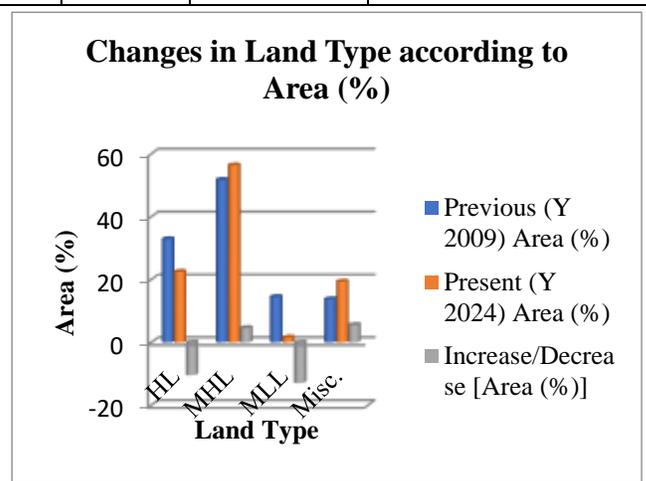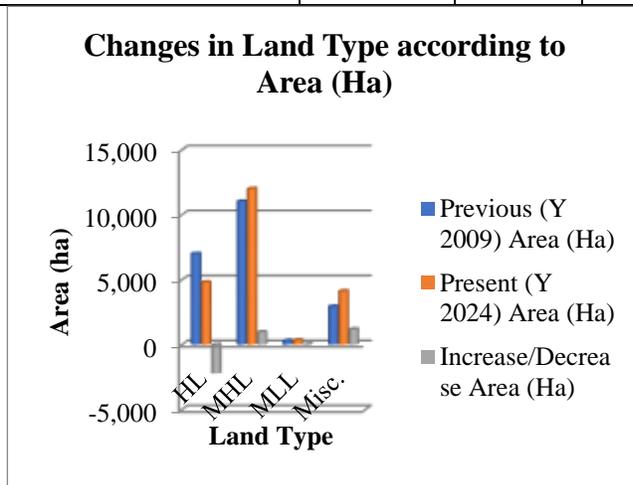
Changes in Land Type according to Area (Ha)

Changes in Land Type according to Area (%)

Changes in Land Use in different Land type

Land Use	Land Type	Previous (Year 2009)		Present (Year 2024)		Increase / Decrease	Reasons
		Area (ha)	%	Area (ha)	%	%	
Mango/Litchi/Banana/Sugarcane	HL	43	0.2	141	0.7	0.5	Invention of High Yielding Variety, Shorter lifetime variety, Modern Agricultural Technology, More Irrigation Facility, Increase of settlement etc.
Rabi Crops (Mustard/Potato/Vegetables)-Boro-T. Aman	MHL	800	3.8	1250	5.9	2.1	
Potato-Maize-T.Aman	HL	44	0.2	58	0.3	0.1	
Rabi Vegetables (Potato/Cauliflower/Cabbage/Onion/Brinjal/Bean/Tomato)-Kharip Vegetables (Bitter Gourd/Snake Gourd/Sponge Gourd/Parball/Pumpkin/Ladies Finger/Basil etc)	HL	472	2.2	35	0.2	-2.0	
Potato/Wheat/Maize/Rabi Vegetables-F-T. Aman	MHL	3,286	15	1130	5.3	-9.7	
Boro (Modern)-Fallow-T. Aman (Modern)	MHL & MLL	13,363	63	10521	49.4	-13.6	
Boro-F-F	MLL	337	1.6	0	0.0	-1.6	
Boro/Wheat/Maize-Jute/Mugbean/Aus-T. Aman	HL & MHL	0	0	3583	16.8	16.8	
Rabi Vegetables/Onion/Wheat/Maize/Mustard - Kharip Vegetables - T. Aman	MHL	0	0	430	2.0	2.0	
Garlic – Onion (Summer) – T. Aman	HL	0	0	5	0.0	0.0	
Others (Settlement/Water body/Forest etc,)	Misc.	2,938	14	4130	19.4	5.4	
Total		21,283	100	21,283	100.0	0.0	

Changes of cropping pattern according to area (Ha)

- Previous (Y 2009) Area (Ha)
- Present (Y 2024) Area (Ha)
- Increase/Decrease (Ha)

Serial Number of Cropping Pattern

Changes of cropping pattern according to area (%)
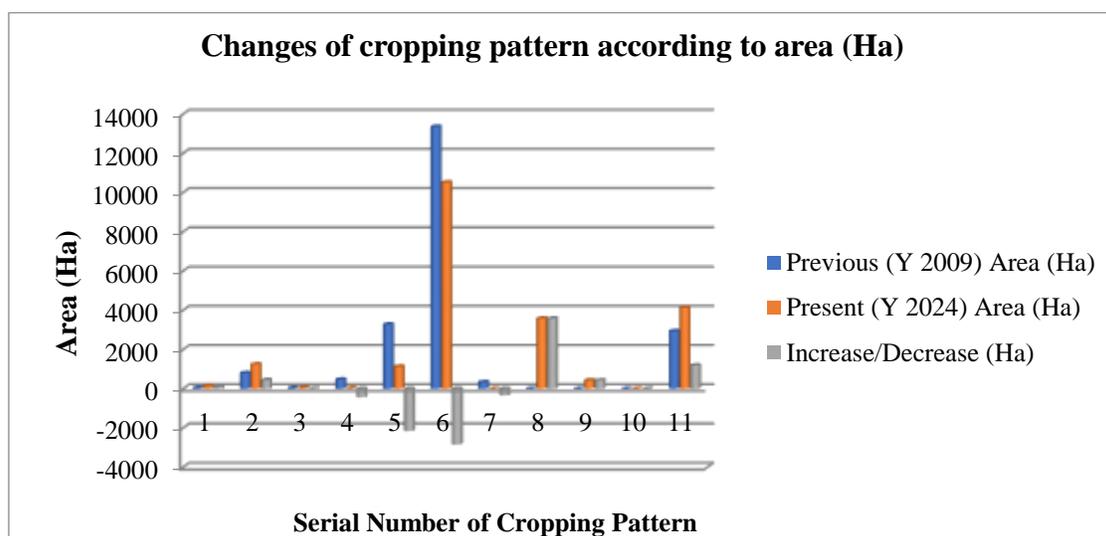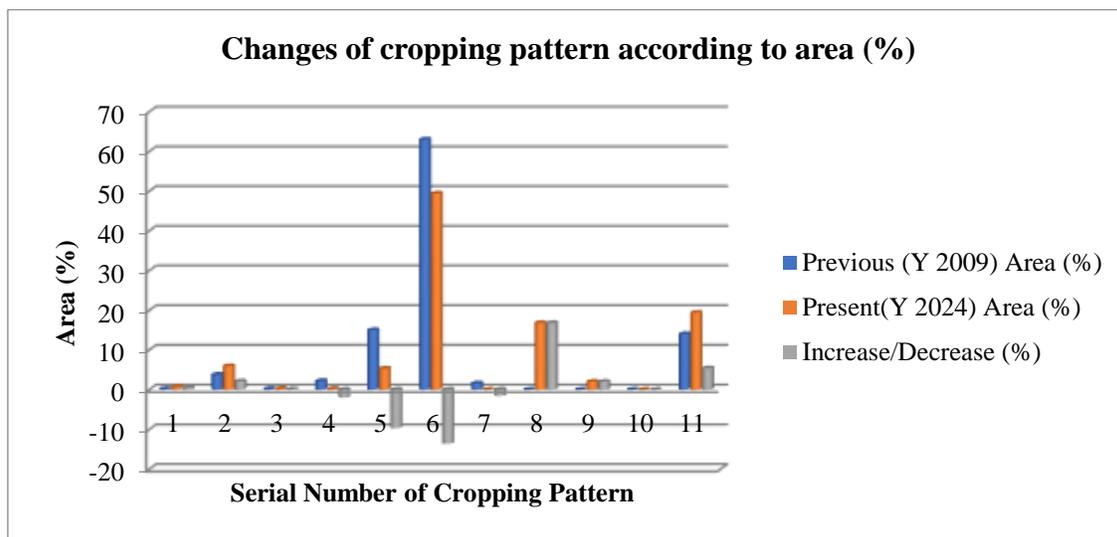
Major findings of Companiganj Upazila, Sylhet

i) Total area- 31237 ha
ii) Total sample colleted-128
iii) Physiography & AEZ code- Eastern Surma Kushiara Floodplain (Code-20), Northern and Eastern Piedmont Plains (Code-22)
iv) Major land type- Medium Low Land
v) Major soil group-Terchibari, Fagu
vi) Major land use- F-F-Boro

Changes in Land Type

Land type	Previous (Year) 1999		Present (Year) 2023		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
High land	2039	6.53%	1790	5.73%	-0.8%	High land decrease due to increase of settlement. Medium High land increase due to siltation from Surma, Dholai, etc rivers during flood. Siltation is also the main reason for the change of Low and Very low land
Medium High land	5195	16.63%	8938	28.61%	11.98%	
Medium Low land	9182	29.40%	6480	20.75%	-8.65%	
Low land	7244	23.19%	5586	17.89%	-5.3%	
Very Low Land	4943	15.82%	5809	18.59%	2.77%	
Miscellaneous	2634	8.43%	2634	8.43%	-	
Total	31237	100	31237	100	-	

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Major findings of Moulvibazar Sadar Upazila, Moulvibazar

i) Total area- 34419 hectare
ii)Total sample colleted- 229
iii)Physiography & AEZ code- Northern and Eastern Hills (29), Northern and Eastern Piedmont Plain (22), Surma-Kushiyara Floodplain (20).
iv)Major land type- High Land, Medium High Land, Medium Low Land, Low Land, Very Low Land
v)Major soil group- Baralekha. Sreemangal, Bijipur, Prithimpasha, Monu, Goainghat, Balaganj, Fagu, Kushiara, Terchibari

Change in Land Type

Slope class/Land type	Previous (2010)		Present (2024)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
High land	3921	11.4	3712	10.8		
Medium High land	14972	43.5	14405	41.9		
Medium Low land	6147	17.9	5640	16.4		
Low land	2569	7.4	2680	7.8		
Very low land	792	2.3	650	1.8		
Miscellaneous	6018	17.5	7332	21.3		
Total	34419	100	34419	100		

Changes in Land Use in different Land type

Land Use	Slope class/land type	Previous (Year)		Present (Year)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
1.Tea Garden	Steep to Very Steep	1006	2.9	1040	3	0.1	
2. Forest	Steep to Very Steep	419	1.2	405	1.2	0	
4. Horticultural crops	Steep to Very Steep	84	0.2	250	0.7	0.5	
5.Rabi Veg-Fallow-T.Aman	MHL	415	1.2	350	1	-0.2	
6.Rabi Veg.-Kharif Veg	HL	267	0.8	450	1.3	0.5	
7. Fallow-T.Aus-T.Aman	MHL	5501	16	6500	18.9	2.9	
8. Boro-Fallow-T.Aman	MHL	957	2.8	3500	10.2	7.4	
9. Fallow-B.Aus-T.Aman	HL, MHL	-	-	-	-	-	
10. Fallow-Fallow-T.Aman	HL, MHL	9561	27.8	9022	26.3	-1.5	
11. Fallow-T.Aus-B.Aman	MHL	785	2.3	150	0.4	-1.9	

12. Boro-Fallow-B.Aman	MLL	361	1	120	0.3	-0.7	
13. Fallow-Fallow-B.Aman	MLL, LL	3004	8.7	350	1	-7.7	
14. Boro-Fallow-Fallow	MLL, LL, VLL	5147	15	4500	13.1	-1.9	
15. Fallow	-	894	2.6	450	1.3	-1.3	
16. Miscellaneous		6018	17.5	7332	21.3	3.8	
Total		34419	100	34419	100	0	

Major findings of Sreemangal, Moulvibazar

i) Total area- 42548 hectare

ii)Total sample colleted-

iii)Physiography & AEZ code- Northern and Eastern Hills (29), Northern and Eastern Piedmont Plain (22), Surma-Kushiyara Floodplain (20).

iv)Major land type- High Land, Medium High Land, Medium Low Land, Low Land, Very Low Land

v)Major soil group- Ramgarh, Khadimnagar, Sreemangal, Bijipur, Prithimpassa, Gowainghat, Fagu, Terchibari.

Change in Land Type

Slope class/Land type	Previous (2010)		Present (2024)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
High land	20094	47.2	19524.0			
Medium High land	10928	25.7	9673.0			
Medium Low land	1964	4.6	2199.0			
Low land	2996	7.1	3419.0			
Very low land	1021	2.4	1117.0			
Miscellaneous	5545	13.0	6615.0			
Total	42548	100	42548			

Changes in Land Use in different Land type

Land Use	Slope class/land type	Previous (Year)		Present (Year)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
1.Tea Garden	Steep to Very Steep	11912	28	11960	28.1	0.1	
2. Forest	Steep to Very Steep	2939	6.9	2820	6.6	-0.3	
3. Bamboo and Bushy Areas	Steep to Very Steep	661	1.6	610	1.4	-0.2	
4. Horticultural crops	Steep to Very Steep	1261	3	1310	3.1	0.1	
5.Rabi Veg-Fallow-T.Aman	MHL	1084	2.5	755	1.8	-0.7	
6.Rabi Veg.-T.Aus-T.Aman	MHL	1555	3.6	1075	2.5	-1.1	
7.Rabi Veg.-Kharif Veg	HL	223	0.5	120	0.3	-0.2	

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8. Fallow-T.Aus-T.Aman	MHL	10553	24.8	7138	16.8	-8	
Boro-Aus-T.Aman	MHL	-	0	3435	8.1	8.1	
9. Boro-Fallow-T.Aman	MHL	379	0.9	1260	3	2.1	
10. Fallow-Fallow-T.Aman	HL,MHL	75	0.2	1130	2.7	2.5	
11. Fallow-Fallow-B.Aman	MLL, LL	788	1.9	130	0.3	-1.6	
12. Boro-Fallow-Fallow	MLL,LL,VLL	3999	9.4	3540	8.3	-1.1	
13. Fallow	-	1574	3.7	650	1.5	-2.2	
14. Miscellaneous		5545	13	6615	15.5	2.5	
Total		42548	100	42548	100	**0**	

Major findings of Zakiganj Upazila, Sylhet

i) Total area- 26589 hectare

ii)Total sample colleted- 110

iii)Physiography & AEZ code- Eastern Surma Kushiara Floodplain, AEZ Code:20

iv)Major land type- Medium High Land

v)Major soil group- Goainghat

vi) Major land use- Fallow- Aus- T. Aman

Changes in Land Type

Land type	Previous (Year) 2011		Present (Year) 2023		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
High land	926	3.48	778	2.92	- 0.56 %	High land decrease due to increase of settlement, Medium High land increase due to siltaion from river Surma and Kushiara during flood. Siltation is also the main reason for the change of Low land and very low land
Medium High land	9449	35.54	12904	48.53	+12.99 %	
Medium Low land	6161	23.17	2810	10.57	-12.6 %	
Low land	2263	8.51	2629	9.89	+1.38%	
Very Low land	1002	3.77	680	2.56	-1.21%	
Miscellaneous	6788	25.53	6788	25.53	-	
Total	26589	100.00	26589	100.00		

Changes in Land Use in different Land type

Land Use	Land type	Previous (year) 2011		Present (year) 2023		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
Fallow-Aus-T.Aman Fallow-Fallow-T.Aman Boro-Fallow-Fallow		4254.24 3190.68	16% 12%	7710.81 6647.25	29% 25%	+13% +13%	Increasing Medium High land is the

Rabi Vegetable-Fallow-T.Aman Others		6115.47	23%	3988.35	15%	-8%	main reason for increasing T.Aman area and also Ravi Vegeables. On the other hand decreasing Boro area is due to the decreasing low and very low land area. Non availability of irregation faccilities is another reason for decreasing Boro area.
		797.67	3%	3988.35	15%	+12%	
		12230.94	46%	4254.24	16%	-30%	

3.2 Union Land, Soil and Fertilizer Recommendation Guide (Union Sahayika) Preparation

Union based Land, Soil and Fertilizer Recommendation Guide (Union Sahayika) is being used as a tool for agricultural development activities/planning at grassroots level. It provides soil and land associated information more precisely at Union level. The guide facilitates the farmers to acquire land and soil related information for their area. In addition, it acts as a tool for location-based fertilizer recommendations for any crops. In 2023-2024, the total number of Union Sahayika prepared by field offices was 248.

Table. Union Sahayika prepared by respective Divisional & Regional office (2022-23)

Name of Divisional/ Regional Office	District	Upazila	No. of Union Sahayika prepared
Regional Office, Faridpur	Faridpur	Bhanga	5
Regional Office, Gopalganj	Satkhira	Shyamnagar	12
Regional Office, Jamalpur	Sherpur	Jhenaigati	4
Regional Office, Madaripur	Shariatpur	Goshyirhut	5
Regional Office, Mymensingh	Mymensingh	Nandail	6
Regional Office, Narsingdi	Narsingdi	Sadar	3
Regional Office, Netrokona	Netrokona	Barhatta & Modon	5
Regional Office, Tangail	Tangail	Kalihati	6
Divisional Office, Barishal	Jhalakathi	Razapur	2
	Pirojpur	Indurkani	3
Regional Office, Patuakhali	Barishal	Agailjhara	5
Regional Office, Bhola	Bhola	Borhanuddin	6

Name of Divisional/ Regional Office	District	Upazila	No. of Union Sahayika prepared
Regional Office, Chapainawabganj	Chapai-nawabganj	Nachole and Volahat Upazila	6
Regional Office, Pabna	Pabna	Iswardi,	5
Regional Office, Bogura	Bogura	Sariakandi	5
Regional Office, Naogaon	Naogaon	Dhamoirhat	6
Regional Office, Sirajganj	Sirajganj	Raiganj	6
Divisional Office, Khulna	Khulna	Khulna metro	5
Regional Office Jashore	Jashore	Keshobpur	05
Regional Office, Jhenaidah	Jhenaidah	Harinakundu	7
Regional Office, Kushtia	Chuadanga	Chuadanga Sadar	7
Regional Office, Satkhira	Khulna	Khulna metro	5
Regional Office, Dinajpur	Dinajpur	Khansama	05
Regional Office, Gaibandha	Gaibandha	Saghata	5
Regional Office, Lalmonirhat	Lalmonirhat	Kaliganj	2
		Sadar	3
Regional Office, Thakurgaon	Thakurgaon	Thakurgaon Sadar	6
Regional Office, Brahmanbaria	Brahmanbaria	Bancharampur	5
Regional Office, Cumilla	Cumilla	Sadar Dakhin	5
Regional Office, Rangamati	Chattogram	Karnophuli	5
Divisional Office, Sylhet	Sylhet	Osmaninagar	5
Regional Office, Moulvibazar	Habiganj	Chunarughat	3
Regional Office Sunamganj	Sunamganj	Jagannathpur	3
Regional Office, Jhenaidah	Magura	Sreepur	8
	Jhenaidah	Harinakundu	2
Regional Office, Satkhira	Khulna	Koyra	7
Regional Office, Patuakhali	Barishal	Hizla	3
		Mehendiganj	2
Regional Office, Bhola	Bhola	Charfassion	5
	Pirojpur	Indurkani	3
	Jhalokati	Rajapur	2
Regional Office, Brahmanbaria	Brahmanbaria	Bancharampur	12
Regional Office, Cumilla	Cumilla	Homna	6
Regional Office,	Brahmanbaria	Akhaura	6
Divisional Office, Sylhet	Sylhet	Balaganj	5
Regional Office, Moulvibazar	Moulvibazar	Juri	6
Regional Office, Sunamganj	Sunamganj	Sunamganj Sadar	10
		Chatok	5
		Total	**248**

Union Sahayika is an effective tool for local level agricultural planning and for location specific fertilizer recommendation. Field officers (SAAOs) of Department of Agricultural Extension (DAE) could be more equipped by this guide in respect of providing advisory services to farmers as a part of their professional demand.

3.3 Monitoring & Evaluation of Farmers' Service through Mobile Soil Testing Laboratories (MSTL)

(a) **Introduction**: Soil Test Based (STB) fertilizer use is considered one of the best practices to minimize the yield gap. The farmers of the country are not yet fully aware of the benefit of the STB fertilizer application for crop production. For this reason, SRDI operates farmers' service through MSTL to provide soil testing service at grass root level with a view to motivating farmers regarding balanced use of fertilizers. Actually, it is a programme for developing awareness among farmers about soil test-based fertilizer use so that farmers become more interested in getting services from static laboratories. SRDI propelled this programme through two MSTL since 1996. At present, SRDI runs 10 MSTL for serving the farmers with soil testing facilities in Rabi and Kharif season every year.

(b) Objectives
- To enhance awareness among the farmers on the benefit of balanced fertilizer application according to STB and crop requirements.
- To assess the effect of soil test-based fertilizer application on crop production.

In 2022-2023, soil analytical service through MSTL provided to 80 Upazila of the country and provided 5,081 farmers with Fertilizer Recommendation Cards.

Table. Name of the Upazila and number of soil samples analyzed through MSTL under Farmer's Service Programme during Rabi 2023 season

Sl. No	Name of Divisional/ Regional Office	District	Upazila	No. of Soil Samples Analyzed
1	Regional Office, Faridpur	Faridpur	Alfadanga	50
2		Rajbari	Goalanda	50
	Regional Office, Gopalganj	Gopalganj	Kotalipara	50
4	Regional Office, Jamalpur	Jamalpur	Islampur	50
5			Dewangonj	50
6		Sherpur	Jhenaigati	50
7			Nalitabari	55
8	Regional Office, Kishoreganj	Kishoreganj	Kuliarchar	50
9	Regional Office, Madaripur	Madaripur	Madaripur Sadar	50
10		Shariatpur	Shariatpur Sadar	50
11	Regional Office, Madaripur	Madaripur	Madaripur Sadar	50
12		Shariatpur	Shariatpur Sadar	50
13	Regional Office, Mymensingh	Mymensingh	Gouripur	50
14	Regional office, Narsingdi	Gazipur	Sadar	52
15			Sreepur	48
16	Regional Office, Netrokona	Netrokona	Netrokona Sadar	50
17	Regional Office, Tangail	Tangail	Gopalpur	50
18	Divisional ofiice, Barishal	Barishal	Babuganj	50
19		Jhalkathi	Kathalia	50
20	Regional Office, Bhola	Bhola	Doulatkhan	50

Sl. No	Name of Divisional/ Regional Office	District	Upazila	No. of Soil Samples Analyzed
21	Divisional Office, Rajshahi	Rajshahi	Bagha	50
22		Natore	Gurudaspur	50
23	Regional Office, Naogaon	Naogaon	Raninagar	50
24	Regional Office, Chapainawabganj	Chapainawabganj	Volahat	79
25	Regional Office Sirajganj	Sirajganj	Kamarkhand	50
26	Regional Office, Pabna	Pabna	Bera	50
27	Regional Office, Bogura	Bogura	Sariakandi	50
28	Divisional ofiice, Khulna	Bagerhat	Chitalmari	50
29		Khulna	Fultola	50
30	Regional Office Jashore	Jashore	Avoynagar	50
31		Jashore	Jashore Sadai	50
32	Regional Office, Jhenaidah	Magur	Shalikha	(50)
33	Regional Office, Satkhira	Satkhira	Kolaroa	50
34	Regional Office, Dinajpur	Dinajpur	Fulbari	50
35	Regional Office, Gaibandha	Gaibandha	Phulchori	50
36	Regional Office,Lalmonirhat	Kurigram	Bhurungamari	50
37	Regional Office, Thakurgaon	Panchagarh	Panchagarh, Sadar	55
38	Regional Office, Brahmanbaria	Brahmanbaria	Akhaura	50
39	Regional Office, Cumilla	Cumilla	Daudkhandi	50
40			Homna	50
41	Regional Office, Rangamai	Khagrachhari	Khagrachhari sadar	50
42			Matiranga	50
43	Divisional Office, Sylhet	Sylhet	Sylhet, Sadar	50
44	Regional Office, Moulvibazar	Moulvibazar	Rajnagar	50
45		Habiganj	Bahubal	50
46	Regional Office Sunamganj	Sunamganj	Doarabazar	50
Total				**2,847**

Table. Name of the Upazila and number of soil samples analyzed through MSTL under Farmer's Service Programme during Kharip 2024 season

Sl. No		District	Upazila	No. of Soil Samples Analyzed
1	Regional Office, Faridpur	Faridpur	Charvadrason	50
2		Rajbari	Rajbari sadar	50
3	Regional Office, Gopalganj	Gopalganj	Tungipara	50
4	Regional Office, Jamalpur	Jamalpur	Melandaha	67
5		Sherpur	Nokla	81
6			Sherpur Sadar	56
7	Regional Office, Kishoreganj	Kishoreganj	Nikli	50
9	Regional Office, Madaripur	Madaripur	Shibchar	50
10		Shariatpur	Naria	50
11	Regional Office, Mymensingh	Mymensingh	Iswarganj	50
12	Regional office, Narsingdi	Gazipur	Kapasia	50
13	Regional Office, Netrokona	Netrokona	Barhatta	50
14	Regional Office, Tangail	Tangail	Nagorpur	49
15			Madhupur	61
16	Divisional Office, Barishal	Barishal	Banaripara	50

Sl. No		District	Upazila	No. of Soil Samples Analyzed
17		Jhalakathi	Jhalakathi Sadar	50
18	Regional Office, Patuakhali	Patuakhali	Dashmina	50
19	Regional Office, Bhola	Bhola	Tazumddin	50
20	Divisional Office, Rajshahi	Rajshahi	Mohonpur	50
21		Natore	Naldanga	50
22	Regional Office, Naogaon	Naogaon	Shapahar	50
23	RegionalOffice,Chapainawabganj	Chapainawabganj	Gomostapur	50
24	Regional Office Sirajganj	Sirajganj	Raygonj	50
25	Regional Office, Pabna	Pabna	Faridpur	50
26	Regional Office, Bogura	Bogura	Sherpur	50
27	Divisional Office, Khulna	Khulna	Batiaghata	49
28	Regional Office, Jashore	Jashore	Bagharpara	55
29		Narail	Lohagara	50
30	Regional Office, Jhenaidah	Jhenaidah	Kaliganj	(50)
31	Regional Office, Kushtia	Chuadanga	Alamdanga	50
32		Kushtia	Kumarkhali	50
33	Regional Office, Satkhira	Satkhira	Shyamnagar	51
34	Regional Office, Gaibandha	Gaibandha	Sundergang	50
35	Regional Office, Lalmonirhat	Lalmonirhat	Aditmari	50
36	Regional Office, Thakurgaon	Thakurgaon	Baliadangi	50
37	Regional Office, Brahmanbaria	Brahmanbaria	Nabinagar	52
38	Regional Office, Cumilla	Cumilla	Laksam	50
39			Chauddogram	50
40	Regional Office, Rangamai	Khagrachhari	Matiranga	50
41	Divisional Office, Sylhet	Sylhet	Bishwanath	50
42	Regional Office, Moulvibazar	Moulvibazar	Kulaura	50
43		Habiganj	Baniachong	50
			Total	**2234**

3.4 Soil and Water Salinity Monitoring

Introduction

The total area of Bangladesh is 147, 570 km^2. The coastal area covers about 20% of the country and over thirty percent of the net cultivable area. It extends inside up to 150 km from the coast. Out of 2.85 million hectares of the coastal and offshore areas about 0.83 million hectares are arable lands, which cover over 30% of the total cultivable lands of Bangladesh. A part of the coastal area, the Sundarbans, is a reserve natural mangrove forest covering about 4,500 km^2. The remaining part of the coastal area is used in agriculture. The cultivable areas in coastal districts are affected by varying degrees of soil salinity. The coastal and offshore area of Bangladesh includes tidal, estuaries and river floodplains in the south along the Bay of Bengal. Agricultural land use in these areas is very poor, which is roughly 50% of the country's average (Petersen & Shireen, 2001). Tidal and estuarine floodplains cover almost 98% of the coastal area. Small areas (2%) with river floodplains and peat basins are found in the northern part of the coastal area. Tidal floodplains occur in Satkhira, Khulna, Bagerhat, Pirojpur, Jhalokati, Barisal, Patuakhali, Chittagong and Cox's

Bazar district. They cover a total of 18,65,000 ha or about 65% of the coastal area. Estuarine floodplains occur in Noakhali, Bhola and Patuakhali districts and in the north-western part of Chittagong district. They cover about 9,37,000 ha or about 33% of the coastal area. Saline soil contains an excess of neutral soluble salts that affects the normal physiological process of plants. Dominant salts are sulphate, chloride of calcium, potassium and sodium. Presence of bicarbonate and carbonate is not significant in the soils of Bangladesh. Saline affected soils of Bangladesh are saline soil rather than being sodic or saline sodic soil. These soils contain soluble salts in such quantities that they interfere with the growth of most crop plants. Ec value having more than 2 dS/m, ESP less than 15 and SAR less than 13. The pH of the saline soil is less than 8.5. It is estimated that Bangladesh has about 2.8 million ha (Chanratchakool, 2007) of land affected by salinity and poor quality water. This comes to about one-fifth of the total areas of Bangladesh and lies around the northern apex of the Bay of Bengal. The saline soils are mainly found in Khulna, Barisal, Patuakhali, Noakhali and Chittagong districts of the coastal and offshore lands (Figure 1).

Out of 2.86 million hectares of coastal and off-shore lands about 1.056 million hectares of arable lands are affected by varying degrees of salinity (SRDI, 2012). Crop production in salt affected areas in the coastal regions differs considerably from non saline areas. Crop yields, cropping intensity, production levels and people's livelihood quality are much lower than that of other parts of the country (BBS, 2001). Many of the projected climate change impacts will reinforce the baseline environmental, socio-economic and demographic stresses already faced by Bangladesh. Therefore, it is imperative to regularly monitor the soil and water salinity.

Objectives
- To determine the soil and water salinity round the year and to delineate area under different degrees of salinity.
- To determine the duration of the year when surface water is suitable for irrigation.
- To record present land use and crop response to soil salinity.
- To provide a necessary data base for developing appropriate technology and disseminate efficiently.

Methodology
Field data was being collected from strategically representative sites over the coastal area. Soil samples at variable depths (0-10cm, 10-30 cm and 30-60cm), water samples from surface (river, canals, ponds and water bodies), underground water (Hand Tube Well, Shallow Tube Well and Deep Tube Well) were collected twice in every month. Salinity of soils and water was determined by EC meter.

Findings

Khulna Division
28 soil salinity sites, 26 surface water salinity sites and were selected in Khulna division (greater Khulna and Jashore district and Satkhira district). In greater Khulna, monitoring sites are located in Batiaghata, Dumuria, Fultala, Koyra, Dakop of Khulna district, Mongla, Morrelganj,

Sharankhola of Bagerhat district and Shyamnagar of Satkhira district. In greater Jashore the monitoring sites are located in Jashore Sadar and Keshabpur of Jashore district and Kalia, Lohagara and Narail Sadar of Narail district. In Satkhira monitoring sites are located in Satkhira Sadar, kolaroa, Ashashuni, Tala of satkhira district. Surface water (river, canals) samples were collected twice in month during dry season and once in a month during rainy season. Salinity of water was determined by EC meter.

Table 6. Site specification of the soil sample collection sites of Khulna Division

Sl no.	Name of site	Location	Soil series	Land type	Land Use	Physiography
Khulna						
1	Krishnanagar,	Krishnanagar, Batiaghata, Khulna	Bajoa	MHL	F-TA	GTF
2	Krishnanagar	Krishnanagar, Batiaghata, Khulna	Dumuria	MHL	F-TA	GTF
3	Ghutudia	Ghutudia, Dumuria, Khulna	Bajoa	MHL	F-TA	GTF
4	Ghutudia	Ghutudia, Dumuria, Khulna	Dumuria	MHL	F-TA	GTF
5	Kismat	Kismat, Fultala, Batiaghata	Bajoa	MHL	F-TA	GTF
6	Kismat	Kismat, Fultala, Batiaghata	Dumuria	MHL	F-TA	GTF
7	Fultala,	Fultala, Batiaghata, Khulna	Bajoa	MHL	F-TA	GTF
8	Fultala,	Fultala, Batiaghata, Khulna	Dumuria	MHL	F-TA	GTF
9	Digraj	Digraj ,Biddarbaon, Mongla	Barisal	MHL	F-TA	GTF
10	Digraj	Digraj, Biddarbaon, Mongla	Barisal	MHL	F-TA	GTF
11	Shibbari	Shibbari, Paikgacha	Barisal	MHL	F-TA	GTF
12	Boloibunia	Boloibunia, Morellganj	Barisal	MHL	F-TA	GTF
Jashore						
13	Narail Ferry ghat	Narail Sadar, Narail	Gopalpur	HL	RV-KV	GRF
14	Baraipara	Kalia, Narail	Gopalpur	MHL	RV-KV	GRF
15	Kalna ghat	Lohagara, Narail	Sara	HL	RC-F-TA	GRF

16	Sagardari	Kesabpur, Jahore	Amjhupi	MHL	B-F-TA	GRF
17	Noapar	Jashore Sadar, jashore	Gopalpur	HL	Banana Orchard	GRF
18	Tularampur	Narail Sadar, Narail	Sara	HL	Banana Orchard	GRF
19	Gobra Bazar	Narail Sadar, Narail	Gopalpur	MHL	RC-F-TA	GRF
20	Baradia	Kalia, Narail	Gopalpur	HL	RC-J-F	GRF
21	Sheikhati	Narail Sadar, Narail	Gopalpur	HL	RV-KV	GRF
Satkhira						
22	kumira	kumira, Tala.	Ishwardi	MHL	B-F-TA	GRF
23	Binerpota	Binerpota, Satkhira	Ishwardi	MHL	B-F-TA	GRF
24	Shreepatipur	Shreepatipur, Kolaroa.	Ishwardi	MHL	B-F-TA	GRF
25	Capra	Capra, Budhhata, Ashashuni.	Barisal	MHL	B-Fish	GTF
26	Shokhipur	Shokhipur, Debhata	Ishwardi	MHL	B-F-TA	GRF
27	Varashimla	Varashimla, kaligonj	Barisal	MHL	B-F-TA	GTF
28	Shrifalkathi	Ishwaripur, Shyamnagar	Barishal	MHL	B-F-TA	GTF

Graphical presentation of some selected soil monitoring site of Khulna division:

Site no. 14A, Soil series: Bajoa, MHL, Location: Krishnanagar, Batiaghata.
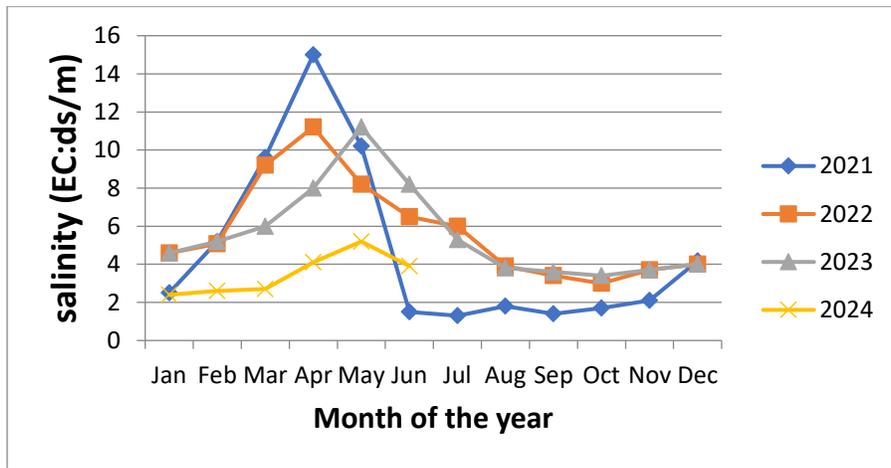
Site no. 14B, Soil series: Dumuria, MHL, Location: Krishnanagar, Batiaghata.
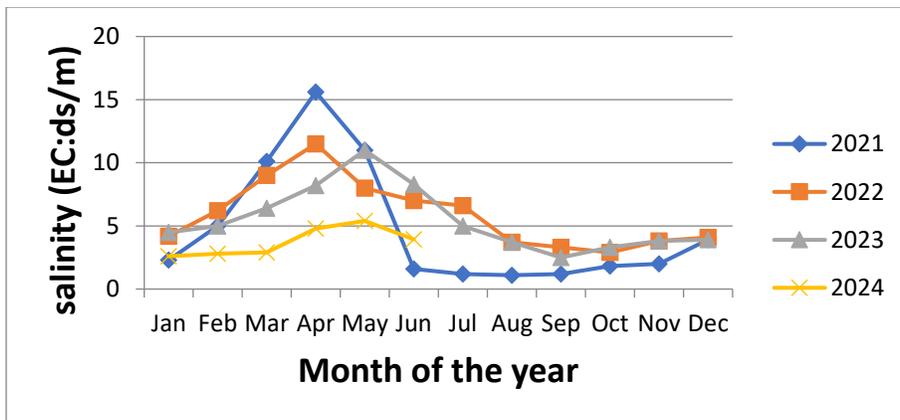
Site no. 15A, Soil series: Bajoa, MHL, Location: Ghutudia, Dumuria.
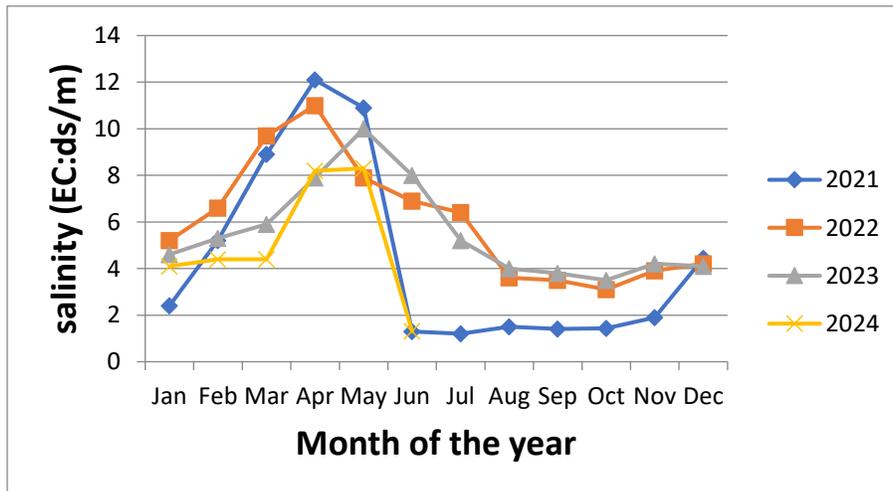
Site no. 15B, Soilseries: Dumuria, MHL, Location: Ghutudia, Dumuria.
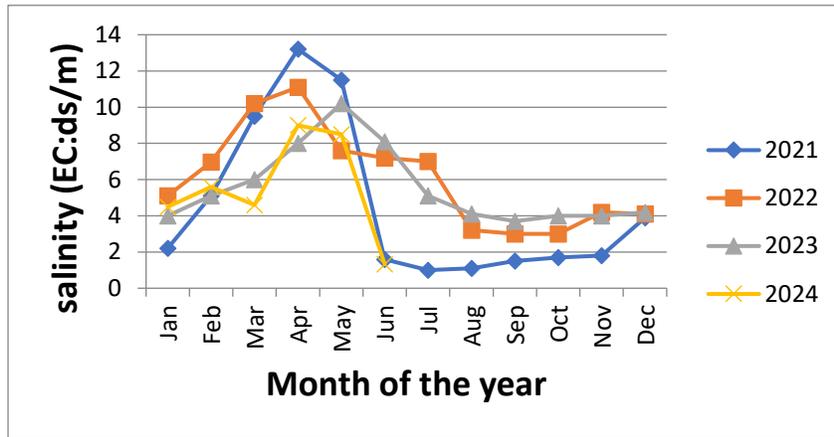
Site no. 16A, Soil series: Bajoa, MHL, Location: KismatFultala, Batiaghata .
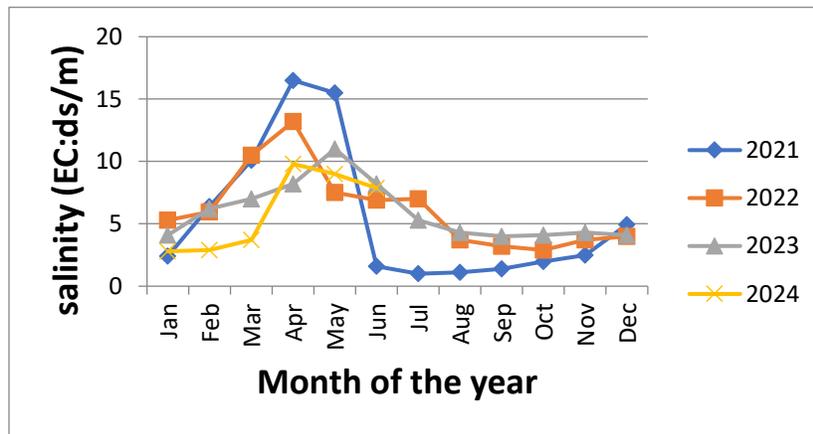
Site no.16B, Soil series:Dumuria, MHL,Location:KismatFultala, Batiaghata.
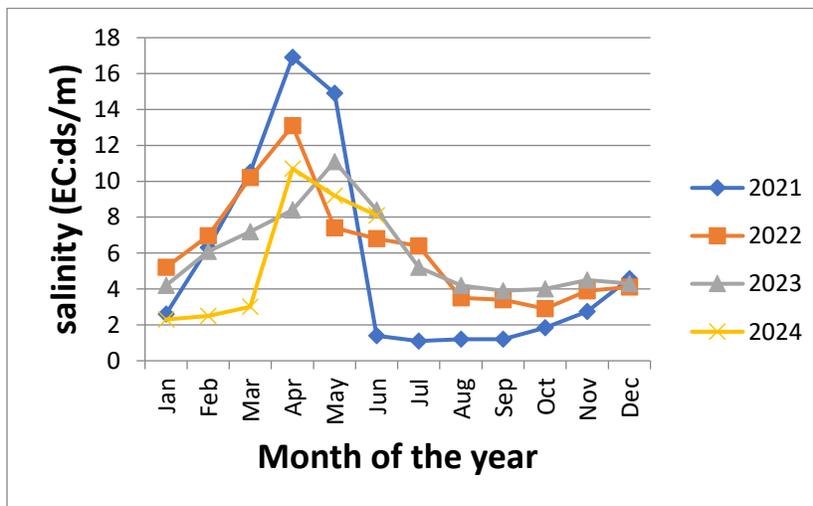
Site no. 17A, Soil series: Bajoa, MHL, Location: Fultala, Batiaghata .
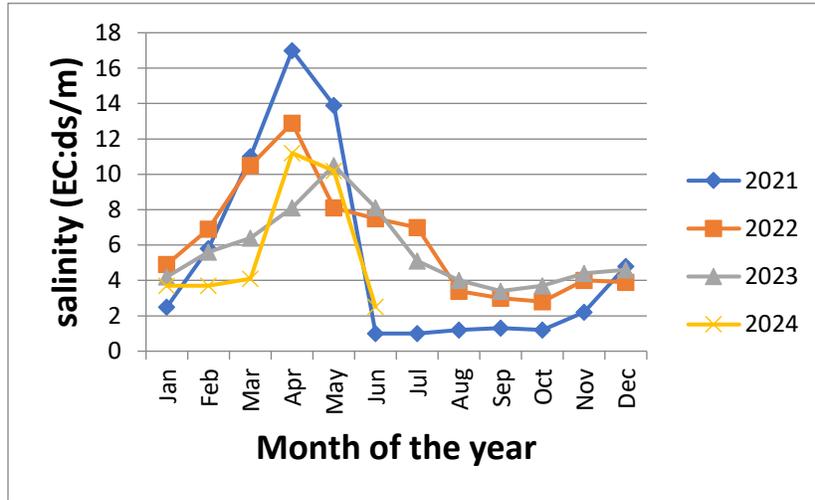
Site no. 17B, Soil series: Dumuria, MHL, Location: Fultala, Batiaghata .
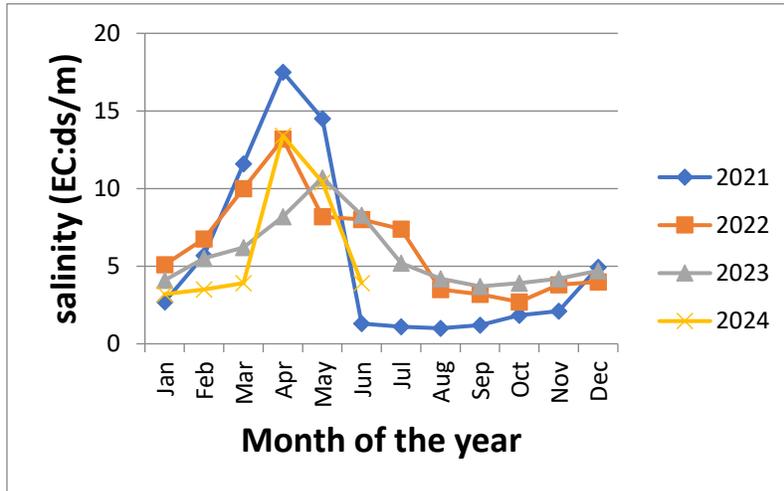
Site no. 18A, Soil series: Barisal, MHL, Location: DigrajBiddarbaon, Mongla .
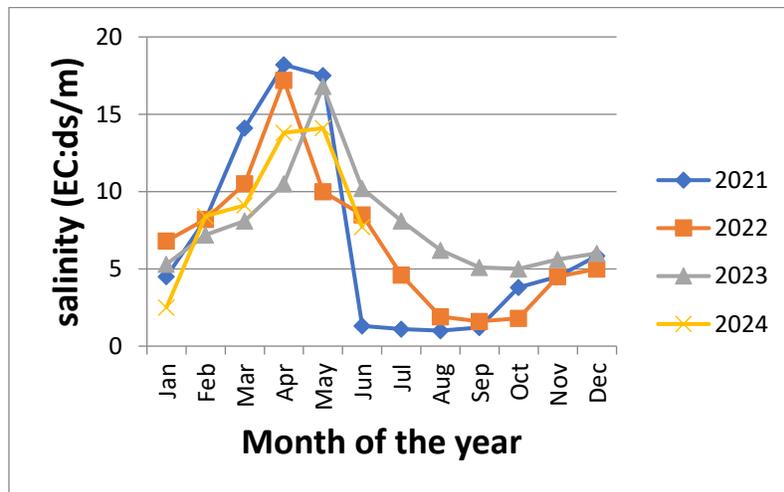
Site no. 18B, Soil series: Barisal, MHL, Location: DigrajBiddarbaon, Mongla.
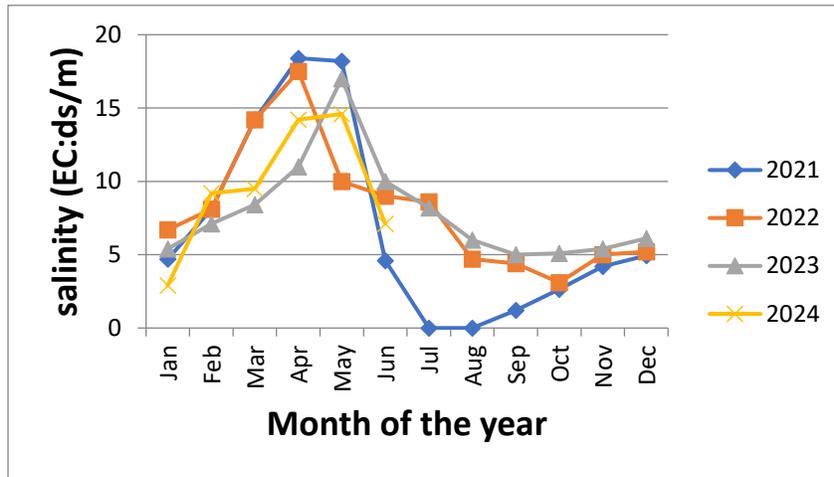
Site no. 19, Soil series: Barisal, MHL, Location: Shibbari, Paikgacha .
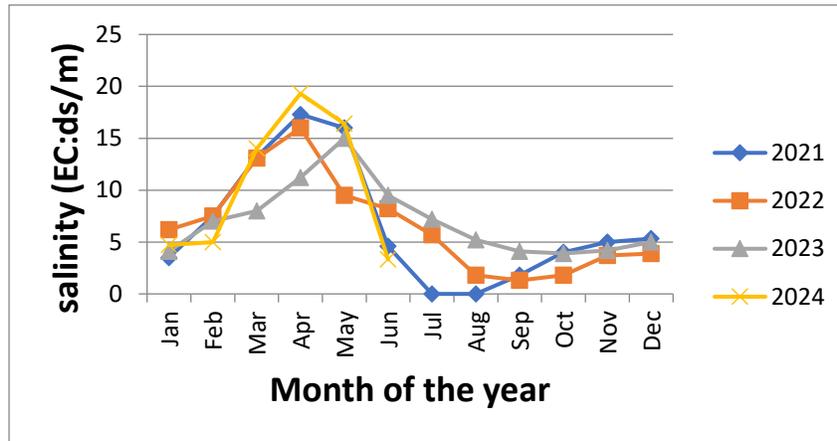
Site no. 20, Soil series: Barisal, MHL, Location: Boloibunia, Morellganj .
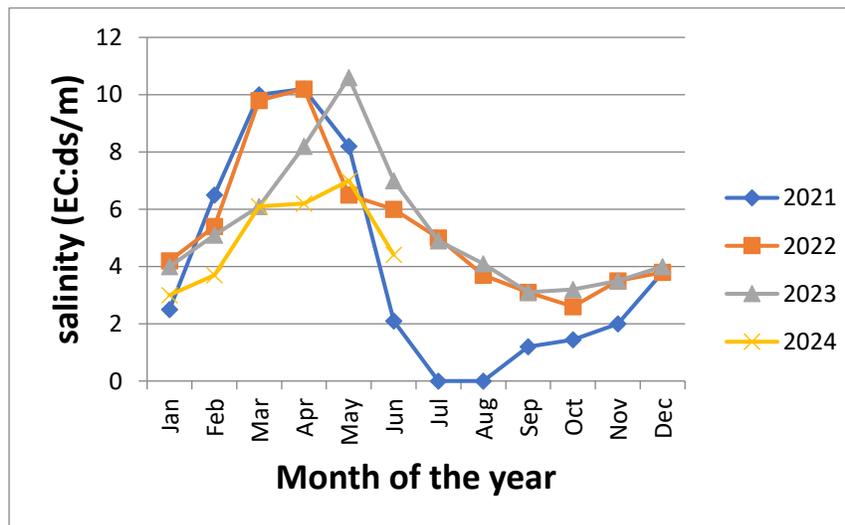
Site no.-3, Narail Ferry ghat, Narail. Soil series: Gopalpur, High land.

Gopalpur, HL at Narail Ferry ghat, Narail Sadar
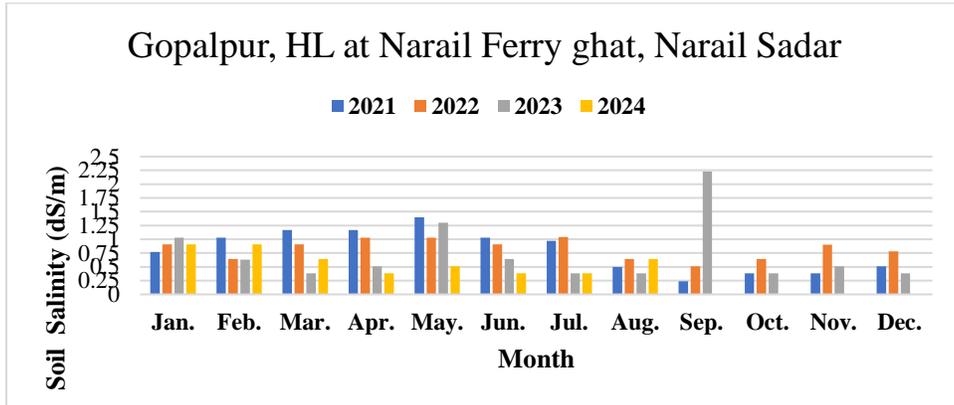
Site no: 4, Gopalpur, medium highland, Location: Baraipara, Kalia, Narail.

Gopalpur, MHL at Baraipara, Kalia, Narail
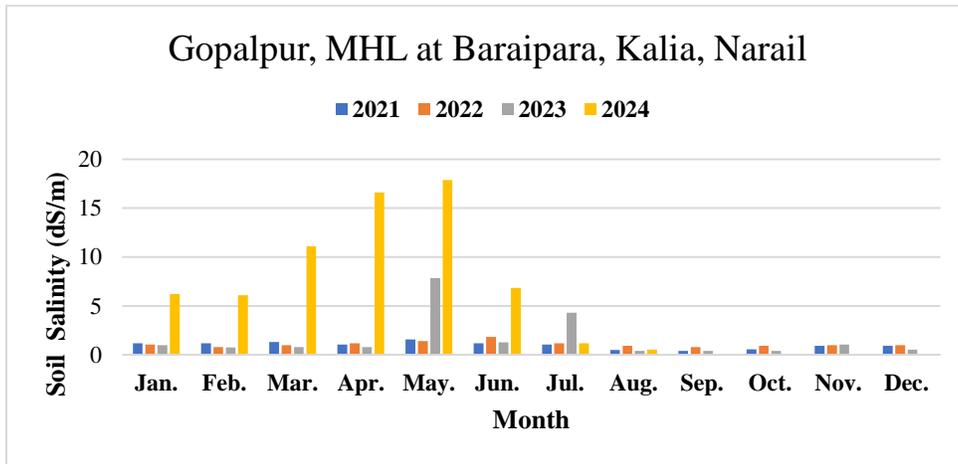
Site No: 5, Sara highland, Location: Kalna ghat, Lohagara, Narail.

Sara HL at Kalna ghat, Lohagara, Narail
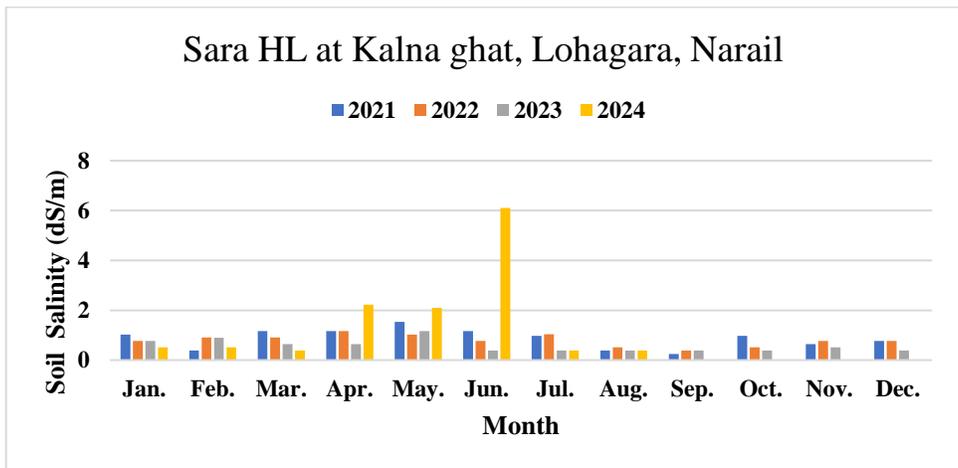
Site No: 7, Amjhupi, medium highland, Location: Sagardari, Kesabpur, Jessore.

Amjupi, MHL at Sagardari, Kesabpur, Jessore
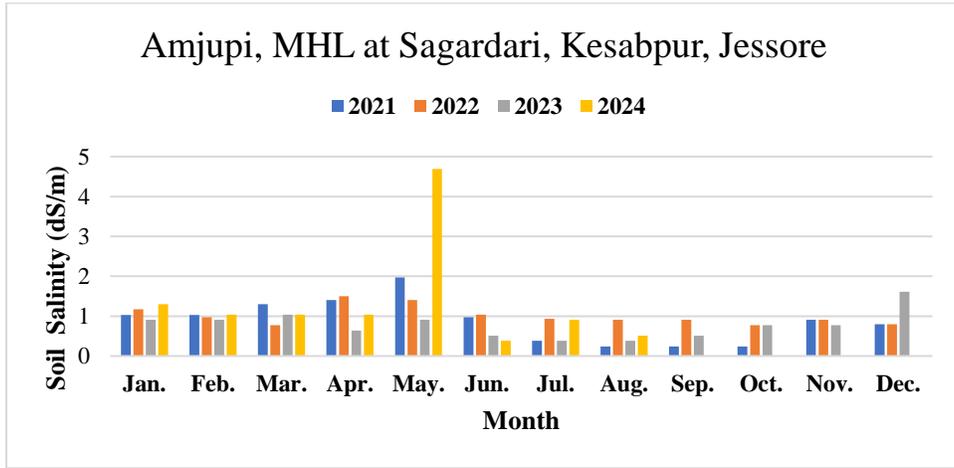
Site No: 9, Gopalpur, highland, Location: Noapara, Jessore.

Gopalpur, HL at Noapara, Jessore
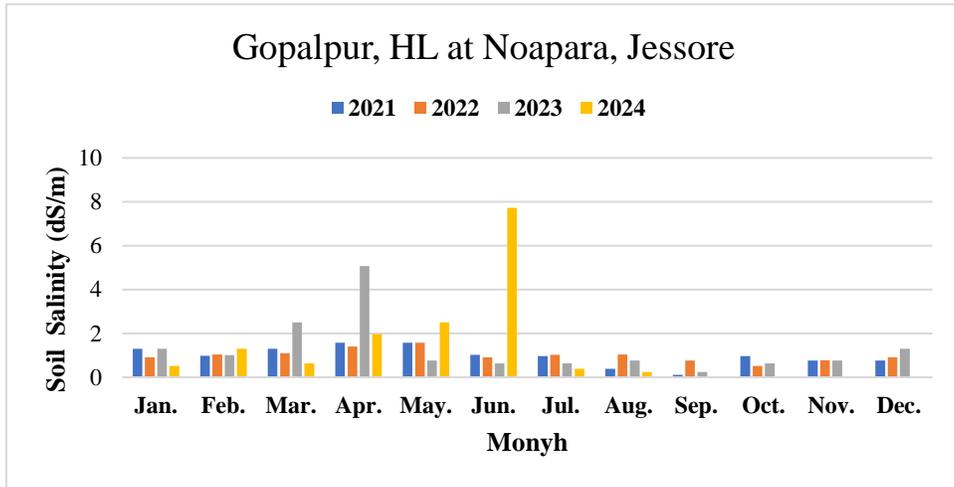
Site no.-10, Tularampur, Narail. Soil series: Sara, High land.

Sara, HL at Tularampur, Narail
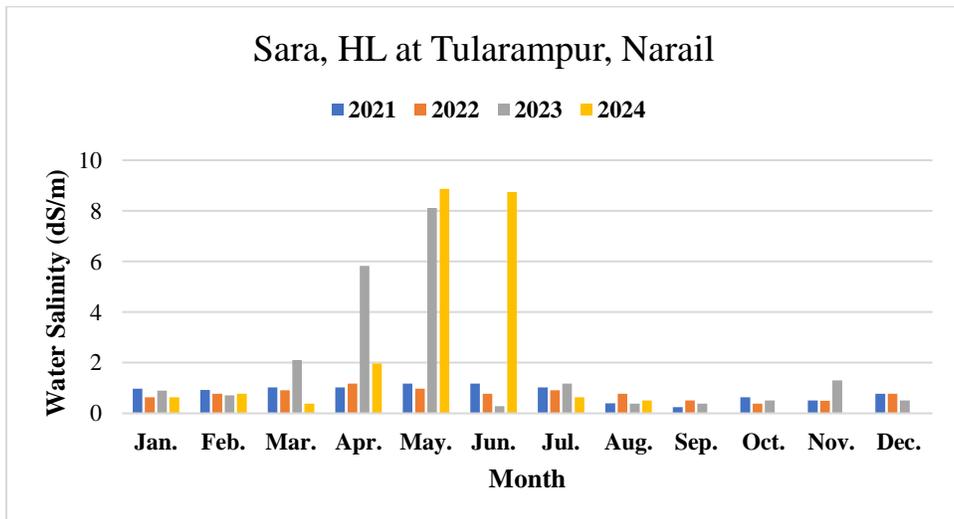
Site no.-12, Gobra Bazar, Narail. (New site). Soil series: Gopalpur, Medium high land.

Gopalpur, MHL at Gobra Bazar, Narail

■ 2021 ■ 2022 ■ 2023 ■ 2024
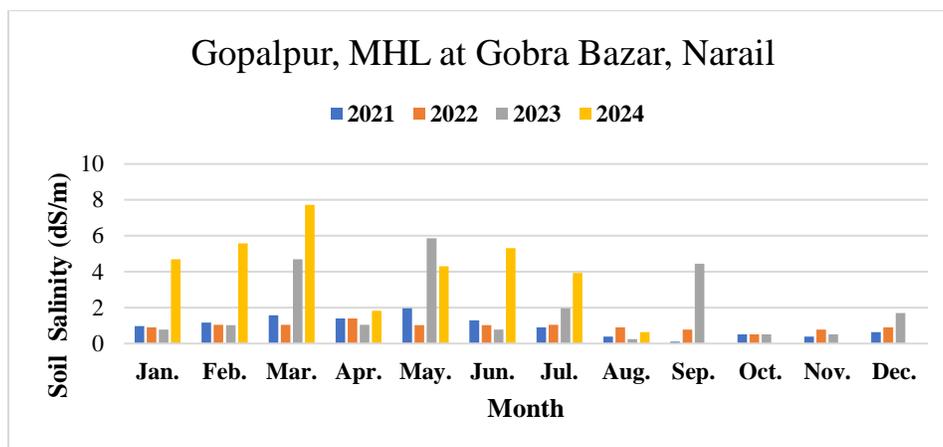
Site no.-13, Baradia, Kalia, (New site). Soil series: Gopalpur, High land.

Gopalpur, HL at Baradia, Kalia

■ 2021 ■ 2022 ■ 2023 ■ 2024
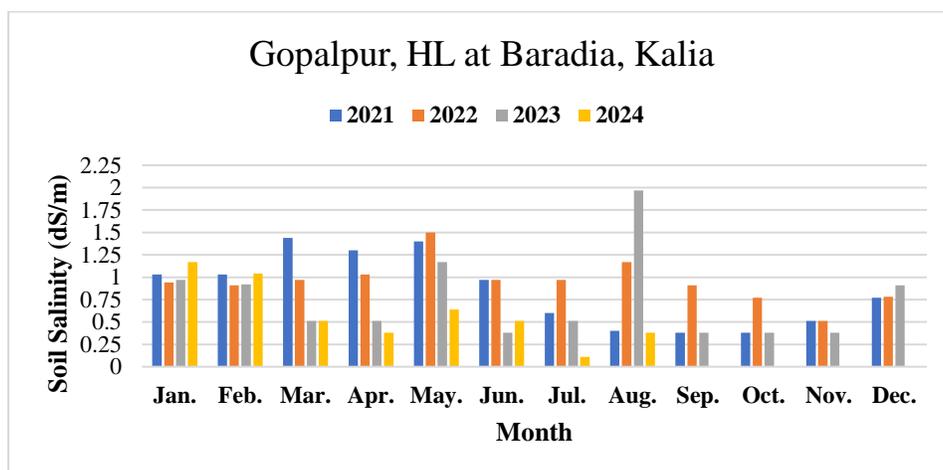
Site no.-26, Sheikhati, Narail Sadar (New site). Soil series: Gopalpur, High land.

Gopalpur, HL at Sheikhati, Narail Sadar

■ 2021 ■ 2022 ■ 2023 ■ 2024
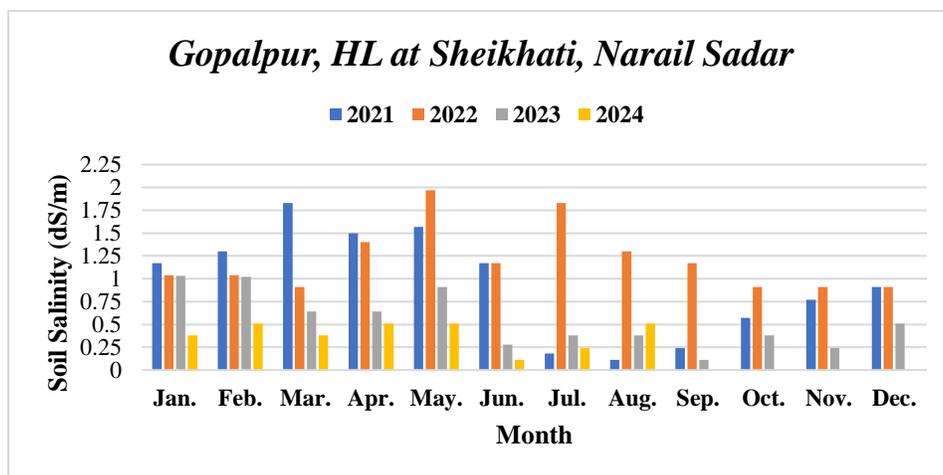
1. Location: Soil series: Ishurdi, MHL, kumira, Tala.
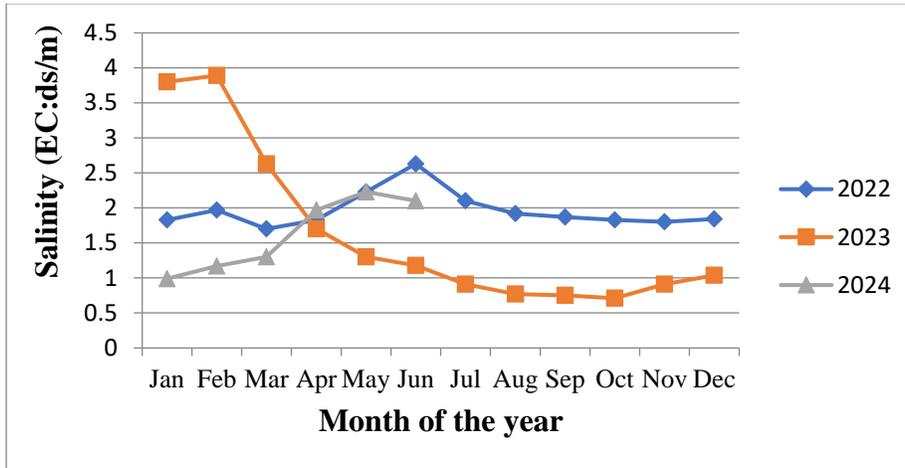
2. Location: Soil series: Ishurdi, MHL, Binerpota, Satkhira
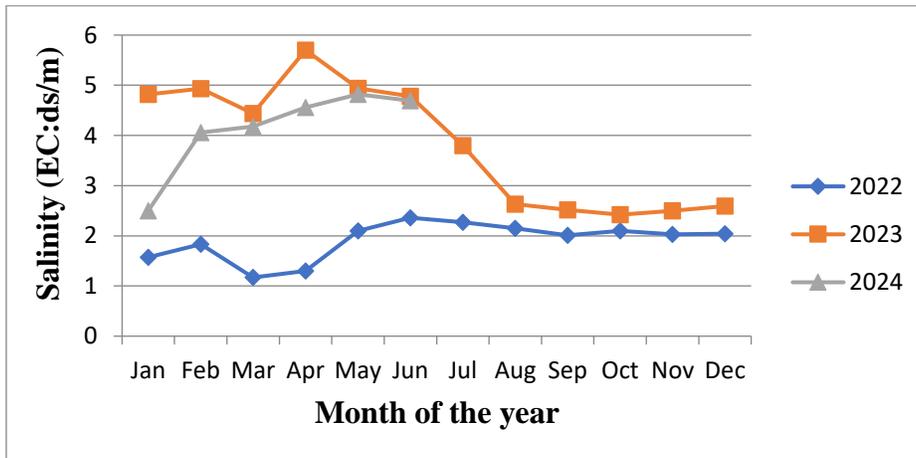
3. Location: Soil series: Ishurdi, MHL, Shreepatipur, Kolaroa
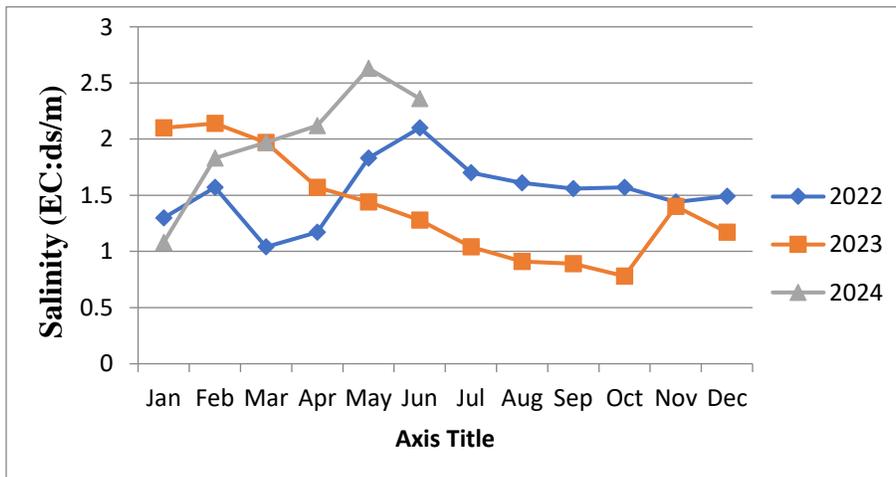
4. Location: Soil series: Barisal, MHL, Capra, Budhhata, Ashashuni.
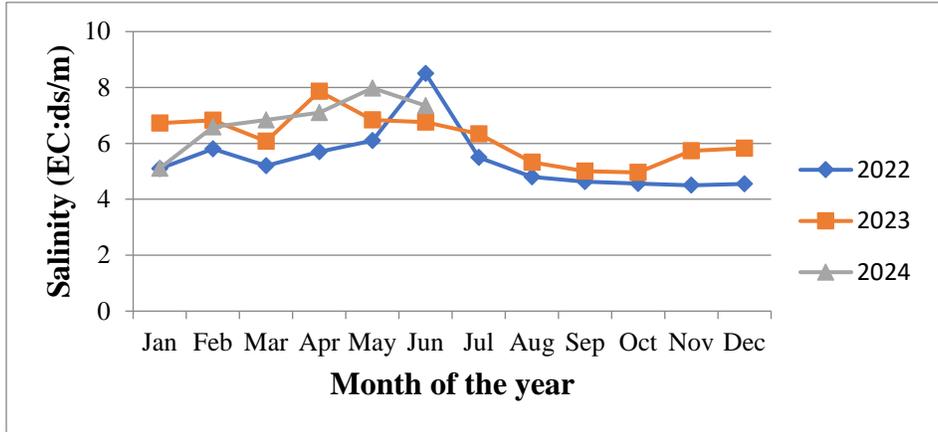
5. Location: Soil series: Ishurdi, MHL, Shokhipur, Debhata
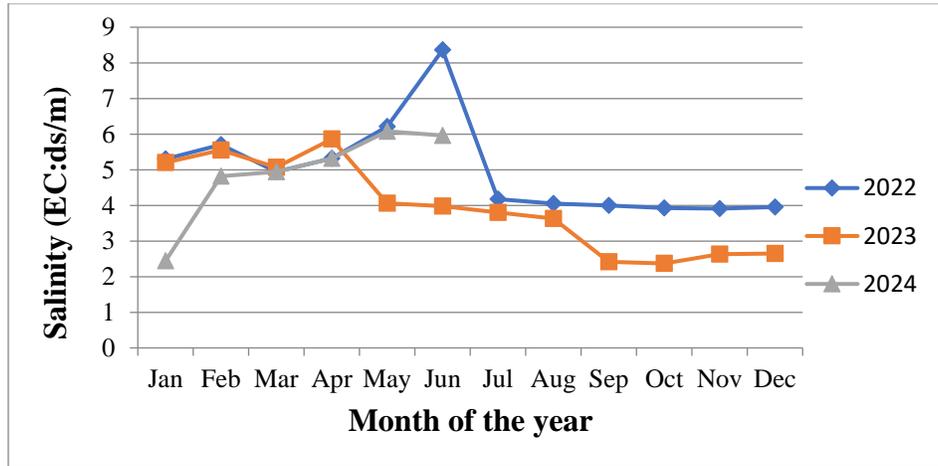
6. Location: Soil series: Barisal, MHL, Varashimla, kaligonj.
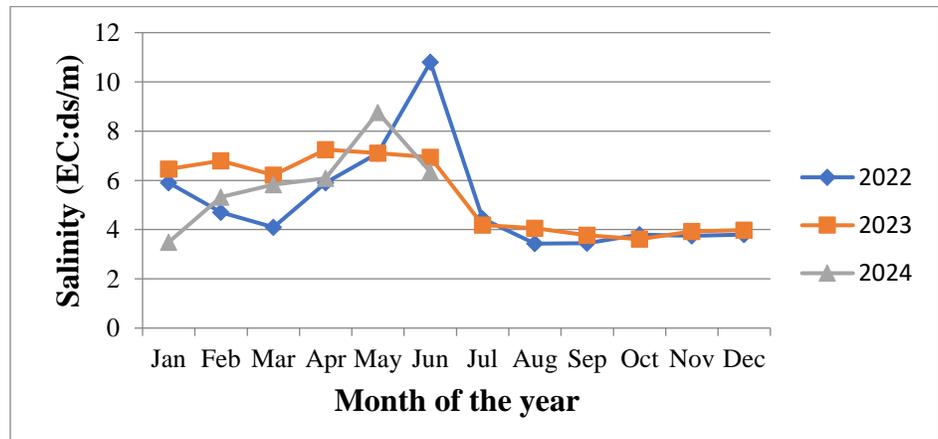
7. Location: Soil series: Barisal, MHL, Shrifalkathi, Ishwaripur, Shyamnagar
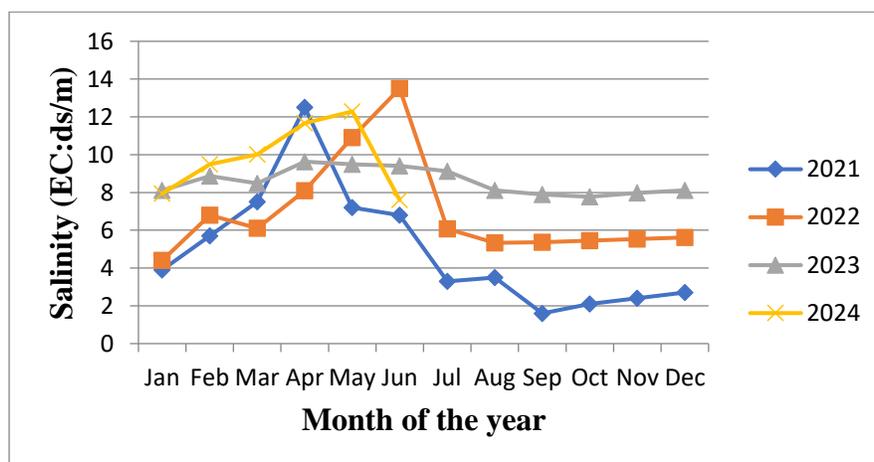
Table 7. Site specification of the water collection sites of Khulna Division

Sl. No	Name of river	Location
Khulna		
1	Madhumati River	Mollahat, Bagerhat
2	Rupsa River	Rupsa Ferryghat, Khulna.
3	Shailmari River	Koiya Bazar, Batiaghata, Khulna.
4	Vadra River	Khornia.Dumuria, Khulna
5	Shibsha River	Paikgacha HQ, Khulna.
6	Kazibachha River	Batiaghata, Khulna
7	Pasur River	Mongla port, Mongla, Bagerhat.
8	Daratana River	Bagerhat ferry ghat, Bagerhat.
9	Panguchi River	Morelgonj HQ, Bagerhat.
10	Ghoshiakhali River	Rampal, Bagerhat
Jashore		
11	Chittra River	Narail Ferry ghat.Narail Sadar
12	Kapotaxma River	Sagardari, Kesabpur, Jessore.
13	Bhairab River	Noapara, Jessore.
14	Afra River	Tularampur, Narail Sadar
15	Chittra River	Gobra, Narail sadar, Narail (New site).
16	Naboganga River	Baraypara, Kalia.
17	Modhumoti River	Bardia, Lohagara.
18	Modhumoti River	Kalna ghat, Lohagara
19	Afra River	Shaikhati, Narail.
Satkhira		
20	Kapotaksha River	Patkelghata, Tala, Satkhira.
21	Betna River	Benerpota, Satkhira sadar, Satkhira.
22	Betna River	kolaroa bazar, kolaroa, Satkhira
23	Morichap River	Ashashuni, Satkhira.
24	Sapmara khal	parulia, Debhata, Satkhira
25	Kakshiali River	Kaligonj HQ, Satkhira.
26	kholpatua River	Noyabeki, Shyamnagar, Satkhira

Graphical presentation of some selected water monitoring site of Khulna division:

Site no. 13. Madhumatiriver, Mollahat, Bagerhat.
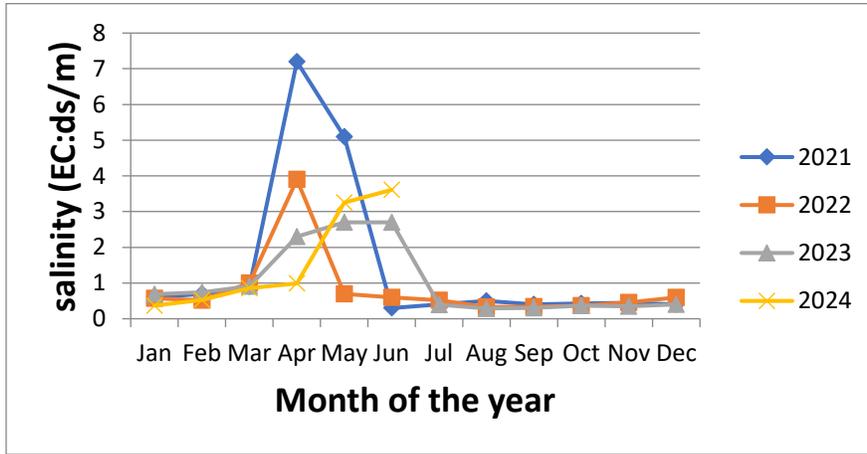
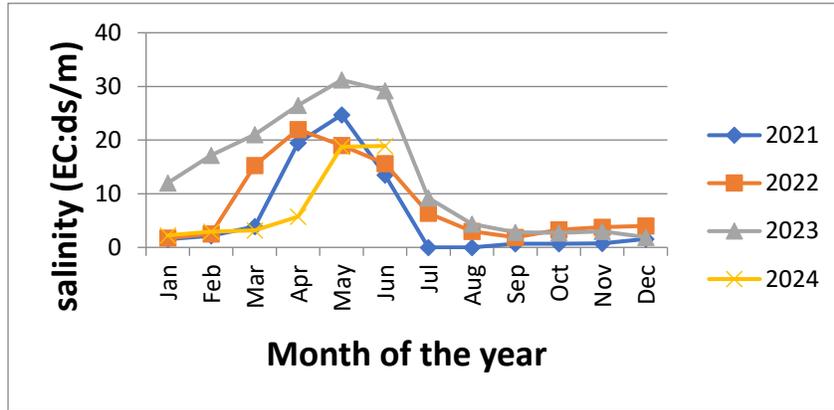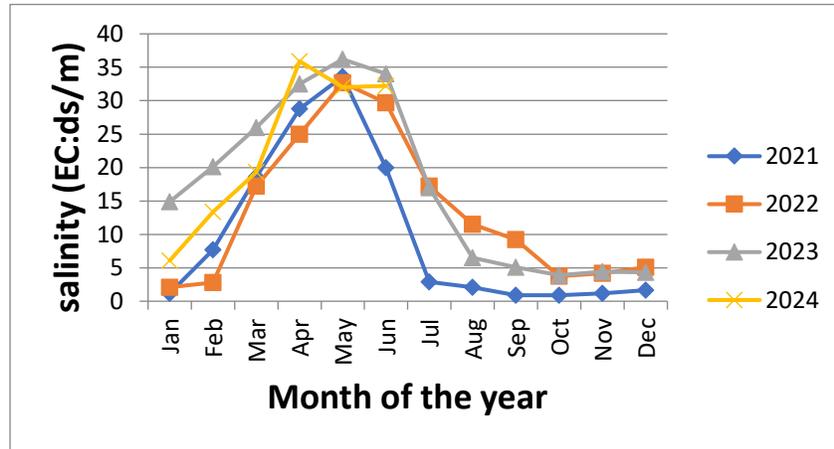
Site no. 15. Rupsa river,Rupsa Ferryghat, Khulna.
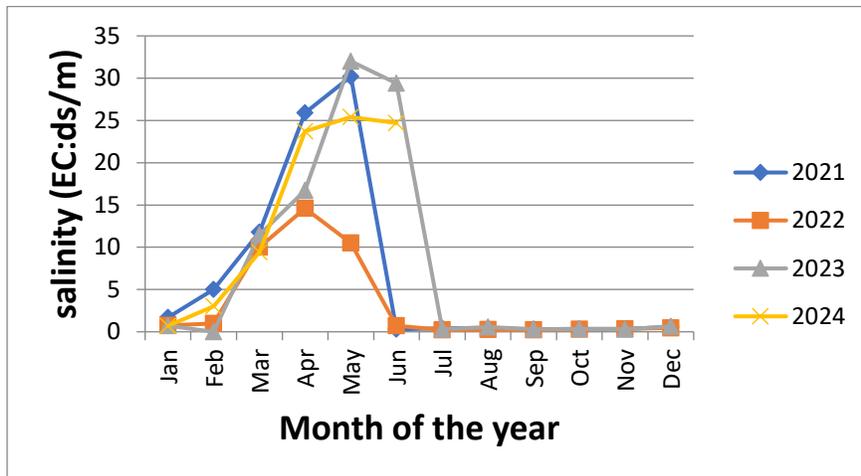
Site no. 16. Shailmaririver, Koiya Bazar, Batiaghata, Khulna.
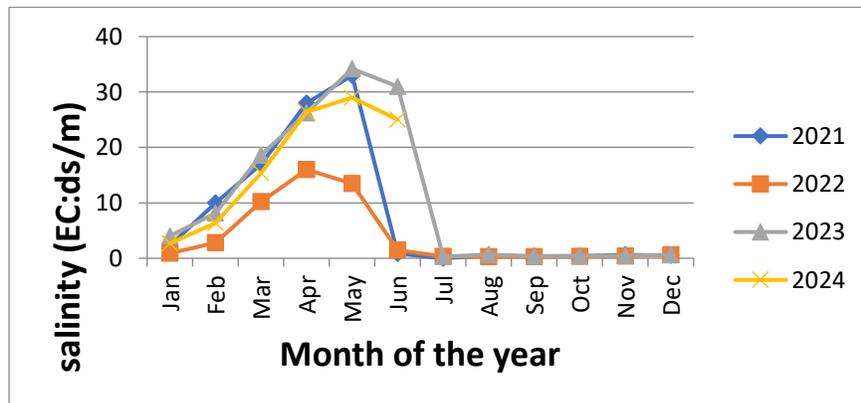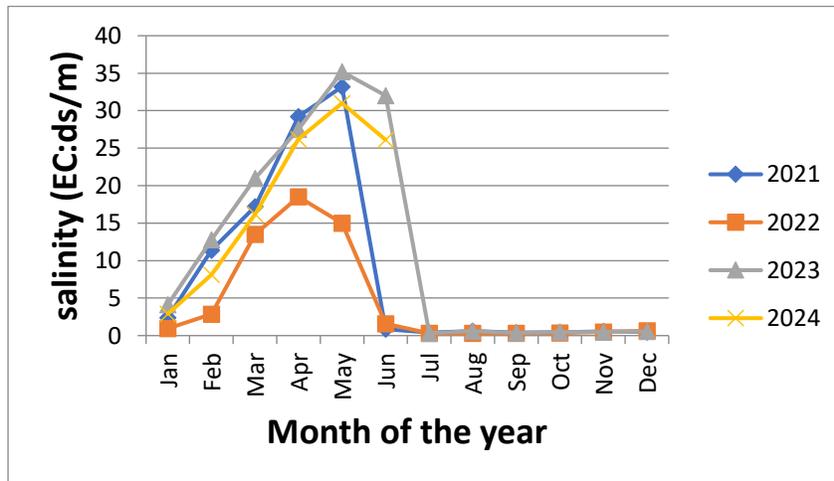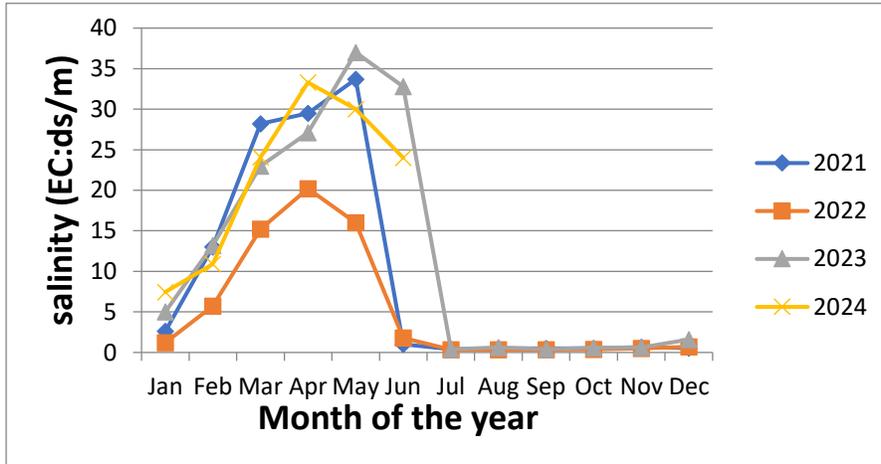
Site no. 17. Vadrariver, Khornia.Dumuria, Khulna

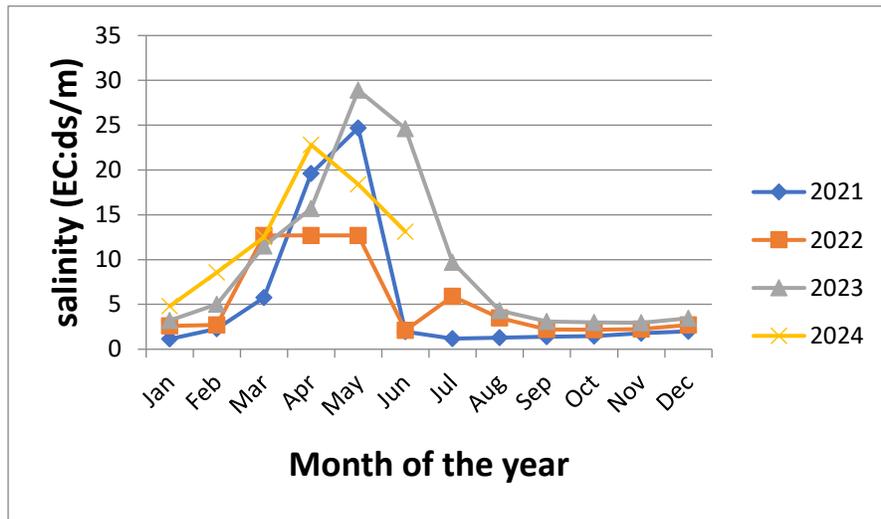Site no. 25. Shibshariver, Paikgacha HQ, Khulna.
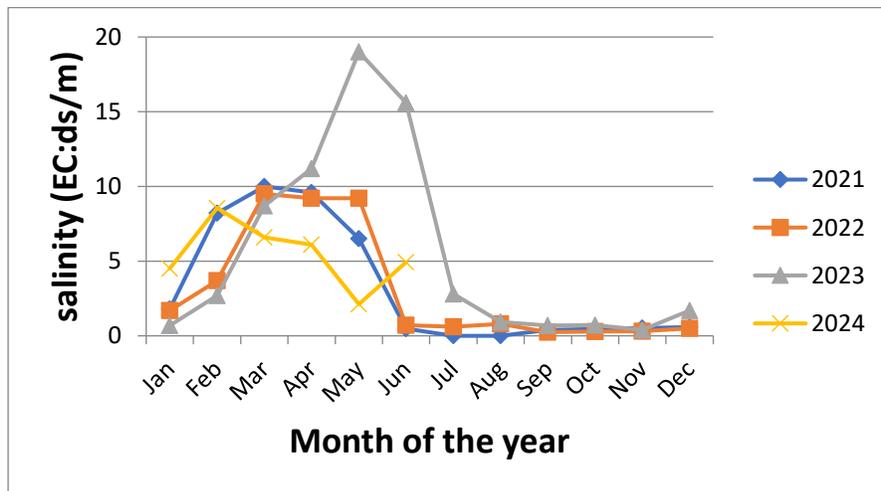

Site no. 26. Kazibachhariver, Batiaghata, Khulna

Site no. 27. Pasurriver, Mongla port, Mongla, Bagerhat.
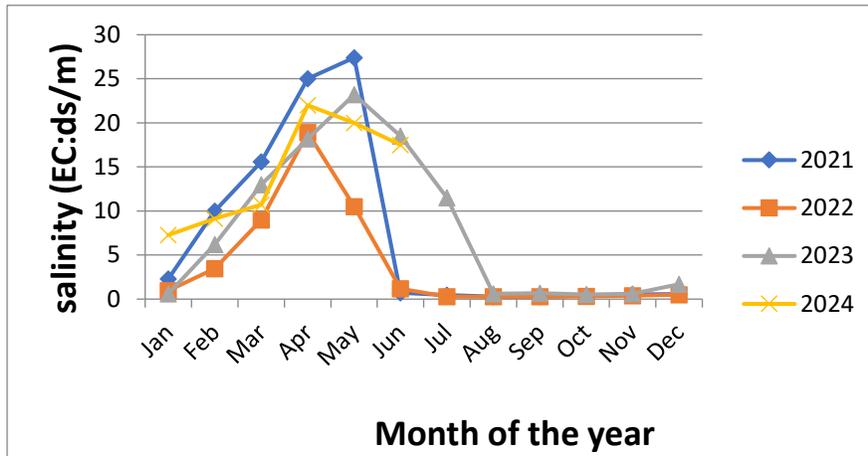

Site no. 28. Daratanariver, Bagerhatferryghat, Bagerhat.


Site no. 30. Panguchiriver, Morelgonj HQ, Bagerhat.

Site no: Ghoshiakhali,Rampal

Site no-1: Chittra River, Narail Ferry ghat.Narail Sadar

Year	Months											
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2021	0.80	0.40	0.60	0.80	0.80	0.50	-	0.30	0.30	0.30	0.40	0.40
2022	0.40	0.50	0.50	0.75	0.70	0.60	0.75	0.60	0.40	0.30	0.40	0.40
2023	0.50	0.45	0.62	0.90	3.00	4.82	0.91	0.63	0.38	1.25	0.42	2.03
2024	2.00	0.64	0.79	1.62	4.32	9.78	8.20	0.89				

Chitra river, Narail Ferry Ghat
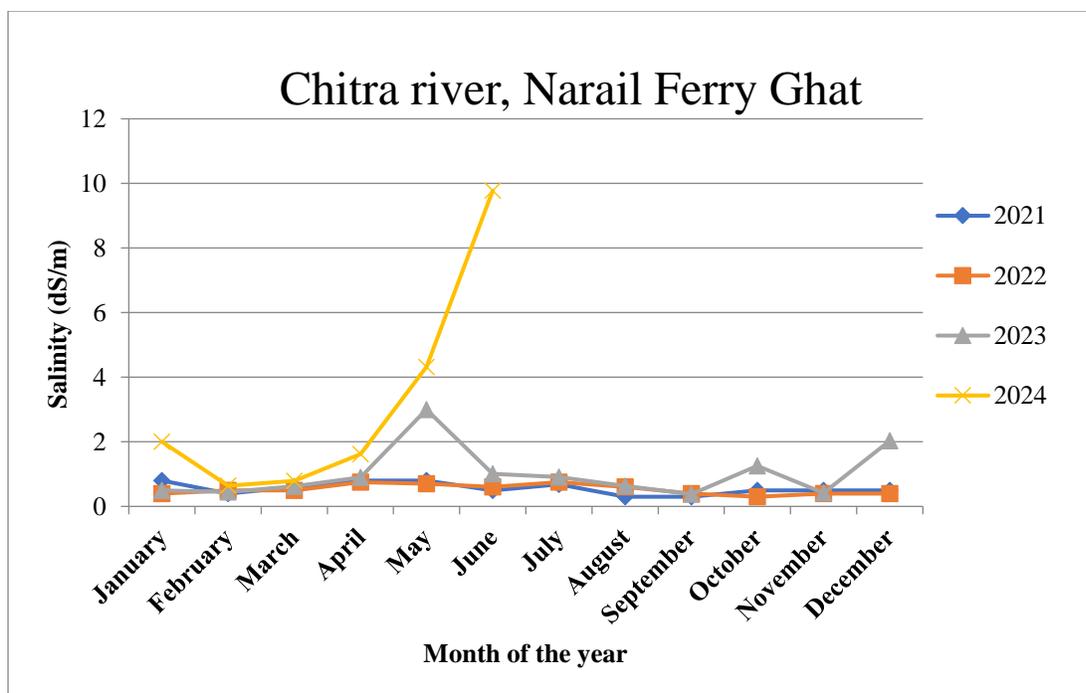
Site no- 2: Kapotaxma river.Sagardari, Kesabpur, Jessore.

Year	Months											
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2021	0.80	1.00	2.50	6.40	13.00	3.00	-	0.40	0.40	0.35	0.60	0.70
2022	0.75	0.80	0.90	9.00	8.50	3.80	9.50	2.00	0.80	0.55	1.50	1.20
2023	1.80	0.82	7.15	10.18	15.70	17.97	11.41	4.97	0.54	0.78	1.45	1.79
2024	1.11	1.35	1.92	6.89	12.50	16.10	16.10	0.63				

Kapatakka river, Sagordari, Jashore
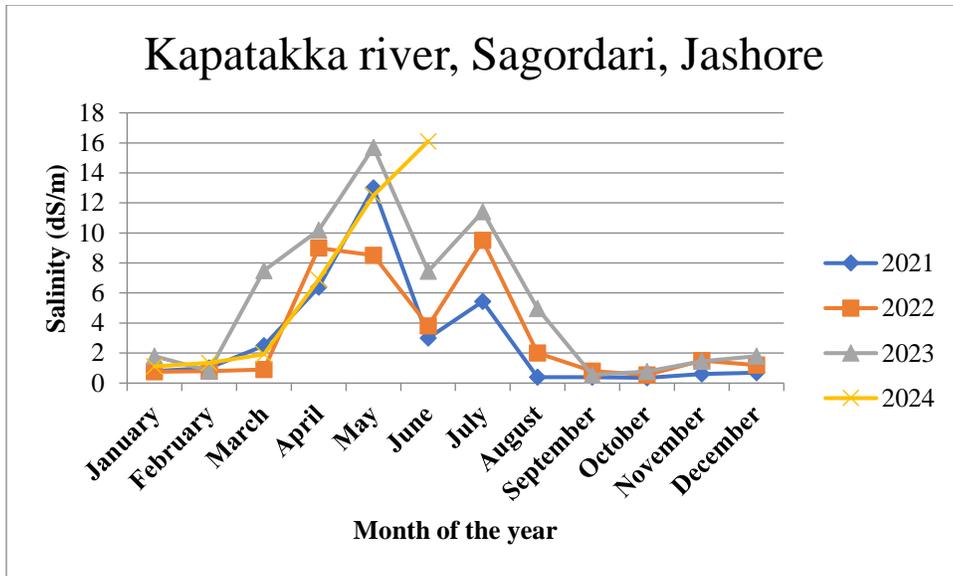
Site no-3: Bhairab river, Noapara, Jessore.

Year	Months											
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug	Sep.	Oct.	Nov	Dec.
2021	0.80	1.20	2.80	4.60	12.50	2.80	-	0.70	0.50	0.30	0.65	0.60
2022	0.60	0.70	0.80	6.00	5.80	4.00	9.00	1.80	0.70	0.60	0.80	0.80
2023	1.00	0.71	6.03	11.81	13.05	16.73	4.28	0.45	0.62	0.62	0.68	1.01
2024	1.29	1.49	1.73	6.60	13.01	14.90	7.86	3.26				

Bhairob River, Noapara, Jashore
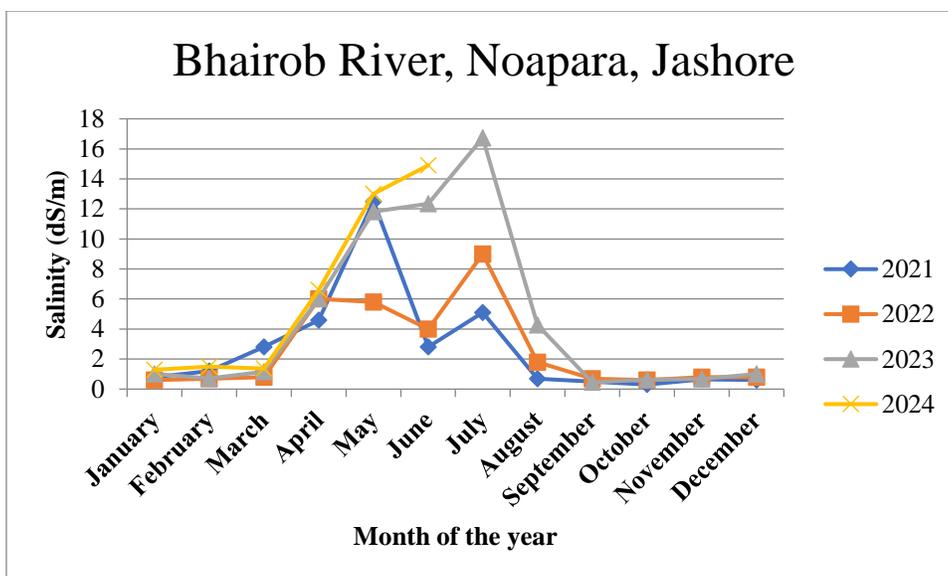
Site no-4: Afra River, Tularampur, Narail Sadar.

Year	Months											
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov	Dec.
2021	0.80	1.40	1.90	2.80	4.80	1.80	-	0.50	0.40	0.40	0.55	0.50
2022	0.60	0.70	0.90	2.00	3.00	2.00	4.50	1.10	0.60	0.50	0.50	0.60
2023	0.75	0.74	1.05	3.64	8.76	11.06	5.58	0.95	0.47	0.24	0.62	0.47
2024	1.02	1.20	1.75	2.51	9.93	12.70	3.96	0.80				

Afra River, Tularampur, Narail
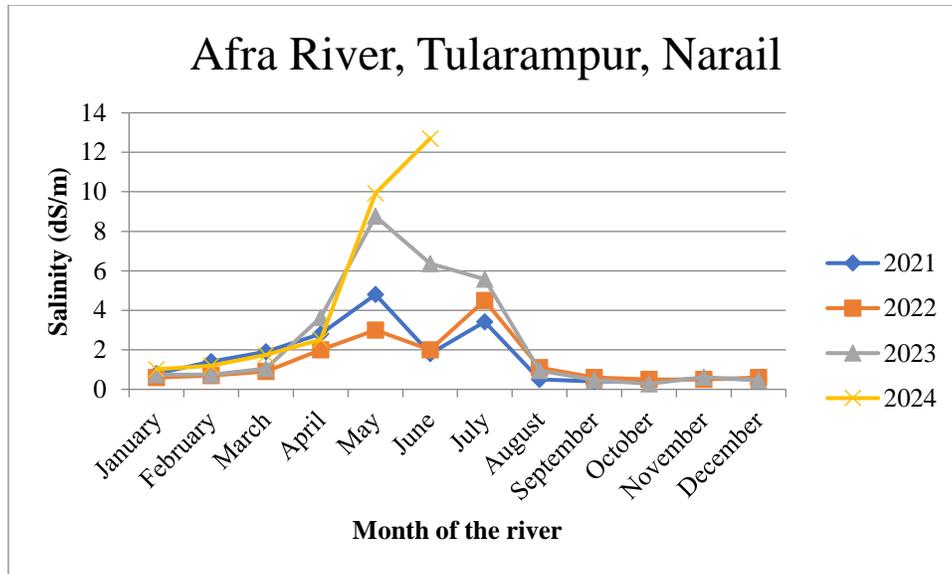
Site no-5: Chittra River, Gobra, Narail sadar, Narail.(New site).

Year	Months											
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug	Sep.	Oct.	Nov.	Dec.
2021	0.75	1.40	1.90	3.60	5.60	2.00	-	0.50	0.35	0.45	0.50	0.60
2022	0.60	0.60	0.90	2.00	2.80	1.70	5.00	1.60	0.60	0.50	0.75	0.90
2023	1.00	0.62	0.75	1.34	4.50	7.13	1.44	0.75	0.31	0.33	0.41	0.48
2024	0.50	0.73	0.76	2.02	2.12	9.78	7.54	1.18				

Chittra River, Gobra, Narail Sadar
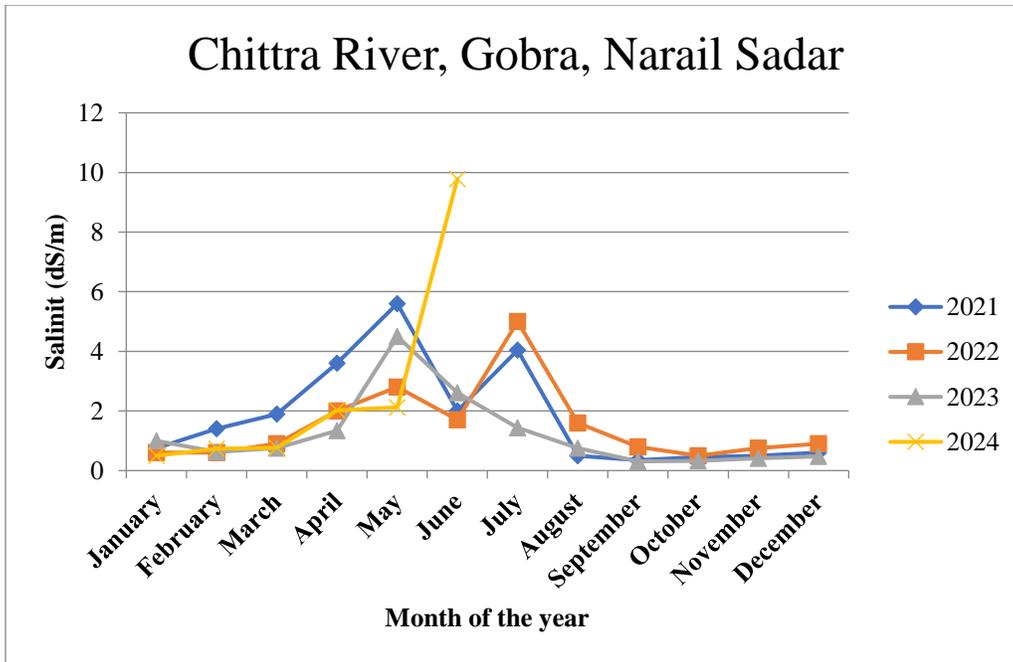
Site no-6: Naboganga River, Baraypara, Kalia.

| Year	Months											
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug	Sep.	Oct.	Nov.	Dec.
2021	0.80	1.35	3.10	6.00	12.00	2.00	-	0.40	0.40	0.60	0.60	0.70
2022	0.70	0.65	0.85	9.10	8.00	4.50	8.90	1.50	0.70	0.50	1.05	1.30
2023	1.40	0.63	1.65	4.76	9.65	11.32	0.51	0.27	0.21	0.23	0.22	0.28
2024	0.30	1.09	1.18	4.42	4.38	8.92	0.17	0.22				
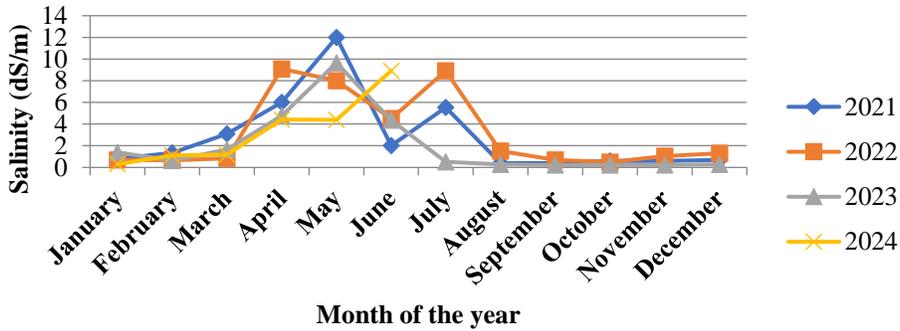
Site no-7: Modhumoti River, Bardia, Lohagara.
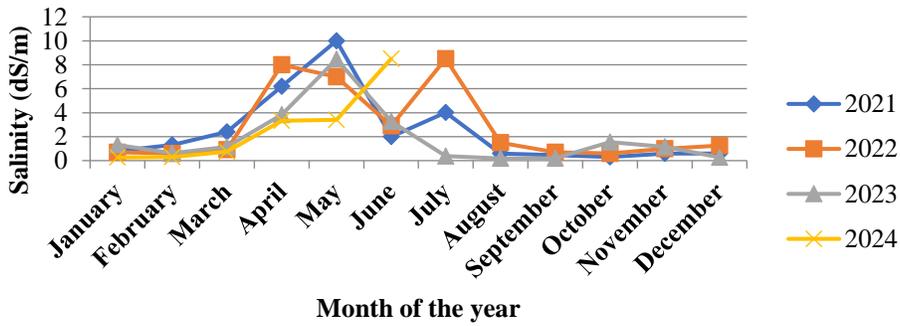
Site no-8: Modhumoti River, Kalna ghat, Lohagara.
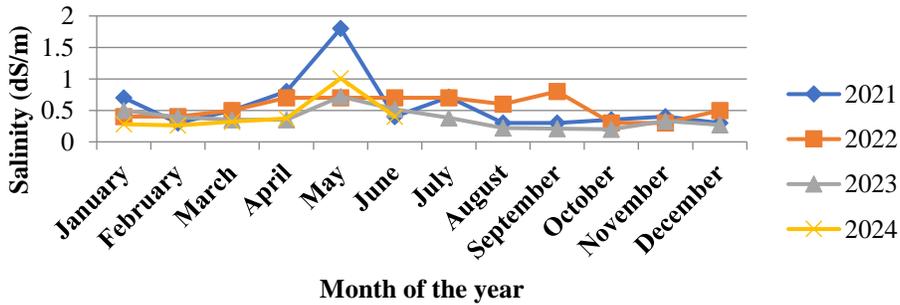
Site no-9: Afra River, Shaikhati, Narail.

Afra River, Shaikhati, Narai
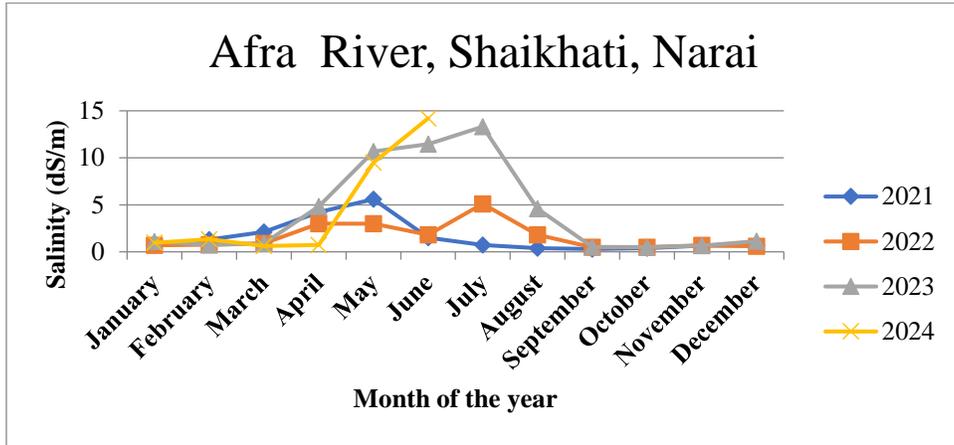
Site no- 1: STW at Narail Ferry ghat, Narail Sadar.

Shallow Tube Well at Narail Ferry ghat, Narail Sadar
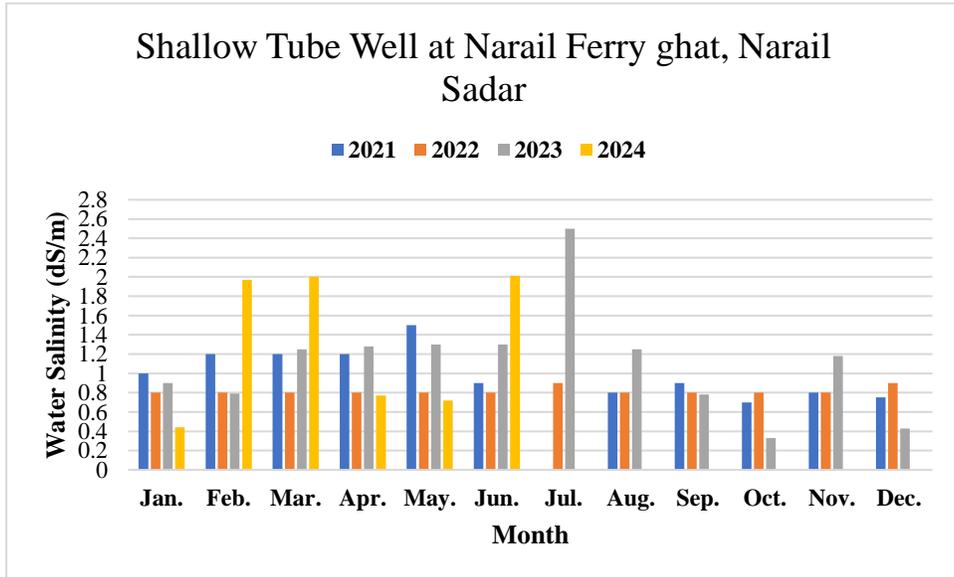
Site no- 2: STW at Sagardari, Kesabpur, Jessore.

Shallow Tube Well at Sagardari, Kesabpur, Jessore
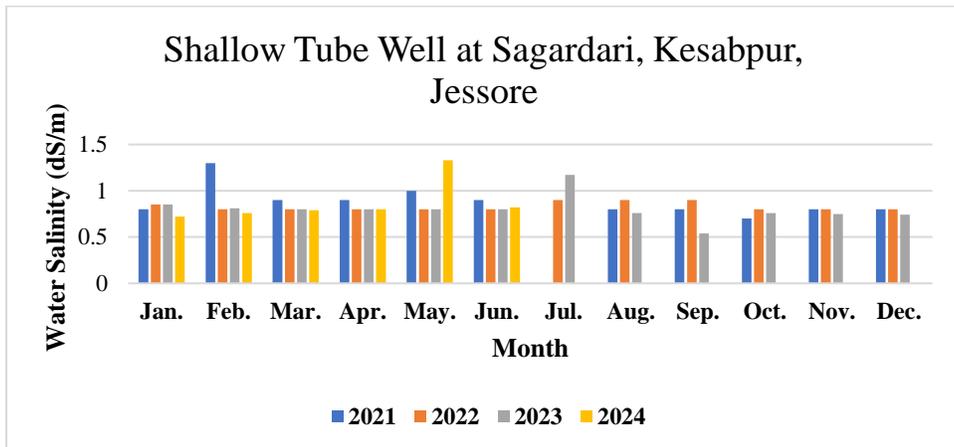
Site no-3: STW at Noapara, Jessore.

Shallow Tube Well at Noapara, Jessore
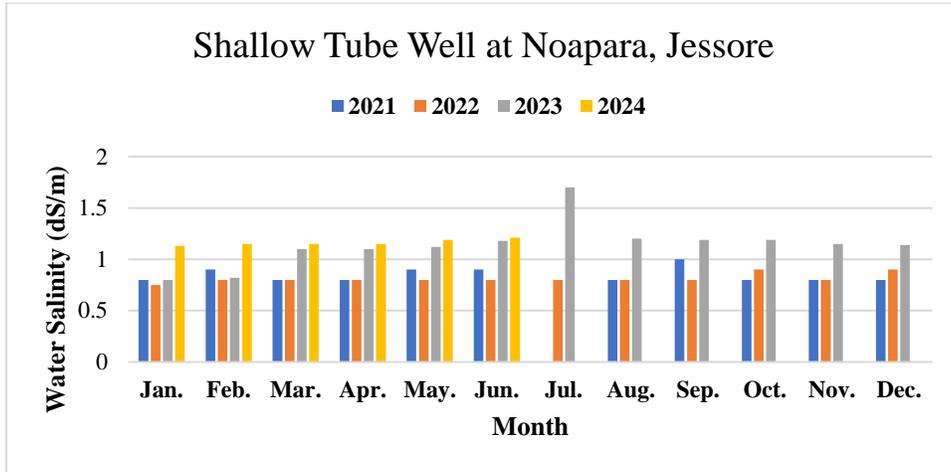
Site no-4: STW at Tularampur, Narail Sadar.

Shallow Tube Well at Tularampur, Narail Sadar
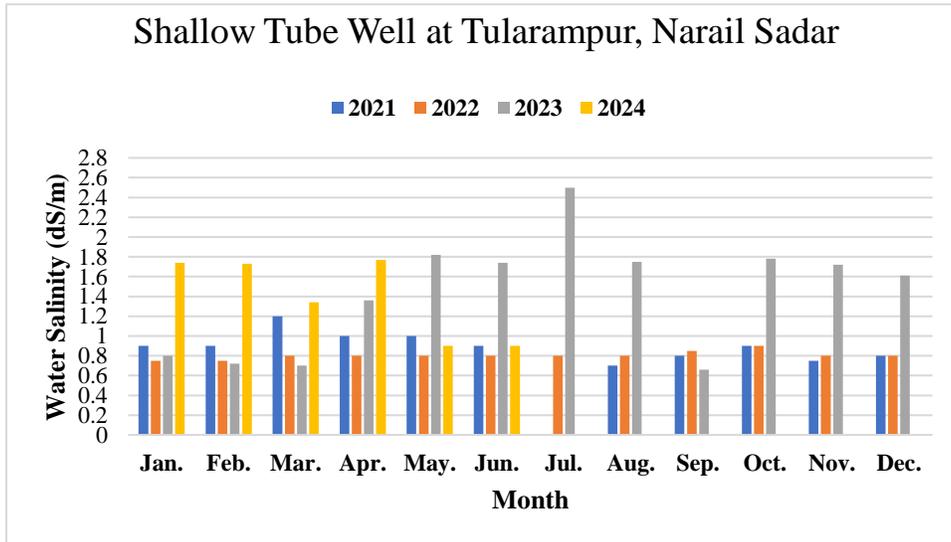
Site no-5: STW at Gobra, Narail sadar, Narail. (New site).

Shallow Tube Well at Gobra, Narail sadar, Narail
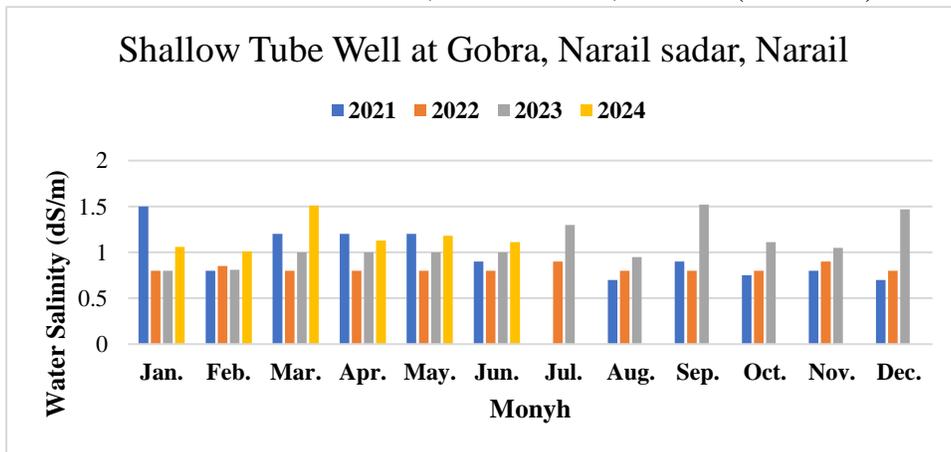
Site no-6: STW at Baraypara, Kalia.

Shallow Tube Well at Baraypara, Kalia

■ 2021　■ 2022　■ 2023　■ 2024
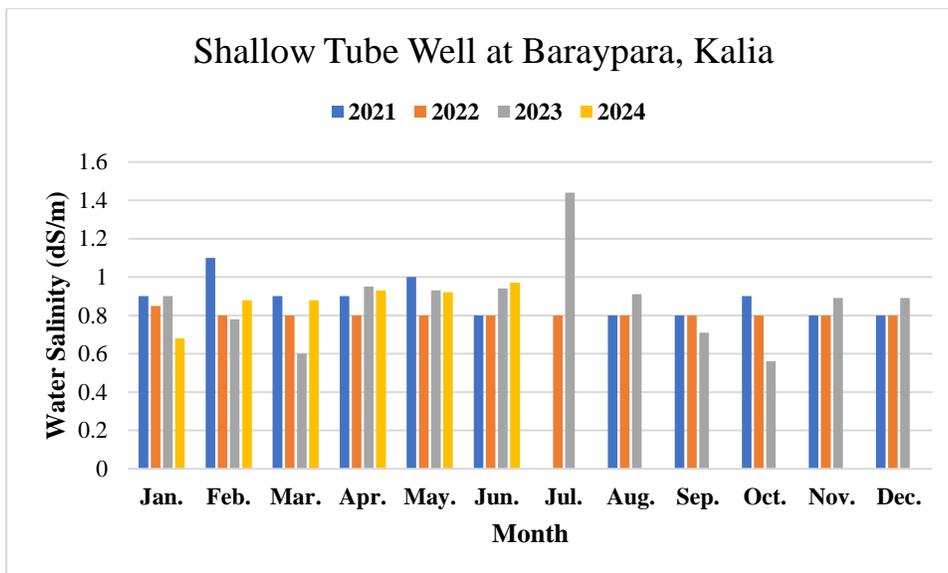
Site no-7: STW at Bardia, Lohagara

Shallow Tube Well at Bardia, Lohagara

■ 2021　■ 2022　■ 2023　■ 2024
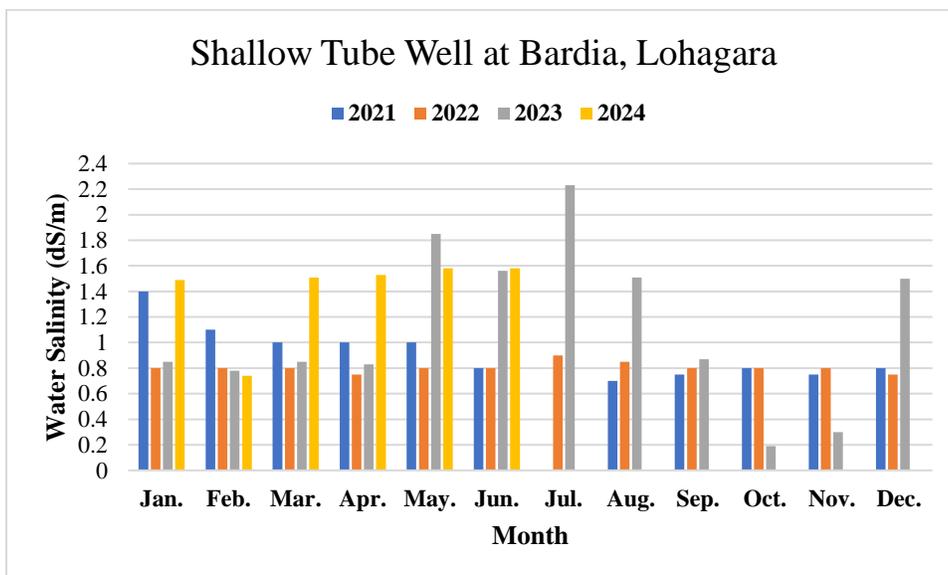
Site no-8: STW at Kalna ghat, Lohagara.

Shallow Tube Well at Kalna ghat, Lohagara

■ 2021 ■ 2022 ■ 2023 ■ 2024

Water Salinity (dS/m) vs *Month* (Jan. – Dec.)

.
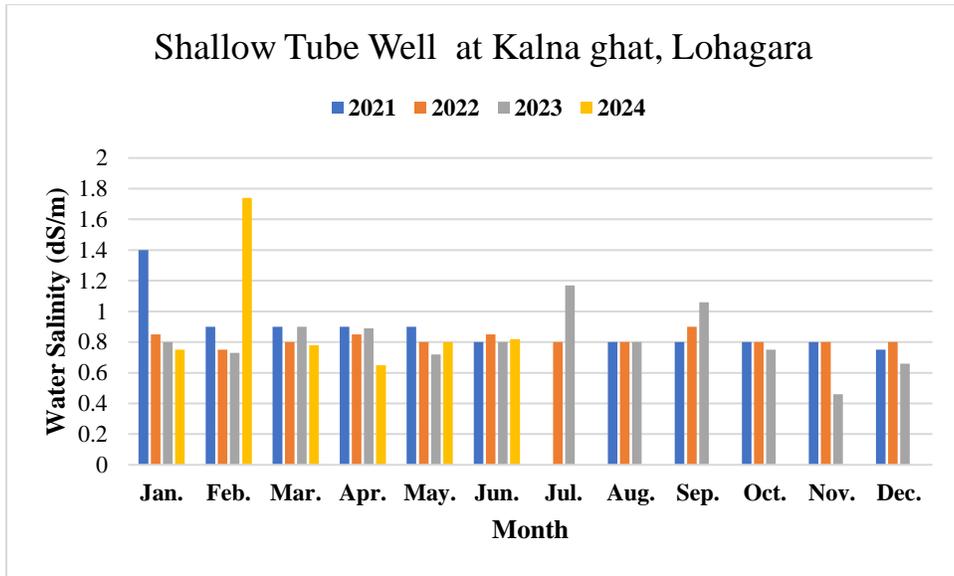
Site no-9: STW at Shaikhati, Narail

Shallow Tube Well at Shaikhati, Narail

■ 2021 ■ 2022 ■ 2023 ■ 2024

Water Salinity (dS/m) vs *Month* (Jan. – Dec.)
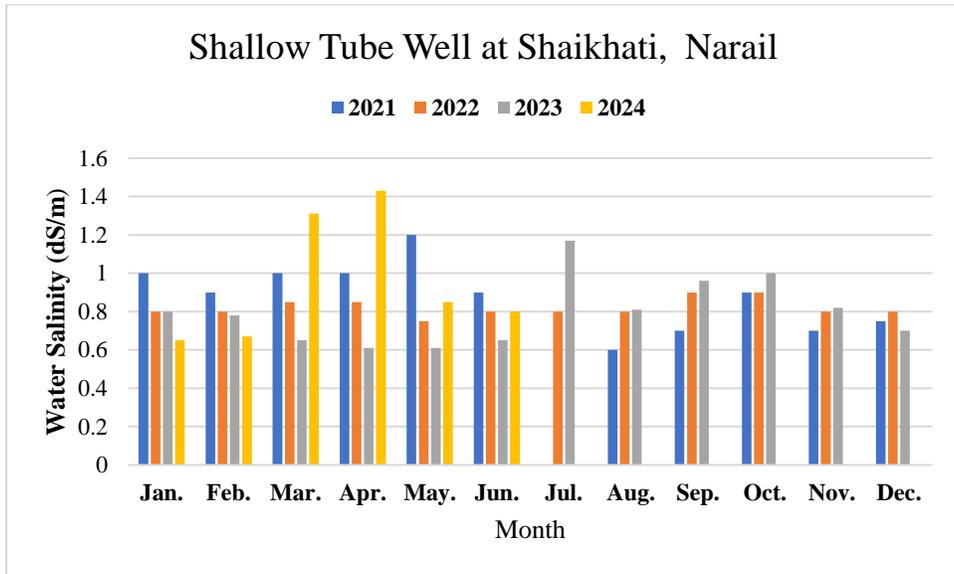
1.Kapotakshariver, Patkelghata, Tala, Satkhira.
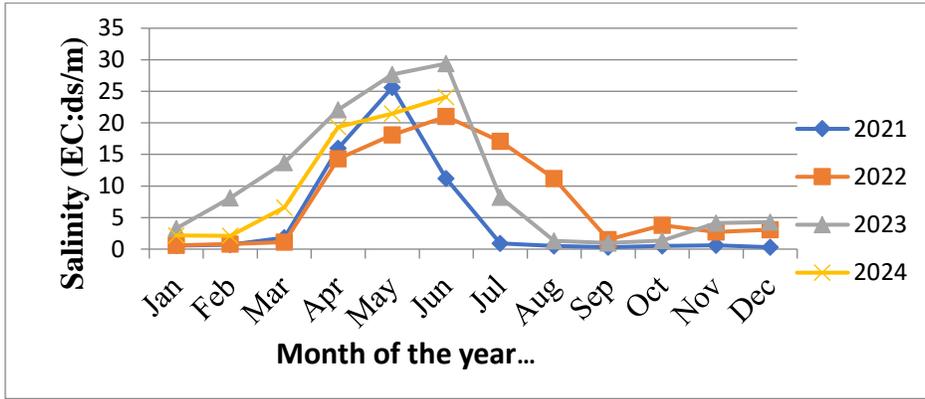
2.Betnariver, Benerpota, Satkhirasadar, Satkhira.

*Due to ongoing river excavation work data collection was not possible
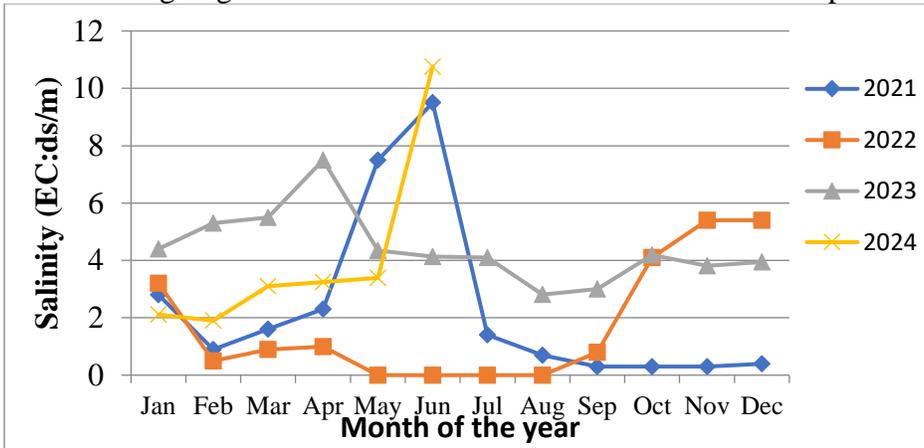
3.Betna river, kolaroa bazar , kolaroa , Satkhira

*Due to ongoing river excavation work data collection was not possible
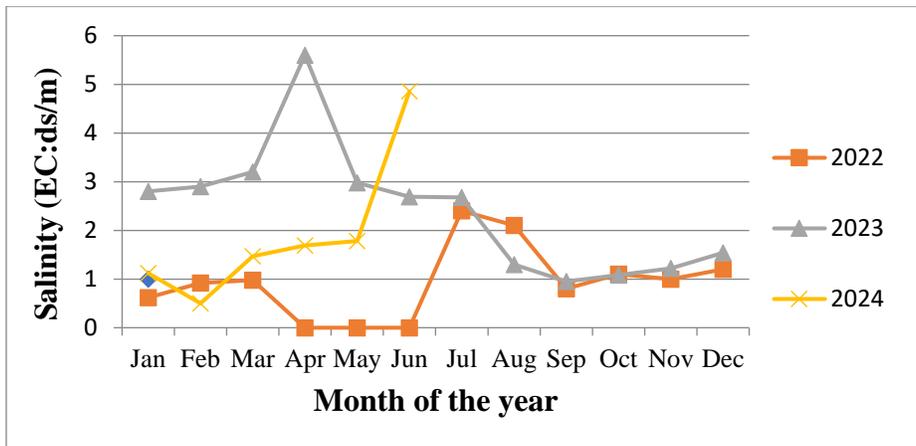
4.Morichap river, Ashashuni, Satkhira.
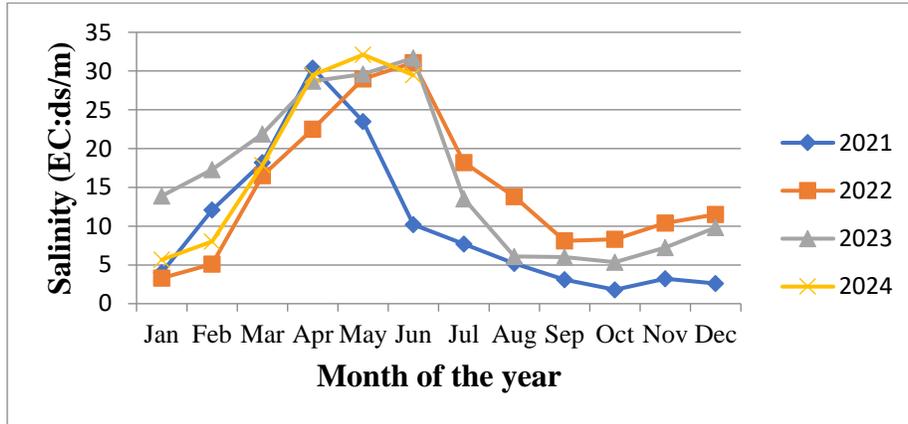
5.Sapmarakhal, parulia , Debhata, Satkhira
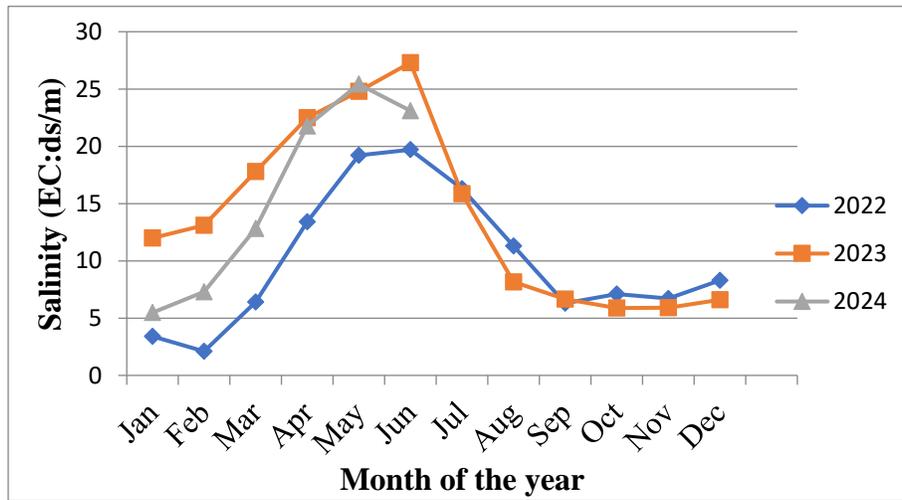
6.Kakshiali river, Kaligonj HQ, Satkhira.
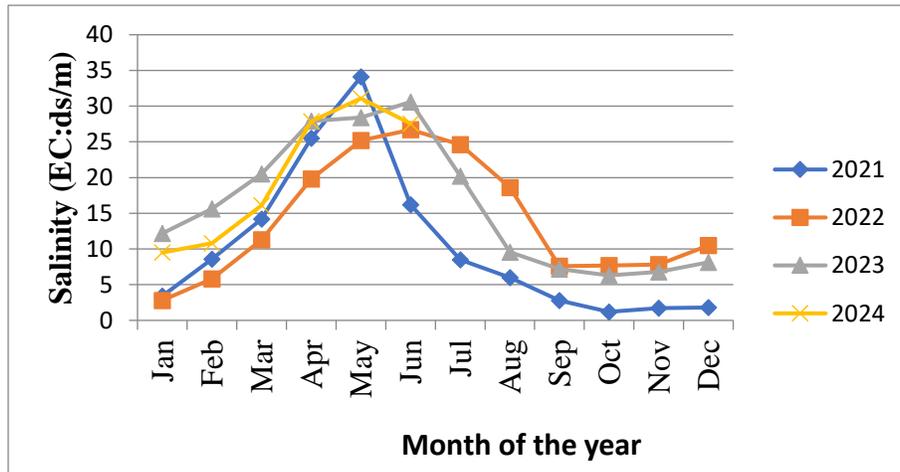
7.kholpatua river, Noyabeki, Shyamnagar, Satkhira
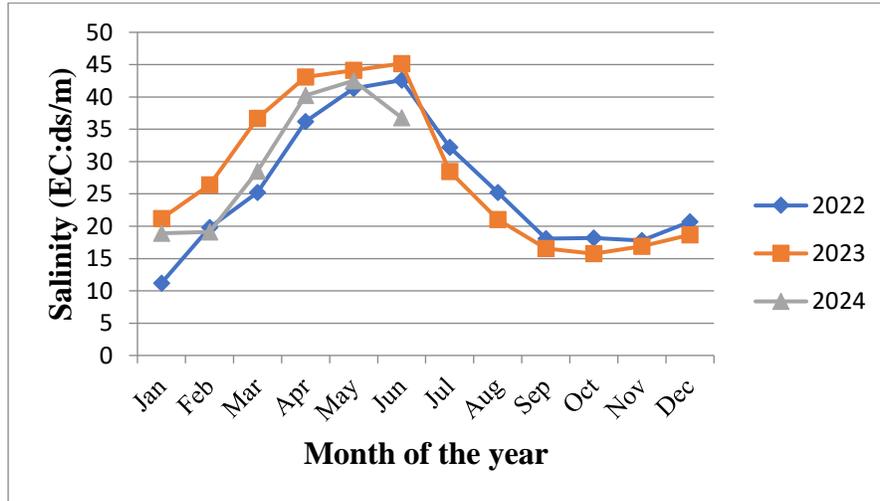
Barishal Division

24 surface water salinity sites and 7 soil salinity sites were selected in greater Barisal and Patuakhali District. In Barisal monitoring sites are located in Nazirpur, Mathbaria, Pirojpur Sadar and Indurkani of Pirojpur District and Charfashion, Manpura, Bhola Sadar, Tazumuddin, Borhanuddin and Lalmohan of Bhola District. In Patuakhali the monitoring sites are located in Amtali, Taltali, Barguna Sadar, Patharghata, Bamna and Betagi of Barguna District and Kalapara, Galachipa, Patuakhali Sadar, Bauphal, Dashmina and Mirzaganj of Patuakhali District. Surface water (river) samples were collected twice in a month during the dry season and once in a month during the rainy season. Salinity of water was determined by EC meter.

Table. Site specification of the soil collection sites of Barishal Division

Sl no.	Name of site	Location	Soil series	Land type	Land Use	Physiography
Patuakhali						
1	Sikandarkhali	Sikandarkhali, Amtali, Barguna	Jhalakathi	MHL	RC- T.Aus -TA	GTF
2	Taltali	Taltali, Sadar, Barguna	Jhalakathi	MHL	RC- T.Aus-TA	GTF
3	Kalapara	Kalapara Sadar, Patuakhali	Barishal	MHL	RC- F- TA	GTF
4	**Kolakopa**	Daulatkhan				
5		Hakimuddin, Borhanuddin				
6		Chanpur, Tazumuddin				

7		Ayeshabag, Betua, Charfassion				

Graphical presentation of soil monitoring site of Barishal division:

Site-1: Vill. - Sikandarkhali, Union & Upazila: Amtali, District: Barguna
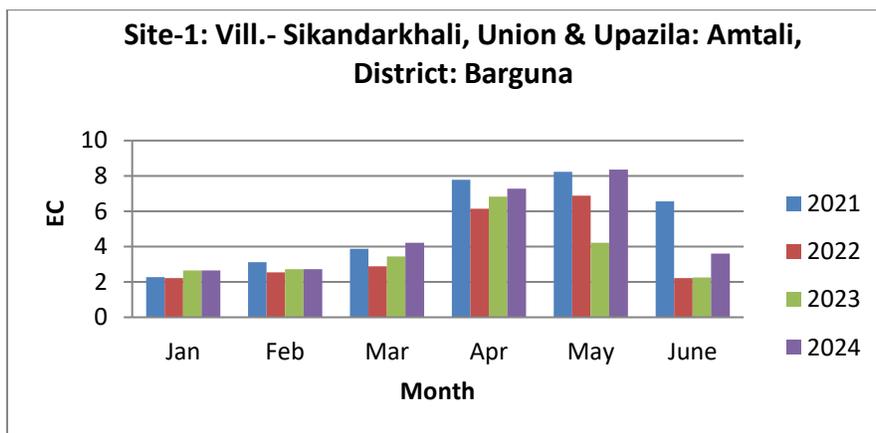
Site-2: Taltali Upazila sadar, District: Barguna
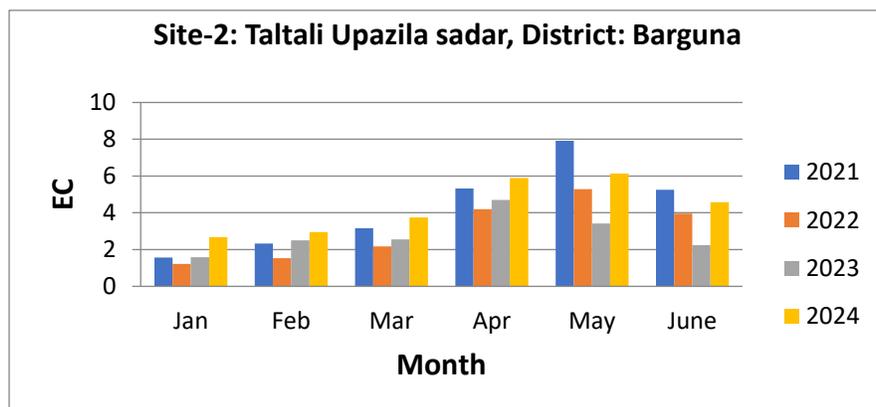
Site-3: Kalapara Upazila Sadar, District: Patuakhali
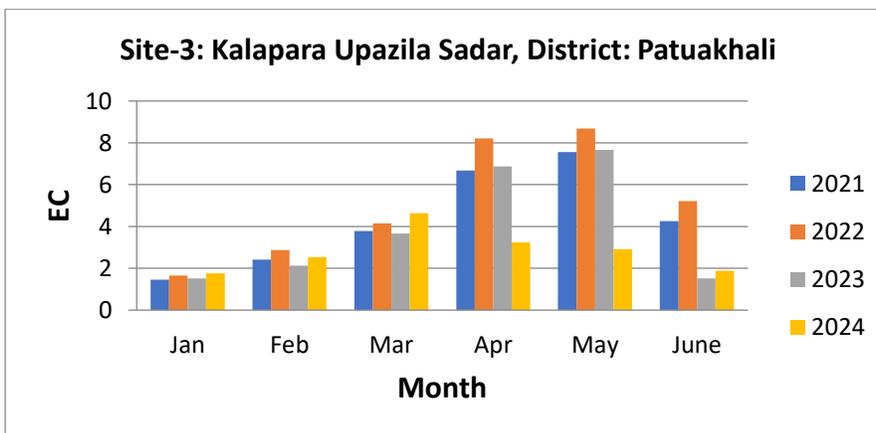
Table. Site specification of the water collection sites of Barishal Division

Sl. No	Name of river/DTW	Location
Barishal		
1	Baleshwar river	Nazirpur Upazila Sadar
2	Panguchi river	Indurkani Upazila Sadar
3	Kacha river	Bekutia Ferry Ghat
Patuakhali		
4	Tentulia	Panpatti Launch Ghat, Galachipa
5	Payra	Taltali Sadar, Taltali, Barguna
6	Payra	Amtali ferry ghat, Amtali, Barguna
7	Payra	Payrakunja, Patuakhali Sadar
8	Bishkhali	Patharghata Launch Ghat, Patharghata, Barguna
9	Bishkhali	Baraitala ferry ghat, Barguna Sadar
10	Bishkhali	Bamna launch ghat, Bamna, Barguna
11	Bishkhali	Betagi launch ghat, Betagi, Barguna
12	Baleswar	Charduani Bazar, Patharghata, Barguna
13	Baleshwar	Bara Machua Ferryghat, Mathbaria, Pirojpur
14	Andharmanik	Kalapara Ferry Ghat, Kalapara, Patuakhali
15	Galachipa	Galachipa Ferry ghat, Galachipa, Patuakhali
Bhola		
16	Meghna	Ilisha Launch ghat, BholaSadar
17	Meghna	Doulatkhan Launch Ghat, Doulatkhan, Bhola
18	Meghna	Hakimuddin Launchghat, Borhanuddin, Bhola
19	Meghna	Tojumuddin Launch Ghat, Tojumuuddin, Bhola
20	Meghna	Mongolsikder Launch ghat, Lalmohon, Bhola
21	Meghna	Betua Launch ghat, Charfassion, Bhola
22	Tetulia	Gongapur Launch ghat, Borhanuddin, Bhola
23	Tetulia	Bhola Kheya ghat, Bhola Sadar, Bhola
24	Tetulia	Veduria launch ghat, Bhola Sadar, Bhola

Site-1:Panpatti Launchghat, Galachipa, River- Tetulia,
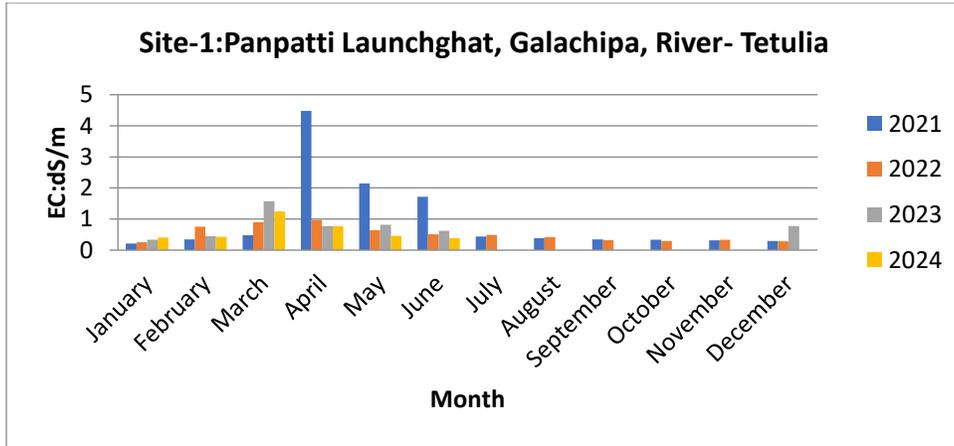
Site-1:Panpatti Launchghat, Galachipa, River- Tetulia

Site-2. Taltali Upazila Sadar,Taltali, Barguna River- Payra

Site-2. Taltali Upazila Sadar,Taltali, Barguna, River- Payra

Site-3. Amtali Ferryghat, Amtali, Barguna River- Payra
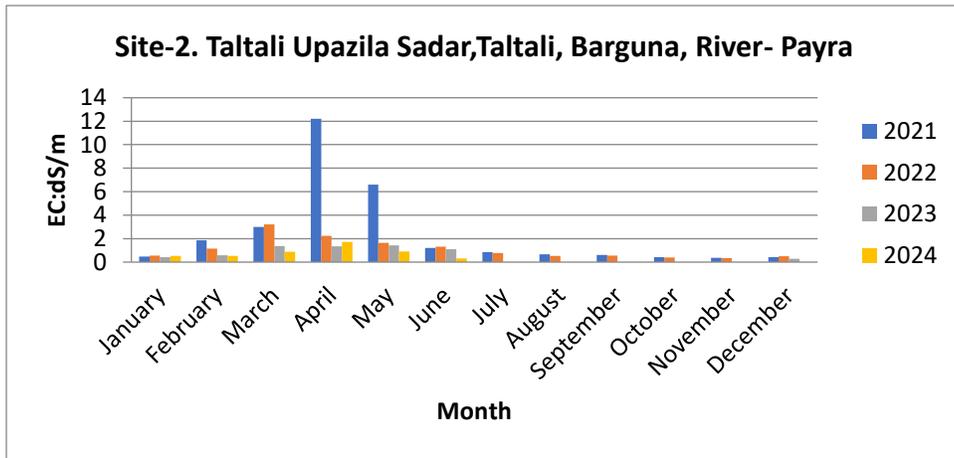
Site-3. Amtali Ferryghat, Amtali, Barguna, River- Payra
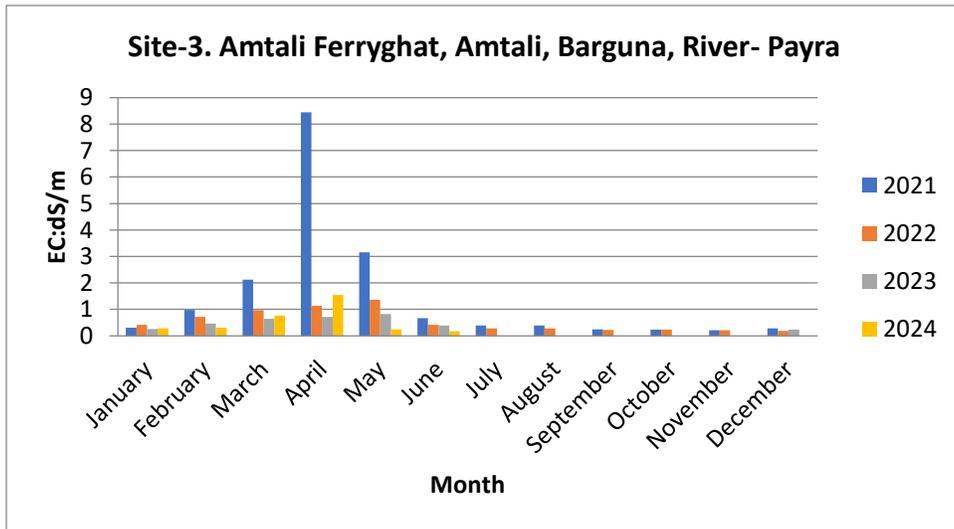
Site-4. Payrakunja Ferryghat, Patuakhali Sadar River- Payra
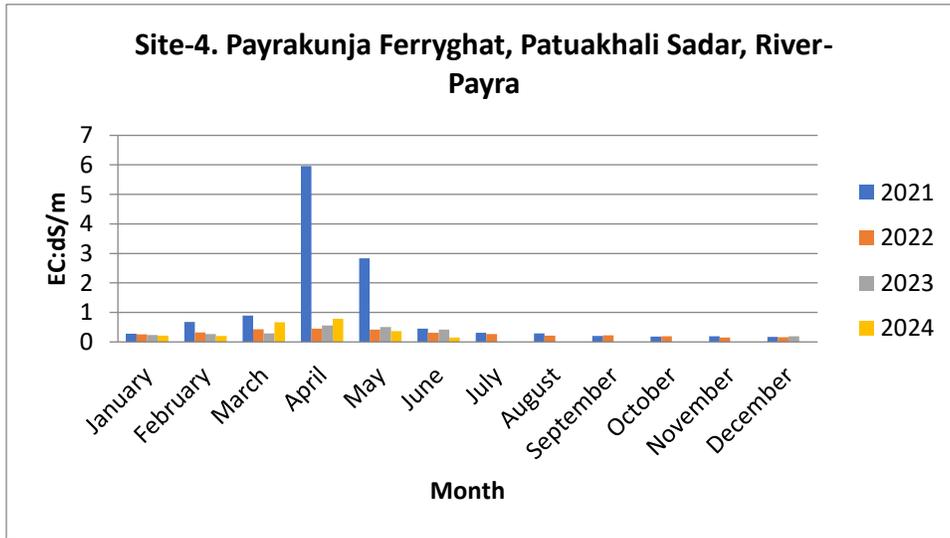
Site-5. Patharghata launchghat, Patharghata, Barguna River- Bishkhali
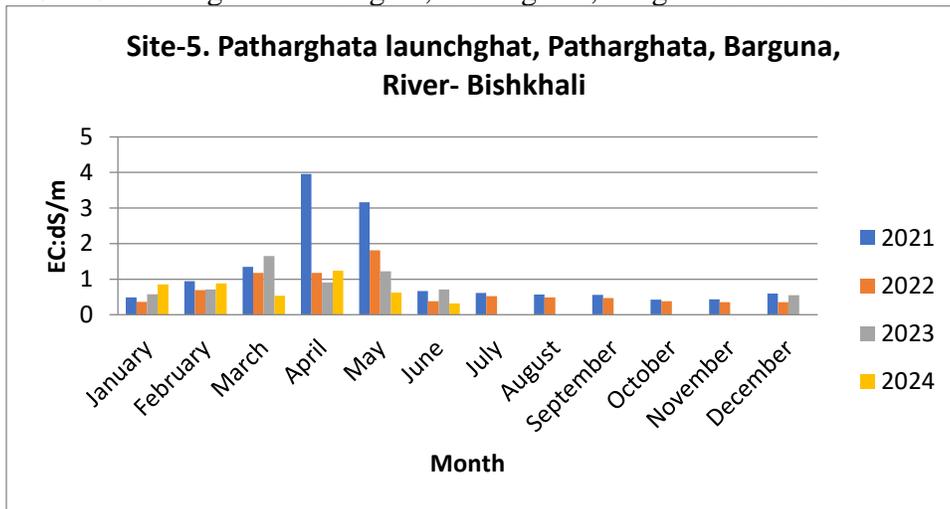
Site-6. BaraitalaFerryghat, Barguna Sadar, River- Bishkhali
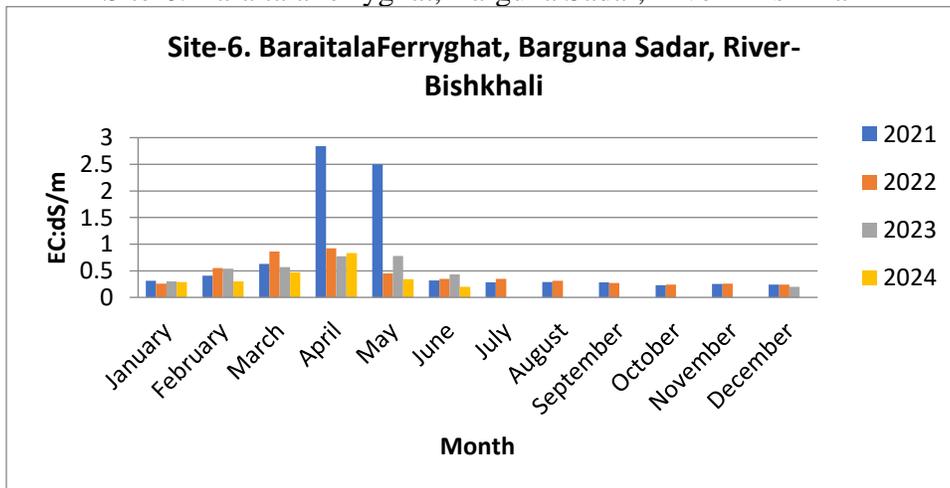
Site-7. Bamna Launchghat, Bamna, Barguna, River- Bishkhali
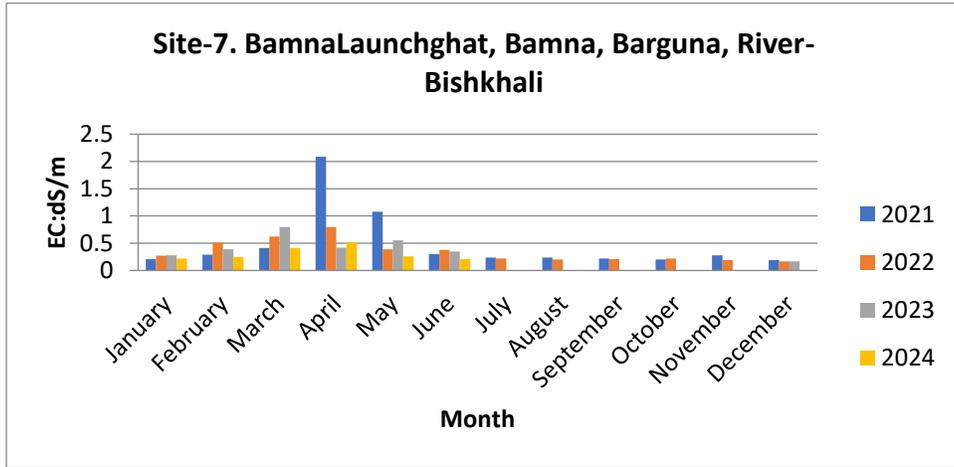
Site-8. Betagi Launchghat, Betagi, Barguna, River- Bishkhali
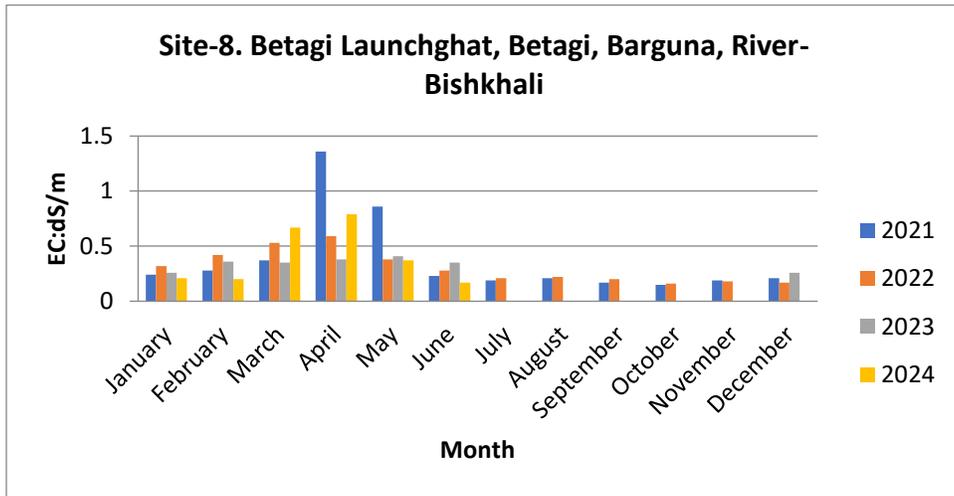
Site-9. Charduani Bazar, Patharghata, Barguna, River- Baleswar

Site-10. Bara Machua Steamerghat, Mathbaria, Pirozpur, River- Baleswar
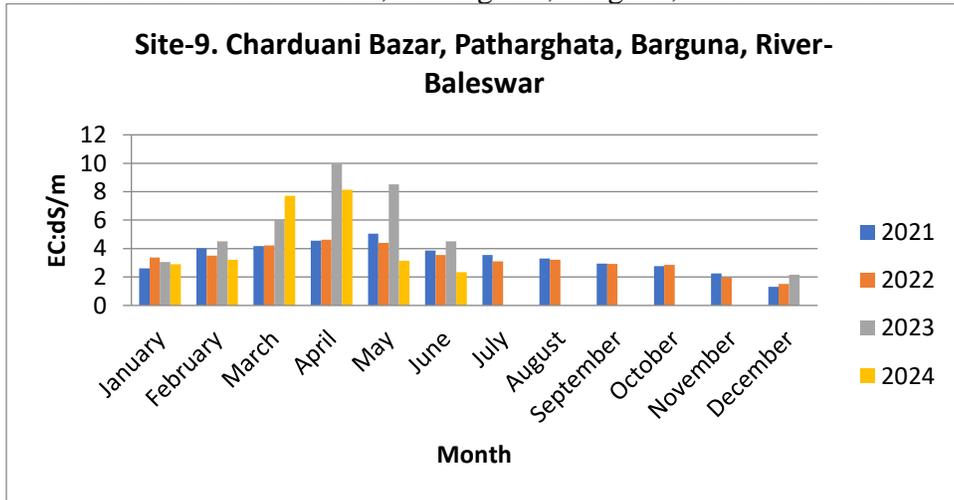
Site-10. Bara Machua Steamerghat, Mathbaria, Pirozpur, River- Baleswar

Site-11. Kalapara Ferryghat, Kalapara, Patuakhali, River- Andharmanik
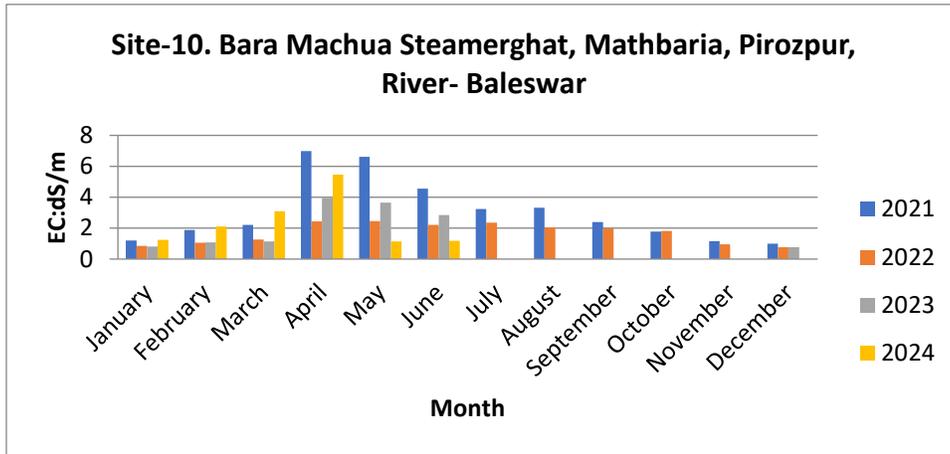
Site-11. Kalapara Ferryghat, Kalapara, Patuakhali, River- Andharmanik

Site-12. Galachipa Ferryghat, Galachipa, Patuakhali, River- Galachipa
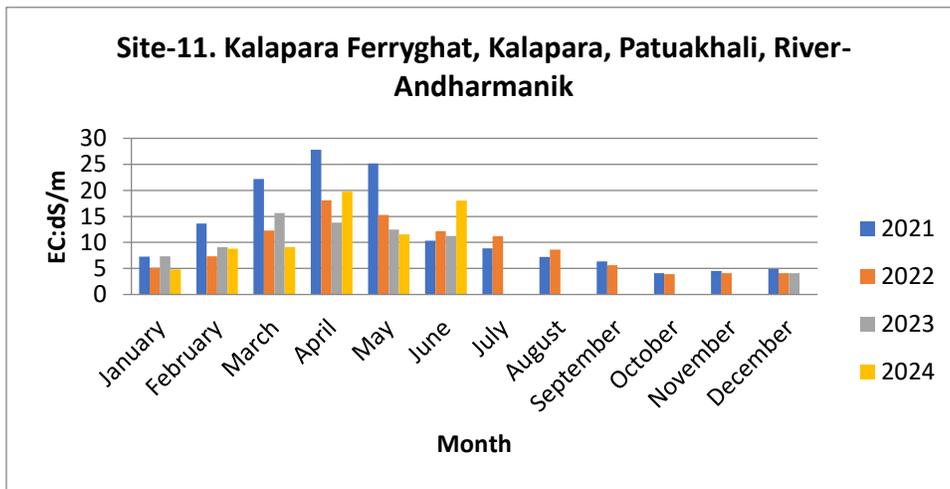
Site-12. Galachipa Ferryghat, Galachipa, Patuakhali, River- Galachipa
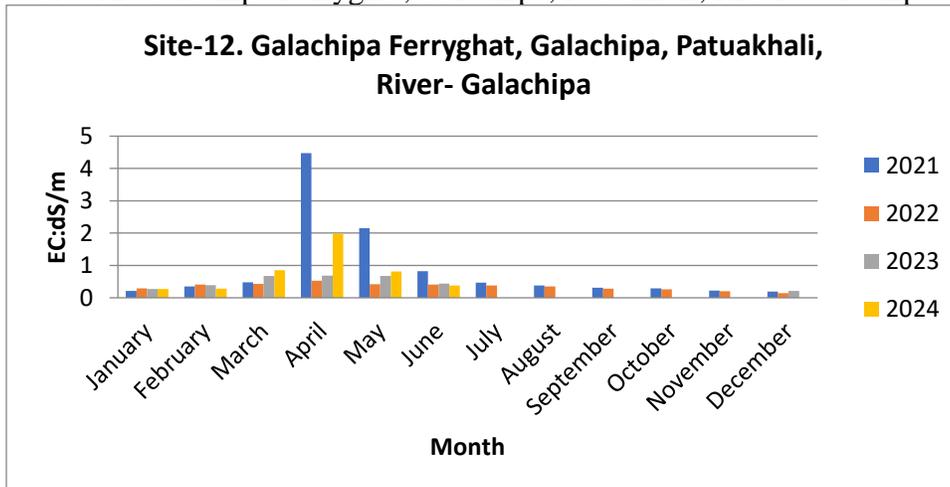
Site no-1: Meghna River, Ilisha Launchghat, Bhola Sadar
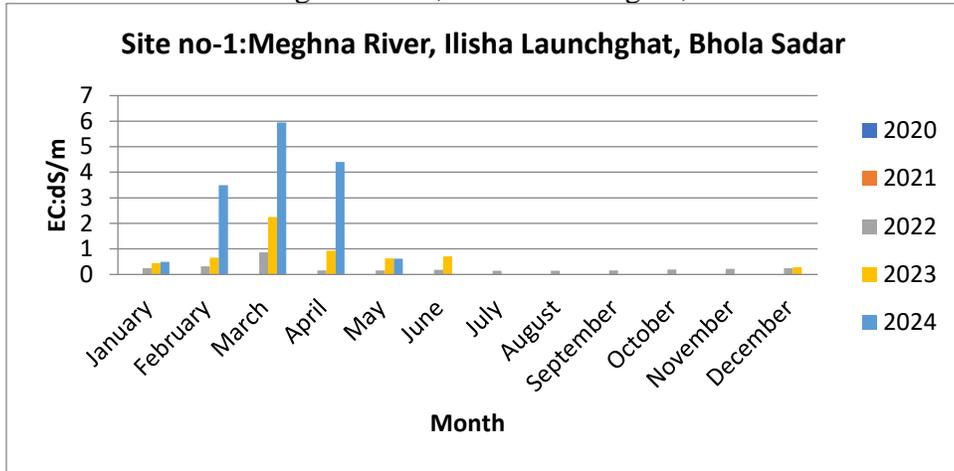
Site no-2: Meghna River, Doulatkhan Launchghat. Doulatkhan, Bhola
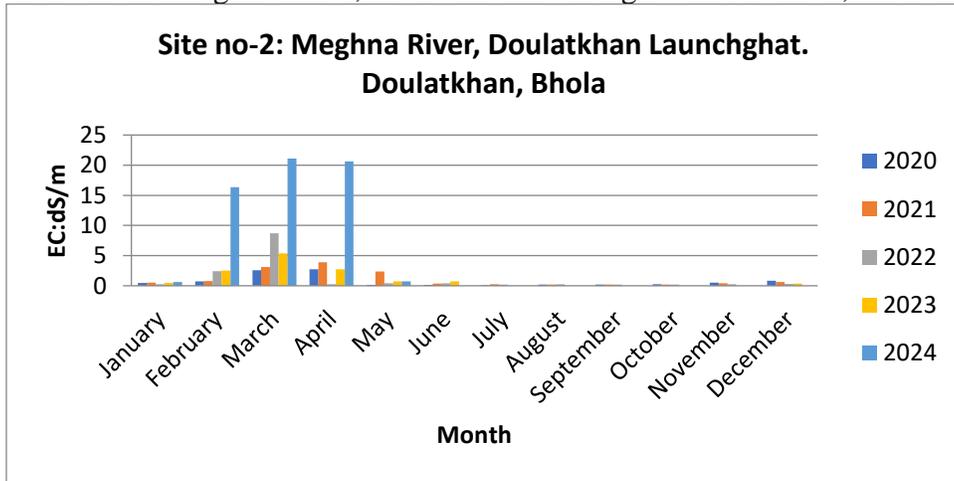
Site no-3: Meghna River, Hakimuddin Launchghat. Borhanuddin, Bhola
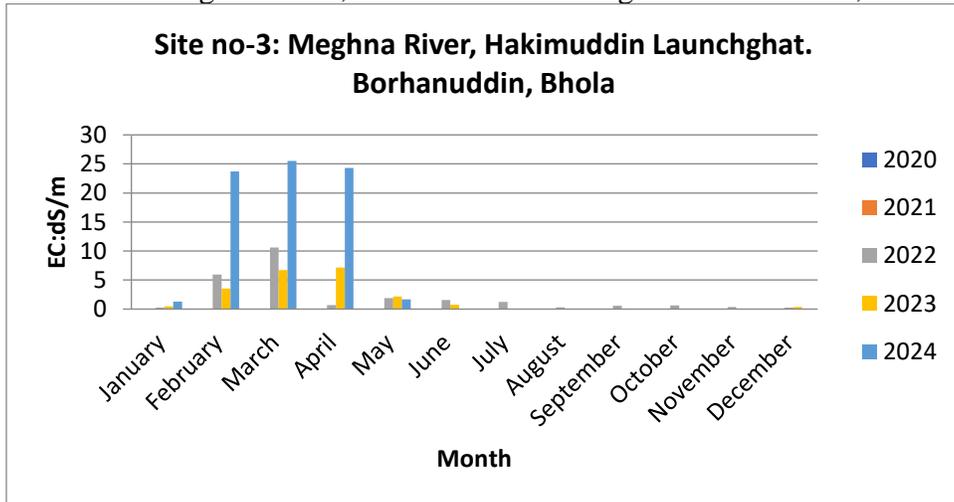
Site no-4: Meghna River, Tojumuddin Launchghat. Tojumuuddin, Bhola

Site no-4: Meghna River, Tojumuddin Launchghat. Tojumuuddin, Bhola

Site no-5: Meghna River, Mongolsikder Launch ghat. Lalmohon, Bhola
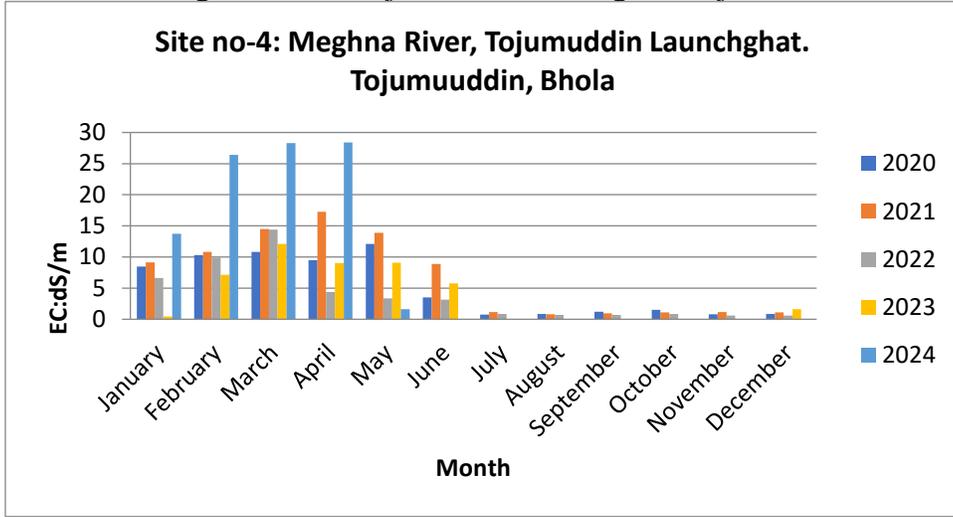
Site no-5: Meghna River, Mongolsikder Launch ghat. Lalmohon, Bhola
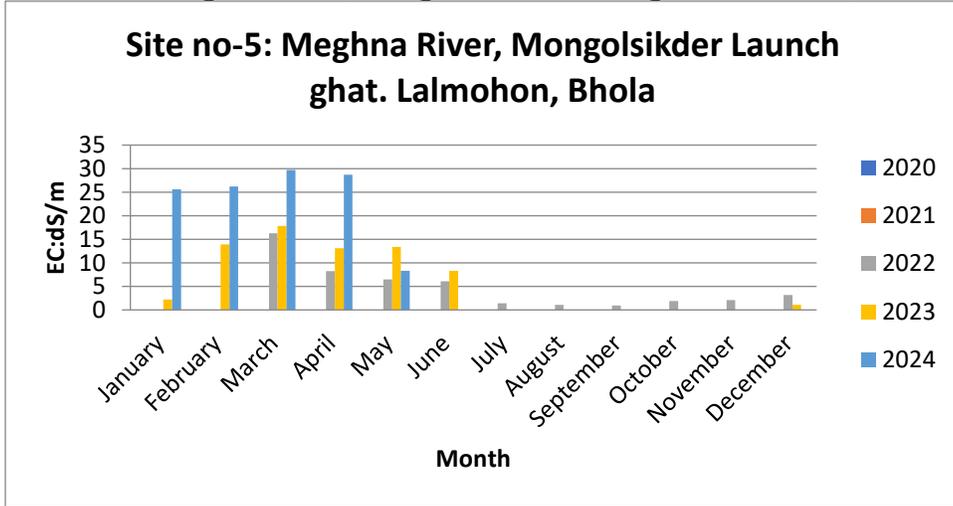
Site no-6: Meghna River, Betua Launchghat. Charfassion, Bhola

Site no-6: Meghna River, Betua Launchghat. Charfassion, Bhola

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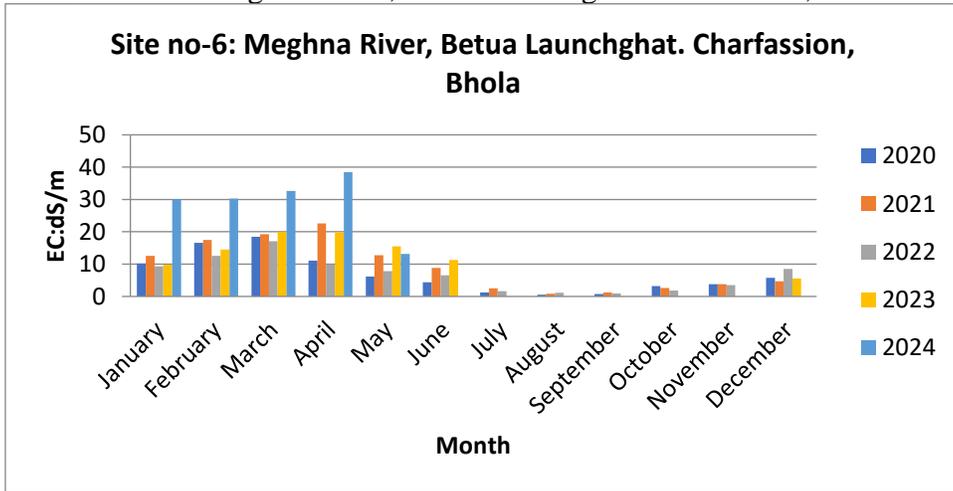
Site no-7: Tetulia River, Gongapur Launchghat. Borhanuddin, Bhola
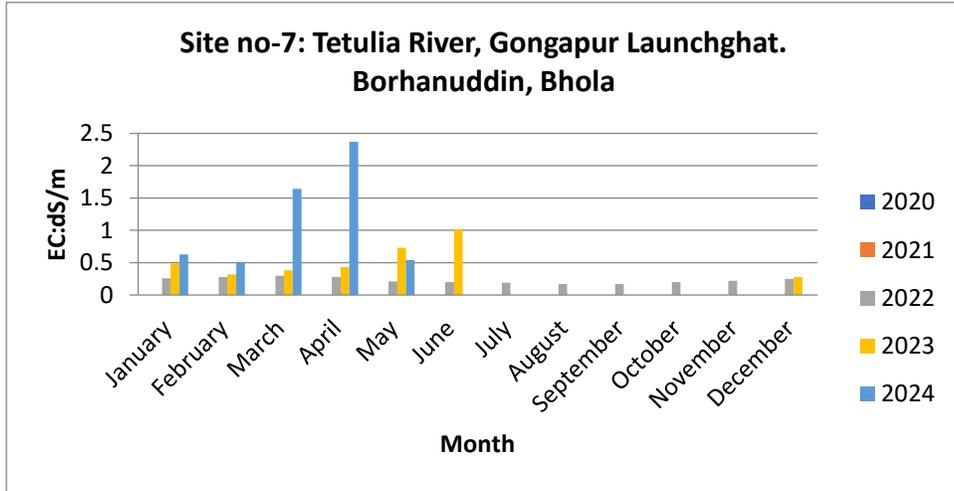
Site no-8: Tetulia River, Bhola Kheyaghat. Bhola Sadar
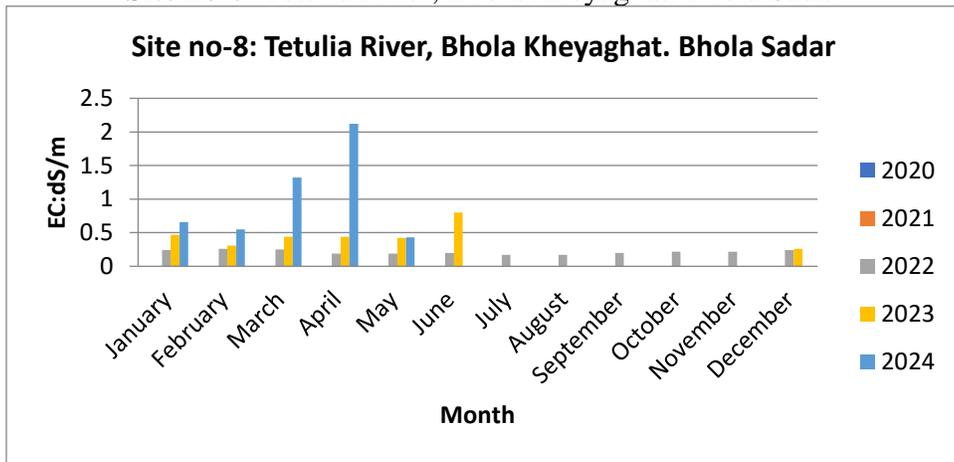
Site no-9: Tetulia River, Veduria launch ghat Bhola Sadar
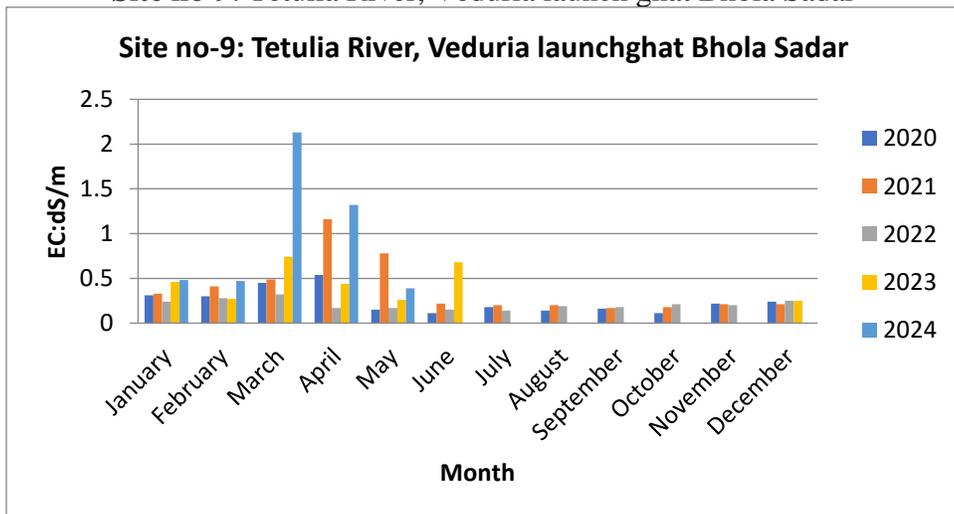
Site-1. Kalapara Upazila Sadar, Kalapara, Patuakhali
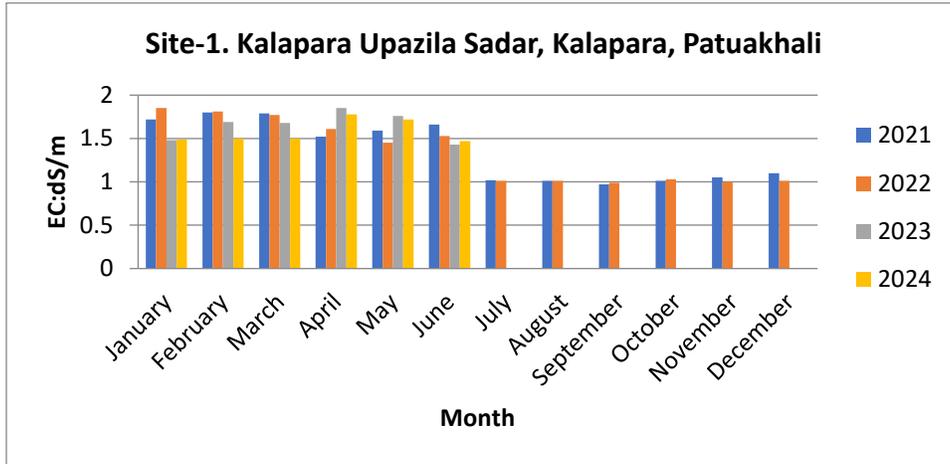
Site-2. Taltali Upazila Sadar, Taltali, Barguna
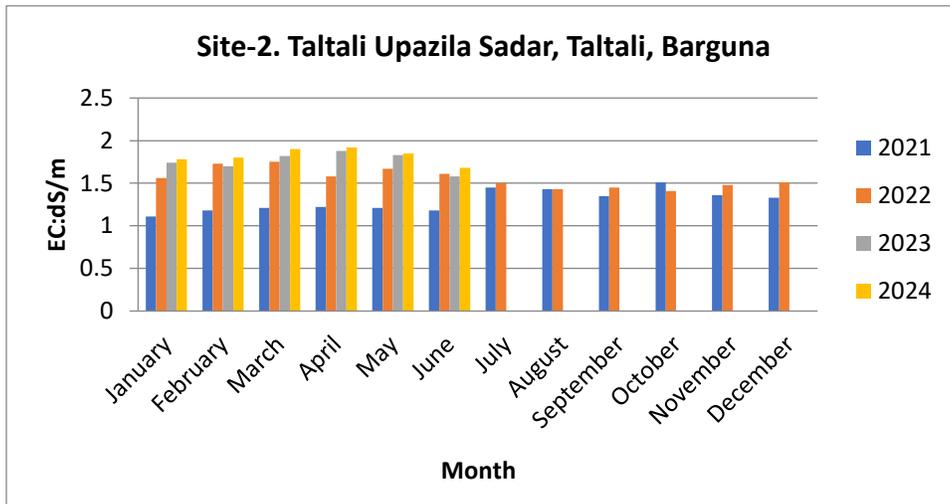
Site-3. Amtali Upazila Sadar, Amtali, Barguna
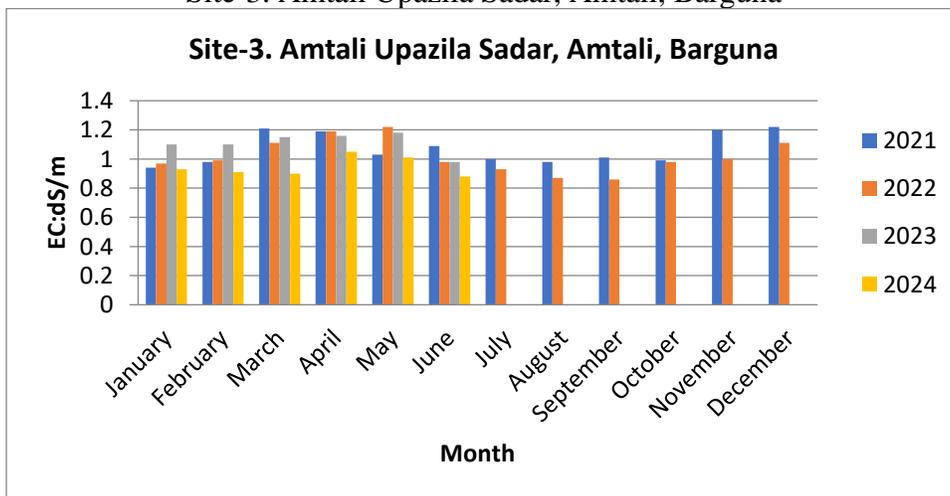
Gopalganj

Gopalganj district started to observe soil and water salinity in the year 2023. 7 surface water salinity sites and 7 soil salinity sites were selected in Gopalganj district. The monitoring sites are located in Different areas of Gopalganj District. Surface water (river, STW) samples were collected twice in month during dry season and once in a month during rainy season. Salinity of water was determined by EC meter.

Soil Salinity Data

Year 2023-2024	Monthwise EC Value											
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Dumuria	0.77	0.38	0.38	0.48	0.67	1.17	1.04	1.17	1.17	1.17	0.24	0.24
Patgati	0.91	0.24	0.38	0.49	0.91	0.77	0.77	0.91	1.04	1.30	0.51	0.64
Khalek Bazar	0.51	0.77	1.04	0.96	1.28	1.44	1.17	1.83	1.83	1.97	0.64	0.64
Horidaspur	4.06	4.18	2.63	4.82	4.18	4.31	4.18	4.44	4.31	4.44	0.77	1.17
Vatiapara	0.51	0.64	0.38	0.70	0.64	0.38	0.38	0.38	0.64	1.57	0.38	0.51
Satpar	1.04	0.38	0.38	0.22	0.28	0.51	0.64	0.51	0.77	0.77	0.91	0.91
South Gangarampur	0.91	0.24	0.24	0.25	0.38	0.38	0.38	0.51	0.51	0.91	0.64	0.64

Water (surface & ground) Salinity Data

Year 2023-2024		Monthwise EC Value											
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Dumuria	river	0.32	0.40	0.44	0.26	0.40	0.44	0.39	0.43	0.53	1.71	1.19	1.14
	STW	6.19	4.50	4.36	4.42	4.24	4.07	3.80	3.97	4.08	4.14	4.04	4.09
Patgati	river	0.28	0.21	0.29	0.34	0.31	0.41	0.37	0.47	0.55	1.96	0.90	1.12
	STW	1.09	0.84	0.84	0.80	0.80	0.78	0.78	0.97	1.13	1.43	0.89	1.02
Khalek Bazar	river	0.25	0.22	0.25	0.25	0.28	0.57	0.46	0.64	0.66	1.49	1.10	1.41
	STW	5.49	4.29	4.13	4.23	3.96	4.05	3.84	4.25	4.13	3.92	1.04	1.62
Horidashpur	river	0.24	0.23	0.23	0.23	0.29	0.42	0.34	0.38	0.46	0.48	0.20	0.36
	STW	0.76	0.57	0.58	0.57	0.60	0.62	0.69	0.60	0.67	0.69	0.98	0.99
Vatiapara	river	0.29	0.22	0.22	0.26	0.40	0.33	0.36	0.36	0.37	0.43	0.57	0.62
	STW	1.22	0.90	0.88	0.91	0.84	0.85	0.78	0.85	0.95	0.86	0.84	0.88
Satpar	river	0.24	0.25	0.30	0.28	0.29	0.43	0.34	0.36	0.40	0.26	0.28	0.27
	STW	1.62	0.88	0.88	1.01	1.04	1.08	1.12	0.86	0.89	1.18	0.88	0.98
South Gangarampur	river	0.26	0.23	0.23	0.31	0.30	0.37	0.37	0.43	0.33	0.33	0.21	0.29
	STW	4.55	3.31	3.28	3.45	3.18	3.16	3.09	3.32	3.15	3.18	3.26	3.22

3.5 Technology Transfer through Adaptive Trials
Introduction
Technology Transfer through Adaptive Trial programme has been initiated to popularize Upazila Nirdeshika based fertilizer recommendation system among the farmers as well as to demonstrate the benefits of balanced fertilizers to conserve soil health with sustainable crop production. Using balanced fertilizers not only averts misuse of valuable fertilizers but also declines environmental

pollution. Use of balanced fertilizers ensures the sustainability of increased trend of crop yields. To popularize balanced fertilizer application among farmers with a view to reducing crop production cost and environmental pollution, adaptive trials are established on the basis of Upazila Nirdeshika.

Objectives

- To exhibit the benefit of using balanced fertilizer in crops according to Upazila Nirdeshika soil test results.
- To promote the use of Upazila Nirdeshika among farmers.
- To stimulate the farmers to conserve soil health through rational use of chemical fertilizers.

Materials and Methods

Two different plots of farmer's are selected for setting up an adaptive trial at Upazila level. Land type and soil group of the plot is identified using Soil and Landform Map attached with Upazila Nirdeshika. Then fertility status is determined from data given Table Kha of the respective mapping unit (Chapter 2). Fertilizer dose is determined according to fertility status. All inputs are supplied by SRDI for both of the farmers for 30 decimal lands. Recommended agronomic practices are followed in the trial plot. But the control plot is managed by the farmers according to their normal practice. Time to time visit and monitoring is ensured by the SRDI and DAE experts to provide timely suggestions. When crops are ready to harvest, a field day is arranged for crop cutting inviting farmers, GO/ NGO officials and public representatives.

Results and Discussion

After crop cutting from the trial plots in every District and Upazila it was observed that trial plot yield was higher than that of control plot. Farmer's knowledge gap, resource constraint and lack of communication with resource persons are responsible for the yield.

Table. Comparative crop yield between FRC based fertilizer and farmer's practice in (FY 2023-2024)

Sl. No.	Name of Upazila	District	Crop & Variety	Average yield (t/ha)		
				Farmer's field	Demonstration plot	Yield increase%
1	Boalmari	Faridpur	Bari sarisha-18	1.5	1.8	+20%
2	Madhukhali	Faridpur	BRRI Gom- 33	4.1	4.7	+15%
3	Tungipara	Gopalganj	Rice (Babylon-2)	7.80	8.70	11.54
4	Gopalganj Sadar	Gopalganj	Rice (Hira-2)	6.40	7.28	13.75
5	Nalitabari	Sherpur	Hybrid Shakti-1	6.72	8.11	20.68
6	Jamalpur Sadar	Jamalpur	BRRI Dhan-29	5.98	7.07	18.22
7	Karimganj	Kishoreganj	Rice (BRRI Dhan-29)	6.95	9.48	36.4
8	Hossainpur	Kishoreganj	Rice (BRRI Dhan-92)	6.45	8.05	24.8
9	Madaripur	Madaripur	BARI Sarisha-14	1.2	1.5	25% increase
10	Sadar		BRRI Dhan-92	7.1	8.3	17% increase
11	Trishal	Mymensingh	Brridhan – 88	5.2	6.5	25%
12	Sadar	Narsingdi	BRRI dhan-96	6.42	7.26	13%
13	Monohordi		BRRI dhan-100	6.27	7.45	18%
14	Netrokona Sadar	Netrokona	BRI-92	7.2	7.3	0.1%
15	Tangail Sadar	Tangail	Boro (BRRI dhan 89)	7.8	6.2	21
16	Madhupur			8.2	6.7	22
17	Wazirpur	Barishal	Boro Rice BRRI dhan 74	5.6	6.3	13
18	Babuganj		Boro Rice BRRI dhan 74	5.3	5.9	11
19	Amtali	Patuakhali	Maize Unisun Hybrid	1.9	2.6	37
20			Boro Rice BRRI dhan 74	5.6	6.4	14
21	Bhola Sadar	Bhola	BARI Sharisha 14	1.4	1.7	21
22	Daulatkhan		BARI Soybean 5	2.1	2.4	14
23	Bijoynagar, Godagari	Rajshahi	Wheat (BARI Gam-33)	3.5	4.20	20.0
24	Binodpur, Tanore	Rajshahi	Potato (Cardinal)	33.53	45.1	34.5
25	Sherpur, Gomostapur	Chapainawabganj	Wheat (BARI Gam-33)	3.89	4.45	14.4
26	Borendra, Nachole	Chapainawabganj	Wheat (BARI Gam-30)	4.49	5.09	13.4
27	Sirajganj Sadr	Sirajganj	Wheat (BARI Gam-33)	3.55	4.19	18.0
28	Sirajganj Sadr	Sirajganj	BRRI dhan-92	6.14	6.97	13.5
29	Hapania, Naogaon, Sadar	Naogaon	Wheat (BARI Gam-33)	3.89	4.69	20.6
30	Chondikhetro,Naogaon, Sadar	Naogaon	Wheat (BARI Gam-33)	3.08	3.59	16.5
31	Bogura Sadar	Bogura	Potato BADC Alu1	12.06	17.78	47
32	Kalai	Joypurhat	Potato BADC Alu1	20.01	20.16	0.75
33	Atghoria	Pabna	Wheat-33	3.8 t/ha	4.19 t/ha	10.26

Sl. No.	Name of Upazila	District	Crop & Variety	Average yield (t/ha)		
				Farmer's field	Demonstration plot	Yield increase%
34	Pabna Sadar	Pabna	BINA Dhan-25	3.0 t/ha	3.4 t/ha	13.33
35	Bagerhat	Fakirhat	BRRI dhan100	6.2	7.1	+14.52
36	Rupsa	Khulna	BRRI dhan100	6.5	7.0	+7.69
37	Bagharpar	Jashore	BRRIdhan100	6.5	7.5	+15
38	Lohagara	Narail	BRRIdhan100	6.2	6.8	+13
39	Jhenaidah Sadar	Jhenaidah	BARI Gom-33	4.56	5.61	+23.0
40	Magura Sadar	Magura	BARI Gom-33	3.99	4.98	+24.8
41	Kushtia Sadar	Kushtia	BARI Gom-33	3.46	3.70	+6.9
42	Kumarkhali	Kushtia	BARI Gom-33	3.95	4.19	+6.1
43	SatkhiraSadar	Satkhira	BRRI dhan100	5.9	6.9	+18.94
44	Kligonj	Satkhira	BRRI dhan67	5.2	5.9	+13.46
45	Dinajpur Sadar	Dinajpur	BARI GOM-33	3.9	4.7	20.51
46			BARI ALU 25 (Asterix)	24.2	28.9	19.42
47	Bodorgonj	Rangpur	Bri-87	990 kg	1122 kg	13.33%
48	Rangpur Sadar	Rangpur	Mustard Bari-14	1041 kg	1065 kg	2.30%
49	Sundorgang	Gaibandha	Mustard (Bari Sarisha-14)	1.3	1.6	23%
50			Potato (asterix)	27.8	37.1	33%
51	Kurigram	Rajarhat	BARI Sarisa-14	1.10	1.30	18.20
52	Lalmonirhat Sadar	Lalmonirhat	Hybrid Maize (Kaberi-54)	9.05	11.30	24
53	Thakurgaon Sadar	Thakurgaon	Wheat (BARI-33)	4.43	4.59	3.6
54	Ranishangkail		Maize	14.2	15.1	0.06
55	Sadar	Brahmanbaria	BINA Sharisha-11	1.15	1.31	(+) 13.91
56	Ashuganj	Brahmanbaria	BRRI Dhan-100	5.6	6.3	(+) 12.50
57	Lalmai	Cumilla	Brri Dhan-92	6.0	6.7	11
58	Burichang	Cumilla	Brri Dhan-92	6.2	7.3	17
59	Rangamati sadar	Rangamati	Boro 2024 (BINA DHAN-25)	6.57	5.89	10.3
60	Rangamati sadar	Rangamati	Boro 2024 (BINA DHAN-25)	6.74	5.93	12.01
61	Dakshin Surma	Sylhet	Binadhan-25	7.4	8.2	10.8%
62	Osmaninagar	Sylhet	Binadhan-25	5.6	6.1	8.9%
63	Moulvibazar Sadar	Moulvibazar	BINA Dhan25	5.9	6.8	15.25
64	Kamalganj	Moulvibazar	BINA Dhan25	6.5	7.3	12.31
65	Shantiganj	Sunamganj	BRRI-92	7.65	9.50	24.18
66	Sadar		BINA-25	7.2	8.46	17.5

Conclusion

Farmers obtained higher yield by using balanced doses of fertilizer on the basis of Upazila Nirdeshika. It is a low/no cost technology which contributes farmers higher yield through sustainable soil management. The results revealed that farmers got 1.09%-28% higher yield in different crops and varieties in comparison to farmers' practices in different locations.

3.6 Distribution of Fertilizer Recommendation Cards

Introduction

Increasing crop production through sustainable soil management is now a global concern. It is also relevant to our Sustainable Development Goals SDGs. It is a harsh reality that our government has to ensure food security with limited land resources. So, food security is indissolubly linked with soil health management. We must feed our swelling population, but it should not be for the cost of nutrient mining. Keeping it in view SRDI launched the programme in order to popularize and disseminate the practice of balanced fertilizer use among farmers throughout the country. In 2023-2024, total number of fertilizer recommendation cards distributed was 15,434 of which 5,793 numbers were on the basis of Upazila Nirdeshika, 7,771 on the basis of OFRS and the rest 1,870 were soil test basis.

Table. Fertilizer Recommendation Cards Distribution:

Name of Office	District	Upazila	Type of service		
			Nirdeshika based	Online based	Soil test based
Regional Office, Faridpur	Faridpur	Madhukhali Nagarkanda	200	**300**	-
Regional Office, Gopalganj	Gopalganj	Gopalganj Sadar Muksudpur Kashiani	100	200	-
Regional Office, Jamalpur	Jamalpur	Jamalpur Sadar, Islampur, Melandaha Sorishabari, Dewanganj, Madarganj	140	230	10
	Sherpur	Sherpur Sadar, Nokla, Nalitabari Jhinaigati	100	165	10
Regional Office, Kishoreganj	Kishoreganj	Kuliarchar, Karimganj	150	300	-
Regional Office, Madaripur	Madaripur	Madaripur Sadar	50	200	-
	Shariatpur	Shariatpur Sadar	50	-	-
Regional Office, Mymensingh	Mymensingh	Mymensingh Sadar, Gouripur, Trishal, Iswarganj	250	340	-
Regional Office, Narsingdi	Narsingdi	Belabo, Raipura Sadar, Monohordi	156	98	-
	Gazipur	Sadar	-	350	-

Name of Office	District	Upazila	Type of service		
			Nirdeshika based	Online based	Soil test based
Regional Office, Netrokona	Netrokona	Netrokona Sadar, Barhatta	50	200	-
Regional Office, Tangail	Tangail	Madhupur, Nagorpur, Gopalpur, Shakhipur, Tangail Sadar	600	200	100
Regional Office, Bhola	Bhola	Daulatkhan	45	-	-
		Charfassion	100	100	-
		Tozumuddin	55	-	25
Regional Office, Patuakhali	Barguna	Taltali	-	150	-
		Patharghata	150	-	-
	Patuakhali	Dashmina	129	-	25
		Kalapara	100	-	-
Divisional office, Rajshahi	Rajshahi		-	13	-
Regional Office, Chapainawabganj	Chapainawabganj		150	150	200
Regional Office, Naogaon	Naogaon		50	30	320
Regional Office, Bogura	Bogura, Joypurhat		100	50	350
Regional Office, Pabna	Pabna		100	140	260
Regional Office, Sirajganj	Sirajganj		160	50	90
Divisional office, Khulna	Bgerhat	Rampal	-	180	-
		Fokirhat	-	180	-
	Khulna	Terokhada	-	180	-
	Satkhira	Satkhira sadar	55	-	-
		kolaroa	45	-	-
Regional Office, Jashore	Jashore	Jashore Sador	50	-	-
	Jashore	Avoynagor	50	-	-
	Narail	Lohagara	-	100	-
	Narail	Kalia	-	100	-
	Jashore	Chaugasha	-	120	-
	Jashore	Monirampur	-	58	-
	Jashore	Jikorgasha	-	102	-
Regional Office, Jhenaidah	Jhenaidah	JhenaidahSadar	100	150	-
Regional Office, Kushtia	Chuadanga	Jibonnogor	50	-	-
	Kushtia	Khoksa	50	-	-
Regional Office, Kushtia	Kushtia	Kumarkhali		300	-
		Khoksa	50	-	-
		Mirpur	50	-	-
Regional Office, Satkhira	Satkhira	Satkhirasadar	100	120	-
		Kaligonj	-	120	-
		koraroa	-	120	-
		Debhata	-	120	-
Regional Office, Dinajpur	Dinajpur	Dinajpur Sadar, Kaharol, Fulbari	251	150	41
Divisional Office, Rangpur	Rangpur	Gangachora	-	50	-

Name of Office	District	Upazila	Type of service		
			Nirdeshika based	Online based	Soil test based
		Rangpur Sadar	-	50	-
Regional Office, Gaibandha	Gaibandha	Pirgonj	-	50	10
		Sadar	50	50	25
		Palashbari	50	50	7
		Saghata	50	50	8
		Sundorgang	50	-	-
Regional Office, Lalmonirhat	Lalmonirhat	Aditmari	250	-	35
	Lalmonirhat	Sadar	-	150	
Regional Office, Thakurgaon	Thakurgaon	Thakurgaon Sadar, Baliadangi, Ranishangkail	250	240	107
Regional Office, Brahmanbaria	Brahmanbaria	Sadar	50	50	20
		Akhaura	50	50	-
		Nabinagar	50	50	-
		Ashugonj	50	50	20
		Sarail	50	50	-
Regional Office, Cumilla	Cumilla	Debidwar		329	
		Cumilla Sadar Dakhin	105	-	105
		Lalmai	100	-	-
		Baurora	-	135	-
Regional Office, Rangamati	Rangamati	Rangamati Sadar	55	90	-
		Kaukhali	45	-	-
		Naniarchar	40	-	-
		Kaptai	42	-	-
	Khagrachhari	Khagrachhari sadar	-	50	-
		Panchhari	30		-
		Matiranga	-	50	-
Divisional Office, Sylhet	Sylhet	Bishwanath	-	100	-
		Balaganj	-	200	-
		Daksin Surma	240	60	12
		Sylhet Sadar	200	-	-
Regional Office, Moulvibazar	Moulvibazar	Moulvibazr Sadar	-	51	15
		Kamalganj	-	150	73
		Kulaura	100	-	1
		Rajnagar	-	-	1
Regional Office Sunamganj	Sunamganj	Shantiganj, Doarabazar	50	250	-
		Total	5793	7771	1870
		Grand Total	15434		

3.7 Advisory Services to Beneficiaries

Name of Office	District	Upazila	Agency	Service Provided
Regional Office, Jamalpur	Jamalpur	Dewangonj, Islampur	PhD student, BAU, Mymensingh	Soil series, Soil structure and other Soil Characters of different AEZ
	Sherpur	Nakla, Nalitabari, Sherpur Sadar	"Mrittika Krishi Club''	Fertilizer Recomandation Card/Festoon Distribution, Soil Sample Collection Tecnic, Adulteraed Fertilizer Identification etc.
	Jamalpur	Jamalpur Sadar, Melandaha	"Mrittika Krishi Club''	
Regional Office, Mymensingh	Mymensingh	Mymensingh Sadar	BAU	Soil series identification, profile description, sample collection of MS & Ph D student.
SRDI, Narsingdi	Narsingdi	Sadar	DD, DAE	Updated Nirdeshika 1. Sadar-5 2. Shibpur-5
Regional Office, Tangail	Tangail	Madhupur	SSS NGO	Soil and Fertilizer management for pineapple cultivation
		Shakhipur	Farmers	Distribution of leaflet, posters soil sample collection and fertilizer management
Divisional Office, Barishal	Barishal	Sadar	Dept. of Soil Sc. BM College	Soil profile description and soil texture and soil series identification.
		All Upazilas	Dept. of Soil Sc. Patuakhali Science & Technology University	Provided information on soil fertility, land type, soil and water salinity of different Upazils.
	Jhalakathi			
	Pirozpur			
Regional Office, Patuakhali	Patuakhali	All Upazilas All Upazilas	DAE	Provided information on soil fertility, land type, soil and water salinity of different Upazila of Patuakhali & Barguna District.
	Barguna			Soil and water salinity trend and Recommendation for increasing Agril production with managing salinity.
Regional Office, Bhola	Bhola	All Upazilla	DAE	Provided information on soil and water salinity of Bhola District.
		Manpura	Farmers	Identify Soil Salinity related problems and gave suggestion for salinity management.

Name of Office	District	Upazila	Agency	Service Provided
Divisional office, Rajshahi	Rajshahi	all	DAE, Farmers, BMDA, BAU, Phd student	Soil sample collection, fertilizer recommendation card and information provided
Regional Office, Chapainawabganj	Bogura, Joypurhat	all	DAE, Farmers & Students	Soil sample collection, fertilizer recommendation card and information provided
Regional Office, BOGURA	Bogura, Joypurhat	all	DAE, Farmers & Students	Soil sample collection, fertilizer recommendation card and information provided
Regional Office, Naogaon	Naogaon, Rajshahi	all	DAE, Farmers & Students	Soil sample collection, fertilizer recommendation card and information provided
Regional Office, Sirajganj	Sirajganj	all	BMDA, BAU, Phd phelo	Information shared about char land. Nitrient status of rayganj
Divisional Office, Khulna	Khulna Bagerhat Satkhira	Rampal, Koyra, Dacope, Bagerhat Sada, Shyamnagar, Ashashuni	Cordaid Bangladesh	Consultative Workshop with the Relevant Stakeholders of Climate Resillient Agriculture in Costal Area
		19 Upazila of Khulna, Bagerhat and Satkhira	DU, KU, BU, KIU, BRAC University,	Provided Salinity data
Regional Office, Jashore	Narail	Lohagara	Upazila Agriculture officer (UAO) Upazila porishaid (UP) Upazila Nirbahi Officer (UNO)	Upazila Soil and Land use nirdeshika and Union fertilizer recommendation Sohyika UAO-20+130 UP- 5+150 UNO-1+13
Regional Office, Satkhira	Satkhira	7 Upazila of Satkhira	KU, KIU	Provided Salinity data
Regional Office, Dinajpur	Dinajpur	Dinajpur Sadar	Hajee Mohammad Danesh Science and Technology University (HSTU)	Soil Profile Presentation in Field Trip
			Department of Agriculture Extension, HSTU	Technical Assistance
			Department of Soil Science, HSTU	Technical Assistance
Regional Office, Lalmonirhat	Dinajpur	-	MS students of Hajee Danesh Science & Technology University, Dinajpur	Technical Support Provided
	Lalmonirhat	Aditmari	LGED	30 Farmers training imparted
			SCA	Technical Support Provided
			DAE	Technical Support Provided
			Bangladesh Air Force	Technical Support Provided
			I Farmer Pvt. Ltd.	Technical Support Provided

Name of Office	District	Upazila	Agency	Service Provided
Regional Office, Thakurgaon	Thakurgaon	Thakurgaon Sadar	DAE	Soil Health Related
Regional Office, Brahmanbaria	Brahmanbaria	Sadar	Titas gas field	6 (six) Soil Samples were collected, tested and reported.
Regional Office, Cumilla	Noakhali	Sadar	NSTU, Noakhali	Soil identification for Cricket Peach Preparation
Reginal Office, Rangamati	Rangamati	Rangamati Sadar	Researchers	Land use data

3.8 Training Imparted

Name of Office	Title of the programme	Duration	Host organization	Participant Type	Number
Regional Office, Faridpur	Soil Sample Collection and Balanced Fertilizer Application	1 day	SRDI	Farmers	200
Regional Office, Gopalganj	Soil sample collection technique, identification of adulterate fertilizers, Soil & Fertilizer management	1 (One day)	SRDI, Gopalganj	Farmer	1620
Regional Office, Jamalpur.	Soil sample collection technique.	1 Day	SRDI, Jamalpur	Farmers	14 X 25 =350
Regional Office, Kishoreganj	Soil sample collection technique, identification of adulterate fertilizers, Soil & Fertilizer management	1(one day)	SRDI, Kishoreganj	Farmer	100
Regional Office, Madaripur	Soil Sample collection and Balanced dose fertilizer use	01 day	SRDI	Farmer	200
Regional Office, Mymensingh	In House Training (No cost)	1 day	SRDI, RO, Mymensingh	11-20 Grade Employees	15
	Training on Method of Soil Sample Collection	1 Day	SRDI, RO, Mymensingh	Farmer	50
	Training on Method of Soil Sample Collection	1 Day	SRDI, RO, Mymensingh	Farmer	50
	Use of various apps on Agriculture	2 days	AIS, RO, Mymensingh	Farmer	30×2=60
	Determination of crop-based TSP/MOP/DAP fertilizer requirements, identification of adulterated fertilizers and Proper application of fertilizers	1 day	BADC, Mymensingh	Fertilizer Dealer	50
Regional Office, Narsingdi	one day farmer training on Soil Sample Collection technique for Soil testing by MSTL	01 day	SRDI	Farmer	150

Name of Office	Title of the programme	Duration	Host organization	Participant Type	Participant Number
Regional Office, Faridpur	Soil Sample Collection and Balanced Fertilizer Application	1 day	SRDI	Farmers	200
Regional Office, Gopalganj	Soil sample collection technique, identification of adulterate fertilizers, Soil & Fertilizer management	1 (One day)	SRDI, Gopalganj	Farmer	1620
Regional Office, Jamalpur.	Soil sample collection technique.	1 Day	SRDI, Jamalpur	Farmers	14 X 25 =350
Regional Office, Kishoreganj	Soil sample collection technique, identification of adulterate fertilizers, Soil & Fertilizer management	1(one day)	SRDI, Kishoreganj	Farmer	100
Regional Office, Madaripur	Soil Sample collection and Balanced dose fertilizer use	01 day	SRDI	Farmer	200
Regional Office, Mymensingh	In House Training (No cost)	1 day	SRDI, RO, Mymensingh	11-20 Grade Employees	15
	Training on Method of Soil Sample Collection	1 Day	SRDI, RO, Mymensingh	Farmer	50
	Training on Method of Soil Sample Collection	1 Day	SRDI, RO, Mymensingh	Farmer	50
	Use of various apps on Agriculture	2 days	AIS, RO, Mymensingh	Farmer	30×2=60
	Determination of crop-based TSP/MOP/DAP fertilizer requirements, identification of adulterated fertilizers and Proper application of fertilizers	1 day	BADC, Mymensingh	Fertilizer Dealer	50
Regional Office, Netrokona	Soil sample collection technique & Identification of adulterated	1 day	SRDI	Farmer	100

Name of Office	Title of the programme	Duration	Host organization	Participant Type	Number
Regional Office, Tangail	Soil sample collection method and fertilizer management	1 day	SRDI	Farmers	150
	Acidic soil management	1 day	SRDI	Farmers & SAAO	50
	Soil sample collection method and fertilizer management	1 day	BADC	Farmers	250
Divisional OfficeBarishal	Method of Soil Sample Collection, Use of Balance fertilizers and Fertilizer Management	01 day	SRDI	Farmers	1080
Regional Office, Patuakhali		01 day	SRDI		250
Regional Office, Bhola		01 day	SRDI		150
Divisional Office, Rajshahi	Training on balanced fertilizer utilization, soil sample collection	1 day	SRDI, Rajshahi	Farmers	200
	Training on Acidic soil management,	1 day	SRDI, Rajshahi	Farmers	50
	Training on use of Land and soil resource utilization guide	2 day		SAAO & Farmers	40
Regional Office, Chapainawabgonj	Training on balanced fertilizer utilization, soil sample collection	1 day	SDRI Chapainawabgonj	Farmers	100
	Training on Acidic soil management,	1 day	SDRI Chapainawabgonj	Farmers	50
	Training on use of Land and soil resource utilization guide	2 day	SDRI Chapainawabgonj	SAAO & Farmers	40
Regional Office, Bogura	Training on balanced fertilizer utilization, soil sample collection	1 day	SRDI, RO, BOGURA	Farmers	100
	Training on Acidic soil management	1 day	SRDI, RO, BOGURA	Farmers	50
Regional Office, Naogaon	Training on balanced fertilizer utilization, soil sample collection	1 day	SRDI, RO, Naogaon	Farmers	100
	Training on Acidic soil management	1 day	SRDI, RO, Naogaon	Farmers	25
Regional Office, Sirajganj	Soil sample collection procedure	01	SRDI Sirajganj	Famer	100
Divisional Office, Khulna	Problematic soil management	2 days	Funded by: GKBSP project Implemented by: SRDI, DO, Khulna	Officers	30

	Soil sample collection technique, identification of adulterate fertilizers, methods & time of fertilizer application, deficiency symptoms of nutrient element and use of balanced fertilizer. Salinity management	1 day	SRDI, DO, Khulna		1480
Regional Office, Jashore	4th industrial revolution and our duties	01	SRDI	Officer Staff	1 4
	Soil sample collection and use of balanced fertilizers	01	SRDI	Farmers	200
	Fertilizer management	01	BEDS (NGO)	Flower Farmers	20
	Fertilizer management for cotton cultivation	05	CDB	Res. Assistant	20
	Soil sample collection and use of balanced fertilizers	01	BADC	Farmers and seed dealers	25+20
	Soil sample collection, use of balanced fertilizers and online fertilizer recommendation	15	DAE	Cadre Officers	20
Regional Office, Jhenaidah	Training on soil sampling, use of balanced fertilizers and methods of detection of adulterated fertilizers	01 day	SRDI, RO, Jhenaidah	Farmers	150
Regional Office, Kushtia	Training of farmers on soil sample collection technique, identification of adulterate fertilizers, methods & time of fertilizer application, deficiency symptoms of nutrient element and use of balanced fertilizer	1 day	SRDI, Kushtia	Farmer	200
Regional Office, Satkhira	Soil sample collection technique, identification of adulterate fertilizers, methods & time of fertilizer application, deficiency symptoms of nutrient element and use of balanced fertilizer. Salinity management	1 day	SRDI, Satklhira	Farmer	1120

Divisional Office, Rangpur	Training on soil sampling methods and application of balanced fertilizers	01 day	SRDI, Divisional Office, Rangpur	Farmers Training	50
	MSTL Training	01 day	SRDI, Divisional Office, Rangpur	Farmers Training	50
Regional Office, Dinajpur	Method of Soil Sample Collection, Use of Balance Fertilizer & Fertilizer Management	01 Day	SRDI, Regional Office, Dinajpur	Farmers	100
	Acidic Soil Management Related	01 Day	SRDI, Regional Office, Dinajpur	Farmers	25
Regional Office, Lalmonirhat	MSTL Farmers Training at Bhurungamari upazila During Rabi season.	1 Day	SRDI, Lalmonirhat	Farmers	50
	MSTL Farmers Training at Aditmari upazila During Kharif season.	1 Day	SRDI, Lalmonirhat	Farmers	50
Regional Office, Thakurgaon	Method of Soil Sample Collection, Use of Balance Fertilizer & Fertilizer Management	01 Day	SRDI, Regional Office, Thakurgaon	Farmers	130
Brahmanbaria	MSTL Training Rabi/2023	1day	Upazila Krishi Office, Akhaura	Farmer	50
	MSTL Training Kharif/2024 Soil Sample Collection Procedure, Use of Balance Fertilizer and Identification of Adulterated Fertilizer etc.	1day	Upazila Krishi Office, Nabinagar	Farmer	50
Regional Office, Cumilla	Soil Sample Collection Procedure, Use of Balance Fertilizer and Identification of Adulterated Fertilizer	1day	SRDI	Farmer	200
Regional Office, Rangamati	Soil sample collection technique, identification of adulterate fertilizers, Soil & Fertilizer management	1(one day)	SRDI, Rangamati	farmer	150
Divisional Office, Sylhet	Soil Sample Collection	2 days	SRDI, DO Sylhet	Farmer (Sylhet Sadar)	25+25 =50

	Soil Sample Collection	2 days	SRDI, DO Sylhet	Farmer (Bishwanath)	25+25 =50
Regional Office, Moulvibazar	Soil Sample Collection Training (MSTL)	1 day	SRDI	Farmers	200
Regional Office, Sunamganj	Soil Sample Collection	2 days	SRDI, Sunamganj	Farmer	25+25 =50

Pursuing field survey activities by SRDI field survey team

Organizing field day of adaptive trial

| Fertilizer recommendation card distribution | Seminar on salinity management |

MSTL Programme	Analysis activities in static laboratory

Technology practices in research centers

Officer's training	Farmer's training

Acid soil management

Inaugaration programme of Annual workshop 2023-24	Seminar on salinity management

Chapter 4: Activities of Analytical services Wing

4.1 Achievement of Divisional and Regional Laboratories

Analytical Works

Abstract

Quality fertilizers recommendations for sustainable crop production soil test, plant analysis and quality determination of fertilizer are useful tools. Soil teste gives a measure of the availability of nutrients to crops, plant analysis indicates the actual removal of the nutrients from the soil and quality determination of fertilizer helps to determine the actual need of fertilizers. Therefore, 24 static laboratories and 10 mobile soil testing laboratories (MSTL) under Analytical Services Wing (ASW) of Soil Resource Development Institute (SRDI) providing analytical work of soil, plant, water and fertilizer to prepare fertilizer recommendation card, standardize fertilizer and fertilizer related materials, qualify irrigation water and to quantify removal of the nutrients from the soil. In 2023-2024, total 44,107 samples and 3,10,547 parameters were analyzed in 23 static laboratories and 10 mobile soil testing laboratories of which 32,979 soil samples with 2,73,374 parameters, 328 plant samples with 1,089 parameters, 425 water samples with 1,001 parameters and 4,583 fertilizer samples. The sources of soil, plant and water samples were mainly farmers, upazila land and soil resource use nirdeshikha update program of SRDI, NARS (National Agricultural Research System) institutes, universities, and different government organizations (GOs) and non-government organizations (NGOs). In case of fertilizer the sources of samples were mainly Department of Agricultural Extension (DAE), port, and different GOs and NGO. The revenue earning from the analytical work Tk. 60,96,451.00. Besides the analysis soil, plant, water and fertilizer samples laboratories under ASW performing training on soil sample collection and adulterate fertilizers identification at field level.

Introduction

Soil is the backbone of our food security. Without healthy soils, farmers wouldn't be able to provide us with feed, fiber, food, and fuel. Soil is the original source of the nutrients that we use to grow crops. The nutrients move from the soil into plants that we eat. Soils naturally contain many nutrients like N, P, K, S, Ca, Mg. B, Zn, Cu, Fe, Mn, Mo and Cl. These nutrients allow plants to grow. When soil nutrients are missing or in short supply, plants suffer from nutrient deficiency and stop growing. When the nutrient level is too low, the plant cannot function properly and produce the food necessary to feed the worlds' population. Once crops are harvested for human consumption, the natural supply of nutrients in the soil must be refilled. This is why farmers add nutrients to their soils. Nutrients can be added from a variety of sources i.e. organic matter, chemical fertilizers, and even by some plants. This maintains the soil fertility, so the farmer can continue to grow nutritious crops and healthy crops.

Agriculture alters the natural cycling of nutrients in soil. Intensive cultivation and harvesting of crops for human or animal consumption can effectively mine the soil of plant

nutrients. In order to maintain soil fertility for sufficient crop yields, soil amendments are typically required. Early humans soon learned to amend their fields with animal manure, charcoal, ash, and lime to improve soil fertility. Today, farmers add numerous soil amendments to enhance soil fertility, including inorganic chemical fertilizers and organic sources of nutrients, such as manure or compost, often resulting in surplus quantities of primary macronutrients. The efficiency of fertilizer application and use by crops is not always optimized, and excess nutrients, especially N and P, can be transported via surface runoff or leaching from agricultural fields and pollutes surface and groundwater (Moss, 2008; Sharpley *et al.*, 2002). Therefore, before adding fertilizer, farmers send a soil sample to a laboratory for baseline testing. By testing their soil, farmers know which nutrients and how much to apply to the soil. If too little is added, crops will not produce as much as they should.

So, while fertilizers serve an important purpose, farmers must be careful to use the right amount, at the right time, to avoid potential negative effects to the environment. For this reason, soil test-based quality fertilizer needs to be applied for profitable crop production along with management of soil fertility and productivity as well as improve soil health.

Objectives

1. To determine the physical, physico- chemical and chemical properties of soils.
2. To prepare soil test-based fertilizer recommendation for crops and cropping patterns.
3. To test and standardize the organic manure, chemical fertilizer and fertilizer related materials.
4. To identify the water quality in irrigation as well as other sources of water.
5. To analyze plant samples for measuring the nutrient content within the plant tissue.
6. To provide advisory services related to soil, fertilizers and crop.

Materials and Methods

A total of 24 static laboratories and 10 Mobile Soil Testing Laboratories (MSTLs) are being operated under the Analytical Services Wing (ASW) of Soil Resource Development Institute (SRDI). Among the static laboratories 07 are divisional (Dhaka, Rajshahi, Rangpur, Chittagong, Khulna, Syhlet, and Barisal), 16 are regional (Mymensingh, Jamalpur, Tangail, Faridpur, Kishoreganj, Gopalganj, Pabna, Bogra, Dinajpur, Comilla, Noakhali, Rangamati, Jessore, Kustia, Jhenaidah and Patuakhali) and 01 is Central laboratory. All static laboratories conduct physical, chemical and physicochemical analyses of soil and fertilizers samples collected by the survey team of SRDI and sent by different sources i.e., farmers, DAE, NARS organizations, universities, entrepreneurs and other GOs and NGOs. Static laboratories under ASW also conduct chemical analysis of water and plant samples. In addition, 10 MSTLs perform two programs at Rabi and Kharif season in a year for distributing soil test-based fertilizer recommendation card at farmers levels (Upazila). The activities of central laboratory under ASW are little bit different than other

static laboratories. Central laboratory is conducting research work and quality control program as well as analytical works according to the direction of higher authority. So, the activities of central laboratory have been discussed separately.

The received soil, plant, water and fertilizer samples by different laboratories were prepared and analyzed following the Method mentioned in Analytical Methods: Soil, Water, Plant Material and Fertilizer (SRDI, 2016); Manual for Fertilizer Analysis (BARC, 2003) and Fertilizer Recommendation Guide (BARC, 2018). Analytical results of soil samples were interpreted for pH and salinity level and nutrient status on the basis of Fertilizer Recommendation Guide-2018 (FRG, 2018). Fertilizer Recommendation cards were also prepared following Fertilizer Recommendation Guide-2018. Advisory services were provided through face-to-face discussion and over telephone.

Result and Discussion

Soil sample

A total of 32,979 samples with 2,73,374 parameters (Moisture, Texture, pH, EC, OC, N, P, S, K, Ca, Mg, B, Zn, Fe, Cu, Mn, Cd, Cr, Pb, Ni and others as per required) were analyzed in the division and regional laboratories of ASW (Table 1).

Table 1: Analyzed soil samples in divisional and regional laboratories of ASW.

Name of Division	Name of Laboratory	No. of Sample	No. of ingredient
Dhaka	Divisional Lab. Dhaka	6,215	84,578
	Regional Lab. Faridpur		
	Regional Lab. Jamalpur		
	Regional Lab. Mymensingh		
	Regional Lab. Kishoreganj		
	Regional Lab. Tangail		
	Regional Lab. Gopalganj		
Rajshahi	Divisional Lab Rajshahi	6,686	48,580
	Regional Lab. Bogura		
	Regional Lab. Pabna		
Khulna	Divisional Lab. Khulna	3,989	34,159
	Regional Lab. Jhenaidha		
	Regional Lab. Kushtia		
	Regional Lab. Jessore		
Chottagarm	Divisional Lab. Chattogram	6,334	39,980
	Regional Lab. Cumilla		
	Regional Lab. Noakhali		
	Regional Lab. Ragamati		
Sylhet	Divisional Lab. Sylhet	2,385	12,934
Barishal	Divisional Lab. Barishal	1,833	10,649
	Regional Lab. Potuakhali		
Rangpur	Divisional Lab. Rangpur	5,537	42,494
	Regional Lab. Dinajpur		
Total		32,979	2,73,374

Among the analyzed soil samples 39.94% was received from farmer 29.63% was received from SRDI program (Upazila Land and Soil Resource Utilization Guide), 2.85% was received from research institute, 5.33% was received from universities and 22.25% was received from different GOs (19.63%) and NGOs (2.62) to backup research/ educational activities (Figure 1). The highest number of soil sample (6,686 sample) was analyzed by Rajshahi division but total parameters (84,578 parameters) was analyzed in the laboratories of Dhaka division (Divisional Lab. Dhaka and Regional Lab. Faridpur, Jamalpur, Mymensingh, Kishoreganj, Tangail, and Gopalganj) whereas lowest number of samples (1,833 sample with 10,649 parameters) was analyzed in the laboratories of Barishal division. Though, the variations of analyzed samples with parameters among the laborites directly depend on manpower and instrumental facilities.
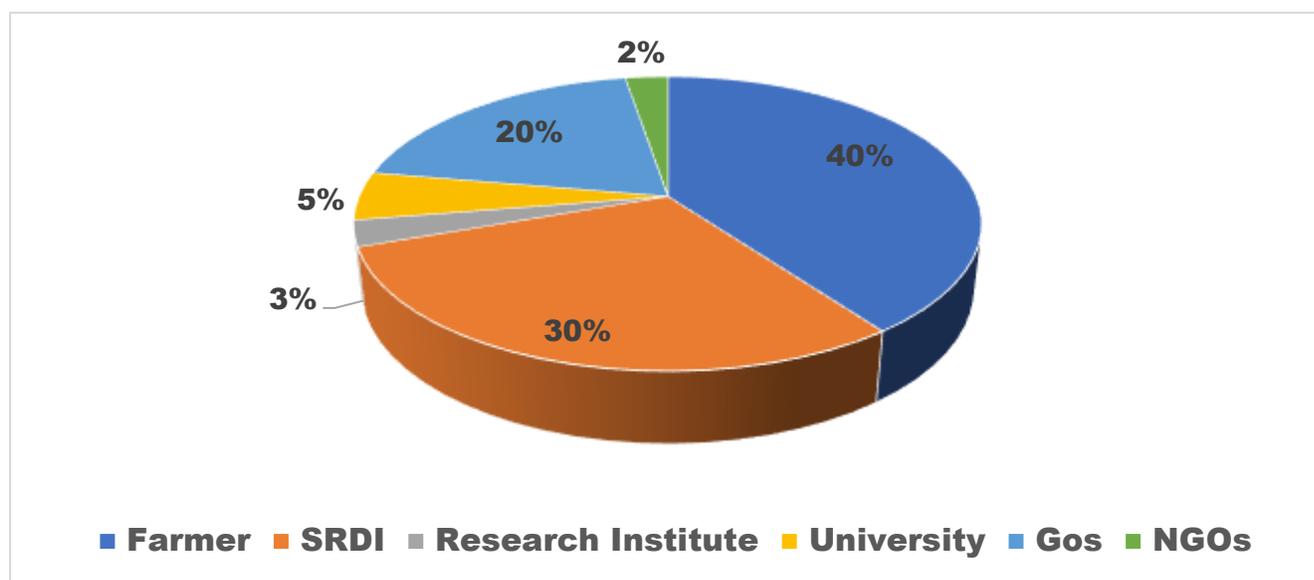
Figure 1: Sources of soil Samples

Fertility status of analyzed farmer's samples

Soil Reaction (pH) status

Soil pH status ranged from very strongly acidic to very strongly alkaline. Among the analyzed soil samples 5.11% soils pH were very strongly acidic, 34.20% soils pH were strongly acidic and 21.75% soils pH were slightly acidic. Consequently, 14.22, 24.08, 0.71 and 0.06% soils pH were neutral, slightly alkaline strongly alkaline and very strongly alkaline respectively (Table 2.1). In Dhaka and Rajshahi division 32% soils pH ranged from very strongly acidic to strongly acidic. While in Khulna and Borishal Division 0 to 19.46% soils pH ranged from very strongly acidic to strongly acidic. In Chattagram, Sylhet and Rangpur Division 38.23 to 70.68% soils pH ranged from very strongly acidic to strongly acidic.

Table 2.1 Soil pH status of analyzed farmer's samples

Division	Sample No.	Very strongly acidic	Strongly acidic	Slightly acid	Neutral	Slightly alkaline	Strongly alkaline	Very strongly alkaline
		<4.5	4.6-5.5	5.6-6.5	6.6-7.3	7.4-8.4	8.5-9.0	>9.0
Dhaka	1922	56	558	369	115	766	58	0
	%	2.97	29.02	19.19	5.98	39.83	3.01	0
Rajshahi	4780	160	1379	1198	752	1280	11	-
	%	3	29	25	16	27	-	-
Khulana	2320	-	-	169	860	1281	10	-
	%	-	-	7.3	37.1	55.2	0.4	-
Chattagram	272	4	100	110	14	13	22	9
	%	1.47	36.76	40.44	5.15	4.78	8.09	3.31
Borishal	411	-	80	128	134	67	2	-
	%	-	19.46	31.14	32.60	16.30	0.49	-
Sylhet	629	64	332	155	11	16	-	-
	%	11.07	57.44	26.82	1.90	2.77	-	-
Rangpur	4240	462	2536	968	187	87	-	-
	%	10.89	59.79	22.84	4.4	2.05	-	-
Total	**14574**	**746**	**4985**	**3097**	**2073**	**3510**	**103**	**9**
	%	**5.11**	**34.20**	**21.75**	**14.22**	**24.08**	**0.71**	**0.06**

Soil EC (dS/m) status

Electrical conductivity (EC) of received soil samples ranged from non-saline to very strongly saline. 54 % of received soil samples of Khulna, Barishal and Chattagram Division were non-saline, 18.44% were very slightly saline, whereas 16.72, 6.28, 2.74 and 1.52 % samples were slightly saline, moderately saline, strongly saline and very strongly saline, respectively (Table 2.2).

Table 2.2 Soil EC (dS/m) status of analyzed farmer's samples

Division	Sample	NS	VSS	SS	MS	StS	VStS
		0.0-2.0	2.1-4.0	4.1-8.0	8.1-12.0	12.1-16.0	>16.0
Khulana	457	252	92	56	23	19	15
	%	55.1	20.2	12.3	5.1	4.2	3.1
Chattagram	119	116	1	2	-	-	-
	%	97.48	0.84	1.68	-	-	-
Borishal	411	165	89	107	39	8	-
	%	40.14	21.65	26.03	9.49	1.95	-
Total	**987**	**533**	**182**	**165**	**62**	**27**	**15**
	%	**54.00**	**18.44**	**16.72**	**6.28**	**2.74**	**1.52**

Soil OM status

Soil OM status ranged from very low to very high. Among the analyzed soil samples 12.87% soils OM were very low, 51.37% soils OM were low and 33.13% soils OM were medium. Consequently, 2.28 and 0.32% soils OM were high and very high respectively (Table 2.3). In Dhaka and Rajshahi Division 68.62 to 70 % soils OM ranged from very low to low. While in Khulna and Borishal Division 59.2 to 71.86% soils OM ranged from very low to low. In Chattogram, Sylhet and Rangpur Division 45.84 to 73.33% soils OM ranged from very low to low.

Table 2.3 Soil OM status of analyzed farmer's samples

Division	Total sample No.	VL ≤ 1.0	L 1.0-1.7	M 1.8-3.4	Deficient ≤ 22.5	O 22.51-30.0	H 30.1-37.5	VH >37.5
Dhaka	1195	255	711	209	1175	0	18	2
	%	9.13	59.49	17.49	98.33	0	1.51	0.17
Rajshahi	4780	323	3023	1423	4769	11	-	-
	%	7	63	30	99.77	0.23	-	-
Khulana	2320	255	1118	898	2271	49	-	-
	%	11.0	48.2	38.7	97.89	2.1	-	-
Chattogram	154	18	68	68	154	-	2	-
	%	11.69	44.15	44.15	100	-	1.29	-
Borishal	334	120	120	87	327	-	7	-
	%	35.93	35.93	26.05	97.90	-	2.07	-
Sylhet	30	1	21	8	30	-	-	
	%	3.33	70.00	26.67	100	-	-	
Rangpur	4240	708	1645	1632	3985	238	17	
	%	16.7	38.8	38.5	93.98	5.6	0.40	
Total	**13053**	**1680**	**6706**	**4325**	**12711**	**298**	**42**	
	%	**12.87**	**51.37**	**33.13**	**97.38**	**2.28**	**0.32**	

Soil Total N status

Soil TN status ranged from very low to very high. Among the analyzed soil samples 51.41% soils TN were very low, 43.93% soils TN were low and 3.55% soils TN were medium. Consequently, 0.71, 0.37 and 0.02% soils TN were optimum, high and very high respectively (Table 2.4). In All Divisions 90.30 to 99.40 % soils TN ranged from very low to low.

Table 2.4 Total N status of analyzed farmer's samples

Division	Total sample No.	VL ≤ 0.09	L 0.091-0.18	M 0.181-0.27	Deficient ≤ 0.27	O 0.271-0.36	H 0.361-0.45	VH >0.45
Dhaka	856	317	430	103	850	3	1	2
	%	37.03	50.23	12.03	99.29	0.18	0.06	0.13
Rajshahi	4780	3459	1302	16	4777	3	-	-
	%	72.16	27.24	0.33	99.94	0.06	-	-
Khulana	2320	459	1817	44	2320	-	-	-
	%	19.8	78.3	1.9	100	-	-	-
Chattagram	334	242	85	7	334	-	-	-
	%	72.45	25.45	2.09	100	-	-	-
Borishal	272	93	172	5	270	1	-	1
	%	34.19	63.23	1.84	99.26	0.37	-	0.37
Sylhet	30	21	8	01	30	-	-	-
	%	70	26.67	3.33	100	-	-	-
Rangpur	4240	2006	1823	280	4109	84	47	-
	%	47.3	43.0	6.6	96.91	2.0	1.5	0.5
Total	**12832**	**6877**	**5637**	**456**	**12690**	**91**	**48**	**3**
	%	**51.41**	**43.93**	**3.55**	**98.89**	**0.71**	**0.37**	**0.02**

Soil Available P (ppm) status

Available P status of received soils ranged from very low to very high. Available P status of 7.22% soils were very low, 9.13% soils were low, while 11.13, 12.52, 10.21 and 49.73% soils were medium, optimum, high and very high, respectively (Table 2.5). In Dhaka and Rajshahi division 10.72 to 31.57 % soils available P ranged from very low to low. While in Khulna and Borishal Division 11.82 to 62.86 % soils available P ranged from very low to low. In Chattogram, Sylhet and Rangpur Division 5.55 to 61.94% soils available P ranged from very low to low.

Table 2.5 Available P (ppm) status of analyzed farmer's samples

Division	Total sample No.	VL	L	M	Deficient	O	H	VH
		Bray & Kurtz Method						
		≤ 5.25	5.251-10.5	10.51-15.75	≤ 15.75	15.76-21.0	21.1-26.25	>26.25
		Olsen Method						
		≤ 7.5	7.51-15.0	15.1-22.5	≤ 22.5	22.51-30.0	30.1-37.5	>37.5
Dhaka	1904	312	283	274	869	194	149	692
	%	16.39	15.18	14.39	45.96	10.19	7.82	36.34
Rajshahi	3914	147	273	496	916	609	485	1904
		3.75	6.97	12.67	23.40	15.56	12.39	48.64
Khulana	2320	70	204	471	745	513	362	700
	%	3.02	8.8	20.3	32.11	22.1	15.6	30.17
Chattagram	409	113	63	40	170	34	39	120
	%	27.63	15.40	9.78	41.56	8.31	9.54	29.34

Borishal	272	118	53	13	216	13	9	52
	%	43.38	19.48	4.78	52.81	4.78	4.31	19.12
Sylhet	578	203	155	43	401	38	5	134
	%	35.12	26.82	7.44	69.38	6.57	0.87	23.18
Rangpur	4240	21	214	181	416	307	343	3180
	%	0.51	5.04	4.27	9.81	7.25	8.10	75.0
Total	**13637**	**984**	**1245**	**1518**	**3747**	**1708**	**1392**	**6782**
	%	**7.22**	**9.13**	**11.13**	**27.48**	**12.52**	**10.21**	**49.73**

Soil Exchangeable K status

Exchangeable K status range of the received soil samples was very low to very high. Exchangeable K status of 10.53% soils were very low, 26.38 % soils were low, while 26.08, 18.13, 12.15, and 10.78% soils were medium, optimum, high and very high, respectively (Table 2.6). In Dhaka and Rajshahi division 37 to 40.39 % soils exchangeable K ranged from very low to low. While in Khulna and Borishal Division 18.34 to 22.20 % soils exchangeable K ranged from very low to low. In Chattogram, Sylhet and Rangpur Division 36.39 to 44.50% soils exchangeable K ranged from very low to low.

Table 2.6 Exchangeable K status of analyzed farmer's samples

Division	Total sample No.	VL ≤ 0.09	L 0.091-0.18	M 0.181-0.27	Deficient ≤ 0.27	O 0.271-0.36	H 0.361-0.45	VH >0.45
Dhaka	1904	340	429	336	1105	295	185	319
	%	17.86	22.53	17.65	58.04	15.49	9.72	10.75
Rajshahi	3837	380	1029	1078	2487	543	277	530
	%	10	27	28	64.82	14	7	14
Khulana	2320	46	469	817	1332	708	192	88
	%	2.0	20.2	35.2	57.41	30.5	8.3	3.8
Chattagram	272	44	55	67	166	40	30	36
	%	16.17	20.22	24.63	61.03	14.71	11.03	13.23
Borishal	409	7	68	133	298	111	56	34
	%	1.71	16.63	32.52	50.85	27.14	13.69	8.31
Sylhet	578	107	145	118	370	53	43	112
	%	18.51	25.09	20.42	64.02	9.17	7.44	19.38
Rangpur	4240	504	1382	988	2874	708	865	343
	%	11.9	32.6	23.3	67.80	16.7	20.4	8.1
Total	**13560**	**1428**	**3577**	**3537**	**8542**	**2458**	**1648**	**1462**
	%	**10.53**	**26.38**	**26.08**	**62.99**	**18.13**	**12.15**	**10.78**

Soil Available S status

Range of available S status of analyzed soils varied from very low to very high. Available S status of 22.63% soils were very low, 22.09% soils were low, whereas 15.49, 15.36, 10.09 and 14.35% soils were medium, optimum, high and very high in available S content, respectively (Table 2.7). In Dhaka and Rajshahi division 36.01 to 37 % soils Available S ranged from very low to low. While in Khulna and Borishal Division 15 to 73.60 % soils Available S ranged from very low to low. In Chattogram, Sylhet and Rangpur Division 44.50 to 74.05% soils Available S ranged from very low to low.

Table 2.7 Available S status of analyzed farmer's samples

Division	Total sample No.	VL ≤ 7.5	L 7.51-15.0	M 15.1-22.5	Deficient ≤ 22.5	O 22.51-30.0	H 30.1-37.5	VH >37.5
Dhaka	1904	710	456	229	1395	155	77	277
	%	22.33	13.68	6.87	41.85	4.65	2.31	8.31
Rajshahi	3992	706	777	595	2070	609	402	903
	%	18	19	15	52.05	15	10	23
Khulana	2320	130	218	445	793	580	529	418
	%	5.6	9.4	19.2	34.18	25.0	22.8	18.0
Chattagram	272	119	62	26	207	16	16	33
	%	43.75	22.99	9.56	76.10	5.88	5.88	12.13
Borishal	382	175	126	71	372	10	-	-
	%	42.79	30.81	17.36	97.38	2.44	-	-
Sylhet	578	225	203	43	471	27	11	69
	%	38.93	35.12	7.44	81.48	4.67	1.90	11.94
Rangpur	3705	911	1064	628	2603	623	292	187
	%	21.5	25.1	14.8	70.25	14.7	6.9	4.6
Total	13153	**2976**	**2906**	**2037**	**7919**	**2020**	**1327**	**1887**
	%	**22.63**	**22.09**	**15.49**	**60.21**	**15.36**	**10.09**	**14.35**

Soil Avail Zn status

Range of available Zn status of analyzed soils varied from very low to very high. Available Zn status of 14.24 % soils were very low, 21.99% soils were low, whereas 19.17, 11.35, 14.11 and 19.08% soils were medium, optimum, high and very high in available Zn content, respectively (Table 2.8). In Dhaka and Rajshahi division 24 to 31 % soils Available Zn ranged from very low to low. While in Khulna Division 28.1 % soils Available Zn ranged from very low to low. In Chattogram and Rangpur Division 44.26% to 100% soils Available Zn ranged from very low to low.

Table 2.8 Avail Zn status of analyzed farmer's samples

Division	Total sample No.	VL ≤ 0.45	L 0.451-0.9	M 0.91-1.35	Deficient ≤ 1.35	O 1.351-1.80	H 1.81-2.25	VH >2.25
Dhaka	779	105	184	111	400	57	78	244
	%	8.6	15.4	9.44	34.34	4.85	6.63	20.74
Rajshahi	3519	530	575	940	2045	345	289	840
	%	15	16	27	58.11	10	8	24
Khulana	2320	128	524	587	1239	283	309	489
	%	5.5	22.6	25.3	53.41	12.2	13.3	21.1
Chattagram	No.27	14	13	-	27	-	-	-
	%	51.85	48.15	-	100	-	-	-
Rangpur	4238	778	1098	448	2324	550	860	504
	%	18.36	25.9	10.58	54.84	12.97	20.3	11.89
Total	10883	**1550**	**2394**	**2086**	**6030**	**1235**	**1536**	**2077**
	%	**14.24**	**21.99**	**19.17**	**55.41**	**11.35**	**14.11**	**19.08**

Soil Available B status

Range of available B status of analyzed soils varied from very low to very high. Available B status of 17.14 % soils were very low, 27.77% soils were low, whereas 21.51, 12.43, 10.61 and 10.54% soils were medium, optimum, high and very high in available B content, respectively (Table 2.9). In Dhaka and Rajshahi division 35.27 to 53 % soils Available B ranged from very low to low. While in Khulna Division 14.0 % soils Available B ranged from very low to low. In Chattogram and Rangpur Division 51.85% to 68.98% soils Available B ranged from very low to low.

Table 2.9 Available B status of analyzed farmer's samples

Division	Total sample No.	VL ≤ 0.15	L 0.151-0.3	M 0.31-0.45	Deficient ≤0.45	O 0.451-0.6	H 0.61-0.75	VH >0.75
Dhaka	769	152	314	123	549	58	27	95
	%	11.51	23.76	9.35	41.72	4.41	2.05	7.2
Rajshahi	3564	686	1204	1040	2930	234	155	245
		19	34	29	82.21	7	4	7
Khulana	2320	42	283	369	694	607	587	432
	%	1.8	12.2	15.9	29.91	26.2	25.3	18.6
Chattagram	No.27	1	13	13	27			
	%	3.70	48.15	48.15	100			
Rangpur	1267	481	393	164	1038	89	74	66
	%	37.96	31.02	12.94	81.92	7.02	5.84	5.22
Total	7947	**1362**	**2207**	**1709**	**5278**	**988**	**843**	**838**
	%	**17.14**	**27.77**	**21.51**	**66.42**	**12.43**	**10.61**	**10.54**

Plant and Water Sample

Nutrient content in plant tissue is a vital indicator of soil fertility, soil productivity as well as crop yield and nutrient deficiency. Moreover, quality water is an important input for agricultural production as well as human health. Divisional and regional laboratories under ASW analyzed a total of 328 plant samples and 425 water samples with the parameters number 1089 and 1001, respectively. The highest number of plant samples (164) and water samples (152) were analyzed by divisional laboratory, Sylhet (Table 3). The number of analyzed parameters of plant and water sample was 751 and 295, respectively.

Table 3: Plant and water samples analyzed by divisional and regional laboratories of ASW

Name of Division	Name of Laboratory	Plant		Water	
		Sample	parameters	Sample	parameters
Dhaka	Divisional Lab. Dhaka	102	186	114	281
	Reginal Lab. Faridpur				
	Reginal Lab. Jamalpur				
	Reginal Lab. Mymensingh				
	Regional Lab. Kishoreganj				
	Regional Lab. Tangail				
	Regional Lab. Gopalganj				
Rajshahi	Divisional Lab Rajshahi	-	-	-	-
	Reginal Lab. Bogra				
	Regional Lab. Pabna				
Khulana	Divisional Lab. Khulana	-	-	24	122
	Reginal Lab. Jhenaidha				
	Reginal Lab. Kushtia				
	Regional Lab. Jessore				
Chittagong	Divisional Lab. Chittagong	5	5	96	115
	Reginal Lab. Comilla				
	Reginal Lab. Nokhali				
	Regional Lab. Ragamati				
Sylhet	Divisional Lab. Sylhet	164	751	152	295
Barisal	Divisional Lab. Borisal	-	-	-	-
	Reginal Lab. Potuakhali				
Rangpur	Divisional Lab. Rangpur	57	147	39	188
	Reginal Lab. Dinajpur				
Total		**328**	**1,089**	**425**	**1,001**

Fertilizer Recommendation Card

Soil test based balanced fertilizer application ensures optimum yield with minimum input maintaining soil health and environment. Divisional and regional laboratories under ASW had prepared 14,369 fertilizer recommendation card basis on soil test base (13,637), online fertilizer recommendation system (157) and Upazila land and soil utilization guide (575) which were distributed to respective farmers (Table 4).

Table 4: Fertilizer recommendation card prepared and distribution by divisional and regional laboratories of ASW

Name of Division	Name of Laboratory	No. of card			
		STB	OFRS	ULSUG	Total
Dhaka	Divisional Lab. Dhaka	1,904	-	-	1,904
	Reginal Lab. Faridpur				
	Reginal Lab. Jamalpur				
	Reginal Lab. Mymensingh				
	Regional Lab. Kishoreganj				
	Regional Lab. Tangail				
	Regional Lab. Gopalganj				
Rajshahi	Divisional Lab Rajshahi	3.914	-	-	3,914
	Reginal Lab. Bogra				
	Regional Lab. Pabna				
Khulana	Divisional Lab. Khulana	2,320	-	-	2,320
	Reginal Lab. Jhenaidha				
	Reginal Lab. Kushtia				
	Regional Lab. Jessore				
Chittagong	Divisional Lab. Chittagong	409	-	-	409
	Reginal Lab. Comilla				
	Reginal Lab. Nokhali				
	Regional Lab. Ragamati				
Sylhet	Divisional Lab. Sylhet	578	-	-	578
Borishal	Divisional Lab. Borisal	272	100	575	947
	Reginal Lab. Potuakhali				
Ranjpur	Divisional Lab. Rangpur	4,240	57	-	4,297
	Reginal Lab. Dinajpur				
Total		**13,637**	**157**	**575**	**14,369**

Revenue earning

Divisional and regional laboratories under ASW earned Tk. 60,96,451.00 as revenue by analyzing soil, water, plant and fertilizer samples (Table 5). The highest amount (Tk. 33,26,072.00) was earned from fertilizer analysis. Divisional laboratory, Dhaka with regional laboratories under the division was the most top position in revenue earning (Tk. 23,16,250.00)

Table 5: Revenue earning by divisional and regional laboratories of ASW

Name of Division	Name of Laboratory	Earning (Tk.)				
		Soil	Water	Plant	Fertilizer	Total
Dhaka	Divisional Lab. Dhaka	11,08,560	-	-	12,07,690	23,16,250
	Reginal Lab. Faridpur					
	Reginal Lab. Jamalpur					
	Reginal Lab. Mymensingh					
	Regional Lab. Kishoreganj					
	Regional Lab. Tangail					
	Regional Lab. Gopalganj					
Rajshahi	Divisional Lab Rajshahi	4,00,906	-	-	2,50,700	6,51,606
	Reginal Lab. Bogra					
	Regional Lab. Pabna					

Name of Division	Name of Laboratory	Earning (Tk.)				
		Soil	Water	Plant	Fertilizer	Total
Khulana	Divisional Lab. Khulana	1,96,299	8,580	-	3,10,007	5,14,886
	Reginal Lab. Jhenaidha					
	Reginal Lab. Kushtia					
	Regional Lab. Jessore					
Chittagong	Divisional Lab. Chittagong	1,79,237	3,215	500	7,27,900	9,10,852
	Reginal Lab. Comilla					
	Reginal Lab. Nokhali					
	Regional Lab. Ragamati					
Sylhet	Divisional Lab. Sylhet	3,37,550	15,200	65,600	1,10,000	5,28,350
Borishal	Divisional Lab. Borisal	85,964	660	-	78,800	1,65,424
	Reginal Lab. Potuakhali					
Ranjpur	Divisional Lab. Rangpur	3,47,833	6,375	13,900	6,40,975	10,09,083
	Reginal Lab. Dinajpur					
Total		**26,56,349**	**34,030**	**80,000**	**33,26,072**	**60,96,451**

Fertilizer and fertilizer related materialsI

1n 2023-2024 fiscal year, 4,583 fertilizer samples were analyzed in different laboratories of ASW (Table 6), in which 3,169 (69.15%) fertilizer samples were standard and 1,414 (30.85%) samples were adulterated (Table 7).

Table 6: Quantity of analyzed fertilizer in divisional and regional laboratories of ASW

Name of the fertilizers	Dhaka	Rajshahi	Khulna & Jessore	Chattogram & Comilla	Borishal	Sylhet	Rangpur	Grand total
Urea	06	-	23	39	21	12	02	103
$(NH4)_2SO_4$	38	-	03	35	-	-	-	76
TSP	24	20	10	57	19	24	06	160
DAP	27	-	17	80	12	32	04	172
MoP	35	05	05	72	14	27	02	160
K_2SO_4	62	12	-	35	-		-	109
Gypsum	133	22	20	117	25	19	34	370
NPKS	25	4	08	11	-	5	07	60
$MgSO_4$	212	87	33	168	10	37	112	659
ZnSO4 (Mono.)	153	242	109	173	26	17	170	890
ZnSO4 (Hepta.)	47	26	05	32	02	18	33	163
Chelated Zn	74	43	-	87	01	5	24	234
Solubor boron	164	119	36	113	11	28	101	572
Boric acid	120	61	19	77	14	17	61	369
Fertibor B15%	55	10	06	37	-	-	19	127
Organic fertilizer	84	13	37	24	-	12	103	299
Dolomite	15	05	02	01	01	-	08	35
Rock phosphate	-	-	-	03	-	-	-	3
Micronutrient	4	-	-	-	-	-	-	4
Bonemeal	2	-	-	-	-	-	-	2
Others	-	-		06		3	06	15
Total	**1280**	**669**	**333**	**1187**	**156**	**266**	**692**	**4583**

Macronutrient fertilizers i.e. Urea, (NH4)$_2$SO$_4$, MgSO4 and K$_2$SO$_4$ were around 100% standard. Besides, other macronutrient fertilizers like TSP, DAP, MoP and Gypsum were 10.00%, 9.88% 8.13% and 17.03% adulterated, respectively (Table 7). In contrast, micronutrient i.e., 69.10% zinc sulfate monohydrate, 38.04% zinc sulfate heptahydrate, 31.62% chelated zinc, 26.75% solubor boron, 40.65% boric acid and 22.05% Boron 15% were adulterated. The highest percent of sub-standard was observed for zinc sulfate monohydrate. The amount of adulterated organic fertilizers was 48.49% (Table 7). The adulteration was observed not only for the nutrient deficit but also for toxic level of heavy metals like cadmium (Cd), lead (Pb), Nickel (Ni) and Chromium (Cr).

Table 7: Quality of analyzed fertilizer in divisional and regional laboratories of ASW

Name of the fertilizers	Total	Standard	Sub- standard
	No.	%	
Urea	103	100.00	0.00
(NH4)$_2$SO$_4$	76	96.05	3.95
TSP	160	90.00	10.00
DAP	172	90.12	9.88
MoP	160	91.7	8.13
K$_2$SO$_4$	109	97.25	2.75
Gypsum	370	82.97	17.03
NPKS	60	50.85	49.15
MgSO$_4$	659	98.94	1.06
ZnSO4 (Mono.)	890	30.90	69.10
ZnSO4 (Hepta.)	163	61.96	38.04
Chelated Zn	234	68.38	31.62
Solubor boron	572	73.25	26.75
Boric acid	369	59.35	40.65
Fertibor B15%	127	77.95	22.05
Organic fertilizer	299	51.51	48.49
Dolomite	35	77.14	22.86
Rock phosphate	3	100.00	0.00
Micronutrient	4	0.00	100.00
Bonemeal	2	50.00	50.00
Others	15	80.00	20.00
Total	**4583**	**69.15**	**30.85**

Table 8: Analyzed soil samples by MSTLs

MSTL	Working area		Upazila	Sample
	Division	**District**		
Jamuna	Dhaka	Munsiganj, Dhaka, Tangail, Netrokona Mymensingh, Kishoreganj, Gazipur, Narshindi, Manikganj.	12	579
Brahmaputra	Dhaka	Jamalpur, Sherpur	10	565
Madhumoti	Dhaka	Faridpur, Rajbari, Sariyatpur, Madaripur, Gopalganj	10	495
Tista	Rajshahi	Naogaon, Chapainawabgonj, Rajshahi, Natore, Pabna, Sirajganj, Joypurhat, Gaibandha, Rangpur	12	731
Karatoa	Rajshahi	Gaibandha, Thakurgoan, Dinajpur, Nilphamari, Kurigram, Bogura, Dinajpur, Thakurgoan	12	603
	Rangpur	Lalmonirhat, Nilphamari, Gaibandha, Panchagor, Rangpur, Kurigram,		
Rupsa	Khulna	Kushtia, Chuadanga, Jhenaidah, Jashore, Narail, Khulna, Satkhira, Bagerhat, Chuadanga, Jhenaidah, Jashore,Khulna	16	804
Shurma	Sylhet	Sylhet, Sunamgonj, Moulavibazar, Habigonj	4	405
Kirtonkhola	Barishal	Bhola, Barguna, Patuakhali, Jhalokati	4	400
Kornafuli	Chattogram, Hill Tracts	Chattugram, Khagrachori, Cox's Bazar, Bandarban, Rangghamati	12	579
Titas	Chattogram	Cumilla, Noakhali, Feni, Chandpur, Brahmanbaria, Laxmipur	12	610
Total			**104**	**5,771**

Service of mobile soil testing laboratory (MSTL)

A total 5,771 soil samples were tested through 10 MSTLs namely Jamuna, Madhumoti, Brahmaputra, Tista, Karatoa, Rupsa, Karnophuly, Titash, Shurma and Kirtonkhola in Robi and Kharif season (Table 8). The tested soil samples were collected from farmer's field of different Upazilas with the cooperation of Department of Agricultural Extension (DAE). After analysis soil test-based fertilizer recommendation cards were prepared and distributed to the respective farmers.

Conclusion

The natural soil fertility of Bangladesh is reducing day by day rapidly which hampering crop productivity. The farmers of Bangladesh have realized the importance and benefits of soil test-based fertilizer recommendation for crop cultivation though soil test-based fertilizer recommendation facility at farmer's level is still inadequate and scanty. Furthermore, input costs are also getting higher step by step. In this situation, increase of recommended quality fertilizer uses through soil and fertilizer testing by the farmers with the support of SRDI and DAE could contribute in resource use efficiency and more economic return from cultivated crops. Nevertheless, managing the soil health and sustainable crop production soil test-based standard fertilizer application has to be ensured through soil and fertilizer testing

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Title: Changes of Soil Fertility in Jamalganj Upazila under Sunamganj District

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Abstract

A comparative study was conducted to assess the soil characteristics and fertility status in Jamalganj Upazila within the Sunamganj District. The primary objective was to evaluate the changes of soil fertility over time by examining various parameters including soil pH, organic matter (OM), total N, available P, S, B, Zn, Cu, Fe, Mn, exchangeable K, Ca, and Mg. Over the years from 2001 to 2023, there were notable trends in soil properties. During the 2001s, the soil in the area exhibited a range of characteristics. The pH has turned very strongly acidic to slightly acidic from very strongly acidic to neutral. Over the observed period, the organic matter (OM) content in the soil increased in recent soil compared to previous soil in most of the soil series except the Monu and Terchibari soil series. The total nitrogen (N) content shows same as OM content. Available phosphorus (P) levels also experienced an increase. The availability of zinc (Zn), iron (Fe), manganese (Mn) and available copper (Cu) showed substantial increases. Additionally, sulfur (S) content showed both cases very high. Exchangeable potassium (K), calcium (Ca), and Magnesium exhibited a decrease. On the other hand, exchangeable magnesium (Mg) In case of soil available boron (B), it actually did not follow specific pattern. In summary, the findings of the study strongly suggest that soil fertility has declined in the study area. These changes in soil properties and nutrient status have implications for agriculture and land management practices in the region.

Key words: Soil group, Soil reaction (pH), Organic matter (OM), Plant nutrients, Soil fertility.

Introduction

Bangladesh, a country known for its fertile deltaic plains and agricultural heritage, is heavily dependent on the agriculture sector, employing a significant portion of its population and

contributing to its economy. However, with the increasing population, the demand for food in Bangladesh is constantly increasing and thus the practice of intensive agriculture using agrochemicals have been dominating the cropping systems for several decades. Unfortunately, in the pursuit of increased food production, sustainability, environmental concerns, and the issue of land degradation have often been overlooked. As a result, soil fertility has significantly declined, particularly in areas where land-use intensification is more pronounced and inefficient. Bangladesh's soils are subjected to/experience high temperatures, abundant rainfall, and the pressure of cultivating two or more crops in a year, sometimes without balanced fertilization practices. This has led to the widespread depletion of nutrients from the soil. The intensification of agricultural land use, coupled with the adoption of modern crop varieties, has contributed to the deterioration of soil fertility and the emergence of new nutrient deficiencies. As a result, soil fertility is deteriorating progressively (Islam, 2008; SRDI, 2010a, b). To address this challenge, it is imperative to assess the trend of soil fertility decline to ensure optimal nutrient management and the development of sustainable cropping systems in Bangladesh. Soil fertility levels vary across regions, necessitating variable fertilizer applications for different types of crops. Insufficient fertilizer application can reduce crop yields, while excessive use can result in economic losses and poses environmental risk.

A comprehensive understanding of soil fertility provides valuable insights into the current nutrient status, distribution patterns, and trends (Dafonte *et al.,* 2010). This knowledge is crucial for decision-making processes aimed at enhancing crop productivity. To assess the extent of soil fertility degradation, it is essential to compare and analyze the initial and current soil fertility status. Therefore, this study examines changes in soil pH, organic matter (OM), total nitrogen (TN), phosphorus (P), sulfur (S), potassium (K), calcium (Ca), magnesium (Mg), boron (B), zinc (Zn), copper (Cu), iron (Fe), and manganese (Mn) over a period spanning from 2001 to 2023. This analysis aims to provide insights into the evolving nutrient dynamics in the soil over time. In summary, the availability of productive soil and land resources is crucial to meet the ever-increasing demand. Addressing this challenges Bangladesh requires a holistic approach that considers sustainable soil management practices, environmental protection, and the prevention of soil fertility degradation. Understanding the changing soil nutrient dynamics is crucial for making informed decisions in agriculture and ensuring long-term food security.

Materials and Method

Study location: The studied site, Jamalganj Upazila under Sunamganj district of Bangladesh covers an area of 131.69 km^2 in the eastern part of the country.

Soil sampling and analysis: Soil sampling was done under the national soil survey program of Soil Resource Development Institute, Bangladesh. Samples were collected based on soil series, land type and land use. Composite samples were collected from the upper 0-15 cm of depth. Collected soil samples were 68 in 2023. Soil pH was measured as described by Jackson (1962). Organic matter (OM) was determined by wet oxidation method (Page *et al.*, 1982). Available P

was extracted by Bray and Kurtz (1945) methodology. The P in the extract was then determined by developing blue color absorbance with ammonium molybdate-ascorbic acid solution and measuring the color by Spectrophotometer at 890 nm wavelength. The S content in the extract was determined turbidimetrically and the turbid was measured by spectrophotometer at 535 nm wavelength (Alvarez *et al.,* 2001). Exchangeable K content was determined by extraction with 1M ammonium acetate, pH 7.0 solution followed by determination of extractable K by flame photometer (Thomas, 1982). Exchangeable Ca and Mg content were determined by extraction with 1M ammonium acetate, pH 7.0 solution followed by measurement by atomic absorption spectrophotometer (Thomas, 1982). Available Zn, Cu, Fe and Mn were extracted by 0.05M DTPA solution (pH 7.3) maintaining 1:2 soil-extractant ratio. The extracted level was measured by flame AAS (Lindsay and Norvell, 1978). Available B was extracted by hot water-0.02M $CaCl_2$ solution (1:2). The extractable B was determined by spectrophotometer following azomethine-H method (Keren, 1996).

Result and discussion:

Soil Reaction (pH): The previous soil pH range was 4.2-6.4 and recent was 4.0-6.5 in different soil series at Jamalganj Upazila. The present pH shows a decreasing trend compared to previous data. These were due to the harvest of high-yielding crops and the nitrification of ammonium and acidic parent material.These findings were supported by Hailin, 2017. Over the course of two decades, from 2001 to 2023, efforts to intensify crop production have led to a notable rise in the application of chemical fertilizers. Unfortunately, this surge in fertilizer use, marked by imbalances and excessive quantities, particularly stemming from improper utilization of ammonia-based acid-forming fertilizers, appears to be the primary factor contributing to the increasing levels of soil acidity in the study area.

Table-1 Change in soil analytical data of pH, OM, N and P

Soil Group	Land type	Elements/Parameters							
		pH		OM (%)		N (%)		P (ppm)	
		Previous	Recent	Previous	Recent	Previous	Recent	Previous	Recent
Pritimpasha	MLL	6.4	5.3	2.4	4.1	0.14	0.20	1.0	1.2
Nalitabari	MLL	4.8	4.3	3.44	3.9	0.26	0.19	2.0	2.5
Monu	LL	4.8	4.1	3.44	2.9	0.26	0.13	1.0	3.5
Balagonj	MHL	4.6-5.4	4.0-5.4	2.2	2.8	0.14	0.15	2.0	2.7
Balagonj	MLL	4.5-4.9	4.6	2.14	3.5	0.12	0.18	2.0	3.4
Goainghat	MHL	4.6-5.0	4.0-5.2	1.9	2.7	0.11	0.14	2.0	3.8
Goainghat	MLL	4.3-5.8	4.6-6.1	2.41	2.8	0.13	0.14	3.0	3.8
Surma'sSilty Soil	MLL	5.5-6.4	4.4-5.3	2.49	2.8	0.15	0.15	2.0	3.2
Surma'sSilty Soil	LL	5.0	4.8	1.72	1.8	0.12	0.10	2.0	4.0
Fagu	LL	4.4-6.5	4.2	6.5	2.5	0.13	0.13	3.0	3.7
Fagu	VLL	4.2-5.2	4.2-5.4	2.88	2.94	0.12	0.15	1.0	3.1
Terchibari	LL	4.6-4.8	4.3-5.0	2.96	2.69	0.13	0.14	1.0	4.5
Terchibari	VLL	4.5-5.0	4.3-6.5	3.26	3.14	0.13	0.15	1.0	4.7
Dhirai	VLL	4.5-4.6	4.3-6.1	3.45	3.32	0.14	0.16	1.0	3.1

Organic Matter (%) and Total N (%): More or less the same trend was observed in the case of nitrogen and organic matter. The organic matter in the soil increased in recent soil compared to previous soil in most of the soil series. In the case of the Monu and Terchibari soil series, the recent soil OM decreased slightly but their status was the same. Organic matter decreased markedly in the Fagu soil series with low land in recent years. Increasing use of organic amendment, leaving crop residues in the field after harvest or incorporating them into the soil and cover cropping might be the cause of increased amount of organic matter in that region.

Phosphorus: The previously available P was found in very low status at different soil series. In recent years, the available P has increased slightly, but their status is the same as in previous data. Increase in soil available phosphorus might be the adoption of practices such as liming acidic soils, application of organic amendments in acidic soils, tillage practices and regulation of time and method of P fertilizer application.

Potassium (K): Out of nine soil series, the recent K level decreased compared to the previous K level, except for the Balaganj soil series (Table 2). The status of exchangeable K did not follow any specific pattern for each soil group and land type. Overall, it was found to be increased in 2023 comapre to 2001 except in Balaganj, it was decreased slightly.

Calcium (Ca) and Magnesium (Mg): The exchangeable Ca was decreased recently compared to previous Ca except Nalitabari and Goainghat soil series. Among the soil series, only Goainghat with MHL occupies a different status. The recent exchangeable Mg have increased in Nalitabari, Monu, Goainghat with MHL and Dhirai soil series compared to previous Mg. A decreasing trend of Mg was observed in the remaining soil series.

Table-2 Change in soil analytical data of K, S, Ca, Mg and B

Soil Group	Land type	Elements									
		K (meq/100g soil)		Ca (meq/100g soil)		Mg (meq/100g soil)		S (ppm)		B (ppm)	
		Previous	Recent	Previous	Recent	Previous	Recent	Previous	Recent	Previous	Recent
Pritimpasha	MLL	0.20	0.10	9.90	6.26	2.90	1.69	72	39	0.54	0.56
Nalitabari	MLL	0.14	0.10	3.40	4.49	1.10	1.28	88	68	0.39	0.32
Monu	LL	0.19	0.15	5.60	3.81	1.00	1.14	59	79	1.00	0.44
Balagonj	MHL	0.18	0.19	5.90	5.00	2.10	1.34	129	65	0.42	0.39
Balagonj	MLL	0.17	0.20	4.30	3.76	1.30	1.17	58	60	0.33	0.22
Goainghat	MHL	0.17	0.17	3.10	5.14	1.10	1.48	50	62	0.40	0.37
Goainghat	MLL	0.20	0.19	4.80	4.95	1.60	1.45	96	66	0.37	0.31
Surma'sSilty Soil	MLL	0.24	0.21	9.10	5.21	2.90	1.40	158	105	0.19	0.29
Surma'sSilty Soil	LL	0.22	0.17	6.50	3.62	2.10	1.33	152	47	0.71	0.33
Fagu	LL	0.21	0.18	6.90	5.08	1.90	1.49	75	66	0.68	0.26
Fagu	VLL	0.23	0.22	8.00	5.47	1.90	1.60	82	44	0.36	0.32
Terchibari	LL	0.27	0.17	9.10	6.50	1.80	1.52	80	104	0.33	0.46
Terchibari	VLL	0.21	0.19	7.10	5.46	1.60	1.54	66	82	0.34	0.33
Dhirai	VLL	0.20	0.20	7.00	5.93	1.50	1.53	60	109	1.04	0.43

Sulfur (S) and Boron (B): Available S was found between 50-150 ppm (Very High) in 2001, while it was observed between 39-109 ppm (Very High) by the year 2023 in different soil series with land types (Table 2). The status of available S was found very high in both cases (previous and present). Available B was found between 0.19- 1.04 ppm (Low to Very High) in 2001, while it was observed between 0.22-0.56 ppm (Low to high) by the year 2023 in different soil groups with land types. Some cases available B values decreased by crop uptake and sediment deposition.

Table-3 Change in soil analytical data of Zn, Cu, Fe and Mn

Soil Group	Land type	Elements							
		Zn (ppm)		Cu (ppm)		Fe (ppm)		Mn (ppm)	
		Previous	Recent	Previous	Recent	Previous	Recent	Previous	Recent
Pritimpasha	MLL	0.70	0.78	2.80	3.39	84	88	9.2	43
Nalitabari	MLL	2.10	3.81	3.70	5.79	240	338	116	138
Monu	LL	1.60	2.52	4.10	3.09	280	103	114	76
Balagonj	MHL	1.00	2.59	3.00	4.03	118	158	141	117
Balagonj	MLL	1.00	3.09	2.30	5.17	164	252	137	117
Goainghat	MHL	0.90	2.46	3.10	4.23	147	222	56	135
Goainghat	MLL	1.40	2.34	3.70	4.70	193	187	108	124
Surma'sSilty Soil	MLL	0.60	2.51	2.80	4.51	74	240	111	149
Surma'sSilty Soil	LL	0.50	2.37	3.20	4.83	340	143	62	59
Fagu	LL	1.60	1.93	4.20	4.54	294	187	151	105
Fagu	VLL	1.80	2.77	4.30	5.09	341	286	142	132
Terchibari	LL	1.90	2.09	4.40	4.64	347	369	143	172
Terchibari	VLL	1.70	2.41	4.70	4.76	321	317	158	164
Dhirai	VLL	1.80	2.81	4.20	4.85	334	362	109	164

Available Zn, Cu, Fe and Mn:

Over time from 2001 to 2023, soil available Zn reserve had been increased all over the soil series (Table 3). In 2001, available Zn was found between 0.70-2.10 ppm (Optimum to Very high), whereas it was observed between 0.78-3.81 ppm (Optimum-Very high) in 2023 in different soil group-land types.

Similarly soil available Cu reserve had been increases from 2001 to 2023 (Table 9.3). Mean available Cu was found between 2.30-4.70 ppm (Very high) in 2001, whereas it was observed between 3.39-5.79 ppm (Very high) by the year 2023 in different soil groups with land types. The change in available Fe content was increased during the time span of 2001 to 2023 (Table 9.3). Mean available Fe was found between 74-347 ppm (Very high) in 2001, though it was observed between 88-369 ppm (Very high) by the year 2023 in different soil groups with land types. In 2001 available Mn was found between 9.2- 158 ppm (Very high), and it was observed between 43-172 ppm (Very high) by the year 2023 in different soil groups with land types (Table 9.3)..

The findings of this study were consistent with the results reported by various authors. Siddique *et al.* (2014) found that the soil pH ranged from 5.4 to 6.0 in the year 1991, but it was observed to be

in the range of 4.4 to 5.4 by the year 2012 in the northeastern piedmont soil. A comparison between the soil pH maps of BARC for the years 2005 and 2012 revealed that there was an expansion of 0.15 million hectares of very strongly acidic soil (pH < 4.5) and 0.44 million hectares of strongly acidic soil (pH 4.5-5.5) over time. The increasing rate of SOC indicates increase of organic matter in soils of Bangladesh over the time. According to SRDI, medium organic matter content of organic matter comprises 55.57% of arable land in 2010, which increases to 59.19% in 2020 (*Soil fertility trends in Bangladesh* 2010 to 2020, 2020). This may be because of rice-rice cropping system, increasing cropping intensity and awareness of the farmers on incorporation of organic manures to their land. Additionally, soil available P, K, S, and B content have arisen in that study area which is a good indication considering our soil health. Increase in soil available phosphorus might be the adoption of practices such as liming acidic soils, application of organic amendments in both alkaline and acidic soils, tillage practices and regulation of time and method of P fertilizer application. The exchangeable K content in the study area might be decreased due to the use of HYV of rice monocrops and negligence of Potash fertilizer use. Zahid *et.al.,* 2020, reported that soil productivity may reduce to 10-25% if soil sulphur is in the range of 18.1-23.5 ppm. In the study area the Sulphur content was 36.89 to 151.40 ppm which indicates that the soil of the study area undergoing a change for the management of crop production. Besides, the Ca and Mg content of the study area was decreased. However, soil magnesium content in loamy to clayey soils both of upland crops and wetland rice crops across the country declined alarmingly over the years. Hasan *et.al.,* 2015, reported that there is a considerable leaching of base materials such as Ca, Mg and K from top soils and subsequent accumulation in sub soils.

Nonetheless, a significant proportion of Bangladeshi farmers opt to apply nitrogen (N) fertilizers due to the immediate and noticeable effects on soil and crop production (Biswas *et al.,* 2008). This preference for N fertilizers contributes to nutrient imbalances that can adversely affect soil characteristics and overall crop production. The decline in soil fertility in regions with intensive cropping practices, as highlighted by Jahiruddin and Satter (2010), suggests that the replenishment of essential nutrients is not occurring, or it exceeds the soil's capacity to provide the necessary nutrients for the cultivation of high-yield crop varieties. During prolonged flooding, as soil Eh reduction continues, pH decreases while zinc availability increases leading to high tissue zinc concentrations (Pavanasasivam, and Axley,1980) and reduced ferric and manganic forms that are soluble (Ponnamperuma, 1972). Increased solubility of Zn, Fe and Mn may result increased movement of these micronutrients to lower horizons from surface horizons, thereby depleting the surface horizons.

Conclusion

The findings of this study highlight significant changes in soil characteristics and agricultural practices in Bangladesh. The study noted a decline in soil pH levels over the years, with an expansion of very strongly acidic and strongly acidic soils in some areas. This shift may have implications for crop production and soil health. The research indicates a positive trend in SOC,

suggesting an increase in organic matter in Bangladeshi soils. Soil available phosphorus, sulfur, and zinc content showed an increase, which is beneficial for soil health and agriculture. This rise may be due to various practices, including liming acidic soils, organic amendments, and regulated phosphorus fertilizer application. The study identified depletion of potash (K) content in selected areas between 2001 and 2023, potentially causing a decline in crop productivity. This depletion may be linked to intensive agricultural practices and a lack of potash supplementation. This is an indication for the need to reverse or restore the soil natural fertility status from current critical nutrients status to increase crop productivity through efficient farming. Soil test based balanced fertilization by quality organic, inorganic and bio fertilizers, judicious and efficient use of acid forming fertilizers like urea and di-ammonium phosphate (DAP), crop diversification, inclusion of green manuring crops and incorporation of crop residue might be some effective tools for soil fertility restoration.

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4.2 Achievement of Central Laboratory

Central Laboratory

Central Laboratory is under the Headquarter of Soil Resource Development Institute. The Laboratory usually conducted chemical and physical analyses of soil received from different stake holders like Government organizations, NARS institutions, Autonomous organizations, Public and Private Universities, research fellow, Private entrepreneurs, farmers, and NGOs. But after the revisit of the organogram Central Laboratory conducted some research activities in collaboration with national and international organizations like FAO, IFDC etc. In addition to that it has been played a vital role to maintain the quality inorganic and organic fertilizers, especially the laboratory performed the quality of fertilizers for registration of new fertilizer companies as well as new fertilizer which was provided by Department of Agricultural Extension (DAE) and Bangladesh Agricultural Research Council (BARC). Central Laboratory has performed the activities of Accreditation process and it has fulfilled almost all of the nonconformity issues. It has participated in Proficiency Test (PT) with European PT providers. Hopefully PT round will be completed soon successfully and all nonconformity to get the accreditation will be resolved.

Goal

Ensure judicious and profitable use of scarce land and soil resources of the country and keep environmental pollution related to agrochemicals at zero level.

Functions of Central Laboratory
- Research activities on different soil and environmental related issues;
- To maintain the quality of analytical work of other Laboratories of SRDI;
- To maintain the quality of imported fertilizers, new fertilizer registration, renewal fertilizer registration;
- To analyze water and plant samples received from different organizations;
- To analyze fertilizer samples in order to assist the agricultural system to control adulteration of fertilizers.

Program of Central Laboratory:
- Quality control of the chemical analysis of different Laboratories for updating Upazila Nirdeshika
- Research Program
- Publications
- Training
- Quality control of fertilizers

Experiment-1   Fertilizers Quality of different Fertilizers in Bangladesh

Introduction

Bangladesh agriculture has made an outstanding achievement in food sufficiency. Even in the midst of the Covid-19 pandemic, Russia- Ukraine war Bangladesh agriculture made a significant contribution to the country's food security. High yielding varieties, hybrids and high value crops have been introduced to its agriculture. Bangladesh agriculture has been passing through a transition from subsistence farming to commercial agriculture. Crop production and cropping intensity increased several times during the last three decades. But such an increase in cropping intensity increases the risk of nutrient depletion by nutrient mining. Farmers are mostly using macronutrient fertilizers like urea, triple superphosphate (TSP), di-ammonium phosphate (DAP), muriate of potash (MoP) and gypsum and micronutrient fertilizers like zinc (Zn) and boron (B). Now a days there are huge advancement is happened in the dairy and poultry sector that create huge opportunity to produce commercial organic fertilizer in Bangladesh. Many private entrepreneurs have come forward for the commercial production and marketing. Some people associated with fertilizer manufacturing, importing and marketing were found dealing with adulterated fertilizers, especially in case of micronutrient fertilizers. Common perception is that Government subsidised macronutrient fertilizers like Urea, TSP, DAP and MoP quality is good enough. In addition, the quality of calcium and magnesium containing low-cost fertilizers like gypsum and magnesium sulphate was found standard from the previous findings. Fertilizer adulteration might one of the causes for yield loss and lack of farmer confidence in fertilizer recommendations. The fertilizer recommendations from NARS and FRG were based on pure and appropriate concentration of N, P, K, S, Zn and B; however, adulterated fertilizers might not provide expected results to the farmers, thus the farmers would deprive of the satisfactory yield of a crop and farmers had to buy and apply more fertilizers to their field for yield maximization. Moreover, continuous application of adulterated fertilizers might have played adverse effect on soil nutrient balance which affected soil health. Quality of fertilizers played an important role to ensure desirable crop yield as well as crop quality.

Considering the above perspective Central Laboratory presented the findings of the fertilizer quality received in the 2023-2024 from different stake holders like sample received from DAE for registration, Bangladesh Agricultural Research Council (BARC), Upazila Agriculture Office (UAO) for quality control activities and Private entrepreneurs.

Methods and materials

In 2023-2024 Central Lab of SRDI determined the quality of different fertilizers that were applied for new registration to DAE and BARC. On the other hand, Upazila Agriculture Office (UAO) of different districts, Bangladesh Life stock Research Institute (BLRI), Sher-E-Bangla Agricultural University (SAU) and Private Entrepreneurs sent different fertilizer samples for quality audit. Central Lab also received sample from some private entrepreneurs. These fertilizer samples were inorganic macro and micronutrient fertilizer as well as organic fertilizers. Most of the fertilizers were analyzed for the purpose of registration or renewal of registration where the private entrepreneurs try to provide the best fertilizer samples to the laboratory. Fertilizers samples received from different stake holders (Table 1) in 2023-2024. Collected micronutrient fertilizer samples were analysed following the standard procedure 'Manual for Fertilizer Analysis, 2003' approved by the Government of the People's Republic of Bangladesh. A total of 1924 chemical

parameters were determined to ensure the quality of 278 different fertilizers. MS Excell was used for statistical analysis.

Table 1 Fertilizer samples received from different stake holders

Fertilizer	Registration	UAO	BARC	BLRI	SAU	Private	Total
Zinc sulfate monohydrate	37	8	-	-	-	10	55
Zinc sulfate heptahydrate	15	3	-	-	-	-	18
Chelated zinc	24	3	-	-	-	-	27
Gypsum	23	-	-	-	-	-	23
Dolomite	9	-	-	-	-	-	9
Boric acid	15	5	-	-	-	-	20
Solubor boron	22	2	-	-	-	-	24
NPKS	19	-	-	-	-	-	19
Organic fertilizer	10	-	14	6	6	19	55
DAP	2	-	-	-	-	-	2
MoP	2	-	-	-	-	-	2
SoP	7	2	-	-	-	-	9
Other fertilizers	11	-	4	-	-	-	15
Total	196	23	18	06	06	29	278

Result and Discussions

Zinc Sulfate Monohydrate

It was found that during 2023-2024 Central Lab received highest number Zinc Sulfate monohydrate fertilizer samples (55) while the lowest number of samples of DAP and MoP were received (Table-1). Out of 55 zinc sulfate monohydrate fertilizer samples of different companies it was found that 47% fertilizer samples were standard while 53% were found substandard (Table 2). The samples were found substandard not only absence of desirable Zinc (Zn) and Sulfur (S) content but also the presence of excess quantity of unwanted heavy metal like lead (Pb), Cadmium (Cd), Nickei (Ni) and Chromium (Cr). According to the source of samples the highest percent of quality Zinc Sulfate monohydrate fertilizer samples were found in the sample for registration which was 59% while the lowest percent (10%) of quality fertilizer samples were found in private samples (Fig. 1).

Zinc Sulfate Heptahydrate

It was observed that a total of 18 zinc sulfate heptahydrate fertilizer samples were received where 78% samples were found standard while 22% were found adulterated (Table 2). Zinc sulfate heptahydrate fertilizers were adulterated due to shortage of Zn and S. According to the source of samples the highest percent of quality Zinc Sulfate Heptahydrate fertilizer samples were found in the sample from Upazila Agriculture Office which was 100% while the lowest percent (73%) of quality fertilizer samples were found in registration samples (Fig. 2).

Chelated Zinc

During the period a total of 27 Chelated Zinc fertilizer samples were received where 85% samples were found standard while 15% were found adulterated. Chelated Zinc fertilizer samples were

adulterated due to presence of undesirable Sulfur and excess quantity of unwanted heavy metal like lead (Pb), Cadmium (Cd), Nickei (Ni) and Chromium (Cr). According to the source of samples the highest percent of quality Chelated Zn fertilizer samples were found in the sample from Upazila Agriculture Office which was 100% while the lowest percent (83%) of quality fertilizer samples were found in registration samples (Fig. 3).

Table 2 Fertilizer quality of different fertilizer in 2023-2024 at Central Lab

Fertilizer	Standard	Sub-standard	Total	Standard (%)	Sub-standard (%)
Zinc sulfate monohydrate	26	29	55	47	53
Zinc sulfate heptahydrate	14	4	18	78	22
Chelated zinc	23	4	27	85	15
Gypsum	22	1	23	96	4
Dolomite	7	2	9	78	22
Boric acid	18	2	20	90	10
Solubor boron	24	0	24	100	0
NPKS	0	19	19	0	100
Organic fertilizer	42	13	55	76	24
DAP	2	0	2	100	0
MoP	0	2	2	0	100
SoP	9	0	9	100	0
Other fertilizers	10	5	15	73	27
Total	181	77	278	-	-
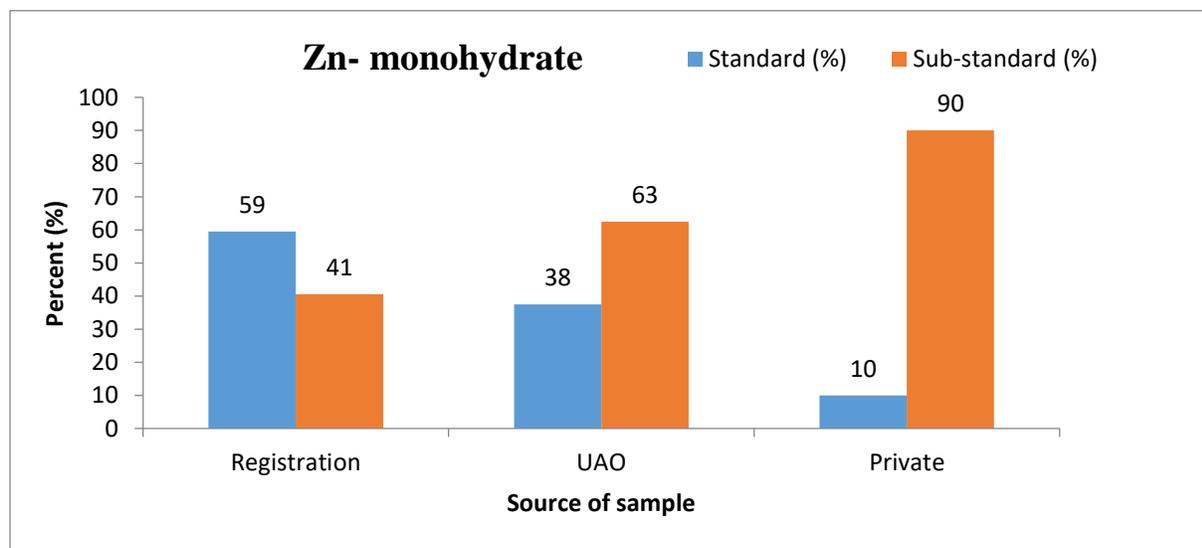
Fig. 1 Zinc sulfate Monohydrate fertilizer quality from different stake holders.
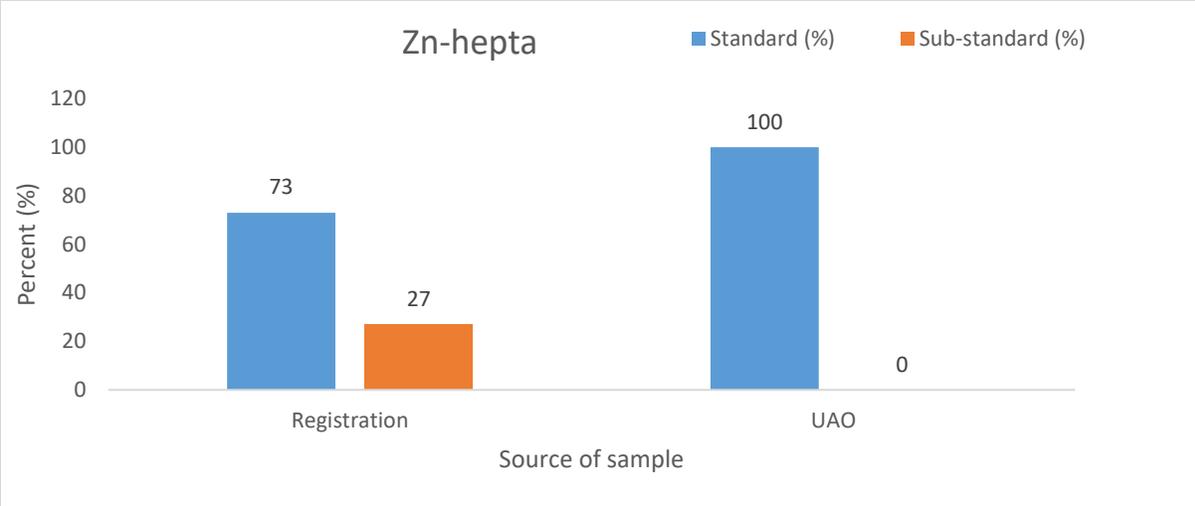
Fig. 2 Zinc sulfate Heptahydrate fertilizer quality from different stake holders.

Gypsum and Dolomite

Gypsum and Dolomite samples were received for registration purpose (Table 1). It was found that 96% Gypsum and 78 % Dolomite were standard as per Government specification (Table 2). Gypsum was adulterated due to the insufficiency of Calcium (Ca) as per specification. On the other hand, Dolomite was found adulterated due to the insufficiency of Calcium (Ca) as per specification and presence of undesirable heavy metal to an excessive level.
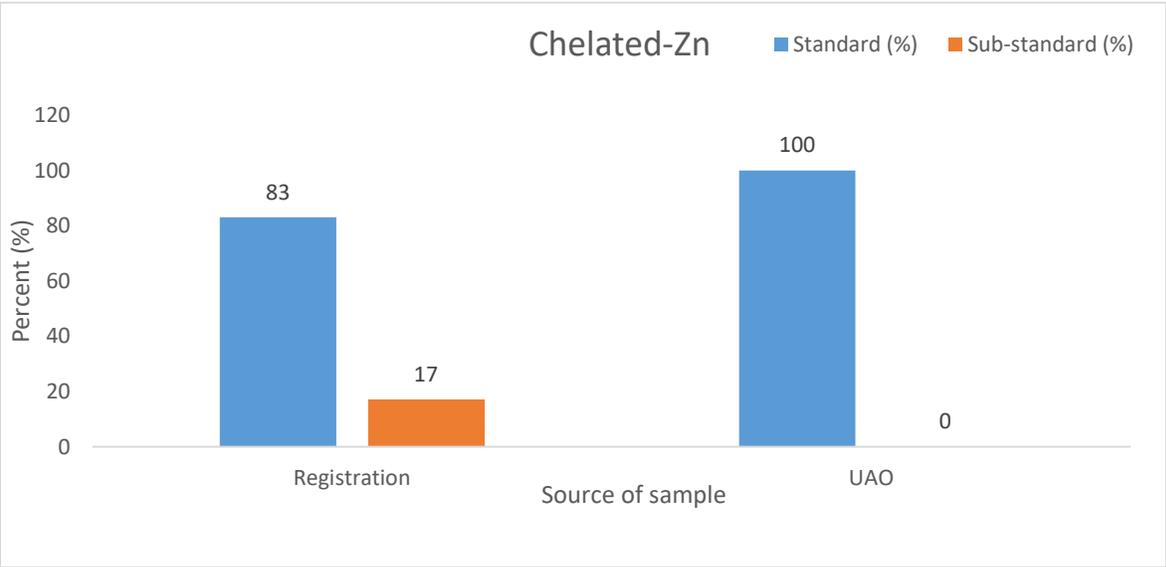
Fig. 3. Chelated Zinc fertilizer quality from different stake holders.

Boric acid and Solubor Boron

Boric acid and Solubor Boron are the major boron containing micronutrient fertilizers at field level. There is another two Boron containing fertilizers named Granobor and Fertibor but their use is

very limited. It was observed that 90% Boric acid and 100% Solubor Boron were found standard as per Government specification. DAE sent these samples for registration purpose. Boric acid adulteration was found due to less boron content as per standard.

DAP, SoP, MoP and NPKS Fertilizers
DAE sent these fertilizers samples from some new importers for registration. It was observed that 100% DAP and SoP fertilizer samples were found standard. On the other hand, it was observed that 100% MoP were found adulterated. DAE sent 19 NPKS fertilizer samples for new registration. It was found that all the fertilizers were failed to meet the Government specification i.e. 100% NPKS fertilizers were adulterated (Table 2). MoP adulteration was found due to less potassium (K) content as per standard. On the other hand, NPKS fertilizer samples were found adulterated due less Nitrogen (N) and Phosphorus (P) content as per standard.
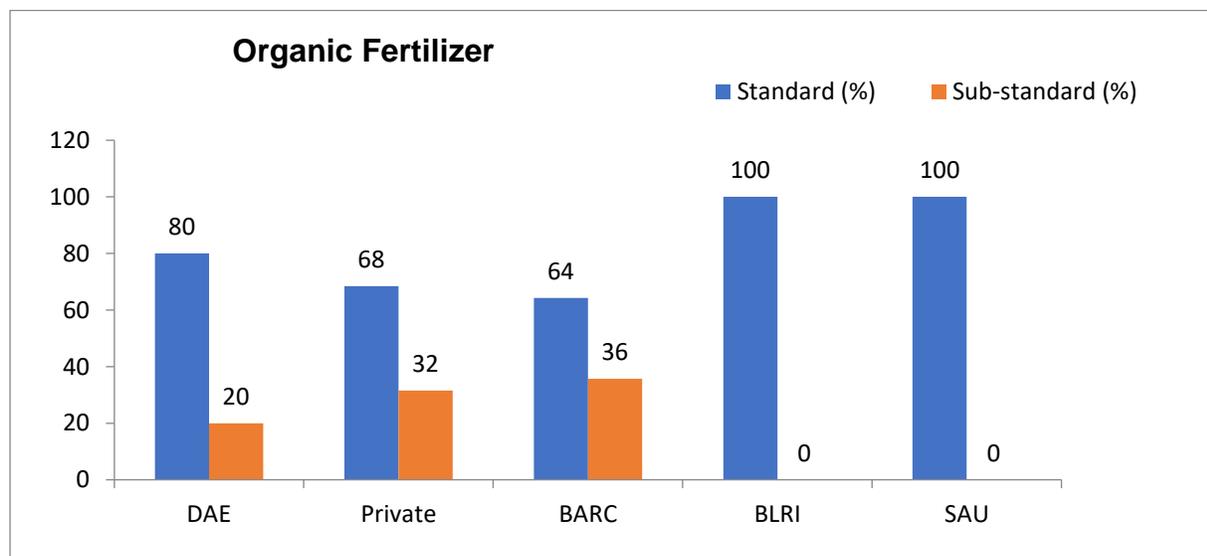

Fig. 4 Organic fertilizer quality from different stake holders.

Organic fertilizer
Central Lab received Organic fertilizers from different stake holders like, DAE, BARC, BLRI, SAU and Private entrepreneurs. The maximum number received from Private entrepreneurs (19) while the minimum number (6) from BLRI and SAU (Table 1). It was found that 76% of the organic fertilizers were standard while 24% were found (Table 2). The highest percent (100%) of standard organic fertilizer were found in the sample from BLRI and SAU while the lowest percent (68%) of standard organic fertilizer samples were found in private entrepreneurs (Fig.4). Organic fertilizers were substandard due to carbon content, C:N ratio were not with in the specified range and also the presence of undesirable level of heavy metals.

Conclusions
Most of the fertilizers were analyzed for the purpose of registration or renewal of registration where the private entrepreneurs try to provide the best fertilizer samples to the laboratory. Therefore, the report does not represent the real feature of fertilizer quality at field level. Most of

the macronutrient fertilizers were found compliant with standards. On the other hand, micronutrient fertilizer like Zinc sulfate mono hydrate, Zinc sulfate heptahydrate and Chelated fertilizers 53%, 22% and 15% respectively, were non-compliant with the standard. Boron containing fertilizers like Boric acid and Solubor boron were 90% and 100% respectively, complaint with standard. Organic fertilizers were 76% complaint as per standard. NPKS physically mixed fertilizers were cent percent noncompliant with the standard.

Ongoing Research program

1. Natural Degradation of Soil: Perspective Barind Tract in Bangladesh
2. Determination the Relationship of Silicon on Mitigating Salinity and Heavy Metal Contamination in Soil and Plant- A collaborative research program with PSTU

Chapter 5: Achievement of Projects & Programmes

1. **Name of the Project/ Programme: Gopalgonj, Khulna, Bagerhat, Satkhira and Pirojpur Agricultural Development Project (GKBSPADP) (SRDI part)**

Duration: July 2018 **to June** 2024

Objectives:

a. Determination of nutrient status and identify of the condition and extent of problematic soils (saline, peat and waterlogged) in respective districts.
b. Preparation of surface water use guide of 37 upazilas for saline areas for safe irrigation.
c. Creation of digital database on soil and land for agricultural development planning.
d. Conducting research activities for reclamation of degraded soils.
e. Organize training for 22,020 farmers and extension workers to increase awareness on soil management.
f. Preparation of union shahayka for balanced fertilizers use.

Achievement:

Types of Activities	Target	Achievements
Union Survey	10	10
Upazila Surface water Survey	3	3
Printing of Union Sohayeka	20	20
Preparation of Union Fertilizer Recommendation Display Board	17	17
Printing Upazila Surface water use guide	3	3
Establishment of adaptive trial plot	300	300
Training of SRDI/DAE Officer	1 **Batch**	1 **Batch**
Training of farmers	350 **batch**	350 **batch**
Procurement of Laboratory equipment	8	8

2.Name of the Project: Construction and Capacity Building of SRDI (CCBS)

Duration: January, 2020 to December, 2024 (1st Revised)
Objectives:
The project is aimed to development of physical and technical facilities of SRDI personnel. Human resources and support staff is the key role player for achieving the goal, hence this service procurement will help project activities definitely.

Specific Objectives:
a. Construction of SRDI Head Office-6 Storied building with two basements; 6 storied building at Rajshahi, Khulna and Cumilla.

b. Boundary wall and internal road at SMRC, Batiaghata, Khulna and SCWMC, Bandarban.

c. ICT backbone built at different sections of SRDI Head Office and modernization of GIS.

Progress of the activities in 2023-24:
SRDI Head Office Dhaka: All roof castings have been completed. Plastering, tiling, electrical and other works are in progress
Rajshahi: All roof castings have been completed. Plastering, tiling, electrical and other works are in progress
Khulna: 2nd roof casting completed, preparation for 3rd roof casting is underway
Cumilla: All roof castings have been completed. Plastering, tiling, electrical and other works are in progress
SMRC, Batiaghata, Khulna: Electrical work, boundary wall and internal road work has been completed.
SCWMC, Bandarban: Construction of boundary wall and internal road, main gate, guard room has been completed, preparations are underway to complete the internal work of the building

3. Name of the Programme: "Acidic soil management and sustainable crop production & improvement of soil fertility by practicing climate smart agricultre in the Rajshahi & Rangpur Division including Madhupur Tract"

Duration: July, 2022 to June, 2025
Objectives:
1. Encouraging farmers to use climate smart agriculture technology to increase soil fertility and sustainably produce more crops in acid soils through the use of dolochun and lime materials, biochar, biofertilizers and SRDI developed technologies.
2. Encouraging farmers to increase production of crops with low water demand (eg wheat, lentil, gram, chickpea, sesame, linseed, cotton, pineapple) in acidic and drought-prone areas.
3. Enumeration of major soil series of soil microorganisms in acidic soils to preserve soil health and balance the environment
4. Distribution of 2,700 fertilizer recommendation cards based on Upazila Guidelines/Union Helper/Online Fertilizer Recommendations/Soil Test for use of organic fertilizers and balanced chemical fertilizers to preserve soil health and maintain environmental balance by managing acidic soil among the farmers of the study area.
5. Encouraging farmers to produce nutrient-rich food for the residents of Madhupur Gard region including Rajshahi and Rangpur divisions by increasing the production of more crops by managing acidic soil.
6. Training of about 970 Sub-Assistant Agricultural Officers/Extension Workers/Progressive Farmers on Soil Testing and Use of Fertilizers and Technology in Field for Increasing Crop

Production and Managing Soil Fertility by Managing Acidic Soils Rajshahi & Rangpur Division including Barendra Region.

Achievement

Types of Activities	Target	Achievements
Conducting field trial	Research trial-8 Nos.	Completed
Two days SAAO training on Acid Soil Management and Sustainable crop Production	SAAO - 5 batch	
	Farmer – 14 batch	Completed
Workshop	1	completed

Name of the Project/ Programme: Strengthening of newly developed Potuakhali & Rangamati regional laboratories

Duration: July 2022 **to June** 2024

Core objective:

 To increase crop production and reduce production costs through soil test based balanced fertilization and conserve soil health

Specific objectives

 Procurement of equipment's, chemicals, glassware and others materials for three newly created laboratories included approved organogram of SRDI for strengthening farmer services activities and soil research in different regions.

 To provide crop-based fertilizer recommendations through analyzing soil samples

 To organize training on related issues for farmers and agricultural extension workers

 Provide technical training of laboratory staffs as a part of human resource development

Achievement

Types of Activities	Target	Achievements
Workshop	1	1
Officer's training	2 batch (each batch contain 25) = 50	50

Chapter 6: Activities of Research Centers

6.1 Soil Conservation and Watershed Management Center (SCWMC)
SoilResource Development Institute
Bandarban

EXPT. No. 01

ANALYZING THE PERFORMANCE OF *PIPER CHABA* (CHUI JHAL) AS AN AGROFORESTRY PRACTICE IN THE CONTEXT OF CHATTOGRAM HILL TRACTS.

Abstract

Chui jhal is a pungent vegetable belonging to the Piperaceae family, commonly utilized in the southern region of Bangladesh, West Bengal, and Tripura in India. Chui jhal is widely utilized as a spice in popular dishes, including meat, fish, and mutton curry, owing to its pungent and flavorful taste. Chui jhal plant possesses numerous medicinal properties and can be beneficial in treating various ailments such as bronchitis, asthma, colic pain, piles, colic, gastralgia and dyspepsia. Agroforestry's potential is often studied through its biophysiological aspects, cost-benefit analysis, and impact on poverty reduction. Research in CHT revealed that agroforestry interventions boosted farmers' income by creating jobs, selling farm products, and improving ecological conditions through reduced soil erosion, increased tree coverage, and enhanced soil fertility. The study is being conducted at the research field of the Soil Conservation and Watershed Management Centre in Bandarban to evaluate the performance and economic viability of Chaba germplasm (Piper chaba) in the agroforestry system of Chattogram Hill Tracts. The experimental site represents the agroecological zone (AEZ)-29, which is recognized as the Northern and Eastern Hill region. Four treatments employed, including Mango as supporting plants (Treatment 1), Gamari as supporting plants (Treatment 2), Jackfruit as supporting plants (Treatment 3), and no supporting plants (Treatment 4). Chuijhal-based agroforestry in hill regions shows promise, with companion plants influencing growth parameters significantly. While initial findings are insightful, longer-term studies of 3-5 years are needed for a comprehensive evaluation. Plant height varied less across treatments, but proximity to Gamari trees favored taller Chuijhal growth. Highest leaf yield per plant occurred when Chuijhal was grown alone, followed by Mango, Gamari, and Jackfruit combinations. Stem and root diameter are crucial for edibility and require further investigation at harvest. Mango proved the most beneficial companion, showing the highest stem diameter early on. These results highlight the potential of Chuijhal-based agroforestry and the importance of selecting suitable companion plan plants for optimal growth and yield.

Introduction

Chui jhal (*Piper chaba* H.) is a pungent vegetable belonging to the Piperaceae family, commonly utilized in the southern region of Bangladesh, West Bengal, and Tripura in India. It is also recognized as Java long pepper or Choi Jhal, and it thrives in warmer regions of Asia, including Sri Lanka, Malaysia, Indonesia, and Singapor (Bhandari SPS, Babu UV, Garg (Late)H. S. 1998 and Basu B.D KKR. 1987). Chui jhal is widely utilized as a spice in popular dishes, including meat, fish, and mutton curry, owing to its pungent and flavorful taste. This creeper type flowering vine from the Piperaceae family spreads on the ground and may also grow around large trees, making it a year-round additive spice for various culinary delights. In Bangladesh, Chui jhal is considered a relatively costly spice, with its roots being more expensive than the stems due to their more potent aroma (Islam MdR, Mehedi MdNH, Ara R, Obaidullah AJM, Moniruzzaman Md, Aktar N.2021)

Chui jhal plant possesses numerous medicinal properties and can be beneficial in treating various ailments such as bronchitis, asthma, colic pain, piles, colic, gastralgia and dyspepsia. (N CR, Chopra IC. 1994.andM. K.S. Krishnan. 1986). Each part of the Chui jhal plant, including the leaves, stems and fruits, contains active medicinal compound (Islam S, Roy AC, Haque M, Hossain S, Abu M.)The aerial parts of this plant have shown various beneficial properties, including antibacterial, anti-diarrheal, carminative, anti-hypertensive, diuretic, stimulant, analgesic, expectorant, and smooth muscle relaxant effects. (Ghani A. 2003, Yusuf M., Chowdhury J.U., Begum D.J. 1994, Rahman MdA, Amin A, Shekher H. Alkamide and Lignan 2007and Sarfaraz S., Najam R., Hassan F.2014). The primary phytochemical constituents of Piper chaba Hunter are isoflavanons and alkaloids, which contribute to its main pharmacological activities such as antioxidant, antimicrobial, anti-inflammatory, cytotoxic, and hypolipidemic effect *(*Haque E, Roy AC, Rani M. 2018).

Piper chaba contains a significant alkaloid that exhibits antimycobacterial activity (Jin J, Zhang J, Guo N, Feng H, Li L, Liang J, et al.2011) along with various pharmacological effects like antihyperlipidemic (Jin Z, Borjihan G, Zhao R, Sun Z, Hammond GB, Uryu T.2009), antiandrogenic (Hirata N, Tokunaga M, Naruto S, Iinuma M, Matsuda H.2007), immunoregulatory (Pradeep CR, Kuttan G.2004), and antidepressant (Lee SA, Hwang JS, Han XH, Lee C, Lee MH, Choe SG, et al. 2008) properties. Additionally, the fruits of Piper chaba are used for their gastro-protective, anti-flatulent, appetizing, expectorant, anti-fungal, and anti-tussive properties. They are also known for their cholesterol-lowering effects (Chojnowska I, Kucharczyk K, Myszkowski L, Radzikowski A, Szymańska K. 1979).The ethanolic fruit juice of Piper chaba has demonstrated erythropoietic effects (Lumb PJ, Slavin BM. 1993) as well as central nervous system depressant and anxiolytic effects. (M. Yusuf, J.U. Chowdhury, M.A. Wahab, J. Begum.1994). The stem of Piper chaba is utilized to alleviate post-delivery pain in mothers and is also beneficial for treating rheumatic pains and diarrhea.(Daware MB, Mujumdar AM, Ghaskadbi S.2000). Natural resource degradation in modern agriculture, especially soil and water, threatens sustainability due to reduced productivity, profits, ecological imbalances, and environmental security. Agroforestry offers a viable solution for maintaining sustainable agriculture.(Sireeratawong S, Itharat A, Lerdvuthisopon N, Piyabhan P, Khonsung P, Boonraeng S, et al. 2012.)

Agroforestry's potential is often studied through its biophysiological aspects, cost-benefit analysis, and impact on poverty reduction. Research in CHT revealed that agroforestry interventions boosted farmers' income by creating jobs, selling farm products, and improving ecological conditions through reduced soil erosion, increased tree coverage, and enhanced soil fertility (Nath TK, Inoue M, Myant H. 2005).Another study in the Chinai union of Rajarhat Upazila, Kurigram district, Bangladesh, surveyed 105 Piper chaba farmers to evaluate the effects of an agroforestry system on their livelihoods. By providing a consistent supply of food, fruit, timber, fodder, and fuelwood, this agroforestry approach significantly enhanced the sustainability of their livelihoods. It is believed that this practice strengthens farmers' livelihood assets, with the most improvement seen in natural capital and the least improvement in social capitals (Hemel SAK, Hasan MK, Wadud MdA, Akter R, Roshni NA, Islam MdT, et al. 2022).

Agroforestry systems are widely acknowledged as an integrated approach to sustainable land use, offering benefits not only in climate change mitigation and adaptation but also in various other aspects (Cubbage F, Balmelli G, Bussoni A, Noellemeyer E, Pachas AN, Fassola H, et al. 2012). Combining agroforestry with Climate-Smart Agriculture (CSA) holds the potential to address multiple concerns, including soil health, resource allocation, carbon sequestration, biodiversity, water management, and food security, leading to significant progress in these areas (Newaj R, Chavan S, Prasad R. 2015). Spice crop-based agroforestry systems, like the Choi Jhal (Piper chaba)-based system, are commonly integrated into home gardens. These agroforestry practices serve as valuable sources of fuelwood and charcoal. Moreover, agroforestry practitioners reduce their expenses, dependency, and time spent gathering fuelwood. For vulnerable food producers, agroforestry can enhance farm income and crop resilience (Waldron A, Garrity D, Malhi Y, Girardin C, Miller D, Seddon N. 2017).

By adopting this approach, one can enhance resilience to climate change while simultaneously improving access to food, livelihood opportunities, health, and environmental stabil (Duffy C, Toth GG, Hagan RPO, McKeown PC, Rahman SA, Widyaningsih Y, et al. 2021). Farmers in the Kurigram district have observed that Piper chaba is a highly lucrative and cost-effective crop, primarily because of its high market value and low production cost (*https://www.thedailystar.net/country/piper-chaba-vines-lucrative-kurigram-farmers-1443340*) Rasul and Thapa evaluated the financial and economic benefits of agroforestry in the Chittagong Hill Tracts, showed that economic returns from agroforestry were better than from shifting cultivation (jhum) (Rasul G, Thapa GB. 2006).

Adoption of sustainable agricultural technologies is very significant due to the global climate crisis. Due to soil erosion and wrong agricultural practices in the hills, on the one hand the living standards of the people living in the hills are decreasing and on the other hand we are losing the precious soil of the hills. Sustainable agriculture in the hills is possible through the practice of agroforestry. Chuijhal is recognized as an economically viable spice in southwestern and northern regions of Bangladesh. Chuijhal-based agroforestry has great potential in the hills.

Objectives:

1. To assess the growth and productivity of *Piper chaba* in agroforestry systems in Chattogram Hill Tracts
2. To analyze the economic viability and profitability of incorporating *Piper chaba* in agroforestry practices

Materials and Methods

The study is being conducted at the research field of the Soil Conservation and Watershed Management Centre in Bandarban to evaluate the performance and economic viability of Chaba germplasm (Piper chaba) in the agroforestry system of Chattogram Hill Tracts. The experimental site represents the agroecological zone (AEZ)-29, which is recognized as the Northern and Eastern Hill region. Germplasm of Chui jhal was collected from Khulna. Saplings were collected in June 2023 and transplanted near different tree species such as *Gmelina arborea, Mangifera indica, and Artocarpus heterophyllus* to provide support for the creeping growth habit of Chui jhal. Chui jhal is being cultivated as a vine crop on these supporting trees. Fertilizers and manures are being applied according to the recommendations in the fertilizer guide. Light irrigation is being provided just after transplantation to ensure optimum soil moisture for normal growth and development. The crop is being managed using the recommended package of intercultural practices.

To ensure the proper growth of all supporting trees, necessary management activities such as pruning, watering, cleaning, weeding, and fertilizing is being performed in a timely manner. The growth and yield performance of the supporting trees are being recorded. The Chui jhal saplings have been then planted beside the supporting plants in pits filled with manures and fertilizers. Pits were be prepared one week before plantation. Waterlogging Condition will be avoided for all of them.

Completely randomized design with thirty replications is being used for all crops in association with the supporting trees. Four treatments will be employed, including Mango as supporting plants (Treatment 1), Gamari as supporting plants (Treatment 2), Jackfruit as supporting plants (Treatment 3), and no supporting plants (Treatment 4).

Data collection is being carried out for the growth parameters and yield parameters of Chui jhal both inside and outside the agroforestry system. Observations on different morphological and yield attributing characters such plant height, number of tillers per plant, number of leaves per plant, leaf length, leaf breadth, branch number, length of internodes, stem girth, root length, spike emergence, number of spikes per plant, length of spike, number of seeds per spike, 1000 seeds weight, weight of seeds per plant, and seed yield will be recorded for Chui jhal. The average total yield value of a supporting tree will be estimated. Statistical analysis will be performed on all recorded data using the CRD design to determine the statistical significance of the experimental results. The means for all recorded data of the studied multistoried agroforestry system were calculated and analyzed statistically by using R Programming software package to find out the statistical significance of the experimental results for all growth and yield parameters were performed. The mean differences were evaluated by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) at 1% level of significance and also by Least Significance Difference (LSD) test.

Result & Discussion

Table 1: Comparative growth study of the chui jhal in different treatments.

Treatment	Plant Height(cm)	Leaves/Plant	Stem Diameter(mm)
No Bearing Plant	111.66 a	55.40 a	6.74 a
Gamari	134.20 a	27.13 b	4.58 b
Jack fruit	99.93 a	17.40 c	4.86 b
Mango	97.60 a	27.80 b	6.75 a
Mean	110.85	31.93	5.739
CV	48.26637	39.42	25.24288
F value	1.4683	25.2925	9.8204
P	0.2369	1.656e-09 ***	4.955e-05 ***
Level of significance		***	***
Significance codes: '***' 0.001, '**' 0.01, '*' 0.05. Means in column followed by the different letter are significantly different by DMRT at P< 0.001			

The growth parameters of Chuijhal, including leaves per plant and stem diameter, were markedly influenced by the presence or absence of bearing plants in the agroforestry system (Table 1). However, a one year period is insufficient for assessing yield-related properties of Chuijhal; a duration of 3-5 years is deemed necessary for comprehensive evaluation of its growth-related characteristics. Regarding plant height, no statistically significant variance was observed across different treatments. Notably, the tallest Chuijhal plants were observed in proximity to bearing Gamari trees, followed by those in the absence of bearing plants, Jackfruit, and Mango. Moreover, the greatest number of leaves per plant was obtained when Chuijhal was cultivated solely, with Mango, Gamari, and Jackfruit respectively following in leaf abundance. Stem and root diameter are particularly crucial growth parameters for Chuijhal, given the edibility of these plant parts. Further data on root diameter and other yield-related metrics will be collected at the time of harvesting. Following the initial six-month period, the highest stem diameter of Chuijhal was observed when Mango served as its companion plant, followed by scenarios where no bearing plant was present, Jackfruit, and Gamari, in that order.

Conclusion:

Chuijhal-based agroforestry in hill regions shows promise, with companion plants influencing growth parameters significantly. While initial findings are insightful, longer-term studies of 3-5 years are needed for a comprehensive evaluation. Plant height varied less across treatments, but proximity to Gamari trees favored taller Chuijhal growth. Highest leaf yield per plant occurred when Chuijhal was grown alone, followed by Mango, Gamari, and Jackfruit combinations. Stem and root diameter are crucial for edibility and require further investigation at harvest. Mango proved the most beneficial companion, showing the highest stem diameter early on. These results highlight the potential of Chuijhal-based agroforestry and the importance of selecting suitable companion plants for optimal growth and yield.

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EXPT. No. 02

PERFORMANCE ASSESSMENT OF KHASIA BETEL LEAF AS AN AGROFORESTRY PRACTICE IN CHATTOGRAM HILL TRACTS.

Abstract

Piper betle L. serves as a profitable cash crop primarily grown in countries such as India, Bangladesh, Sri Lanka, Thailand, Taiwan, Malaysia, and a handful of other nations in Southeast Asia. The Khasia people in the greater Sylhet district cultivate tree betel leaf, known as Khasia pan. Additionally, nearby Bengali residents also cultivate Khasia betel leaf around their homes . Over 80% of the Khasia population relies on livelihoods tied to the cultivation of tree-based betel-leaf. Cultivation of betel-leaf on trees stands as a significant agroforestry practice in Bangladesh, and it is ecologically and economically sustainable. In forested regions, this practice involves using forest trees as support for climbing betel vines, creating a cash-oriented production system. Although labor-intensive and localized, it holds significance for the Khasia community's agroforestry and biodiversity conservation efforts. In the realm of tradition, the plant is employed to heal various maladies like colds, bronchial asthma, cough, stomach pain, and rheumatism. It also serves as a remedy for conditions like boils, halitosis, constipation, conjunctivitis, gum inflammation, abscesses, and cuts, whether contagious or non-contagious in nature. The experience of economic development and forest conservation of Khasia community through cultivation of khasia betel leaf in the hilly areas of the north-eastern part of the country shows that it is possible to improve the quality of life of the tribals of Chittagong Hill Tracts and preserve the hilly soil and forest by cultivating khasia betel leaf. The experiment was being held at the research area of Soil Conservation and Watershed Management Centre in Bandarban. Four treatments employed including *Litchi chinensis, Mangifera indica, Artocarpus heterophyllus* and no supporting plants aimed at providing structural support for the creeping growth habit of Khasia betel leaf. This study represents the importance of integrating Khasia Pan with agroforestry system so that environment and the livelihood standard of the people of Chattogram hill tract improve. While planting Khasia betel plants solely yields the highest growth, certain bearing trees, such as Litchi can still contribute positively. However, further research with long-time observations spanning 3-5 years is crucial to ascertain the most suitable bearing plants for optimal Khasia betel leaf cultivation in hilly region.

Introduction

Piper betle L. is a widely familiar perennial creeping plant that belongs to the Piperaceae family. It has its origins in central and eastern Peninsular Malaysia but can also be found in East Africa and various tropical Asian countries (Madhumita M, Guha P, Nag 2019). It serves as a profitable cash crop primarily grown in countries such as India, Bangladesh, Sri Lanka, Thailand, Taiwan, Malaysia, and a handful of other nations in Southeast Asia (Bajpai V, Sharma D, Kumar B, Madhusudanan KP 2010 and Sudjaroen Y. 2012). The term "green gold of India" is attributed to the betel vine due to its role as a livelihood source for nearly 20 million individuals. These people rely on the plant for their earnings, which come from various stages like cultivating, transporting, managing, processing, and arranging betel leaves (Das S, Parida R, Sriram Sandeep I, Nayak S, Mohanty S 2016 and Jane NS, Deshmukh MAP, Joshi MMS 2014)

The betel vine, often asexually propagated, features multiple cultivars with male and female plants. Worldwide, there are about a hundred betel plant varieties, with 40 exclusives to India. Of these, 30 are identified in West Bengal and Bangladesh (Khan, A. A., Bhatnagar, S. P., Sinha, B. N., & Lal, U. R. 2013). P. betel is recognized by diverse names across the globe in various countries, yet 'Paan' is predominantly employed in India, Pakistan, Nepal, and Bangladesh. (Guha P, Nandi S. 2019). Betel quid consumption is a widespread tradition in multiple nations, valued for its natural revitalizing properties that help combat oral malodor. The International Agency for Research on Cancer conducted a survey, approximating a global user count ranging between 200 to 600 million individuals (Jeng JH, Chang MC, Hahn LJ. 2001 and Yoonus J, Resmi. R, Beena B. 2021).

In Bangladesh, approximately 30% of adults partake in betel quid chewing, while on a global scale, this practice is observed at around 10-20% (Gupta PC, Warnakulasuriya S. 2002 and Meerjady S Flora, Mascie-Taylor CG, Rahmanc M. 2012). In addition to its socio-cultural and ceremonial significance, betel quid possesses antacid, carminative, and calming properties. These attributes aid in digestion, eliminate oral malodor, enhance taste and appetite, and fortify dental health (Islam Q, Matin M. 2017). P. betle finds roles in traditional medicine systems including Ayurveda, Chinese medicine, and West Indies/Latin American remedies. Ayurveda employs it in formulations like Lokantha Rasa, Puspadhava Rasa, and others to treat diverse conditions. Betle leaf juice is a common Ayurvedic enhancer in herbal combinations (Taukoorah U, Lall N, Mahomoodally F. 2016).

In the realm of tradition, the plant is employed to heal various maladies like colds, bronchial asthma, cough, stomach pain, and rheumatism. It also serves as a remedy for conditions like boils, halitosis, constipation, conjunctivitis, gum inflammation, abscesses, and cuts, whether contagious or non-contagious in nature (Gundala SR, Yang C, Mukkavilli R, Paranjpe R, Brahmbhatt M, Pannu V, et al. 2014). The intense, sharp scent emitted by betel leaves originates from the presence of abundant terpenes and phenols within its essential oil (Bhagath B, Guha P. 2014; and Bhoite VS, Kamble DK, Patil YN.2019). Various phytochemicals found in betel plants include chavicol, chavibetol, hydroxychavicol, eugenol, estragole, methyl eugenol, hydroxycatechol, α-pinene, caryophyllene, β-pinene, 1,8-cineol, and similar compounds (Arambewela LSR, Kumarathunge KGA, Dias K. 2013). Numerous research studies have demonstrated the effectiveness of the bioactive components within essential oils as antioxidants for deterring cancer, inflammation, neurodegenerative ailments, and as agents with qualities like antimutagenic, antifertility,

antilipidemic, antiglycemic, and cardioprotective properties (Arawwawala L, Arambewela LSR, Ratnasooriya WD. 2014; and Chakraborty D, Shah B. 2011).The essential oil derived from betel leaves also possesses the ability to counter bacterial, protozoan, and fungal infections, as well as repel insect assaults (Biswas P, Anand U, Saha SC, Kant N, Mishra T, Masih H, et al. 2022).

Well-prepared betel quid remains a valued mouth freshener and mild energizer, commonly served during social, cultural, and religious occasions. This tradition of offering betel quid to guests signifies respect and cultural heritage, particularly in countries like Bangladesh, Burma, China, India, Indonesia, Malaysia, Nepal, Pakistan, Philippines, South Africa, Sri Lanka, and Thailand. These societies have a long history of chewing betel leaves with various natural ingredients, emphasizing its unique cultural significance. Research validates the protection of tree diversity facilitated by betel leaf cultivation practiced by the Khasia community in the Sylhet district (Mohiuddin M. AM. 1995).Betel cultivation is extensive in various regions of Bangladesh including Sylhet, Moulvibazar, Jessore, Khulna, Kustia, Bagerhat, Satkhira, Narail, Bhola, Barisal, Faridpur, Rajshahi, Rangpur, Gaibanda, Pabna, Cox's Bazar, and the broader Chittagong district (Fila P, Haider MR, Mohiuddin M, Zashimuddin M & Alam MK, Khasia 2006.

In Bangladesh, betel vines are divided into plain land betel-leaf (boroj pan) and tree-betel-leaf (gach pan) based on cultivation practices. The Khasia people in the greater Sylhet district cultivate tree betel leaf, known as Khasia pan. Additionally, nearby Bengali residents also cultivate Khasia betel leaf around their homes (Haider MR, Khair A, Rahman MM, Alam MK.) cultivation by the Khasia community in Bangladesh. 2013). Over 80% of the Khasia population relies on livelihoods tied to the cultivation of tree-based betel-leaf (Costa T, Dutta A. 2007). Cultivation of betel-leaf on trees stands as a significant agroforestry practice in Bangladesh, and it is ecologically and economically sustainable (Alam MK, Ahmed FU, Mohiuddin M. 1993). In forested regions, this practice involves using forest trees as support for climbing betel vines, creating a cash-oriented production system. Although labor-intensive and localized, it holds significance for the Khasia community's agroforestry and biodiversity conservation efforts (Bhattee SS, 1994,).

A study in North-eastern Bangladesh's forests revealed sustainable betel leaf production within agroforestry. Positive attributes like disease control, soil fertility, profitability, and cultural acceptance thrive under traditional management. Betel leaf sales sustain livelihoods, aided by villagers conserving forest resources through collaborative efforts (Nath TK, Inoue M. 2009).

The experience of economic development and forest conservation of Khasia community through cultivation of khasia betel leaf in the hilly areas of the north-eastern part of the country shows that it is possible to improve the quality of life of the tribals of Chittagong Hill Tracts and preserve the hilly soil and forest by cultivating khasia betel leaf.

Objectives:

1. To assess the growth and productivity of Khasia Betel Leaf plants in an agroforesty system

2. To evaluate the economic viability of Khasia Betel Leaf cultivation in Chattogram Hill Tracts

Materials and methods:

The experiment is being held at the research area of Soil Conservation and Watershed Management Centre in Bandarban. The geographical location of this area is N $22^0\,10^/\,30^{//}$ and E $92^0 11^/ 14^{//}$. The present study focuses on an experimental site representing agroecological zone (AEZ)-29, acknowledged as the Northern and Eastern Hill region. In June 2023, Germplasm of Khasia betel leaf (Piper betle) was collected from Moulvibajar and transplanted adjacent to diverse tree species such as *Litchi chinensis, Mangifera indica, and Artocarpus heterophyllus,* aimed at providing structural support for the creeping growth habit of Khasia betel leaf. The Khasia betel leaf is being cultivated as a vine crop utilizing these supporting trees. Fertilizers and manures are being applied as per the recommendations outlined in the fertilizer guide. After transplantation, light irrigation was administered to maintain optimal soil moisture for ensuring normal growth and development. The recommended package of intercultural practices is being implemented for managing the crop. The avoidance of waterlogging is crucial, as excessive moisture accumulation can have adverse impacts on the growth and overall health of the betel vines. To mitigate this potential issue, proper drainage measures are being implemented. The planting pits were designed and prepared in a manner that facilitates efficient water drainage, thereby minimizing the risk of waterlogging. The betel vine plantation was done in June. Prior to planting, meticulous weed and grass clearance was carried out in the base of the supporting trees. Subsequently, planting pits were carefully prepared, adhering to specific dimensions. These pits measure approximately 6 to 7 inches in depth, 1 foot in length, and 6 inches in width. During the planting process, the seedling was positioned in the pit in such a way that two nodes were buried beneath the soil surface, while one node remains exposed above the ground.

To fill the pit, loose mud was carefully added without any compacting. Two pits were created around a supporting tree. At least three years old cuttings were taken from healthy vines. After planting, the seedlings are being kept Weed-free to prevent shoot suppression. Debranching (2-3 weeks after planting) was done in supporting plants. Completely randomized design with thirty replications is being used for all crops in association with the supporting trees. The experiments involved four distinct treatments: Treatment 1 using mango as supporting plants, Treatment 2 utilizing litchi as supporting plants, Treatment 3 involving jackfruit as supporting plants, and Treatment 4 without any supporting plants. Appropriate and timely application of manures and fertilizers will be confirmed after testing the soil nutrients contents.

The amount of growth such as leaf size, length of plants, diameter of plant as well as compatibility with host plant will be measured over a period. Harvesting, sampling, and data collection are being conducted to assess the growth parameters and yield parameters of the betel leaf in the agroforestry system. For betel leaf, the edible portion of individual plants will be recorded both inside and outside the agroforestry system. Observations on different morphological and yield-related characteristics such as germination percentage, days to germination, plant height, number of tillers per plant, number of leaves per plant, leaf length, root length, spike emergence, number of spikes per plant, length of spike, number of seeds per spike, 1000 seeds weight, weight of seeds per plant, and seed yield will be documented for betel leaf. The average total yield value of a supporting tree will be estimated for various crop combinations in the multistoried agroforestry system.

Statistical analysis will be performed on all recorded data using the Completely randomized design to determine the statistical significance of the experimental results. The means for all recorded data of the studied multistoried agroforestry system were calculated and analyzed statistically by using R Programming software package to find out the statistical significance of the experimental results for all growth and yield parameters were performed. The mean differences were evaluated by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) at 1% level of significance and also by Least Significance Difference (LSD) test.

Results & Discussion

Table 2: Comparative growth study of the Betel Leaf in different treatments.

Treatment	Plant Height(cm)	Leaves/Plant	Stem Diameter(mm)
No Bearing Plant	247.40 a	54.00 a	5.72 a
Jack fruit	98.13 c	15.66 b	4.09 b
Litchi	185.06 b	28.13 b	4.42 b
Mango	132.60 bc	22.33 b	4.36 b
Mean	165.8	30.03333	4.6505
CV	46.04028	57.44945	17.85272
F value	10.9067	14.16	11.611
Pr	1.996e-05 ***	1.603e-06 ***	1.129e-05 ***
Level of significance	***	***	***
Significance codes: '***' 0.001, '**' 0.01, '*' 0.05. Means in column followed by the different letter are significantly different by DMRT at P< 0.001			

Different growth parameters of Khasia Pan (plant height, leaves/plant, stem diameter) were significantly influenced by the presence or absence of bearing trees in agroforestry system (Table 2). It was found that all the growth parameters are significantly higher in case of planting Khasia Pan solely. The most desired growth character in Khasia pan is the size and number of the leaves. Among the bearing plants Litchi showed more compatibility than the other two in terms of number of leaves per plant, height, and diameter of stem. This result is obtained from only six months observations. At least 3-5 years data might be necessary to get the most suitable bearing pants for the cultivation of Khasia Pan in hilly region.

Conclusion

This study represents the importance of integrating Khasia Pan with agroforestry system so that environment and the livelihood standard of the people of Chattogram hill tract improve. While planting Khasia betel plants solely yields the highest growth, certain bearing trees, such as Litchi can still contribute positively. However, further research with long-time observations spanning 3-5 years is crucial to ascertain the most suitable bearing plants for optimal Khasia betel leaf cultivation in hilly region.

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EXPT. No. 03

STUDYING PERFORMANCE OF WATER MELON IN RAINY SEASON AT HILL SLOPES USING SOIL CONSERVATION TECHNIQUE.

Abstract

A study on performance of Watermelon in rainy season at hill slope using Soil Conservation Technique has been taken by Soil Conservation and Watershed Management Centre, Bandarban. Its main objective is to find out the sustainability and challenges of cultivation of watermelon on sloping lands during rainy season. Three types of sloping land like gentle, moderate and steep sloping has been selected for this study. There were three plots on three sloping lands having an equal area. Soil conservation technique like pineapple hedge and Vetiver hedge were introduced following contour... Bamboo made colored pegs were inserted into the soil to estimate the soil erosion hazard. Local bamboos made platforms (Macha) were used for cultivation of watermelon during rainy season. Height yields and lowest soil loss were gained from the managed plot by pineapple hedge and gentle slope. Lowest yields and Height soil loss were gained from the control plot and steep slope. Hedge always plays a vital role on plant growth, crops productivity, no of fruit & weight as well as minimizing of soil erosion. soil conservation technique is must for any agricultural practice on the slopping land.

Introduction

Watermelon (*Citrullus lanatus*) belongs to the family Cucurbitaceae. It is one of the most widely cultivated crops in the world with global production reaching about 89.9 million ton per year. Its centre of origin has been traced to both Kalahari and Sahara desert in Africa and these areas have been regarded as point of diversification to other parts of the world. The crop has wide distribution as a garden crop while as a commercial vegetable production; its cultivation is confined to drier Savanna region of the Nigeria. It is horticultural crop that provide high return and has relatively low water requirement compared to other crops. It is traditional food plant in Africa with potential to improve nutrition, boost food security, foster rural development and support sustainable land cares. Smallholder farmer in different semi-arid zones of the world grow watermelon mostly under rainfed conditions and to lesser suplimental furrow irrigation. Now a day the demand of watermelon is increasingly growing up day by day. *Citrullus lanatus* is an important Cucurbitaceous Vegetable/Fruit in our neighboring country India. It is an excellent desert fruit and its juice contains 92% water along with proteins, minerals and carbohydrates. Now it is going to be extended day by day. In India, Watermelons are mainly cultivated in Maharashtra, Karnataka, Tamil Nadu, Panjab, Rajasthan, Madhya Pradesh and Uttar Pradesh.

 The growth and development of watermelon describes the sequential order of the different stages of growth attained by this crop. The growth phase of watermelon includes the emergence stage, vegetative stage, flowering stage, yield formation stage and the ripening stage. However,

crop growth and development depend largely on climatic factors such as precipitatin, relative humidity, solar radiation, evaporation etc. Each of these climatic factors affects the growth of crops, most especially in the tropics. For instance, the presence or absence of precipitation will have either positive or negative impact on the crop growth and productivity. Climate is also responsible for seasonal variation in the tropic.

A well-drained soil of loamy type is preferred for Watermelon. It is important that soil should be fertile and rich in organic matter. The most suitable P^H range is between 6.0 and 7.0. It is noted that soil should not be water logged in the rainy season. Watermelon is warm season crop and do not withstand even light frost and strong wind. Seed do not germinate below 11^0 C; optimum germination occurs at 18^0 C and germination increases with the rise of temperature till 30^0 C. Watermelon grows best at temperature 18^0 C - 24^0 C. It prefers tropical climate with high temperature during fruit development with day temperature of 35^0 C-40^0 C. But excess chillness occures hamper. Cool nights and warm days give better quality fruits in watermelon.
There are many varieties of watermelon like Seminis Apoorva Watermelon, Mayco Super Sakkar Watermelon, Suger Pack Watermelon, Aishwariya Watermelon, Anmol Yellow Watermelon, Arun Watermelon, Dragon King Watermelon, Black Magic Watermelon, NS 292 Watermelon, Jaguar F1 Watermelon etc. The crop duration ranges from 55 days to 120 days depending on the varieties.

  Chittagong Hill Tracts Comprising the three districts of Bandarban, Rangamati and Khagrachari has an area of 13,181 Sq. Km. endowed with natural beauty and high economic potentiality. The tribal along with the Bengali people are living there for long maintaining their district socio-cultural identities and harmony. The area is hilly with mild to very steep (15% to over 70%) often breaking or ending cliffs. More than 90% of the area is covered by hills with only 1'29'000 ha. of cropped land. About 87% of the land is covered with forest mostly owned by the Government (Dasgupta and Ahmed. 1998). According to Banglapedia (2009) about 20,000 hectares of land are being brought under jhum cultivation each year.

Jhum cultivation, sloppiness, heavy rainfall and improper management of soil enhanced nutrients depletion through erosion. Accelerated soil erosion is the greatest hazard for the long-term maintenance of soil fertility. Gafur *et al.* (2003) carried out a research to find out runoff and losses of soil and nutrients from a small watershed under shifting cultivation in CHT. Borggaard et al. (2003) carried out a study to analyze the sustainability the sustainability appraisal of shifting cultivation in CHT. Dewan (2008) conducted a survey work to analyze the socio-economic status of jhum cultivators. The Chittagong Hill Tract region is of great importance for various crops which are different from the plains. But unfortunately, few eco-friendly sustainable practices for CHT have so for been developed.

Land degradation is one of the major ecological issues of the world. Land degradation means loss in the capacity of given land to support growth of useful plants on a sustained basis (Singh, 1994). Erosion hazard caused by water in the rainy season is one of the mostly responsible for land degradation in Bangladesh. In the hilly region of Bangladesh received huge amount of rainfall in this time. This amount of excess rainfall drains out along with eroded soil materials through numerous channels, canals and rivers of the hilly regions without natural or artificial obstacle. Thus, following heavy downpour of the rainy season, the area suffers from severe draught and water scarcity in the dry season. Vegetation and land use play an important role controlling the intesity and frequency of overland flow and surface erosion (Mitchel, 1990; Gafur el at 2001b). Cultivation of watermelon in the rainy season using hedge of different species established across the slope could be introduced to mitigate the demand of food, to improve the socio-economic status of the hill dwellers and to minimize the land degradation.

In these circumstances, a very little scientific effort has been taken in hand to study the performance in cultivation of watermelon in the rainy season using soil conservation technique at the Research Area of Soil Conservation and Watershed Management Centre, SRDI, Bandarban. If the challenges along with other difficulties can be overcome, it would be a mile stone of eco-friendly sustainable agriculture of this hilly region.

Objectives:

a. To find out the suitability of water melon without irrigation (rainy season) at hill slopes.
b. To compare soil loss, runoff and nutrient mining under different hedge species & different slopes.
c. To find out a significant source of income.

Materials and Methods

The research was conducted at the Research Area of Soil Conservation and Watershed Management Centre (SCWMC), SRDI under Bandarban Sadar upazila, Bandarban. Three types of slopping land like Gentle, Moderate and Steep Slopes were selected for this research to have comparative data. There are 3 plots in every individual slopping land having an area of 100 m² (5m x 20 m) for each plot. Total area of each slopping land was 300 m². The experimental plots were selected in such a way that the area individually can be treated as a micro watershed. Prior to selection of the plots, the area was cleaned. Jungles were removed. Slope percentage of the land was measured by Abney's level. To conduct the study, 3 plots of 100 m² (5m x 20 m) in each slopping land were selected for applying different soil conservation technique. Among the three plots- one was controlled and remaining others two were pineapple hedge and vetiver hedge. Slope gradient of the selected three types of sloping lands were: 12%, 26% and 36% respectively. Each plot is separated by plot boundary in such a way that runoff from one plot cannot enter to another

plot. On 25th of April-2021, Pineapple and Vetiver hedge in single row were established following contour at 5.0 m horizontal interval in each plot. There are four lines of hedge row in each plot. A number of bamboo made pegs painted by different colors were inserted in to the soil plot to determine the soil loss.

On 5th May-2021, seeds of watermelon placed in soil filled poly packet for germination and to have seedlings. Digging up pits for transplantation of watermelon seedlings were started from 7th of May-2021. Prior to Digging up pits, composite topsoil samples were collected from each plot has been collected for physical, chemical and mineralogical analysis to compare the soil nutrients status. Pit size was 15″x15″ having 1′-0″ depth. During preparation of pits, at least one kg of dried cow dung along with 100 gr. TSP and 50 gr. MOP (Murat of Potash) were applied in each pit. Hill method or raised bed was practiced to avoid excess amount of water which causes root rot diseases. On 29th of May-2021, the seedlings of watermelon (having the seedlings age at 21 days) were transplanted from poly packs to pits. Two seedlings were planted in each pit/bed. In the rainy season, weeding is very necessary as this season promotes weed growth and the incidence of pest and diseases. When 25 to30 days has passed after plantation of the seedling, 2nd dose of fertilizer @50 gr. urea, 100 gr. TSP and 50 gr. MOP was applied in each pit.

Intercultural operation was done when necessary. Mulching practice around the plant was applied to prevent the rainwater from splashing soil onto the plants, reducing the chance of bacterial or fungal infection that might come from the soil. Bamboo made platform (Mancha) was placed for climbing up the plants and to protect melon bursting for excess water. During the fruiting time of the watermelon 3rd dose of fertilizer @ TSP 125 gr. and MOP 50 gr. in each pit was applied.

To estimate the soil loss on different slopping land under different treatment peg method was followed. In this practice, each plot was divided into three parts namely- Upper part, middle part and lower part. At the beginning of the monsoon, 9 nos. bamboo made pegs having marked by different color of paint were inserted in the soil for each part. Soil loss near each peg was measured by using leveling instrument and recorded. Average of nine pegs was calculated for each part. Insecticides, Pesticides and fungicides were applied depending upon the symptom of the plants at 3rd week, 5th week, 7th week, 9th week and 11th week after planting. When the fruits were in growing stage, those were supported to hang from the platform by using cotton made net bags.

Results and discussion

Maximum soil loss 20.734 ton/ha. y^{-1} ,17.920 ton /ha y^{-1} & 22.680 ton /ha y^{-1} were recorded at controlled plot on steep slope in the years of 2021-22, 2022-23, & 2023-24 whereas minimum soil loss was 8.834 ton/ha.y^{-1} , 7.322 ton /ha y^{-1} & 9.464 ton /ha y^{-1} at pineapple hedge plot on gentle slope in the years of 2021-22, 2022-23 & 2023-24. On field yield data was recorded. Only the ripen watermelon those were collected from field was included in yield data. Maximum number of fruits with maximum weight was recorded on pineapple hedge plot on gentle slope. On the other hand, minimum number of fruits with average minimum weight was recorded at controlled plot on steep slope. Maximum yield was.12.844, 14.040 & 15.252 ton/hac.y^{-1} at

pineapple hedge plot on gentle slope and minimum yield was 8.505, 7.680 & 6.441 ton/hac.y^{-1} at controlled plot on steep slope or the years of 2021-22, 2022-23 & 2023-24

Table-03: Soil Loss under the cultivation of Watermelon in different treatments & different slope for the year 2021-22.

Year.	Slope Class	Treatments	Average soil loss in each row (mm)			Average Soil Loss of all row (mm.)	Total soil loss (ton/ hac)
			Upper Row	Middle Row	Lower Row		
2021-22	Gentle	Pineapple	0.585	0.623	0.685	0.631	8.834
		Vetiber	0.600	0.684	0.720	0.668	9.352
		Controlled	0.690	0.75	0.810	0.750	10.500
	Moderate	Pineapple	0.695	0.790	0.840	0.775	10.850
		Vetiber	0.780	0.864	0.914	0.853	11.942
		Controlled	1.000	1.100	1.20	1.100	15.400
	Steep	Pineapple	1.140	1.200	1.260	1.200	16.800
		Vetiber	1.190	1.243	1.32	1.251	17.514
		Controlled	1.410	1.470	1.563	1.481	20.734

Table-04: Soil Loss under the cultivation of Watermelon in different treatments & different slope for the year 2022-23.

Year.	Slope Class	Treatments	Average soil loss in each row (mm)			Average Soil Loss of all row (mm.)	Total soil loss (ton/ hac)
			Upper Row	Middle Row	Lower Row		
2022-23	Gentle	Pineapple	0.443	0.516	0.610	0.523	7.322
		Vetiber	0.510	0.605	0.715	0.610	8.543
		Controlled	0.649	0.694	0.760	0.701	9.820
	Moderate	Pineapple	0.695	0.790	0.840	0.775	9.459
		Vetiber	0.780	0.864	0.914	0.853	10.386
		Controlled	0.924	1.013	1.108	1.015	14.210
	Steep	Pineapple	0.942	1.086	1.200	1.076	15.064
		Vetiber	1.06	1.125	1.220	1.135	15.890
		Controlled	1.160	1.270	1.410	1.280	17.920

Table-05: Soil Loss under the cultivation of Watermelon in different treatments & different slope for the year 2023-24.

Year.	Slope Class	Treatments	Average soil loss in each row (mm)			Average Soil Loss of all row (mm.)	Total soil loss (ton/hac)
			Upper Row	Middle Row	Lower Row		
2023-24	Gentle	Pineapple	0.582	0.657	0.788	0.676	9.464
		Vetiber	0.624	0.738	0.810	0.724	10.138
		Controlled	0.775	0.914	1.023	0.904	12.656
	Moderate	Pineapple	0.700	0.850	0.916	0.822	11.508
		Vetiber	0.850	0.900	0.980	0.910	12.740
		Controlled	0.950	1.250	1.300	1.167	16.338
	Steep	Pineapple	1.100	1.250	1.280	1.210	16.940
		Vetiber Hedge	1.250	1.285	1.395	1.310	18.325
		Controlled	1.350	1.600	1.910	1.620	22.680

Table-06: Yield of the Watermelon in different treatments in financial year 2021-22

Sl. No.	Slope Class	Treatments	Number of fruits (Nos.)	Av. weight per fruit (Kg)	Yield per plot (Kg.)	Yield per hectare (Ton)
1	Gentle	Pineapple hedge	76	1.69	128.44	12.844
		Vetiver Hedge	75	1.65	123.75	12.375
		Controlled	73	1.61	117.53	11.753
2	Moderate	Pineapple	74	1.64	121.36	12.136
		Vetiver	72	1.62	116.64	11.664
		Controlled	70	1.56	109.20	10.920
3	Steep	Pineapple	74	1.50	111.00	11.100
		Vetiver	73	1.45	105.85	10.585
		Controlled	63	1.35	85.05	8.505

Table-07: Yield of the Watermelon in different treatments in financial year 2022-23

Sl. No.	Slope Class	Treatments	Number of fruits (Nos.)	Av. weight per fruit (Kg)	Yield per plot (Kg.)	Yield per hectare (Ton)
1	Gentle	Pineapple	78	1.80	140.40	14.040
		Vetiver	76	1.73	131.48	13.148
		Controlled	69	1.54	106.26	10.626
2	Moderate	Pineapple	78	1.62	126.36	12.636
		Vetiver	75	1.61	120.75	12.075
		Controlled	71	1.45	102.65	10.265
3	Steep	Pineapple	72	1.48	106.56	10.656
		Vetiver	69	1.47	101.43	10.143
		Controlled	60	1.28	76.80	7.680

Table-08: Yield of the Watermelon in different treatments in financial year 2023-24

Sl. No.	Slope Class	Treatments	Number of fruits (Nos.)	Av. weight per fruit (Kg)	Yield per plot (Kg.)	Yield per hectare (Ton)
1	Gentle	Pineapple	82	1.86	152.52	15.252
		Vetiver	80	1.85	148.00	14.000
		Controlled	68	1.49	101.32	10.132
2	Moderate	Pineapple	79	1.75	138.25	13.825
		Vetiver	76	1.64	124.64	12.464
		Controlled	72	1.30	93.60	9.360
3	Steep	Pineapple	69	1.46	100.74	10.074
		Vetiver	66	1.45	95.70	9.570
		Controlled	57	1.13	64.41	6.441

Conclusion

Hedge always plays a vital role on plant growth, crops productivity, no of fruit & weight as well as minimizing of soil erosion. Height yields and lowest soil loss were gained from the managed plot by pineapple hedge and gentle slope. Lowest yields and Height soil loss were gained from the control plot and steep slope. soil conservation technique is must for any agricultural practice on the slopping land. Fungal, bacterial and virus diseases are more during rainy season which affects badly on growing watermelon and its yields and quality. Attract of white flies hampers the production of watermelon during rainy season.

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EXPT. No. 04

STUDYING BROOM GRASS FOR CONTOLLING SOIL EROSION AND ITS ECONMIC VALUE AT CHT.

Abstract

Soil erosion is a major concern all over the world. Grasses are generally used to reduce soil erosion. Grasses develop rapidly and produces humus too. They can recover from damage and completer burial. Grasses are the key component in many ecosystems of the world. Broom grass *(Thysanolaena Maxima)* is a multipurpose perennial cash crop suitable for minimizing erosion hazard. It has also medicinal value as well as fuel, fodder and others domestic use. The main objectives of the research are to find out a significant source of income, to prevent frequent

landslides, retain ground moisture and to increase soil fertility, to provide green forage for livestock and to rehabilitate the endangered animals and to keep ecological balance. There are two treatments. In one treatment, the saplings were planted maintaining plant to plant distance 0.50 m. and row to row distance 1.00 m. In another treatment, the saplings were planted maintaining plant to plant distance 0.50 m. and row to row distance 2.00 m. there was 1.00 m distance in between two double rows for both plots. Selling broom grass can be financially beneficial. Row to Row distance of 2 meters is more effective in horizontal contours on hill slopes in broom grass cultivation. Broom Grass may open the door of enrichment for the poor hill dwellers' and be an important method for rehabilitation of degraded land.

Introduction

Soil erosion is accelerated due to high rainfall intensities (Keesstra et al., 2016), steep slopes (Beskow et al., 2009) and the fragile nature of topsoil (Lal, 1998; Rodrigo Comino et al., 2016; Ochoa et al., 2016). Soil erosion is a naturally occurring process on all land. Soil erosion is a major concern all over the world. It may be a slow process that continues relatively unnoticed, or it may occur at an alarming rate causing serious loss of topsoil (HIMCAT News Letter #2, Spring-2008). Soil loss by water erosion on slopping lands adversely affects the physical, chemical and biological properties of soils, leading to low crop productivity (Larson *et al.* 1985 and Sur *et al.* 1994). Worldwide loss of water and sediment due to soil erosion is a major environmental threat (Prosdocimi et al., 2016; Pimentel, 1993). Water erosion is the main cause of land degradation, affecting an area of about 2 billion ha throughout the world, with the largest part in tropics, and affecting the two most important natural resources, namely soil and water (Mandal and Sharda,2011a; DeOliveriaetal.,2010; Keesstraetal.,2014; Novara et al., 2011, 2016; Seutloali and Beckedahl, 2015). Water plays a vital role in the ecosystem. The precipitation over the country is not only unevenly distributed, but also uneven with regard to seasonal distribution as well as within season. Steep slope and terrain in hilly areas quickly releases the flow towards the outlet and thus creates scarcity of water. Geomorphology and the way land surface are managed, strongly influences the movement of water over and below the ground (Ashok Kumar and Bhanupriya Sharma-2017). In our Bangladesh have high annual rainfall confined to only 4 to 5 months (June–october). During the 7–8-month dry period, scarcity of water causes a severe shortage of fodder in farmlands, which leads to an increase in grazing vpressure on forest and community lands. Vegetation resources are required for different local needs including grazing, fuel-wood, timber and non-timber forest products. These resource needs are closely linked with each other and several hot spots have been identified by Lempelius (2007). Soil conservation is an important requirement in sustainable farming. Basics of soil erosion control are to reduce detachment and transportation capacity of the eroding agents (water and wind) through different agronomic, vegetative measures generally known as conservative measures (Amatya and Shrestha, 2002). Good crop husbandry is an effective soil conserving practice (Joshi, 1992). Grasses are generally used to reduce soil erosion. Grasses develop rapidly and produces humus too. They can recover from damage and completer burial. In India most of the studies on the role of grasses as vegetative/ filter strips have been done in isolation with fewer slope categories and with limited objectives restricted to soil erosion (Njoroge and Rao, 1994). Strategies to reverse land degradation are critical since soil is a non-renewablere source (Mandal and Sharda, 2011b; Mandal et al., 2010). Soil erosion rates more than tolerance values are considered unacceptable (Mandal and Sharda, 2013), which leads to irreversible land degradation and need to be reduced through appropriate soil conservation measures (SCMs) (Biswas et al., 2015). Generally, soil conservation planning

requires knowledge of soil loss tolerance values, which show the higher limit of soil erosion rate that can be allowed without long-term land degradation (Jha et al., 2009). Perennial grasses provide ground cover throughout the year and help in reducing runoff and soil loss when used as barriers along the contour, particularly in hill slopes (Dhruvanarayana and Rambabu, 1983). Grasses are the key component in many ecosystems of the world (ParrasAlcántara et al., 2015; Hu et al., 2016; Mekonnen et al., 2016). Soils typically account for 70–90% of the total carbon sequestered in a grassland ecosystem (Batjes, 2001). It is known from different studies conducted in India that the inclusion of grasses in the agricultural landscape often improves the productivity of system while providing opportunities to create carbon (C) sinks (Ghosh et al., 2009; Cogle et al., 2011; Huang et al., 2010; Mutegi et al., 2008).

The croplands in sloppy areas suffer from excessive soil erosion and erosion-induced nutrient depletion. Soil erosion in these areas ranges between 20 and 40Mgha−1 yr−1 as compared to the national average of 16.35Mgha−1 yr−1 (Dhruvanarayana and Rambabu, 1983). Such high rates of soil erosion result in considerable depletion of nutrients from the topsoil, which in turn causes poor productivity of crops. Research evidence from the land subjected to shifting cultivation reported that about 600Mt of soil is eroded annually, which led to losses of 258000, 73000 and 179000t of N, P2O5 and K2O, respectively (Kumar, 2011).

Thysanolaena maxima is a genus of plants in the grass family, the only genus in the tribe. It is locally known as Broom grass, Jharuful, Fuljharu, Foruin etc. It's other names are Tiger Grass, Nepalese Broom Grass, Broom stick, Nepali amliso or kuchcho, jhadu (phooljhadu) in Hindi. Broom grows well in hot and temperate climate of South Eastern Asia. It grows up-to 3 meters in height, has sharp leaves in long branches. Broom grass received its name because people construct sweeping brooms out of the large flower heads. It is a multi-purpose plant. Besides creating hillside stabilization and serving as household brooms, its leaves provide fodder for livestock during the dry season, and people can burn the stalks as fuel or use the broom grass as mulch to protect the soil.

Nepalese broom grass (Thysanolaena Maxima) is a multipurpose perennial cash crop that belongs to the family Poecea (Bisht and Ahlawat, 1998). It is found growing along steep hills, sandy banks of rivers and damp steep banks along ravines (Bisht and Ahlawat, 1998). It is widely distributed throughout Nepal but only up to an altitude of 2000 metres (Bisht and Ahlawat, 1998). The grass can be grown on severely degraded and marginal lands (SatNet Asia, 2014). Broom grass tends to grow in tussocks, with 4-5 tussocks in a 100 metre radius and is harvested during the winter seasons between January and March (Bisht and Ahlawat, 1998). Broom grass is a significant source of income for subsistence communities, primarily for the women who collect it to manufacture and sell them as brooms across Nepal (Llewellyn, 2015). In addition to providing cash income when sold as brooms the plant provides a variety of uses to the farmers such as, the leaves provide green forage for livestock, the roots promote soil conservation, and the dried up stems can be used as stakes to support growing vegetables (Llewellyn, 2015). Broom grass has had a direct impact in preventing frequent landslides, helping retain ground moisture and fertility, and improving soil quality by reducing soil erosion (Llewellyn, 2015). Broom Grass can moderately support the soil mass by its strong and long fibrous roots. Broom Grass can bind average 3.8 cu. m. soil, and that for napier, stylo, and molasses are 0.37 cu. m., 0.45 cu. m. and 0.04 cu. m. soil respectively. Broom grass has the ability to crowd out invasive species when intercropped and is beneficial in retaining

soil nutrients to regrow vegetation (Llewellyn, 2015). The grass also possesses numerous medicinal properties that are essential in subsistence communities (SatNet Asia, 2014). Gautam, 2015 wrote that it is very helpful to grow others vegetation rapidly on shushed and burnt cultivated land and thus save the endangered animals like barking dears and monkeys.The start of Nepalese farmers growing broom grass has increased the local biodiversity in the communities (SatNet Asia, 2014). Broom grass does not compete for land with cereal crops so they can be grown simultaneously (SatNet Asia, 2014). The farming of broom grass has had a sincere impact on the women in the communities (Gautam, 2015). It has helped women become more empowered by raising their financial status and lessening the burden of other tasks (Gautam, 2015). Brooms are required in most households across the world so there is a large market for the product. Producing good quality brooms at low prices gives the product a comparative advantage and makes it very marketable. In Nepal, brooms sold on the local market sell for an average of $0.48, while in Canada it can range from $10-20$ (SatNet Asia, 2014). It has been noted that broom grass has been tried by paper and pulp industries to make paper, which means once that method of manufacturing becomes more popular Nepalese farmers can mass produce broom grass to be sold to these companies (Bisht and Ahlawat, 1998). The brooms can be transported quite easily as cargo because it is a finished product.

The improved varieties of grasses have a number of features that make it desirable. The densely tufted perennial clumps of grass seem not to spread or become a pest and terraces rise as the soil accumulates behind the hedges, converting erodible slopes into stabilized terraces where farming can be carried out safely without threats of erosion. Planting of improved varieties of grasses on the risers will not only bind the soil but also provide a rich source of fodder for the livestock (Pandit, 2002). The functions of the root system are Engineering (anchorage, armour, catch, reinforcement and drain) and physiological (storage, conduction, and absorption). The fibrous root system of the grasses consists of several main roots that branch to form a dense mass of intermeshed lateral roots. Anchorage is not the main function of shallow rooted species like grass. Armour is the main function and catch, reinforcement and drain (if planted accordingly) are other engineering functions of grasses (Rost et al., 1979). Plants themselves show considerable variation of rooting depth within the soil profile (Etherington, 1976). The maximum effective depth of rooting of plants, and therefore the depth to which they can reinforce or anchor the soil, is also a subject for debate in the world-wide bio-engineering literature. In exceptional cases, it is clear that certain plants can have extremely long roots. Grass clumps can sometimes send roots to four or five metres below the surface and trees can send roots even deeper (Howell, 1999). The majority of roots, especially the small absorbing roots, are located in the upper soil horizons where favourable aeration, nutrients, and moisture conditions occur (Spur and Barnes, 1980).

Nepalese broom grass *(Thysanolaena Maxima)* is a multipurpose perennial cash crop suitable for minimizing erosion hazard. It has also medicinal value as well as fuel, fodder and others domestic use. But sufficient Research is not conducted yet on this plant (Grass) in our country. Considering all, Soil Conservation and Watershed Management Centre (SCWMC), Bandarban has taken a small scientific effort in its Research Area under BandarbanSadarUpazila in fiscal year 2017-2018 to conduct a study on broom grass" Effectiveness on controlling soil erosion and economic value at CHT).

This proposed research program was designed to study the quantity of soil loss, surface run-off, nutrient status and also the yield of broom in different replication. Broom Grass may open the door

of enrichment for the poor hill dwellers' and be an important method for rehabilitation of land degraded by shifting cultivation or slush and burn agriculture.

Objectives

a. To find out a significant source of income.
b. To prevent frequent landslides, retain ground moisture and to increase soil fertility.
c. To provide green forage for livestock.
d. To rehabilitate the endangered animals and to keep ecological balance.

Materials and Methods

The research was conducted near multi-fruits garden situated by the side of multi-purpose dam at the Research Area of Soil Conservation and Watershed Management Centre (SCWMC), SRDI under Bandarban Sadar upazila, Bandarban. The experimental plots were selected in such a way that the area individually can be treated as a micro watershed. Prior to selection of the plots, the area was cleaned. Jungles were removed. Slope percentage of the land was measured by Abney's level. To conduct the study, two plots of 100 m² (5m x 20 m) each were selected on a degraded land of steep slope having 48 % slope. Brick masonry plot boundary was constructed for each plot. Contour lines were marked maintaining 1.00 m. vertical interval from a distance of 0.50 m. from the upper plot boundary. A set of multi-slot devisor was set up in connection of each plot to determine the soil loss and runoff calculation.

Prior to plantation of broom's saplings (stump), composite topsoil samples were collected from each plot has been collected for physical, chemical and mineralogical analysis to compare the soil characteristics. There are two treatments. In one treatment, the saplings were planted maintaining plant to plant distance 0.50 m. and row to row distance 1.00 m. In another plot, the saplings were planted maintaining plant to plant distance 0.50 m. and row to row distance 2.00 m. there was 1.00 m distance in between two double rows for both plots. Saplings were planted just following minimum tillage system during June-2018. Extra fertilizer or manure has not been added to the pits before or during plantation of saplings. Jungles were cleaned around the year when it was necessary.

Results and Discussion

Prior to plantation of broom's saplings (stump), composite topsoil samples were collected from each plot has been collected for physical, chemical and mineralogical analysis to compare the soil characteristics. After cultivation of broom, composite top soil samples are being taken for analysis and the result were shown in table-09. Soil loss and run-off data were collected after each and every shower. Soil loss and run-off data were collected after each and every shower. Total soil loss and runoff from 100.0 m² plot were presented in table-11 & 12 and Height Total soil loss and runoff was recorded in row-to-row 2m distance plot. Average plant height and number of plants per clump was recorded after winter in each year. Broom planted in 2.0 m. distance (row to row) grows better than that of 1.0 m. row to row distance (as shown in Table-14). Yield defers from row-to-row distance (shown in Table-15). Economical return from broom grown in 2m row to row distance plot were Tk. 1,35,500/-, Tk. 2,01,000/- Tk. 2,11,500/-, Tk 2,28,000/-, Tk 2,44,500/- & Tk 2,61,000/-. per hectare per year during FY 2018-19, 2019-20, 2020-21, 2021-22, 2022-23 & 2023-24 and average return was Tk. **2,13,583/33** for six years. while those were Tk. 90,000/-, Tk.

1,83,000/- & Tk. 1,92,000/-, Tk 2,07,000/-, Tk 2,10,00/- & Tk. 2,29,500/- during FY. 2018-19, 2019-20, 2020-21, 2021-22, 2022-23, & 2023-24 and average return was **1,85,250/-** for six years when it was planted 1.0 m. row to row distance. Economical return of leaves used as fodder and residual sticks used for house activities or handicraft use and others benefits like biodiversity has not been calculated.

Table-09: Initial fertility status and fertility status after broom cultivation

Para meter	Year	pH	OM (%)	N (%)	P	K	S	Zn	B	Ca	Mg	Cu	Fe	Mn
					meq/100g soil		µg/g soil			meq/100g soil		µg/g soil		
Broom 1 Meter	2017	4.6	4.24 H	0.212 M	2.65 VL	0.42 H	2.82 VL	1.87 H	0.29 L	5.54 O	1.98 VH	0.74 H	69.16 VH	14.27 VH
	2018	4.1	4.2 H	0.210 M	1.12 VL	0.53 VH	19.11 M	0.45 VL	0.58 O	6.16 M	2.57 VH	0.31 M	40.51 VH	15.53 VH
Broom 2 Meter	2017	5.7	4.64 H	0.232 M	0.34 M	0.54 VH	0.002 VL	2.22 H	0.34 M	7.28 H	2.35 VH	0.77 VH	81.17 VH	16.08 VH
	2018	4.1	3.8 H	0.190 M	1.05 VL	0.50 VH	17.44 M	0.28 VL	0.46 O	7.04 H	2.22 VH	0.27 L	38.68 VH	10.21 VH

Note: VL=very low; L=low; M= medium; O=optimum; VH=very

Table-10: Soil Texture

Particulars	Soil Textural Class	Sand	Slit	Clay
		%		
Broom 1 Meter	Silt Loam	23	59	18
Broom 2 Meter	Silt Loam	20	59	21

Table-11: Soil loss under the cultivation of broom grass hill different treatments-2018-24 (t/h/y).

Particulars	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total S0il loss (T/ha)	Average Soil loss (T/ha)
Broom-1 Meter	2018-19	_	_	_	_	_	3.24	3.97	2.90	1.98	2.34	_	_	14.43	**10.13**
	2019-20	_	_	_	_	_	1.60	5.84	1.41	1.83	0.65	_	_	11.33	
	2020-21	-	-	-	-	0.96	1.05	1.18	2.36	1.74	1.88			9.17	
	2021-22	-	-	-	-	0.25	2.32	1.28	2.89	1.36	0.95	-	-	9.05	
	2022-23	-	-	-	-	0.20	2.96	1.86	0.85	1.58	0.89	-	-	8.34	
	2023-24	-	-	-	-	0.11	1.68	1.83	2.52	1.75	0.56	-	-	8.45	
Broom-2Meter	2018-19	_	_	_	_	_	4.16	4.78	3.56	2.47	3.68	_	_	18.65	**12.43**
	2019-20	_	_	_	_	_	1.96	7.63	1.92	2.21	0.92	_	_	14.64	
	2020-21					0.94	1.31	1.63	3.33	1.69	2.76			11.66	
	2021-22	-	-	-	-	0.32	2.86	1.54	3.45	1.61	1.20	-	-	10.98	
	2022-23	-	-	-	-	0.39	3.46	1.39	1.28	1.32	1.26	-	-	9.10	
	2023-24	-	-	-	-	0.17	1.76	1.88	3.25	1.62	0.84			9.52	
Rainfall	2018-19	3	0	0	67	207	607	691	256	249	266	-	14	2360.00	**- -**
	2019-20	0	57	9	72	234	244	1024	398	411	141	43	9	2642.00	
	2020-21	40.0	-	-	133.0	217.0	297.0	380.0	410.0	361.0	405.0	23.0		2266.00	
	2021-22	-	-	-	-	108.0	545.0	531.0	585.0	376.0	203.0	-	-	2348.00	
	2022-23	7	-	-	-	207	364	264	145	352	216	-	18	1573	
	2023-24	-	-	-	9	112	222	414	1473	412	129	21	19	2811	

Table-12: Run off (%) under the cultivation of broom grass hill different treatments-2018-23 (t/h/y).

Particulars	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Broom 1 Meter	2018-19	-	-	-	-	-	28.87	42.38	38.46	40.12	39.56	-	-
	2019-20	-	-	-	-	-	27.56	46.67	37.72	44.93	30.72	-	-
	2020-21	-	-	-	-	22.50	24.82	25.70	35.42	31.20	33.20	-	-
	2021-22	-	-	-	-	10.60	26.45	25.96	34.70	30.24	28.40	-	-
	2022-23	-	-	-	-	9.60	20.25	21.29	20.6	23.60	20.80	-	-
	2023-24	-	-	-	-	5.45	11.39	26.54	39.62	27.16	15.14	-	-
Broom 2 Meter	2018-19	-	-	-	-	-	31.7	45.37	43.56	41.36	44.25	-	-
	2019-20	-	-	-	-	-	32.15	51.37	41.31	48.95	34.37	-	-
	2020-21	-	-	-	-	25.60	26.35	28.92	41.82	33.69	39.38	-	-
	2021-22					12.50	28.56	29.30	36.20	34.15	35.42	-	-
	2022-23	-	-	-	-	11.20	24.75	23.40	23.50	25.22	22.10	-	-
	2023-24	-	-	-	-	6.73	15.46	29.56	45.81	29.94	18.78	-	-

Table 13. Nutrient loss (tha^{-1}) from plots under different treatments.

Particulars	N	P	K	S	Zn	B	Ca	Mg	Cu	Mn
Broom 1 Meter	4.3	0.00206	0.32844	0.00618	0.00082	0.00016	1.76	0.6048	0.0004	0.0173
Broom 2 Meter	4.3	0.00212	0.37536	0.1576	0.00164	0.00054	1.952	0.588	0.00086	0.0179

Table: 14. Comparative growth study of the Broom grass in different treatments.

Treatment	No. of Sticks /Sheaf	Av. height of sticks (cm)	Av. Nos. of flower /Sheaf
Treatment 1. (Row to row distance 1 m)	18.00 b	146.88	11.15 b
Treatment 2. (Row to row distance 2 m)	33.33 a	148.38	22.95 a
CV (%)	12.73	12.05	12.99
CD (0.05)	11.48	NS	7.79

In a column means having dissimilar letter(s) differ significantly as per 0.05 level of probability.

NS- Non –significant, CV- Coefficient of Variation, CD – Critical Difference

Statistical Analysis:

The collected data were statistically analyzed following the analysis of variance (ANOVA) using WASP 1.0 (Web based Agri Stat Package 1.0) program and means were separated by critical difference (CD) values at 5% level of significance.

Table-15: Yield and Return (BDT) of the broom grass in different treatments.

Year	Treatment-1 (1. 0 m. distance)			Treatment-2 (2.0 m. distance)			Total return in BDT. per ha/yr		Average Total return in BDT. per ha/yr	
	Nos. of sticks	Nos. of broom	Sale value	Nos. of sticks	Nos. of broom	Sale value	Treatment-1	Treatment-2	Treatment-1	Treatment-2
2018-19	960	60	900/-	1440	90	1350/-	90.000/-	1,35,500/-	**1,85,250/-**	**2,13,583/33-**
2019-20	1892	122	1,830/-	2085	134	2010/-	1,83,000/-	2,01,000/-		
2020-21	1994	128	1,920/-	2198	141	2,115/	1,92,000/-	2,11,500/-		
2021-22	2064	138	2070/-	2278	152	2,280/-	2,07,000/-	2,28,000/-		
2022-23	2080	140	2100/-	2450	163	2,445/-	2,10,000/-	2,44,500		
2023-24	2298	153	2295/-	2616	174	2,610/-	2,29,500/-	2,61,000/-		

Conclusions

Broom Grass are particularly useful in preventing soil erosion and landslides in hilly areas. Broom Grass play an effective role in bringing eroded hill slopes and fallow land under cultivation. Broom Grass leaves are used as fodder for cattle, house fences and residual stems are used as fuel. Selling broom grass can be financially beneficial. Row to Row distance of 2 meters is more effective in horizontal contours on hill slopes in broom grass cultivation.

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EXPT. No. 05

EFFECT OF INDIGENOUS & ZERO TILLAGE CULTIVATION METHODS OF PINEAPPLE ON SOIL EROSION, RUN OFF, NUTRIENT MINING IN HILLY AREAS.

Abstract

The study was conducted at the Soil Conservation and Watershed Management Centre (SCWMC), Soil Resource Development Institute (SRDI), Bandarban. The present research work was undertaken to introduce an eco-friendly productive crop production system that is zero tillage cultivation system in sloping lands of CHT which will mitigate the process of land degradation due to digging up cultivation as well as take care of food security of Hill people. The main objectives of the research are to estimate & compare soil loss, runoff and nutrient mining under indigenous and zero tillage cultivation systems of pineapple, to calculate effect of soil loss on soil chemical properties and to create awareness about soil conservation & watershed management among hill dwellers. There are four treatments such as (1) Digging up across the slope (2) Digging up along the slope (3) Zero tillage across the slope and (4) Zero tillage across the slope. Measurement of soil loss and run-off was carried out by established and locally fabricated multi-slot divisors. Nutrient loss was calculated in every experimental plot from eroded soil. Tillage is not recommended on hill slopes. Soil erosion increases by tillage cultivation in hilly areas. Zero tillage farming maintains soil fertility by controlling soil erosion. Pineapple cultivation of zero tillage system on hillsides, soil erosion is much less and yields are high than other practices. use of indigenous methods of pineapple cultivation has created negative effect on soil.

Introduction

The Chittagong Hill Tracts comprising the three districts of Bandarban, Rangamati and Khagrachhari has an area of 13181sq km endowed with natural beauty and high economic potentiality. The tribal along with the Bengali people are living there for long maintaining their distinct socio-cultural identities and harmony. The area is hilly with mild to very steep slopes (from 15% to over 70%) often breaking or ending in cliffs. More than 90 percent of the area is covered by hills with only 129,000 hectares (ha) of cropped land. About 87 per cent of the land is covered with forest (totaling 11,475 sq.km) mostly owned by the government (Das gupta and Ahmed, 1998). Presently, it is increasingly becoming denuded due to unplanned management of hills and agricultural practices at steep slope without any conservation measure. There are hills with altitudes of more than 3000 feet (Brammer, 1986) having steep and long slope. The total annual precipitation is also high (2000-3550mm). Continuous depletion of soil fertility is the major constraint to sustainable crop production in the hilly areas of Bangladesh.

Land use change associates erosion is mostly responsible for land degradation and desertification in different part of Asia and Africa, bringing about large reduction in vegetation growth, siltation of water courses, filling of valleys and reservoirs and the formation of deltas along the coastal areas. Erosion is accompanied by deposition of alluvial materials by flooding and filling of valleys, waterways or extending coastal plains and deltas towards the sea.

The impact of soil erosion on the productive potential of agricultural lands is well known (Pathak*et al*., 2004), but the magnitude depends on local circumstances. In the study areas, the organic matter

depletion was also observed irrespective of land use. The loss of the essential plant nutrients (N, K, S, Zn, B, Ca, Mg and Mn) in association with the suspended sediments and runoff during the measurement period was remarkable. The selective erosion of plant nutrients in runoff is a well known phenomena (Sharpley, 1985), and the sediment lost from the experimental plots on the micro-watershed was clearly enriched in all elements except P, relative to the topsoil of the watershed. The highest loss was displayed by Mn, Zn and S possibly resulting from reductive dissolution of oxides caused by sudden saturation of the soils in the earlier heavy rainfalls of the season. The results are in partial conformity with Gafur*et al*. (2003). This suggests that soil conservation control efforts should be prioritized in areas with high soil and nutrient loss potential so that their productivity is maintained.

Keeping the above views in mind the present research work was undertaken to introduce a eco-friendly productive crop production system that is zero tillage cultivation system in sloping lands of CHT which will mitigate the process of land degradation due to digging up cultivation as well as take care of food security of Hill people.

Objectives
  i.   To estimate & compare soil loss, runoff and nutrient mining under indigenous and zero tillage cultivation systems of pineapple.
 ii.   To calculate effect of soil loss on soil chemical properties.
iii.   To create awareness about soil conservation & watershed management among hill dwellers.

Materials and Methods

The experiment was carried out under non-replicated condition. Four experimental plots of 100 sqm. (5 m x 20 m) on steeply (32%) were selected in the SCWMC, Bandarban. There are four treatments such as (1) Digging up across the slope (2) Digging up along the slope (3) Zero tillage across the slope and (4) Zero tillage across the slope. Pineapple suckers are inserted in double row. The distance between single row to row was 30 cm and double row to row was70 cm. Fertilizers were applied as per recommendation of soil test value. Cultural operations were done as usual in all the plots. Measurement of soil loss and run-off was carried out by established and locally fabricated multi-slot divisors. Soil loss and run-off from each 100sqm (5m x 20m) experimental plots were measured after each shower throughout the rainy season. Daily and eventually monthly soil loss and run-off were estimated from each treatment by processing aliquot of sample every day. Every morning (if rains previous day) amount of run-off water is measured in the multi-slot and aliquot of about 2 Litre is sampled from each tank. Suspended sediment in the sampled aliquot is measured by simple filtering and oven drying. Corresponding rainfall is recorded from the automatic and ordinary rain gauge of SCWMC. Climatic data like rainfall, temperature, humidity, evaporation etc. were recorded daily. Different agronomic practices were done when it was necessary. Nutrient loss was calculated in every experimental plot from eroded soil.

Results and Discussion

Table 16. Initial soil fertility status and fertility status after crop harvest.

Para-meter	Year	pH	OM (%)	N (%)	P	K	S	Zn	B	Ca	Mg	Cu	Fe	Mn
					meq/100g soil		µg/g soil			meq/100g soil		µg/g soil		
Digging Up Across	2017	5.1	3.56 H	0.178 L	9.82 L	0.39 H	0.001 VL	1.41 O	0.19 L	3.81 M	0.78 M	0.79 VH	65.00 VH	28.38 VH
	2018	4.0	4.2 H	0.210 M	1.05 VL	0.44 H	11.15 L	0.38 VL	0.53 O	4.30 O	1.15 O	0.33 M	47.27 VH	10.50 VH
Digging Up Along	2017	5.7	3.63 H	0.182 M	3.48 VL	0.37 H	0.002 VL	4.18 VH	0.17 L	3.60 M	0.77 M	0.83 VH	66.46 VH	34.02 VH
	2018	4.1	3.5 H	0.175 L	1.07 VL	0.46 VH	22.30 O	0.27 VL	0.30 L	8.01 VH	0.88 M	0.18 L	39.80 VH	11.48 VH
Zero Tillage Across	2017	6.0	3.50 H	0.175 L	1.63 VL	0.36 O	0.001 VL	6.30 VH	0.15 VL	4.34 M	0.86 M	1.04 VH	65.00 VH	28.84 VH
	2018	4.0	4.3 H	0.275 L	1.21 VL	0.55 VH	18.53 M	0.50 L	0.60 O	6.52 H	1.59 H	0.25 L	37.55 VH	12.69 VH
Zero Tillage Along	2017	5.7	3.90 H	0.195 M	3.21 VL	0.42 H	1.15 VL	5.75 VH	0.26 L	5.18 O	0.93 M	0.84 VH	93.90 VH	33.84 VH
	2018	4.0	5.5 H	0.275 O	1.04 VL	0.52 VH	17.54 M	1.17 M	0.32 M	5.92 O	1.79 H	0.56 M	50.15 VH	18.18 VH

Note: VL=very low; L=low; M= medium; O=optimum; H= High,VH=very high

Table-17: Soil Texture

Particulars	Soil Textural Class	Sand	Slit	Clay
		%		
Digging Up Across	Silt Loam	15	57	28
Digging Up Along	Silt Loam	18	56	26
Zero Tillage Across	Silt Loam	17	57	26
Zero Tillage Along	Silt Loam	18	56	26

The highest soil loss recorded in digging up along the slope were 68.59, 60.19, 52.55, 40.21, 30.90 & 36.55 ton/ha/yr. in the year of 2018-19,2019-20 ,2020-21, 2021-22, 2022-23 & 2023-24 respectively and finally the average highest soil loss was **48.17** ton/ha/yr. The lowest soil loss recorded in practicing zero tillage cultivation method across the hill slope were 8.69 ,7.48, 6.45, 6.21, 5.52 & 6.58 ton /ha/yr. in the year of 2018-19, 2019-20 ,2020-21 ,2021-22, 2022-23 & 2023-24 respectively and finally the average lowest soil loss was **6.82** ton/ha/yr. On the other hand, soil loss recorded in digging-up across the slope were 52.04, 49.91, 43.35 ,34.12, 25.15 & 31.34 ton/ha/yr. in the year of 2018-19, 2019-20, 2020-21, 2021-22, 2022-23 & 2023-24 respectively and average was **39.42** ton/ha and zero tillage cultivation method along the hill slope were 14.48,

13.19 ,12.41, 11.38, 7.40 & 9.16 ton/ha/yr in the year of 2018-19, 2019-20, 2020-21, 2021-22, 2022-23 & 2023-24 respectively and average was **11.37** ton/ha.

Table 18. Total Soil Loss (ton/ha/yr) under indigenous & Zero Tillage cultivation methods of Pineapple for 2018-19, 2019-2020, 2020-21, 2021-2022 and. 2022-23.

Particulars	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Average
Digging up Across	2018-19	-	-	-	-	-	6.83	15.52	11.85	10.27	8.16	-	-	52.63	
	2019-20	-	-	-	-	-	4.12	22.38	8.89	10.12	4.40	-	-	49.91	
	2020-21	-	-	-	-	3.55	5.12	6.13	10.64	8.55	9.26	-	-	43.35	**39.42**
	2021-22	-	-	-	-	1.54	6.85	7.69	8.08	5.76	4.24	-	-	34.12	
	2022-23	-	-	-	-	1.80	6.55	3.93	4.60	4.95	3.32	-	-	25.15	
	2023-24	-	-	-	-	1.38	4.92	5.29	10.31	5.88	3.56			31.34	
Digging up Along	2018-19	-	-	-	-	-	7.71	19.83	16.25	14.83	9.97	-	-	68.59	
	2019-20	-	-	-	-	-	4.84	27.69	9.52	11.91	6.23	-	-	60.19	
	2020-21	-	-	-	-	4.23	7.68	8.04	11.50	10.05	11.0	-	-	52.55	**48.17**
	2021-22	-	-	-	-	2.89	8.79	8.23	9.49	6.65	4.25	-	-	40.21	
	2022-23	-	-	-	-	2.80	7.80	5.44	4.92	5.84	4.10	-	-	30.90	
	2023-24	-	-	-	-	2.29	5.84	6.42	11.95	6.59	3.46	-	-	36.55	
Zero tillage Across	2018-19	-	-	-	-	-	0.96	3.49	2.29	0.72	1.23	-	-	8.69	
	2019-20	-	-	-	-	-	0.85	2.83	2.29	0.82	0.69	-	-	7.48	
	2020-21	-	-	-	-	0.61	0.89	1.25	1.46	0.77	1.37	-	-	6.45	
	2021-22	-	-	-	-	0.25	1.32	0.94	1.66	1.25	0.84	-	-	6.21	**6.82**
	2022-23	-	-	-	-	0.38	1.51	1.02	0.52	1.37	0.72	-	-	5.52	
	2023-24	-	-	-	-	0.29	0.98	1.26	2.20	1.34	0.51			6.58	
Zero tillage Along	2018-19	-	-	-	-	-	1.4	6.22	3.57	1.76	1.53	-	-	14.48	
	2019-20	-	-	-	-	-	0.87	6.62	2.81	2.28	0.61	-	-	13.19	
	2020-21	-	-	-	-	1.14	1.56	2.34	2.95	1.33	3.09	-	-	12.41	**11.37**
	2021-22	-	-	-	-	0.35	2.64	2.39	3.11	1.70	1.24	-	-	11.38	
	2022-23	-	-	-	-	0.54	1.79	1.34	0.88	1.63	1.22	-	-	7.40	
	2023-24	-	-	-	-	0.33	1.06	2.18	3.44	1.23	0.92	-	-	9.16	

Table-19: Run off (%) under the cultivation indigenous & Zero Tillage cultivation methods of Pineapple. (2018-19, 2019-2020, 2020-2021, 2021-22, 2022-23 and 2023-24).

Particu-lars	Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Total Rain fall (mm)
Digging up Across	2018-19	_	_	_	_	_	29.48	61.10	61.12	63.39	63.36	_	_	2360
	2019-20	_	_	_	_	-	40.78	51.99	50.26	44.28	34.37	_	_	2642
	2020-21	_	_	_	_	26.49	42.45	46.54	45.65	30.56	68.95	-	_	2266
	2021-22	-	-	-	-	11.35	23.56	21.45	24.75	22.45	20.12	-	-	2348
	2022-23	-	-	-	-	15.20	22.42	20.24	11.42	21.10	16.63	-	-	1573
	2023-24	-	-	-	-	8.68	12.75	21.16	55.86	38.63	14.36	-	-	2811.0
Digging up Along	2018-19	_	_	_	_	_	27.26	59.24	68.66	65.75	57.15	_	_	2360
	2019-20	_	_	_	_	-	45.01	53.75	53.50	47.42	38.03	_	_	2642
	2020-21	_	_	_	_	28.42	45.25	49.37	46.10	33.82	70.38	_	_	2266
	2021-22	-	-	-	-	12.40	30.25	28.70	31.32	27.85	23.54	-	-	2348
	2022-23	-	-	-	-	0.40	30.65	33.44	15.82	28.34	21.60	-	-	1573
	2023-24	-	-	-	-	13.84	18.72	29.66	63.32	41.94.	18.25	-	-	2811.0
Zero Tillage Across	2018-19	_	_	_	_	_	25.78	56.77	65.75	53.93	54.05	-	_	2360
	2019-20	_	_	_	_	-	33.39	49.72	46.38	38.64	30.72	-	_	2642
	2020-21	_	_	_	_	19.43	23.90	37.03	39.99	26.23	57.62	-	_	2266
	2021-22	-	-	-	-	9.4	22.70	20.45	23.20	19.80	18.50	-	-	2348
	2022-23	-	-	-	-	10.35	15.44	12.35	9.72	13.41	11.44	-	-	1573
	2023-24	-	-	-	-	6.18	10.22	18.65	48.27	34.28	11.18	-	-	2811.0
Zero Tillage Along	2018-19	_	_	_	_	_	26.52	55.53	57.15	58.66	50.94	_	_	2360.0
	2019-20	_	_	_	_	_	36.56	51.24	50.91	41.15	32.55	_	_	2642.0
	2020-21	_	_	_	_	23.36	39.76	41.11	43.76	29.14	60.16	_	_	2266.0
	2021-22	-	-	-	-	10.5	24.30	22.8	26.80	21.64	19.60	-	-	2348.0
	2022-23	-	-	-	-	12.22	18.54	16.29	10.69	16.35	12.55	-	-	1573.0
	2023-24					11.67	15.34	25.46	57.52	36.48	15.54	--	--	2811.0

Rainfall and its pattern have a vital role on surface run off and soil loss hazard. Annual rainfall was measured by manual type rain gauge. Total Annual Rainfall was 2360 mm, 2642 mm , 2266 mm , 2348mm,1573 mm & 2811.0 mm in the year of 2018-19, 2019-20 ,2020-21 , 2021-22 2022-23 & 2023-24 respectively. The impact of soil erosion on the productive potential of agricultural lands is well known (Pathak*et al*., 2004), but the magnitude depends on local circumstances. In the study areas, the organic matter depletion was also observed irrespective of land use. The loss of the essential plant nutrients (N, K, S, Zn, B, Ca,Mg and Mn) in association with the suspended sediments and runoff during the measurement period was remarkable.

Table.20. Nutrient loss (tha^{-1}) from plots under different land use.

Particulars	N	P	K	S	Zn	B	Ca	Mg	Cu	Mn
Digging up Across	4.0	0.00384	0.2737	0.00264	0.00216	0.0007	1.912	0.4656	0.00096	0.0291
Digging up Along	4.4	0.00502	0.3128	0.0059	0.00224	0.00084	2.072	0.4752	0.001	0.03164
Zero tillage Across	3.0	0.00222	0.1955	0.00198	0.00064	0.00024	1.328	0.3072	0.00038	0.02242
Zero tillage Along	3.6	0.00284	0.24242	0.00258	0.00128	0.0004	1.64	0.4152	0.00062	0.022852

It was observed that highest nitrogen loss i.e. 4.4 tha^{-1}occurred from Digging up Along the plot and the lowest (3.0tha^{-1}) from Zero Tillage Across the plot along with other nutrient elements. In case of Digging up Across and Zero Tillage Along the plot nitrogen loss was 4.0 and 3.6 tha^{-1} along with other nutrient elements.

Table.21. Yield Study of Pineapple under different Cultivation Practices:

Cultivation practices	Yield per Plot (Nos).						Sale Value per plot						Average Earning for 5 yrs.(tha^{-1})
							Total Earning (tha^{-1})						
	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	
Digging up Across	12	187	214	225	220	172	216/-	3366/-	3,852/-	4050/-	3,960/-	2,580/-	**300400/-**
							21,600/-	336600/-	3,85,200	4,05,000/-	396000/-	258000/-	
Digging up Along	10	190	196	200	202	165	150/-	2850/-	2,940/-	3000/-	3,030/-	2,475/-	**240750/-**
							15,000/-	285000/-	294000/-	300000/-	303000/-	247500/-	
Zero tillage Across	15	255	270	280	294	248	300/-	5,100/-	5,400/-	5,600/-	5,880/-	3,720/-	**433333/-**
							30,000/-	510000/-	5,40,000/-	560000/-	588000/-	372000/-	
Zero tillage Along	13	205	212	228	233	182	234/-	3690/-	3,816/-	4104/-	4,194/-	2,730/-	**312800/-**
							23,400/-	369000/-	381600/-	410400/-	419400/-	273000/-	

For judging economic viability, the input & output cost of pineapple cultivation in different practices are also being studied. It was observed that the highest average return comes from Zero Tillage Across the slope was Tk. **4,33,333/-**and the lowest average return comes from Digging up Along the slope Tk. **2,40,750/-** for six years. On the other hand, average return comes from Zero Tillage Along the slope Tk. **3,12,800/-**and digging-up across the slope was Tk. **3,00,400/-**for six years. It was also observed that both the size & number of fruits were decreased in the recent year.

Conclusions

Tillage is not recommended on hill slopes. Soil erosion increases by tillage cultivation in hilly areas. Zero tillage farming maintains soil fertility by controlling soil erosion. Pineapple cultivation of zero tillage system on hillsides, soil erosion is much less and yields are high than other practices. use of indigenous methods of pineapple cultivation has created negative effect on soil.

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EXPT. No. 06

STUDYING BRUSHWOOD CHECK DAM FOR MINIMIZING EROSION HAZARD AND RECLAMATION OF GULLIED LAND.

Abstract

Gullies are the common features throughout the areas where the land comprises with High and slopping lands all over the world. The hilly region receives a huge amount of precipitation which is not well distributed. Due to different type of land degradation by rain, Bangladesh lost a substantial amount of production which in terms of money may be thousands of billion takas in every year. Brushwood check dams made of posts and brush are placed across the gully. Check-dams are constructed across the gully bed to stop channel bed erosion. The main objectives of brushwood check dams are to reduce the velocity of run-off, to prevent deepening and widening of the gully and to collect sedimentation and recharge the water table. Its catchment area was nearly 0.12 hectares. The types of Brush wood check were double row brush-wood check dam across the gully bed. The potential of the check dam to deposit the soil was evaluated by using leveling Instrument to observe the change of gully depth, cross sectional area and soil loss data were collected. Result obtained after five years indicates that the gully bed was filled with eroded soil from its catchment area of 0.12hac is 0.748 m which is equivalent to 164.588 ton/ha. The check dam interrupt surface run-off velocity, it also increases the permeability of water in to the soil. It also very cost effective for using locally available materials which are cheap and effective to rehabilitate gully.

Introduction

Gullies are common features throughout the Highlands. Induced environmental degradation comprises not only the loss of soil volume and of arable lands, but also the triggering of landslides (Nyssen et al., 2002) or off-site sedimentation problems (Nigussie et al., 2005). The phenomenon of gully development is not restricted to Highlands, but seems to be a phenomenon on sub-continental scale all over the world (Moeyersons, 2001). Land degradation, comprising degradation of the natural vegetation cover, soil erosion, loss of soil fertility and moisture stress is a well-known problem in hilly regions of Bangladesh as well as all over the world (Herweg and Stillhardt, 1999). Land degradation, particularly by water erosion, is an important factor in both the long-term decline and the seasonal reduction in food crop production (FAO, 1986). Soil erosion in Highlands degrades the soil resources on which agricultural production are based (Hurni, 1986, Nyssen, 1995 and many others). This threat stems from the depletion and degradation of the vegetation cover of the country, especially forest and exploitative farming practices. Water plays a vital role in the ecosystem. The precipitation over the country is not only unevenly distributed,

but also uneven with regard to seasonal distribution as well as within season. Steep slope and terrain in hilly areas quickly releases the flow towards the outlet and thus creates scarcity of water.

Brushwood check dams made of posts and brush are placed across the gully. The main objective of brushwood check dams is to hold fine material carried by flowing water in the gully. Small gully heads, no deeper than one meter, can also be stabilized by brushwood check dams. Brushwood check dams are temporary structures and should not be used to treat ongoing problems such as concentrated run-off from roads or cultivated fields. They can be employed in connection with land use changes such as *reforestation* or improved range management until vegetative and slope treatment measures become effective. Temporary physical and structural measures such as gully brushwood dam are used to dissipate the energy of runoff and to keep the gully stable. Check-dams are constructed across the gully bed to stop channel bed erosion. By reducing the original gradient of the gully channel, check-dams reduce the velocity and erosive power of runoff. Run-off during peak flow is conveyed safely by check-dams. The structures can be either temporary or permanent.

The main requirement of temporary gully control structures is that, they must be quick and easy to construct, should be made by using cheap and readily available material in nearby areas. In areas where the soil in the gully is deep enough, brushwood check-dams can be used if proper construction is assured. The gradient of the gully channel may vary from 5 to 12 percent, but the gully catchment area should not be as such huge which produces high amount of runoff volume.

Objectives

a) To reduce the velocity of run-off.
b) To prevent deepening and widening of the gully.
c) To collect sedimentation and to recharge the water table.

Materials and Methods

The study has been introduced at SCWMC research area to minimize erosion hazard and reclamation of a gully formed by the South-east side of the Administrative Building of SCWMC, SRDI, Bandarban. The length of the gully is 16.50 m. and width were variable with 1.80 m. near head and 5 m. where the Brush-wood check dams were constructed. It is situated in between two small hills. Average width of the gully in front of upper check dam is 2.30 m. Its catchment area was nearly 0.12 hectares. The gully head was very adjacent to the Administrative Building which was increasingly extending towards the Administrative Building. So, it was a future threat for the stability of the Administrative Building.

Brushwood check-dams made up of posts and brushes are placed across the gully. The main objective of brushwood check-dams is to hold fine materials carried by flowing water in the gully. Small gully heads, no deeper than one meter, can also be stabilized by brushwood check dams. Brushwood check-dams are temporary structures and should not be used to treat ongoing problems such as concentrated run-off from roads or cultivated fields. They can be employed in connection with land use changes such as reforestation or improved range management until vegetative and slope treatment measures become effective. The main requirement of temporary gully control structures is that, they must be quick and easy to construct, should be made by using cheap and readily available material in nearby areas.

There are two types of brushwood check-dams: these are single row and double row brush wood check-dams. Following the principle for construction of Brush-wood check dam, a decision had been taken to construct two nos. double row brush-wood check dam across the gully bed in series to reclamation of this gully.
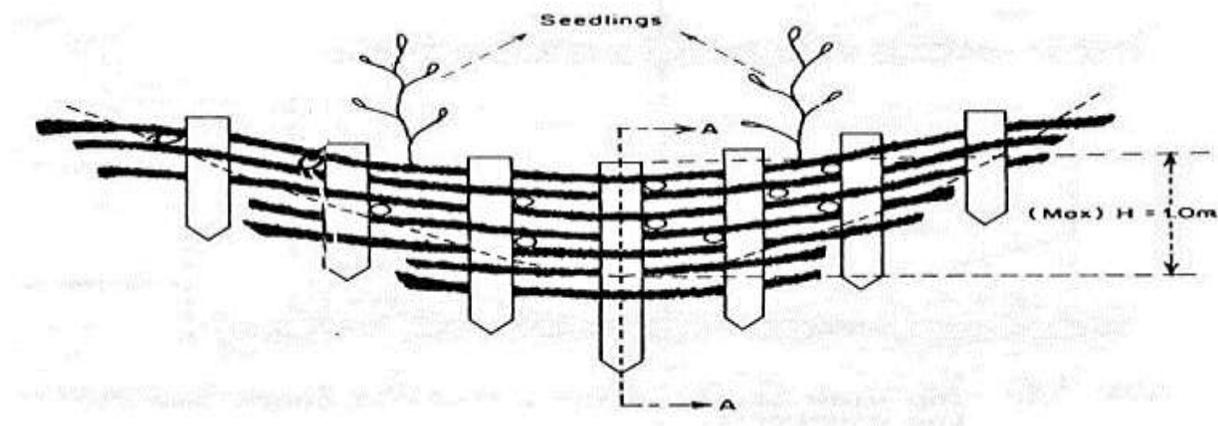
The construction of the dam started with an excavation in the floor and into the sides of the gully to a depth of 0.30 m to 0.50 m. Two rows of living posts 5-10 cm in diameter and 1-20 m in length were placed into the holes maintaining a distance from post to post 0.60 m across the floor of the gully to a depth of 0.50 m to 0.60 m. The spacing between two rows was 1.00 m for upper check dam and 0.70 m for lower one. The width of the upper and lower brush wood check dam was 1.10 m. and 0.80 m, and height was 1.20. Brushwood and branches are packed between the posts. The height of the posts in the center was kept in such a way that it should not exceed the height of the spillway so that the flow would be blocked and water may be forced to move to the gully sides. The distance between upper and lower check dam was 6.00 m. Deposition of eroded soil from the catchment area is observed carefully.

Results and Discussion

Average width and length of the gully was 2.30 m. and 16.50m. adjacent to the upper Brush wood check dam. Soil deposited length in the gully was 8.20 m. and average width was 2.30 m. where the eroded soil was deposited in various depth. Soil deposition area was (8.20 m. x 2.30 m.) = 18.86 Sq.m. The Reduced Level (RL) of the gullied land wad measured by Theodolite Instrument. Before construction of the brush-wood check dam, the altitudes of the gully bed was were recorded in June-2018. Average RL of the gully was 94.102 m. (June-2018). After one rainy season during 2018-19, the RL of the gully bed was observed and it was found 94.418m. in March-2019. It was found that the average deposition height (by eroded soil from the catchment area) was 0.316 m. which is equivalent to 69.533 tonh^{-1}y^{-1}. After 2nd year, the average RL of gully bed was again measured and found that the average RL was 94.54 m. Hench, the deposition depth by eroded soil carried from the upper catchment was 0.122 m. which is equivalent to 26.842 tonh^{-1}y^{-1}., The average R.L. gully bed was measured in April-2021 and after 3rd year it was found that the average R.L. of the bed is 94.62 m. It shows that the deposition depth of eroded soil from the upper catchment is 0.080 m. which equivalent to 17.605 tonh^{-1}y^{-1}. Again the average R.L. gully bed was measured in April-2022 and after 4th year it was found that the average R.L. of the bed is 94.73 m. It shows that the deposition depth of eroded soil from the upper catchment is 0.110 m. which

equivalent to 24.208 tonh^{-1}y^{-1}. Thus the average R.L. of the gully bed was measured in each year. In April/2024, it was found that the average RL of the gully bed level was 95.01 m. which indicates that the depth of deposited soil was increased by 0.16 m. than that of April/2023 and it is equivalent to 35.210 tonh^{-1}y^{-1}. After Six years, in April/2024, the average RL of the gully Bed was 95.01 m and total deposition depth by eroded soil from the catchment area (0.12 hec.) was increased by 0.91 m. During this period (2018-19 to 2023-24), total deposited soil amount was 199.798 ton/hac which average is 33.30 tonh^{-1}y^{-1}. Amount of deposited soil is shown in Table-22. Weight of deposited soil was assumed to be on average 1400 kg per cubic meter.

Table-22: Amount of soil deposited by Brush wood Check Dam.

Location	Cross Sectional Area of the Gully bed (m².)	Catchment area of the gully (check dam) in hac.	RL of gully bed (m)							Depth of deposition (m)	Amount of deposited soil (m³)	Deposited amount from the catchment each year (ton)	Deposited amount tonh⁻¹y⁻¹	Total Deposition (ton/ha)
			June-18	March-19	April-20	April-21	April-22	April-23	April-24					
Upper check dam	8.20x2.30 = 18.86	0.12	94.10 (Initial)	94.418	94.54	94.62.	94.73	94.85	95.01	0.31 (2019)	5.96 (2019)	8.344 (2019)	69.533 (2019)	**199.798**
										0.122 (2020)	2.301 (2020)	3.221 (2020)	26.842 (2020)	
										0.080 (2021)	1.509 (2021)	2.113 (2021)	17.605 (2021)	
										0.110 (2022)	2.075 (2022)	2.905 (2022)	24.208 (2022)	
										0.120 (2023)	2.263 (2023)	3.168 (2023)	26.400 (2023)	
										0.160 (2024)_	3.018 (2024)	4.22 (2024)	35.21 (2024)	

Note: Weight of 1.0 m³ soil = 1.3 to 1.7 ton. Here considered 1.4 ton per m³ of soil.

Conclusions

The gully bed has been raised up 0.91 m which proves that the check dam is capable to check 199.79 ton/hac sedimentation carried from the upper catchment area. Not only that, as the check dam interrupt surface run-off velocity, it also increases the permeability of water in to the soil. It

also very cost effective for using locally available materials which are cheap and effective to rehabilitate gully.

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New Program (2024-2025)

Expt. No. 01: Fallout Radionuclides (FRN) methods focusing on Cs-137 for Soil Erosion Assessment in Chattogram Hill Tracts.
Objectives:

a) To assess the extent of soil erosion in the Chattogram Hill Tracts using fallout radionuclide

   (Cs 137) techniques.

b) To assess the applicability of fallout radionuclide-based techniques for measuring soil erosion rates in hilly regions and compare their effectiveness with traditional methods.

c) To develop a comprehensive soil vulnerability map for Chattogram Hill Tracts using FRN methods.

Methods and materials

The study will be conducted in the Chattogram Hill Tracts. The area is characterized by hilly and mountainous terrain, with peaks and valleys throughout the landscape.Finding a suitable reference site is crucial in utilizing FRN (Fallout Radionuclide) techniques. In the Chattogram Hill Tracts, undisturbed flat site with perennial grass cover will be chosen as reference site. It will be located within the study area. The reference site will be situated approximately 800 m away from the managed study area. Refference sample will be collected in 60 cm depth. Several sampling campaigns will be conducted at the reference site to establish the baseline levels of 137Cs.

Soil sampling will be performed using a core sampler in various depth. In the top it will be 45 cm, in the middle it will be 60 cm and in the bottom it will be 100cm depth. Chemical analysis will be done in each depth. Bulk density and texture will be measured in each depth too.

Soil samples will go a pre-treatment process following the method described by Pennock and Appleby (2002). This included air drying, manual disaggregation, sieving to < 2 mm, grinding, and homogenization of the samples. Collected Soil samples from the managed site will be analyzed for 137Cs using gamma spectrometry with HPGe (High Purity Germanium) detectors. The gamma spectrometry measurements will be conducted at the Bangladesh Atomic Energy Commission.

ADAPTIVE RESEARCH

PROGRAME-1
INTRODUCTION OF BENCH TERRACE FOR DEMONSTRATION AND YEAR ROUND CROP PRODUCTION.

Objectives

- To reduce the quantum of overland flow/sheet flow or runoff, and their velocity.

- To minimize the soil erosion.

- To conserve soil moisture.

- To conserve soil fertility and to facilitate farming operations such as ploughing, irrigation etc. on sloping land.

- To promote intensive land use, permanent agriculture and checking shifting cultivation on steep lands.

Justification:

Terracing is one of the most accepted measures of controlling erosion on sloping and undulated lands. It is widely adopted in many countries of the world. Suitable bench terrace will facilitate intensive cultivation make the land suitable for multiple use in hilly areas. It is also helpful to increase the beauty of the land along with increasing the stability. At present most of the farmers are practicing Jhum on hill slope, which accelerate erosion. On sloping lands farmers usually can't use fertilizer or other input to produce more crops per unit of land. Bench terrace helps in proper water management, application of fertilizers or manure. It will also help to increase cropping intensity within a stable farming system. Now a day, Bench Terrace are widely being used in the hilly areas of India, Nepal, Srilanka, Tamilnadu etc. But the hill dwellers are not concerned about the construction, use and benefit of the Bench Terrace. Considering above factors study of sustainability of Bench terrace has been taken account in the farmer's field. As the

measure is very cost effective, so widely subsidy is very essential to popularize the Bench Terracing mainly in the hilly areas in our country.

PROGRAME-2:
REHABILITATION OF DEGRADED/ERODED SLOPING LAND BY JUTE GEO-TEXTILE ON DIFFERENT HILL SLOPES OF CHT.

Objectives

1) To study the effectiveness of geo-jute (untreated) in controlling soil erosion.

2) To rehabilitate degraded/eroded/landslide hilly areas

3) To stabilize/rejuvenate degraded/landslide areas of CHT

Justification:

1. Like any other natural fibre, jute geo-textile gets biodegraded in soil.

2. The live poll will give vegetation coverage and soil losses will be minimized at the area treated
   with jute geo textile.

3. The decomposition of the fibre will takes place within the ecological process that assists in the retention of moisture, improvement of soil permeability and establishment of vegetation.

PROGRAME-3
ESTABLISHMENT OF DIFFERENT HEDGE SPECIES IN FARMERS' FIELD AS TRANSFERABLE TECHNOLOGY IN CHT.

Objectives

a. To introduce modern hill cultivation and suitable technology for Soil Conservation and Watershed Management.

b. To mitigate the need of fuel, fodder and economical purpose of the hill dwellers.

c. To minimize soil erosion hazard.

d. To increase bio-mass in soil properties.

e. To accelerate the infiltration and water holding capacity of soil.

Justification:

The conservation of soil and water is essential for sustainable production, environment preservation and balanced ecosystem. Loss of soil by water erosion on slopping lands adversely affects the physical, chemical and biological properties of soils, leading to low crop productivity. Contour hedgerows are also effective in controlling run off and soil erosion and improve soil physical properties. Controlled plots have higher run off and soil loss than those plots with hedge row. Hill slope may be divided into a series of alley separated by hedgerow on contour lines, because hedgerow plants are effective in controlling soil erosion and reducing run off.

Trees and shrubs have several functions to control erosion like (i) increase soil cover, by liter and pruning (ii) provide partly permeable hedgerow barriers (iii) lead to the progressive development of terraces, through soil accumulation upslope of hedgerows (iii) increase soil resistance to erosion, by maintenance of organic matter (iv) stabilize earth structures by root systems and (v) make productive use of the land occupied by the conservation works . This study was, therefore, designed to select suitable hedge species and their alley width in respect to slope which minimized soil loss and increase crop yield.

PROGRAME-4
TITLE: GULLY CONTROL BY GABION CHECK DAM & VEGETATIVE MEASURES FOR THE RECLAMATION OF DEGRADED LANDS IN THE HILLS OF CHT.

Objectives

1) To check widening & head extension of gully.

2) To reduce runoff and subsequently retain washed out sediments/debris at the gully head and increase filtering effect of the run-off sediment.

   To rehabilitate/reclaim the degraded land.

Justification:

Construction of Gabion check dam needs no high-tech technology. Locally available materials can be used for construction of gabion. Others high tech construction materials except 10 SWG and 22 SWG GI wire are not required for Gabion. So, it can be constructed even at remote areas. After achieving the target, the used materials can be shifted to another place without any wastage. As this structure is considered as a flexible structure, there is a less possibilities to be damaged except scouring. If the well graded local stone bolder is used in gabion, it works well to check the sediments carried with and is finally very good for rehabilitation of degraded land by plugging the gully head.

PROGRAME-5
INTRODUCTION OF HALF-MOON TERRACE, STAGGERED TRENCHING, CONTOUR GRASSED WATERWAYS, AND CONTOUR TRENCHING IN FARMER'S FIELD.

Objectives

I. To minimize the soil erosion hazard.
II. To increase the optimum soil moisture capacity.
III. To convert the eroded land in to productive.
IV. To divert the excess water causing no damages in the rainy season.
V. To rehabilitate the degraded land.
VI. To provide facilities for applying fertilizers, manure and irrigation on the sloping land.

Justification:

HALF MOON TERRACE

Half-moon terrace is a kind of terrace used for planting of fruit and horticultural purposes. It is called the Half Moon Terrace for its shape. Construction of Half Moon Terrace is easier than others. It is made by cutting the upside soil of the plant in half moon shape to create a circular level bed having 1.0-1.5 m. diameter. The dug-out soil is deposited on down side of the plants to make ridges for retaining moisture. Mulch materials are used in the terraced area which will add organic matter in to the soil. It also provides facilities for all intercultural operation like application of fertilizer and manure along with irrigation in the drought. This type of terrace is generally made just before the end of monsoon when the soil is saturated. It also helpful for healthy growth of plants.

STAGGERED TRENCHING

The staggered trenches are constructed for shorter length, as compared to the graded trenches. These trenches are arranged in staggered form (i.e. not in straight line). Staggered trenches are generally constructed at the land slope greater than 33% receiving high rainfall to prevent erosion and absorb rain water for horticulture and forestry land . The trenches run level for distance of maximum 90 to 120 m, than on the gradient increasing from 1 in 500 to 1 in 300 at the outlet. The bunds are constructed at closer interval about 3 to 5 m. The important points about this type of trench are as follows:

The trenches have shorter length; and are arranged in the row along the Contour with interspace between them.

a) The vertical interval between two successive trenches is decided on the basis of expected runoff from the area, above,

b) In staggered sequence, the alternate rows trench are located directly below one another;

c) The length of row and slope between them are fixed based on the Concept that there should be greater length of unprotected or uninterrupted slope to cause unexpected runoff and erosion.

CONTOUR GRASSED WATERWAYS

A grassed waterway is a natural or constructed channel that is shaped or graded to carry surface water at a nonerosive velocity to a stable outlet. The required dimensions are those needed for the waterway to convey runoff from the design storm, generally the 10-year, 24-hour storm. The grassed waterway is designed to ensure that the velocity of runoff water is not excessive.

The primary purpose of a grassed waterway is to convey runoff from terraces, diversions, or other areas of water concentration without causing erosion or flooding. Another purpose is to improve water quality. Grassed waterways are natural drainage ways that are graded and shaped to form a smooth, bowl-shaped channel. They are seeded to sod-forming grasses. Runoff water that flows down the drainage way flows across the grass rather than tearing away soil and forming a larger gully. An outlet is commonly installed at the base of the drainage way to stabilize the waterway and to keep a new gully from forming. The most critical time for successful installation of a grassed waterway is immediately following construction, when the channel is bare and unprotected from runoff. Waterways are generally planted to perennial grass and then mulched with straw. In some areas silt fences or straw bales in the waterway reduce the velocity of the runoff, thereby reducing the risk of gully formation in the new waterway.

A grassed waterway provides a vegetative strip that benefits the environment in several ways   in addition to the primary benefit of providing a non-erosive waterway. These additional benefits include diversity of wildlife habitat, corridor connections, vegetative diversity, non-cultivated strips of vegetation, and improved esthetics. An additional grassed width on each side of the grassed waterway allows the waterway to better serve as a conservation buffer.

Contour Trenching

Contour trenching is excavating trenches along a uniform level across the slope of the land in the top portion of catchment. Bunds are formed downstream along the trenches with materials taken out of them. The main idea is to create more favorable moisture condition and thus accelerate the growth of vegetation.

Contour trenches break the velocity of runoff. The rain water percolates through the soil slowly and travels down and benefits the better types of land in the middle and lower

section of the catchment. Where the lower fields are bunded, these trenches also protect the bunds from the runoff from the upper portion of the catchment. It also traps and stores the soil particles carried from the upper ends with runoff.

PROGRAME- 6
GULLY CONTROL BY BRUSHWOOD CHECK DAM FOR MINIMIZING EROSION HAZARD AND RECLAMATION OF GULLIED LAND.

Objectives

I. To reduce the velocity of run-off.
II. To prevent deepening and widening of the gully.
III. To collect sedimentation and to recharge the water table.

Justification:

In the hills of CHT, stone is not generally available everywhere, but brushes and unused trees are available Where stones are not readily available, Brushwood check dam can be constructed for slowly reclamation of the gullied land. Brushwood check dam increases absorption /infiltration of water into the soil. It also reduces the speed of runoff and therefore also reduces the erosive power of surface flows. Brushwood check dams allow for planting of crops once the dam is matured. It needs branches and plant materials/brushwood, ideally use of cuttings of trees that will strike fort the struts. Brushwood check dam can be built easily. But it needs for regular maintenance and repairing.

6.2 Salinity Managrement and Research Center (SMRC)

Soil Resource Development Institute

Batiaghata, Khulna

Effect of Different types of organic matter on Soil Salinity and Yield of Sweet gourd in Coastal Saline Soil

A Biswas, Md. Z Islam

Abstract

Salinity causes serious cellular damage and limits crop productivity. Accumulation of organic matter is one of the best adaptive mechanisms to reduce salinity affect in plants. By reducing soil salinity and for obtaining a better sustainable yield, a low-cost and farmer-ecofriendly method is required for sweet gourd, a well-known vegetable. Accordingly, a field experiment was carried out in Salinity Management and Research Center, Soil Resource Development Institute, Batiaghata, Khulna during Kharif-1 season in 03-03-2024 to investigate the effect of different types of organic matter on soil salinity and yield of sweet gourd. The experiment includes five treatments viz. no organic matter (control), cow dung, saw dust, poultry manure and vermi-compost. The experiment was carried out in Randomized Complete Block Design (RCBD) with three replications. Field Soil salinity was recorded at 30 days intervals. Organic matter has showed that this causes effectively reduction the salt accumulation in the plant body and some modification accelerated. After three months of seed sowing, the highest soil salinity (15.8 dS/m) and lowest soil salinity (9.4 dS/m) were found at no organic matter (control) and poultry manure treatment respectively in the month of May. Organic matter treatments obviously have increased the growth and yield attributes of sweet gourd. The highest value of four growth parameters i.e., fruit length (19.48 cm), fruit diameter (70.48 cm), fruit weight (3.22 kg) and total yield (25.48 t/h) was found on poultry manure as compared to control. Again, the lowest value of four growth parameters i.e., fruit length (11.47 cm), fruit diameter (33.19 cm) , fruit weight (1.91 kg) and total yield (8.54 t/h) were found on saw dust treatment. The results revealed that the use of organic matter decrease soil salinity strength and also increases the yield of sweet gourd in saline soil. These findings suggest that the application of organic matter not only reduces soil salinity but also increases the structure of soil, regulate microbes and yield of sweet gourd.

Keywords: Salinity; cow dung; saw dust; vermin-compost; poultry manure; yield; sweet gourd.

Introduction

Salinity as a whole is very dangerous problem at present situation of crop production of southern part of Bangladesh. Soil salinity stress increases the accumulation of toxic ions such as Na+ and Cl$^-$ in different plant parts, tissues, cells and cell organelles (Gadallah, 1999). Soil salinization is a major process of land degradation that decreases soil fertility and crop productivity. There is a report that coastal regions of Bangladesh are quite lower in soil fertility

(Haque, 2006; Kibria et al., 2015). All soils contain a few water-soluble salts, but when these salts happen in sums that are harmful for the germination of seeds and plant development, they are called saline (Conway, 2001). Salt affected soils generally exhibit poor structural stability due to low organic matter content. Many researchers have suggested that the structural stability of soil can be improved by the addition of organic materials (e.g. saw dust, vermin compost, cow dung and poultry manures). Soil salinity is a major barrier to crop production all over the world that affects probably all plant activities. Million hectares of land throughout the world are too saline to produce economic crops, and more land is becoming nonproductive each year due to salinity build up. Approximately 7% of the world's land area, 20% of the world's cultivated land and nearly half of the irrigated land are affected by soil salinity (Zhu, 2001; FAO, 2008; Mali et al., 2012). In view of another projection, 2.1% of the global dry land agriculture is affected by salinity (FAO, 2008). Besides this, increasing soil salinity of arable land is expected to have devastating global effects, resulting in up to 50% land losses by the middle of the twenty-first century (Mahajan and Tuteja, 2005). Out of total agricultural land about 2.86 million hectares of coastal and offshore lands of Bangladesh , about 10.56 lakh hectares are affected by varying degrees of soil salinity (SRDI, 2010). Among the environmental stresses, soil salinity is the most devastating (Shahbaz and Ashraf, 2013) which not only affect the plant growth and metabolism but also poses a foremost limitation to sustainable agricultural production (Tayyab et al., 2016). Important practice is the application of organic manure which can both ameliorate and increase the fertility of saline soil (Melero et al., 2007). Organic mulches can reduce the effect of salt toxicity on plant growth (Ansari et al. 2001; Landis 1988; Yobterik and Timmer, 1994) or actively accelerate soil desalinization (Dong et al. 1996). Considering the above fact, applying organic matter is one of the suitable technologies for reducing soil salinity, it reduces evapotranspiration and helps soil salinity remains lower in the soil. There are evidences that soil amendments with organic matter reduce the toxic effects of soil salinity in various plant species (Idrees et al., 2004; Abou El-Magd et al., 2008; Leithy et al., 2010; Raafat and Thawrat, 2011). Yield characteristics like diameter of fruit, weight of fruit and fruits per vine showed significant results with black polyethylene mulch in case of different high value vegetables in Bangladesh (Islam F, et al., 2010). Organic matter amendments improve physical, chemical and biological properties of soils under saline conditions. This experiment is designed to find out the effect of different organic matter on soil salinity management and to observe the yield performance of sweet gourd.

Materials and Methods

Study location

This experiment was conducted at the Salinity Management and Research Centre (SMRC), Soil Resource Development Institute, Batiaghata, Khulna, Bangladesh during the Kharif-1 season of 03-03-2024. Geographically, the study site was at 22°46'01.8" N latitude and 89°24'15.2" E longitude and under AEZ-13. With an average yearly temperature of 79.3 °F and monthly mean temperatures ranging from 54.3 °F in January to 93.7°F in May, the area is among the warmest in Bangladesh. Land type of plot was medium high land, Land use was F-KV-TA, Depth of flooding 1.5 to 2.0 feet, duration of flooding was 3-4 months, Soil series was Barisal.

Layout of Experiment and Management of crop

The following expecting experiment was carried out in Randomized Complete Block Design (RCBD) with three replications. Sweet gourd (variety: Maya) was taken as an experimental crop. Five experimental treatments were considered: (T_1) control (no organic matter), (T_1) cow dung, (T_2) vermi-compost, (T_3) saw dust and (T_4) poultry manure with three replication. For gaining good tilt of soil condition, the experiment plot was prepared by several ploughs and cross ploughs followed by laddering and harrowing with tractor and power tiller. Weeds and other stables were removed carefully from the experimental plot and leveled properly. Basal doses of fertilizer were applied during land preparation.

Pit preparation

Total land was designed according to achieving the expected yield. The measurement of pit was One foot length x one foot breadth according to experimental demand. Then five experimental treatments were considered (T_1) control (no organic matter), (T_1) cow dung, (T_2) vermi-compost, (T_3) saw dust and (T_4) poultry manure. Then pit soil and treatments materials were mixed with soil very properly, leveling and marked for data collection. After processing the pit area, sweet gourd seeds were sown in the pit with experimental need. Proper care and management were taken when pit was prepared. Necessary care and other intercultural operations were done when necessary. Data were recorded in accordance with the requirements. Soil salinity was measured by using an EC Meter at 30 days intervals. All the intercultural operations like watering, gap filling, staking, weeding, and plant protection measures were executed carefully.

Measurement of Growth and Yield attributes

Four growth and yield parameters such as fruit length (cm), fruit diameter (cm), fruit weight (kg) and total yield (t/ ha) were taken into consideration to analyze the effect of organic matter on yield of sweet gourd. Total yield (t/ha) was calculated by measuring the total fruit weight of the plot.

Initial Chemical properties of soil of pot

pH	OM (%)	K meq/100 gm soil	Total N (%)	P	S	Zn	B
				μg/g			
7.6	2.98	0.37	0.17	10.72	14.98	2.96	0.52

Statistical Analysis

The collected data were tabulated and statistically analyzed using Statistix10 software. The treatment means were separated statistically at a 5 % level of significance using Duncan's Multiple Range Test (DMRT).

Results and Discussion

Effects of Different organic matter on Soil Salinity reduction

Salinity controlling in root zone area in saline soil fields is highly considered beneficial to seed emergence and stand establishment. In modern studies has shown that organic matter is a promising technique for salinity control in present agriculture. An upward trend of soil salinity at all treatments was observed from March to June (Table 1). In the month of March, the lowest soil salinity was found at poultry manure (4.2 dS/m) while the highest soil salinity was observed at control (7.3 dS/m) where no organic matter was used and saw dust (7.2 dS/m). In the month of May, the lowest soil salinity was found at poultry manure (9.4 dS/m) in comparison with the highest soil salinity found in control condition (15.8 dS/m) (Table 1). This data revealed that soil salinity can be reduced by using different organic matter in which poultry manure has a great significant effect on reducing soil salinity. Some authors emphasized These results and reported that all organic matter effectively reduced salt accumulation in the root zone (Taia A, et al., 2016).

Table 1: Month wise soil salinity of the experimental plot

Treatment	Month wise Soil salinity (EC: dS/m)			
	Mar	April	May	June
T_0 (Control)	7.3	11.3	15.8	14.3
T_1 (Cow dung)	6.3	9.4	12.6	11.7
T_2 (Vermi-compost)	5.0	9.1	10.4	9.6
T_3 (Saw dust)	7.2	11.4	15.6	14.2
T_4 (Poultry manure)	4.2	7.7	9.4	8.7

Effects of different organic matter on Yield Attributes of sweet gourd

Fruit length of sweet gourd

This experiment shows that, fruit length and other fruit length related parameters varies a lot that were statistically analyzed as shown in Table 2. They showed a significant variation in relation to different organic matter. The fruit length at control condition was 12.26 cm, at the saw dust treatment it was about 11.47 cm and at treatment with cow dung it was 13.51 cm but at vermi compost treatment it was 18.23 cm of fruit length. The highest fruit length (19.48 cm) was found at poultry manures which was statistically similar to vermi-compost application treatment (18.73 cm), while the lowest (11.47 cm) was found where saw dust was applied. The highest fruit length (19.48 cm) was observed at poultry manure in comparison with the saw dust treatment where the lowest fruit length (11.47 cm) was found (Table 2).

Table 2: Yield and Yield attributes of sweet gourd in saline soil

Treatment	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (kg)	Yield (t/ha)
Control	12.26 b	51.15 b	2.03 b	12.44 c
Cow dung	13.51 b	57.46 b	2.22 b	17.29 b
Vermi- compost	18.73 a	68.54 a	3.14 a	24.34 a
Saw dust	11.47 b	33.19 b	1.91 b	8.54 d
Poultry Manure	19.48 a	70.48 a	3.22 a	25.48 a
CV	9.70	5.08	7.61	9.49
LSD	2.75	5.36	0.35	3.14

Fruit Diameter of sweet gourd

Fruit diameter manipulated in accordance with the organic matter treatment at the plot. So that continuing experiment showed that, fruit diameter and other components of creating fruit diameter quality enhance related parameters varies to a wide that were statistically analyzed as shown in Table 2. Those attributes showed a significant variation in relation to different organic matter. The fruit diameter at control condition was 51.15 cm, at the saw dust treatment the diameter was about 33.19 cm and at treatment with cow dung it was 57.46 cm but at vermi-compost treatment, the fruit diameter was 68.54 cm. The highest fruit diameter (70.48 cm) was found at poultry manure which was statistically similar resulted with vermi-compost (68.54 cm). The lowest fruit diameter (33.19 cm) was found where saw dust was applied. The highest fruit diameter (70.48 cm) was observed at poultry manure in comparison with the saw dust treatment where the lowest fruit diameter (33.19 cm) was found (Table 2). It had been observed that fruit diameter (cm) and other fruit diameter contributing characteristics to plant of sweet gourd were significantly superior to poultry manure organic matter while plants without organic matter (control situation) resulted in poor growth and fruit diameter.

Fruit weight of sweet gourd

Different growth stages and developmental indicators of sweet gourd varied at the different plot. It was happened due to application of different organic matter to plants. The fruit weight of different plants of various plot of sweet gourd grown under different organic matter treatments are presented in Table 2. Statistical analysis was carried out on yield and yield attributes which revealed that these were significantly varied due to different organic matter. The fruit weight at control condition was 2.03 kg, at the saw dust treatment the weight was about 1.91 kg and at treatment with cow dung it was 2.22 kg but at vermin-compost treatment, the fruit weight was 3.14 kg which possess the statistically similar result compared to the highest fruit weight (3.22 kg) that was found at poultry manure. The lowest fruit weight (1.91 kg) was found where saw dust was applied. The highest fruit weight (3.22 kg) was recorded in poultry manure whereas the lowest fruit weight (1.91 kg) was found in saw dust treatment (Table 2). That experiment indicated that

plants under different organic matter treatment, produce larger fruit and have higher fruit weight per plant because of the better plant growth that is due to a favorable hydrothermal regime of soil and a completely weed free environment. Organic matter changes the micro environment of the plant and thus it enhances plant growth and vigor as well as production and yield. This result may be due to the improvement of soil physical properties as well as increasing soil water holding capacity which gave rise to good aeration and drainage that encourage better root growth and nutrient absorption.

Total yield of sweet gourd

Properly completion of sweet gourd growth stages and developmental process varied at the different plot. It was occurred due to application of different organic matter to plants. The total yield of different plants of various plot of sweet gourd grown under different organic matter treatments are presented in Table 2. Statistical analysis was carried out on yield and yield attributes which revealed that these were significantly varied due to different organic matter. The total yield of sweet gourd at control condition was 12.44 t/ha, at the saw dust treatment the total yield was about 8.54 t/ha and at the treatment with cow dung it was 17.29 t/ha but at vermi -compost treatment, the fruit yield was 24.34 t/ha that shows the similar results to the highest fruit yield (25.48 t/ha) was found at poultry manure. The lowest fruit weight (8.54 t/ha) was found where saw dust was applied (Table 2). The doing experiment showed that plants under different organic matter promotes larger fruit and have higher fruit yield per plant because of the better plant growth that is due to a favorable nutrient channel through the soil and a completely symbiosis environment. This result may be due to the improvement of soil physical properties as well as increasing soil water holding capacity which gave rise to good aeration and drainage that encourage better root growth and nutrient absorption. Organic matter changes the micro environment of the plant and thus it enhances plant growth and vigor as well as production of total yield of sweet gourd.

Conclusion

Sustainable soil management practices and the maintenance of soil salinity are central issues to agricultural sustainability. It may be concluded from that experiment's findings that using organic matter prompt to a noticeable decrease in the accumulation of soil salinity. Maximum soil salinity was reduced by using poultry manure in comparison with the control treatment where no organic matter was applied. This experiments point out that, soil salinity reduce by the following order of treatment: poultry manure > vermi-compost > cow dung > control > saw dust. Different growth and yield attributes were significantly impacted due to different organic matter treatments. This results showed that, poultry manure treatments gave the highest yield (25.48 t/ha) whereas, the lowest yield (8.54 t/ha) was recorded in saw dust treatment. Among five of organic treatment, poultry manure as well as vermin-compost can be used at the farmer's level to reduce soil salinity strength and increase the yield of sweet gourd. However, further research is still needed to work out a cost effective technology to reduce soil salinity and increase the yield of sweet gourds.

Effect of different sowing method for avoiding soil salinity in coastal saline soil

A Biswas, Md. Z Islam

Abstract

A field experiment was conducted at Salinity Management and Research Center, Soil Resource Development Institute, Batiaghata, Khulna during 2024 in kharif-1 season to study the impact of saline water in the saline soil on the economics of sweet gourd (*Cucurbita pepo*) yield and soil salinity after the end of the crop. There were three treatments having early pit method, tray seedling transplanting method and conventional method. The design of the experiment was Randomized Complete Block Design (RCBD) with five replications. Every plot received recommended rate of nitrogen, phosphorus and potash fertilizer. The promising text crop was sweet gourd. Field Soil salinity was recorded at 15 days intervals. The treatments were early pit method, tray seedling transplanting and seed sowing directly conventional method. After three months of seed sowing into early pit method, tray seedling transplanting and conventional method the highest soil salinity (14.2 dS/m) and the lowest soil salinity (2.9 dS/m) were found at conventional method plot and early pit method plot respectively in the month of May. Early pit method treatment obviously has increased the growth and yield attributes of sweet gourd. The highest value of four growth parameters viz., fruit length (18.28 cm), fruit diameter (62.73 cm) , fruit weight (3.32 kg) and total yield (24.62 t/h) were found on early pit method as compared to other method. Again, the lowest value of four growth parameters i.e., fruit length (13.17 cm), fruit diameter (49.44 cm) , fruit weight (1.98 kg) and total yield (15.55 t/h) were found on conventional method respectively. The changing of crop production time and method has a positive effect on fruit yield. Application of different time of cultivation and method increase soil moisture content and reduce electrical conductivity therefore it is recommended for sustainable yield of sweet gourd in saline soil and reduces soil salinity related land degradation and have a great potential under saline prone areas.

Keywords: salinity; pit method; tray; conventional; potential

Introduction

Limitation in crop productions in south and south western area due to salinity problem in soil and water is a very serious problem. In the coastal saline belt with short winter season timely sowing/planting of Rabi (winter season) crops is essential but this is restricted by late harvest of aman rice. Rainy water storing in land causes late water recession from the cropping land. This water inundation condition makes the 'Joe' stage occurring in late in soil. And when Joe comes in cropping soil, at the same time salinity starts to increase in soil and water. Evaporation, evapotranspiration, hydrolysis, and leakage are the causes of salt accumulation when mineralized ground water near the ground surface continually evaporates and causes minerals to precipitate and by evapotranspiration where infiltrating recharge water is continually taken up by plants and salt is concentrated in the unsaturated root zone. It is very difficult to control of salinity existing

in soil and water. It affects crops depending on degree of salinity at the critical stages of growth, which reduces yield and in severe cases total yield is lost. If planting date or seedling transplantation may change in early or time may convert in different sowing time, it will cause the crop production in early without any damage of yield. It will prohibit salt storing and upward in top soil by breaking down the capillary action that increases starts from last of February. Ground water depth and salinity are affected by the sea and river water level and river water salinity. Since groundwater is the lower boundary condition of surface soil salinity, and also groundwater is closed related to river water, it is the important link between soil and river water. As the river water level and salinity changes, groundwater environment and soil salinity would be affected. Salinity level increases starts from February to May and decrease starts from the starting of rainy season in every year. It has a great effect on crop yield in dry season due to increased salinity level. If fresh water supply may increase in dry season, it reduces the salinity effect in crop production in Khulna. Rainfall also reduces the surfaces soil salinity. Soil salinity adversely influences seed germination, agricultural productivity, and soil and water quality, particularly in semiarid and arid regions, bringing about loss of arable areas and land degradation (Balkanlou et al., 2020; Bennett et al., 2019; Buthelezi-Dube et al., 2020). Soil salinization is the main reason for land degradation and crop yield reduction (Ivushkin et al., 2019; Makinde & Oyelade, 2019). In dry irrigated regions, the combination of elevated evapotranspiration (ET), little precipitation and soil factors hamper infiltration. Agricultural land use in these areas is very poor, which is much lower than a country's average cropping intensity that cause hydrological situation that restrict the normal crop production throughout the year. The factors which contribute significantly to the development of saline soil are tidal flooding during wet season (June to October), direct inundation by saline water, and upward or lateral movement of saline ground water during dry season (February to May). The severity of salinity problem in Bangladesh increases with the desiccation of the soil. In general, soil salinity is believed to be mainly responsible for low land use as well as low cropping intensity in the area (Rahman & Ahsan, 2001). Salt accumulation in the root zone or soil surface results in loss of soil fertility and alters the soil properties and therefore harmfully impacts soil's environmental functions (Fu et al., 2020). For instance, it restricts water intake and soil water capacity limit to plant uptake, which prompts surface runoff and erosion (Gorji et al., 2020). The occurrence of parent materials and physical or chemical weathering of minerals and seawater intrusion is the leading natural cause of soil salinization (Ramos et al., 2020). Saltwater intrusion is a natural process where seawater mix with coastal groundwater aquifers due to the density difference between saline and fresh waters, creating a barrier that evolves landward (Barlow and Reichard, 2010). Since, soil "joe" condition comes late in coastal area, thus farmer starts cultivation in late and that is why that crop faced high salinity. But if we start cultivation early, then we can avoid salinity. Thus, the study was carried out to find out the yield of sweet gourd by avoiding the soil salinity.

Materials and Methods

Study location

   This experiment was conducted at the Salinity Management and Research Centre (SMRC), Soil Resource Development Institute, Batiaghata, Khulna, Bangladesh during the Kharif-1 season of 2024. Geographically, the study site was at 22°46'01.8" N latitude and 89°24'15.2" E longitude and under AEZ-13. With an average yearly temperature of 79.3 °F and monthly mean temperatures ranging from 52.4 °F in January to 99.8°F in May, the area is among the warmest in Bangladesh (AEZ-13). Land type of plot was medium high land, Land use was F-KV-TA, Depth of flooding 1.5 to 2.0 feet, duration of flooding was 3-4 months, Soil series was Barisal.

Experimental design

   The following expecting experiment was carried out in Randomized Complete Block Design (RCBD) with three replications. Sweet gourd (variety: Maya) was taken as an experimental crop. Three experimental treatments were considered: (a) early pit method, (b) Tray seedling transplanting method, (c) Conventional pit preparation method with three replications.

Preparation of early pit

   Water recession condition of south west part of Bangladesh is late. Thus "joe" condion comes at first week of February. Before that soil keep moist. In early pit method, pit was prepared in 01-02-2024 in moist soil without ploughing the land. Then pit was kept fallow in sunshine. The "joe" condition of pit came in 10-02-2024. Then sweet gourd seed was sown in 10-02-2024.

Tray seedling preparation

   The second method was transplanting of tray seedling. Seedlings were grown early in tray. Seed was sown in tray in 25-02-2024. 15 days old seedlings were transplanted in main field in 13-03-2024.

Conventional pit preparation

   In conventional method land was plough and made pit. Then pit soil and other fertilizer treatments were mixed with soil very properly. After processing the pit area, seeds were sown in the pit in 13-03-2024. Soil salinity was measured by using an EC Meter at 15 days intervals. All the intercultural operations like watering, gap filling, staking, weeding, and plant protection measures were executed very carefully.

Measurement of Growth and Yield attributes

   Experiment was carried out for four growth and yield parameters such as fruit length (cm), fruit diameter (cm), single fruit weight (kg) and total yield (t/ha) were taken into consideration to analyze the effect of different pit method on yield of sweet gourd. Total yield (t/ha) was calculated by measuring the total fruit weight of the plot.

Initial Chemical properties of soil of pot							
pH	OM (%)	K meq/100 gm soil	Total N (%)	P	S	Zn	B
				μg/g			
7.6	2.98	0.37	0.17	10.72	14.98	2.96	0.52

Statistical Analysis

The collected data were tabulated and statistically analyzed using Statistix10 software. The treatment means were separated statistically at a 5 % level of significance using Duncan's Multiple Range Test (DMRT).

Results and Discussion

Soil salinity condition of different types of pit

When seed was sown (10-02-2024) in pit that made early method, then soil salinity was 2.9 dS/m. At the time of tray seedling sowing and normal seed sowing (13-03-2024), then soil salinity was 4.5 dS/m (Table 1). Soil salinity of early pit method at harvesting time (28-04-2024) was 8.1 dS/m, whereas other two method pit crops were in growing condition. In 13-05-2024 tray seedling crops were harvested and that time salinity was increasing at that time. Crops grown in conventional method harvested in 28-05-2024, faced long period high salinity. At harvesting time of conventional method the salinity was 14.2 dS/m.

Table 1: EC (dS/m) at different sowing/transplanting date in the field

Treatment	EC (dS/m)					
	10-02-2024	13-03-2024	13-04-2024	28-04-2024	13-05-2024	28-05-2024
T$_1$ (Early pit method)	2.9	4.5	6.6	8.5	-	-
T$_2$ (Tray seedling method)	-	4.5	6.6	8.5	11.9	-
T$_3$ (Conventional method)	-	4.5	6.6	8.5	11.9	14.2

EC: Electrical Conductivity

EC determined by 1: 1 extraction Method

Effects of different sowing method on Yield Attributes of sweet gourd
Fruit length of sweet gourd

The research showed that, the fruit length varies to a great extent that was statistically analyzed as shown in Table 2. Fruit length showed a significant variation in relation to different pit method treatment. After production with different pit method, the fruit length at early pit method (seed sown in 10-02-2024) was 18.28 cm, the fruit length at tray seedling method (transplanted at 13-03-2024) was 15.23 cm and the fruit length at conventional method (seed sown in 13-03-2024) was 13.17 cm. The highest fruit length (18.28 cm) was found at early pit method while the lowest fruit length (13.17 cm) was found where conventional method was followed. It was also found that fruit length (cm), numbers of fruit per plant of sweet gourd were significantly

superior in early pit method to other treatments plot. Other planting treatments resulted in poor growth and yield of sweet gourd.

Table 2: Yield and Yield attributes of sweet gourd at different sowing method

Treatment	Fruit Length (cm)	Fruit Diameter (cm)	Fruit weight (kg)	Yield (t/ha)
T1 (Early pit method)	18.28 a	62.73 a	3.32 a	24.62 a
T2 (Tray seedling method)	15.23 b	55.64 b	2.45 b	20.45 b
T3 (Conventional method)	13.17	49.44 c	1.98 c	15.55 c
CV	4.56	6.85	7.06	7.33
LSD	1.03	5.58	0.26	2.16

Fruit Diameter of sweet gourd

Salts affect plant growth due to increasing soil osmotic pressure and to interference with plant nutrition. A high salt concentration in soil solution reduces the ability of plants to acquire water, which is referred to as the osmotic or water deficit effect of salinity. The highest fruit diameter (62.73 cm) was found at early pit method. In case of tray seedling method, the fruit diameter was 55.64 cm and in case of conventional method, the fruit diameter was 49.44 cm. The highest fruit diameter (62.73 cm) was observed at early pit method in comparison with the conventional planting method where the lowest fruit diameter (49.44 cm) was found (Table 2). It is a great sign that shows different pit method cultivation positively affect the soil salinity and manipulates the soil structure, texture, biochemical reaction and soil fertility. It is also found that fruit diameter, numbers of fruits per plant and other growth of sweet gourd were significantly superior in early pit method to other method of another plot. Salinity lowers the total photosynthetic capacity of the plant through decreased leaf growth and inhibited photosynthesis limiting its ability to grow.

Single fruit weight of sweet gourd

Sweet gourd yield parameters and single fruit weight grown under different methods are presented in Table 2. Statistical analysis was carried out on yield and yield attributes which revealed that these are significantly varied due to different planting method. The single fruit weight 3.32 kg was found in early pit method. In case of tray seedling method, the single fruit weight was 2.45 kg and in case of conventional method, the single fruit weight was 1.98 kg. The highest single fruit weight 3.32 kg was observed in early pit method in comparison with the conventional method where the lowest single fruit weight 1.98 kg was found (Table 2). That experiment indicated that plants under different planting method produce larger fruit and have higher single fruit weight per plant because of the better plant growth that is due to a favorable agro climate environment of soil and a completely moderate environment. Different planting method changes the micro environment of the plant and thus it enhances plant growth and vigor as well as production.

Total yield of sweet gourd

Soil salinity works against the growth of plants and developmental structure that varies of sweet gourd due to different planting method at different plot. The total yield and yield attributes grown under different pit method are presented in Table 2. Statistical analysis was carried out on yield and yield attributes which revealed that these are significantly varied due to different pit method. The total yield of fruit (24.62 t/ha) was found in early pit method. In case of tray seedling method, the total yield of fruit was 20.45 t/ha but in case of conventional method, the total yield of fruit was 15.55 t/ha. The highest total fruit yield (24.62 t/ha) was observed in early pit method in comparison with the conventional method where the lowest total fruit yield (15.55 t/ha) was found (Table 2).

Conclusion

Soil salinity is becoming a major constraint to vegetable crop production. These experiments point out that, soil salinity remain by the following order of planting method: early pit method > tray seedling method > conventional method. Different growth and yield attributes were significantly impacted due to different pit method. These results showed that, early pit method gave the highest total yield (24.62 t/ha) whereas, the lowest total yield (15.55 t/ha) was recorded in conventional method. It may be concluded that early pit method may be helpful for avoiding soil salinity.

Effect of Different doses of gypsum on Soil Salinity and Yield of Sweet gourd in Coastal Saline Soil

A Biswas, Md. Z Islam

Abstract

Soil salinity obviously is a major threat for growing sweet gourd vegetables in the coastal zone of Bangladesh. A noticeable experiment was conducted at Salinity Management and Research Center, Soil Resource Development Institute, Batiaghata, Khulna during Kharif-1 season in 2024 to investigate the effect of different doses of gypsum on soil salinity and yield of sweet gourd to find out if gypsum fertilizer can reduce soil salinity related degradation of soil and increase sweet gourd yield. There were five treatments having control (no application of gypsum/pit), gypsum fertilizer (5 g/pit), gypsum fertilizer (10 g/pit), gypsum fertilizer (15 g/pit) and gypsum fertilizer (20 g/pit). The design of the experiment was Randomized Complete Block Design with three replications. Every plot received recommended rate of nitrogen, phosphorus and potash fertilizer. The promising text crop was sweet gourd. Field Soil salinity was recorded at 30 days intervals. After three months of seed sowing, the highest soil salinity (15.5 dS/m) and lowest soil salinity (9.2 dS/m) were found at no gypsum application plot (control) and 20 g/pit of gypsum application treatment respectively in the month of June. Gypsum (20 g/pit) treatments obviously have increased the growth and yield attributes of sweet gourd. The highest value of four growth parameters viz., fruit length (20.54 cm), fruit diameter (61.89 cm) , fruit weight (3.10 kg) and total

yield (28.28 t/h) were found on gypsum treatment (20 g/pit) as compared to other treatments. Again, the lowest value of those four growth parameters i.e., fruit length (9.35 cm), fruit diameter (40.40 cm) , fruit weight (1.43 kg) and total yield (14.58 t/h) were found on control (no gypsum application) respectively. The gypsum application has a positive effect on fruit yield when it is applied with precise rate. Application of gypsum reduces soil salinity related land degradation in salt affected region of Bangladesh.

Introduction:

Soil salinity impedes soil and crop productivity in over 900 million hectare of arable lands worldwide due to the excessive accumulation of salt (NaCl) (Kumar,et al., 2018, Wani, et al., 2020). For utilizing saline soils in agriculture, halophytes (salt-tolerant plants) are commonly cultivated. Most food crops are glycophytes (salt-sensitive). Thus, to enhance the productivity of saline soils, gypsum ($CaSO_4 2H_2O$) has been continuously recognized to improve the biological, physical and chemical properties of saline soils. Gypsum ($CaSO_4 2H_2O$) regulates the exchange of sodium ($Na+$) for calcium (Ca_2+) on the clay surfaces, thereby increasing the $Ca_2+/Na+$ ratio in the soil solution (Pitman, et al., 2002). gypsum has been reported several times to sustain optimal $K+/Na+$ and $Ca_2+/Na+$ ratios, reduced pH as well as furnish crops with the required S nutrition in saline soils (Ahmed, et al., 2016; Abdel Hamid et al., 2013, Abdel-Fattah, M.K, 2015). Intracellular, Ca_2+ also promotes a higher $K+/Na+$ ratio (Almeida, et al., 2017). Simultaneously, gypsum furnishes crops with sulfur (S) for enhanced growth and yield through the increased production of phytohormones, amino acids, glutathione and osmoprotectants, which are vital elicitors in plants responses to salinity stress (Gadallah, 1999). Gypsum as a cheapest source of reclamation has been reported by many workers (Mohammad et al., 1969; Ghafoor & Muhammed, 1981; Ramzan et al., 1982). The use of gypsum as a reclaim agent is the most economic one compared to rest of other chemical reclaim agent. Its rate of dissolution in the irrigation water is very low and therefore its application needs large amount of irrigation water (Richards, 1954; Murphy, 2018). Oster and Halvorson (1978) however, have shown that the solubility of gypsum may increase more than other fertilizer when an amendment mixed with highly saline soils. Through the provision of S, gypsum increases plants' tolerance and resistance to both biotic and abiotic stress factors by aiding the synthesis of proteins, chlorophyll-containing compounds as well as an increased uptake of P and N (Capaldi, et al., 2015,Wiedenfeld, et al., 2011). Soil salinity could be a major restricting factor that imperils the capacity of agricultural crops to sustain the developing human population. It is characterized by a high concentration of solvent salts that significantly decreases the yield of most crops (Sharma A, et al., 2016).The ameliorating effect of gypsum on saline soils, sweet gourd was selected to monitor its response to various levels of gypsum doses under saline conditions, as sweet gourd influenced by the gypsum amendment. In this respect the residual effect of gypsum was also evaluated by next growing crop in the same land.

Keywords: salinity; gypsum; sulfur; halophytes; glycophytes.

MATERIALS AND METHODS

Study location

This experiment was conducted at the Salinity Management and Research Centre (SMRC), Soil Resource Development Institute, Batiaghata, Khulna, Bangladesh during the Kharif-1 season of 2024. Geographically, the study site was at 22°46'01.8" N latitude and 89°24'15.2" E longitude and under AEZ-13. With an average yearly temperature of 79.3 °F and monthly mean temperatures ranging from 52.4 °F in January to 99.8°F in May, the area is among the warmest in Bangladesh (AEZ-13). Land type of plot was medium high land, Land use was F-KV-TA, Depth of flooding 1.5 to 2.0 feet, duration of flooding was 3-4 months, Soil series was Barisal.

Fertilizer at experimental plot

The following expecting experiment was carried out in Randomized Complete Block Design with three replications. Sweet gourd (variety: Maya) was taken as an experimental crop. Five experimental treatments were considered: (a) control (no gypsum application), (b) Gypsum at 5g/pit, (c) Gypsum at 10g/pit, (d) Gypsum at 15g/pit and (e) Gypsum at 20g/pit with 4 replications. For gaining good tilt, soil condition, the experiment plot was prepared by several ploughs and cross plough followed by laddering and harrowing with tractor and power tiller. Weeds and other stables were removed carefully from the experimental plot and leveled properly. Basal doses of fertilizer as soil test base were applied during land preparation.

Pit preparation

Total land was designed according to achieving the expected yield. Pit was made by measuring one foot length x one foot breadth that was determined in earlier. Then five experimental treatments were considered: (a) control (no gypsum application), (b) Gypsum at 5g/pit, (c) Gypsum at 10g/pit, (d) Gypsum at 15g/pit and (e) Gypsum at 20g/pit. Then pit soil and gypsum treatments were mixed with soil very properly, leveling and distinguished according to the gypsum treatments. After processing the pit area, seeds were sown in the pit with experiments need. Proper care and management were taken when pit was prepared. Necessary care and other intercultural operations were done when necessary. Data were recorded in accordance with the requirements. Soil salinity was measured by using an EC Meter at 15 days intervals. All the intercultural operations like watering, gap filling, staking, weeding, and plant protection measures were executed timely and carefully.

Measurement of Growth and Yield attributes

Four growth and yield parameters such as fruit length (cm), fruit diameter (cm), fruit weight (kg) and total yield (ton/hectare) were taken into consideration to analyze the effect of gypsum treatments on yield of sweet gourd. Total yield (t/ha) was calculated by measuring the total fruit weight of the plot.

Initial Chemical properties of soil of pot

pH	OM (%)	K meq/100 gm soil	Total N (%)	P	S	Zn	B
				μg/g			
7.4	1.95	0.22	0.11	17.52	57.25	1.03	1.22

Statistical Analysis

The collected data were tabulated and statistically analyzed using Statistix10 software. The treatment means were separated statistically at a 5 % level of significance using Duncan's Multiple Range Test (DMRT).

Results and Discussion

Effects of Different gypsum treatments on Soil Salinity reduction

Soil salinity strength is a most carrier of harmful effect for crop production in salt based land. In modern studies has shown that gypsum is a promising technique for soil salinity control in present agriculture. An upward trend of soil salinity at all treatments was observed from March to June (Table 1). In the month of March, the lowest soil salinity was found at gypsum treatments at 15g/pit and 20g/pit (4.0 dS/m) respectively, while the highest soil salinity was observed at control (4.2 dS/m) where no gypsum was applied. Since soil salinity increases gradually from the month of March to June, the lowest salinity was found in the month of March (4.0 dS/m) as compared to the highest in the month of June (15.5 dS/m). In the month of June, the lowest soil salinity was found at gypsum application at 20g/pit (9.2 dS/m) in comparison with the highest soil salinity found in control there was no application of gypsum (15.5 dS/m) (Table 1). This data proved that soil salinity can be reduced by using different doses of gypsum. Application of gypsum has a great significant effect on reducing soil salinity. Gypsum is a salt reducing chemical that protect the upward movement of salinity capillary action to the top soil and promote the crop production.

Table 1: Month wise soil salinity of the experimental plot

Treatment	Month wise Soil salinity (EC: dS/m)			
	March	April	May	June
T_0 (Control)	4.2	7.5	11.0	15.5
T_1 (5 gm/pit)	4.1	6.9	9.8	11.2
T_2 (10 gm/pit)	4.1	6.7	8.7	9.8
T_3 (15 gm/pit)	4.0	6.5	8.6	9.3
T_4 (20 gm/pit)	4.0	6.5	8.5	9.2

Effects of different doses of gypsum on Yield Attributes of sweet gourd

Fruit length of sweet gourd
This experiment proved that, the fruit length varies to a great extent that was statistically analyzed as shown in Table 2. Fruit length showed a significant variation in relation to different doses of gypsum application. After treating with gypsum, the fruit length at control treatment (no gypsum was applied) was 9.35 cm, the fruit length at 5 gm/pit of gypsum application was 15.45 cm, the fruit length at 10 gm/pit of gypsum application was 19.33 cm, the fruit length at 15 gm/pit of gypsum application was 19.92 cm, but the highest fruit length (20.54 cm) was found at 20 gm/pit of gypsum application and all of three applications were statistically similar. The lowest (9.35 cm) was found in control condition where no gypsum was applied. It is also found that fruit length (cm), numbers of fruit per plant of sweet gourd were significantly superior at 10 gm/pit, 15 gm/pit and 20 gm/pit of gypsum treatments to other non management plot or other fertilizer treatments, while plants without gypsum treatments (control condition) resulted in poor growth and yield sweet gourd.

Table 2: Yield and Yield attributes of sweet gourd in saline soil

Treatment	Fruit Length (cm)	Fruit Diameter (cm)	Fruit weight (kg)	Yield (t/ha)
T_0 (Control)	9.35 c	40.40 c	1.43 c	14.58 c
T_1 (5 gm/pit)	15.45 b	55.06 b	1.95 b	18.75 b
T_2 (10 gm/pit)	19.33 a	60.53 a	2.78 a	26.66 a
T_3 (15 gm/pit)	19.92 a	61.53 a	2.95 a	27.54 a
T_4 (20 gm/pit)	20.54 a	61.89 a	3.10 a	28.28 a
CV (%)	7.69	4.28	8.12	4.43
LSD	2.44	4.49	0.37	1.93

Fruit Diameter of sweet gourd
The application of gypsum in soil maintains a good soil condition and decrease the level of salinity strength. The fruit diameter (40.40 cm) found at control condition where no gypsum was applied. In case of 5 gm/pit of gypsum application, the fruit diameter was 55.06 cm and in case of 10 gm/pit of gypsum application, the fruit diameter was 60.53 cm, but at the rate of 15 gm/pit of gypsum application it was found that the fruit diameter was 61.53 cm. The highest fruit diameter (61.89 cm) was observed at 20 gm/pit of gypsum application which is statistically similar in comparison with all the three applications to control treatment (no gypsum treatment was applied) where the lowest fruit diameter (40.40 cm) was found (Table 2). It is a great sign that shows different doses of gypsum positively affect the soil salinity and manipulates the soil structure, texture, biochemical reaction and soil fertility. It is also found that fruit diameter (cm), numbers of fruits per plant and

other growth of sweet gourd were significantly superior in gypsum treatments to other none management plots or other fertilizer treatments, while plants without gypsum treatments (control condition) resulted in poor growth and total yield components sweet gourd.

Fruit weight of sweet gourd
Different growth stages and development structure that was expected varies of sweet gourd due to different doses of gypsum application at the different plot. Sweet gourd yield parameters and fruit weight grown under different gypsum treatments are presented in Table 2. Statistical analysis was carried out on yield and yield attributes which revealed that these are significantly varied due to different doses of gypsum. The fruit weight (1.43 kg) found at control condition where no gypsum was applied. In case of 5 gm/pit of gypsum application, the fruit weight was 1.95 kg and in case of 10 gm/pit of gypsum application, the fruit weight was 2.78 kg, but at the rate of 15 gm/pit of gypsum application it was found that the fruit weight was 2.95 kg. The highest fruit weight (3.10 kg) was observed at 20 gm/pit of gypsum application that were statistically similar with other three treatments in comparison with the control treatment (no gypsum treatment was applied) where the lowest fruit weight (1.43 kg) was found (Table 2). That experiment indicated that plants under gypsum treatments produce larger fruit and have higher fruit weight per plant because of the better plant growth that is due to a favorable agro climate environment of soil and a completely moderate environment. The data depicted that the highest fruit weight (3.10 kg) was found at 20 gm/pit of gypsum application while the lowest (1.43 kg) was found where no gypsum was applied. Application of gypsum changes the micro environment of the plant and thus it enhances plant growth and vigor as well as production. This result may be due to the improvement of soil physical properties as well as increasing soil water holding capacity which gave rise to good aeration and drainage that encourage better root growth and nutrient absorption. It also helps to uptake of others nutrient by making easy soil metabolism.

Total yield of sweet gourd
Soil salinity works against the growth of plants and developmental structure that varies of sweet gourd due to different doses of gypsum application at the different plot. The total yield and yield attributes grown under different gypsum treatments are presented in Table 2. Statistical analysis was carried out on yield and yield attributes which revealed that these are significantly varied due to different doses of gypsum. The total yield of fruit (14.58 t/ha) was found at control condition where no gypsum was applied. In case of 5 gm/pit of gypsum application, the total yield of fruit was 18.75 t/ha and in case of 10 gm/pit of gypsum application, the total yield of fruit was 26.66 t/ha, but at the rate of 15 gm/pit of gypsum application it was found that the total fruit yield was 27.54 t/ha. The highest fruit yield (28.28 t/ha) was observed at 20 gm/pit of gypsum application which were statistically similar to all three treatments in comparison with the control treatment (no gypsum treatment was applied) where the lowest fruit yield (14.58 t/ha) was found (Table 2) The experimental data indicated that the plants under gypsum treatments produce larger fruit and have higher fruit yield per plant because of the better plant growth that is due to a favorable agro climate environment of soil and a completely moderate environment. The data showed that the highest

total yield (28.28 t/ha) was found at 20 gm/pit of gypsum application while the lowest (14.58 t/ha) was found where no gypsum was applied. Application of gypsum changes the micro environment of the plant and thus it enhances plant growth and vigor as well as production and total yield. This result may be due to the improvement of soil physical properties as well as increasing soil water holding capacity which gave rise to good aeration and drainage that encourage better root growth and nutrient absorption. Gypsum reaction in soil makes it good nutrient up taking condition and helps to yield contributing parameters high.

Conclusion

Soil salinity management practices and the overcoming from soil salinity are central issues to agricultural productivity. It may be resolved from the experiment's findings that using gypsum prompts to a noticeable decrease in the accumulation of soil salinity. The maximum soil salinity reduced by using 20 gm/pit of gypsum in comparison with the control treatment where no gypsum was applied. This experiments point out that, soil salinity reduce by the following order of treatment: 20 gm/pit of gypsum > 15 gm/pit of gypsum > 10 gm/pit of gypsum > 5 gm/pit of gypsum > control. Different growth and yield attributes were significantly impacted due to different gypsum treatments. This results showed that, 20 gm/pit of gypsum treatment gave the highest yield (28.28 t/ha) whereas, the lowest yield (14.58 t/ha) was recorded in control (no application of gypsum) treatment. Among five of gypsum treatment, 10, 15 and 20 gm/pit of gypsum treatment gives statistically similar result in Barisal soil. Thus 10 gm/pit gypsum can be used at the farmer's level to reduce soil salinity strength and increase the yield of sweet gourd. For increasing the yield of sweet gourd and reclamation of saline soil further research is still needed to work out a cost effective technology.

Effect of different strength of soil salinity on growth and yield of cauliflower
A Biswas, Md. Z Islam

Abstract
Salt concentration in saline soil is a serious agricultural problem in south and south-western part of Bangladesh. This salt intensity creates a vital obstruction for cauliflower (*Brassica oleracea* Lin.) and other crops production. The experiment was conducted in the Salinity Management and Research Center under Soil Resource Development Institute at Batiaghata, Khulna to observe the effects of soil salinity strength management on growth and yield of cauliflower. The research work was conducted in a completely randomized design (CRD) with three replication of salt concentration (2, 4, 6, 8, 10, 12 dS/m EC). Result of the experiment showed that the different combinations of soil salinity significantly influenced all the indicators that studied. Yield performance per plant was investigated for Plant height (cm), Numbers of leaves/ plant, Leaf length (cm), Spreading diameter (cm), Curd diameter (cm), Curd yield/plant (gm) and Gross yield/plant (gm). The yield data were recorded at harvest time. The parameters were significantly varied due to soil salinity management. The Higher curd yield/plant (741 gm) was found in T_1

treatment (2±0.2 dS/m EC). It was demonstrated that salinity strength affect to decrease all the indicators that impact directly to the cauliflower yield with the increasing salt intensity.

Introduction

Cauliflower (*Brassica oleracea* Lin.) is one of the popular cole crops (botrytis Group) belonging Brassicaceae family (or Cruciferae) in the world. In the cultivation time excess salt level in saline soil causes serious physiological functional disorders, limiting vegetative and reproductive growth of vegetables and causes fertilization disorders decreases in marketing values, and also causes plant death (Dolarslan and Gul, 2012). Soil Salinity tolerance levels that affect yield are between 1.0-2.5 dS/m EC (Machado and Serralheiro, 2017). Cauliflower is a moderate salt sensitive vegetable, and the soil salinity uptaking level of irrigation water yield of cauliflower starts to decline between 1.9 and 2.7 dS/m EC (Snapp et al., 1991; Kotuby et al., 1997). The optimum temperature for cauliflower with stands is 10° to 15°C. Soil salinity strength effects the extensive number of observations on the physiology of plant salt tolerance to a genetic basis and particular modification (Zhu, 2000; Pardo, 2010). Soil salinity is a serious problem in arid and semi-arid region of the world where poor quality water is available for irrigation (Tanji, 1990; Maas and Grattan, 1999). The yield of cauliflower is low due to lack of proper management practices and nutrients deficiency in the saline soil. National production of cauliflower was 268.48 thousand MT from 19.42 thousand ha (BBS, 2016). It was estimated that about 20% (45 million ha) of irrigated land, producing one-third of the world's food, is salt-affected (Shrivastava, P.; Kumar, R., 2015). The amount of world agricultural land destroyed by salt accumulation each year is estimated to be 10 million ha (Pimentel, D et al., 2004). It is estimated that, by 2050, 50% of the world's arable land will be affected by salinity (Bartels, D.; Sunkar, R., 2005). In saline region it is almost impossible to cultivate more than one crop for salt concentration in soil and water. Farmer can not supply fresh and salt free irrigation in their field at crops demand time due to salinity problem in soil and water. The proper management of adequate soil physical, chemical and biological properties in saline environments may be gain by using irrigation water and soil amendments and proper cultural practices (Grattan and Oster, 2003). Short duration vegetables can be introduced in that region of medium high land. There is a huge scope in saline areas for vegetable cultivation through intensification and diversification of technology in the medium high land during winter. The shortage of fresh water and soil salt level, negatively effects on plant growth (Asık et al., 2009). Cauliflower would be a promising crop for that region. After recession of saline water and minimum salt concentration in soil and water, cauliflower and other winter vegetables could be grown easily in south saline area. Soil salinity generally stresses plant growth responses from specific salt tolerance properties (Dalton et al., 2000). Salinity inhibits photosynthesis by decreasing CO_2 availability as a result of diffusion limitation (Flexas, J, et al., 2007) and a reduction of the contents of photosynthetic pigments. Salt accumulation in cauliflower inhibits photosynthesis, primarily by decreasing stomatal and mesophyll conductance to CO_2 (Di Martino, C.; Delfine, S.; Alvino, A.; Loret, 1999) and reducing chlorophyll content, which can affect light

absorbance (Thompson et al., 2007).Appropriate saline water and soil management would play an important role in plant growth and curd formation especially in saline soil in winter crops production. In saline soil condition, Saline water should be used optimally and carefully to get the desire results from the irrigated crops (Alsaadawi and Mohamed ,2000). Research showed that saline soil and water management enhanced curd yield/plant, gross yield/plant and yield attributes substantially. Utilization of saline water has been well documented to improve physical, chemical and biological properties of soil. But the farmers of saline area are not habituated of cauliflower cultivation with proper soil salinity management of the crop. The goal of this study was to test the salt tolerance of cauliflower at different soil salinity level. As a result, the current study was designed to evaluate the impacts of saline soil on cabbage growth and yield.

Materials and methods

The experiment was carried out at the salinity management and research center, under soil resource development institute, Batiaghata, Khulna to test the effect of different strength of saline soil on emergence, growth and yield of cabbage plant. Plastic pots were used in conducting the experiment. The plastic pots were firstly washed and followed by rinsing with distilled water. Then those pots were dried in air. After drying the plastic pots were ready for the experiment. Finely prepared soil was filled of the pot by saline soil. Necessary amount of salt treatment was given to create saline environment by saturating the soil before placing the cabbage seedling. The trial included the following treatments: $T_1 = 2\pm0.2$ dS/m EC, $T_2 = 4\pm0.2$ dS/m EC, $T_3 = 6\pm0.2$ dS/m EC, $T_4 = 8\pm0.2$ dS/m EC, $T_5 = 10\pm0.2$ dS/m EC and $T_6 = 12\pm0.2$ dS/m EC. The single factor experiment used Completely Randomized Design (CRD) with three replications. The experiment was divided into three equal replication blocks, each with six plots. As a result, the total number of unit plots was 18. The experiment's treatment combinations were randomized at random to 18 plots, each with three replications. Proper management about salinity control over the pot and growth of plants were observed. Time to time weeding, fertilizer application, irrigation, pot checking and special care to plant proper growth were following up to yield harvesting. Every three days later water application, pest controlling chemical and abiotic affect was observed. The data was collected at 60 days after cauliflower was fully matured. Intercultural operations were carried out when needed. The following yield related indicators were measured: Plant height (cm), numbers of leaves/plant, leaf length (cm), Spreading diameter (cm), Curd diameter (cm), Curd yield/plant (gm) and Gross yield/ plant (gm).

Preparation of saline soil

For developing the expected soil salinity of 2 to 12 dS/m EC, salt affected soil was collected from different place of saline affected area. Different concentrations of soil salinity (2, 4, 6, 8, 10 and 12 dS/m EC) was applied to the transplanted seeding on plastic pot. The salinity level was maintained by assessing the salt level from laboratory test.

<p style="text-align: center">Initial Chemical properties of soil of pot</p>

pH	OM (%)	K meq/100 gm soil	Total N (%)	P	S	Zn	B
				μg/g			
7.4	1.95	0.22	0.11	17.52	57.25	1.03	1.22

Statistical analysis

The data obtained for different characters were statistically analyzed. The mean values of all the characters were evaluated and analysis of variance was performed by the 'F' test by using statistix software, version 10.

Results and discussions

Plant height

The highest cauliflower plant height was found at T_1 (2±0.2 dS/m EC) treatment. The highest plant height at T_1 (2±0.2 dS/m EC) is 43.13 cm. The plant height at T_2 (4±0.2 dS/m EC) treatment is also the highest and that is 41.40 cm. In T_3 (6±0.2 dS/m EC) treatment, the plant height is 37.53 cm. At the T_4 (8±0.2 dS/m EC) treatment, plant height is 34.96 cm. The plant height at T_5 (10±0.2 dS/m EC) is 32.60 cm and the lowest plant height is at T_6 (12±0.2 dS/m EC) treatment that is 30.70 cm. So, the highest plant height at T_1 (2±0.2 dS/m EC) is 43.13 cm & T_2 (4±0.2 dS/m EC) is 41.40 cm and the lowest plant height is at T_6 (12±0.2 dS/m EC) treatment is 30.70 cm respectively (shown in table No. 01). The main causes of above result are the presence of available salinity strength of soil in sole application to pot for plant growth.

Table 1: Different plants parameter of different growth stages at different Soil salinity strength.

Treatment	Plant height (cm)	Number of leaves plant/plant	Leaf length (cm)	Spreading Diameter (cm)
T_1 (2±0.2 dS/m EC)	43.13 a	24.33 a	36.83 a	66.61 a
T_2 (4±0.2 dS/m EC)	41.40 a	20.00 b	33.36	63.59 ab
T_3 (6±0.2 dS/m EC)	37.53 b	17.66 c	32.56	61.37 b
T_4 (8±0.2 dS/m EC)	34.96 c	17.00 cd	28.00	56.50 c
T_5 (10±0.2 dS/m EC)	32.60 cd	16.00cd	24.66	53.38 cd
T_6 (12±0.2 dS/m EC)	30.70 d	15.00 d	23.33	50.06 d
CV	3.59	6.90	2.85	3.63
LSD	2.39	2.30	1.54	3.87

*EC determined by 1: 1 extraction Method

Number of leaves per plant

Number of leaves per plant for every cauliflower plants at different for soil salinity that has been shown in Table 1, because of the influence of different salinity strength of soil, a significant difference in number of leaves per plant was observed that was statistically significant at different level of salinity strength. The plants treated with T_1 (2±0.2 dS/m EC) had the highest number of

leaves per plant (24.33), at T_2 (4±0.2 dS/m EC) treatment, the plants had 20.00 number of leaves per plant, the plants treated with T_3 (6±0.2 dS/m EC) had the 17.66 number of leaves per plant. But the number of leaves per plant (17.00) treated with T_4 (8±0.2 dS/m EC) treatment. The plant treated with T_5 (10±0.2 dS/m EC) treatment has given 16.00 no. of leaves /plant. The lowest number of leaves per plant (15.00) treated with T_6 (12±0.2 dS/m EC). Effect of saline soil showed significant variations in leaves number to every plant.

Leaf length

Cauliflower plant showed significant variations in leaf length at 2, 4, 6, 8, 10 and 12 (±0.2 dS/m EC) of soil salinity strength (Table 1). Significant variation on leaf length was found due to application of different saline water strength. The maximum length of leaf (36.83) was found in T_1 (2±0.2 dS/m EC) treatment. But the lowest number of leaf length (23.33) treated with T_6 (12±0.2 dS/m EC). Due to different soil salinity preparation, the increase salt concentration hit to cell elongation and cell division probably influenced the leaf growth of cauliflower.

Spreading diameter

The Higher spreading diameter of cauliflower was observed at T_1 (2±0.2 dS/m EC) treatment that is 66.61 cm which is statistically similar to T_2 (4±0.2 dS/m EC) of 63.59 cm respectively (shown Table 1). The lowest spreading diameter was 50.06 cm at T_6 (12±0.2 dS/m EC). The interaction effects of cauliflower and saline soil showed significant variation in spreading diameter.

Yield contributing characters of cauliflower
Curd diameter

The maximum curd diameter was recorded at T_1 (2±0.2 dS/m EC) treatment and it was 19.33 cm shown (Table 2) while the lowest curd diameter (7.00 cm) was recorded with the T_6 (12±0.2 dS/m EC) with recommended saline soil management, Curd size has a positive response towards the proper irrigation and salt management. It is a mass message that, at 6, 8, 10 dS/m EC facing cauliflower has given salinity result based curd formation due to high soil salinity.

Table 2: Showing of different plant parameter of different growth stages for different Soil salinity strength.

Treatment	Curd Diameter (cm)	Curd yield (gm)	Biological yield (gm)
T_1(2±0.2 dS/m EC)	19.33 a	741.00 a	1208.7 a
T_2(4±0.2 dS/m EC)	16.83 b	622.33 b	1012.0 b
T_3(6±0.2 dS/m EC)	14.16 c	464.67 c	838.7 c
T_4(8±0.2 dS/m EC)	12.23 d	345.67 d	535.3 d
T_5(10±0.2 dS/m EC)	11.00 d	246.67 e	394.3e
T_6(12±0.2 dS/m EC)	7.00 e	98.33 f	286.0 e
CV	7.46	3.66	9.73
LSD	1.82	27.93	125.81

*EC determined by 1: 1 extraction Method,

Curd yield

Curd yield of cauliflower drastically affected by soil salinity. When the soil and water become saline then curd production get seriously low. The highest curd yield was recorded (shown Table 2) at T_1 (2±0.2 dS/m EC) treatment that was 741 gm and the lowest curd yield was recorded at T_6 (12±0.2 dS/m EC) of 98.33 gm. Combination of different saline soil gives result to curd yield goes down due to higher strength of saline soil.

Biological yield per/plant

Saline soil hardly performs for plant growth. The gross yield per plant was significantly influenced by different soil salinity strength (Table 2). The maximum gross yield/plant (1208.70 gm) was observed in T_1(2±0.2 dS/m EC) treatment, while the lowest gross yield/plant (286 gm) was observed in the plants treated with T_6 (12±0.2 dS/m EC). It is a clear message that, at 6, 8, 10 dS/m EC facing cauliflower plant has given salinity result based gross yield due to high soil salinity that is very drastically different to other plants yield.

Conclusion

This research results revealed that the cauliflower plants grow better with T_1(2±0.2 dS/m EC) soil salinity strength condition. The objective of the experiment was to determine the influence of different levels of soil salinity strength performance on cauliflower growth and production. From the results, it can be concluded that applying different levels of saline soil have a significant effect on cauliflower growth and yields. The highest gross obtained yield from lower level of soil salinity and gives the maximum gross yield (1208.70 gm) per plant is helpful for increasing the growth and yield of cauliflower. The findings of the research may be applicable to other region of the southern area of the country. However, further research work at different doses of salinity strength of saline soil on the growth and yield of cauliflower will need to be performed in different saline area of Bangladesh to suggest specific conclusions and recommendations.

Effect of different strength of soil salinity on growth and yield of cabbage

A Biswas, Md. Z Islam

Abstract

Salinity of soil is a major problem in south and south-western part of Bangladesh. An investigation was made on growth and yield performance of cabbage (*Brassica oleracea* var. *capitata*) under different soil salinity strength to plants by saline soil at salinity management and research center. The experiment was laid out in a completely randomized design (CRD) with three replications of salt concentration (2, 4, 6, 8, 10, 12 dS/m EC). Result of the experiment revealed that the different combinations of saline soil significantly influenced all the parameters that studied. Yield performance per plant was investigated for Plant Height (cm), numbers of leaves/plant, fresh

weight of loose leaves/plant (gm), diameter of head (cm), thickness of head (cm), fresh weight of head/plant (gm), numbers of folded leaves/plant and gross yield/ plant. It was proved that soil having salinity 2 dS/m gives the best result for all parameter of cabbage.

Introduction

Continuous rising of global temperature and associated climate changes are creating severe abiotic stresses that are seriously hampering crop yields and quality in many salt affected areas. Among those sufferings, major is soil salinity. Yield and quality traits of vegetable crops are adversely affected by environmental factors such as drought and/or high salinity of the root zone (Goyal et al., 2003). It is recognized that water and ions are the main physiological catalogue of processing plants physiology that need to optimize to resume growth in saline environments (Lauchli and Luttge, 2002). Over 9% of the world's total land and approximately 20% of irrigated land is affected by high salinity barrier. The problem is particularly severe in the Mediterranean, semi-arid and arid areas (Zhang et al., 2014; Munns and Gilliham, 2015). Cabbage (*Brassica oleracea var. capitata* L.) is a popular green leafy vegetable of the family Brassicaceae. It is an herbaceous, biennial, dicotyledonous flowering plant distinguished by a short stem crowned with a mass of leaves, typically green but in some varieties red or purple, which while immature form a characteristic compact, globular cluster (cabbage head). Photosystem II (PSII) is the most sensitive part of the apparatus to salt stress (Kalaji et al., 2011; Jajoo, 2014; Oukarroum et al., 2015). Cabbage is a great source of vitamin C, with a moisture content of 60.6%. It also contains vitamin B complex, potassium, and calcium (Haque KMF, 2006). Soil contributes to the maintenance of cells' redox systems and the regulation of stomatal aperture in drought and salinity responses (Sharma et al., 2017). Saline soil plays crucial roles in plants' physiological responses and adaptation to salinity stress (Fahad et al., 2015). Cabbage ranks second in terms of production and area among all vegetables grown in Bangladesh. It is grown on an 18 thousand hectares area with a total production of 312 thousand tons (BBS, 2017), but the yield is poor. In south and south-western part of Bangladesh is facing a huge constraint of salt problem. Every year farmers are losing their hope for cabbage cultivation for soil salinity. The main reason is NaCL toxicity in soil (Almeida et al., 2017). The reason for such low cabbage production is due to a lack of fresh water for cultivation. This low cabbage yield could be increased by adopting improved saline soil management research. It is very important to determine the limit of soil salinity that crops can tolerate and determine if they can uptake and accumulate salts to use them for soil desalination. This may encourage and motivate farmers to introduce cabbage plants into their cropping system. The goal of this study was to test the salt tolerance of Cabbage (*Brassica oleracea var. capitata* L.) at different soil salinity level. As a result, the current study was designed to evaluate the impacts of saline soil on cabbage growth and yield.

Materials and methods

The experiment was carried out at the salinity management and research center, under soil resource development institute, Batiaghata, Khulna to test the effect of different strength of saline

soil on emergence, growth and yield of cabbage plant. Plastic pots were used in conducting the experiment. The plastic pots were firstly washed and followed by rinsing with distilled water. Then those pots were dried in air. After drying the plastic pots were ready for the experiment. Finely prepared soil was filled of the pot by saline soil. Necessary amount of salt treatment was given to create saline environment by saturating the soil before placing the cabbage seedling. The trial included the following treatments: $T_1 = 2\pm0.2$ dS/m EC, $T_2 = 4\pm0.2$ dS/m EC, $T_3 = 6\pm0.2$ dS/m EC, $T_4 = 8\pm0.2$ dS/m EC, $T_5 = 10\pm0.2$ dS/m EC and $T_6 = 12\pm0.2$ dS/m EC. The single factor experiment used completely Randomized design (CRD) with three replications. The experiment was divided into three equal replication blocks, each with six plots. As a result, the total number of unit plots was 18. 30 days cabbage seedlings were transplanted. The experiment's treatment combinations were randomized at random to 18 plots, each with three replications. Proper management about salinity control over the pot and growth of plants were observed. Time to time weeding, fertilizer application, irrigation, pot checking and special care to plant proper growth were following up to yield harvesting. Every three days later water application, pest controlling chemical and abiotic affect was observed. The data was collected at 60 days after cabbage transplanting. Intercultural operations were carried out when needed. The following parameters were measured: plant height (cm), numbers of leaves/plant, fresh weight of loose leaves/plant (gm), diameter of head (cm), thickness of head (cm), fresh weight of head/plant (gm), numbers of folded leaves/plant and gross yield/ plant (gm).

Preparation of saline soil

For developing the expected soil salinity of 2 to 12 dS/m EC, salt affected soil was collected from different place of saline affected area. Different concentrations of soil salinity (2, 4, 6, 8, 10 and 12 dS/m) was applied to the transplanted seeding on plastic pot. The salinity level was maintained by assessing the salt level from laboratory test.

Initial Chemical properties of soil of pot

pH	OM (%)	K meq/100 gm soil	Total N (%)	P	S	Zn	B
				μg/g			
7.4	1.95	0.22	0.11	17.52	57.25	1.03	1.22

Statistical analysis

The data obtained for different characters were statistically analyzed. The mean values of all the characters were evaluated and analysis of variance was performed by the 'F' test by using statistix software, version 10.

Results and Discussions

All the contributing parameters at different soil salinity strength have been shown. The influence of different saline soil of different strength caused a considerable variation in plant height and numbers of leaves per plants which was statistically significant at different soil salinity strength.

Initial Salinity of pot soil was 1.54 dS/m EC. After applying different strength of soil salinity to different pot, the evaluating indicator was different.

Plant height

The highest plant height was found from T_1 (2 ± 0.2 dS/m EC) treatment. The highest plant height at T_1 (2 ± 0.2 dS/m EC) is 23.00 cm. The plant height at T_2 (4 ± 0.2 dS/m EC) is 20.00cm. In T_3 (6 ± 0.2 dS/m EC) the plant height is 17.66 cm. At the T_4 (8 ± 0.2 dS/m EC) treatment, plant height is 15.33 cm. The plant height at T_5 (10 ± 0.2 dS/m EC) is 13.66 and the lowest plant height is at T_6 (12 ± 0.2 dS/m EC) that is 13.33 cm. So, the highest plant height at T_1 (2 ± 0.2 dS/m EC) is 23.00 cm and the lowest plant height is at T6 (12 ± 0.2 dS/m EC) that is 13.33 cm respectively (shown in table No. 01).

Number of leaves per plant

Number of leaves per plant at different soil salinity strength has been shown in Table 1. Due to the influence of different soil saline strength, a significant difference in Number of leaves per plant was observed that was statistically significant at different soil salinity. The plants treated with T_1 (2 ± 0.2 dS/m EC) had the highest number of leaves per plant (54.00), at T_2 (4 ± 0.2 dS/m EC), the plants treated with T_2 had number of leaves per plant (51.33), the plants treated with T_3 (6 ± 0.2 dS/m EC) had the 46.66 number of leaves per plant. Numbers of leaves at T_4 (8 ± 0.2 dS/m EC) is at 45.00. Treatment with T_5 (10 ± 0.2 dS/m EC), the no. of leaves is 42.00. But the lowest number of leaves per plant (39.00) treated with T_6 (12 ± 0.2 dS/m EC) treatment.

Table 1: Different plants parameter at different Soil salinity strength.

Treatment	Plant height(cm)	No of leaves/ plant	Fresh weight of loose leaves (gm)	Diameter of head (cm)	Thickness of head(cm)
T_1 (2 ± 0.2 dS/m EC)	23.00 a	54.00 a	332.00 a	16.66 a	9.23 a
T_2 (4 ± 0.2 dS/m EC)	20.00 b	51.33 b	325.67 ab	15.00 ab	7.66 b
T_3 (6 ± 0.2 dS/m EC)	17.66 c	46.66 c	312.67 b	13.33 bc	7.63 b
T_4 (8 ± 0.2 dS/m EC)	15.33 d	45.00 d	247.33 c	11.33 c	6.83 bc
T_5 (10 ± 0.2 dS/m EC)	13.66 e	42.00 e	230.33 d	8.83 d	6.00 c
T_6 (12 ± 0.2 dS/m EC)	13.33 e	39.00 f	218.67 d	8.16 d	5.76 c
CV	5.32	2.19	3.33	11.07	8.44
LSD	1.66	1.84	16.81	2.46	1.10

*EC determined by 1: 1 extraction Method

Fresh wt. of loose leaves (gm)

The effects of different saline strength of soil on fresh weight of loose leaves were significant (Table 1). The plants grown under the soil saline treatment of T_1 (2±0.2 dS/m EC) had the highest fresh weight of loose leaves (332 gm), however the plants grown under the treatment of T_6 (12±0.2 dS/m EC) had the lowest fresh weight of loose leaves (218.67 gm).

Diameter of head (cm)

Different saline strength of soil of pot culture and management had a significant effect on head diameter (Table 1). The plants with the largest diameter of head (16.66 cm) were grown with T_1 (2±0.2 dS/m EC) treatment while the plants with the smallest diameter of head (8.16 cm) were grown with the treatment of T_6 (12±0.2 dS/m EC). It is noticed that at 8, 10, 12 dS/m EC of soil, Cabbage crop has response salinity level related result based with poor growth of head formation due to soil salinity.

Thickness of head

It would appear that the various soil saline conditions had a significant effect on the thickness of the head (Table 1). The T_1 (2±0.2 dS/m EC) treatment showed the highest thickness of head (9.23 cm), whereas the T_6 (12±0.2 dS/m EC) gave the lowest thickness of head (5.76 cm). It is noticed that, at 6, 8,10, dS/m EC of soil tolerant cabbage has response very lightly with poor growth of thickness of head formation due to soil salinity.

Table 2: Different plants parameter at different Soil salinity strength.

Treatment	Fresh weight of head (gm)	Number of folded leaves/plant	Gross yield (gm)
T_1 (2±0.2 dS/m EC)	954.33 a	39.00 a	1258.3 a
T_2 (4±0.2 dS/m EC)	853.67 b	34.33	1168.0 b
T_3 (6±0.2 dS/m EC)	777.33 c	32.33	1054.3 c
T_4 (8±0.2 dS/m EC)	723.67 d	28.10	922.7 d
T_5 (10±0.2 dS/m EC)	374.00 e	24.00	585.3 e
T_6 (12±0.2 dS/m EC)	310.67 f	22.66	555.3 e
CV	2.64	4.77	2.14
LSD	31.96	2.60	36.05

*EC determined by 1: 1 extraction Method

Fresh weight of head/plant (gm)

The highest fresh weight of head (954.33 gm) was found in plants grown with T_1 treatment (2±0.2 dS/m EC) (Table 2), while the lowest fresh weight of head (310.67 gm) was found in plants grown with T_6 (12±0.2 dS/m EC) treatment and this difference was statistically significant. At different soil saline strength of 6, 8, 10, dS/m EC, any cabbage plants has given small significant responded salinity level related result based thickness of head.

Number of folded leaves/plant

The highest number of folded leaves/plant (39.00) was found in plants grown under treatment T_1 (2±0.2 dS/m EC) (Table 2), while the lowest number of folded leaves/plant (22.66) was found in plants grown under treatment T_6 (12±0.2 dS/m EC) and the significant difference was found. At different soil salinity strength of 6, 8, 10, dS/m EC, any cabbage plants has given very salinity level related result based folded leaves per plant.

Gross yield per/plant

The gross yield per plant was significantly affected by different saline soil intensity (Table 2). The maximum gross yield (1258.30 gm) per plant was observed in T_1 treatment (2±0.2 dS/m EC), while the lowest gross yield/plant (555.30 gm) was observed in the plants treated with T_6 (12±0.2 dS/m EC). At 6, 8,10 dS/m EC of soil saline condition has formed salinity level related result based gross yield per plant.

Conclusion

The purpose of the experiment was to determine the influence of different levels of soil saline strength effect on cabbage growth and production. From the results, it can be concluded that management of different levels of saline soil have a significant effect on cabbage growth and yields. The highest gross and marketable yield were obtained at the combination from the application of T_1 treatment (2±0.2 dS/m EC) of soil and gives the maximum fresh weight of head (954.33 gm) per plant and gross yield (1258.30 gm) per plant is helpful for increasing the growth and yield of cabbage. The findings of the study may be applicable to other locations of the southern region of the country as well. However, further research work at different cultivated land of different soil salinity strength on the growth and yield of cabbage will need to be performed in different saline area of Bangladesh to reach a specific conclusions and recommendations.

Effect of different strength of soil salinity on growth and yield of knol khol

A Biswas, Md. Z Islam

Abstract

Salinity is a crucial agricultural constraint for crops production in saline area. In south and south-western area of Bangladesh is overcoming a huge barrier of salt accumulation to soil and problematic condition for different agricultural activities. So, for solving such a curse a field experiment was carried out to investigate the effect of different soil salinity strength on the growth and yield of knol khol (*Brassica oleracea* var. *caulorapa L.*) during Rabi season. The experiment was laid out in Completely Randomized Design (CRD) comprising of 18 treatments viz., T_1- 2±0.2 dS/m EC, T_2 -4±0.2 dS/m EC, T_3 –6±0.2 dS/m EC, T_4 –8±0.2 dS/m EC, T_5 –10±0.2 dS/m EC, T_6 - 12±0.2 dS/m EC. Each replication was three times repeated. Treatments were randomly arranged

in each replication that divided into 18 pots. The results revealed that the application of T_1- 2 ± 0.2 dS/m EC gave the maximum plant height, highest number of leaves per plant, Diameter of stem/plant, diameter of knob, Fresh weight of knob/plant and Gross yield/plant. So, we can consider 2 dS/m EC (2 ± 0.2 dS/m) for our soil health, environmental benefits and ecological safety.

Keywords: Knol khol, Growth, saline water, diameter of knob, knob yield.

Introduction

Soil salinity problem is the most abiotic barrier for crop production for arid and semi-arid region in the world now a days. Soil salinity has great detrimental effects on crop production, especially in arid and semi-arid regions (Moud and Maghsoudi 2008; Keshavarzi 2011). High soil salinity is deleterious to most Knol khol (*Brassica oleracea var. caulorapa* L.), as it is a cole crops that produced worldwide, but very popular in Bangladesh also. The soil salinity of coastal saline soil is sometimes high, and with the same ion composition compared to sea water (Khan et al., 1996). In the other hand, the groundwater table of that saline region is quite shallow and the soil salinity changes seasonally (Shi et al., 2005). Different soil salinization process causes soil erosion on a global scale and reduces crop productivity (Acosta JA, Boris J, Karsten K, Martínez SM, 2011). Salt accumulation in soil is one of the most destructive environmental pressures in the uncultivated area, crop production and quality cause deficit (Yamaguchi, T., Blumwald, E., 2005, Lugtenberg, at al., 2002). There are long light green colored round shape structures, which come out as its shoots. Knol khol (*Brassica oleracea* var*. caulorapa* L.) also is known as kohlrabi belongs to the family cruciferae. It is a cold, hardy crop and can tolerate well in extremely cold weather and saline condition also. The fleshy portion of the stem develops entirely above the ground, called knob and is used as a vegetable (Raj et al., 2014). It is an excellent vegetable if it is used before it becomes tough and fibrous. It is high in minerals and vitamins A and C. It contains adequate amount of water (85.9 g), calories (28.5.0 g), protein (2.10 g), carbohydrate (7.6 g), fibre (1.0 g)) per 100 g of edible stem (Kamal et al., 2013). It also contains satisfactory amount of calcium, phosphorus, iron, sodium, potassium and vitamin A and C (Dadhich et al., 2015). Basically edible part of knol khol is knob, which is form swelling of the stem tissue above the plants. The crop has miracle medicinal value like, acidosis, asthma, cancer, cholesterol level, heart problems, indigestion, muscle and nerve functions, prostate and colon cancer, skin problems, weight loss etc. The fleshy turnip like portion of the stem develops entirely above the ground. The modern nutrient management policy has changed its focus towards the concept of sustainability and eco-friendliness and productivity (N and P Mehta et al., 2015). The increasing use of chemical fertilizers and soil saline condition in Bangladesh has a great impact to increase vegetable production. Plant growth decreases significantly under the influence of salt stress however the plants differ considerably in their sensitivity and ability to tolerate salinity stress (Amzallag et al., 1993). For irrigation purposes, saline water should be used optimally and carefully to get the desire results from the irrigated crops (Alsaadawi and Mohamed (2000). It has been widely recognized

but its long run impact on soil health, ecology and other natural resources are detrimental which affect living organisms including beneficial soil microorganism for crop production. However, at high level of crop production, those saline environments are not congenial to plant growth and yield. Ground soil salinity is known to inhibit plant growth (Paul, D., 2012). Soil salinity strength has a negative effect on the yield and quality of beet crops like sugar beet,turnip, knol khol etc especially from the excessive absorption of sodium (Mekki and El Gazaar 1999; Cheggour and Fares 2002).This saline movement can also hamper soil physical and biological fertility, making it non ideal for land application as a working microclimate. Soil salinity is also a major problem in areas where high ground salt water is used for irrigation (Rausch, T., at all, 1996). The agricultural practices in saline soil is considered as a bad management practice in any agricultural production system because of its negatively stimulation of soil microbial growth and activity, subsequent convertion of plant nutrients, and promote to loss soil fertility and quality for any types of crops production. Bangladesh is a developing country. Most of the people living here are suffering from nutrient deficit i.e., malnutrition. Fresh knol khol can be a cheap and safe vegetable for health and that is our ultimate destination to produce crop. So, cultivation of knol khol in saline soil deserves great importance. In fine, the studied was undertaken to observe the evaluation of comparative effects of different soil salinity strength on growth and yield of Knol khol and to find out best intensity of soil salinity strength for obtaining higher economic yield.

Materials and Methods

The experiment was carried out at the salinity management and research center, under soil resource development institute, Batiaghata, Khulna to test the effect of different strength of saline soil on emergence, growth and yield of knol khol plant. Plastic pots were used in conducting the experiment. The plastic pots were firstly washed and followed by rinsing with distilled water. Then those pots were dried in air. After drying the plastic pots were ready for the experiment. Finely prepared soil was filled of the pot by saline soil. Necessary amount of salt treatment was given to create saline environment by saturating the soil before placing the knol khol seedling. The trial included the following treatments: T_1 = 2±0.2 dS/m EC, T_2 = 4±0.2 dS/m EC, T_3 = 6±0.2 dS/m EC, T_4 = 8±0.2 dS/m EC, T_5 = 10±0.2 dS/m EC and T_6 = 12±0.2 dS/m EC. The single factor experiment used completely Randomized design (CRD) with three replications. The experiment was divided into three equal replication blocks, each with six plots. As a result, the total number of unit plots was 18. The experiment's treatment combinations were randomized at random to 18 plots, each with three replications. 25 days knol khol seedlings were transplanted. Proper management about salinity control over the pot and growth of plants were observed. Time to time weeding, fertilizer application, irrigation, pot checking and special care to plant proper growth were following up to yield harvesting. Every three days later water application, pest controlling chemical and abiotic affect was observed. The data was collected at 60 days after knol khol transplanting. Intercultural operations were carried out when needed. The following parameters were measured: Plant height (cm), number of leaves/plant, diameter of stem (cm) at 60 days, diameter of knob (cm), fresh weight of knob/plant (gm) and gross yield/plant (gm).

Preparation of saline soil

For developing the expected soil salinity of 2 to 12 (±0.2 dS/m) EC of salinity strength, salt affected soil was collected from different place of saline affected area. Different concentrations of soil salinity (2, 4, 6, 8, 10 and 12 ds/m EC) was applied to the transplanted seeding on plastic pot. The salinity level was maintained by assessing the salt level from laboratory test.

Initial Chemical properties of soil of pot

pH	OM (%)	K meq/100 gm soil	Total N (%)	P	S	Zn	B
				μg/g			
7.4	1.95	0.22	0.11	17.52	57.25	1.03	1.22

Statistical analysis

The data obtained for different characters were statistically analyzed. The mean values of all the characters were evaluated and analysis of variance was performed by the 'F' test by using statistix software, version 10.

Results and Discussions

All the characters of promoting vegetative growth and yield performance parameters at different DAT have been shown (table 1 and 2). Results on main and combined effect of different soil salinity strength and fertilizer management practices and their interactions have been presented and discussed here. The influence of different soil salinity caused a considerable variation in plant growth, production of yield and economic benefits of plants which was statistically significant at 60 DAT. After applying different strength of soil salinity in different pot, the expected parameters were changed.

Table 1: Showing result of different plants of different growth stages at different soil salinity strength.

Treatment	Plant height (cm)	Number of leaves/plant	Diameter of Stem (cm) 60 DAT	Diameter of knob (cm)	Fresh weight of knob (gm)	Gross Yield (gm)
T_1 (2±0.2 dS/m EC)	46.63 a	20.00 a	2.03 a	13.80 a	796.00 a	994.33 a
T_2 (4±0.2 dS/m EC)	39.33 b	16.66 b	1.83 b	11.90 b	592.33 b	823.33 b
T_3 (6±0.2 dS/m EC)	37.46 bc	16.00 b	1.63 c	10.80 c	525.33 bc	778.00 bc
T_4 (8±0.2 dS/m EC)	34.80 cd	15.66 b	1.56 cd	10.20de	506.33 c	702.33 cd
T_5 (10±0.2 dS/m EC)	33.73 de	15.00 b	1.50 d	9.60 e	463.33 c	645.33 d

T$_6$ (12±0.2 dS/m EC)	32.00 e	13.00 c	1.30 e	8.33	373.67 d	473.67 e
CV	4.10	5.76	4.39	4.82	6.98	8.72
LSD	2.78	1.68	0.13	0.94	68.90	116.77

*EC determined by 1: 1 extraction Method

Plant height

The outside variation in plant height due to different soil salinity strength was statistically significant in Knol khol at different strength of soil salinity after transplanting (DAT) (Table 1). At T$_1$ (2±0.2 dS/m EC) treatment the maximum plant height was 46.63 cm. In the T$_2$ (4±0.2 dS/m EC) treatment it was found the plant height was 39.33 cm. At the T$_3$ (6±0.2 dS/m EC) treatment, the plant height was 37.46 cm and for T$_4$ (8±0.2 dS/m EC) treatment plant height resulted in 34.80 cm. The minimum plant height was found in the treatment T$_6$ (12±0.2 dS/m EC) and it was 32 cm. It is stated that 12±0.2 dS/m of soil salinity strength knol khol plant had given very lowest plant growth at all.

Number of leaves per plant

A lots of ingredients helps to produce plant leaves. The production of different number of leaves per plant at different DAT has been shown in Table 1. Due to the influence of different soil salinity strength, a significant difference in number of leaves per plant was observed that was statistically significant at different DAT. The plant irrigated with T$_1$ (2±0.2 dS/m EC) had the highest number of leaves per plant (20). At T$_2$ (4±0.2 dS/m EC) the numbers of leaves per plant was 16.66. The plants treated with T$_3$ (6±0.2 dS/m EC) had 16.00 number of leaves per plant and the lowest numbers of leaves per plant (13) for treatment of T$_6$ (12±0.2 dS/m EC). The plants treated with T$_1$ (2±0.2 dS/m EC) had the highest number of leaves per plant (20) but the lowest number of leaves per plant (13) treated with T$_6$ (2±0.2 dS/m EC).

Diameter of stem (cm)

Soil salinity strength has a profound effect on plant canopy and yield production characters and management had a significant effect on stem diameter (Table 1). The plants with the largest diameter of stem (2.03 cm) was grown with T$_1$ (2±0.2 dS/m EC) treatment. In the T$_2$ (4±0.2 dS/m EC) treatment, diameter of stem resulted at 1.83 cm. At T$_3$ (6±0.2 dS/m EC) treatment, the diameter of stem was 1.63 cm while the plants with the smallest diameter of stem (1.30 cm) was grown with the treatment of T$_6$ (12±0.2 dS/m EC). It is shown that at 8, 10 dS/m EC of salinity strength tolerant knol khol had given the smallest stem formation due to soil salinity.

Diameter of knob (cm)
Effect of different soil salinity strength had a great significant influence on the diameter of knob (Table 1). The maximum diameter of knob (13.80 cm) was found with the treatment T_1 (2±0.2 dS/m EC) and the minimum diameter of knob (8.33 cm) was obtained from T_6 (12±0.2 dS/m EC) treatment. As knol khol is a short duration crops and highly feeding crops it was affected when grown under saline condition.

Fresh weight of knob/plant (gm)
Different intensity of saline soil salinity had a great significant effect on fresh weight of knob per plant (Table 1). The maximum fresh weight of knob per plant (796.00 gm) was obtained from the treatment T_1 (2±0.2 dS/m EC) and the minimum fresh weight of knob (373.67 gm) was found from the T_6 (12±0.2 dS/m EC) treatment. The maximum weight of single tuber might be due to soil salinity effect and plant growth resistant. Interaction effects of different strength of soil salinity treatment were significant on fresh weight of knob.

Gross yield/plant (gm)
Application of different strength of saline soil to knol khol plant contributes on economic yields per plant. It reveals that variation among different soil salinity strength were statistically significant. It is obvious from the present study that the maximum marketable gross yield (994.33 gm) resulted from T_1 (2±0.2 dS/m EC) and the lowest marketable gross yield (473.67 gm) was found from treatment T_6 (12±0.2 dS/m EC)treatment. It was observed that the interaction effect of different soil salinity strength on economic yield per plant was statistically significant.

Conclusion
From the above discussion it is clear that, higher yield could be obtained by cultivating the knol khol variety early in different saline prone area under saline region of Bangladesh. Recommended soil salinity strength T_1 (2±0.2 dS/m EC) produced maximum vegetative gross yield (994.33 gm) and economic yield. So, we can consider the treatment T_1 (2±0.2 dS/m EC) of soil salinity for our soil health, environmental benefits and crops production. Further experiment may be carried out before giving final recommendation.

Effect of different strength of soil salinity on growth and yield of Red Beet
A Biswas, Md. Z Islam

Abstract
Salinity is a crucial agricultural constraint for crops production in saline area. In south and south-western area of Bangladesh is overcoming a huge barrier of salt accumulation to soil and problematic condition for different agricultural activities. So for solving such a curse a field experiment was carried out to investigate the effect of different soil salinity strength on the growth

and yield of Red beet (*Beta vulgaris subsp. vulgaris*) during Rabi season. The experiment was laid out in Completely Randomized Design (CRD) comprising of 18 treatments viz., T_1- 2±0.2 dS/m EC, T_2 -4±0.2 dS/m EC, T_3 –6±0.2 dS/m EC, T_4 –8±0.2 dS/m EC, T_5 –10±0.2 dS/m EC, T_6 - 12±0.2 dS/m EC. Each replication was three times repeated. Treatments were randomly arranged in each replication that divided into 18 pots. The results revealed that the application of T_1- 2±0.2 dS/m EC gave the maximum plant height, leaf length, leaf width, highest number of leaves/plant, Beet root length, Diameter of beet root/plant, Fresh weight of beet root/plant and Gross yield/plant. So, we can consider 2 dS/m EC (2±0.2 dS/m) for our soil health, environmental benefits and ecological safety.

Keywords: Red beet, Growth, saline water, diameter of root, beet root yield.

Introduction

Soil salinity problem is the most abiotic barrier for crop production for arid and semi-arid region in the world now a days. Soil salinity has great detrimental effects on crop production, especially in arid and semi-arid regions (Moud and Maghsoudi 2008; Keshavarzi 2011). High soil salinity is deleterious to most Red beet (*Beta vulgaris* subsp. *vulgaris*), as it is a cole crops that produced worldwide, but very popular in Bangladesh also. The soil salinity of coastal saline soil is sometimes high, and with the same ion composition compared to sea water (Khan et al., 1996). In the other hand, the groundwater table of that saline region is quite shallow and the soil salinity changes seasonally (Shi et al., 2005). Different soil salinization process causes soil erosion on a global scale and reduces crop productivity (Acosta JA, Boris J, Karsten K, Martínez SM, 2011). Salt accumulation in soil is one of the most destructive environmental pressures in the uncultivated area, crop production and quality cause deficit (Yamaguchi, T., Blumwald, E., 2005, Lugtenberg, at al., 2002). There are long light green colored round shape structures, which come out as its shoots. Red beet (*Beta vulgaris* subsp. *vulgaris*) also is also known as the table beet, garden beet, red beet, dinner beet or golden beet. Beet root can be eaten raw, roasted, or boiled. Beetroot can also be canned, either whole or cut up, and often are pickled, spiced, or served in a sweet-and-sour sauce. It is one of several cultivated varieties of Beta vulgaris grown for their edible taproots and leaves (called beet greens) they have been classified as B. vulgaris subsp. vulgaris Conditiva Group. Other cultivars of the same species include the sugar beet, the leaf vegetable known as chard or spinach beet which is a fodder crop. Three subspecies are typically recognized. It is a cold, hardy crop and can tolerate well in extremely cold weather and saline condition also. The fleshy portion of the stem develops entirely above the ground, called knob and is used as a vegetable (Raj et al., 2014). It is an excellent vegetable if it is used before it becomes tough and fibrous. It is high in minerals and vitamins A and C. It contains adequate amount of water (85.9 g), calories (28.5.0 g), protein (2.10 g), carbohydrate (7.6 g), fibre (1.0 g)) per 100 g of edible stem and Raw beet root is 88% water, 10% carbohydrates, 2% protein, and less than 1% fat. In a 100-gram (3+1⁄2-ounce) amount providing 180 kilojoules (43 kilocalories) of food energy, raw beetroot is a rich source (27% of the Daily Value - DV) of folate and a moderate source (16% DV)

of manganese, with other nutrients having insignificant content. A clinical trial review reported that consumption of beetroot juice modestly reduced systolic blood pressure but not diastolic blood pressure (Kamal et al., 2013). It also contains satisfactory amount of calcium, phosphorus, iron, sodium, potassium and vitamin A and C (Dadhich et al., 2015). Basically edible part of Red beet is root, which is form swelling of the stem tissue above the plants. The crop has miracle medicinal value like, acidosis, asthma, cancer, cholesterol level, heart problems, indigestion, muscle and nerve functions, prostate and colon cancer, skin problems, weight loss etc. The fleshy turnip like portion of the stem develops entirely above the ground. The modern nutrient management policy has changed its focus towards the concept of sustainability and eco-friendliness and productivity (N and P Mehta et al., 2015). The increasing use of chemical fertilizers and soil saline condition in Bangladesh has a great impact to increase vegetable production. Plant growth decreases significantly under the influence of salt stress however the plants differ considerably in their sensitivity and ability to tolerate salinity stress (Amzallag et al., 1993). For irrigation purposes, saline water should be used optimally and carefully to get the desire results from the irrigated crops (Alsaadawi and Mohamed (2000). It has been widely recognized but its long run impact on soil health, ecology and other natural resources are detrimental which affect living organisms including beneficial soil microorganism for crop production. However, at high level of crop production, those saline environments are not congenial to plant growth and yield. Ground soil salinity is known to inhibit plant growth (Paul, D., 2012). Soil salinity strength has a negative effect on the yield and quality of beet crops like sugar beet, turnip, knol khol etc especially from the excessive absorption of sodium (Mekki and El Gazaar 1999; Cheggour and Fares 2002).This saline movement can also hamper soil physical and biological fertility, making it non ideal for land application as a working microclimate. Soil salinity is also a major problem in areas where high ground salt water is used for irrigation (Rausch, T., at all, 1996). The agricultural practices in saline soil is considered as a bad management practice in any agricultural production system because of its negatively stimulation of soil microbial growth and activity, subsequent convertion of plant nutrients, and promote to loss soil fertility and quality for any types of crops production. Bangladesh is a developing country. Most of the people living here are suffering from nutrient deficit i.e., malnutrition. Fresh Red beet root can be a cheap and safe vegetable for health and that is our ultimate destination to produce crop. So, cultivation of Red beet root in saline soil deserves great importance. In fine, the studied was undertaken to observe the evaluation of comparative effects of different soil salinity strength on growth and yield of Red beet root and to find out best intensity of soil salinity strength for obtaining higher economic yield.

Materials and Methods

The experiment was carried out at the salinity management and research center, under soil resource development institute, Batiaghata, Khulna to test the effect of different strength of saline soil on emergence, growth and yield of Red beet plant. Plastic pots were used in conducting the experiment. The plastic pots were firstly washed and followed by rinsing with distilled water. Then those pots were dried in air. After drying the plastic pots were ready for the experiment. Finely

prepared soil was filled of the pot by saline soil. Necessary amount of salt treatment was given to create saline environment by saturating the soil before placing the red beet seedling. The trial included the following treatments: T_1 = 2±0.2 dS/m EC, T_2 = 4±0.2 dS/m EC, T_3 = 6±0.2 dS/m EC, T_4 = 8±0.2 dS/m EC, T_5 = 10±0.2 dS/m EC and T_6 = 12±0.2 dS/m EC. The single factor experiment used completely Randomized design (CRD) with three replications. The experiment was divided into three equal replication blocks, each with six plots. As a result, the total number of unit plots was 18. The experiment's treatment combinations were randomized at random to 18 plots, each with three replications. 25 days Red beet seedlings were transplanted. Proper management about salinity control over the pot and growth of plants were observed. Time to time weeding, fertilizer application, irrigation, pot checking and special care to plant proper growth were following up to yield harvesting. Every three days later water application, pest controlling chemical and abiotic affect was observed. The data was collected at 60 days after Red beet transplanting. Intercultural operations were carried out when needed. The following parameters were measured: Plant height (cm), leaf length (cm), leaf width (cm), number of leaves/plant, Red beet root length (cm), diameter of root (cm) at 60 days, fresh weight of root/plant (gm) and gross yield/plant (gm).

Preparation of saline soil

For developing the expected soil salinity of 2 to 12 (±0.2 dS/m) EC of salinity strength, salt affected soil was collected from different place of saline affected area. Different concentrations of soil salinity (2, 4, 6, 8, 10 and 12 ds/m EC) was applied to the transplanted seeding on plastic pot. The salinity level was maintained by assessing the salt level from laboratory test.

Initial Chemical properties of soil of pot

pH	OM (%)	K meq/100 gm soil	Total N (%)	P	S	Zn	B
				μg/g			
7.4	1.95	0.22	0.11	17.52	57.25	1.03	1.22

Statistical analysis

The data obtained for different characters were statistically analyzed. The mean values of all the characters were evaluated and analysis of variance was performed by the 'F' test by using statistix software, version 10.

Results and Discussions

All the characters of promoting vegetative growth and yield performance parameters at different strength of salinity have been shown (table 1). Results on main and combined effect of different soil salinity strength and fertilizer management practices and their interactions have been presented and discussed here. The influence of different soil salinity caused a considerable variation in plant growth, production of yield and economic benefits of plants which was statistically significant at 60 DAT. After applying different strength of soil salinity in different pot, the expected parameters were changed.

Table 1: Showing result of different plants of different growth stages at different soil salinity strength.

Treatment (dS/m)	Plant height (cm)	Leaf length (cm)	Leaf width (cm)	Leaves numbers	Beet Root length (cm)	Diameter of red beet root (cm)	Beet root fresh weight (gm)	Gross yield (gm)
2	55.73 a	51.83 a	18.46 a	28.33 a	12.26 a	10.53 a	527.00 a	726.67 a
4	48.06 b	45.76 b	13.96 b	24.33 b	10.33 b	10.13 ab	401.33 b	601.67 b
6	43.10 c	40.23 c	12.56 bc	22.66 bc	9.80 bc	9.43 bc	303.00 c	446.33 c
8	39.80 cd	37.53 cd	10.03 bcd	22.00 bc	8.83 bcd	8.93 c	247.33 d	362.00 cd
10	37.16 d	34.50 d	9.43 cd	19.66 c	8.33 cd	7.80 d	196.00 e	302.00 d
12	31.26 e	29.90 e	8.36 d	16.33 d	7.20 d	6.43 e	115.67 f	167.33 e
CV	5.04	4.48	18.28	7.78	9.66	5.96	9.24	11.40
LSD	3.89	3.25	4.03	3.14	1.66	0.96	50.16	91.81

*EC determined by 1: 1 extraction Method

Plant height
The outside variation in plant height due to different soil salinity strength was statistically significant in Red beet at different strength of soil salinity after transplanting (DAT) (Table 1). At T_1 (2 ± 0.2 dS/m EC) treatment the maximum plant height was 55.73 cm. In the T_2 (4 ± 0.2 dS/m EC) treatment it was found the plant height was 48.06 cm. At the T_3 (6 ± 0.2 dS/m EC) treatment, the plant height was 43.10 cm and for T_4 (8 ± 0.2 dS/m EC) treatment plant height resulted in 39.80 cm. The minimum plant height was found in the treatment T_6 (12 ± 0.2 dS/m EC) and it was 31.26 cm. It is stated that 12 ± 0.2 dS/m of soil salinity strength Red beet plant had given very lowest plant growth at all.

Leaf length
Red beet plant showed significant variations in leaf length at 2, 4, 6, 8, 10 and 12 (±0.2 dS/m EC) of soil salinity strength (Table 1). Significant variation on leaf length was found due to application of different saline water strength. The maximum length of leaf (51.83 cm) was found in T_1 (2 ± 0.2 dS/m EC) treatment. But the lowest number of leaf length (29.90 cm) treated with T_6 (12 ± 0.2 dS/m EC). Due to different soil salinity preparation, the increase salt concentration hit to cell elongation and cell division probably influenced the leaf growth of red beet plant.

Leaf width
Red beet plant revealed significant variations in leaf width at 2, 4, 6, 8, 10 and 12 (±0.2 dS/m EC) of soil salinity strength (Table 1). Very notable variation on leaf width was found due to application

of different saline water strength. The maximum width of leaf (18.46 cm) was found in T_1 (2 ± 0.2 dS/m EC) treatment. The lowest number of leaf width (8.36 cm) treated with T_6 (12 ± 0.2 dS/m EC). Due to different soil salinity preparation, the increase salt concentration hit to cell elongation and cell division probably influenced the leaf growth of Red beet plant.

Number of leaves per plant
A lots of ingredients helps to produce plant leaves. The production of different number of leaves per plant at different DAT has been shown in Table 1. Due to the influence of different soil salinity strength, a significant difference in number of leaves per plant was observed that was statistically significant at different DAT. The plant irrigated with T_1 (2 ± 0.2 dS/m EC) had the highest number of leaves per plant (28.33). At T_2 (4 ± 0.2 dS/m EC) the numbers of leaves per plant was 24.33. The plants treated with T_3 (6 ± 0.2 dS/m EC) had 22.66 number of leaves per plant and the lowest numbers of leaves per plant (16.33) for treatment of T_6 (12 ± 0.2 dS/m EC). The plants treated with T_1 (2 ± 0.2 dS/m EC) had the highest number of leaves per plant (28.33) but the lowest number of leaves per plant (16.33) treated with T_6 (2 ± 0.2 dS/m EC).

Beet root length
Red beet plant revealed very crucial variations in beet root length at 2, 4, 6, 8, 10 and 12 (±0.2 dS/m EC) of soil salinity strength (Table 1). Very notable variation on leaf width was found due to application of different saline water strength. The maximum beet root length (12.26 cm) was found in T_1 (2 ± 0.2 dS/m EC) treatment. The lowest beet root length was pointed (7.20 cm) where treated with T_6 (12 ± 0.2 dS/m EC) treatment. Due to different soil salinity preparation, the increase salt concentration hit to cell elongation and cell division probably influenced the leaf growth of Red beet plant.

Diameter of red beet root
Soil salinity strength has a profound effect on plant canopy and yield production characters and management had a significant effect on red beet root diameter (Table 1). The plants with the largest diameter of red beet root (10.53 cm) was grown with T_1 (2 ± 0.2 dS/m EC) treatment. In the T_2 (4 ± 0.2 dS/m EC) treatment, diameter of red beet root resulted at 10.13 cm. At T_3 (6 ± 0.2 dS/m EC) treatment, the diameter of red beet root was 9.43 cm while the plants with the smallest diameter of red beet root (6.43 cm) was grown with the treatment of T_6 (12 ± 0.2 dS/m EC). It is shown that at 8, 10 dS/m EC of salinity strength tolerant red beet root had given the smallest stem formation due to soil salinity.

Fresh weight of beet root/plant (gm)
Different intensity of saline soil salinity had a great significant effect on fresh weight of beet root per plant (Table 1). The maximum fresh weight of beet root per plant (527 gm) was obtained from the treatment T_1 (2 ± 0.2 dS/m EC) and the minimum fresh weight of beet root (115.67 gm) was found from the T_6 (12 ± 0.2 dS/m EC) treatment. The maximum weight of single beet root might

be due to soil salinity effect and plant growth resistant. Interaction effects of different strength of soil salinity treatment were significant on fresh weight of beet root.

Gross yield/plant (gm)
Application of different strength of saline soil to Red beet plant contributes on economic yields per plant. It reveals that variation among different soil salinity strength were statistically significant. It is obvious from the present study that the maximum marketable gross yield (726.67 gm) resulted from T_1 (2±0.2 dS/m EC) and the lowest marketable gross yield (167.33 gm) was found from treatment T_6 (12±0.2 dS/m EC)treatment. It was observed that the interaction effect of different soil salinity strength on economic yield per plant was statistically significant.

Conclusion

From the above discussion it is clear that, higher yield could be obtained by cultivating the Red beet variety early in different saline prone area under saline region of Bangladesh. Recommended soil salinity strength T_1 (2±0.2 dS/m EC) produced maximum vegetative gross yield (726.67 gm) and economic yield. So, we can consider the treatment T_1 (2±0.2 dS/m EC) of soil salinity for our soil health, environmental benefits and crops production. Further experiment may be carried out before giving final recommendation.

Effect of ground water table & salt concentration on top soil salinity

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Abstract

The process of soil and water salinization that occurs in different geological, hydro-geomorphological, agricultural, and climatic environment is very complex reaction by various mechanisms. Specifically, the objective is to characterize and find out the groundwater conditions contributing to existing salinity problems. Salinization of land and water is brought about by physical and chemical processes that increase salt concentrations in soil ground water. The process responsible for the development of salinity in soil and water is intimately related to the transport of dissolved salt ion mass in groundwater flow systems. According to the experiment, when ground water level starts to down and the same time salinity in soil and water starts increase. In February, the ground water level was 5 feet 8 inch, the salinity in ground water was 2.5 dS/m, at single layer mulching, the salinity in soil was 2.6 dS/m and the highest soil salinity was 3.8 dS/m in open soil and the lowest salinity was in double layer mulching soil (2.2 dS/m). In June, the ground water level was in down at 10 feet 6 inch, salinity at water was 8.5 dS/m, in single layer mulching, the salinity was 13.4 dS/m and the lowest salinity was in double mulching covered top soil (10.0 dS/m), the salinity level was very high in open top soil (19.8 dS/m). This experiment shows that soil water level starts to decrease from February month to June (early dry season to early rainy

season). It is very much significant that salinity increase relation has simultaneously co-relation with the decreasing of ground water level in soil.

Introduction

Crop production in saline area is highly limited because of salinity in ground water. During kharif-1 season, salinity starts to increase from the January and it ranges to November. Saline water from the river water and seawater moves vertically and horizontally to other cropping area. This saline particle and mineral co-exist with other yield beneficial up taking nutrient and those create a bilateral saline solution. This saline solution directly moves to ground water and turns the soil micro water into saline. Salinity increases very rapidly when evaporation of water from the top soil get started by sun rays. It influences the vertical upward of saline water at the root zone of plant. The main obstacle to intensification of crop production in the coastal areas is seasonally high content of salts at the root zone of the soil. The salts enter inland through rivers and channels, especially during the early part of the dry (winter) season, when the downstream flow of fresh water becomes very low. During this period, the salinity of the river water increases. The salts enter into the soil by flooding with saline river water or by seepage from the rivers, and the salts become concentrated in the surface water layers through evaporation and evapotranspiration. The saline water may also cause an increase in salinity of the ground water and make it unsuitable for irrigation. The increase in water salinity in ground water of these areas has created a limitation for cultivation. Utilization of low quality ground water for crop irrigation because of prolonged dry spells in conjunction with heavy salt minerals is the principal source bringing about soil salinization. Scarcity of quality irrigation water during dry season limits cultivation of rabi (winter) crops and kharif-1 (March-July) season. Variability of rainfall, uncertain dates of onset and recession of seasonal floods and risk of drought restrict cultivation. Uncertain rainfall delays sowing/transplanting and flood damages of crops. The texture of most of the saline soils varies silt clay to clay. Land preparation becomes very difficult as the soil dries out. Deep and wide cracks develop and surface soil becomes very hard. These also necessitate deep and rapid tillage operations. Presence of saline ground water table throughout the year within top soil depth is another factor affecting crop production in the saline belt. Sea level rise and reduction of fresh ground water reservoirs due to changes in rainfall patterns are the two major climate change induced hydrological variables that can severely affect saltwater intrusion in coastal water bank. Tidal flooding occurs during wet season (June to October), direct inundation by saline water and upward on lateral movement of saline ground water during the dry season (February to May). In addition, cyclone and tidal surge is accelerating this problem. In the coastal areas of Bangladesh, salinization is one of the most serious types of land degradation as well as a major obstacle to the optimal utilization of ground water resources. Salinization is the process where the concentration of dissolved salts in water and soil is increased due to natural or human induced processes. Fresh water is lost through evapotranspiration and hydrolysis. Arid and semiarid climates are associated with water logging and ground water access. In all represented cases, ground water is the main geological agent for transmitting, accumulating, and discharging salt. Salinization in land and

water is brought by physical and chemical processes that increase concentrations of salt in soil and water. The processes that responsible for the development of saline land and water is very complex and intimately related to the transport of dissolved salt mass in groundwater flow systems. The redistribution of soluble salts accumulated in a soil micro pore is evident mainly in topographically lower areas by terminal salt water in river, dry area and sea water. Evaporation, evapotranspiration, hydrolysis, and leakage leads salt accumulation in water. When mineralized groundwater near the ground surface continually evaporates and causes minerals to precipitate, it increases the salt concentration in root zone. This process involve the mineralization of the groundwater, the physical transport of dissolved salts, the discharge of saline base flow into streams and river and the precipitation of salts within the soil cropping zone. Most of the salt in the groundwater system comes from micro pore, which includes parent materials structures, salt dissolved in the water recharging system and salt contributed from mineral dissolution within the groundwater flow system. The most important process that adds salt to groundwater is mineral dissolution reactions in the subsoil and to a lesser extent along the entire bilateral movement of saline water flow system. The land geography is low lying land, down ward movement of fresh water and inland along the sea coastal part of Bangladesh. According to salinity survey findings and salinity monitoring information about 1.02 million ha (about 70%) of the cultivated lands are affected by varying degrees of soil salinity. Million hectares of lands is affected by very slight, slight, moderate, strong and very strong salinity respectively. Cropping intensity may be increased from very slight to slightly in saline areas by adopting proper soil and water management practices with introduction of salt tolerant varieties of different crops. To mitigate the salt water for fill up the demand of fresh water for irrigation, especial emphasis may be given to adopt ground water reservoir technology.

Materials and Method

This experiment was conducted at the Salinity Management and Research Centre (SMRC), Soil Resource Development Institute, Batiaghata, Khulna, Bangladesh during the Kharif-1 season of 2024. Ground water depletion is a serious problem for irrigation in crop production. A deep pipe was installed directly into the soil vertically in the field at 10-02-2023. It was used for checking the ground water level measurement. Three beds were made for salinity level correction. One bed was open soil condition where no mulch was used, another one was made by single layer mulching bed where mulch was spread under the top soil and third one was double layer mulching bed where two layers of mulch was used. In double layer mulching bed, two layers of mulch was spread out, one was under the soil and another one was upper the top soil. Those three beds were made for measurement of soil salinity in every 15 days later.

Results and Discussion

Every 15 days later, the ground water layer depletion was measured through the deep pipe. This collected water and soil salinity were measured and salinity level was recorded (table 1). In 15-02-2024, the ground water depth was 5 feet 8 inch, ground water salinity was 2.5 dS/m, at open soil

layer, the highest soil salinity was 3.8 dS/m, at single mulching layer the salinity was 2.6 dS/m and at double mulching layer, the lowest soil salinity was 2.2 dS/m.

Table 1: Different Salinity level at different dates of water and soil salinity

Parameter	15-02-2024	01-03-2024	16-03-2024	01-04-2024	16-04-2024	01-05-2024	16-05-24	01-06-24
Water depth	5′8″	6′1″	6′8″	7′3″	7′9″	8′3″	9″3″	10′6″
Ground Water salinity (dS/m)	2.5	3.1	3.9	5.8	6.5	8.4	8.9	8.5
Soil salinity dS/m (open)	3.8	5.2	6.5	8.8	11.3	12.1	14.9	19.8
Soil salinity dS/m (SLM)	2.6	4.3	5.8	6.2	7.8	9.4	11.2	13.4
Soil salinity dS/m (DLM)	2.2	3.8	4.9	5.9	7.0	7.3	8.6	10.0

SLM- Single Layer Mulching

DLM **-** Double Layer Mulching

In 01-03-2024, the ground water depth was 6 feet 1 inch, water salinity was increased to 3.1 dS/m, at open soil layer soil, the highest soil salinity was 5.2 dS/m, at single mulching layer, the soil salinity was 4.3 dS/m but at double mulching layer, it was the lowest soil salinity was 3.8 dS/m. After 15 days later in 16-03-2024, the ground water depth was down to 6 feet 8 inch, water salinity was raised to 3.9 dS/m, at open soil layer soil, the highest soil salinity was 6.5 dS/m, at single mulching layer, the soil salinity was 5.8 dS/m and at double mulching layer, the lowest soil salinity down to 4.9 dS/m. Again 15 days later, in 01-04-2024, the ground water depth was measured at 7 feet 3 inch, water salinity was 5.8 dS/m, at open soil layer soil, the highest soil salinity ranged at 8.8 dS/m, at single mulching layer, the soil salinity was 6.2 dS/m and at double mulching layer, the lowest soil salinity was gained 5.9 dS/m. In 16-04-2024, the ground water depth was recorded at 7 feet 9 inch, water salinity was 6.5 dS/m, at open soil layer soil, the highest soil salinity was 11.3 dS/m, at single mulching layer, the soil salinity was 7.8 dS/m but at double mulching layer, the lowest soil salinity was found 7.0 dS/m. About 15 days later, in 01-05-2024, the ground water depth was measured at 8 feet 3 inch, water salinity was 8.4 dS/m, at open soil layer soil, the highest soil salinity was 12.1 dS/m, at single mulching layer, the soil salinity was 9.4 dS/m but at double mulching layer, the lowest soil salinity was 7.3 dS/m. In 16-05-2024, the ground water depth was decreased to 9 feet 3 inch, water salinity was 8.9 dS/m, at open soil layer soil, the highest soil salinity was calculated at 14.9 dS/m, at single mulching layer, the soil salinity was 11.2 dS/m and at double mulching layer, the lowest soil salinity was gone down at 8.6 dS/m. At the date of 01-06-2024, the ground water depth was reached at 10 feet 6 inch, water salinity was touched at 8.5 dS/m, at open soil layer soil, the highest soil salinity was 19.8 dS/m, at single mulching layer, the soil salinity was 13.4 dS/m and at double mulching layer, the lowest soil salinity was recorded at 10.0 dS/m. In seepage areas dry spell and waterlogging induces clay eluviation near the surface

and salinization at water depth in present day that reducing environments. When the water table rises to the surface, seepage areas are flushed by fresh water and salinization takes place. The resulting dis-equilibrium develops severe salinity environment land and degradation problems as a result of rising saline groundwater tables particularly when they act together in down surface positions of the land.

Conclusion

Groundwater plays a major role in the mobilization, accumulation, and discharge of salts into the root zone plant. Salinity increases during these periods of low recharge where only deep water resources are present and the groundwater flows are insufficient. Saline groundwater flows along the vertical and horizontal streams and is accumulated in the soil system acts as a salt depository. This ground water store directly influence the upper soil surface layer salinity range and water uptake by plants. However, ground water is the critical geological agent in the development of salinization.

Chapter 7: Research Activities done by Head Quarter & Field Offices

Study on Acidic soils physico-chemical properties and bacterial populations of three major soil series in Barind Tract Soils of Bangladesh

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Abstract

Bangladesh is one of the densely populated country in the world. To ensure food security for our huge population Sustainable Soil Management (SSM) is essential. Land is a complex mixture of soil, water and biodiversity. Soil is the foundation for life on earth. Soil is a mixture of minerals, organic matter, air and water that supports the life of plants and soil organisms. It is a non-renewable resource of environment. Sustainable soil health management increases carbon sequestration, reduces greenhouse gas emissions, increases drought resilience, enhances water quality, boosts crop yield, increases nutrient availability, provides pollinator habitat, suppresses many plant diseases. So, it is important to identify the proper management techniques for ensuring sustainable soil health in barind tract. This paper aims to explore the recent physical, chemical and microbial data of major soil profile in Barind Tract in comparison to the legacy soil data of RSS (Reconnaissance Soil Survey) report. The findings indicate textural changes due to the clay migration as well as alterations in nutrient status and pH levels. This research provides valuable insights for future investigations, technological advancements, planning, and policy-making in the field of agriculture.

Keywords: Sustainable Soil Management (SSM), RSS (Reconnaissance Soil Survey), Soil Properties, Bacterial Populations, Barind Tract Soils

Introduction

In Bangladesh, the soil acidification problem is becoming more severe than in previous periods due to the removal of base material from topsoil in acidic soil, low phosphorus (P) availability and iron (Fe) toxicity are considered two major yield-limiting factors for crop production in Barind soils of Bangladesh. Soils of the Barind Tract play a crucial role in ensuring food security for the country. Due to their unique characteristics, these soils are utilized for cultivating multiple crops under intensive cultivation. The Barind Tract comprises the Level Barind Tract (4,208 km2), High Barind Tract (1,567 km2), and Northern Barind Tract (1,912 km2). It exhibits less complex relief and soil composition than the Madhupur Tract, with significantly less dissection, fewer valleys and a higher proportion of poorly drained soils compared to the Madhupur Clay. Occupying a total area of 7,687 km2, the Barind Tract has developed over the Madhupur Clay parent material. Across extensive areas of this Barind Tract, the parent clay has weathered to red and

grey mottled clay, in which the original structural properties of the Madhupur Clay have been partially or wholly altered. Although soils of Barind Tract are used for diversified cropping but less attention has been given for maintaining soil health. Consequently, soils are losing their properties, leading to soil degradation. Soils in the study area of the Barind Tract of Bangladesh are becoming acidic (strongly acidic) day by day. Soil pH is an indicator of the soil environment and soil quality, which regulates the availability of plant nutrients, crop yield, and crop quality. The Barind Tract covers approximately 5.7% of the country's land area. It has also improved farmers' socioeconomic conditions, contributing to the achievement of SDG targets 1 and 2. Therefore, it is necessary to study the physical, chemical and microbiological properties to evaluate its potentials for sustainable agricultural development for the upcoming days (H. Brammer, 2012).
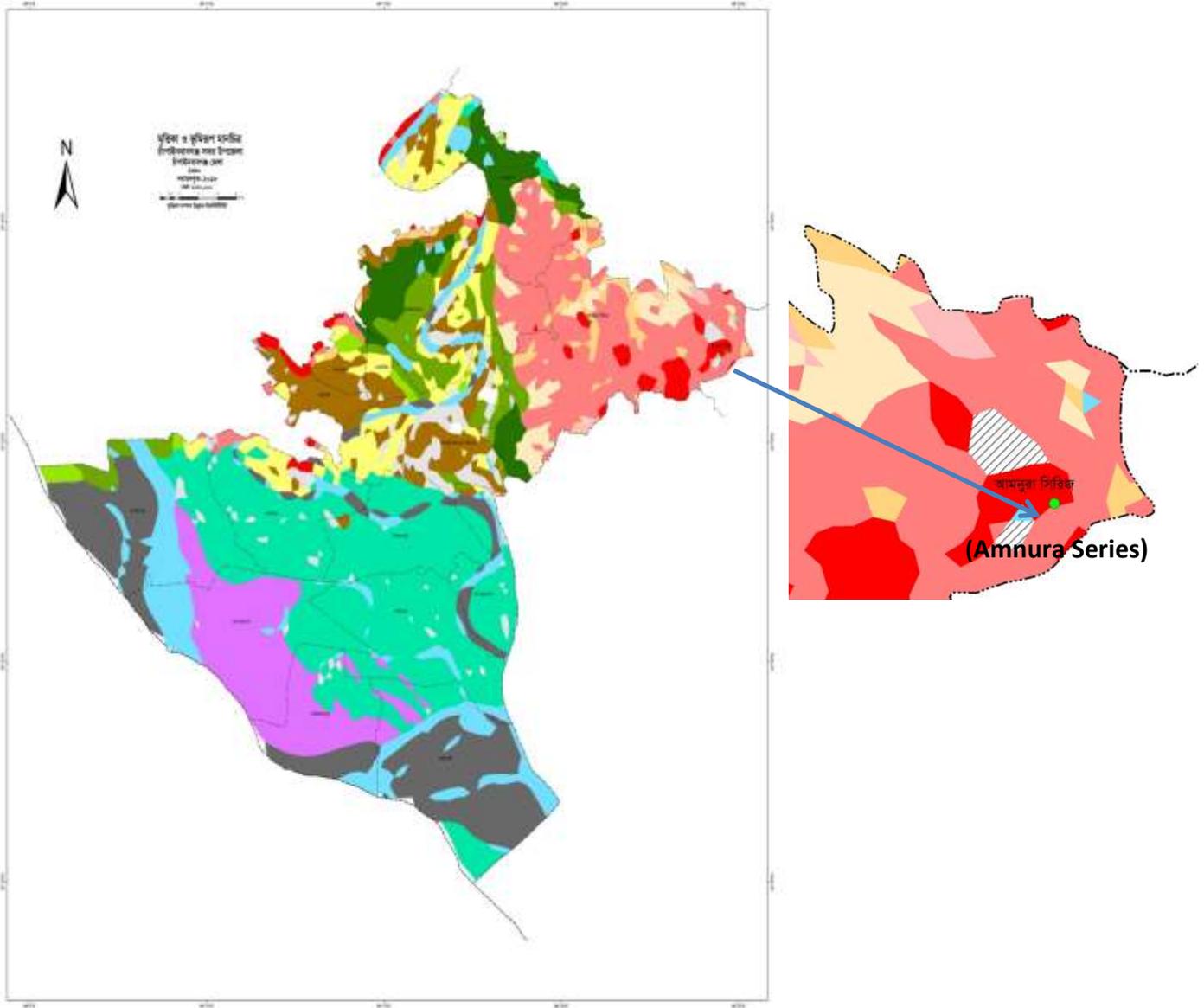
Study area

1.   **Atahar series**, **Location: Atahar, Chapainawabganj**, GPS: **24°37′44", 88°20′51"**
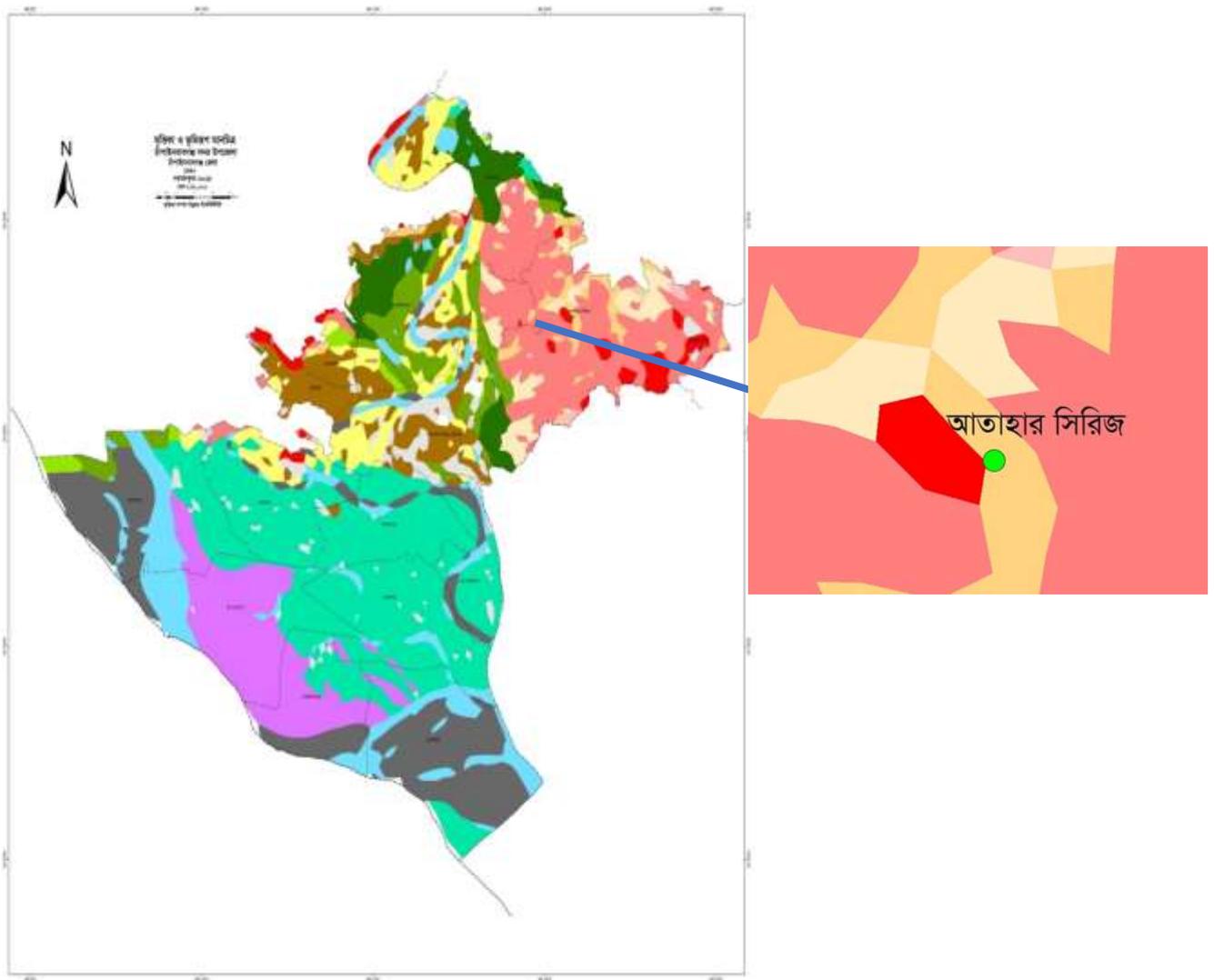
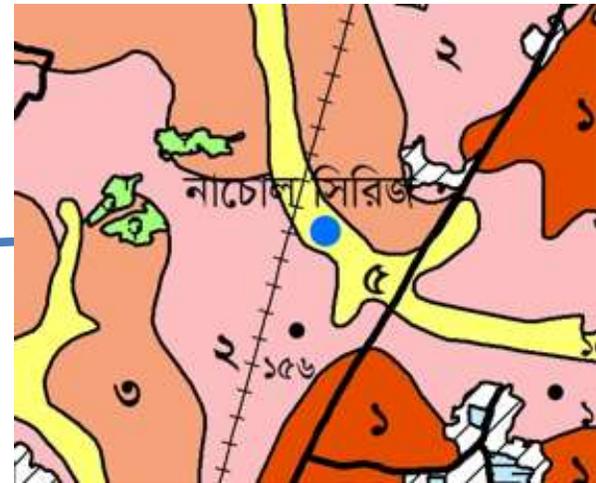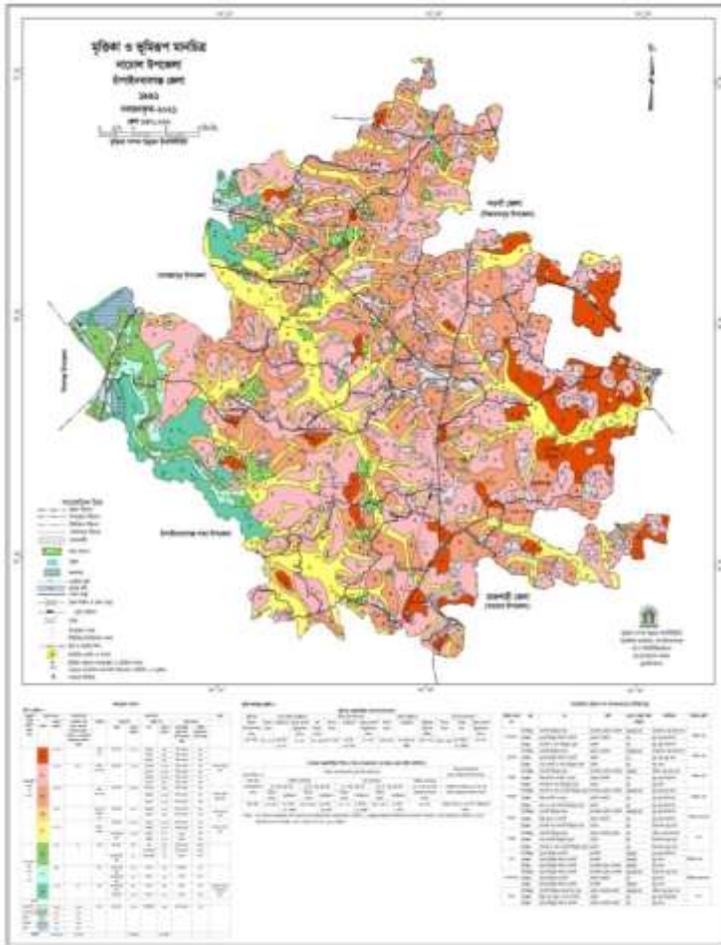**Soil and Landform Map**
Upazila: Chapainawabganj Sadar
District: Chapainawabganj

3. Nachol Series, Location : Nachol, Chapainawabganj, GPS: 24°39′43″, 88°24′36″

Soil and Landform Map
Upazila: Nachol
District: Chapainawabganj

Objectives

1. To determine physical properties of three major soil series in Acidic soils of Barind Tract.
2. To find out chemical properties changes of three major soil series in Acidic soils of Barind Tract.
3. To make a soil bacterial population's benchmark data of three major soil series in Acidic soils of Barind Tract.

Methodology

Three representative (Major soil series) sites of Barind Tract were selected for soil sample collection from a benchmark soil profile. Different horizons of a profile were properly delineated according to FAO guidelines. Soil sampling for analysis of physical properties were collected in core boxes using a core sampler. Different core boxes containing soil samples from the different horizons were sent to the laboratory for analysis. Soil texture, bulk density, particle density, porosity and moisture content were analyzed as per the standard methodology of the central laboratory, Soil Resource Development Institute (SRDI), Dhaka.

For chemical analysis, soil samples were collected using a knife and a Dutch Auger. Soil nutrients such as p^H, Organic Matter, N, P, K, Ca, Mg, S, B,Zn,Cu, Fe, Mn were analyzed according to the standard methodology of the central laboratory, Soil Resource Development Institute (SRDI), Dhaka.

For study of bacterial populations, soil samples were collected from different layers of soil profile. An ice box was used for transportation of the samples. Total bacterial populations count was performed according to the dilution series method. The analysis was conducted in the plant pathology laboratory of Haji Danesh Science and Technology University (HSTU), Dinajpur.

Atahar series, RSS, Rajshahi
Location: Stop 3/B7-10. Jamtara, Chapainawabganj
GPS: 24°37′44″, 88°20′51″

Table-1: Physical properties of Atahar series in RSS location (1968)

Depth (cm)	Sand	Silt	Clay	Texture	Colour
	\%			Class	(Munsell color chart)
0-12.7 (AP1g)	18	60	22	Silt Loam	Grey (5Y6/1) moist to light grey (5Y7/1) dry
12.7-17.78 (AP2g)	18	58	24	Silt Loam	Grey (5Y6/1) moist to light grey (5Y7/1) dry
17.78-50.8 (1)	16	47	37	Silty Clay Loam	Light yellowish brown (2.5Y6/4) moist
50.8-78.74 (2)	15	41	44	Silty Clay	Grey (5Y5/1) moist

| 78.74-106.68 (3) | 16 | 41 | 43 | Silty Clay | Grey (5Y6/1) moist |
| 106.68-139.7 (4) | 15 | 42 | 43 | Silty Clay | Light grey (5Y6/1) moist |

Atahar series
Location: Atahar, Chapainawabganj
GPS: 24°37′44", 88°20′51"

Table-2: Physical properties of Atahar series of the study area in RSS location (2023)

Depth (cm)	Sand	Silt	Clay	Texture	Bulk density	Particle density	Porosity	Moisture content	Colour
	%			Class	g/cm3		%		(Munsell color chart)
0-15.24 (AP$_1$)	18.00	55.75	26.25	Silt Loam	1.22	2.42	49.60	14.62	Grey (5y5/1) moist to light grey (5Y7/1) moist
15.24-24.13 (AP$_2$)	14.25	60.75	25.00	Silt Loam	1.64	2.47	33.74	14.42	Grey (5y5/1) moist to light grey (5Y7/1) moist
24.13-33.02 (B$_1$)	15.50	60.75	23.75	Silt Loam	1.74	2.38	26.86	12.94	Light yellowish brown (2.5Y6/4) moist
33.02-53.34 (B$_{21}$)	15.50	55.75	28.75	Silty Clay Loam	1.61	2.51	35.84	15.77	Grey (5Y6/1) and yellowish brown (10 YR5/6) moist

Atahar series, RSS, Rajshahi
Location: Stop 3/B7-10. Jamtara, Chapainawabganj
GPS: 24°37′44", 88°20′51"

Table-3: Chemical properties of Atahar series in RSS location (1968)

Depth (cm)	pH	EC	CEC	C	N	K	Ca	Mg	BSP
		10^3	me/100g	%	%	me/100g	me/100g	me/100g	
0-12.7 (AP1g)	5.8	-	11.9	0.55	0.05	0.11	5.9	3.6	81
12.7-17.78 (AP2g)	6.4	-	-	0.41	0.04	-	-	-	-
17.78-50.8 (1)	6.5	-	16.3	0.29	0.04	0.18	9.1	1.0	82
50.8-78.74 (2)	5.8	-	-	-	-	-	-	-	-
78.74-106.68 (3)	6.0	-	-	-	-	-	-	-	-
106.68-139.7 (4)	6.0	0.06	-	-	-	-	-	-	-

Atahar series
Location: Atahar, Chapainawabganj
GPS: 24°37′44", 88°20′51"
Table-4: Chemical properties of Atahar series of the study area in RSS location (2023)

Depth (cm)	pH	EC	OM	TN	P	K	S	B	Zn	Ca	Mg	Cu	Fe	Mn
		dS/m	%		mg/kg	meq/100g	mg/kg	mg/kg	mg/kg	meq/100g	meq/100g	mg/kg	mg/kg	mg/kg
0-15.24 (AP$_1$)	5.1	-	1.54	0.0725	4.28	0.32	13.90	0.45	1.09	6.36	3.68	3.96	298.11	35.86
15.24-24.13 (AP$_2$)	6.2	-	0.61	0.0305	1.48	.20	19.51	.43	.92	7.40	3.85	1.83	25.84	21.94
24.13-33.02 (B$_1$)	6.7	-	0.27	0.0135	2.70	0.23	10.23	0.34	0.49	8.69	4.41	1.10	14.33	6.03
33.02-53.34 (B$_{21}$)	6.3	-	.34	0.017	1.2	0.31	5.91	0.12	0.51	10.99	5.91	0.82	15.53	7.29

Atahar Soil Series:

General information:
Atahar soils develop in deeply weathered Madhupur clay and occupy summits and slopes of dissected areas of the Barind tract. During the monsoon season, these soils are typically subject to intermittent flooding by rainwater ponded within the fields. Atahar soils are characterized by light olive brown to light yellowish brown coloration, with strong grey mottling. The soil texture ranges from silty clay loams to silty clays, transitioning into grey Madhupur clay with yellow and red mottling below approximately 60 cm depth. Occasionally, a minimal presence of calcareous nodules is observed below approximately 120 cm depth.

Observation from soil profile analysis:
The RSS report (1968) and the study area (2023) analysis show the clay migration in the Atahar soil profile as well as Amnura. No major changes were observed on chemical analysis.

Amnura series, RSS, Rajshahi
Location: Stop 1/B7-12. Amnura, P.S. Nawabganj.
GPS: 24°37′02", 88°24′40"

Table-5: Physical properties of Amnura series in RSS location (1968)

Depth (cm)	Sand	Silt	Clay	Texture	Colour
	%			Class	(Munsell color chart)
0-15.24 (APg)	17	63	20	Silt Loam	Grey (5y5/1) moist to light grey (5Y7/1) moist
15.24-43.18 (1)	15	59	26	Silt Loam	Yellowish brown (10YR5/6) and Light olive grey (5Y6/2) moist
43.18-66.04 (2)	14	43	43	Silty clay	Grey (5Y5/1) and yellowish brown (10YR5/6) moist

66.04-101.6 (3)	16	41	43	Silty clay	Grey (5Y5/1) moist
101.6-139.7 (4)	13	42	45	Silty clay	Grey (5Y5/1) moist

Amnura series
Location: Amnura, Chapainawabganj.
GPS: 24°37′02″, 88°24′40″
Table-6: Physical properties of Amnura series of the study area in RSS location (2023)

Depth(cm)	Sand	Silt	Clay	Texture	Bulk density	Particle density	Porosity	Moisture content	Colour
		%		Class		g/cm3		%	(Munsell color chart)
0-5.08 (AP1)	13.38	67.88	18.75	Silt Loam	1.47	2.43	39.42	10.33	Grey (5y5/1) moist to light grey (5Y7/1) moist
5.08-10.16(AP2)	15.50	67.00	17.50	Silt Loam	1.77	2.34	24.64	12.60	Grey (5y5/1) moist to light grey (5Y7/1) moist
10.16-15.2(B21)	14.25	67.00	18.75	Silt Loam	1.81	2.51	27.96	10.86	Yellowish brown (10YR5/6) and Light olive grey (5Y6/2) moist
15.24-73.66 (B22)	16.75	44.50	38.75	Silty Clay Loam	1.59	2.51	36.47	17.12	Grey (5Y5/1) and yellowish brown 2.5y 6/4 moist
73.66- 177.8 (B3)	15.50	40.75	43.75	Silty clay	1.59	2.51	36.84	18.67	Grey (5Y5/1) moist

Amnura series, RSS, Rajshahi
Location: Stop 1/B7-12. Amnura, P.S. Nawabganj.
GPS: 24°37′02″, 88°24′40″
Table-7: Chemical properties of Amnura series in RSS location (1968)

Depth (cm)	pH	EC	CEC	C	N	K	Ca	Mg	BSP
		10^3	me/100g	%	%	me/100g	me/100g	me/100g	
0-15.24 (APg)	5.5	-	12.2	0.54	0.06	0.17	6.4	2.0	71
15.24-43.18(1)	6.9	-	11.9	0.19	0.03	0.46	8.6	0.3	72
43.18-66.04(2)	6.6	-	-	0.17	0.03	-	-	-	-
66.04-101.6(3)	6.5	-	-	-	-	-	-	-	-
101.6-139.7(4)	6.4	0.09	24.5	-	-	0.24	16.4	4.4	85

Amnura series
Location: Amnura, Chapainawabganj
GPS: 24°37′02″, 88°24′40″

Table-8: Chemical properties of Amnura series of the study area in RSS location (2023)

Depth (cm)	pH	EC	OM	TN	P	K	S	B	Zn	Ca	Mg	Cu	Fe	Mn
		dS/	%		mg/kg	meq/100g	mg/kg	mg/kg	mg/kg	meq/100	meq/100g	mg/kg	mg/kg	mg/kg
0-5.08 (AP1)	6.8	-	1.61	0.080	67.40	0.30	13.16	1.0	3.72	9.73	4.12	2.49	102.67	1.92
5.08-10.16 (AP2)	7.5	-	0.94	0.047	23.48	0.11	1.15	0.80	1.28	7.97	3.49	2.16	85.21	2.63
10.16-15.24 (B21)	7.6	-	0.20	0.010	2.14	0.27	1.00	0.24	0.38	13.72	4.43	0.60	9.70	1.48
15.24-73.66 (B22)	7.5	-	0.20	0.010	1.75	0.26	1.00	0.33	0.58	13.64	4.58	0.55	6.91	1.03
73.66-177.8 (B3)	7.4	-	0.07	0.003	2.23	0.33	7.74	0.12	0.33	16.44	5.30	0.35	5.45	1.02

Amnura Soil Series:

General information:

Amnura soils are developed in deeply weathered Madhupur clay. These soils are present on expansive, level areas as well as summits and slopes of dissected regions within the Barind tract. During the monsoon season, these soils are typically subject to intermittent inundation by rainwater accumulated within the fields. Amnura soils are mixed yellowish brown and grey to light grey silt loams to silty clay loams grading into grey, mottled yellowish brown, weathered Madhupur clay below about 2 feet.

Observation from soil profile analysis:
In the RSS report (1968), the Amnura soil profile exhibited a soil texture ranging from 43.28 cm to 66.04 cm of silty clay, whereas the study area (2023) demonstrated a soil texture ranging from 15.24 cm to 73.66 cm of silty clay loam. Due to the clay migration this change in texture is observed.

Chemical analysis of Amnura soil reveals that the pH range reported in the RSS (1968) document was 5.5 to 6.4, whereas in the study area (2023), the pH range increased to 6.8 to 7.4. Increase in calcium and magnesium values were noticed with the increase in pH level, also. This alteration in soil nutrient composition is attributed to cultural management practices such as use of Magnesium Sulphate fertilizer, Dolomite and Biochar. Clay migration increases the availability of Potassium also.

Nachol series
Location: Stop 10/B7. Pachakandar, Nachol, Chapainawabganj

GPS: 24°39′43″, 88°24′36″

Table-9: Physical properties of Nachol series in RSS location (1968)

Depth (cm)	Sand	Silt	Clay	Texture	Colour
		%		Class	(Munsell color chart)
0-15.24 (APg)	15	56	29	Silty Clay Loam	Grey (5Y6/1) moist to light grey (5Y7/1)
15.24-30.48 (1)	16	55	29	Silty Clay Loam	Grey (5Y6/1) and yellowish brown (10 YR5/6) moist
30.48-66.04 (2)	15	52	33	Silty Clay Loam	Grey (5Y6/1) and stong brown (7.5 YR5/6) moist
66.04-93.98 (3)	16	50	34	Silty Clay Loam	Grey (5Y5/1) moist
93.98-127.00 (4)	16	52	32	Silty Clay Loam	Grey (5Y5/1) and dark brown (7.5YR 4/2)

Nachol Series
Location : Nachol, Chapainawabganj.
GPS: 24°39′43″, 88°24′36″

Table-10: Physical properties of Nachol series of the study area in RSS location (2023)

Depth (cm)	Sand	Silt	Clay	Texture	Bulk density	Particle density	Porosity	Moisture content	Colour
		%		Class	g/cm3		%		(Munsell color chart)
0-4 (AP_1)	15.50	55.75	28.75	Silty Clay Loam	1.61	2.51	35.84	15.77	Grey (5Y6/1) moist to light grey (5Y7/1)
4-7.5 (AP_2)	11.75	47.00	41.25	Silty Clay	1.54	2.33	34.06	18.24	Grey (5Y6/1) and yellowish brown (10YR5/6) moist
7.5-16 (B_1)	14.25	44.50	41.25	Silty Clay	1.74	2.52	30.78	14.96	Grey (5Y5/1) and dark brown (7.5 YR 4/2) moist
16-31 (B_2)	13.00	33.25	53.75	Clay	1.59	2.46	35.15	18.26	Grey (5Y5/1) moist
31-40 (B_3)	9.75	30.50	59.75	Clay	1.56	2.52	37.95	21.53	Grey (5Y5/1) moist
40-60 (B_4)	12.25	30.50	57.25	Clay	1.50	2.35	36.26	20.98	Grey (5Y5/1) moist
-	Could not be grounded due very hard CaCO3 concretions				1.64	2.56	36.23	11.26	-
-	12.25	50.50	37.25	Silty Clay Loam	1.65	2.45	32.67	16.41	-

Nachol series
Location: Stop 10/B7. Pachakandar, Nachol, Chapainawabganj.
GPS: 24°39′43″, 88°24′36″

Table-11: Chemical properties of Nachol series in RSS location (1968)

Depth (cm)	pH	EC	CEC	C	N	K	Ca	Mg	BSP
		10^3	me/100g	%	%	me/100g	me/100g	me/100g	
0-15.24 (APg)	4.9	-	16.4	0.46	0.06	0.15	6.9	1.5	56
15.24-30.48 (1)	6.3	-	14.4	0.19	0.03	0.15	8.5	2.3	76
30.48-66.04 (2)	6.2	-	16.9	0.16	0.02	0.17	8.9	2.8	84
66.04-93.98 (3)	6.2	-	-	-	-	-	-	-	-
93.98-127.00 (4)	6.3	0.17	16.4	-	-	0.15	8.6	3.5	84

Nachol series
Location : Nachol, Chapainawabganj
GPS: 24°39′43″, 88°24′36″

Table-12: Chemical properties of Nachol series of the study area in RSS location (2023)

Depth (cm)	pH	EC	OM	TN	P	K	S	B	Zn	Ca	Mg	Cu	Fe	Mn
		dS/m	%	%	mg/kg	meq/100g	mg/kg	mg/kg	mg/kg	meq/100g	meq/100g	mg/kg	mg/kg	mg/kg
0-4 (AP1)	6.4	-	0.27	0.014	1.10	0.32	5.50	0.15	0.49	10.71	5.70	1.10	14.33	6.03
4-7.5 (AP2)	6.9	-	0.34	0.017	2.50	0.35	5.37	0.005	0.34	13.10	6.66	0.55	8.33	2.55
7.5-16 (B1)	6.8	-	1.48	0.074	16.28	0.30	3.16	0.40	0.76	14.79	5.79	3.39	172.54	16.69
16-31 (B2)	7.6	-	0.40	0.020	3.85	0.32	3.90	0.36	0.39	18.53	5.99	1.30	16.31	6.55
31-40 (B3)	7.7	-	0.40	0.020	2.45	0.33	1.35	0.15	0.40	20.51	6.14	1.11	10.84	2.40
40-60 (B4)	7.6	-	0.40	0.020	2.88	0.42	4.68	0.28	1.04	25.07	7.19	1.52	14.65	4.56

Nachol Soil Series:

General information:
Nachol soils are formed in local colluvium or alluvium derived from the Madhupur clay. These soils are present in nearly level to gently sloping valleys (bydes) of approximately 50-120 yards width that dissect the Barind tract. During the monsoon season, the majority of these soils experience intermittent flooding by rainwater that accumulates within the fields. They have imperfectly drained, mixed grey and yellowish brown silty clay loams with moderate angular blocky structure in the subsoil.

Observation from soil profile analysis:
In the RSS report (1968), the Nachol soil profile exhibited a soil texture ranging from 0.0 cm to 127.00 cm of silty clay loam, whereas the study area (2023) demonstrated a soil texture ranging

from 0.0 cm cm to 4.0 cm of silty clay loam, 4.0 cm to 16.0 cm of silty clay and 16.0 cm to 60.0 cm of clay. Due to the clay migration this change in texture is observed.

Chemical analysis of Nachol soil reveals that the pH range reported in the RSS document (1968) was 4.9 to 6.3, whereas in the study area (2023), the pH range increased to 6.4 to 7.6. Concurrent with the increase in pH level, calcium and magnesium values were also exhibited an increase level. This change in soil nutrient composition is attributed to cultural management practices such as use of Magnesium Sulphate fertilizer, Dolomite, Biochar and others. Clay migration increases the availability Potassium also.

Table-13: Bacterial populations of Amnura, Atahar and Nachol series of the study site (2023)

Location	Different Layer of soil Profile (cm)	Soil bacterial Population/1 gm)
Amnura series Amnura, Chapainawabganj **GPS: 24°37′02″, 88°24′40″**	AP1(0-5.08)	$3.8*10^8$
	AP2 (5.08-10.16)	$3.1*10^8$
	B21(10.16-15.24)	$3.1*10^8$
	B22 (15.24-73.66)	$2.9*108$
	B3 (73.66- 177.8)	$2.9*10^8$
Atahar series Atahar, Chapainawabganj **GPS: 24°37′44″, 88°20′51″**	AP_1(0-15.24)	$3.3*10^8$
	AP_2(15.24-24.13)	$2.8*10^8$
	B_1(24.13-33.02)	$3.1*10^8$
	B_{21}(33.02-53.34)	$3.2*10^8$
Nachol series Nachol, Chapainawabganj **GPS: 24°39′43″, 88°24′36″**	AP_1(0-4)	$3.6*10^8$
	AP_2(4-7.5)	$3.4*10^8$
	B_1(7.5-16)	$2.8*10^8$
	B_2(16-31)	$1.9*10^8$
	B_3(31-40)	$2.5*10^8$
	B_4(40-60)	$2.7*10^8$

Recommendation

1. The study has provided the analytical data to understand the overall situation of soil properties and degree of soil degradation which is necessary to suggest sustainable soil management practices needed for the soil health and future soil monitoring.
2. The research will help to make decision about the efficient use of soil nutrients as well as fertilizers, irrigation water, ways and means of increasing carbon capture.
3. Bacterial populations of the studied soils will help to ensure soil health and organic agriculture planning in future.

Conclusion

The study findings will make awareness among extension peoples to get rid of bad practices and to make positive attitude for friendly sustainable land management. Benchmark data for Soil

microbial populations will also be generated from different major soil series of Barind Tract soils. The research findings will also help to identify the new research area for further soil biodiversity research activities in Barind soils of Bangladesh.

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