ANNUAL REPORT
2021-2022

SOIL RESOURCE DEVELOPMENT INSTITUTE

MINISTRY OF AGRICULTURE

MRITTIKA BHABAN, FARMGATE, DHAKA-1215

2022

Government of the people's Republic of Bangladesh

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Foreward

Publication of annual report is one of the indispensible activities of SRDI. The annual report 2021-2022 comprises all activities performed during the year. The report encompasses the achievement against target of Annual Performance Agreement (APA) 2021-2022.

As a government and NARS organization SRDI's all activities are aiming at generating and developing inventories on soil and land resources, generating technologies for constrained soil management and ensuring measures for soil health management. All these endeavors have a common goal- sustainable agricultural development.

Preparation of Upazilla Nirdheshika is one of the core works of the institution. It is a unique tool for local level agricultural planning. The Nirdeshika comprises all land and soil related data, information including soil fertility aspects. It is prepared for Upazila level DAE official including SAAOs to make them more equipped with local level land and soil related data.Upazila Nirdeshika has multidimensional uses. Among them, recommendation of balanced fertilizer is most important. Next to Upazila Nirdeshika SRDI also prepare Union Shahayika as a tool for developing agricultural planning at grass root level. In addition to 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 turned on number of programmemes, like conducting research trial and distribution of fertilizer recommendation cards.

Analysis of soil, fertilizer, plant & water is another vital activity of the institution. These services are delivered mainly by static laboratories. Beyond that another type of farmers' service is given through Mobile Soil Testing Laboratories (MSTL) which is merely a motivational programmeme.

Monitoring of soil and water salinity is another important activity of the institution which is devoted to generating database for improved management of saline soils and also for programmeme planning.

Research is another vital activity of SRDI which is carried out in hilly region and saline affected area with an objective to develop technologies for better management of soil.

Apart from these, the institution renders support services to DAE, NARS organization, educational institutions and other GO and NGOs by providing data through its affluent data base.

Divisions and sections of SRDI head office have significant contributions to achieve the annual targets other than their othervaluable jobs.

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

I would like to extend my heartiest thanks to all officers and staffs of field offices, laboratories, research centers and head offices who are involved in implementing the annual programmeme 2021-2022 with sincere efforts.

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

Finally, members of the annual report preparation committee also deserve thanks for their contributions.

(Md. Kamaruzzaman)
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 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 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 area. Besides, 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 2021-22, updating soil survey programme 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 vegetable and fruits as 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 area. 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 of 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 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 170 Union Sahayikas were prepared and published in the fiscal year 2021-22.

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 2021-22, about 15,449 farmers/beneficiaries were served through OFRS software. Number of farmers served on the basis of Upazila Nirdheshika and soil test are 10,615 and 24 respectively.

SRDI's activities also involve GIS based data processing and map preparation. This endeavor employed for utilizing GIS in storage, retrieval as well as visualization of land and soil related maps. Under this programmeme, National level map on drainage condition, topsoil texture, topsoil consistency and water recession were prepared in 2021-22 fiscal year. The digitized maps depict the updated scenario of nutrient deficiency, degraded soil area, flood prone area, physiography as well as AEZ related features throughout the country.

SRDI initiated Soil Test Based (STB) Fertilizer Recommendation System through Mobile Soil Testing Laboratories (MSTL) since 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 2021-2022, 5,682 farmers of 112 Upazilas were given soil testing service and fertilizer recommendation cards through this programmeme.

SRDI is conducting salinity monitoring in coastal area of the country to observe short term and long term trend of salinity fluctuation. Data disclose that soil and water salinity was much higher in 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 sanity 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 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 desalinization 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 buried pipe irrigation network. This could be achieved through modern polder management. In Cox's Bazar District farmers use their lands as salt bed because of higher return. 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 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 area 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 agro-forestry 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 area.

Government has to pay a cosmic amount of money for subsidy in 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 adaptive trial programmeme 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 programmeme has been implemented throughout the country to visualize superiority of balanced fertilization over farmers' assumed dose. Besides yield increase balanced fertilization help to maintain soil health and good environment. Altogether 42 adaptive trials were set up in the year 2021-22. The yield data of Adaptive Trial plots revealed that farmers got 3.04%-37.6% higher yield in different crops and varieties in comparison to farmers' practices in different locations.

Chemical analysis of soil, fertilizer, plant and water sample is one of the core functions of SRDI. This programmeme 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 programmeme 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 2021-22 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) 25435 soil samples, 522 water samples, 309 plant samples and 4654 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, 5,682 soil samples were analyzed by 10 MSTLs.

Building up resourceful manpower to cope with upcoming challenges SRDI is implementing good deal of training programmemes 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 150 Officers of SRDI/DAE on the use of Upazila Nirdeshika along with various aspects of soil management/capacity building & skill development and 190 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; 10,500 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.

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 Ministry of Agriculture which was 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 emergence of Bangladesh, the then East wing office of the Central Soil Resource Institute started functioning as Department of Soil Survey under 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 the recent creation of 33 regional offices as well as 23 regional laboratories to flourish soil management services up to grass root level. It is now prepared to face the challenges of future to make breakthrough 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 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 its functioning with

2 wings, 2 divisions and 11 sections. Field Services Wing consists of 7 divisional offices and 33 regional offices. Analytical Services Wing includes 7 divisional laboratories, 23 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. 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 Director General`s office.

Soil Resource Development Institute is headed by 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). Cartography Section is headed by Senior Cartographer, Publication and Record Section is headed by Publication & Liaison Officer.

1.3.1 Functions of Survey and Land Management Division

Planning, co-ordination and supervision of all technical programmemes and activities of the component sections. Review and/or editing of all technical reports prepared by the component sections. Co-ordination with allied Government, Autonomous/other agencies in national programmemes 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.

1.3.2 Functions of Survey and Classification Section

Planning and supervision of soil surveys. Updating of 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.

1.3.3 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.

1.3.4 Functions of Land Evaluation and Soil Correlation Section

Planning and execution of annual targeted programmeme. 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.

1.3.5 Functions of Training and Communication Division

Organizing all central training programmeme and coordinating other trainings 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 of four sections.

1.3.5.1 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.

1.3.5.2 Functions of DPS and ICT Section

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

1.3.5.3 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.

1.3.6 Functions of Central Laboratory

Planning and implementation of annual programmeme Coordinating functions of component sections sections viz. Soil Chemistry Section; Soil Physics & Mineralogy Section and Soil Microbiology & Biochemistry Section. Execution of physical and chemical analyses of soil samples collected through different programmeme of SRDI. Analytical services are also provided to different organizations including DAE, NARS organizations and universities. Chemical analysis of water, plant and fertilizer samples. Planning and supervision of basic and adaptive research works such as soil degradation, crop and soil moisture relationship studies, variation of nutrient status of different soils, soil toxicity, etc. Carrying out research for controlling fertilizer adulterations.

1.3.7 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 programme on agricultural development. Assisting Director General on technical and administrative issues.

1.3.7.1 Divisional Offices

Implementation of the central technical programmeme 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 plan by providing soil and related data and information. Conducting training programmeme for SAAOs, farmers, entrepreneurs, fertilizer dealers and

NGOs' field worker. 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.

1.3.7.2 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 programmeme for SAAOs, farmers, entrepreneurs, fertilizer dealers and NGOs' field worker. 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.

1.3.8 Functions of Analytical Services Wing

Planning and implementation of annual programmeme 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) programmeme. Fulfilling research needs of SRDI and other research organizations through central and other laboratories. Assisting Director General on various technical and administrative issues.

1.3.8.1 Functions of Divisional Laboratory

Implementation of annual targeted programmeme under the guidance and supervision of Analytical Services Wing. Analyses of soil, water and plant samples to evaluate soil fertility, diagnosis of salinity, acidity, nutrient mining for the purpose of providing services and research supports. Analysis of fertilizer sample 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 supports to research organizations and educational institutions. Conducting training programmeme for farmers, entrepreneurs, fertilizer dealers, NGOs field workers.

1.3.8.2 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 laboratory for achieving annual target. Participate in execution of Mobile Soil Testing Laboratory programmeme. Supporting regional

offices of SRDI through soil and water analysis. Conducting training programmeme for farmers, entrepreneurs, fertilizer dealers, NGOs field workers.

1.3.9 Research Centers

1.3.9.1 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 area. Organizing training programmemes for SAAOs, farmers and NGOs field workers for technology dissemination. Providing support to university students fulfilling their academic needs.

1.3.9.2 Salinity Management and Research Center (SMRC):

Salinity Management and Research Center is located at Batiaghata, Khulna. SMRC is responsible for generating database 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 Land Classification Section

Technical Work:

1.Updating soil survey.

a) **Title of the Programme**

Updating Upazila Nirdeshika of Newly formed Guimara Upazila of Khagrachari district.

b) **Objectives**

-To prepare a digital interpretative map for conveying semi-detailed soil survey at field level.

-To conduct a semi-detailed survey to identify the changes in land and soil resources over time in GuimaraUpazila

c) **Methodology**

Digital orthophoto maps were created using the most advanced technologies of GIS and ArcGIS software database including cadastral data was created in order to produce digital data of orthophoto maps at the scale of 1:25,000 covering the whole upazila. The maps were printed out to be used for field identification of annotation data, such as administrative boundaries and geographical names, roads, settlements, water bodies etc. The appearance of the printed sheet was close to that of the final printed maps. However, the sheet names and marginal information also had to be checked during the field survey. Thus an interpretative soil and land form map is prepared at 1:25,000 scale. Finally the prepared map was converted to 1:50000 scale.

d) **Findings/Results & Discussion**

- A huge area under settlements was found in the newly formed Guimara upazila.
- People's livelihood changed positively with the availability of hat-bazars, school-college, roads as well as with access to new agricultural works in this hilly region.
- Most of the low hills as well as parts of medium high hills (especially in Guimara union and halfchari union) are now converted with plantation forests, fruit orchards, pineapple, vegetables, high valued horticultural crops e.g. papaya, dragon fruit, guava etc.
- Natural hilly ecosystems were found degraded seriously by the settlers.
- Jhum cultivation was rarely seen in the surveyed area.
- Water scarcity was found as the major problem for living and for agricultural activities.

2. Project (DPP) Preparation:

Sustainable soil health and fertility management for increasing soil resilience and crop yield in Bangladesh (as part of Programme on Agricultural and Rural Transformation for Nutrition, Employment and Resilience (PARTNER) proposed by World Bank.

Objectives

- Promotion of green growth agriculture using GAP, organic farming etc. in HYV rice and non-rice cereal and other diversified crops.
- Activities on organic soil amendments for increasing soil health and carbon sequestration.
- Adaptive trials of diversified crops with modern sustainable soil and land management technologies.
- Formulating bench mark data of soil microbes for major soil series of Bangladesh.
- Screening and isolation of effective and efficient bio inoculant.
- Formulating potential climate smart bio fertilizers.

Major activities of the project

1. Establishment of Soil Microbiological Laboratory for generating benchmark data of soil microbes in major soil series of Bangladesh.
2. Sustainable Soil health and fertility management in extended areas of HYV rice and non rice cereals and other diversified crops.
3. Strengthening of Accreditation laboratory for quality analysis of heavy metals and some other nutrient elements.

Administrative Work:

1. Compilation and Submission of Monthly Progress Report
2. Submission of Progress Report on Implementation of Prime Minister's Guidelines.
3. Question Answer of Honorable Agricultural Minister for the meeting of National Parliament
4. Written comments on the modules of Good Agricultural Practices(GAP) prepared by BARC.
5. Provided comments on the draft concept note on celebration of National Survey Day prepared by SOB.
6. Preparation of Soil Atlas.
7. Provided Information on "Survey on Research and Development 2021" to Bangladesh Bureau of Statistics.
8. Performance of official work of "Grievance Redress System (GRS)' Committee.

Activities in photography

Soil identification and collection of information from the local people during Surveying at Guimara Upazila

Soil identification, sample collection and conversation with the local people with the monitoring team of Agricultural Ministry Representatives at the Surveyed area

Land Use (fruit trees and pineapple) of Guimara Upazila

Observing Soil profile of Guimara Upazila

2.2 Land Use Planning Section

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. Achievements (2021-22) are shown under following heads

- Soil Survey related activities (Conducting Field Survey for Updating Upazila Nirdeshika)
- Annual Performance agreement (APA) related activities
- National Integrity strategy (NIS) related activities
- E-governance and Innovation related activities
- National Social Security Strategy
- Other Activities

3. Soil Survey related activities (Conducting Field Survey for Updating Upazila Nirdeshika):

- Semi-detailed soil survey programme was conducted at Lama upazila, Bandarban.
- Areial photographs, topographic maps, existing upazila soil and landform maps as well as DLR map have been used as base materials. During the updating soil survey programme, 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.
- Composite soil samples were collected with GPS reading to compare the changes of nutrient status due to intensive cultivation of modern varieties of different crops with imbalanced application of chemical fertilizers and climate changes.

4. 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. 7th 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 2021-22 fiscal year:

1. Field Survey for Updating Upazila Nirdeshika: 50 Upazila.
2. Preparation of union sahayika: 132 unions.
3. Soil sample analysis in static laboratory: 25,651 samples.
4. Fertilizer sample analysis: 4,586 samples.
5. Soil sample analysis through MSTL: 5,721 samples.
6. Soil and water sample analysis for salinity monitoring: 1118 samples.
7. Field trial establishment: 42
8. Online fertilizer recommendation system data updating: 35
9. Training on soil sample collection technique and fertilizer application: 16015
10. Distribution of Fertilizer Recommendation Card: 54,077

Annual Performance Agreement 2021-22 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 2020-21 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 21st June, 2021.

5. 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 2021-22 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.

6. 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 2021-22 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.

7. 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 programmemes 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 programme 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.

8. Other Activities:

8th Five Year Plan related activities.
Report on best practices has been provided by SRDI to MoA.
Soil related data was served to BBS as per BBS format.

2.3 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 standard of methodology on soil survey works & keeping records of soil information.
3) Correlation of soil surveys done by the 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. Achievements

3.1 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 (180 visitors in 6 batches)

3.2 Virtual Soil Museum

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

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

Sl	Upazila & district	Assigned Officer	Role of section	Date
1.	Madarganj, Jamalpur	Premangshu Majumder, SO	Surveyor	Dec, 2021
2.	Durgapur, Netrokona	Neelima Akter Kohinoor, PSO	Co-surveyor & Coordinator	Dec, 2021
3.	Teknaf, Cox's bazar	F. M. Mamun, SSO	Co-surveyor	Dec, 2021
4.	Kendua, Netrokona	Mohsana Akhter, SSO	Co-surveyor	Dec, 2021

3.4 Project / Programme Implementation

Title	Assigned Officer	Role	Period
1. Establishing National Land Use and Land Degradation Profile toward Mainstreaming SLM Practices in Sector Policies [ENALULDEP/ SLM] Project	Ameer Md. Zahid, PSO	Focal Person	Since October 2018
2. Sustainable Productivity in Agriculture in the Context of CSA and Agro-ecology	Ameer Md. Zahid, PSO	Focal Person	Since 31-05-2022
3. The enhancement of the Khamari mobile app	Ameer Md. Zahid, PSO	Representative	19-05-2022
4. Urban Agricultural (Pilot) Support Project	Premangshu Majumder, SO	M&E Officer	Till 31-03-2022
5. Soil Research & Strengthening Research Facilitation Project (SRSRF Project)	Premangshu Majumder, SO	M&E Officer	Since 01-06-2022

3.5 Project / Programme Plans Preparation

Sl	Title	Year	Contribution
1	পাহাড়ী এলাকায় টেকসই মৃত্তিকা ও ভূমি ব্যবস্থাপনার প্রযুক্তি প্রয়োগ এবং মৃত্তিকা গুণাগুণের ভিত্তিতে শস্য উপযোগিতা নিরূপণ। প্রস্তাবিত (2022-2025)	Since 24 March 2022	Assistance PSO
2	Advancing agro-ecological zone (AEZ) monitoring and information system to improve adaptation to climate change and food security in Bangladesh" Project	Since 29-11-2021	Focal Person PSO
3	"Climate Smart/Resilient Agriculture" concept note development for GCF	Since 10-04-2022	Focal Point PSO

3.6 Technical Report preparation:

Sl	Title	Year of Publication	Contribution
1.	Soil Atlas of Bangladesh	2021	Associate Author, PSO
2.	Land degradation in Bangladesh 2020	2022	Author, PSO
3.	ছাদ বাগান ব্যবস্থাপনা ম্যানুয়াল	2020	Author, SO

3.7 Discussion/ Presentation in Webinar /Seminar & Newspaper Article

Sl.	Subject line	Responsibility	আয়োজক সংস্থা / পত্রিকা	স্থান / প্রতিবেদক	Date
1.	জৈব উপাদান কমে যাওয়ার প্রভাব কী হতে পারে বাংলাদেশের কৃষি জমিতে?	Live Interview	BBC NEWS বাংলা	মুন্নি আক্তার	23-12-2021
2.	National Convention on Knowledge Sharing on SLM	Presentation	SRDI	DoE	02-06-2022
3.	Seminar: Rising Up from Drought Together: বিশ্ব মরুময়তা ও খরা প্রতিরোধ দিবস ২০২২ এর উপলক্ষ্যে আয়োজিত অনুষ্ঠান	Presentation	DoE	Agargaon, DoE	20-06-2022

3.8 Training received

Sl	Title	Institution	Location	Date
1.	Training on Online map resource of DLDD Cell software and Land Degradation survey mobile app	DoE	Agargaon, Dhaka	16-04-2022 to 18-04-2022
2.	অষ্টম পঞ্চবার্ষিক পরিকল্পনা ও এসডিজি বাস্তবায়ন।	Planning Commission	Dhaka	21-04-2022 & 24-04-2022
3.	Training on GIS & Remote Sensing	SRDI	Dhaka	16-11-2021 to 20-11-2021
4.	Training on Procurement	NATA	Gazipur	24-10-2021 to 04-11-2021

3.9 Training imparted

Sl	Title	Organized by	Location	Date
1.	One-day training on balanced fertilizer application and soil sample collection (MSTL)	Divisional Office, SRDI, Dhaka	Makikganj	03-11-2021
2.	Five-day DAE Officers' Training on Upazila Soil Resources Utilization Guide	SRSRF Project, SRDI, Dhaka	SRDI, Dhaka	04-06-2022 to 09-06-2022

3.10 Rendered Services in Different Committees

Sl	Work / Task / Programme of action	Responsibility	Date
1.	টেকসই উন্নয়ন অভীষ্ট (এসডিজি)	ফোকাল পয়েন্ট কর্মকর্তা (PSO)	Since 17-10-2021
2.	সেবা প্রদান প্রতিশ্রুতি কর্মপরিকল্পনা বাস্তবায়ন কমিটি	ফোকাল পয়েন্ট কর্মকর্তা (PSO)	Since 17-10-2021
3.	"Climate Smart/Resilient Agriculture" concept note development for GCF	Focal Point (PSO)	Since 10-04-2022
4.	Planning Cell	আহবায়ক (PSO)	Since 30-04-2022
5.	United Nations Convention to Combat Desertification (UNCCD) বাস্তবায়ন	ফোকাল পয়েন্ট কর্মকর্তা (PSO)	20-07-2022
6.	ইনোভেশন কমিটি	সদস্য (SO)	Since 06-07-2021
7.	ই-গভর্নেন্স কমিটি	সদস্য (SO)	Since 18-07-2021
8.	সফটওয়্যার ব্যবস্থাপনা কমিটি	সদস্য (SO)	Since 01-06-2021

4. Development need

The main problem of the section is its poor workforce. Practically only one technical person (PSO) is working in the section with four supporting staff. This should be immediately solved.

5. Future programme

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.

6. Activities in photography


Study of survey base materials. Nov. 2021


Coordinating survey, Durgapur, Dec. 2021


Semi-detailed survey, hill summit, Teknaf. Dec 2021


Semi detailed survey, Madarganj, Netrokona. Dec 2021.


Seminar on World Day for Combating Dissertation & drought. DoE. June 2021.


National Convention on SLM. DoE. June 2021

A2I Lab visit by Innovation Team, May 2022.

Meeting of Planning Cell. SRDI HQ. Dhaka. May 2022.

Citizen's Charter Monitoring Team visits Lab section, June 2022

Visitors in Soil Museum, SRDI

2.5 Training & Communication Division

The core function of the Training & Communication Division is the design and coordination of training interventions intended to enhance skill development of SRDI officials and staffs. This division also works on the development, integration, and implementation of a broad range of public affairs activities relative to the strategic direction and positioning of the organization. Training & Communication Division consists of 4 (four) sections viz. Human Resource Development Section, Cartography Section, Publication and Record Section and Data Processing & Statistical and Information & Communication Technologies (DPS & ICT) Section.

2.4.1. Human Resource Management section (HRD)

The functions of Human Resource Development Section are planning and execution of in-service training programme, organizing refresher courses in terms of short training programmes for the technical officers and staffs wherever required, organizing training programmes on use of soil information obtained through soil surveys for the technical officers and staffs of the beneficiary agencies like Department of Agriculture Extension (DAE), BRRI, BARC, etc. This section works on preparation and collection of training materials in terms of course syllabus such as audio-visual materials, soil monoliths, etc. HRD section also works on the arrangement of theoretical and practical training for the student of different educational 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/Thana Nirdeshika as per their requirements and request. Arrangement of departmental training of newly recruited officers is another work of this section.

Activities of HRD Section

(i) In-house Training Plan & Achievement in 2020-2021

Grade	No. of Officers & Staff	Target		Achieved (up to June'21)	% of achievement against target to June'21
		Per person	Total		
10-12	8	60	480	480	100
13-17	65	60	3900	3900	100
18-20	63	60	3780	3780	100

*14 officers are engaged in higher studies from July/2019

(ii) Higher Education

Sl. No.	Degree		No. of Officers				Remarks
		On-going	Obtained Scholarship	Received permission	Requested for permission	Completed	
1	PhD	13	2	2	2	2	-

(iii) Foundation Training for 4/6 Months

Sl. No.	No. of Trainees		
	BCS (Ag.) Cadre	Non-Cadre	Total
1	2	-	2

(iv) Special Training

Sl. No.	Courses	No.	Duration
1	Training of Trainers (ToT)-1 on Upazila Land and Soil Resources Utilization Guide	25	6 days
2	Training of Trainers (ToT)-1 on Upazila Land and Soil Resources Utilization Guide	25	6 days
3	Training of Trainers (ToT)-2 on Upazila Land and Soil Resources Utilization Guide	25	6 days
4	Training of Trainers (ToT)-1 (Refreshers) on Upazila Land and Soil Resources Utilization Guide	25	3 days
5	Training of Trainers (ToT)-1 (Refreshers) on Upazila Land and Soil Resources Utilization Guide	25	3 days
6	Training of Trainers (ToT)-2 on Upazila Land and Soil Resources Utilization Guide	25	6 days
7	Service Process Simplification	20	2 days
8	Application of GIS Technology in Preparing Maps	15	5 days
9	Application of GIS Technology in Preparing Maps	15	5 days
10	Skill Development Training on Remote Sensing	20	5 days
11	Laboratory Equipment Maintenance and Methodology	20	3 days
12	Training on Innovation in Public Service	30	2 days
13	Training on E-filing	20	1 days
14	Training on E-filing	20	3 days
15	Use of Computer and Software	30	2 days

In house Training Topics

- 100th Birth Anniversary of Father of the Nation Bangabandhu Sheikh Mujibar Rahman
- The Public Employee's Discipline (Punctual Attendance Ordinance), 2019.
- The Govt. Servants (conduct) Rules, 1979
- The Govt. Servants (Discipline and Appeal), 2018
- The General Provident Fund Rules, 1979.
- Keeping Service Records
- Office management
- Drafting letters and notes with especial emphasis to Promito Bangla Bananer Nyom)
- National Integrity Strategy etc.
- Food & nutrition
- Disaster Management
- COVID-19: Our duties and responsibilities
- Dengue Fever
- Social SafetyNet
- Nagor Krishi
- Administrative Tribunal Act, 1980 & Rule, 1982
- Income tax calculation
- Public service act, 2018

- Fundamental right as per constitution and service rule
- APA, Citizen Charter
- Maintenance and repairing of vehicles, driving rules and regulations
- Outsourcing policy
- Instructions for Non-cadre recruitment rule formulation
- General Principles of Seniority
- ACR
- Treatment facilities for govt. Servants
- Sustainable Development Goal

(v) Local Training Programmes Attended by Officers

Sl.	Title/Courses	No.	Duration	Institute
1	Statistical Data and Metadata Exchange (SDMX) Metadata preparation based on International Standards (Online)	2	1 day	FAO
2	"Trends.Earth" for the Calculation of SDG Indicator 15.3.1 and Sub-indicators (Online)	2	1 day	
3	Salinity Mappling (Online)	2	10	
4	Soil Organic Carbon Sequestration Potential Map (Online)	2	7	
5	PY-AEZ (Online)		3	
6	Soil Doctor Programme in Bangladesh (Online)	2	1 day	
7	Disaster Management in Agriculture	1	5 days	NATA
8	Project Appraisal and Formulation of DPP	1	5 days	
9	Food Security and Nutrition	1	5 days	
10	Modern Office Management (Online)	1	5 days	
11	Sustainable Development Goals (SDGs) (Online)	2	1 day	
12	Public Financial Management	1	5 days	
13	Rules & Regulations for Organizational Management	2	5 days	
14	Good Governance	1	5 days	
15	Training of Trainers (ToT) on Teaching Method & Techniques	2	5 days	
16	Soil Health Management	4	5 days	
17	Project Appraisal and Formulation of DPP	1	5 days	
18	Climate Smart Agriculture	1	5 days	
19	Human Resource Management	2	5 days	
20	Public Procurement Procedure	1	10 days	
21	Advanced ICT	1	10 days	
22	Public Procurement Procedure (PPP)	1	10 days	
23	Integrated Water Resource Management in Agriculture	3	5 days	
24	Project Appraisal and Formulation of DPP	1	10 days	
25	Food Quality and Nutrition Management (Online)	3	1 day	BARC
26	Research Methodology	1	12 days	
27	Monitoring and Evaluation in Project Management	1	5 days	
28	Excel Based Data Analysis for Early Career Scientist	2	3 days	
29	Project Development and Management	1	5 days	
30	Training course on bioinformatics for sustainable development in agriculture	2	3 days	
31	Use of Fertilizer Recommendation Guide-2018	4	3 days	BARC
32	Climate Smart Agriculture	2	2 days	

Sl.	Title/Courses	No.	Duration	Institute
33	Climate Change, Carbon Sequestration and Adaptation Strategies	4	3 days	
34	Awareness Training on Nutrition and Food Safety (Online)	3	1 days	
35	Scientific Report Writing	2	5 days	
36	Fiscal Economics and Economic Management (FEEM)	1	10 days	IPF
37	Budget Management Specialist (BMS)	1	19 days	
38	iBAS++	2	1 day	
39	iBAS++ for Development Project)	8	1 days	
40	Capacity Building for Generating SDGs Data with Focus to Environment, Climate Change and Disaster Management	2	2 days	BBS
41	Capacity Building for Generating Data on Environment, Climate Change and Disaster Management Issues in focusing to policy coherence for sustainable development	1	3	
42	Use of SEPAL Platform for Preparing Local to National SDG Indicator 15.3.1	2	3 days	
43	Fundamentals of Remote Sensing (Online)	4	32 hours	GeoSRF
44	Fundamentals of GIS (Online)	3	50 hours	
45	Professional GIS Training (Online)	1	50 hours	
46	Greenhouse Gas Inventory and MRV System	1	4 days	DoE
47	Inaugural Ceremony and General Introductory Training Programme	1	1 day	
48	Disaster Risk Management	1	5 days	Planning Commission
49	Appraisal of Civil Works of Agriculture Sector's Project	2	5 days	
50	Preparation of e-Book	2	-	BANSDOC
51	Training of Trainers (ToT) Course on "Concept and Practice of Integrated Water Resources Management	1	5 days	CEGIS
52	Service Process Simplification	3	3 days	BIAM
53	R for Data Analytics (Online)	2	50 hours	ISRT (DU)

2.4.2 Data Processing and Statistical and Information and Communication

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

- GIS related
- ICT related
- 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.

c. Upazila Nirdeshika Survey

- Gazipur Sadar Upazila Nirdeshika updating survey has been done and draft soil map has been prepared.
- Lalmai Upazila Nirdeshika updating survey has been done and draft soil map has been prepared.

d. Hardware maintenance and trouble shooting for different computer of SRDI head office.

e. Take part with proper logistic support of different agricultural fair.

f. Technical assistance and necessary support provided to prepared different on demand report for MoA, BARC and others.

g. Different on demand report for Woman Development has been prepared and send to MoA.

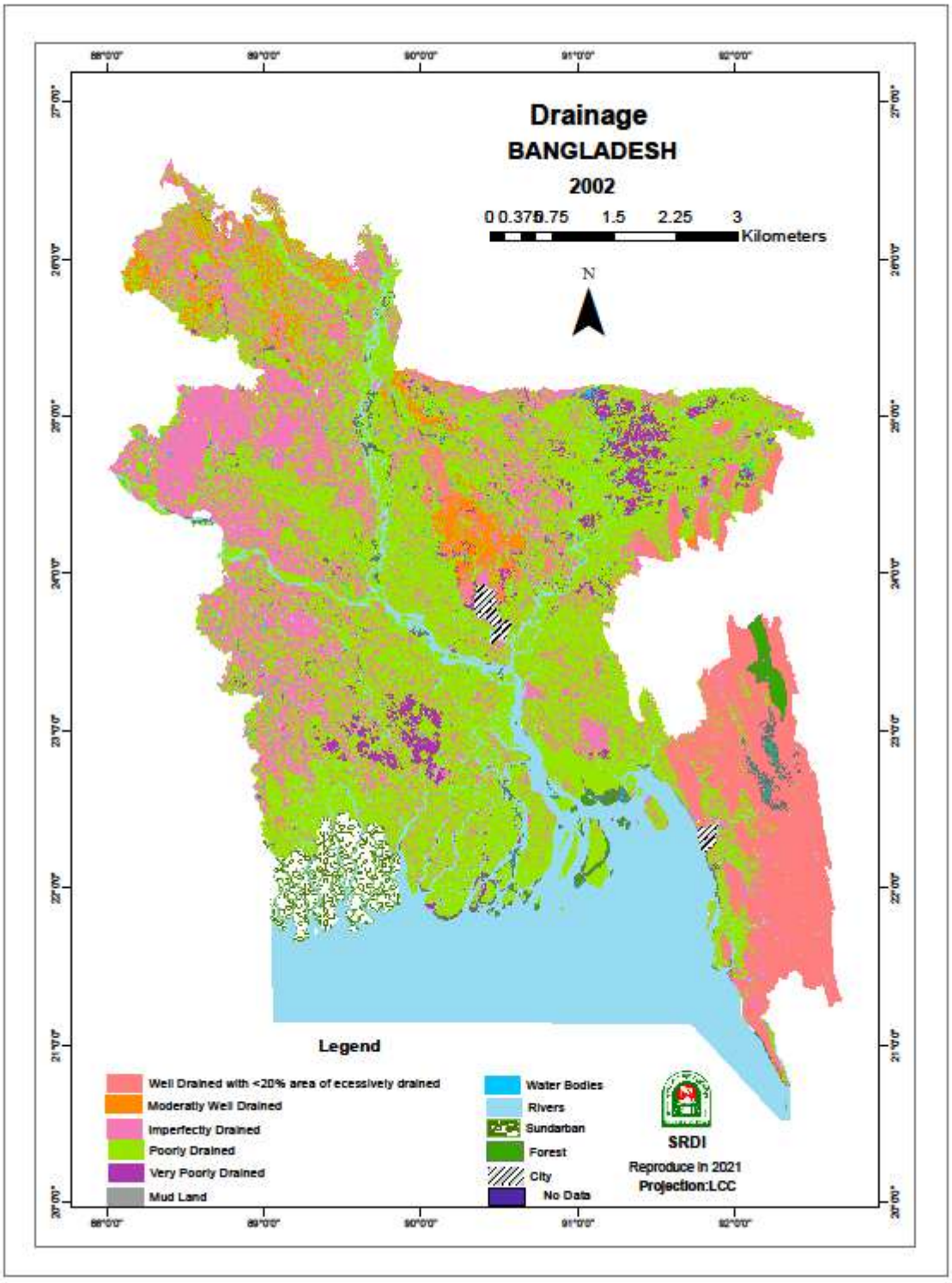
h. Involved in the innovation activities of SRDI.

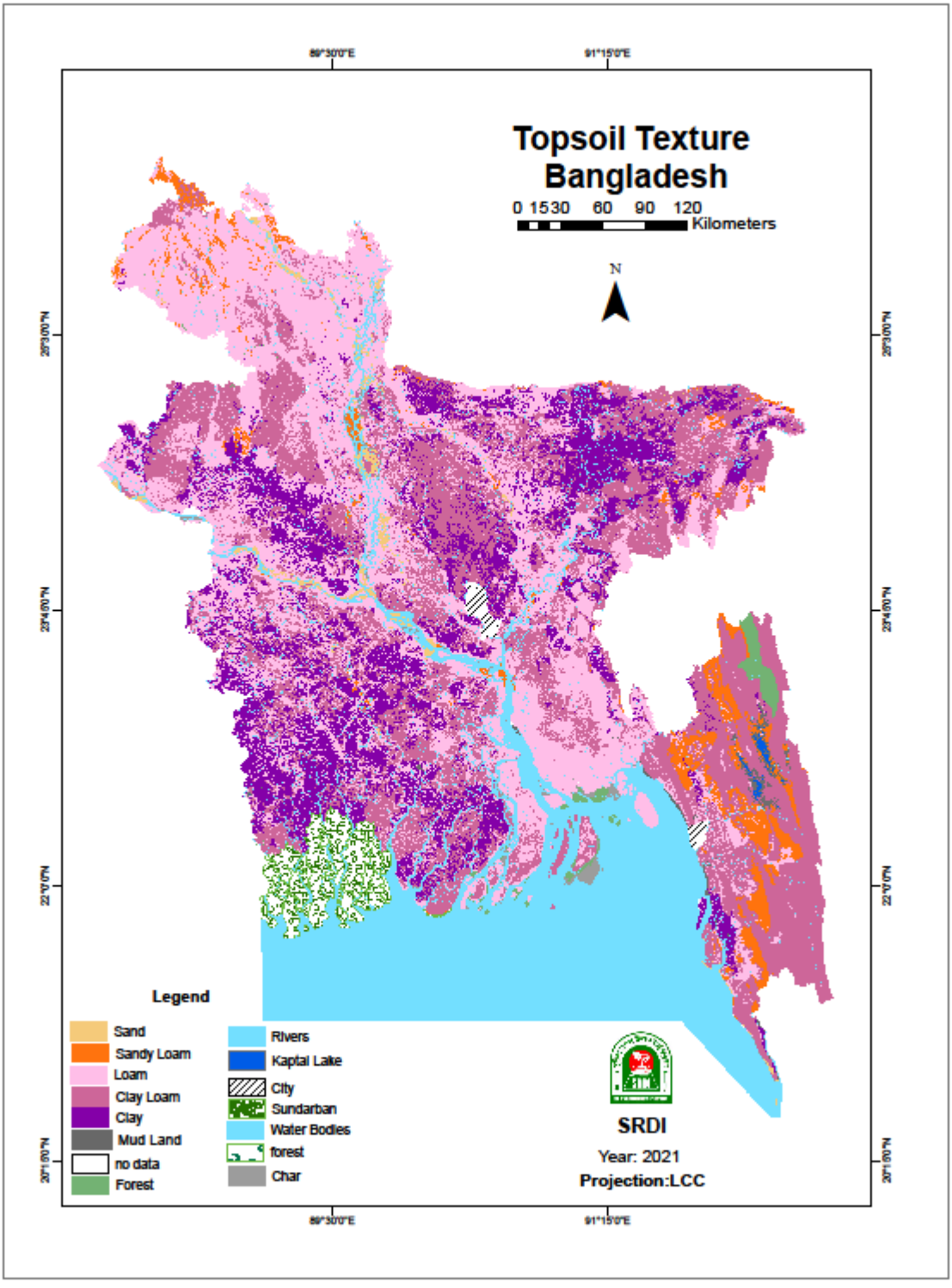
i. Technical assistance provided to the students, scientists other visitors for research purpose.

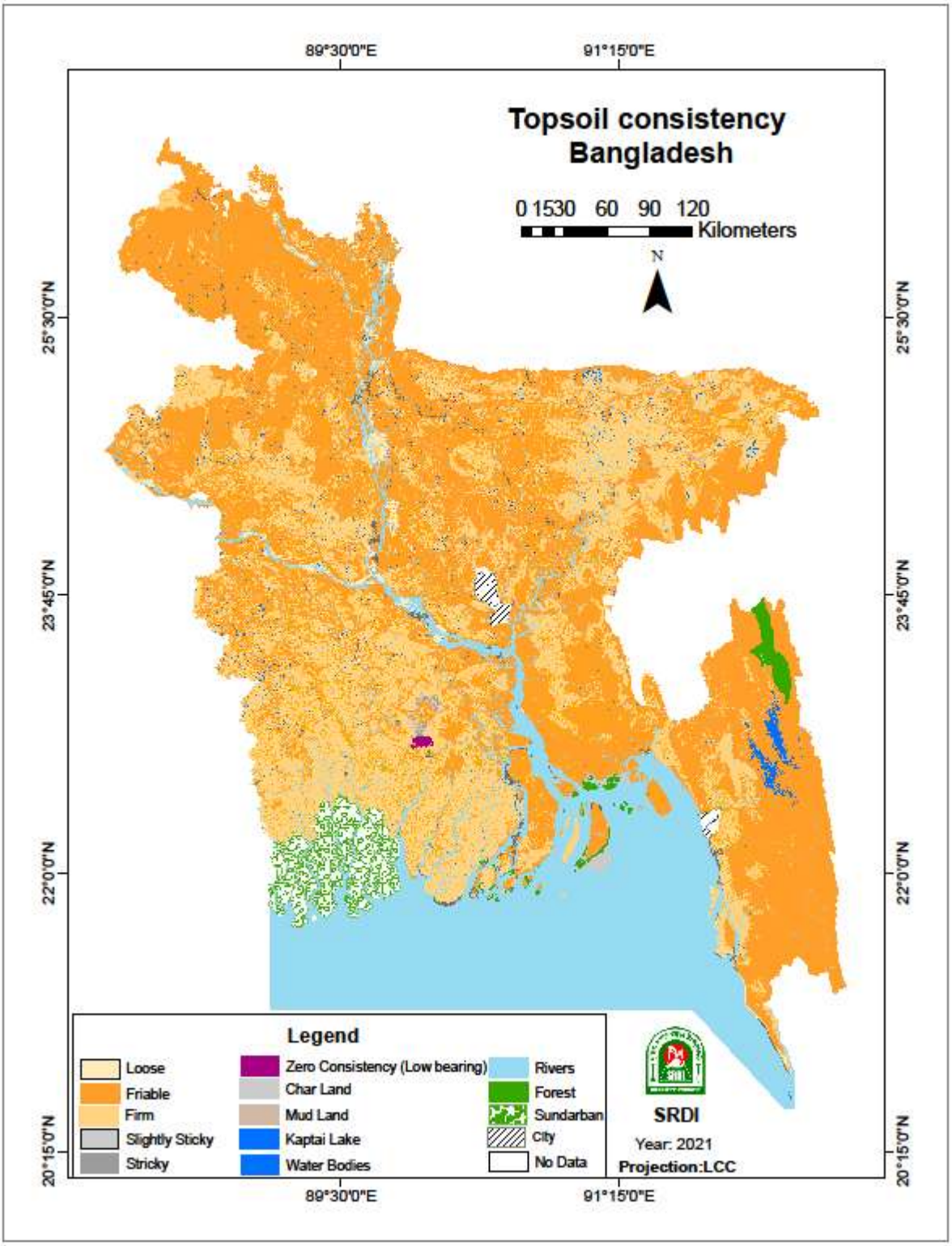
j. Progtamme implementation:

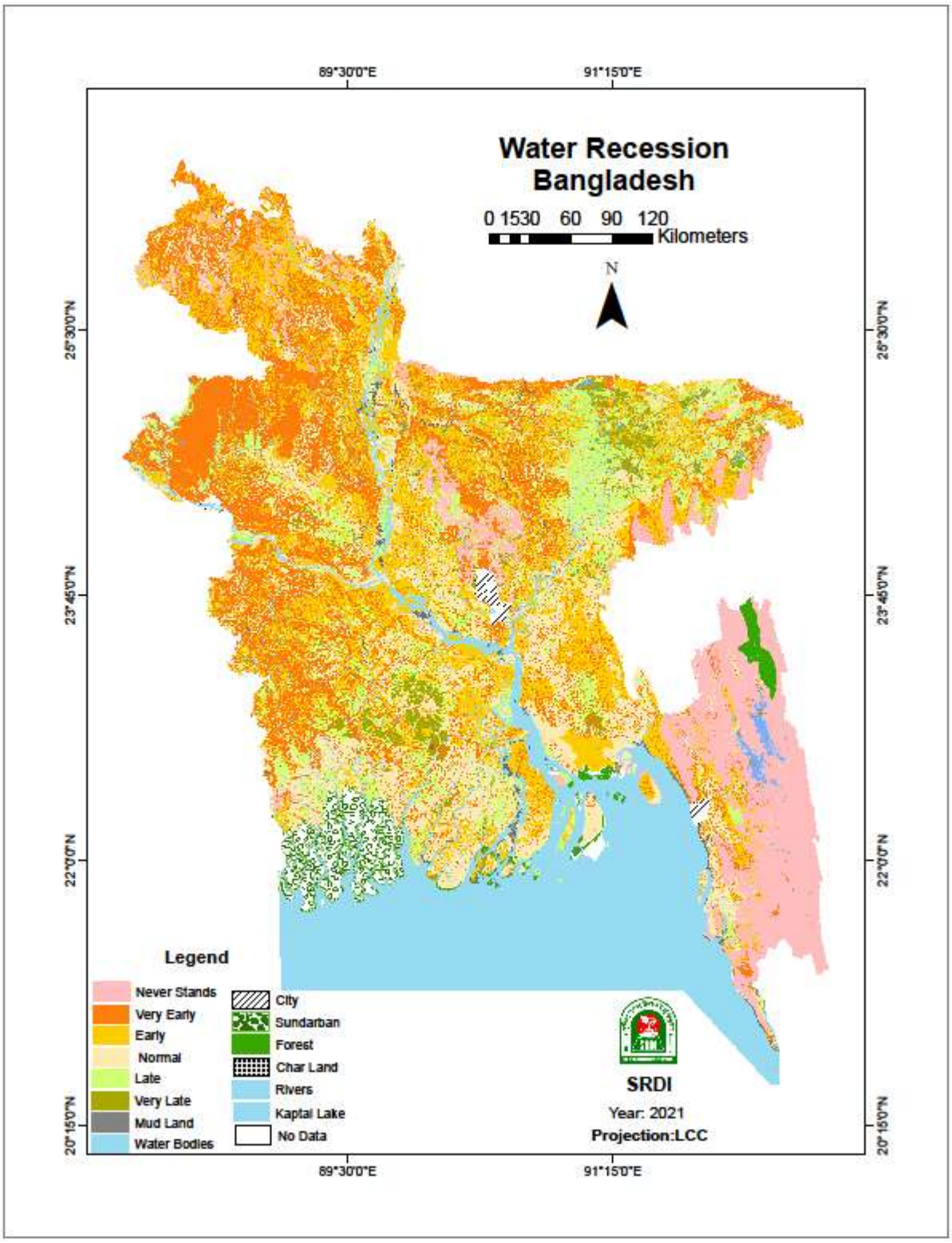
A promramme named “Assessment of Cultivated Land Area for Different Crops Using Remote Sensing and UpazilaNirdeshika”has been implementing with the help of DPS &ICT section.

Map Preparation & Printing




Topsoil Texture
Bangladesh
0 15 30 60 90 120
Kilometers
N
88°30'0"E
91°15'0"E
25°0'0"N
23°45'0"N
22°0'0"N
20°15'0"N
Legend
Sand
Sandy Loam
Loam
Clay Loam
Clay
Mud Land
no data
Forest
Rivers
Kaptai Lake
City
Sundarban
Water Bodies
forest
Char
SRDI
Year: 2021
Projection:LCC


Topsoil consistency
Bangladesh
0 1530 60 90 120
Kilometers
N
89°30'0"E
91°15'0"E
25°30'0"N
23°45'0"N
22°0'0"N
20°15'0"N
Legend
Loose
Friable
Firm
Slightly Sticky
Stricky
Zero Consistency (Low bearing)
Char Land
Mud Land
Kaptai Lake
Water Bodies
Rivers
Forest
Sundarban
City
No Data
SRDI
Year: 2021
Projection:LCC


Water Recession
Bangladesh
0 1530 60 90 120
Kilometers
N
89°30'0"E
91°15'0"E
26°30'0"N
23°45'0"N
22°0'0"N
20°15'0"N
Legend
Never Stands
Very Early
Early
Normal
Late
Very Late
Mud Land
Water Bodies
City
Sundarban
Forest
Char Land
Rivers
Kaptai Lake
No Data
SRDI
Year: 2021
Projection:LCC

Data processing & uploading for OFRS (APA target 50 Updated Upazila/ year)

Updating the crop list for OFRS:

2.4.3 Cartography Section

1. Map Digitizing:

Name of map	Upazila Name	Map Scale	Nos.
a) Soil and Land type Map	Rowangchari, Kaliganj, Harirampur, Muradnagar, Lalmohan, Naria, Sarsha, Kalkini, ShibganjNalchity, Bajitpur, Jaldhaka, Sujanagar, Barhatta, Tanore, Shibchar, Sariakandi, Shibalaya, Bhaluka, Titas and Ramgarh Upazila Map	1:50000	21
b) Mouza Wise Upazila Map	Rowangchari, Kaliganj, Harirampur, Muradnagar, Lalmohan, Naria, Sarsha, Kalkini, ShibganjNalchity, Bajitpur, Jaldhaka, Sujanagar, Barhatta, Tanore, Shibchar, Sariakandi, Shibalaya, Bhaluka, Titas and Ramgarh Upazila Map		21

2. Map Tracing:

Name of map	Upazila Name	Map Scale	Nos.
a) Soil and Landtype Map	Kaliganj,Harirampur,Muradnagar, Lalmohan,Naria,Sarsha,Kalkini and Ramgarh Upazila Map	1:50000	8
b) MouzaWiseUpazila Map	Kaliganj,Harirampur,Muradnagar, Lalmohan,Naria,Sarsha,Kalkini and Ramgarh Upazila Map		8

2. Map Checking & Correction:

Name of map	Upazila/ Union	Map Scale	Nos.
Various Map	Various Upazila and Union Map	1:50000	20

3. Map Printing:

Name of map	Upazila/ Union	Map Scale	Nos.
Soil and Land form Map	Various Upazila and Union Map	1:50000	45

4. Map Colouring:

Name of map	Upazila/Union	Map Scale	Nos.
Upazila and Union	Soil and Landtype Map of VariousUpazila&Union.	1:50000	25

5. Area Calculation:

Name of map	Upazila Name	Map Scale	Nos.
a) Soil and Landtype Map	Various Upazila and Union Map	1:50000	20

6. Collection of base materials from SOB

Name of map	Index No./Area	Photo scale	Nos.
a) Topo Map	Collected from SOB.	1:25000	150

b) Do	Latest Topo Map Collection from SOB under processing.	1:25000	750 (Appx.)
c) Aeral Photo	Latest Aeral Photo Collection from SOB under processing.	1:25000	150

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

2.4.4 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.

Achievements:

a) Sale of publications (2021-22)

Title	Name of the organization		Qty (Copy)	Purpose
Land & Soil resources Utilization guide.	Govt.	Upazila Agriculture Office, Rangamati	01	Fertilizer Recommendation
		Department of Urban Development	21	Research
	University/ Private Organi zation	Dhaka University	98	Academic
		Private Organization	02	Agricultural Farming
		BRAC, University	01	Academic
		Comilla University	01	Academic
		East West University	53	Academic
		Total:	**177**	

b) Collection
- Book/Bulletin/Report 12 copies

c) Prepare Proposal of Nomination for
- Bangabandhu National Agriculture Award,
- Ekushe Award,
- Independent Award,
- Begum Rokea Award etc.

d) Reader Services-Provided library services for 20 readers

Future programme for 2022- 23

- Procurements of Books, Journal, Magazines etc.
- Publish Journal, Poster and Leaflet.

- Publish Annual Report.
- Publish Mrittika Katha
- Publish Calendar, Note Book, Diary etc.
- SRDI's publication selling.
- Book/Journal Collection.
- Printing UpazilaNirdeshika, Union Shohayeka & Rss Report.
- Distribution of UpazilaNirdeshika, Union Shohayeka, Poster, Booklet and Leaflet.
- Library renovation.
- Provided technical & administrative support on different aspect.

2.5 Upazila Nirdeshika Cell

Three hundred and ten reports of Upazila Nirdeshika have been updated till June 2021 with a series of coordinated effort 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 16).

The activities of updating Nirdeshika previously were funded solely by SRDI projects (till June 2016) and the activities linked with the Nirdeshika updating have also been conducted utilizing revenue budget from the financial year 2016–2017. The entire activity is coordinated by Upazila Nirdeshika Cell at SRDI Head Office. Thirty-five updated Nirdeshika has been published during the period of 2020-2021 under revenue budget as well as Crop zoning project of SRDI (Table 1)

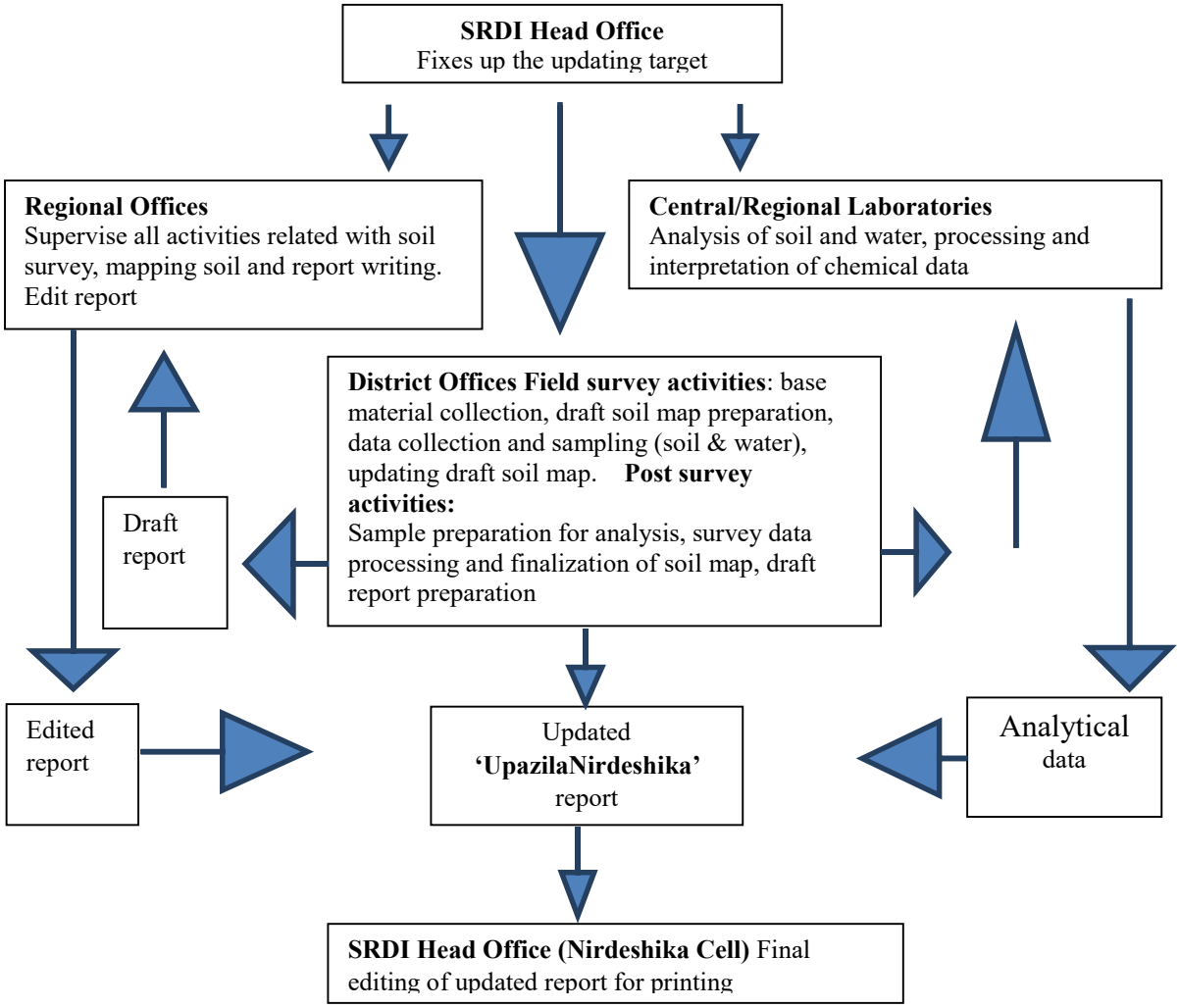


Figure . Flow Chart of Upazila Nirdeshika Updating System

Table 1. List of Updated Upazila Nirdeshika published during 2021-22

SL. No.	Name of Upazila Nirdeshika	Name of Respective District
1	Assasuni	Satkhira
2	Lohagora	Narail
3	Moheshpur	Jhenaidah
4	Chatmohar	Pabna
5	Gojaria	Munshiganj
6	Shamnagar	Satkhira
7	Choughachha	Jashore
8	Munshiganj Sadar	Munshiganj
9	Mirsharai	Chattogram
10	Biswamvarpur	Sunamganj
11	Kamalganj	Moulvibazar
12	Lakhai	Habiganj
13	Pakundia	Kishorganj

14	Rangabali	Patuakhali
15	Pirojpur Sadar	Pirojpur
16	Raojan	Chattogram
17	Gurudaspur	Natore
18	Tetulia	Ponchhoghar
19	Meghna	Cumilla
20	Monohorganj	Cumilla
21	Banaripara	Barishal
22	Shibchar	Madaripur
23	Parbatipur	Dinajpur
24	Gosairhat	Shariatpur
25	Mirpur	Kustia
26	Mahadebpur	Naogaon
27	Chakoria	Cox’s Bazar
28	Mohonpur	Rajshahi
29	Kapashia	Gazipur
30	Fultala	Khulna
31	Mujibnagar	Meherpur
32	Natore Sadar	Natore
33	Chouhali	Sirajganj
34	Sundarganj	Gaibandha
35	Joypurhat Sadar	Joypurhat

Chapter 3: Activities of Field Offices

3.1 Updating Upazila Land and Soil Resource Utilization Guide (Upazila 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 programmeme 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 limitations and potentialities of a Upazila. As our agricultural lands are changing due to urbanization, industrialization and construction of new settlement, the need for planning and execution updating Nirdeshika programmeme has arisen. As a result, SRDI carrying out programmeme to update previous data for developing realistic agricultural planning. Other than resource based planning tool the Nirdeshika also guide the user to make fertilizer recommendation for crops. To mitigate upcoming challenge in agriculture rational use of soil and land resources is of prime importance. Therefore, the programmeme 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) was 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 mapping unit.

Composite soil samples are collected from adjacent to or possibly nearer point 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 using 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 2. Progress of Upazila Nirdeshika Updating

District	Field Survey		Map finalization		Draft Report Preparation		Final Report Preparation	
	Target	Achievement	Target	Achievement	Target	Achievement	Target	Achievement
Divisional Office, Dhaka								
Dhaka	-	-	-	-	-	-	Bajitpur	Completed
	-	-	-	-	-	-	Gazaria	Completed
Tangail	Kendua	Completed	Mirzapur	Completed	Mirzapur	In process	Gopalpur	Completed
	-	-	-	-	Delduar	In process	Shibaloy	Completed
	-	-	Gopalpur	Completed	Gopalpur	Completed	Delduar	In process
Faridpur	Madaridpur sadar	Completed	Nagarkanda	Completed	Zajira	Completed	Shibchar	In Process
	-	-	Faridpur sadar	Completed	-	-	Kalkini	In Process
	-	-	-	-	-	-	Damuda	Completed
	-	-	-	-	-	-	Goshairhat	Completed
Kishorgonj	Bhaluka	Completed	Bhaluka	Completed	Bhaluka	Completed	Bhaluka	Completed
	Katiyadi	Completed	Katiyadi	Completed	Katiyadi	Completed	Katiyadi	Completed
	Mymensingh Sadar	Completed	Netrokona	Completed	Mohongonj	In process	Barhatta	Completed
Mymensingh	Nandail	Completed	Goforgaon	Completed	Kalmakanda	In process	-	-
Narshingdi	shaistagonj	Completed	shaistagonj	Completed	kamalganj	Completed	kamalganj	Completed
Gopalganj	Haimchar	Completed	Assasuni	Completed	Assasuni	Completed	Assasuni	Completed
	-	-	Fultala	Completed	Fultala	Completed	Fultala	Completed
Madaripur	Bilaichari	Completed	-	-	-	-	-	-
	Companiganj	Completed	-	-	-	-	-	-
Netrokona	Durgapur	Completed	Munshiganj Sadar	Completed	-	-	Munshiganj Sadar	Completed
	Dighinala	Completed	-	-	-	-	-	-
Jamalpur	.Sherpur Sadar	Completed	Jamalpur Sadar	Completed	Vedargonj	Completed	Modon	Completed
	Juraichari	Completed	-	-	-	-	Shibchar	Completed
Divisional Office, Chattogram								
Cumilla	Itna	Completed	Meghna	Completed	Meghna	Completed	Meghna	Completed
	Barkol	Completed	Chuddagram	Completed	Chuddagram	In Process	Chuddagram	
Rangamati	Lakshmichhari	Completed	Mirsorai	Completed	Mirsorai	Completed	Mirsorai	Completed
	Baghaichhari	Completed	-	-	-	-	-	-
Brahmanbaria	Nabinagar	Completed	Dherai	Completed	Dherai	Completed	Raujan	In Process
	Hajiganj	Completed	-	-	-	-	-	-
Divisional Office, Rajshahi								
Chapai-nawabganj	-	-	-	-	Mohonpur	Completed	Tanore	Completed
	-	-	-	-	-	-	Gurudaspur	Completed
Naogaon	Potnitola	Completed	Potnitola	Completed	Natore Sadar	Completed	Natore Sadar	Completed
Pabna	Charghat	Completed	Chouhali	Completed	Chouhali	Completed	Chouhali	Completed
Bogura	Ful chori	Completed	Fulchori	In Process	Sariakandi	Completed	Sariakandi	Completed
	-	-	-	-	-	-	Panch bibi	Completed
Sirajganj	Fotikchai	Completed	Baraigram	Completed	shazadpur	Completed	shazadpur	Completed
	Motlob Uttar	Completed	Belkuchi	Completed	-	-	-	-
Divisional Office, Rangpur								
Rangpur	Chilmari	Completed	Dimla	Completed	Sunderganj	Completed	Aditmari	Completed
Gaibandha	Alikadam	Completed	Saghata	Completed	Joypurhat Sadar	Completed	Sariakandi	Completed
	Thanchi	Completed	-	-	-	-	-	-
Lalmonirhat	Ruma	Completed	Bhurungamari	Completed	Bhurungamari	In Process	Kaliganj	Completed
	Longodu	Completed	-	-	-	-	-	-
Thakurgaon	Naikkhangchari	Completed	Panchagarh Sadar	Completed	Pakundia	Completed	-	-
Dinajpur	Domar	Completed	Birol	Completed	Birol	In Process	Parbatipur	Completed
Divisional Office, Khulna								
Khulna	-	-	Ashashuni	Completed	Dumuria	Completed	Ashashuni,	Completed
	-	-	-	-	-	-	Shyamnagar	Completed
Jashore	-	-	Lohagara	Completed	Keshobpur	Completed	Lohagara,	Completed
	-	-	Mohespur	Completed	-	-	Moheshpur	Completed
	-	-	Jashore sadar	Completed	-	-	Chowgacha	Completed
	-	-	Chowgacha	Completed	-	-	-	-
Kushtia	Meherpur Sadar	Completed	Kushtia sadar	Completed	-	-	Kushtia sadar	Completed
Satkhira	Potuakhali Sadar	Completed	Digholia	Completed	Digholia	Completed	Khulna Metro	Completed
Jhenaidah	Baliakandi,	Completed	Goshairhat	Completed	Goshairhat	Completed	Kalkini	Completed
	-	-	Mujibnagar	Completed	Mujibnagar	Completed	-	-
Divisional Office, Barishal								

District	Field Survey		Map finalization		Draft Report Preparation		Final Report Preparation	
	Target	Achievement	Target	Achievement	Target	Achievement	Target	Achievement
Barishal	Jhalakati Sadar	Completed	Nesarabad	Completed	Nesarabad	Completed	Banaripara	Completed
	-	-	-	-	Bakerganj	Completed	Mehendiganj	Completed
Bhola	Barishal Sadar	Completed	BorhaunUddin	Completed	Borhaunuddin	Completed	-	-
Patuakhali	Patuakhali sadar	Completed	Rangabali	Completed	Rangabali	Completed	Rangabali	Completed
	Teknaf	Completed	Mehendiganj	Completed	Agailjhara	Completed	Mehendiganj	Completed
Divisional Office, Sylhet								
Sylhet	Golapganj	Completed	-	-	Jagannathpur	Completed	Jagannathpur	Completed
-	-	-	-	-	Bishwambarpur	Completed	Bishwambarpur	Completed
Moulvibazar	Ajmirigonj		Baniachong	Completed	Lakhai	Completed	Lakhai	Completed
Sunamganj	Tahirpur	Completed	Tahirpur	Completed	-	-	-	-
	Dharmapasha	Completed	Dharmapasha	Completed	-	-	-	-

Findings of Selective Upazilas under Field Services Wing

Major findings of Madaripur Sadar Upazila, Madaripur

i) Total area-31,382 ha
ii)Total sample colleted-121
iii)Physiography & AEZ code-Ganges River Floodplain (12), Gopalganj-Khulna Beels (14), Meghna Estuarine Floodplain (19)
iv)Major land type- High Land, Medium High Land, Medium low land & Low land.
v)Major soil group-Sara, Gopalpur, Ishwardi, Ghior, Ujirpur, Rajoir, Harta & Satla.

Changes in Land Type:

Land type	Previous Survey (2004)		Present Survey (2021)	
	Area (ha)	%	Area (ha)	%
Highland	1364	4.3	529	1.6
Medium Highland	8712	27.8	7125	22.7
Medium Lowland	9742	31.0	8523	27.2
Lowland	3426	10.9	3280	10.5
Miscellaneous	8156	26.0	11925	38.0
Total	**31,382**	**100**	**31,382**	**100**

Changes in Land Use:

Land Use	Previous Survey (2004)		Present Survey (2021)	
	Area (ha)	%	Area (ha)	%
Rabi vegetables- Kharif vegetables	606	1.90	812	2.59
Rc -B.Aus/Jute/Till	4914	15.7	3020	5.62
Rc- Jute- T.Aman	955	3.10	1205	3.84
Rc- B.Aus/Jute/Fello	-	-	1850	5.90
Rc-Jute/B.Aus-Aman	3855	12.30	2755	8.78
Boro- Fellow-T.Aman	1916	6.10	1846	5.88
Mustard- Boro-T.Aman	1605	5.10	1500	4.78
Kheshari/Maskalai/ Mustard-Boro	3832	12.20	2937	9.36
Boro- Fellow- Fellow	4708	15.00	3350	10.67
Others	824	2.60	182	0.58
Miscellanious (crops)	8156	26.00	11925	38.00
Total	**31,382**	**100.0**	**19,314**	**100.0**

Changes in Settlement area increment:

Settlement Area	Previous Survey (2004)		Present Survey (2021)	
Settlement	Area (ha)	%	Area (ha)	%
	6067	19%	9974	31%

Major Finding of Mymensingh Sadar Upazila, Mymensingh

i) Total area-37,763
ii) Total sample colleted-150
iii) Physiography & AEZ code- Brahmaputra Floodplain (7, 8, 9).
iv) Major land type- HL, MHL & MLL.
v) Major soil group- Sonatala, Silmandi, Ghatail, Balina, Mohonganj, Melandaha & Dhamrai.

Changes in Land Type:

Land type	Previous Survey (2009)		Present Survey (2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	12,347	33.00	10,573	28	(-)5%	1. Urbanization for newly established City Corporation. 2. MLL area converted to MHL due to change in flooding depth.
Medium Highland	12,947	34.0	13,784	36.5	(+)2.5	
Medium Lowland	5,745	15.0	4721	12.5	(-) 2.5	
Lowland	188	0.5	188	0.5	-	
Miscellaneous	6,536	17.5	8497	22.5	(+)5%	
Total	**37,763**	**100**	**37,763**	**100**	-	

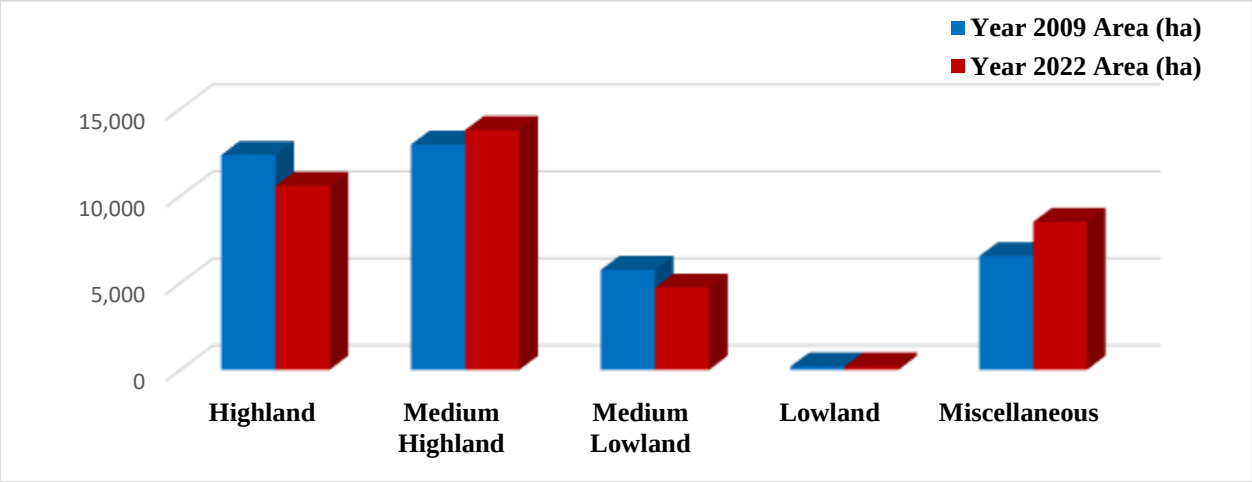


Fig. Comparison of land type between 2009 & 2022 of Mymensingh Sadar Upazila

Changes in Land Use:

Land Use	Previous Survey (2009)		Present Survey (2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
R.veg- K.veg	1888	5	1888	5.0	-	Boro area increased due to irrigation facilities
Rabi crop -F- T.Aman	2832	7.5	944	2.5	(-)5.0	
Boro-F-T.Aman	13279	35	17372	46.0	(+)11.0	
Boro-Aus-T.Aman	2832	7.5	3776	10.0	(+)2.5	
F-Aus/Jute-T.Aman	1888	5	755	2.0	(-)3.0	
Rabi crop-Aus/Jute-F	2832	7.5	755	2.0	(-)5.5	
Boro-F-F	5664	15	3776	10.0	(-)5.0	
Miscellaneous	6548	17.5	8497	22.5	(+)5.0	
Total	**37763**	**100**	**37763**	**100**		

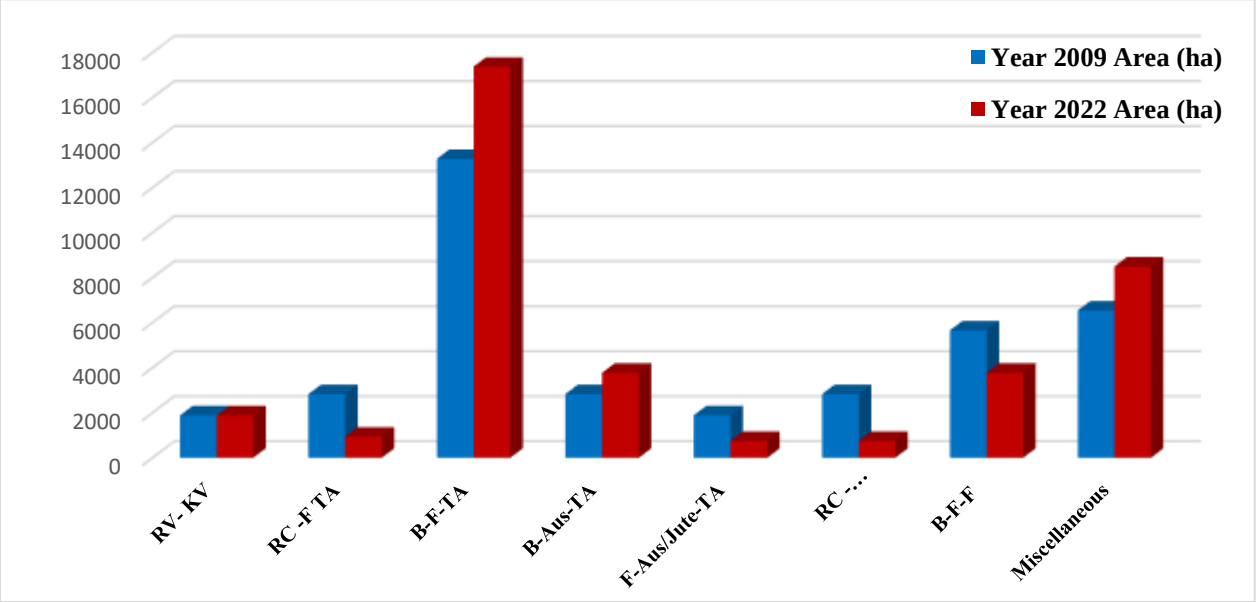


Fig. Comparison of land use between 2009 & 2022 of Mymensingh Sadar Upazila

Major findings of Durgapur Upazila, Netrokona

i) Total area- 27,930 ha
ii) Total sample collected- 158
iii) Physiography & AEZ code- Northern and Eastern Hill (29), Northern and Eastern Piedmont plain (22), Old Brahmaputra Floodplain (9)
iv) Major land type- Highland, Medium Highland, Medium Lowland & Lowland.
v) Major soil group- Susang, Kangsha, Ramnagar, Nunni, Chinakuri, Marishi, Kulaura, Borolekha, Bijipur, Pritimpasha, Ghoshgaon, Sonatola, Silmondi & Ghatail.

Changes in Land Type of Durgapur Upazila, Netrokona:

Land type	Previous Survey (1993)		Present Survey (2021)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	12208	43.7	12236	43.8	(+)0.1	Construction of settlement, roads and infrastructures for increased population, riverbank erosion, sandy over wash, siltation etc.
Medium Highland	6711	24.0	6623	23.7	(-)0.3	
Medium Lowland	4878	17.5	4445	15.9	(-)1.6	
Lowland	1579	5.7	1395	5.0	(-)0.7	
Miscellaneous	2554	9.1	3231	11.6	(+)2.5	
Total	**27930**	**100**	**27930**	**100**	**0**	

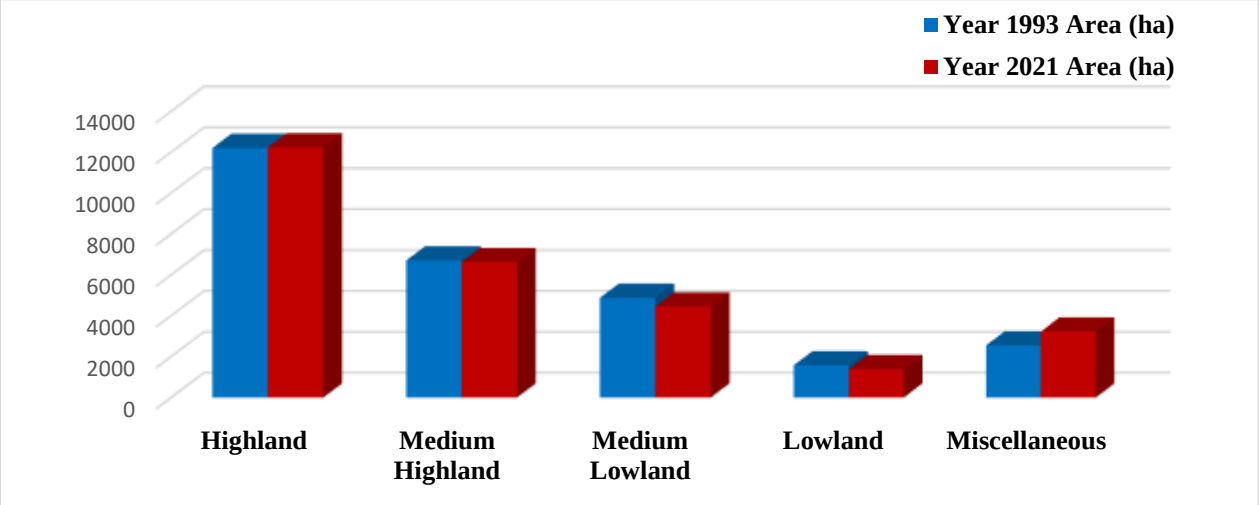


Fig. Comparison of Land type between 1993 & 2021 of Durgapur Upazila

Changes in Land Use of Durgapur Upazila:

Land Use	Previous Survey (1993)		Present Survey (2021)		% increase/ decrease	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Perennial trees (Mixed wood, Sal, Bamboo, Shrubs)	926	3.3	975	3.5	(+) 0.2	Reasons of declining Aus coverage: Introducing modern varieties for Boro and T.Aman, unavailability of labour during transplanting time, uncertainty of rainfall in April-May, adverse weather condition during Aus harvesting time.
Robicrops-Aus-T.Aman	1074	3.8	-	-		
Fallow-Aus-T.Aman	8167	29.3	-	-		
Boro- F- T.Aman	3308	11.8	15725	56.3	(+) 44.5	
Robicrops-Aus/Mesta	4656	16.7	-	-		
Boro-Fallow-Fallow	4912	17.6	5840	20.9	(+) 3.3	
Boro-DWT.Aman	725	2.6	-	-		
Robicrops-Boro-T.Aman	-	-	1886	6.8		
Robicrops-F-F	-	-	123	0.5		
Miscellaneous patterns	1608	5.8	150	0.5	(-)5.3	
Miscellaneous uncultivated areas	2554	9.1	3231	11.5	(+) 2.4	
Total	**27930**	**100**	**27930**	**100**		

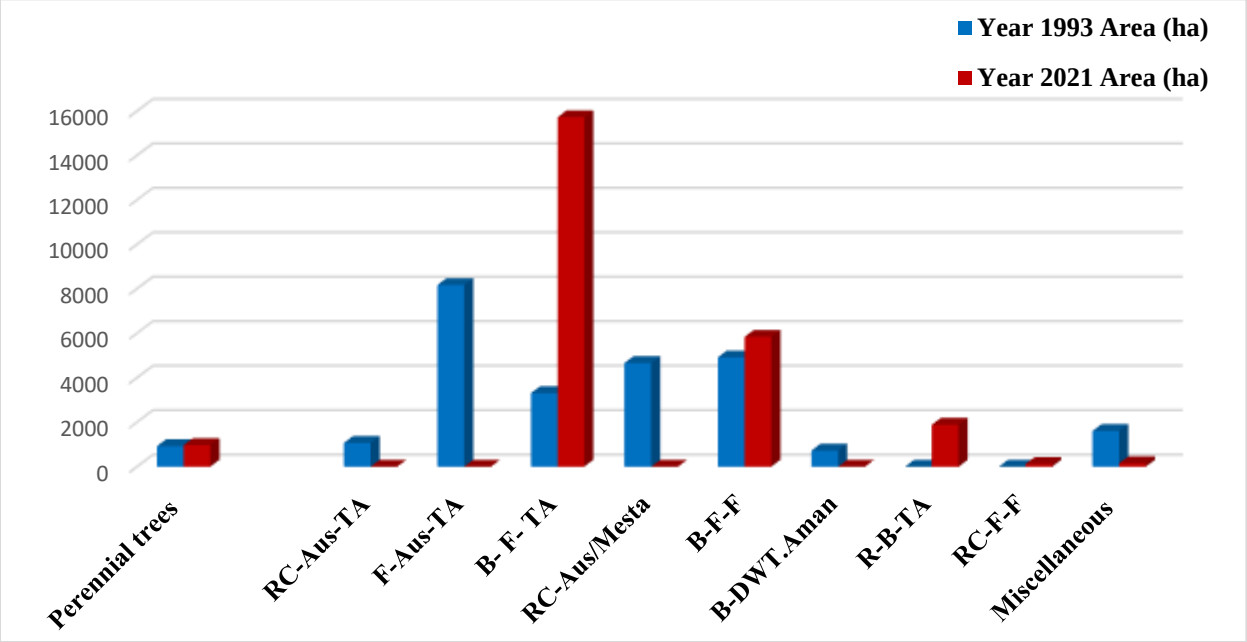


Fig. Comparison of Land use between 1993 & 2021 of Durgapur Upazila

Changes in Settlement area increment of Durgapur Upazila:

Settlement Area	Previous Survey (1993)		Present Survey (2021)		% increase/ decrease	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Settlement and infrastructure	1275	4.6	2085	7.5	(+)2.9	Increased Population

Major findings of Haimchar Upazila, Chandpur

i) Total area-15,347 ha
ii)Total sample collected - 44
iii)Physiography& AEZ code - Meghna River Floodplain (17), Ganges River Floodplain (10)
iv)Major land type - Medium high land
v)Major soil group - Ramgati

Changes in Land Type:

Slope class/Land type	Previous Survey (2002)		Present Survey (2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	288	1.9	172	1.1	(-)40.3	River bank erosion
Medium Highland	4272	27.8	4012	26.1	(-)6.1	River bank erosion
Medium Lowland	135	0.9	128	0.8	(-)5.2	River bank erosion
Lowland	403	2.6	680	4.4	(+)68.7	Formation of new char lands
Very lowland	1613	10.5	2720	17.7	(+)68.6	Formation of new char lands
Miscellaneous	8636	56.3	7635	49.7	(-)11.6	Total river area decreased

Total	**15347**	**100**	**15347**	**100.0**	-	-

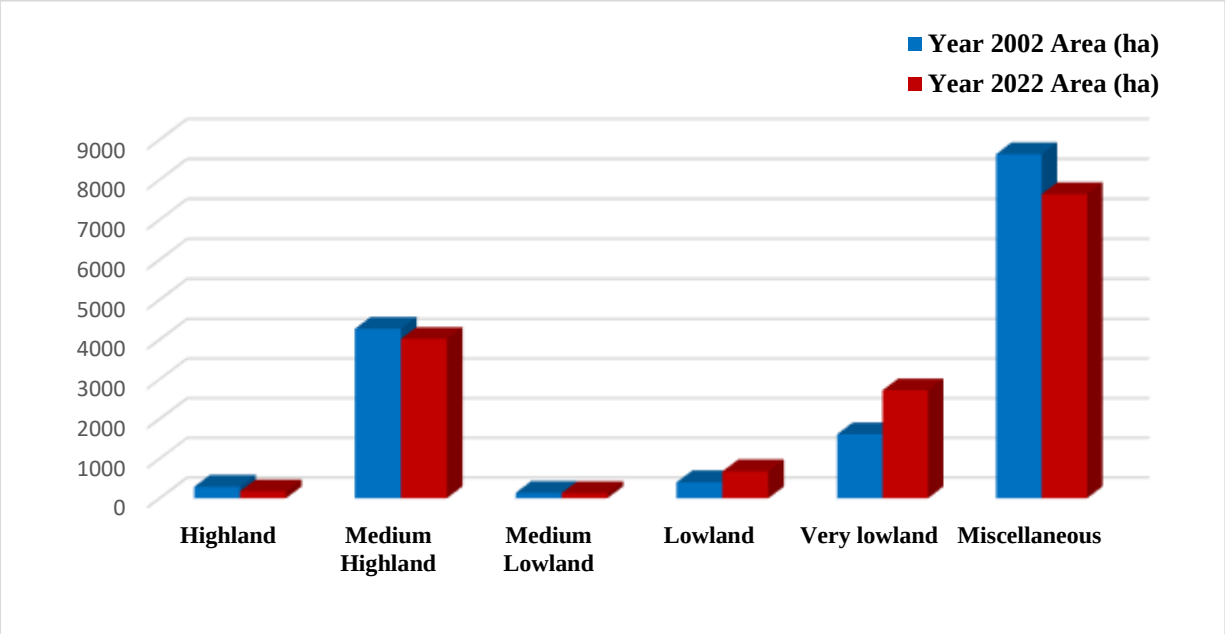


Fig. Comparison of Land type between 2002 & 2022 of Haimchar Upazila

Changes in Land Use:

Land Use	Previous Survey (2002)		Present Survey (2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Boro-F-TA	1329	8.7	1510	9.8	13.6	Introduction of Modern varieties of Boro& dam on river
RC-T.Aus-TA	992	6.5	610	4.0	-38.5	Converted to Boro
RC-F-TA	840	5.5	1030	6.7	22.6	Replacement by Oil & pulse crops
Boro-T.Aus-TA	681	4.4	712	4.6	4.6	-
F-F-TA	330	2.2	150	1.0	-54.5	Converted to Boro
Perennial	88	0.6	61	0.4	-30.7	Converted to settlement
Fallow/Others	2215	14.4	1943	12.7	-12.3	-
Miscellaneous	8636	56.3	8636	56.3	-	-
Total	**15347**	**100**	**15347**	**100**	-	-

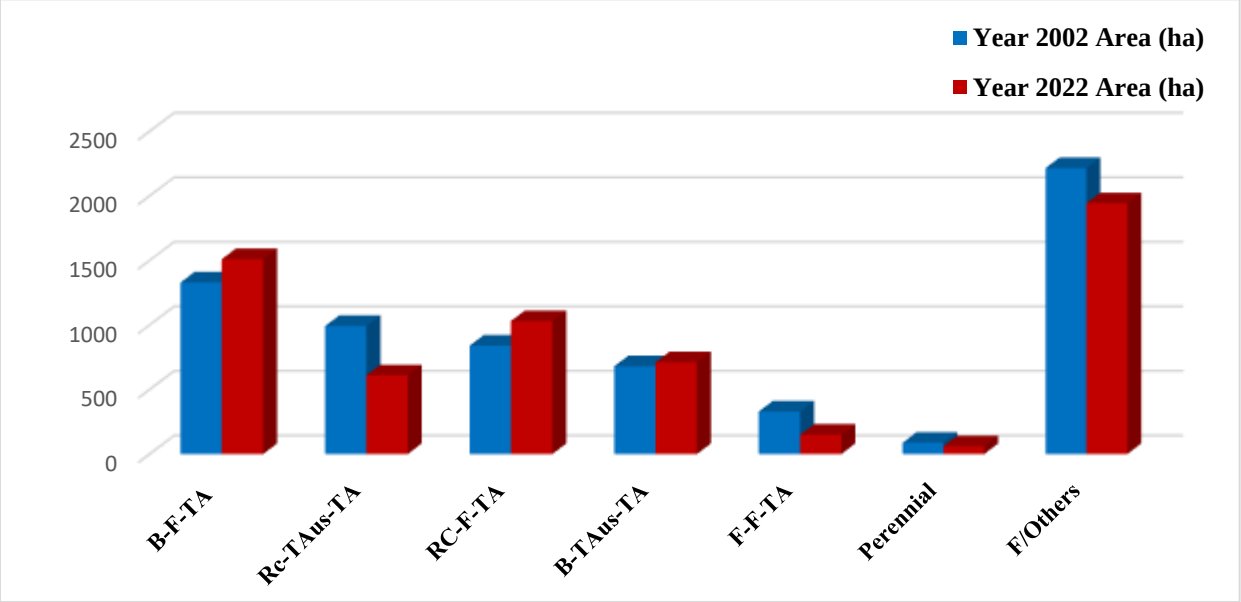


Fig. Comparison of Land use between 2002 & 2022 of Haimchar Upazila

Major findings of Sherpur Sadar Upazila

i) Total area- 35,781 ha.
ii) Total sample collected- 186.
iii) Physiography & AEZ code- Old Brahmaputra Flood plain (9), Young Brahmaputra Flood plain (8), Active Brahmaputra Flood plain (7).
iv) Major land type- High Land, Medium High Land, Medium Low Land, Low Land.
v) Major soil group- Nakla, Sherpur, Sonatala, Silmondi, Ghatail, Balina, Melandaha, Dhamrai, Borarchar, Brahmaputra Sandy Alluvium, Brahmaputra Silty Alluvium.

Changes in Land Type:

Land type	Previous Survey (2007)		Present Survey (2021)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	11,436	32.04	9,632	26.92	(-)5.12	New Settlement for increased population & Infrastructure.
Medium Highland	13,105	36.63	13,396	37.44	(+)0.81	Converted from MLL
Medium Lowland	6,005	16.78	5,628	15.73	(-)1.05	Decreased flooding depth
Lowland	2,037	5.69	1,832	5.12	(-)0.57	
Miscellaneous	3,171	8.86	5,292	14.79	(+)5.93	Increase of Settlement
Total	**35,781**	**100.00**	**35,781**	**100.00**		

Changes in Land Use:

Land Use	Previous Survey (2007)		Present Survey (2021)		% increase/ decrease
	Area (ha)	%	Area (ha)	%	
Sugarcane	903	2.5	110	0.31	(-)2.19
Spices	-	-	652	1.82	(+)1.82
R. Vegetable- K. Vegetable	1,130	3.2	1,722	4.82	(+)1.62
R. Vegetable- B.Aus- F	940	2.6	-	-	(-)2.60
R. Vegetable- Jute- F	833	2.3	-	-	(-)2.30
R/C- B. Aus- T. Aman	2,068	5.8	-	-	(-)5.80
Rc- Jute/T.Aus- T. Aman	2,245	6.2	3,324	9.29	(+)3.09
Mustard- Boro- T. Aman	2,598	7.3	1,160	3.24	(-)4.06
Potato- Boro- T. Aman	-	-	1,450	4.05	(+)4.05
Potato- Boro- Jute/ T.Aus-T.A	-	-	2,320	6.49	(+)6.49
Potato- Jute- T.A	-	-	870	2.43	(+)2.43
Potato- Jute- K. Vegetable	-	-	870	2.43	(+)2.43
Wheat- Vegetable- T.Aman	-	-	1,740	4.86	(+)4.86
Boro- F- T. Aman	10,805	30.2	8,728	24.39	(-)5.81
Boro- T Aus- T. Aman	431	1.2	1,160	3.24	(+)2.04
Boro- F- DWTA	1,464	4.1	742	2.07	(-)2.03
Boro- F- F	5,880	16.4	4,640	12.97	(-)3.43
Groundnut- F- F	241	0.7	74	0.21	(-)0.49
Others	3,072	8.6	927	2.59	(-)6.01
Miscellaneous	3,171	8.9	5,292	14.79	(+)5.89
Total	**35,781**	**100.00**	**35,781**	**100.00**	

Changes in Settlement area increment:

Settlement Area	Previous Survey (2007)		Present Survey (2021)		% increase/ decrease	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Settlement	2,443	6.83	4,704	13.5	(+)6.67	-

Major findings of Companigonj Upazila Noakhali

i) Total area- 40,125 ha
ii)Total sample collected- 122 and Salinity Sample: 17
iii)Physiography & AEZ code- Young Meghna Estuarine Floodplain (18), Old Meghna Estuarine Floodplain (19)
iv)Major land type- Medium High Land
v)Major soil group- Ramgati, Hatia, Chandina, Chandraganj, faridganj, Chilania

Changes in Land Type:

Land type	Previous Survey (1996)		Present Survey (2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Medium Highland	28775	71.7	22468	56	-15.7%	New settlement
Miscellaneous	11350	28.3	17639	44	+15.7%	

Total	**40,125**	**100**	**40,125**	**100**	**-**	for increased population

Changes in Land Use:

Land Use	Previous Survey (1996)		Present Survey (2022)		% increase/ decrease	Possible Reasons
	Area (ha)	%	Area (ha)	%		
F-F-T.Aman	13239	33.0	8343	20.8	(-)12.2%	Expanding modern Boro cultivation, crop diversification & cultivation of high value crops
Boro- F- T.Aman	-	0.0	854	2.1	(+)2.1%	
RC – F – T. Aman	3518	8.8	9467	23.6	(+)14.8%	
F-F-F	5864	14.6	-	0.0	(-)14.6%	
RC – D. Aus – T.Aman	2610	6.5	2000	5.0	(-)1.5%	
F – Summer Vegetable- T.Aman	-	0.0	562	1.4	(+)1.4%	
F- D. Aus - T.Aman	3544	8.8	-	0.0	(-)8.8%	
Winter Vegetable- Summer Vegetable- F	-	0.0	1260	3.1	(+)3.1%	
Miscellaneous	11350	28.3	17639	44.0	(+)15.7%	
Total	**40125**	**100**	**40,125**	**100**		

Changes in Settlement area increment

Settlement Area	Previous Survey (1996)		Present Survey (2022)		% increase/ decrease	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Settlement	1910	4.7	5590	13.9	(+)9.1%	New settlements for increased population

Major findings of Lauhajang Upazila, Munsiganj

i) Total area- 12889 hectare
ii)Total sample colleted- 61
iii)Physiography & AEZ code- Old Meghna Estuarine Floodplain (19), Ganges River Floodplain (10, 12),
iv)Major land type- Medium high land, medium low land & low land
v)Major soil group- Naraibag, Jalkundi, Richi, Raina, Ishwardi, Katra, Arial, Sara & Gopalpur

Major findings of Shaistaganj Upazila, Habiganj

i)Total area- 4970 ha
ii)Total sample collected- 62
iii) Physiography & AEZ code- Northern & Eastern Hills (29), Northern & Eastern Piedmont Plains (22), Old Meghna Estuarine Flood Plains (19)
iv) Major land type- High land (including hill), Medium high land & Medium low land

v) Major soil group- Baralekha, Bijipur, Pritimpasha, Monu, Madhabpur, Richi & Baniachong,

Change in Land Type (for mixed landform i.e., hill, piedmont and floodplain area):

Slope class/Land type	Previous Survey (2014)		Present Survey (2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland - Steep slope (30-50%)	111	2.23	111	2.23	0	
Highland	433	8.71	433	8.71	0	
Medium Highland	2286	46.00	2036	97	(-)5.03	New settlement & industrialization
Medium Lowland	1084	21.81	985	19.82	(-)1.99	
Lowland	0	0.00	0	0.00	0	
Very lowland	0	0.00	0	0.00	0	
Miscellaneous	1056	21.25	1405	28.27	(+)7.02	
Total	**4970**	**100.00**	**4970**	**100.00**	**0**	

Major finding of Kendua Upazila, Netrokona

i) Total area-32,729 ha
ii)Total sample colleted-105
iii) Physiography & AEZ code-Brahmaputra Floodplain (9), Surma Kusiyara Floodpain (20)
iv)Major land type- High land,Medium high land,Medium low land,low land & Very low land
v)Major soil group-Sonatola, silmondi, ghatail, balina, mohonganj, fagu

Changes in Land Type:

Land type	Previous Survey (1985)		Present Survey (2021)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	4620	14.1	4414	13.5	(-)0.6	New settlements
Medium Highland	13,443	41.1	13082	40.0	(-)1.1	
Medium Lowland	2442	7.5	2647	8.1	(+)0.6	
Lowland	2297	7.0	2450	7.5	(+)0.5	
Very Lowland	2463	7.5	2127	6.5	(-)1.0	
Miscellaneous	7464	22.8	8004	24.4	(+)1.6	
Total	**32,729**	**100**	**32,729**	**100**		

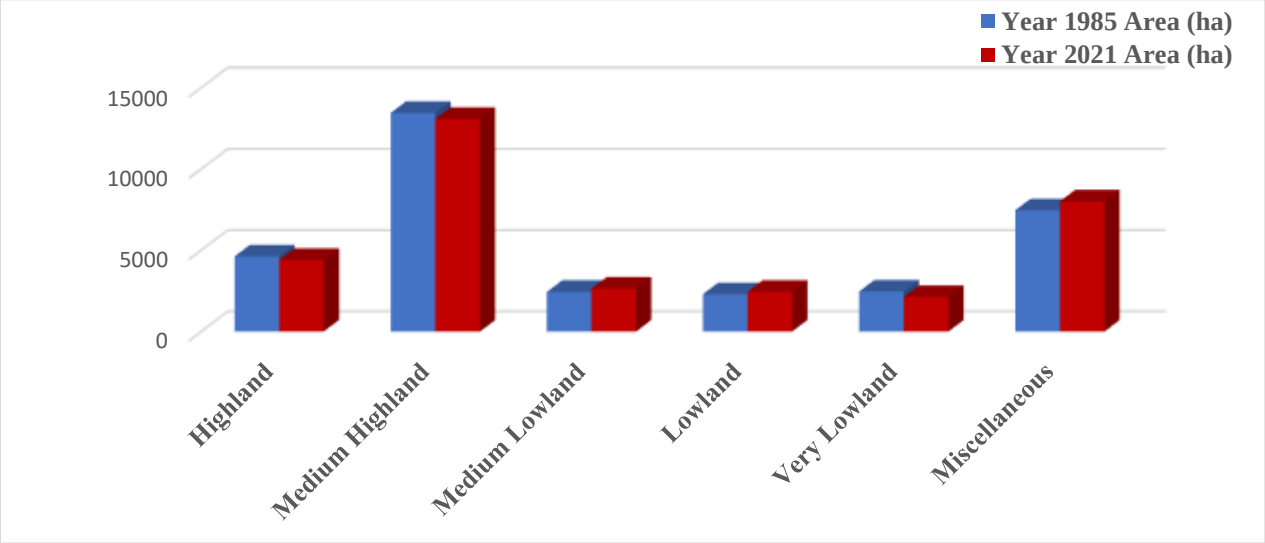


Fig. Comparison of Land type between 1985 & 2021 of Kendua Upazila

Changes in Land Use:

Land Use	Previous Survey (1985)		Present Survey (2021)		%Increase/ decrease	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Banana-Papaya-Ginger-Turmeric	-	-	652	2		Introduction of new crop and cropping pattern
Rabi veg. – Aus/Jute	3273	10	2617	08	(-)2	
Mustard – Boro – T. Aman			4580	14		
Rabi veg. – Aus/jute - T.Aman	7200	22	3926	12	(-)10	
Mustard – Boro – Fallow			2942	9.0	-	
Boro – F – T.Aman	4582	14	3466	10.6	(-)3.4	
Boro – F – B. Aman/ DTW	2945	9	3600	11	(+)2	
Rabi veg. – Mixed Aus & Aman	1374	4.2	-	-	-	
Boro – F – F	3928	12	1306	4	(-)10	
Others	1963	6	1636	5.0	(+)1.0	
Miscellaneous	7464	22.8	8004	24.4	(-)1.6	
Total	**32,729**	**100**	**32,729**	**100**		

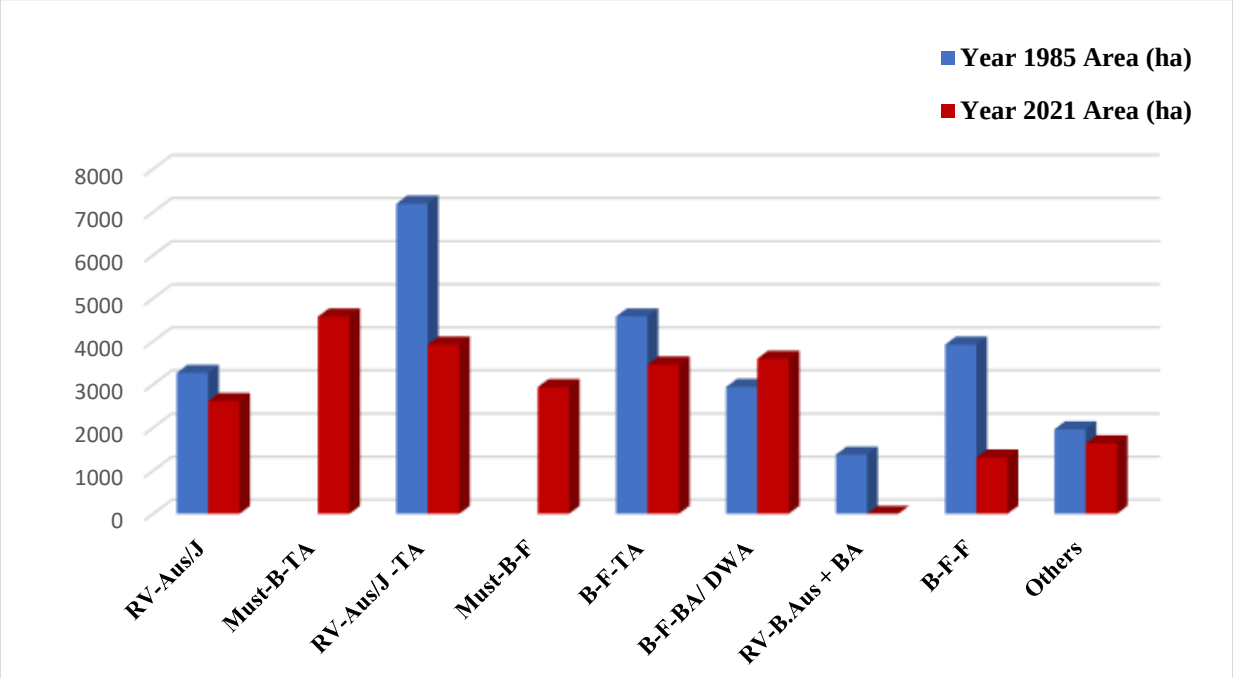


Fig. Comparison of Land type between 1985 & 2021 of Kendua Upazila

Changes in Settlement area increment:

Settlement Area	Previous Survey (1985)		Present Survey (2021)		% increase/ decrease	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Settlement	6323	19.3	7200	23	+3.7	New settlement

Major Findings of Nabinagar Upazila, Brahmanbaria

i) Total area- 35750 ha
ii)Total sample colleted-215
iii)Physiography & AEZ code- Middle Meghna River Floodplain (AEZ-16), Old Meghna Estuarine Floodplain (AEZ -19), Sylhet Basin (AEZ-21)
iv)Major land type- Medium Low Land
v)Major soil group- Debidwar

Changes in Land Type:

Land type	Previous Survey (1994)		Present Survey (2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	411	1.14	420	1.18	(+)0.04	Due to new roads, homesteads and decrease of annual rainfall
Medium Highland	4216	11.80	4300	12.02	(+)0.22	
Medium Lowland	15142	42.36	15080	42.19	(-) 0.17	
Lowland	4673	13.08	4600	12.87	(-) 0.21	
Very lowland	5078	14.20	5050	14.12	(-) 0.08	
Miscellaneous	6230	17.42	6300	17.62	(+)0.20	
Total	**35750**	**100.0**	**35750**	**100.0**	-	

Changes in Land Use:

Land Use	Previous Survey (1994)		Present Survey (2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Homestead Vegetables	411	1.14	420	1.18	(+)0.04	Due to changes in land type.
Boro (Modern)-F-T.Aman	3056	8.55	3056	8.55	0.00	
RabiVegetables-F-T. Aman	1160	3.24	960	2.69	(-) 0.55	
Rc-F-T.Aman	-	-	284	0.80	0.80	
Boro (HYV)-F-F	5049	14.12	5044	14.11	(-) 0.01	
Boro (Local)-F-F	4047	11.32	4010	11.21	(-) 0.11	
Boro (Seedbed)-F-F	3026	8.47	3016	8.44	(-) 0.03	
Chilli / Sweet potato/ Ground nut-F-F	3020	8.44	3010	8.41	(-) 0.03	
Boro (HYV) -F-F	3650	10.21	3600	10.07	(-) 0.14	
Boro (Local) -F-F	1023	2.87	1000	2.80	(-) 0.07	
Boro (HYV)-F-F	3132	8.77	3120	8.72	(-) 0.05	
Boro (Local) -F-F	1946	5.45	1930	5.40	(-) 0.05	
Miscellaneous	6230	17.42	6300	17.62	(+)0.20	
Total	**35750**	**100.0**	**35750**	**100.0**	**-**	

Changes in Settlement area increment:

Settlement Area	Previous Survey (1994)		Present Survey (2022)		% increase/ decrease	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Settlement	4113	11.50	4183	11.70	(+)1.70	New settlements

Major findings of Lakshmichhari Upazila, Khagrachhari

i) Total area-22,015 ha
ii)Total sample collected- 104
iii)Physiography & AEZ code- Northern & Eastern Hill (29)
iv)Major land type- Highland (hill)
v)Major soil group- Nalua

Changes in Land Type:

Slope class/Land type	Previous Survey (2002)		Present Survey (2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Nearly level (<5%)	1191	5.4	1191	5.4	-	-
Medium slope (15-30%)	3593	16.3	3593	16.3	-	-
Steep slope (30-50%)	12944	58.8	12944	58.8	-	-
Very steep (50-70)	2447	11.1	2447	11.1	-	-
Excessively steep (>70)	1575	7.2	1575	7.2	-	-
Miscellaneous	265	1.2	265	1.2		
Total	**22015**	**100**	**22015**	**100**		

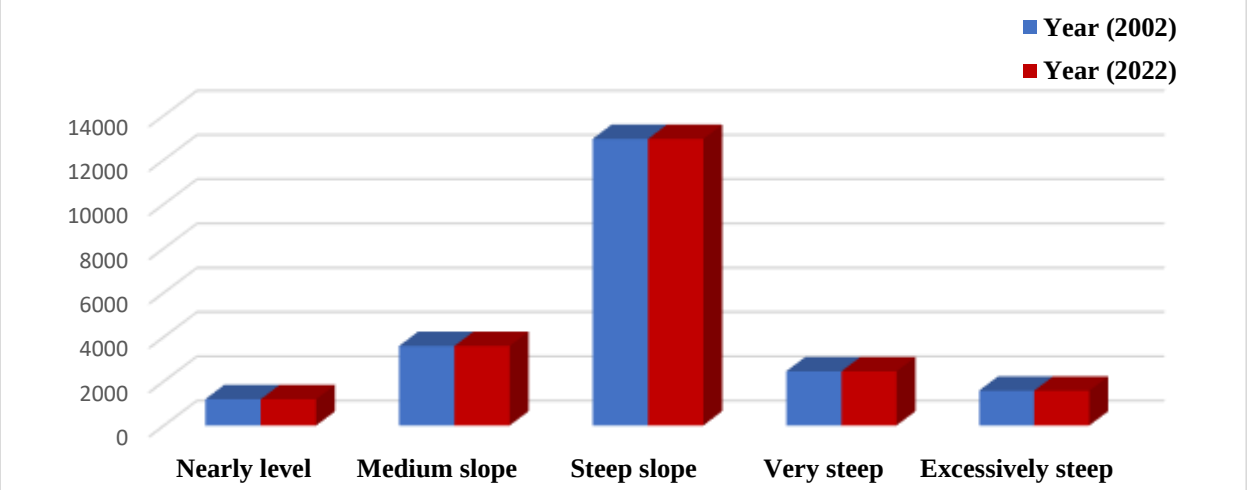


Fig. Comparison of Land type between 2002 & 2022 of Lakshmichhari Upazila

Changes in Land Use:

Land Use	Slope class/land type	Previous Survey (2002)		Present Survey (2022)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
1.Forest	Very steep, Steep	8170	37.1	6470	29.4	(-)20.8%	Logging
2.Fallow	All slopes	8577	39.0	6433	29.2	(-)25%	Increased jhum area
3.Shifting cultivation	All slopes	2367	10.7	1430	6.5	(-)39.6%	Converted to orchard
4.Orchard	Moderately steep	1668	7.6	2460	11.2	(+)47.5%	Increased profit
5.Teak plantation	All slopes	-	-	3989	18.1		-
5. Field crops	Valley	968	4.4	968	4.4		-
Miscellaneous	High land	265	1.2	265	1.2		-
Total		**22015**	**100**	**22015**	**100**		

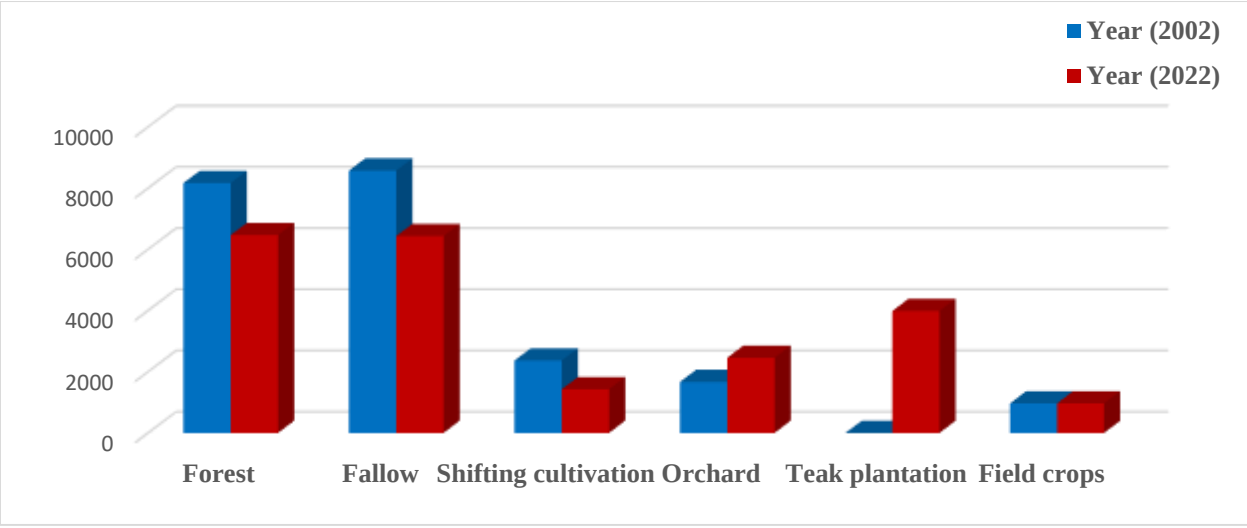


Fig. Comparison of Land use between 2002 & 2022 of Lakshmichhari Upazila

Major findings of Patnitala Upazila, Naogaon

i) Total area- 37927 ha
ii) Total sample collected- 172
iii) Physiography & AEZ code- Barind Tract ((25) & Tista flood plain (2)
iv) Major land type- High Land
v) Major soil group- Amnura

Changes in Land Type:

Land type	Previous Survey (1993)		Present Survey (2021)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	31953	84.25	30997	81.7	(-)2.99	
Medium Highland	905	2.39	1105	2.91	(+)22.09	
Medium Lowland	203	0.54	239	0.63	(+)17.73	
Lowland	36	0.09	-	-		siltation
Miscellaneous	4830	12.73	5586	14.7	(+)15.65	Increased settlement
Total	**37927**	**100.00**	**37927**	**100**		

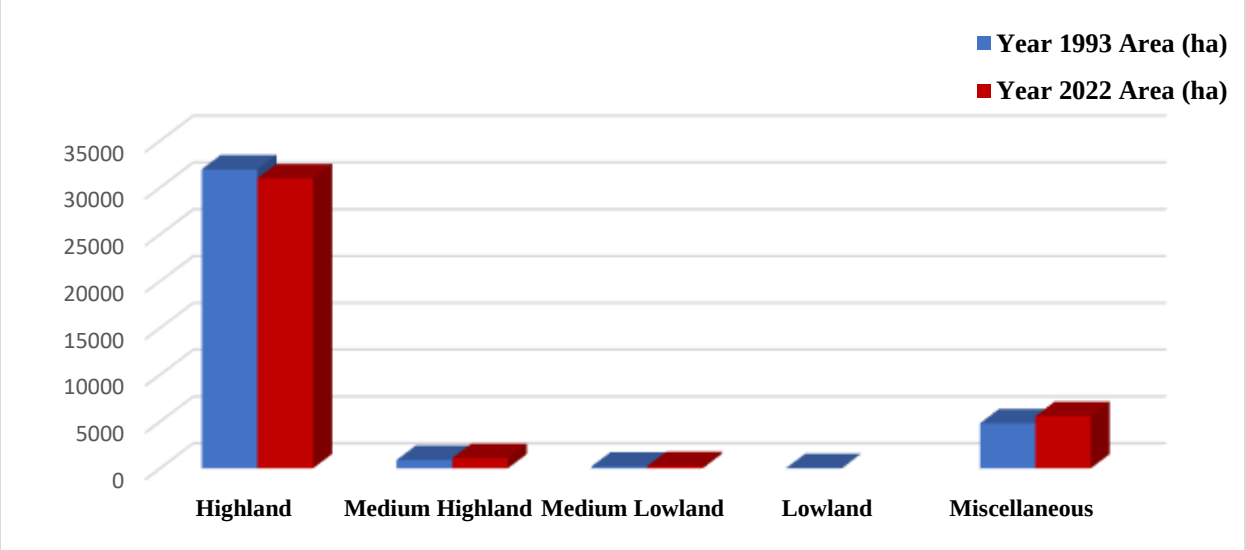


Fig. Comparison of Land type between 1993 & 2022 of Patnitala Upazila

Changes in Land Use:

Land Use	Previous Survey (1993)		Present Survey (2021)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Orchard (Litchi, Guava)	0	0	5265	13.8	-	
Rabi Crops (Potato/ Mustard/Pulse crops - Boro (Hybrid)-T aman.	1913	5.04	8505	22.4	(+)345	High profit

Rabi vegetables, jute, Mango-T.Aman	0	0	1090	2.87	-	
Rabi(Rabi/wheat/Pulse crops) - Aus – T.Aman	2451	6.46	0	0	-	
Rabi vegetabes- Maize - Fallow	0	0	70	0.18	-	
Rabi vegetabes- Maize/potato –Fallow-T aman	0	0	13015	34.31	-	
Boro– Fallow – T aman	6762	17.82	0	0	-	
Rabi Crops (Potato/Mustard/wheat/Pulse Crops-Fallow-T Aman	5252	13.84	0	0	-	
Fallow - Fallow -T.Aman	13603	35.86	4415	11.64	-	
Boro- Fallow-Fallow	880	2.32	0	0	-	
Other Cropping Patterns	7066	18.63	5567	14.67	-21.21	Converted to other profitable cropping patterns
Total	**37927**	**100**	**37927**	**100**		

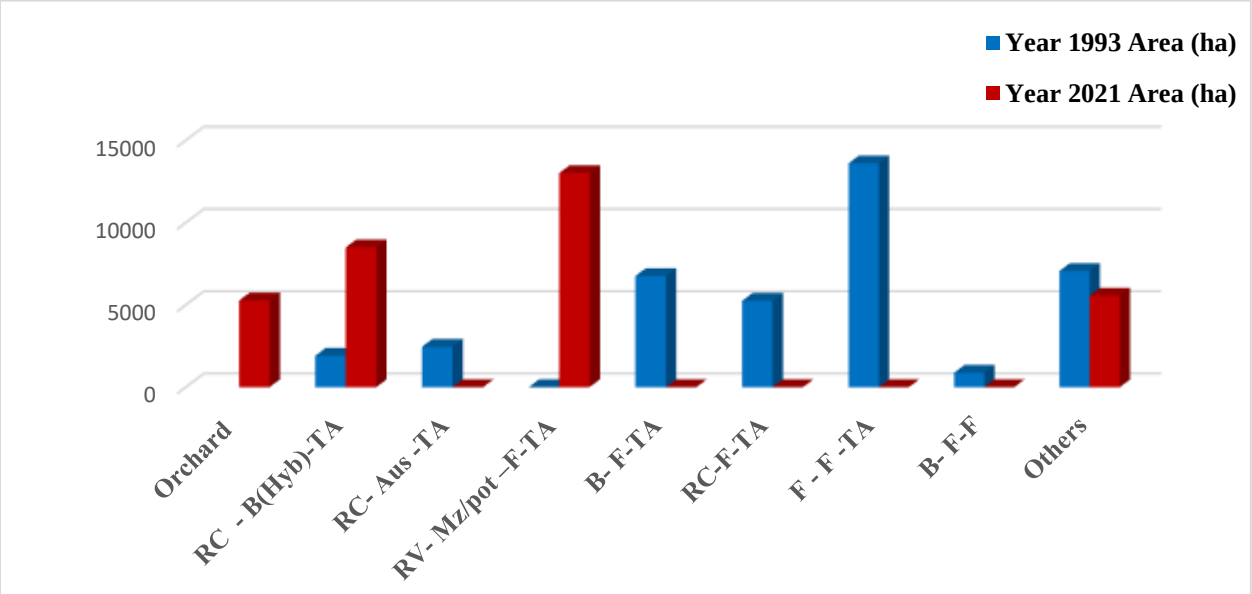


Fig: Comparison of land use changes between 2013 &2022 of Patnitala Upazila

Changes in Settlement area increment:

Settlement Area	Previous Survey (1993)		Present Survey (2021)		% increase/ decrease	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Settlement	3160		5073		(+)60.53	Demand for increased population

Major findings of Gomostapur Upazila

i) Total area-31812 ha

ii) Total sample colleted-191
iii) Physiography & AEZ code-Barind Tract: High Barind (26), High ganges (11), Tista Flood plain (3)
iv) Major land type-Highland and medium Highland
v) Major soil group- Atahar , Amnura, Nachole, Sara, Gopalpur and Jaonia.

Changes in land type:

Land type	Gomostapur Upazila			
	Previous Survey (1999)		Present Survey (2019)	
	Area (ha)	%	Area (ha)	%
Highland	17,991	56.6	15,855	49.9
Medium Highland	3,563	11.2	3,151	9.9
Medium Lowland	1,694	5.3	2,215	7.0
Lowland	3,131	9.8	2,894	9.0
Very Lowland	1,455	4.6	1,530	4.8
Miscellaneous Land	3,978	12.5	6,167	19.4
Total	**31,812**	**100**	**31,812**	**100.0**

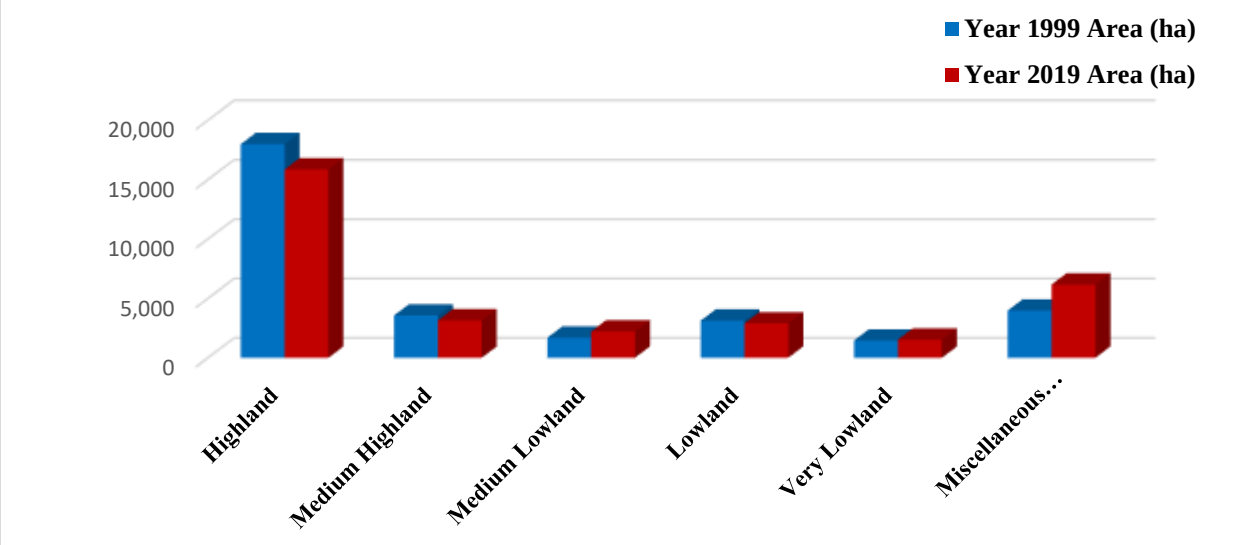


Fig: Comparison of land type changes between 1994 &2020 of Gomostapur Upazila

Major findings: Shahazadpur Upazila

i) Total area- 32,462 ha
ii) Total sample collected- 125
iii) Physiography & AEZ code-Karotoya Bangali Floodplain (4), Mixed Karotoya- Bangali and Jamuna Floodplain (4 and 7), Active and young jamuna Flood plain (7) and Old Ganges Floodplain (11)
iv) Major land type- High Land, Medium High Land, Medium Low land and Low Land
w) Major soil group-Sonatola, Silmondi, Ghatail, Savar bazaar, Kazla, Matia, Maldah, Daspara and Sands and Silt of Jamuna.

Changes in land type:

Land type	Shahazadpur Upazila			
	Previous Survey (1994)		Present Survey (2020)	
	Area (ha)	%	Area (ha)	%
High land	1296	4	1257	4
Medium High Land	9100	28	7854	24
Medium Low Land	6736	21	7080	22
Low Land	5442	17	5846	18
Very Low Land	904	3	866	3
Miscellaneous Land	8984	27	9559	29
Total	**32,462**	**100**	**32,462**	**100.0**

Major Findings of Kaliganj Upazila, Lalmonirhat

Change in Land Type

Land type	Previous Survey (1998)		Present Survey (2021)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	6,447	27.2%	4,874	20.6%	(-)6.6	Increase of settlement, industries
Medium Highland	12,995	54.8%	10,594	44.7%	(-)10.1	
Medium Lowland	1,873	7.9%	1,400	5.9%	(-)2.0	
Miscellaneous	2,379	10%	6,826	28.8%	(+)18.8	
Total	**23,694**	**100**	**23,694**	**100**		

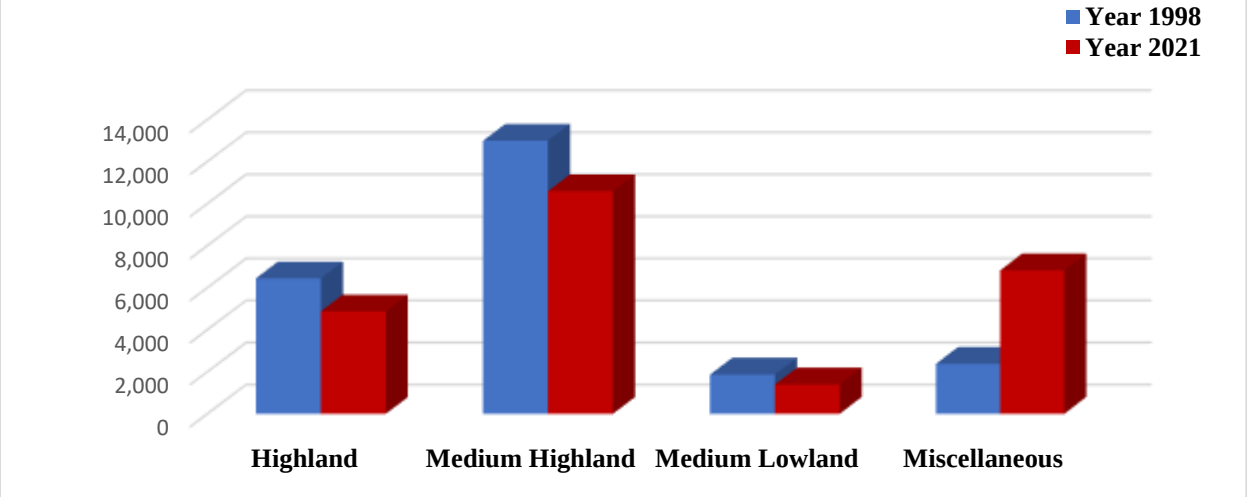


Fig: Comparison of land type changes between 1998 to 2021 of Kaliganj upazila

Change in Land Use

Land Use	Previous Survey (1998)		Present Survey (2021)		% increase/ decrease	Possible Reasons
	Area (ha)	%	Area (ha)	%		
1.Boro-fallow-T.aman	5593	23.6	7581	32.0	(+)8.4 %	Increasing cropping intensity with new cropping pattern Increase of settlement, industries
2.Maize-Fallow-T.aman	1020	4.3	2789	11.8	(+)7.5 %	
3.Tobacco-Maize-T.aman	615	2.6	1083	4.5	(+)1.9 %	
4. Rabi & kharif vegetable	723	3.1	674	2.9	(-) 0.2 %	
5.Boro-Fallow-fallow	671	2.8	1019	4.3	(+)1.5 %	
6.Tobacco-jute-T.aman	240	1.0	329	1.4	(+)0.4 %	
7. Mustard-Boro-T.aman	-	-	464	2.0	(+)2.0 %	
8.Potato-Boro-T.aman	-	-	364	1.5	(+)1.5 %	
9. Tobacco- Boro-T.aman	1510	6.4	363	1.5	(-)4.9 %	
10.Wheat-Aus-T.aman	61	0.3	397	1.7	(+)1.4 %	
11.Others	10931	46.1	1805	7.6	-35.0 %	
Miscellaneous	2330	9.8	6826	28.8	(+)19 %	
Total	**23694**	**100.0**	**23694**	**100**		

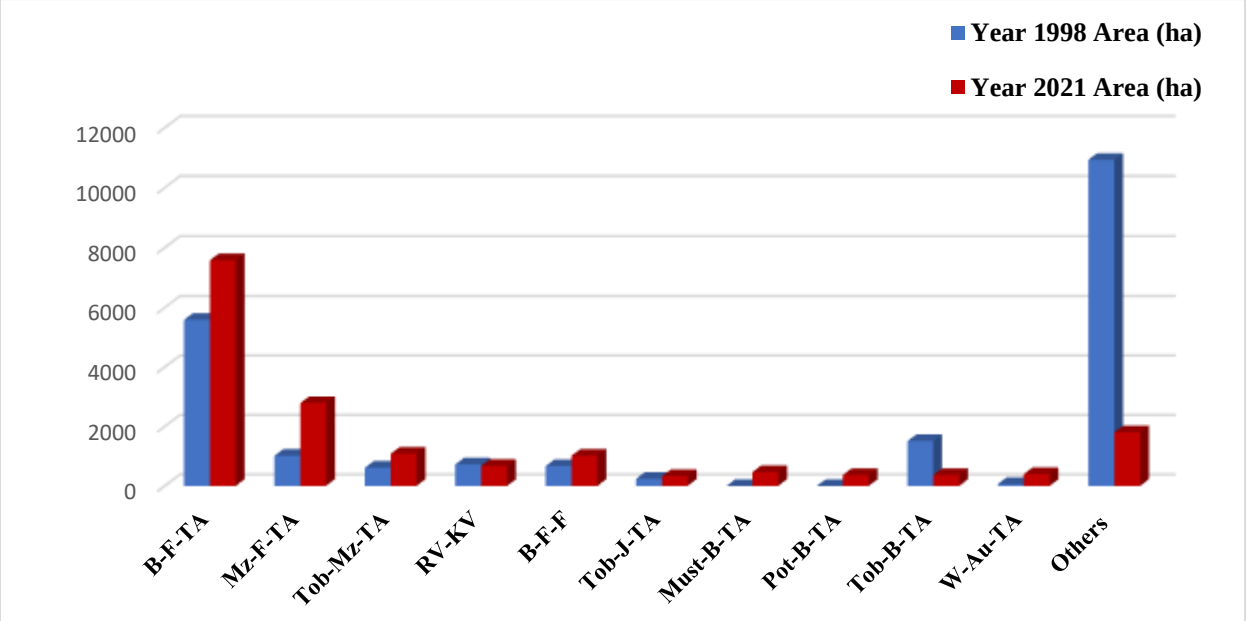


Fig: Comparison of land use changes between 1998 to 2021 of Kaliganj upazila

Major findings of Chirirbandar Upazila, Dinajpur

Change in Land Type

Land type	Previous Survey (2002)		Present Survey (2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	17174	56.00	14269	46.2	(-)9.8	Increase of settlement area
Medium Highland	10561	34.00	9051	29.3	(-)4.7	Siltation

Medium Lowland	-	-	516	1.7	(+)1.7	-
Miscellaneous	3133	10.00	7032	22.8	(+)12.8	New settlements for increased population
Total	**30868**	**100.0**	**30868**	**100.0**		**-**

Change in Land Use

Land Use	**Previous Survey (2002)**		**Present Survey (2022)**		**% increase/ decrease**	**Possible reasons**
	Area (ha)	**%**	**Area (ha)**	**%**		
1.Perennial	-	-	1586	5.13	(+)5.13	Perennial Orchard & Boro cultivation increased. T.Aus & T.Aman area decreased. Vegetable growing area increased
2. Annual	1345	4.35	1675	5.42	(+)1.07	
3. Rabi Crops-Kharif Vegetable	1064	3.44	2069	6.70	(+)3.26	
4. Rabi crops-Aus/Jute- Fallow	1874	6.07	-	-	(-)6.07	
5. Rabi crops-Fallow- T. Aman	2392	7.74	-	-	(-)7.74	
6. Rabi crops-Aus/Jute- T. Aman	5970	19.34	-	-	(-)19.34	
7.Fallow-Fallow-T. Aman	2082	6.74	-	-	(-)6.74	
8.Boro-Fallow- T. Aman	1041	3.37	2086	6.76	(+)2.99	
9.Potato/mustardBoro(M)/Maize-T. Aman (M)	-	-	1143	3.70	(+)3.70	
10.Boro(M)-T. Aus- T. Aman(M)	-	-	89	0.29	(+)0.29	
11.Rabicrops-Fallow-T.Aman	-	-	3588	11.62	(+)11.62	
12.Rabi crops-Maize- T. Aman	-	-	2860	9.27	(+)9.27	
13.Rabicrops-Fallow-T.Aman	2392	7.74	1428	4.63	(-)3.11	
14.Fallow-Fallow-T. Aman	2029	6.57	-	-	(-)6.57	
15.Boro-Fallow-T. Aman	5916	19.26	2822	9.14	-	
16.Fallow-Aus/Jute- T. Aman	194	0.63	726	2.35	-	
17.Rabicrops-Aus/Jute- T. Aman	1436	4.75	596	1.93	-	
18.Rabicrops-T.Aus-T.Aman	-	-	139	0.45	(+)0.45	
19.Potato/mutard-Boro(M)/Maize-T. Aman (M)	-	-	2632	8.52	(+)8.52	

20.Boro-Fallow-Fallow	-	-	397	1.29	(+)1.29	
Miscellaneous	3133	10.0	7032	22.8	(+)12.8	
Total	**30868**	**100.0**	**30868**	**100.0**		

Major findings of Meherpur Sadar Upazila, Meherpur

i) Total area-26,063 ha
ii)Total sample colleted-120
iii)Physiography & AEZ code- High Ganges River Floodplain (11)
iv)Major land type- High land, Medium high land, Medium Lowland & Lowland
v)Major soil group- Sara, Gopalpur, Ishurdi, Ghior & Ramdia

Changes in Land Type:

Land type	Previous Survey (1991)		Present Survey (2021)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	10894	41.8	8992	34.5	(-)7.3	
Medium Highland	7871	30.2	8210	31.5	(+)1.3	
Medium Lowland	2085	8	2267	8.7	(+)0.7	
Lowland	261	1	209	0.8	(-)0.2	
Miscellaneous	4952	19	6385	24.5	(+)5.5	
Total	**26063**	**100**	**26063**	**100**		

Changes in Land Use:

Land Use	Land type	Previous Survey (1991)		Present Survey (2021)		% increase/ decrease	Possible reasons
		Area (ha)	%	Area (ha)	%		
1. Perennial	HL	521	2	652	2.5	(+)0.5	
2. Annual (Banana\Papaya/ Sugarcane / Turmeric)	HL	2737	10.5	2085	8	(-)2.5	
3. Rabi vegetables- Kharif vegetables	MHL	2346	9	2606	10	(+)1.0	
4. Rabi Vegetables-Jute / B. Aus-fallow	MLL	2736	10.5	1955	7.5	(-)3.0	
5. Fallow- Jute / B. Aus - B. Aman	MLL	2346	9	-	-	(-)9.0	
6. Tobacco-F- B. Aman/ T.Aman	MHL	1772	6.8	1460	5.6	(-)1.2	
7. Boro- Fallow-T. Aman	MHL	1564	6	2085	8	(+)2.0	
8. Boro-Fallow-B.Aman	MLL	2554	9.8	-	-	(-)9.8	
9. Boro-Fallow-Fallow		2606	10	2085	8	(-)2.0	
10. Robi Crop-Jute-Fallow	LL	-	-	2606	10	(+)10	
11. Boro-Jute -T. Aman	MHL	-	-	3128	12	(+)12	
12. Others	-	1929	7.4	1016	3.9	(-)3.5	
13. Miscellaneous	-	4952	19	6385	24.5	(+)5.5	
Total		**26063**	**100**	**26063**	**100**		

Changes in Settlement area

Settlement Area	Previous Survey (1991)		Present Survey (2021)		% increase/ decrease	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Settlement	2059	7.9	3258	12.5	(+)4.6	New settlements

Major Findings of Baliakandi, Rajbari

Change in Land Type

Land type	Previous Survey (2009)		Present Survey (2021)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	2,969	12.4	2,440	10.2	(-)2.2	
Medium Highland	3,918	16.4	4,067	17.0	(+)1.4	
Medium Lowland	4,738	19.8	4,760	19.9	(+)0.7	
Lowland	6,289	26.3	6,124	25.6	(+)0.7	
Very lowland	1,154	4.8	861	3.6	(-)1.2	
Miscellaneous	4,853	20.3	5,669	23.7	(+)3.4	
Total	**23,921**	**100**	**23,921**	**100**		

Change in Land Use

Land Use	Previous Survey (2009)		Present Survey (2021)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
1. Betel leaf	77	0.3	-	-	(-)0.3	
2. Sugarcane / Banana / Papaya/Turmeric	577	2.4	950	4.0	(+)1.6	High value crops
3. Rabi vegetables-Kharif vegetables	305	1.3	1,088	4.5	(+)3.2	
4. Rabi vegetables-jute / Bona Aus-fallow	76	0.3	-	-	(-)0.3	
5. RC-Sesame/jute-fallow	3,168	13.2	-	-	(-)13.2	
6. Chilli-T. Aman	134	0.6	-	-	(-)0.6	
7. Fallow-jute-T. Aman	181	0.8	-	-	(-)0.8	
8. RC-jute-T. Aman	134	0.6	-	-	(-)0.6	
9. RC-Mixed Aus and Aman	3,754	15.7	10,770	45.0	(+)29.3	Diversified rabi cropping
10. Boro-Fallow-T. Aman	663	2.8	950	4.0	(+)1.2	Increased Boro coverage
11. Boro-Fallow-B. Aman	1,518	6.3	-	-	(-)6.3	

12. Fallow-Mixed Aus and Aman	1,731	7.2	-	-	(-)7.2	
13. Boro-Fallow-Fallow	3,248	13.6	396	1.6	(-)12.0	
14. Fallow-B. Aman	2,878	12.0	-	-	(-)12.0	
15.RC-B. Aus-Fallow/Vegetables	-	-	1,150	4.8	(+)4.8	Diversified & high value crop
16. RC-Sesame-Vegetables	-	-	1,000	4.2	(+)4.2	
17. Onion-Jute-Vegetables/Fallow	-	-	1,450	6.1	(+)6.1	High value crop
18. Others	624	2.6	498	2.1	(-)0.5	
19. Miscellaneous	4,853	20.3	5,669	23.7	(+)3.4	
Total	**23,921**	**100.0**	**23,921**	**100.0**		

Major findings of Patuakhali Sadar, patuakhali

i) Total area-[illegible] ha
ii) Total sample colleted-137
iii) Physiography & AEZ code- Ganges tidal floodplain and (13)
iv) Major land type- Medium high land
v) Major soil group- Jhalakati, Barishal

Changes in Land Type:

Land type	Previous Survey (2002)		Present Survey (2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	819	2.3	756	2.1	(-)0.2	Occupied by new settlements
Medium Highland	26873	74.6	25786	71.6	(-)3.0	
Miscellaneous	8322	23.1	9472	26.3	(+)3.2	Increased settlements
Total	**36,014**	**100.0**	**36,014**	**100.0**		

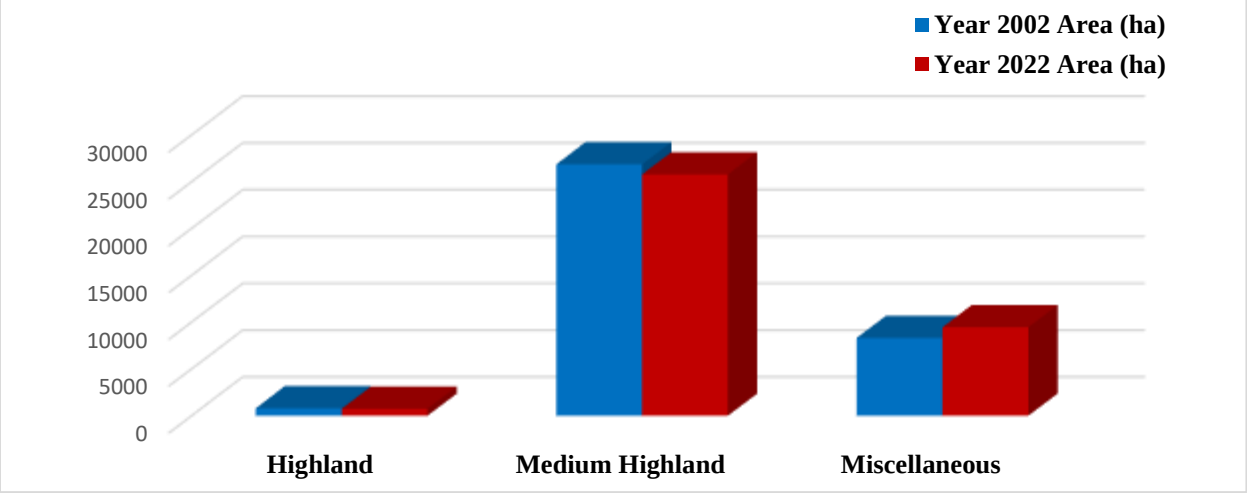


Fig: Comparison of land type changes between 2002 to 2022 of Patuakhali Sadar upazila

Changes in Land Use:

Land Use	Previous Survey (2002)		Present Survey (2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
1.F-T.Aus- TA	13159	36.5	10069	27.9	(-)8.6	Boro coverage increased (+)
2.RC- T.Aus- TA	6211	17.3	3072	8.5	(-)8.8	
3.RC-F- TA	4791	13.3	6024	16.7	(+)3.4	
4.Boro-F-TA	2923	8.1	6789	18.8	(+)10.7	
5.Others	608	1.7	588	1.6	(-)0.1	
Miscellaneous	[illegible]	[illegible]	[illegible]	[illegible]	(+)[illegible]	
Total	**36,014**	**100**	**36,014**	**100**		

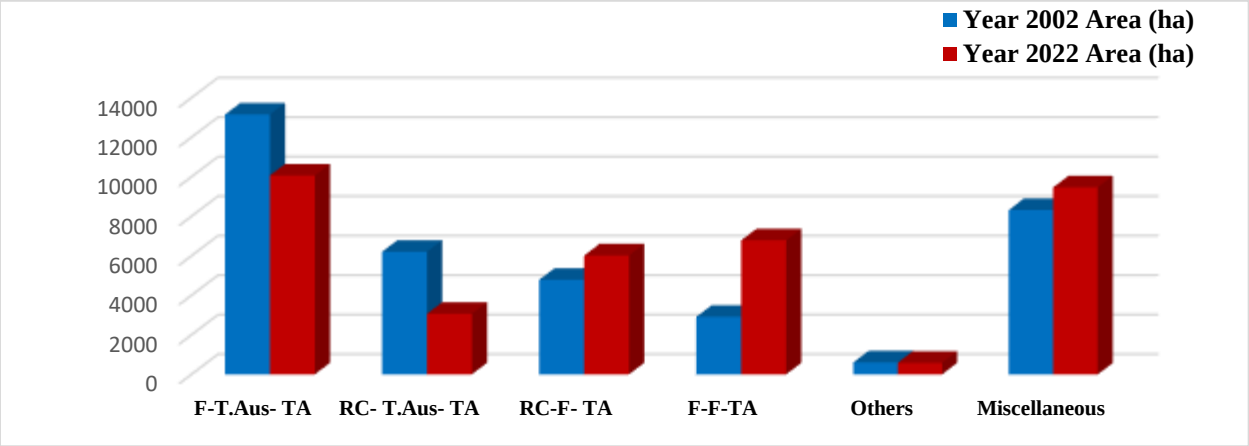


Fig: Comparison of land type changes between 2002 to 2022 of Patuakhali Sadar upazila

Changes in Settlement area increment:

Settlement Area	Previous Survey (2002)		Present Survey (2022)		% increase/ decrease	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Settlement	4,054	11.25	6,061	16.83	(+)5.58	

Major findings of Jhalakathi Sadar upazila, Jhalokathi

i) Total area- 21,293 ha
ii)Total sample collected-86
iii)Physiography & AEZ code-

Physiography	AEZ Name & Code
Ganges River Floodplain	Low Ganges River Floodplain (12)
Ganges Tidal Floodplain	Ganges Tidal Floodplain (13)

iv)Major land type- High Land, Medium High Land and Medium Low Land
v)Major soil group-

Physiography	Agroecological Zones (AEZ)	Major soil series	Other soil

Ganges River Floodplain	Low Ganges River Floodplain (12)	Sara, Gopalpur	-
Ganges Tidal Floodplain	Ganges Tidal Floodplain (13)	Ramgati, Jhalakathi, Barishal, betagi, Pirojpur	Tidal alluvium

Changes in Land Type

Land type	Previous Survey (2007)		Present Survey (2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	1061	5	Almost nil	-	(-)100	Loss of cultivable land due to homestead forest and settlement
Medium Highland	14031	66	13049	61	(-)5.0	
Medium Lowland	461	2	230	1	(-)1.0	Siltation
Miscellaneous	5740	27	8014	38	(+)11.0	Gain of area due to homestead forest and settlement
Total	**21293**	**100**	**21293**	**100**	**-**	**-**

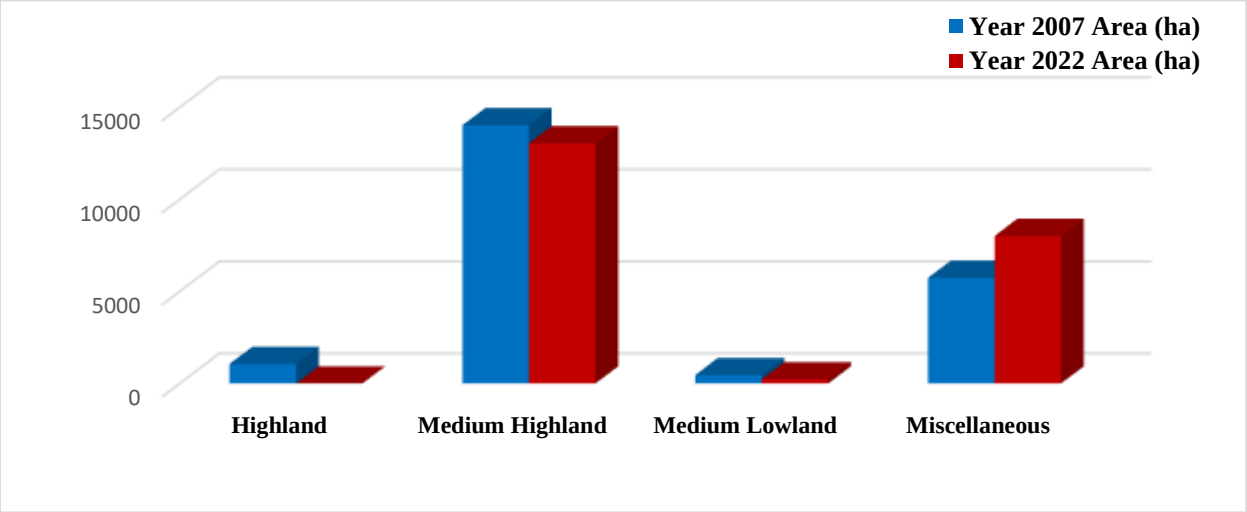


Fig. Comparison of Land type between 2007 & 2022 of Jhalokathi Sadar Upazila

Changes in Land Use

Land Use	Previous Survey (2007)		Present Survey (2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
1.Boro-Fallow-T. aman	3045	14	3833	18	(+)4	Increased irrigation facility
2.Fallow-T.aus-T.aman	4141	20	3619	17	(-)3	Difficulty in post-harvest operation of T. aus crop

3. Rabi crop-Fallow T. aman	2423	11	2768	13	(+)2	Government incentive
3.Fallow-Fallow-T.aman	2203	10	852	4	(-)6	
Boro-Fallow -Fallow	2119	10	1278	6	(-)4	
Guava/ hog plum/lemon/banana orchard	212	1	426	2	(+)1	Improved land use & higher return
Others	1410	7	503	2	(-)5	
Miscellaneous	5740	27	8014	38	(+)11	
Total	**21293**	**100**	**21293**	**100**	**-**	

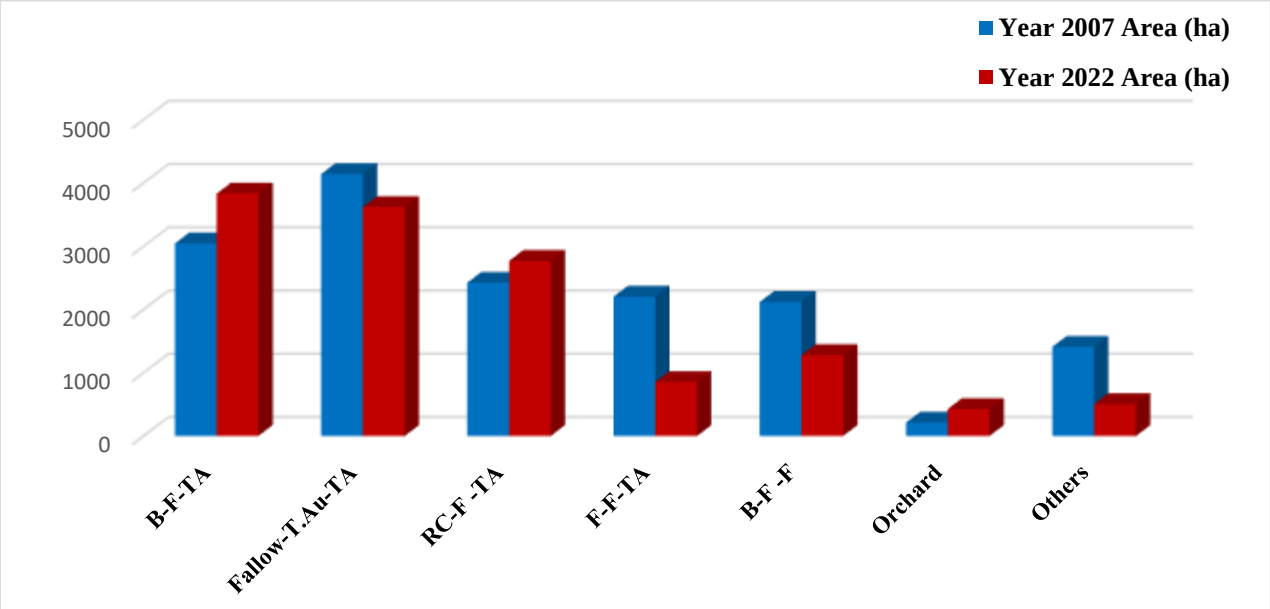


Fig. Comparison of Land use between 2007 & 2022 of Jhalokathi Sadar Upazila

Changes in Settlement area increment:

Settlement Area	Previous Survey (2007)		Present Survey (2022)		% increase	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Settlement	4201	19.7	4690	22	(+)11.6	New settlement

Major findings of Teknaf Upazilas, Cox's bazar

i) Total area- 34938 Hactare
ii)Total sample colleted- 152
iii)Physiography & AEZ code-
1. Northern and Eastern Hills (29)
2.Chittagong Coastal Flood Plain (23)
3. Chittagong Tidal Flood Plain (23)
4. Beach Ridge Sand (23)
5. Coral Beach Sand (24)
iv)Major land type- High Land & Medium High Land

v)Major soil group-1) Tamabill, 2) Sitakunda, 3) Barkal, 4) Subalong, 5) Dhum, 6) Khadimnagar, 7) Shalbon, 8) Nalua, 9) Rangapani, 10) Pahartali, 11) Mirsarai, 12) Bijipur, 13) Nila, 14) Chokoria, 15) Dhurong, 16) Kutubdia, 17) Teklnaf, 18) Monakhali, 19) Zinjira & 20) Narikeldia

Changes in Land Type:

Land type	Previous Survey (2001)		Present Survey (2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	19626	56.2	17800	50.9	(-)5.23	Increased homestead & other infrastructure, Hill erosion etc.
Medium Highland	5385	15.4	4685	13.4	(-)2.00	
Miscellaneous	9927	28.4	12453	35.6	(+)7.23	
Total	**34938**	**100.0**	**34938**	**100.0**		

Changes in Land Use:

Land Use	Previous Survey (2001)		Present Survey (2022)		% increase/ decrease	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Forest	6,068	17.4	5610	16.1	(-)1.3	Deforestation
Shrubs and creepers	4,972	14.2	4250	12.2	(-)2.1	
Annual & perennial fruit garden	3,294	9.4	3560	10.2	(+)0.8	Tree plantation
Perennial tree	293	0.8	250	0.7	(-)0.1	Tree plantation
RC-F-TA	1944	5.6	1567	4.5	(-)1.1	
	3916	11.2	3245	9.3	(-)1.9	
Watermelon-F-TA	350	1.0	342	1.0	0.0	
Maize-F-TA	66	0.2	62	0.2	0.0	
F-F-TA	1249	3.6	956	2.7	(-)0.8	
	913	2.6	465	1.3	(-)1.3	
RC-F-F	1529	4.4	1160	3.3	(-)1.1	
Ground nut-F-F	100	0.3	70	0.2	(-)0.1	
Salt bed-F-F	205	0.6	654	1.9	(+)1.3	More profitable
Homestead	112	0.3	290	0.8	(+)0.5	
Miscellaneous	9927					
Total	**34,938**	**-**	**34,938**	**-**	**-**	**-**

Changes in Settlement area increment:

Settlement Area	Previous Survey (2001)		Present Survey (2022)		% increase/ decrease	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Settlement	112	0.3	290	0.8	(+)0.5	Increased population and urbanization

Major findings of Barishal Sadar, Barishal

i) Total area-[illegible] ha
ii)Total sample collected- 100
iii)Physiography & AEZ code- Ganges River Floodplain (11) and Ganges Tidal Floodplain (13)
iv)Major land type- Medium Highland
v)Major soil group- Ramgati, Jhalkati, Barisal, Sara, Gopalpur, Kalbodor, Muladi, Hizla, Mehendigonj

Changes in Land Type

Land type	Previous Survey (2009)		Present Survey (2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	1253	3.8	2015	6.2	(-)0.2	Cultivable land converted to homestead and settlement
Medium Highland	18015	55.2	15505	47.6	(-)7.6	
Medium Lowland	1752	5.4	1600	5	(-)0.4	Siltation
Lowland	419	1.3	400	1.2	(-)0.1	
Miscellaneous	11210	34.3	13039	40	(+)5.7	Gain of area due to homestead and settlement
Total	**32,649**	**100.0**	**32,649**	**100.0**		

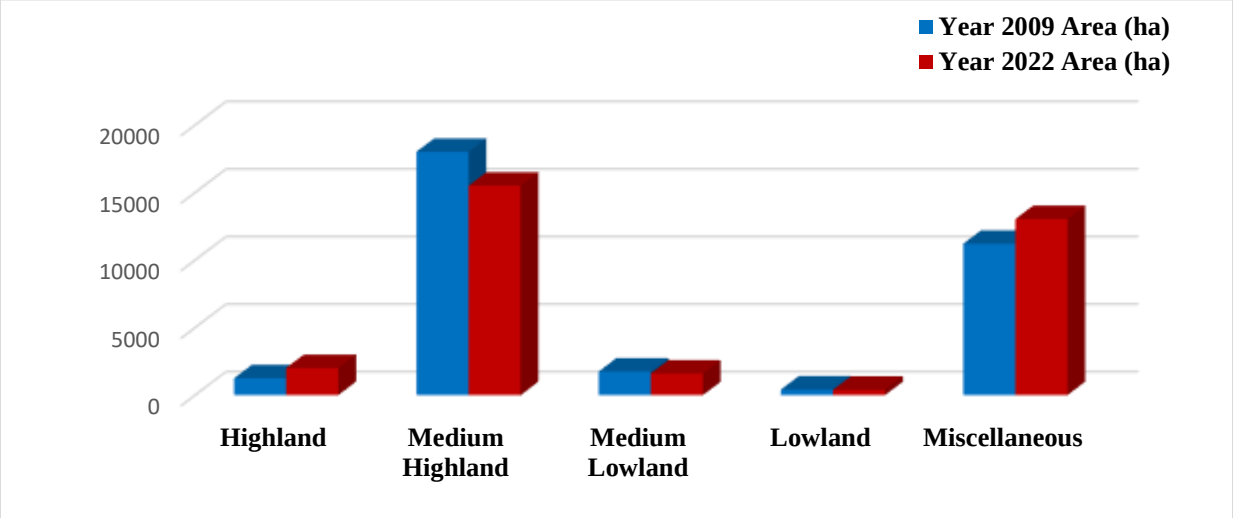


Fig. Comparison of Land type between 2009 & 2022 of Barishal Sadar Upazila

Changes in Land Use

Land Use	Previous Survey (2009)		Present Survey (2022)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
RV-KV	8014	24.5	1633	5	(-)19.5	
Boro-F-TA	4948	15.2	7183	22	(+)6.8	Development of irrigation

						infrastructure & more profit
RC- T.Aus- TA	2569	7.9	-	-	(-)7.9	Change in Rainfall Pattern and less cost effectiveness
F-T.Aus- TA	2350	7.2	-	-	(-)7.9	
RC-F- TA	-	-	8162	25	(+)25	Government incentive
F-F-TA	-	-	1632	5	(+)5	
B-F-F	2077	6.4	1632	5	(-)1.4	
Others	2101	6.4	1633	5	(-)1.4	
Miscellaneous	10590	[illegible]	10774	33	(+)[illegible]	
Total	**32,649**	**100**	**32,649**	**100**		

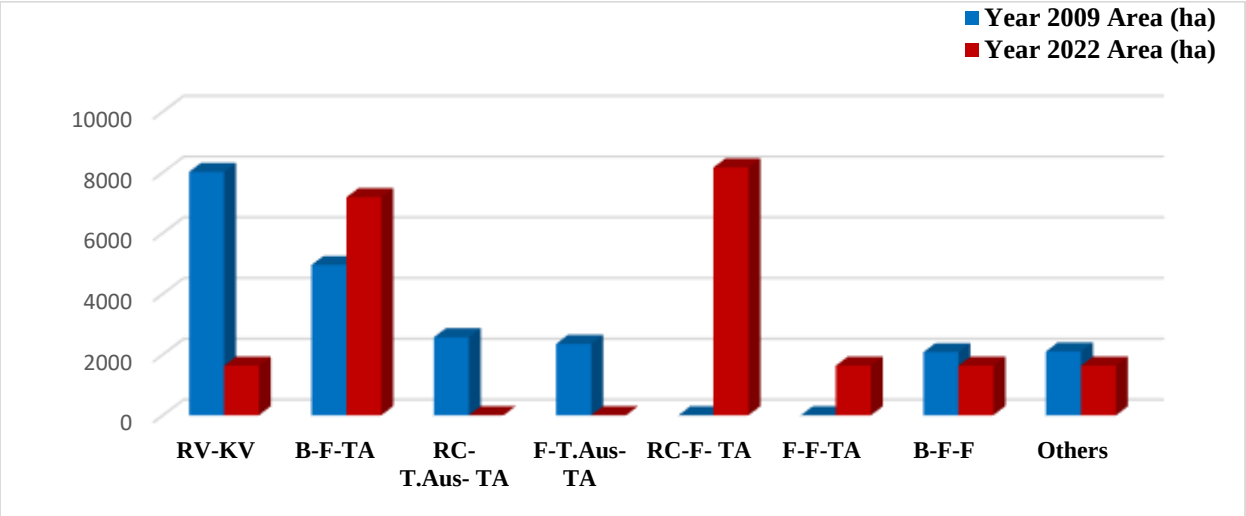


Fig. Comparison of Land use between 2009 & 2022 of Barishal Sadar Upazila

Changes in Settlement area

Settlement Area	Previous Survey (2009)		Present Survey (2022)		% increase/ decrease	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Settlement	5133	15.7	6330	19.4	(+)3.7	New settlements

Major findings of Ajmiriganj upazila

i) Total area- 18417
ii)Total sample collected- 93
iii)Physiography & AEZ code- Old Meghna Estuarine Floodplain (19), Surma Kushyara Floodplain (20)
iv)Major land type- MHL, MLL, LL, VLL
v)Major soil group- Madhabpur, Baniachong, Richi, Balua, Balaganj, Goainghat, Ajmiriganj, Sulla

Changes in Land Type

Land type	Previous Survey (2000)		Present Survey (2021)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Highland	33	0.18	44	0.24	(+)0.06	Siltation, construction of dam and settlement area increase
Medium Highland	82	0.45	296	1.61	(+)1.16	
Medium Lowland	5111	27.75	6618	35.93	(+)8.18	
Lowland	5869	31.87	6718	36.48	(+)4.61	
Very lowland	4889	26.55	2383	12.94	(-)13.61	
Miscellaneous	2433	13.21	2358	12.8	(-)0.41	
Total	**18417**	**100**	**18417**	**100**	-	-

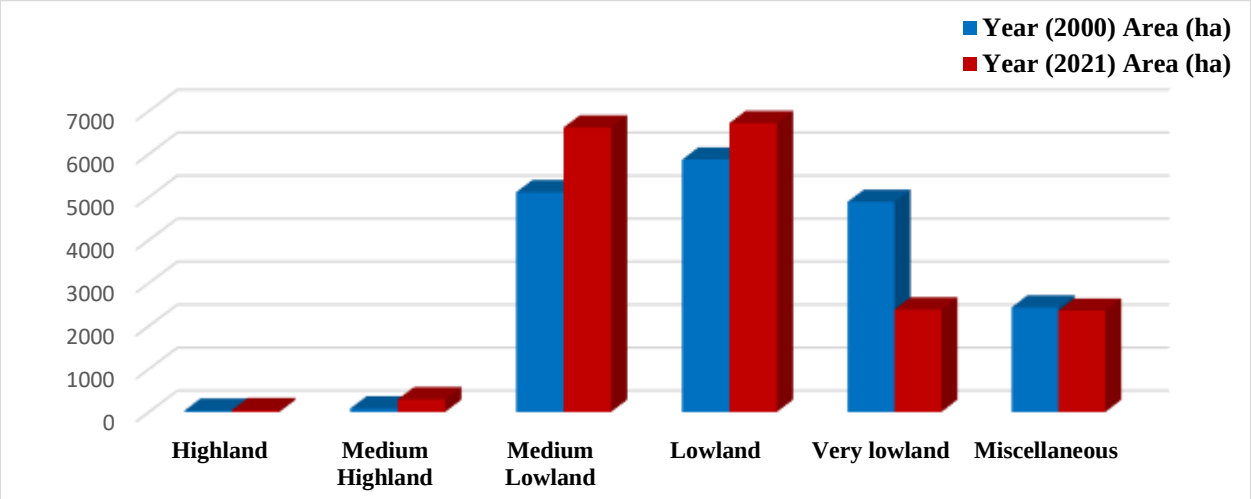


Fig. Comparison of type use changes between 2000 to 2021 of Ajmiriganj upazila

Changes in Land Use

Land Use	Previous Survey (2000)		Present Survey (2021)		% increase/ decrease	Possible reasons
	Area (ha)	%	Area (ha)	%		
Boro-Fallow-Fallow	13340	72.43	10604	57.58	(-)14.85	Boro-F-F replaced by more intensive pattern
Boro-B.Aman	0	0	867	4.71	-	
Boro-Fallow-T.aman	0	0	1152	6.26	-	
Rabi crops-Fallow-T.aman	0	0	197	1.07	-	
Fallow-B.Aman	0	0	2641	14.34	14.34	
Rabi crops-Fallow-Fallow	370	2.01	299	1.62	(-)0.39	
Seedbed-F-F	1156	6.28	255	1.38	(-)4.90	

Rabi crops-Sesame-Fallow	659	3.58	0	0.00	(-)3.58	
Others	459	2.49	44	0.24	(-)2.25	
Miscellaneous	2433	13.21	2358	12.80	(-)0.41	
Total	**18417**	**100**	**18417**	**100**	**-**	**-**

Fig: Comparison of land use changes between 2000 to 2021 of Ajmiriganj upazila

Changes in Settlement area increment

Settlement Area	Previous Survey (2000)		Present Survey (2021)		% increase/ decrease	Possible Reasons
	Area (ha)	%	Area (ha)	%		
Settlement	669	3.63	866	4.70	(+)1.07	New settlements

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 2021-2022, total number of Union Sahayika prepared by field offices was 170.

Table 3. Union Sahayika prepared by respective Divisional & Regional office (2021-22)

Name of Regional/District Office	District	Upazila	No. of Union Sahayika prepared
Regional Office, Faridpur	Faridpur	Alfadanga	5
Regional Office, Gopalganj	Madaripur	Rajoir	5
Regional Office, Jamalpur	Jamalpur	Jamalpur Sadar	6
Regional Office, Madaripur	Shariatpur	Damuyda	5
Regional Office, Mymensingh	Mymensingh	Ishwarganj	5
Regional Office, Netrokona	Gazipur	Kaliakoir	5
Regional Office Tangail	Tangail	Bhuapur	5
Regional Office, Cumilla	Cumilla	Debidwar	5
Regional Office,Rangamati	Chattogram	Satkania	9
Regional Office, Chapainawabgonj	Chapainawabganj	Gomostapur	10
	Naogaon	Shapahar	

Name of Regional/District Office	District	Upazila	No. of Union Sahayika prepared
Regional Office, Pabna	Pabna	Sathia	5
Regional Office, Bogura	Joypurhat	Panchbibi	5
Regional Office, Naogaon	Naogaon	Naogaon Sada	3
	Naogaon	Badalgachi	2
Regional Office, Sirajganj	Sirajganj	Kazipur	5
Divisional Office, Rangpur	Gaibandha	Sadullapur	5
Regional Office, Gaibandha	Gaibandha	Gaibandha Sadar	5
Regional Office, Dinajpur	Dinajpur	Chirirbandar	5
Regional Office, Thakurgaon	Thakurgaon	Pirganj	5
Regional Office, Lalmonirhat	Lalmonirhat	Lalmonirhat Sadar	5
Divisional Office, Khulna	Satkhira	Kaligonj	5
Regional Office, Jashore	Narail	Lohagara	5
Regional Office, Kushtia	Kushtia	Kumarkhali	6
Regional Office, Jhenaidah	Jhenaidah	Kaliganj	5
Regional Office, Satkhira	Satkhira	Kaligonj	7
Regional Office, Patuakhali	Patuakhali	Galachipa	12
Regional Office, Bhola	Bhola	Charfassion	6
	Khulna	Dakope	4
Divisional Office, Sylhet	Sylhet	Balaganj	5
Regional Office, Sunamgonj	Chatok	Chatok	5
Regional Office, Moulvibazar	Habiganj	Bahubal	5
		Total	**170**

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 programmeme for developing awareness among farmers about soil test-based fertilizer use so that farmers become more interested to get services from static laboratory. 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)

(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 2021-2022, soil analytical service through MSTL provided to 112 Upazila of the country and provided 5,682 farmers with Fertilizer Recommendation Cards (Table 4, 5).

Table 4. Name of the Upazila and number of soil samples analyzed through MSTL under Farmer's Service Programme during Rabi 2021 season

Sl. No	District	Upazila	No. of Soil Samples Analyzed
1	Manikgonj	Manikgonj Sadar	50
2	Faridpur	Faridpur Sadar	50
3	Rajbari	Kalukhali	50
4	Gopalganj	Gopalganj Sadar	50
5	Jamalpur	Islampur	52
6		Dewanganj	50
7	Sherpur	Sribordi	58
8		Jhenaigati	50
9	Kishoreganj	Hosenpur	50
10	Shariatpur	Zajira	50
11	Narayanganj	Sonargaon	53
12	Mymensingh	Tarakanda	50
13	Narsingdi	Palash	52
14	Netrokona	Purbadhala	50
15	Tangail	Basail	50
16		Mirzapur	50
17	Chattogram	Fatikchari	50
18		Hathazari	50
19		Satkania	50
20	Cox's bazar	Sadar	50
21	Noakhali	Suborno char	50
22	Feni	Fulgazi	50
23	Cumilla	Monohornganj	50
24		Homna	50
25	Chandpur	Matlob Uttar	50
26	Brahmanbaria	Nasirnagar	50
27	Khagrachari	Mohalchhari	50
28	Rangamati	Rangamati Sadar	50
29	Khulna	Terokhada	50
30		Batiaghata	50
31	Bagerhat	Mollahat	50
32	Jashore	Jashore sadar	54
33		Monirampur	50
34		Jhikargacha	50
35	Jhenaidah	Shailkupa	50
36	Meherpur	Meherpur Sadar	50

Sl. No	District	Upazila	No. of Soil Samples Analyzed
37	Sirajganj	Ullapara	50
38	Pabna	Ishwardi	50
39	Rajshahi	Puthia	50
40	Natore	Bagatipara	50
41	Bogura	Gabtoli	50
42	Chapainawabganj	Nachole	50
43	Naogaon	Patnitala	50
44	Nilphamari	Saidpur	50
45	Gaibandha	Gaibandha sadar	50
46	Lalmonirhat	Kaliganj	51
47	Dinajpur	Birampur	50
48	Thakurgaon	pirganj	50
49	Barishal	Wazirpur	50
50	Patuakhali	Bauphal	52
51	Barguna	Amtali	50
52	Bhola	Borhanuddin	50
53	Sylhet	Biswanath	50
54	Moulvibazar	Kulaura	59
55	Habiganj	Chunarughat	56
56	Sunamganj	Shantiganj	50
Total			**2837**

Table 5. Name of the Upazila and number of soil samples analyzed through MSTL under Farmer's Service Programme during Kharip 2022 season

Sl. No	District	Upazila	No. of Soil Samples Analyzed
1	Manikgonj	Daulatpur	47
2	Rajbari	Baliakandi	50
3	Faridpur	Madhukhali	60
4	Gopalganj	Kashiani	50
5	Jamalpur	Melandaha	62
6		Sarishabari	50
7	Sherpur	Sherpur Sadar	56
8		Nalitabari	56
9	Kishoreganj	Karimganj	50
10	Madaripur	Rajoir	50
11	Narayanganj	Araihazar	27
12	Mymensingh	Fulbaria	50
13	Gazipur	Kaliakoir	50
14	Netrokona	Barhatta	50
15	Tangai	Ghatail	50
16		Shakhipur	50
17	Chattogram	Raojan	50
18		Mirsarai	50
19		Chandonaish	50
20	Cox's bazar	Ukhiya	50
21	Lakshmipur	Raypur	50
22	Noakhali	Companigonj	50
23	Cumilla	Debidwar	50
24		B-para	50

Sl. No	District	Upazila	No. of Soil Samples Analyzed
25	Chandpur	Chandpur Sadar	50
26	Brahmanbaria	Brahmanbaria Sadar	66
27	Khagrachari	Manikchari	50
28	Bandarban	Bandarban sadar	50
29	Khulna	Rupsha	50
30	Bagerhat	Kachua	50
31	Jashore	Chougaha	50
32		Bagharpara	50
33	Magura	Sripur	50
34	Meherpur	Gangni	50
35	Kushtia	Bheramara	50
36	Satkhira	Debhata	50
37	Sirajganj	Sirajganj sadar	50
38	Pabna	Sujanagar	50
39	Rajshahi	Tanore	50
40	Natore	Baraigram	50
41	Bogura	Kahalu	50
42	Chapainawabganj	Chapainawabganj sadar	56
43	Naogaon	Badalgachi	50
44	Rangpur	Kaunia	54
45	Gaibandha	Sadullapur	50
46	Kurigram	Ulipur	50
47	Dinajpur	Ghoraghat	51
48	Panchagarh	Atwari	50
49	Barishal	Muladi	50
50	Jhalakati	Rajapur	50
51	Patuakhali	Galachipa	50
52	Barguna	Bamna	50
53	Sylhet	Balaganj	50
54	Moulvibazar	Juri	52
55	Habiganj	Baniachong	58
56	Sunamganj	Dowarabazar	50
		Total	**2845**

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 with 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, Pirozpur, Jhalukhati, 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 soluble salts, especially sodium chloride. In other words, soils that develops under the influence of the electrolyte of sodium salts, with a nearly neutral reaction. Dominant salts are sodium sulphate and sodium chloride, but seldom sodium nitrate, magnesium sulphate, or magnesium chloride. They are non-sodic soils containing soluble salts in such quantities that they interfere with the growth of most crop plants. The pH of the saturated saline soil is usually less than 8.3. These soils are geographically associated with arid, semi-arid, sub-humid and humid areas as well. The estimates indicate that Bangladesh has about 2.8 million ha (Chanratchakool, 2007) of land affected by salinity and poor quality water. The total area includes deltaic floodplains and offshore islands. 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). Due to a number of environmental factors the coastal soils are slightly moderately saline on the surface, and highly saline in sub-surface layers and substrata.

According to SRDI (2012) 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. Crop production in salt affected areas in the coastal regions differs considerably from non saline areas. Crops 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 particular time frame in a year when surface water is suitable for irrigation.
- To record present land use and crop response to soil salinity.
- To provide necessary data base for developing appropriate technology to deal with the changed situation.

Methodology

Field data is being collected from strategically representative sites of the coastal area. Soil samples at variable depths (0-10cm, 10-30cm 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) are collected twice in every month. Salinity of soils and water is determined by EC meter.

Findings

Khulna Division

25 soil salinity sites and 35 surface water salinity sites were selected in greater Khulna and Jashore district. In Khulna, monitoring sites are located in Batiaghata, Dumuria, Fultala, Koyra, Dakop of Khulna district, Mongla, Morelganj, Sharankhola of Bagerhat district and Shyamnagar of Satkhira district. In Jashore the monitoring sites are located in Jashore Sadar and Kesobpur of Jashore District and Kalia, Lohagara and Narail Sadar of Narail 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
13	Islampur	Bagali, Koyra	Barishal	MHL	F-TA	GTF
14	Kholisha	Kholisha, Dakop	Barishal	MHL	F-TA	GTF
15	Dhansagor	Dhansagor, Sharonkhola	Jhalokathi	MHL	F-TA	GTF
Jashore						
16	Narail Ferry ghat	Narail	Gopalpur	HL	RV-KV	GRF
17	Baraipara	Kalia, Narail	Gopalpur	MHL	RV-KV	GRF
18	Kalna ghat	Lohagara, Narail	Sara	HL	RC-F-TA	GRF
19	Sagardari	Kesabpur, Jahore	Amjhupi	MHL	B-F-TA	GRF
20	Noapar	Jashore Sadar, jashore	Gopalpur	HL	Banana Orchard	GRF

21	Tularampur	Narail Sadar, Narail	Sara	HL	Banana Orchard	GRF
22	Gobra Bazar	Narail Sadar, Narail	Gopalpur	MHL	RC-F-TA	GRF
23	Baradia	Kalia, Narail	Gopalpur	HL	RC-J-F	GRF
24	Sheikhati	Narail Sadar, Narail	Gopalpur	HL	RV-KV	GRF
Satkhira						
25	Shrifalkathi	Ishwaripur, Shyamnagar	Barishal	MHL	B-F-TA	GTF
26	Varashimla	Varashimla, kaligonj	Barisal	MHL	B-F-TA	GTF
27	Capra	Capra, Budhhata, Ashashuni.	Barisal	MHL	B-Fish	GTF
28	Shokhipur	Shokhipur, Debhata	Ishwardi	MHL	B-F-TA	GRF
29	Shreepatipur	Shreepatipur, Kolaroa.	Ishwardi	MHL	B-F-TA	GRF
30	Binerpota	Binerpota, Satkhira	Ishwardi	MHL	B-F-TA	GRF
31	kumira	kumira, Tala.	Ishwardi	MHL	B-F-TA	GRF

Table 7. Site specification of the water collection sites of Khulna Division

Sl. No	Name of river/HTW	Location
Khulna		
1	Madhumati	Mollahat, Bagerhat
2	Rupsa	Rupsa Ferryghat, Khulna.
3	Shailmari	Koiya Bazar, Batiaghata, Khulna.
4	Vadra	Khornia.Dumuria, Khulna
5	Kapotaksha	Patkelghata, Tala, Satkhira.
6	Betna	Benerpota, Satkhira sadar, Satkhira.
7	Kakshiali	Kaligonj HQ, Satkhira.
8	Morichap	Ashashuni, Satkhira.
9	Shibsha	Paikgacha HQ, Khulna.
10	Kazibachha	Batiaghata, Khulna
11	Pasur	Mongla port, Mongla, Bagerhat.
12	Daratana	Bagerhat ferryghat, Bagerhat.
13	Panguchi	Morelgonj HQ, Bagerhat.
14	Hand tube well	Koiya bazar, Batiaghata.
15	Hand tubewell	Phultala (South), Batiaghata.
16	Hand tubewell	Phultala (North), Batiaghata
17	Hand tubewell	Hogladanga, Batiaghata.
18	Chittra River	Narail Ferry ghat.Narail Sadar
19	Kapotaxma river	Sagardari, Kesabpur, Jessore.
20	Bhairab river	Noapara, Jessore.
21	Afra River	Tularampur, Narail Sadar
22	Chittra River	Gobra, Narail sadar, Narail (New site).
23	Naboganga	Baraypara, Kalia.
24	Modhumoti	Bardia, Lohagara.
25	Modhumoti	Kalna ghat, Lohagara
26	Afra	Shaikhati, Narail.
27	STW	Narail Ferry ghat, Narail Sadar.
28	STW	Sagardari, Kesabpur, Jessore.
29	STW	Noapara, Jessore
30	STW	Tularampur, Narail Sadar.

31	STW	Gobra, Narail sadar, Narail.(New site).
32	STW	Baraypara, Kalia.
33	STW	Bardia, Lohagara
34	STW	Kalna ghat, Lohagara
35	STW	Shaikhati, Narail

Graphical presentation of some selected soil monitoring site:

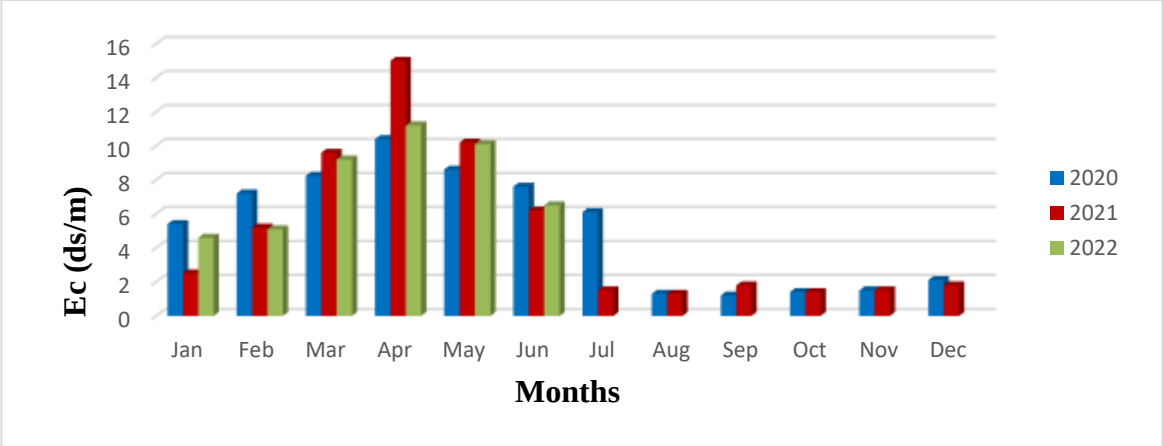


Fig. Salinity level of Soil series: Bajoa, MHL, Location: Krishnanagar, Batiaghata

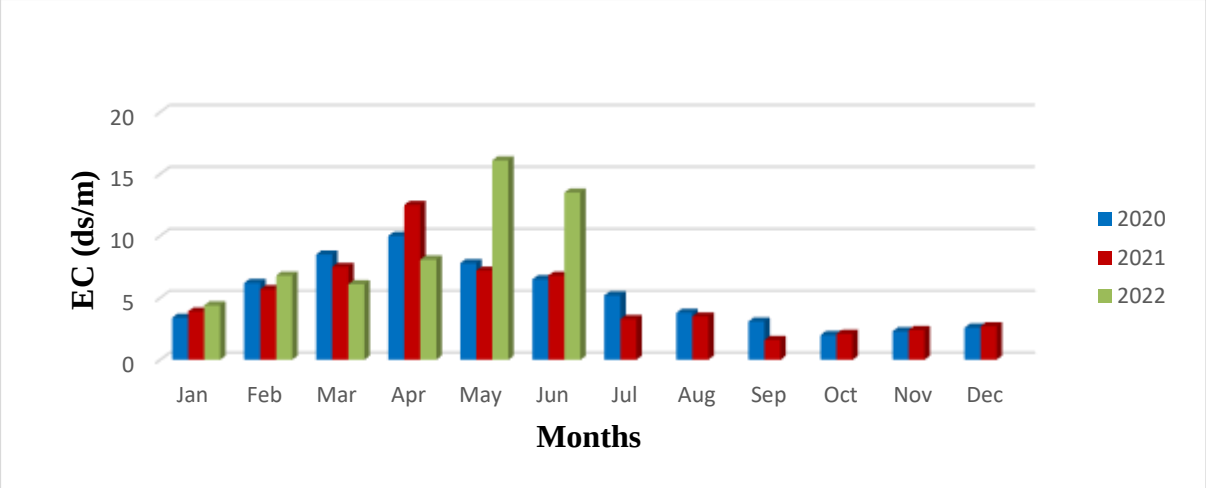


Fig. Salinity level Soil series: Barishal, MHL, Location: Shrifalkathi, Ishwaripur, Shyamnagar

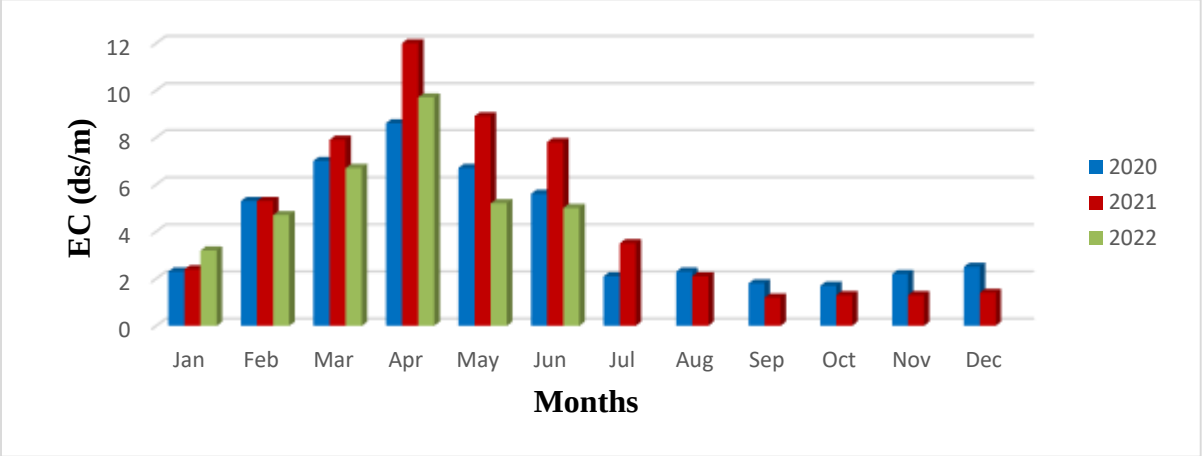


Fig. Salinity level Soil series: Jhalokathi, MHL, Location: Dhansagor, Sharonkhola

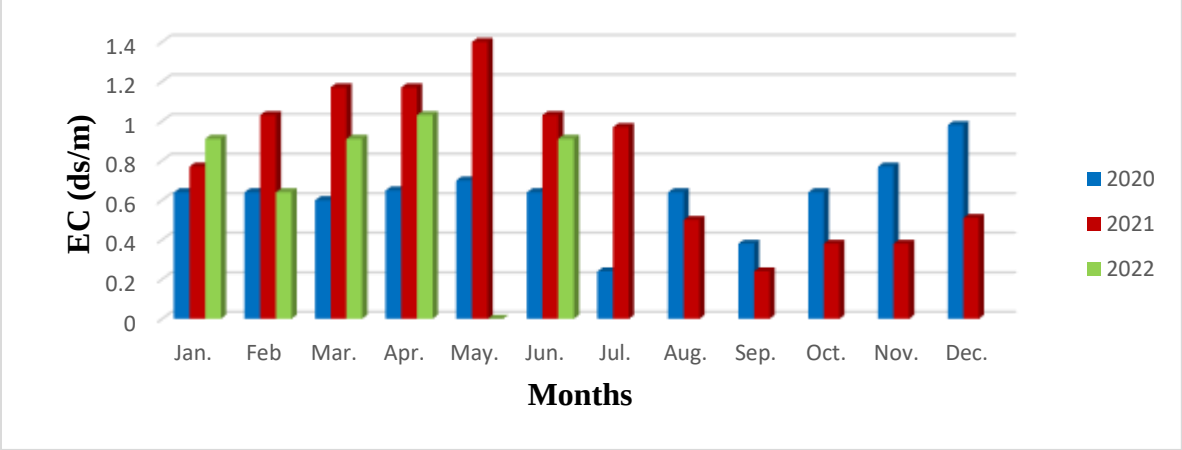


Fig. Salinity level Soil series: Gopalpur, HL, Narail Ferry ghat, Narail

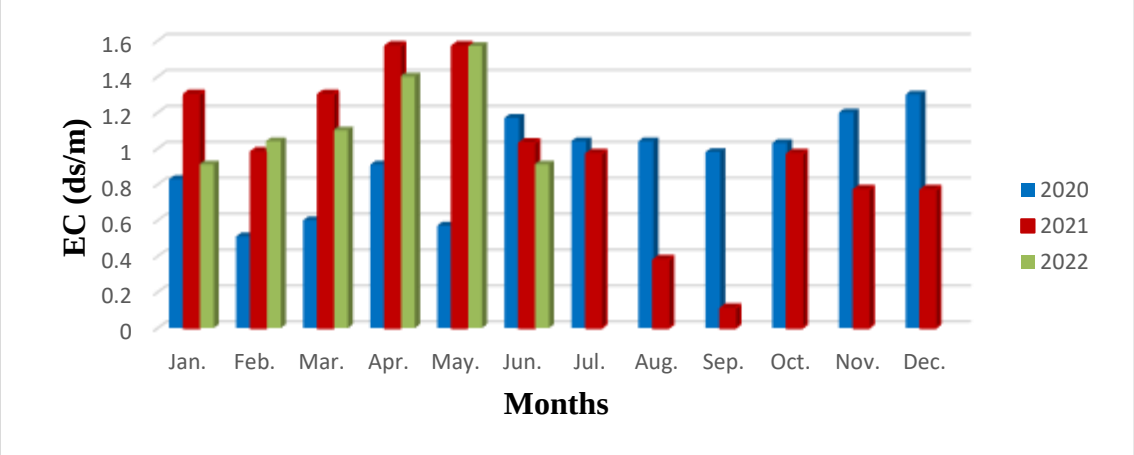


Fig. Salinity level Soil series: Gopalpur, HL, location: Noapara, Jashore

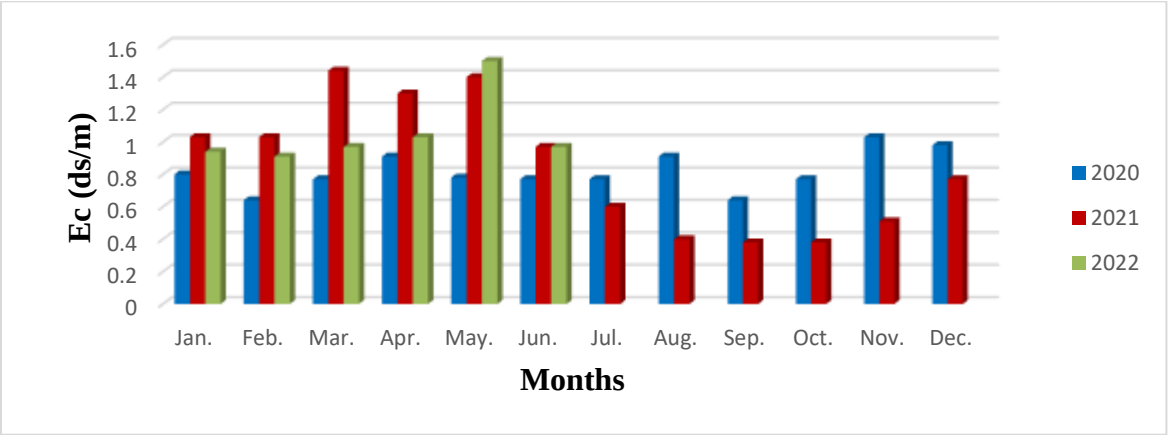


Fig. Salinity level Soil series: Gopalpur, HL Baradia, Kalia, Narail

Graphical presentation of some selected water monitoring site:

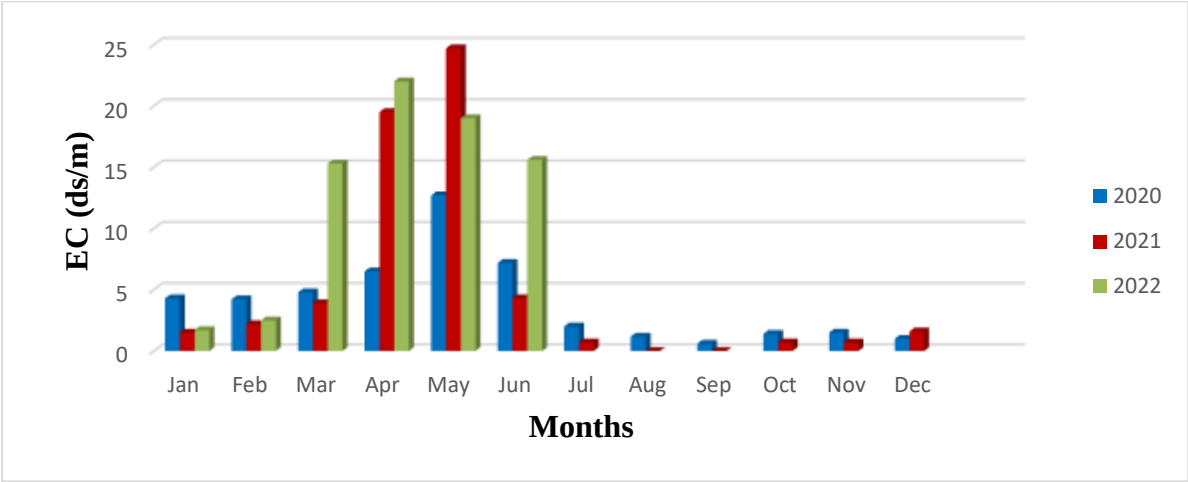


Fig. Salinity level of the Vadra river, Khornia, Dumuria, Khulna

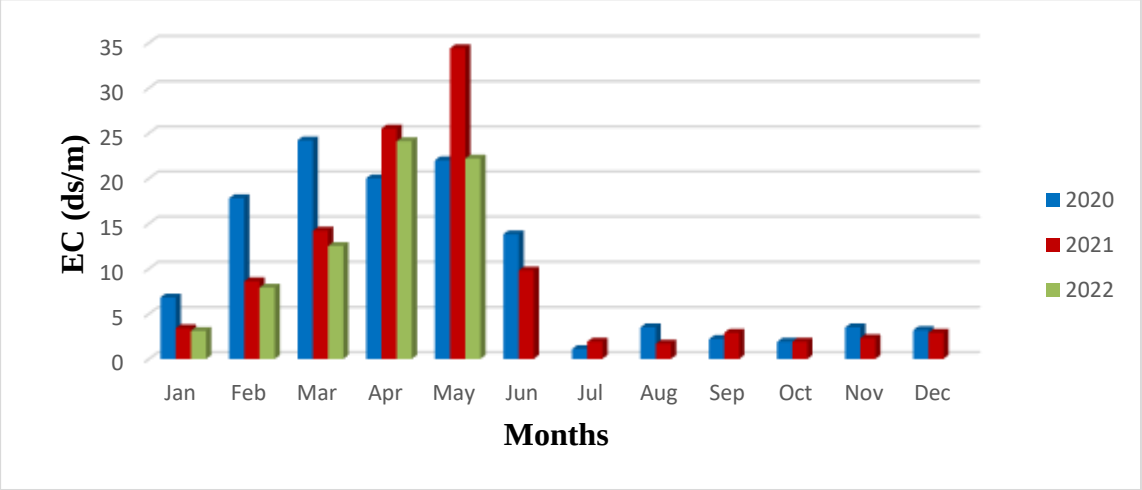


Fig. Salinity level of the Kakshiali river, Kaligonj HQ, Satkhira

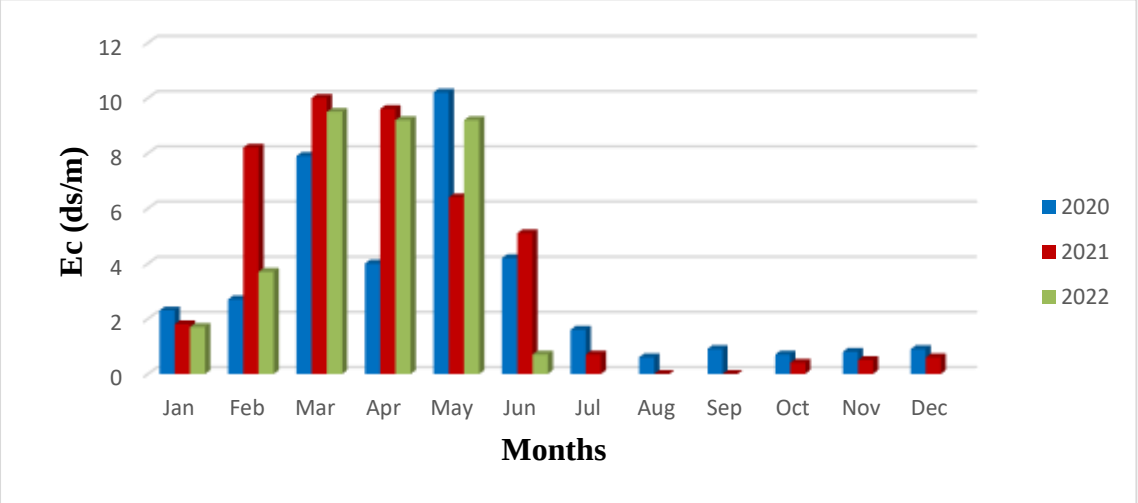


Fig. Salinity level of the Panguchi river, Morelgonj HQ, Bagerhat

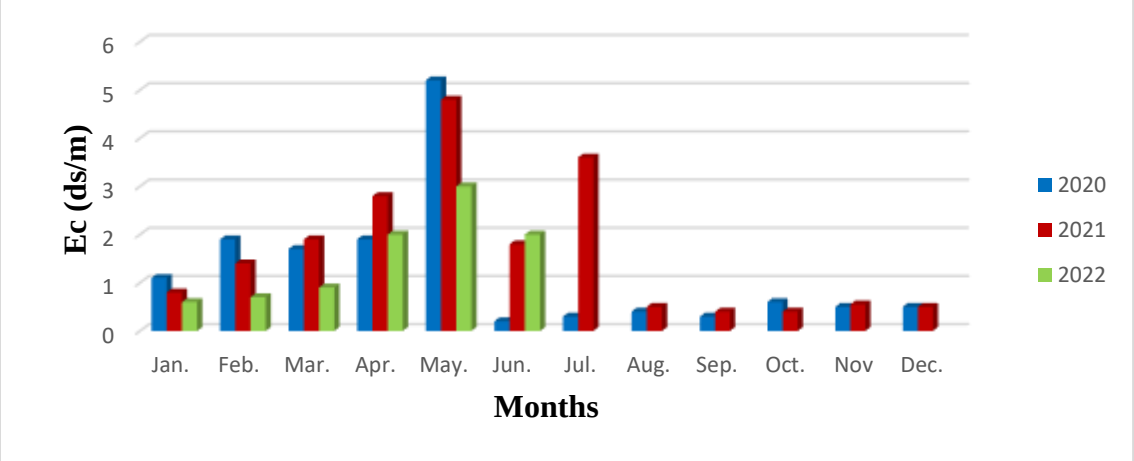


Fig. Salinity level of the Afra River, Tularampur, Narail Sadar

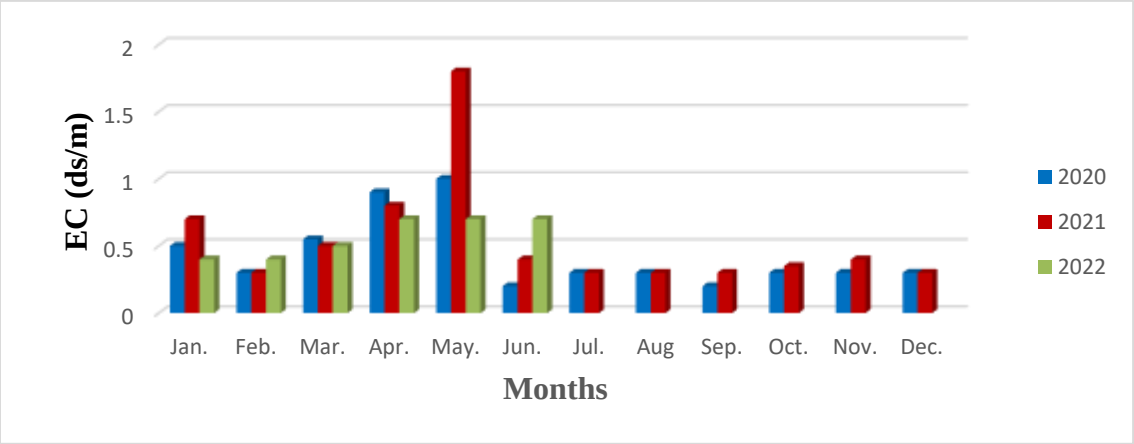


Fig. Salinity level of the Modhumoti River, Kalna ghat, Lohagara, Narail

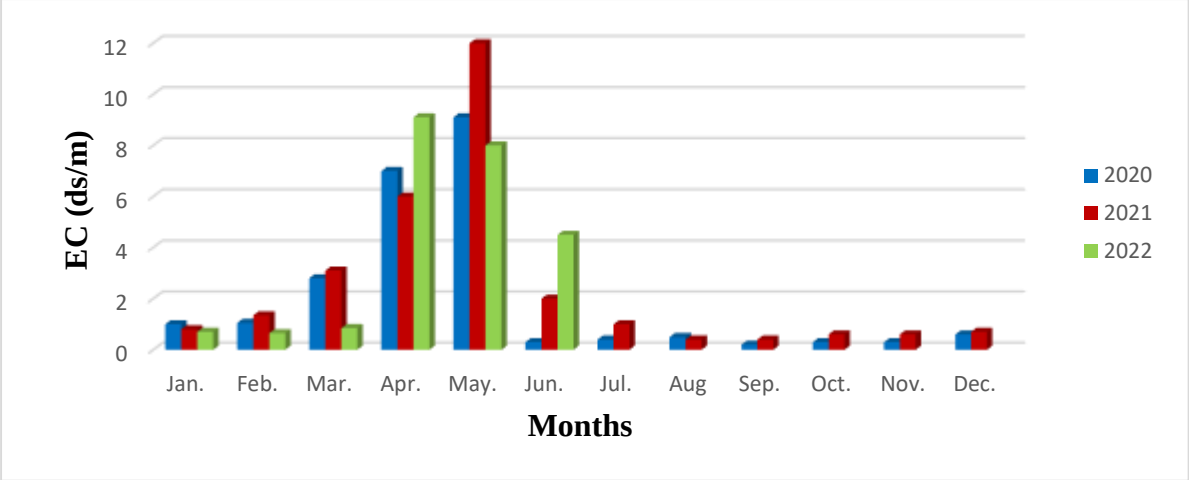


Fig. Salinity level of the Naboganga River, Baraypara, Kalia

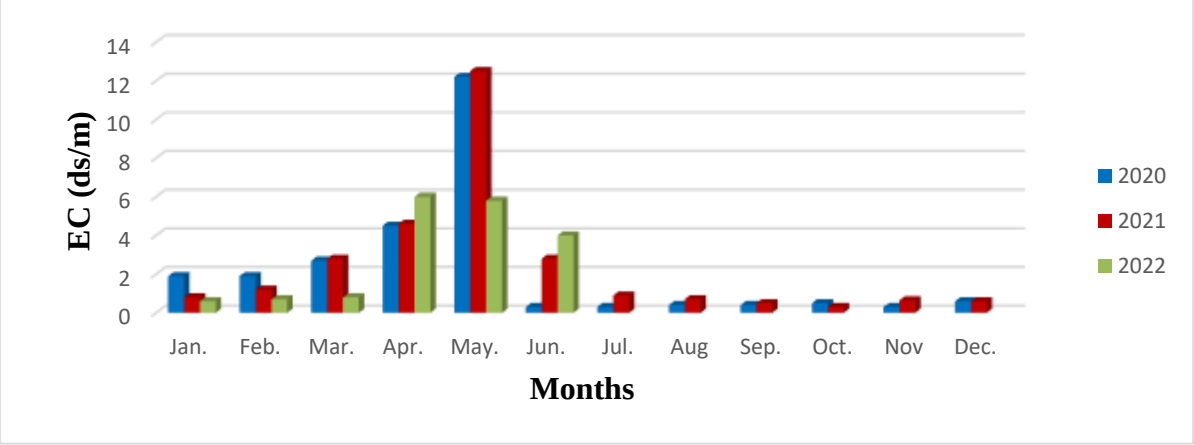


Fig. Salinity level of the Bhairab river, Noapara, Jashore

Barishal Division

23 surface water 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, 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 8. 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	Payra	Taltali
5	Payra	Amtali ferryghat
6	Payra	Payrakunja, Patuakhali Sadar
7	. Bishkhali	Patharghata Launchghat
8	Bishkhali	Baraitala ferryghat
9	Bishkhali	Bamna launchghat
10	Andharmanik	Kalapara
11	Baleshwar	Charduani, Pathargatha
12	Galachipa	Galachipa Ferryghat
13	Tentulia	Panpatti Launchghat
14	Baleshwar	Bara Machua Ferryghat
Bhola		
15	Meghna	Ilisha Launchghat.BholaSadar
16	Meghna	Doulatkhan Launchghat.Doulatkhan, Bhola
17	Meghna	Hakimuddin Launchghat.Borhanuddin, Bhola
18	Meghna	Tojumuddin Launchghat.Tojumuuddin, Bhola
19	Meghna	, Mongolsikder Launchghat.Lalmohon, Bhola
20	Meghna	Betua Launchghat.Charfassion, Bhola
21	Tetulia	Gongapur Launchghat.Borhanuddin, Bhola
22	Tetulia	BholaKheyaghat.BholaSadar
23	Tetulia	Veduria launchghat.BholaSadar

Graphical presentation of some selected water monitoring site:

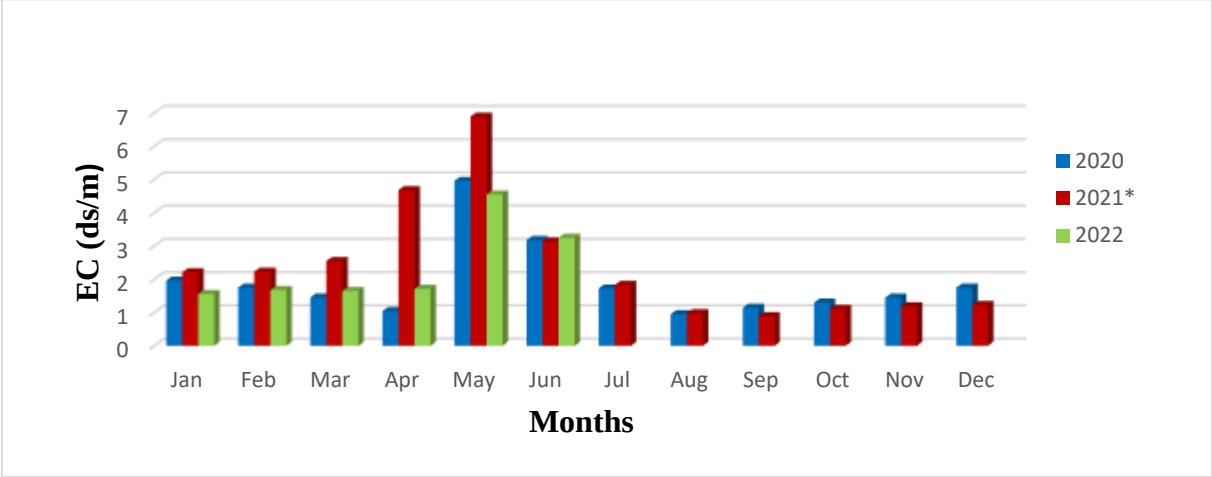


Fig. Salinity Level of the Baleshwar River at Nazirpur Upazila Sadar

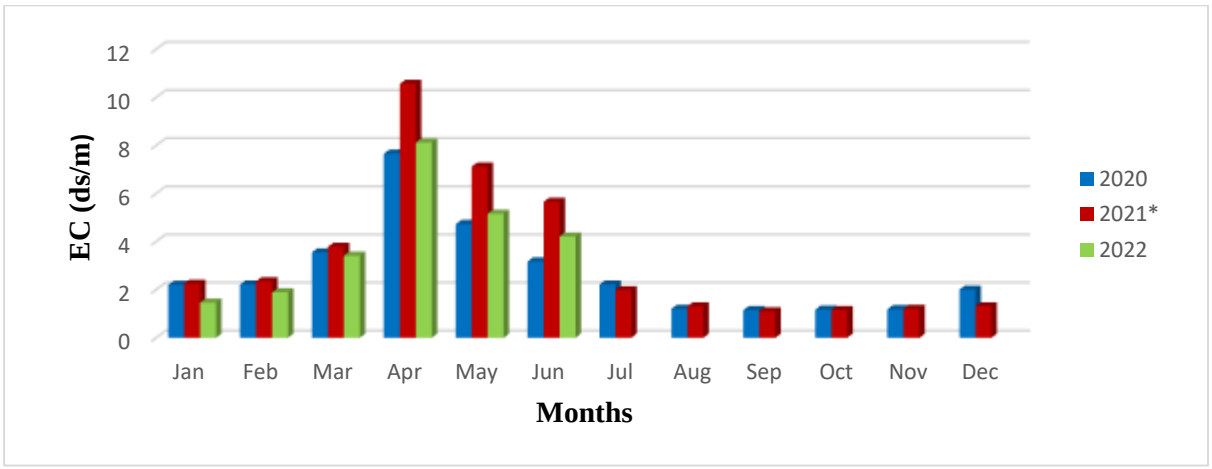


Fig. Salinity level of the Panguchi river at Indurkani Upazila Sadar

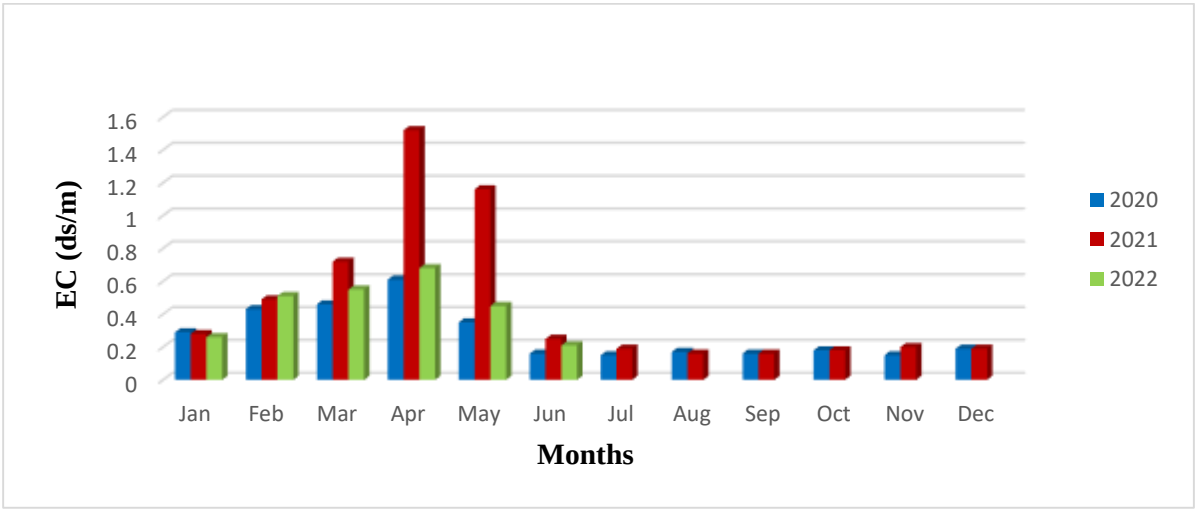


Fig. Salinity level of the Kacha river at Bekutia Ferry Ghat

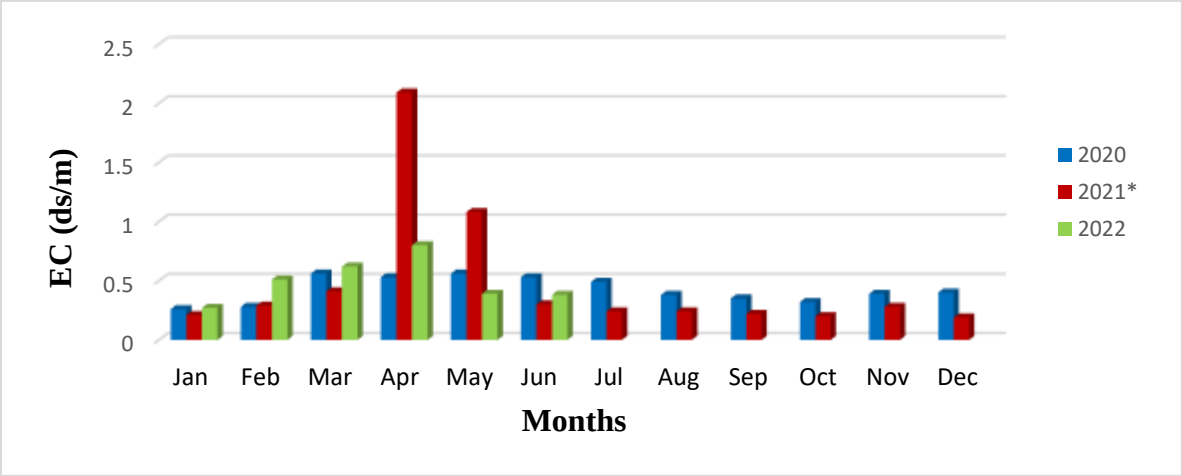


Fig. Salinity level of the Bishkhali River at Bamna launchghat

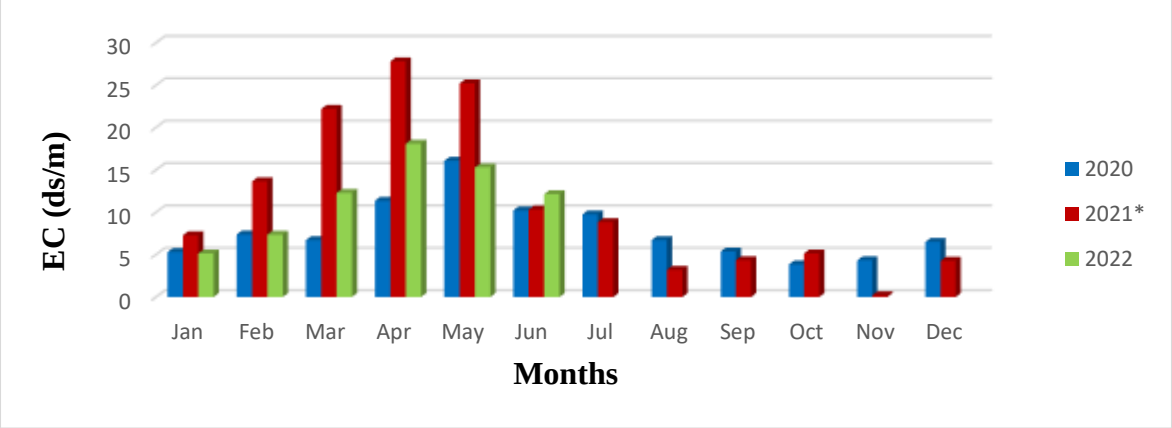


Fig. Salinity level of the Andharmanik River at Kalapara

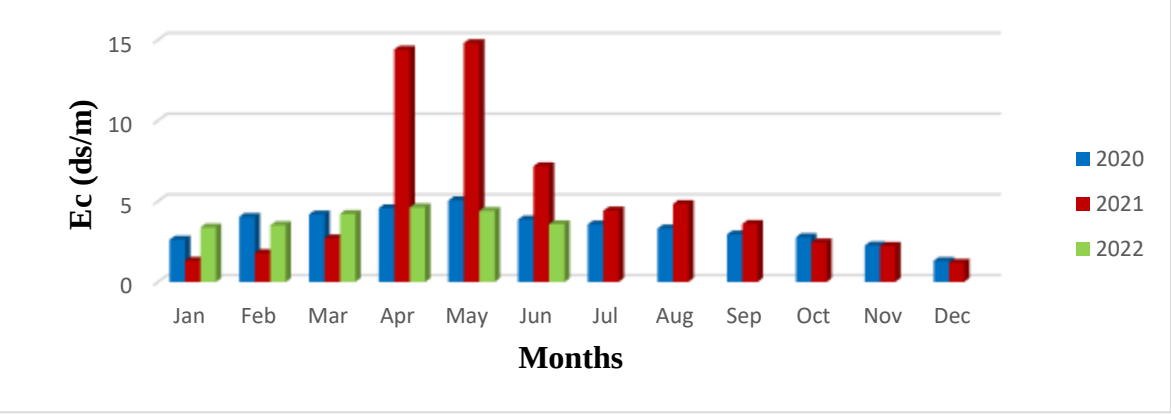


Fig. Salinity level of the Baleshwar River at Charduani, Pathargatha

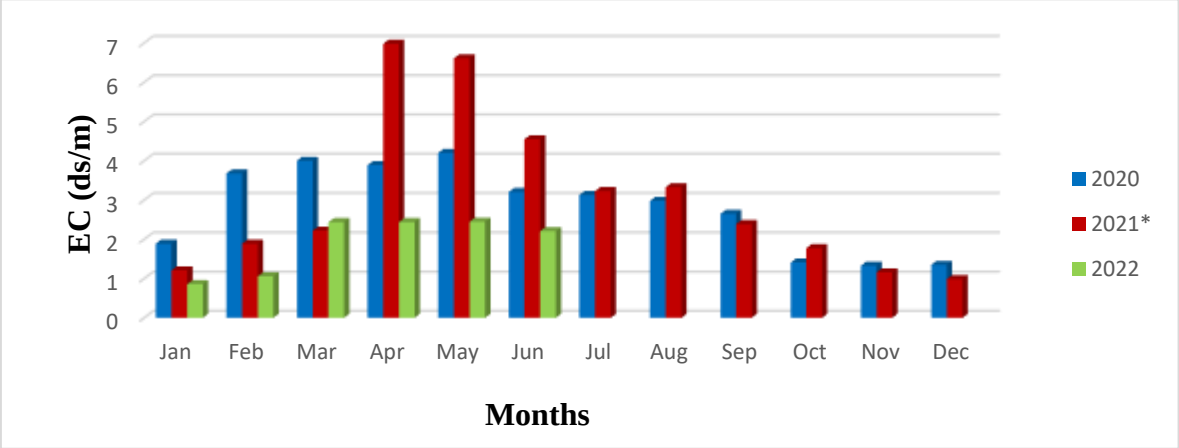


Fig. Salinity level of the Baleshwar River at Bara Machua Ferryghat

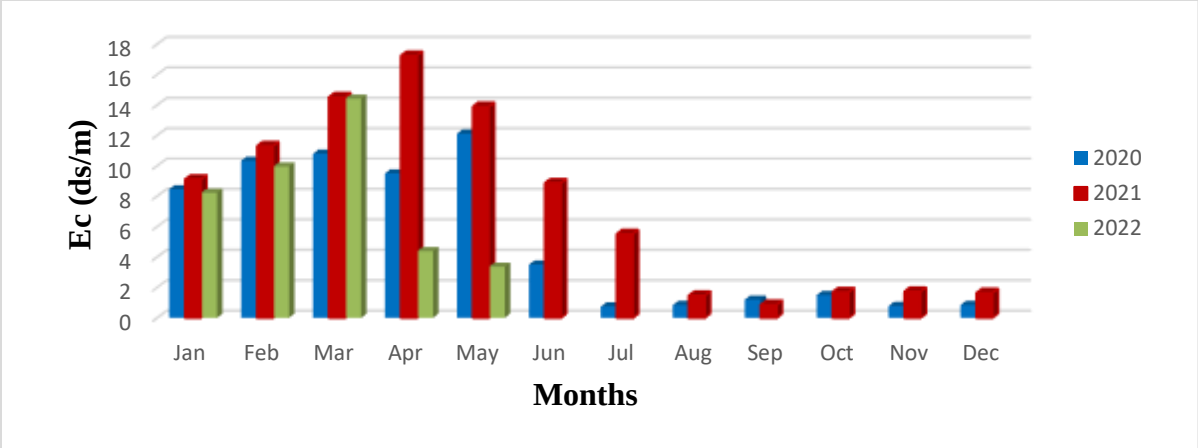


Fig. Salinity level of the Meghna River, Tojumuddin Launchghat.Tojumuuddin, Bhola

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 contributes ensuring 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 rationale use of chemical fertilizers.

Materials and Methods

Two different plots of farmer's are selected for setting up of 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 suggestion. 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 (Table 56). Farmer's knowledge gap, resource constraint and lack of communication with resource persons are responsible for the yield.

Table 9. Comparative crop yield between FRC based fertilizer and farmer's practice in (FY 2021-2022)

Sl. No.	Name of Upazila	District	Crop & Variety	Average yield (t/ha)		
				Farmer's field	Demonstration plot	Yield increase%
1	Saturia	Manikgonj	BRRI Dhan-89	7.5	9.7	30
2	Saturia	Manikgonj	BRRI Dhan-89	6.75	7.9	17
3	Faridpur Sadar	Faridpur	BARI Gom-25	5.1	6.0	18
4	Madhukhali	Faridpur	BARI Sharisha-15	1.75	2.2	25
5	Melandaha	Jamalpur	BRRI Dhan-84	4.31	5.93	38
6	Sherpur Sadar	Sherpur	BRRI Dhan-89	6.31	8.38	33
7	Trishal	Mymensingh	BRRI Dhan-29	6.88	8.92	30
8	Trishal	Mymensingh	BRRI Dhan-92	6.5	8.00	23
9	Tangail sadar	Tangail	BRRI Dhan 92	6.8	8.5	25
10	Tangail sadar	Tangail	BRRI Dhan 89	6.5	8.0	23
11	Lalmai	Cumilla	BRRI Dhan-89	6	7	17
12	Debidwar	Cumilla	BRRI Dhan-84	5.7	6.2	9
13	Rangamati sadar	Rangmati	BRRI Dhan-81	6.6	8.3	26
14	Naniarchar	Rangamati	BRRI Dhan-81	6.2	7.1	15
15	Fatikchari	Chattogram	BRRI Dhan-81	6.0	7.0	17
16	Hathazari	Chattogram	BRRI Dhan-28	5.5	6.0	9
17	Feni sadar	Feni	Bri Dhan-92	6.5	7.5	15
18	Daganbhuiyan	Feni	Bri Dhan-29	6.8	7.5	10

Sl. No.	Name of Upazila	District	Crop & Variety	Average yield (t/ha)		
				Farmer's field	Demonstration plot	Yield increase%
19	Rupsha	Khulna	Boro hybrid (Hira 19)	7.1	7.6	7
20	Fakirhat	Bagerhat	Boro hybrid (Chokka)	6.9	7.7	12
21	Jhikargacha	Jashore	BRRI Dhan-81	6.1	6.5	7
22	Sharsha	Jashore	BRRI Dhan-81	5.9	6.6	12
23	*Kumarkhali*	Kushtia	Bari Gom-33	*4.69*	5.31	13
24	Mirpur	Kushtia	Bari Gom-33	*4.94*	5.43	10
25	Godagari	Rajshahi	Potato-Asteric	38.73	39.91	3
26	Godagari	Rajshahi	BARI Gom 33	2.7	3.3	22
27	Bogura Sadar	Bogra	Potato-Red dalia	35.06	40.63	16
28	Kahalu	Bogra	BRRI Dhan-100	4.45	4.6	15
29	Pabna Sadar	Pabna	BARI Gom-30	3.0	3.53	18
30	Atgharia	Pabna	BARI Gom-30	3.3	4.30	30
31	RangpurSadar	Rangpur	Potato-Asterix	33.5	40	19
32	Kaunia	Rangpur	BRRI Dhan-58	6.07	8.1	33
33	Dinajpur Sadar	Dinajpur	BRRI Dhan 81	3.61	4.47	23
34	Birol	Dinajpur	BARI Gom-33	3.9	4.7	20
35	Barishal Sadar	Barishal	Boro (Hybrid)	5.5	6.7	22
36	Babuganj	Barishal	BRRI Dhan-74)	5.0	5.8	16
37	Patuakhali Sadar	Patuakhali	BRRI Dhan 74	6.05	6.98	15
38	Amtali	Barguna	BRRI Dhan 67	6.59	7.72	17
39	Osmaninagar	Sylhet	BRRI Dhan-100 (BangabandhuDhan)	7.38	8.75	19
40	Dakshin Surma	Sylhet	BRRI Dhan-89	6.46	7.5	16.12%
41	Moulvibazar Sadar	Moulvibazar	BRRI Dhan-29	6.28	7.19	14.49
42	Srimangal	Mouvibazar	BRRI Dhan-89	7.2	8.01	11.25

Conclusion

Farmers obtained higher yield by using balanced dose 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 3%-37% higher yield in different crops and varieties in comparison to farmers' practices in different locations.

3.6 Distribution of Fertilizer Recommendation Card

Intoduction

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 programmeme in order to popularize and

disseminate practice of balanced fertilizer use among farmers throughout the country. In 2021-2022, total number of fertilizer recommendation cards distributed was 26088, of which 10615 numbers were on the basis of Upazila Nirdeshika, 15449 on the basis of OFRS and rest 24 were soil test basis.

Table 10. Fertilizer Recommendation Cards Distribution:

Name of Office	District	Upazila	Type of service			Total
			Nirdeshika based	Online based	Soil test based	
Regional Office, Gopalganj	Gopalganj	Sadar Kashiani Muksudpur	600	-	-	600
Regional Office, Jamalpur	Jamalpur	Jamalpur Sadar Islampur Melandh Dewangonj Mathergonj Bokshigonj Sorishabari	540	283	-	1347
	Sherpur	Sherpur Sadar Nokla Sreebordi Nalitabari Jhinaigati	421	103	-	
Regional Office, Tangail	Tangail	Tangail sadar Basail, Mirzapur Kalihati Dhanbari	700	300	-	1000
Regional Office, Madaripur	Shariatpur	Zajira	50	150	-	200
	Madaripur	Madaripur Sadar				
Regional Office, Munshiganj	Munshiganj	Sadar Tongibari Sirajdikhan	-	250	-	250
Regional Office, Mymensingh	Mymensingh	Mymensingh Sadar Trishal, Tarakanda	550	450	-	1,000
Regional Office, kishoreganj	kishoreganj	karimganj	200	400	-	600
	kishoreganj	Hossenpur			-	
Regional Office, Narsingdi	Narsingdi	monohordi shibpur sadar raipura bellabo	100	315	-	415
Regional Office, Netrokona	Netrokona	Atpara Netrokona Sadar Barhatta Kendua Durgapur Purbadhala	109	443	24	576
	Faridpur	Faridpur Sadar	200	350	-	550
		Madhukhali				

Name of Office	District	Upazila	Type of service			Total
			Nirdeshika based	Online based	Soil test based	
Regional Office, Faridpur		Boalmari				
	Rajbari	Kalukhali				
Regional Office, Rangamati	Rangamati	Sadar	389	50	-	439
		Naniarchar				
		Laksmichari				
		Khagrachhari sadar				
		Matiranga				
		Baghaichari				
		Kaukhali				
		Rajasthali				
		Langudu				
		Jurachhari				
		Kaptai				
Divisional Office, Barishal	Barishal	Wazirpur	1000	-	-	1000
	Jhalakati	JhlakatiSadar				
	Pirojpur	Mathbaria				
Regional Office, Potuakhali	Patuakhali	Bauphal	1315	-	-	1315
	Patuakhali	Patuakhali Sadar				
	Barguna	Barguna Sadar				
Regional Office, Bhola	Bhola	BholaSadar	505	-	-	505
		Doulatkhan				
		Borhanuddin				
		Monpura				
Divisional Office, Khulna	Khulna	Dumuria	120	840	-	1060
	Bagerhat					
	Satkhira					
Regional Office Kushtia	Meherpur	Gangni	200	500	-	700
	Kushtia	Mirpur				
	Kushtia	Kumarkhali				
	Kushtia	Kushtia sadar				
	Kushtia	Khoksha				
	Chuadanga	Alamdanga				
	Chuadanga	Damurhuda				
	Meherpur	Meherpur sadar				
	Chuadanga	Jibonnagar				
	Kushtia	Bheramara				
Regional Office, Jhenaidah	Jhenaidah	Jhenaidah Sadar	334	250	-	584
Regional Office, Satkira	Satkhira	Satkhira sadar	110	500	-	610
Divisional Office, Rajshahi	Rajshahi	-	-	-	-	700
Regional Office, Chapainawabganj	Chapainawab-ganj	-	51	649	-	700
Regional Office,	Bogura	Bogura	100	600	-	700

Name of Office	District	Upazila	Type of service			Total
			Nirdeshika based	Online based	Soil test based	
Bogura						
Regional Office, Sirajganj	Sirajganj	Sirajganj	100	600	-	700
Regional Office, Pabna	Pabna	Pabna	40	400	-	440
Divisional Office, Rangpur	Rangpur	Mithapukur	765	260	-	1025
	Rangpur	Rangpur Sadar				
	Rangpur	Badarganj				
	Rangpur	Pirganj				
Regional Office, Gaibandha	Gaibandha	Sadar	500	1200	-	1700
		Saghata				
		sadullapur				
		Palashbari				
Regional Office, Lalmonirhat	Lalmonirhat	Sadar	540	-		540
	Kurigram	Sadar				
Regional Office, Dinajpur	Dinajpur	Fajilpur	500	-	-	500
Regional office, Thakurgaon	Thakurgaon Panchagarh	Thakurgaon Sadar	206	700	-	906
	Thakurgaon	Baliadangi				
	Thakurgaon	Ranishangkail				
	Thakurgaon	Pirganj				
	Thakurgaon	Haripur				
Divisional Office, Sylhet	Sylhet	Jaintapur	-	1064	-	1064
		Kanaighat				
		Biswanath				
		Fenchuganj				
		Golapganj				
		Goainghat				
		Zakiganj				
Regional Office, Moulvibazar	Moulvibazar	Moulvibazar Sadar	185	866	-	1051
		Srimangal				
	Habiganj	Habiganj Sadar				
		Bahubal				
		Madhabpur				
		Nabiganj				
Regional Office, Sunamganj	Sunamganj	Bishwambarpur	185	3926	-	4111
		Dirai				
		Dharmapasha				
		Chatok				
		Jamalganj				
		Tahirpur				
		Shulla				
		Total	**10615**	**15449**	**24**	**26088**

3.7 Other Activities

Table 11. Training Imparted:

Name of Office	Title of the programmeme	Duration	Host organization	Participant	
				Type	Number
Dhaka Division	Method of soil sample collection and use of balance fertilizer	1day	SRDI	Farmer	1800
	Use of Upazila Nirdeshika	5 day	SRDI, HQ	SAAO	250
	Collection of crop signature data using survey 123 apps	1 days	SRDI, Gopalganj	SAAO	30
	Method of soil sample collection & Identification of adulterated fertilizer	1 day	SRDI, Jamalpur, SRSRF Project.	farmers	270
	Use of Upazila Nirdeshika	5 day	SRDI, Jamalpur.	SAAO	50
	In House Training	01 day	SRDI	Officers and Staffs	30
	Soil sample collection methodology and Identification of adulterated fertilizer for MSTL Jamuna	2 days (Rabi season)	SRDI, Munshiganj	Farmers	100
Chattogram Division	Method of soil sample collection, use of balanced fertilizer and identification of adulterated fertilizer	01	SRSRF Project	Farmers and Fertilizer dealer	180
	Method of soil sample collection, use of balanced fertilizer	01	Revenue Budget	Farmers	990
	Use of Upzila Nirdeshika	05	SRSRF Project	SAAO	150
	Collection of crop signature data using survey 123 apps	01	SRDI, Chattogram	SAAO	30
	Utilization of Upzila Nirdeshika	05	SRSRF Project	SAAO	50
Barishal Division	Method of soil sample collection & identification of adulterated fertilizers	1 Day	SRDI, Barishal DO, Financed by SRSRF Project	Fertilizer dealer, entrepreneur & farmer	90
	Method of soil sample collection, identification of adulterated fertilizers, use of balanced fertilizer & salinity management	1 Day	SRDI, Barishal DO, Financed by GKBSP Project	Farmer	120
	Method of soil sample collection & use of balanced fertilizer	1 Day	SRDI, Barishal DO, Revenue funded	Farmer	600
	Use of Upazila Nirdeshika	5 Days	SRDI, Barishal	SAAO	100
	Collection of crop signature data using survey 123 apps	1 Day	SRDI, Barishal	SAAO	90

Khulna Division	Method of soil sample collection, identification of adulterated fertilizers, use of balanced fertilizer & salinity management	1 day	SRDI, Khulna	Farmer	1890
	Use of Upazila Nirdeshika	5 days	SRDI, Khulna	SAAO	150
	Collection of crop signature data using survey 123 apps	day	SRDI, Khulna	SAAO	
Rajshahi division	Method of soil sample collection & use of balanced fertilizer	01	SRDI, Rajshahi	Farmers	750
	Use of Upazilla Nirdeshika	05	SRDI, Rajshahi	SAAO	100
	Method of soil sample collection & identification of adulterated fertilizers	01	SRDI, Bogura	Farmer, entrepreneurs	145
	Collection of crop signature data using survey 123 apps	01	SRDI, Bogura	SAAO	90
	Acid Soil Management and Sustainable crop production	03	SRDI, Chapai	SAAO	30
Rangpur Division	Method of soil sample collection & identification of adulterated fertilizers	01day	SRSRF PROJECT, SRDI	Farmers, SAAO & Fertilizer dealer	90
	Collection of crop signature data using survey 123 apps	01day	SRDI, Rangpur	SAAO	150
	Method of soil sample collection & use of balanced fertilizer	01day	SRDI, Rangpur	Farmers	780
	Use of upazila Nirdeshika	05day	SRSRF PROJECT, SRDI	SAAO	100
	Data Entry for Crop signature collection	01day	SRDI, Gaibandha	SAAO	30
Sylhet Division	Method of soil sample collection & use of balanced fertilizer	1 day	SRDI	Farmers	300
	Method of soil sample collection & identification of adulterated fertilizers	1 day	SRDI	Farmers, UDC Entrepreneurs And Other Beneficiaries	180
	Use of Upazila Nirdeshika	5 day	SRDI	SAAO	100
	Collection of crop signature data using survey 123 apps	1 day	SRDI	SAAO	60

Pictorial View of some SRDI's Activities

Honourable Agriculture Minister on the eve of foundation stone ceremony of MRITTIKA BHABAN

Handing over SRDI's newly published book to honourable secretary MoA at his office

Plantationof tree sapling by Director General, Director, Field Services Wing & PD, SRSRF Project, SRDI at SRDI Lalmonirhat premises

Inaugural speech by Director General, SRDI in a farmer's training programme

Monitoring laboratory activities by Director, Analytical Services Wing, SRDI

Fig. Supervising under construction work of MRITTIKA BHABAN by PD, CCBS Project

	
Supervising field survey activities by monitoring team of MoA	Pursuing field survey activities by SRDI field survey team
	
Adaptive trial Plot of Potato	Organizing field day of adaptive trial

	
Research Plot visited by Additional secretary, MoA	Visitors infront of SRDI's stall at Information fair
	
Mobile Soil Testing Laboratory (MSTL)	Fertilizer recommendation card distribution through MSTL programme

Chapter-4 Analytical Services Wing

4.1 Achievement of Analytical Services Wing (2021-2022)

Soil testing, plant analysis and quality determination of fertilizer are useful tools for constructing recommendations of quality fertilizers to crops. Therefore 24 static laboratories and 10 mobile soil testing laboratories (MSTLs) 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 by plant. The sources of soil, plant and water samples were mainly farmers, Upazila land and soil resource utilization guide update programme of SRDI, NARS institutes, universities, and different government organizations (GOs) and non-government organizations (NGOs). In case of fertilizer the sources of samples were mainly port, department of agricultural extension (DAE) and different GOs and NGOs. Besides to analysis soil, plant, water and fertilizer samples laboratories under ASW performing training on soil sample collection and adulterate fertilizers identification at field level.

Main activities of the laboratories under ASW

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

To prepare the achievement of the ASW, needed information has collected from all the laboratories under ASW. The activities of central laboratory under ASW are little bit different than other static laboratories. As per newly approved organogram of SRDI, central laboratory is designated to conduct research work and quality control programme as well as analytical works according to the permission of higher authority. So, the activities of central laboratory are discussed separately.

All static laboratories conduct physical, chemical and physic-chemical analyses of soil and fertilizers samples. Static laboratories under ASW also conduct chemical analysis of water and plant samples. The received soil, plant, water, fertilizers and fertilizer related materials 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 card were also prepared following Fertilizer Recommendation Guide-2018. Advisory services were provided through face-to-face discussion and over telephone.

Analysis of soil, plant and water sample

A total number 25435 soil samples with 2,13,047 ingredients (Moisture, Texture, pH, EC, OC, N, P, S, K, Ca, Mg, B, Zn, Fe, Cu, Mn, Cd, Cr, Pb and Ni), 309 plant samples with 1,352 ingredients (P, S, K, Ca, Mg, B, Zn, Fe, Cu, Mn, Cd, Cr, Pb and Ni) and 522 water samples with 2,167 ingredients (pH, EC, S, Na, K, Ca, Mg and B,)were analyzed (Table 1).

Table 1. Analytical work (soil, plant and water samples)

Nature of sample	Sources of sample	No. of sample	No. of ingredient
Soil	Farmers	11,561	79,407
	SRDI programme	9,058	100,625
	NARS institute	272	2,126
	University (Student)	1,622	6,612
	GOs	2,383	16,848
	NGOs/private	38	2,787
	Quality control	501	4,642
	Total	**25,435**	**2,13,047**
Plant	University	261	1,117
	NARS institute	48	235
	Total	**309**	**1,352**
Water	University	424	1,302
	NARS institute	81	257
	DAE	12	57
	Private	5	29
	Total	**522**	**2,167**
Grand total		**26,266**	**2,16,566**

Among the analyzed soil samples 45.45, 35.61, 1.07, 6.38, 9.37, 0.15 and 1.97% were received from farmer, SRDI programme (Upazila land and soil resource utilization guide i.e., Upazila Nirdeshika), NARS institute, University (Student), GOs, NGOs/private and quality control programme, respectively (Figure 1). The farmer's response was mentionable because the highest number of samples was supplied by them. Though the number is very negligible comparable to farm family of Bangladesh.

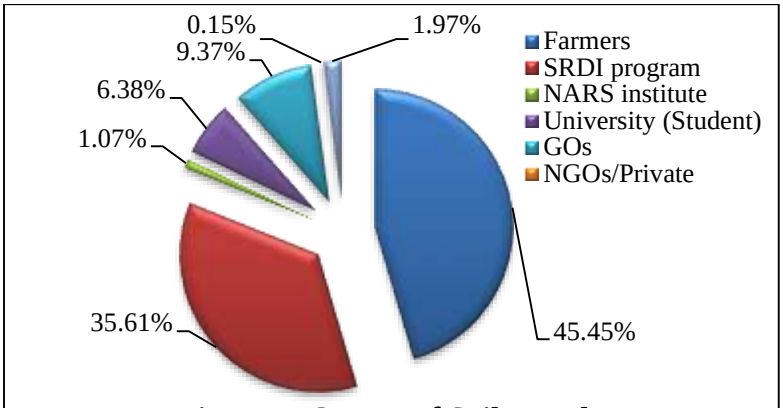


Figure 1: Source of Soil samples

The number of analyzed water and plant samples were 522 and 309 with the ingredient number 2,167 and 1352, respectively. Among the 309 plant samples, 84.87% samples were received from University (Student) and 15.53% samples were received from NARS institute. Besides, University (Student), NARS institute, DAE and private sector provided 81.23, 15.52, 2.30 and 0.96% water samples, respectively.

Fertilizer Recommendation Card, Training and Revenue earning

Static laboratories under ASW had prepared 19,005 soil test-based fertilizer recommendation cards and distributed among the respective farmers to ensure optimum yield with minimum input maintaining soil health and environment. Promoting Soil test based balanced quality fertilizer application training on soil sample collection, importance of soil test-based fertilizer application and physical techniques for adulterated fertilizers identification to 2,510 farmers, SAAO and public representative. Officers and stuff number 105 received training to skilled up and gather current knowledge on Laboratory management, Use of Upazila Nirdeshika, Soil Health Management, Modern Farm Mechanization, Commercial Farm Mechanization, Modern Office Management, Good Governance, Seed technology, Food security and safety, Service Digitalization on my gov platform-A2i, Advanced ICT, Eco-friendly Plant Protection and Scientific Report Writing. Revenue Tk. 51,13,159.00 was earned from soil, plant, water and fertilizer analysis following the charge fixed up by the ministry (Table 2).

Table 2. Provided other services (fertilizer recommendation card and training) and revenue earning.

Item	Beneficiary	Quantity
Preparation & distribution of fertilizer recommendation card	Farmers	19,005
Training performed	Farmers, SAAO and public representative	2,510
Training received	Officers and stuffs	105
Revenue earning (Tk.)	Soil, plant, water and fertilizer analysis	51,13,159.00

Analysis of fertilizer and fertilizer related materials

Laboratories under ASW standardized 4635 fertilizer samples and 19 fertilizer related materials during 2021-2022 fiscal year. Among the total analyzed fertilizer 3,193 (68.61%) samples were standard and 1,461 (31.39%) samples were sub-standard (Table 3).

Table 3. Analyzed fertilizer and fertilizer related materials

Name of fertilizers	Amount		
	Total	Standard	Sub-standard
Urea {(CO(NH2)}	136	129	7
Ammonium sulphate $(NH4)_2 SO_4$	23	21	2
Triple super phosphate (TSP)	305	278	27
Monoammonium phosphate (MAP)	19	12	7
Diammonium phosphate (DAP)	384	324	60
Muriate of Potash (MOP)	273	256	17

Name of fertilizers	Amount		
	Total	**Standard**	**Sub-standard**
Potasium sulphate (K_2SO_4)	89	86	3
Gypsum (CaSO4. $2H_2O$)	313	251	62
Magnesium sulphate ($MgSO_4$. H_2O)	702	696	6
Zinc sulphate monohydrate ($ZnSO_4.H_2O$)	845	54	791
Zinc sulphate heptahydrate ($ZnSO_4.7H_2O$)	284	171	113
Chelated zinc	193	150	43
Boric acid	324	190	134
Solubor boron	451	362	89
Fertibor	90	83	7
Organic fertilizer	140	87	53
NPKS mixed fertilizer	64	34	30
Lime (Dolomite)	19	9	10
Grand Total:	**4,654**	**3,193**	**1,461**

The sources of samples were: DAE (Registration), DAE (Upazila Agricultural officer), port, and private sector. The highest amount (75.82%), the second highest amount (11.99%) and 9.64 and 2.55% were received from was received from Upazila agricultural officer, port, DAE for registration and private sector, respectively (Figure 2).

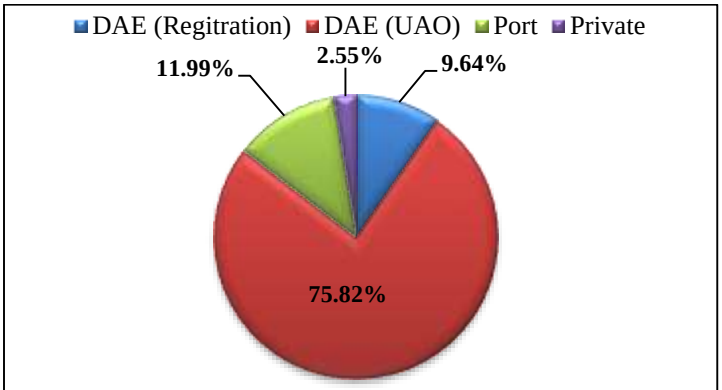


Figure 2: Source of fertilizer & fertilizer relatd materials

The order of the standard fertilizers according to the source was port > DAE for registration > private sector > Upazila agricultural officer (Figure 2). That means quality of fertilizer is deteriorated at the field level.

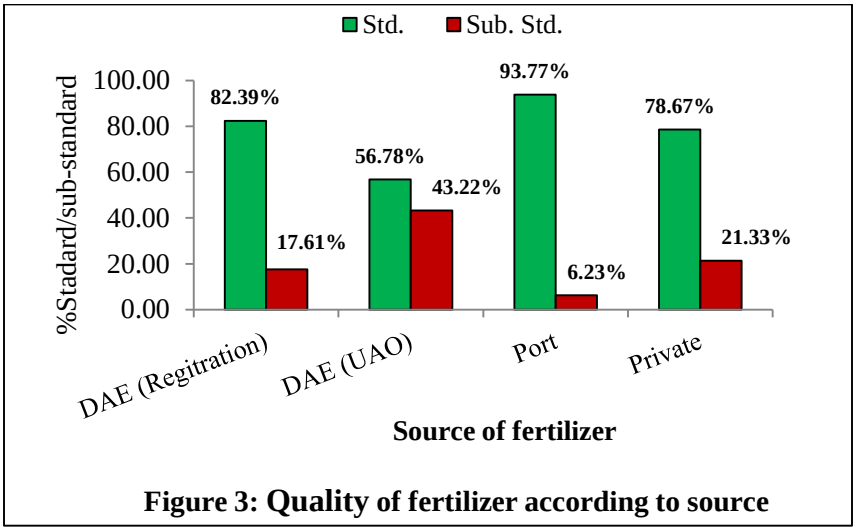


Figure 3: Quality of fertilizer according to source

Figure 4 showed that macronutrient fertilizers like urea, ammonium sulfate, triple super phosphate, muriate of potash, magnesium sulphate and ammonium sulfate fertilizers were more or less 90.00 - 100.00% standard as per government specification.

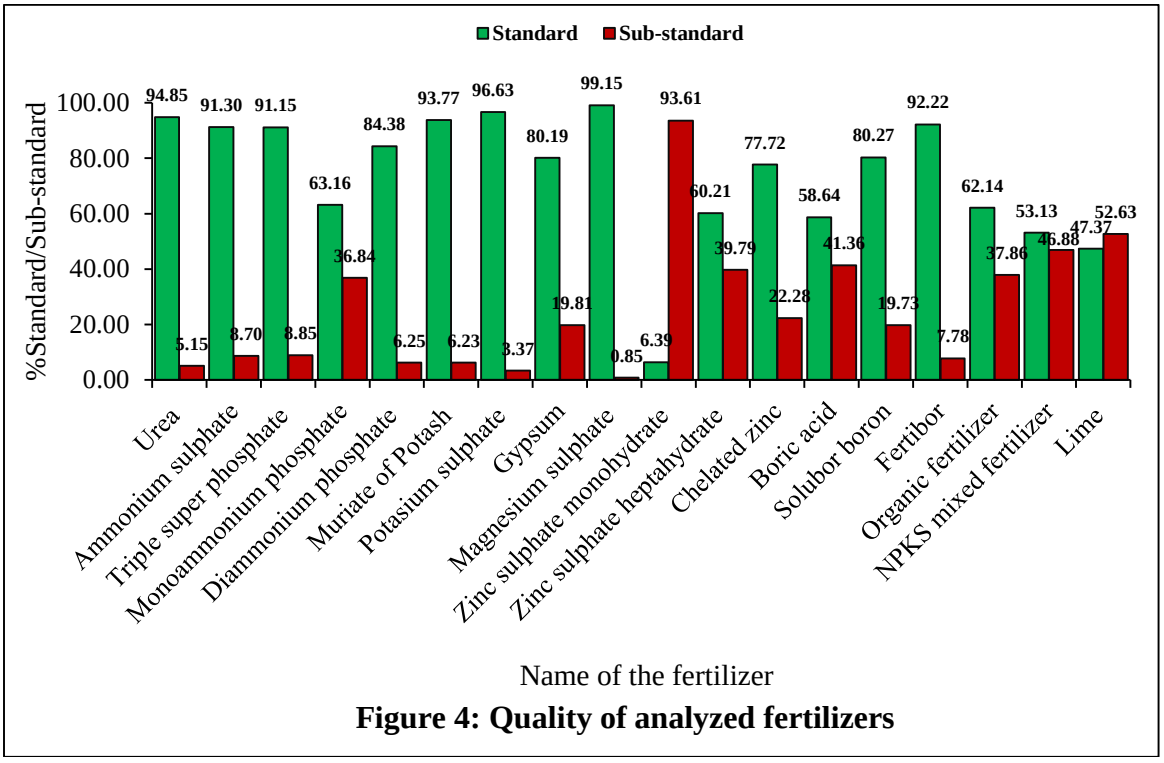


Figure 4: Quality of analyzed fertilizers

Other macronutrient fertilizers like DAP and Gypsum were 84.34% and 80.19% standard, respectively. In case of micronutrient, 93.61% zinc sulfate monohydrate, 39.79% zinc sulfate heptahydrate and 22.28% chelated zinc were sub-standard. Boron fertilizer i.e. fertibor was more (92.22%) standard than solubor boron (80.27%) and boric acid (41.36%). The purity percentage of organic fertilizer and lime was 62.14% and 47.37% respectively. Here, the adulteration was observed not only in nutrient content but also by toxic level of heavy metals like cadmium (Cd), lead (Pb), Nickel (Ni) and Chromium (Cr).

Service through Mobile Soil Testing Laboratory (MSTL)

Ten MSTLs namely Jamuna, Madhumoti, Brahmaputra, Tista, Karatoa, Rupsa, Karnaphuli, Titash, Shurma and Kirtonkhola tested 4,573 soil samples of 112 upazilas (Table 4). The tested soil samples were collected from farmer's field of different upazilas through Department of Agricultural Extension (DAE). Then prepared fertilizer recommendation cards (FRC) based on soil test value following FRG-2018 according to crops and cropping pattern were distributed to respective farmers. The analytical results of soil samples were as follows.

Table 4. Analyzed soil samples by MSTLs

MSTL	Working area		Upazila	Sample
	Division	District		
Jamuna	Dhaka	Dhaka, Tangail, Mymensingh, Netrokona, Kishoreganj	16	401
Brahmaputra	Dhaka	Jamalpur, Sherpur	8	204
Madhumoti	Dhaka	Faridpur, Gopalgonj,Rajbari, Shariatpur, Madaripur	8	400
Tista	Rajshahi	Rajshahi, Chapainababganj, Naogaon, Sirajganj, Pabna, Natore	12	623
Karatoa	Rajshahi	Bogura,Dinajpur, Thakurgaon,	12	604
	Rangpur	Lalmonirhat, Nilphamari, Gaibandha, Panchagor, Rangpur, Kurigram,		
Rupsa	Khulna	Khulna, Meherpur, Jashore, Bagerhat, Jhenaidah	16	404
Karnaphuli	Chattogram	Chattogram, Cox'sbazar, Bandarban,Khagrachori	12	598
Titash	Chattogram	Feni, Noakhali, Chandpur, Cumilla, B. Baria,	12	505
Shurma	Sylhet	Sylhet, Habiganj, Mowlavibazar, Sunamganj	8	432
Kirtonkhola	Barishal	Patuakhali,Barguna, Barishal, Bhola, Jhalokathi	8	402
Total			**112**	**4,573**

Exploration of analytical data generated by MSTL

Soil Reaction (pH)

Soil pH status ranged from very strongly acidic to very strongly alkaline. Among the analyzed soil samples 2.82% soils pH were very strongly acidic, 28.56% soils pH were strongly acidic and 31.10% soils pH were slightly acidic. Consequently, 12.97, 24.11 and 0.46% soils pH were neutral, slightly alkaline and strongly alkaline, respectively (Table 5). In Lalmonirhat, Nilphamari, Gaibandha, Panchagor, Rangpur, Kurigram, Bogura,Dinajpur, Thakurgaon, Chattogram, Cox'sbazar, Bandarban,Khagrachori, Sylhet, Habiganj, Mowlavibazar and Sunamganj districts, 42 to 61% soils pH ranged from very strongly acidic to strongly acidic. While in Dhaka, Tangail, Mymensingh, Netrokona, Kishoreganj Jamalpur, Sherpur Rajshahi, Chapainababganj, Naogaon,

Sirajganj, Pabna, Natore Feni, Noakhali, Chandpur, Cumilla and B. Baria districts, 33 to 66% soils pH ranged from very strongly acidic to strongly acidic. In Faridpur, Gopalgonj, Rajbari, Shariatpur, Madaripur, Patuakhali, Barguna, Barishal, Bhola, Jhalokathi, Khulna, Meherpur, Jashore and Bagerhat districts only 10% soils pH ranged from very strongly acidic to strongly acidic. Data showed that soils became more acidic in highly intensified cropping area. It was because of abuse of nitrogenous fertilizer as well as crop residue removal.

Table 5. pH level of analyzed soil samples

MSTL	Sample		pH range						
		VStA	StA	VStA-StA	SlA	N	SlAl	StAl	VStAl
		<4.5	4.6-5.5	4.5-5.5	5.6-6.5	6.6-7.3	7.4-8.4	8.5-9.0	>9.0
		%							
Jamuna	401	6.48	59.60	66.08	24.69	7.23	2.00	-	-
Brahmaputra	204	-	19.12	19.12	63.73	17.16	-	-	-
Madhumoti	400	-	-	-	0.50	6.75	88.25	4.50	-
Tista	623	2.09	23.09	25.18	19.58	13.32	41.41	0.48	-
Karatoa	604	4.80	36.80	41.60	45.20	10.43	2.32	-	-
Rupsa	404	-	-	-	0.74	11.14	88.12	-	-
Karnaphuli	598	3.85	38.63	42.48	56.19	1.34	-	-	-
Titash	505	5.15	27.52	32.67	38.81	19.60	8.91	-	-
Shurma	432	2.78	58.10	60.88	30.79	6.71	1.62	-	-
Kirtonkhola	402	-	10.15	10.15	31.93	43.57	15.35	-	-
Total	4573	2.82	28.56	31.38	31.10	12.97	24.11	0.46	-

*VSTA = Very strongly acid, STA = Strongly acid, SLA = Slightly acid, N = Neutral, SLAL = Slightly alkaline, STAL = Strongly alkaline, VSTAL = Very strongly alkaline

Electrical Conductivity (EC)

Electrical conductivity of received soil samples ranged from non-saline to moderately saline. 61.5% of received soil samples were non-saline, 9.1% were very slightly saline, whereas 10.5, 2.7, 0.2 and 0.5% samples were slightly saline, moderately saline, strongly saline and very strongly saline, respectively (Table 6).

Table 6. EC (Salinity) status of analyzed soil samples

MSTL	Sample	EC(dS/m)					
		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
Rupsa	200	73	15	10	3	-	-
	%	72.50	15.00	10.00	2.50	0.00	0.00
Kirtonkhola	402	297	40	53	13	1	3
	%	73.88	9.95	13.18	3.23	0.25	0.75
Total	602	370	55	63	16	1	3
	%	61.5	9.1	10.5	2.7	0.2	0.5

* NS = Non-saline, VSS = Very slightly saline, SS = Slightly saline, MS = Moderately saline, STS = Strongly saline, VSTS = Very strongly saline

Exchangeable Potassium (K)

Exchangeable K status range of the received soil samples was very low to very high. Exchangeable K status of 14.93% soils were very low, 32.41% soils were low, while 22.53, 12.77, 6.23, and 11.32% soils were medium, optimum, high and very high, respectively (Table 7). In Lalmonirhat, Nilphamari, Gaibandha, Panchagor, Rangpur, Kurigram, Bogura, Dinajpur, Thakurgaon, Dhaka, Tangail, Mymensingh, Netrokona, Kishoreganj, Feni, Noakhali, Chandpur, Cumilla, B. Baria, Sylhet, Habiganj, Mowlavibazar, Sunamganj, Chattogram, Cox'sbazar, Bandarban and Khagrachori districts 72 to 85% samples were deficient in exchangeable K content, whereas in Jamalpur, SherpurFaridpur, Gopalgonj, Rajbari, Shariatpur, Madaripur, Rajshahi, Chapainababganj, Naogaon, Sirajganj, Pabna and Natore 57 to 64% samples were deficient in exchangeable K. In Khulna, Meherpur, Jashore, Bagerhat, Jhenaidah, Patuakhali, Barguna, Barishal, Bhola and Jhalokathi districts exchangeable K deficient soils were only 37 to 61%.

Table 7. Exchangeable K status of analyzed soil samples

MSTL	Sample	Exchangeable K (meq/100g soil)						
		VL	L	M	*K def.	O	H	VH
		≤ 0.09	0.091-0.18	0.081-0.27	≤ 0.27	0.271-0.36	0.361-0.45	> 0.45
		%						
Jamuna	401	23.19	36.66	20.20	80.00	11.97	2.99	4.99
Brahmaputra	204	13.24	26.96	22.06	62.00	20.10	6.37	11.27
Madhumoti	400	1.25	25.50	30.25	57.00	16.50	10.25	16.25
Tista	623	18.14	26.48	20.22	64.85	14.61	5.94	14.61
Karatoa	604	8.11	37.91	25.99	72.02	11.26	6.62	10.10
Rupsa	404	0.00	12.87	24.75	37.62	21.78	14.11	26.49
Karnaphuli	598	18.73	44.98	21.74	85.45	6.69	2.68	5.18
Titash	505	13.86	43.96	21.98	77.82	8.91	5.35	5.74
Shurma	432	44.91	26.62	11.81	83.33	9.26	2.31	5.09
Kirtonkhola	402	4.96	31.44	26.98	60.90	14.11	7.92	17.08
Total	4573	14.93	32.41	22.53	69.43	12.77	6.23	11.32

*VL = Very low, L = Low, M = Medium, O = Optimum, H = High, VH = Very high

Available Phosphorus (P)

Available P status of received soils ranged from very low to very high. Available P status of 16.70% soils were very low, 17.16% soils were low, while 13.31, 9.70, 8.50 and 34.92% soils were medium, optimum, high and very high, respectively (Table 8). In Faridpur, Gopalgonj, Rajbari, Shariatpur, Madaripur, Patuakhali, Barguna, Barishal, Bhola, Jhalokathi districts 62 to 67% samples were deficient in available P content. Accordingly, in Dhaka, Tangail, Mymensingh, Netrokona, Kishoreganj, Rajshahi, Chapainababganj, Naogaon, Sirajganj, Pabna, Natore,Chattogram, Cox'sbazar, Bandarban, Khagrachori, Sylhet, Habiganj, Mowlavibazar, Sunamganj districts 41 to 63% samples were deficient in available P content. In Jamalpur, Sherpur, Bogura, Dinajpur, Thakurgaon, Lalmonirhat, Nilphamari, Gaibandha, Panchagor, Rangpur, Kurigram, Feni, Noakhali, Chandpur, Cumilla, B. Baria,Khulna, Meherpur, Jashore, Bagerhat, districts 28 to 40% samples were P deficient (Table 8).

Table 8. Available P status of analyzed soil samples

MSTL	Sample	Available P (µg/g)						
		VL	L	M	P defi.	O	H	VH
		≤ 7.5	7.51-15.0	15.1-22.5	≤ 22.5	22.51-30.0	30.1-37.5	> 37.5
		%						
Jamuna	401	30.42	15.71	15.46	63.09	7.73	8.23	22.44
Brahmaputra	204	7.84	15.20	17.16	40.20	6.86	8.33	44.61
Madhumoti	400	21.5	28.75	16.75	67.00	10.75	8.00	14.25
Tista	623	12.68	14.45	14.45	41.57	8.83	16.37	33.23
Karatoa	604	5.30	10.93	11.42	27.65	8.44	7.28	56.62
Rupsa	404	3.47	8.42	22.28	34.16	16.83	12.62	36.39
Karnaphuli	598	21.74	22.74	8.36	52.84	8.53	4.01	35.52
Titash	505	15.25	11.29	10.89	37.43	11.88	6.14	44.55
Shurma	432	30.56	19.91	5.79	56.25	7.87	5.09	30.79
Kirtonkhola	402	18.81	26.49	16.34	61.65	9.16	8.17	23.02
Total	4573	16.70	17.16	13.31	47.30	9.70	8.50	34.92

*VL = Very low, L= Low, M = Medium, O = Optimum, H = High, VH = Very high

Available Sulphur (S)

Range of available S status of analyzed soils varied from very low to very high. Available S status of 29.27% soils were very low, 26.86% soils were low, whereas 11.97, 7.55, 4.75 and 16.31% soils were medium, optimum, high and very high in available S content, respectively (Table 9).

Table 9. Available S status of analyzed soil samples

Name of MSTL	Sample	Available S (µg/g)						
		VL	L	M	S def.	O	H	VH
		≤ 7.5	7.51-15.0	15.1-22.5	≤ 22.5	22.51-30.0	30.1-37.5	> 37.5
		%						
Jamuna	401	32.92	13.47	6.48	52.87	9.98	2.99	34.16
Brahmaputra	204	22.06	35.29	19.61	80.88	7.35	5.88	9.80
Madhumoti	400	31.5	16.75	17.00	65.25	11.75	7.00	16.00
Tista	623	39.65	31.46	9.63	80.74	5.62	3.69	9.95
Karatoa	604	31.46	40.07	15.23	86.75	6.62	2.48	3.64
Rupsa	404	8.91	22.52	10.64	42.08	11.63	7.67	38.61
Karnaphuli	598	36.24	31.49	20.59	88.32	6.14	2.57	2.97
Titash	505	39.65	31.46	9.63	80.74	5.62	3.69	9.95
Shurma	432	6.25	9.95	6.48	22.69	11.34	15.51	50.46
Kirtonkhola	402	29.85	45.52	13.18	88.56	4.23	2.24	4.98
Total	4573	29.27	26.86	11.97	67.15	7.55	4.75	16.31

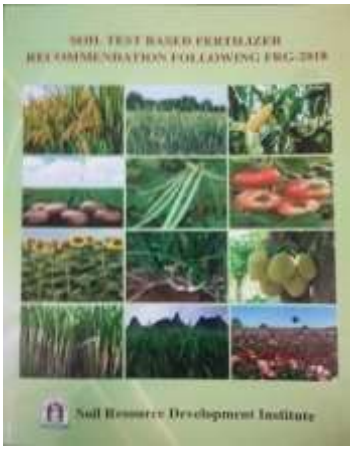
*VL = Very low, L = Low, M = Medium, O = Optimum, H = High, VH = Very high

In Jamalpur, SherpurRajshahi, Chapainababganj, Naogaon, Sirajganj, Pabna, NatoreFeni, Noakhali, Chandpur, Cumilla, B. Baria, Bogura, Dinajpur, Thakurgaon, Lalmonirhat, Nilphamari, Gaibandha, Panchagor, Rangpur, Kurigram, Chattogram, Cox's bazar, Bandarban,KhagrachoriPatuakhali, Barguna, Barishal, Bhola,Jhalokathi districts 81 to 88% samples were deficient in available S content. While in Sylhet, Habiganj, Mowlavibazar,

Sunamganj Dhaka, Tangail, Mymensingh, Netrokona, Kishoreganj, Faridpur, Gopalgonj, Rajbari, Shariatpur, Madaripur, Khulna, Meherpur, Jashore, Bagerhat, Jhenaidah districts 23 to 65% samples were deficient in available S content.

Publication and Innovation

A hand book on soil test-based fertilizer recommendation guide was published following FRG-2018 especially for using at MSTLs. Dose of different fertilizer can find out very easily from this guide using only the soil test value of the specific nutrient. A mobile apps "Sufala Matin" was also innovated for soil test-based fertilizer recommendation.



STB fertilizer recommendation guide

Mobile apps: Sufala Mati

Conclusion

In Bangladesh overall trend of soil fertility of Bangladesh is either static or declining which is a challenge for upcoming food security as well as economic growth. Our population is rising, but agricultural lands are diminishing. Consequently, we are to feed our growing population with limited lands. Our per hectare yield of rice is lower than most other south Asian country. Due to lower yield farmers can't earn desired profit against augmentation of cultivation cost. Moreover, government has to pay several thousand crore taka each year for fertilizer subsidy. So, nowadays fertilizer is a costly input. On the other hand, our farmers are lagging behind with respect to neither rational use of fertilizers nor soil health management. In this context, use of soil test based balanced fertilizer use is of prime importance. More number of farmers need to be motivated by DAE so that they come forward to receive soil testing service from SRDI laboratories. Quality control of fertilizer should be more strictly maintained simultaneously for expected output through balanced fertilization. SRDI's MSTL programmeme should be run more effectively in order to create mass awareness on balanced fertilizer use.

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4.2 Achievement of Central Laboratory (2021-2022)

Introduction

Central Laboratory is operated under the Headquarter of Soil Resource Development Institute. This Laboratory usually conducted physical and chemical analyses of soil samples supplied by different stake holders like Government organization, private entrepreneur, farmers, students, NARS institutions. But after the revisit of the organogram Central Laboratory conducted some research activities in collaboration with other national and international organizations. In 2021 Central laboratory conducted a study "Micronutrient Quality Audit" with an international collaborative Project named Nutrient Management for Diversified Cropping in Bangladesh (NUMAN) Project jointly funded by Krishi Gobeshona Foundation (KGF) and Australian Centre for International Agricultural Research (ACIAR). Another research programme was conducted by the guidance of FAO, a German Government funded project named "Sustainable Soil Management for Nutrition-sensitive Agriculture in Sub-Saharan Africa and South East Asia Project, Bangladesh.

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

- To evaluate soil fertility status and recommend balanced fertilizer doses for different crops based on soil analytical results and crop requirements through static laboratory.
- To analyze soil samples for preparing different soil use guides (Upazila Land and Soil Resources Utilization Guide, Union Sahayika etc).
- To popularize soil test-based fertilizer application, to build awareness about the benefits of using balanced fertilizer.
- To analyze water and plant samples received from different organizations.
- To analyze fertilizer samples in order to assist the agricultural system to maintain fertilizer quality.

Programmes of Central Laboratory

- ❑ Analyses of Soil, Water and Plant Samples.
- ❑ Research Programme.
- ❑ Publications.
- ❑ Training.
- ❑ Quality Control of Fertilizers.

Research Programme conducted by Central Laboratory in 2021-2022

Experiment-1

Nutrient Management for Diversified Cropping in Bangladesh (NUMAN): Micronutrient Fertilizer Quality Audit 2021-2022

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Abstract

Fertilizer quality plays an important role achieving desirable yield as well as maintain soil health. To assess the quality of micronutrient fertilizer marketed by different fertilizer company an investigation was carried out under the fertilizer quality audit activities of Nutrient Management for Diversified Cropping in Bangladesh (NUMAN) Project. There were five micronutrient fertilizers considered for the study named zinc sulphate monohydrate, zinc sulphate heptahydrate, chelated zinc as Zn source and solubor, boric acid as B source. As a part of NUMAN Project, Soil Resource Development Institute (SRDI) collected and determined the nutrient content of 234 zinc and boron fertilizer samples (Zinc sulphate monohydrate-87; Zinc sulphate heptahydrate-20; Chelated zinc- 58; Solubor-41 and Boric acid-28) from the six study areas of the Project of different fertilizer marketing companies on the basis of their availability in those localities during 2020-2021. It was observed that 100% zinc sulfate monohydrate fertilizers were found non-complaint; 45% zinc sulfate heptahydrate fertilizer were complaint and 55% were non-complaint; 48% chelated zinc fertilizers were found complaint and rest 52% were non- complaint. In case of solubor boron, 85% was found complaint while 15% was non-complaint and in case of boric acid 54% was found complaint while 46% was non-complaint.

Introduction

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. It is imperative to collect various fertilizers from the local level during establishment of crops in the selected cropping patterns in project hub

areas and analyze the samples to verify the nutrient concentrations in fertilizer. It would help on policy guidelines to ensure quality fertilizer at field level. To assess the quality of fertilizer marketed by different fertilizer company an investigation needed to carry out under the fertilizer quality audit activities of Nutrient Management for Diversified Cropping in Bangladesh (NUMAN) Project. As a part of NUMAN Project, Soil Resource Development Institute (SRDI) collected and determined the nutrient content of different fertilizers applied by the farmers. As per the decision of the 2nd year Annual Review meeting that only micro nutrient fertilizers quality would be determined in the 3rd year and on ward due to the adulteration rate was found higher in micronutrient fertilizer samples. The study findings of 2018 and 2019 revealed that the Government subsidised macronutrient fertilizers like Urea, TSP, DAP and MoP quality was found good enough. So, no need to make further quality audit for Urea, TSP, DAP, MoP. In addition, the quality of calcium and magnesium containing low-cost fertilizers like gypsum and magnesium sulphate was found standard that was found in the study area. To assess the quality of micronutrient fertilizer marketed by different fertilizer company an investigation was carried out under the fertilizer quality audit activities of Nutrient Management for Diversified Cropping in Bangladesh (NUMAN) Project. Therefore, considering the above perspectives, under the quality audit activities of fertilizer, SRDI collected and determined the nutrient content only in micronutrient fertilizers to identify the real feature of the nutrient content of different company's micronutrient fertilizers marketed at field level.

Objectives

To identify the real feature of the nutrient content of different company's micronutrient fertilizers marketed at field level.

Methodology

Activity 1.3: Conduct fertilizer quality audit in different cropping season (KGF funding)

Soil Resource Development Institute (SRDI) conducted the study of fertilizer quality audit of different Government specified fertilizers used in the farmer's field of the study areas. As per the decision of the 2nd year Annual Review meeting, only micro nutrient fertilizers quality would be determined from the 3rd year and onward due to the adulteration rate was found higher in micronutrient fertilizer samples. Therefore, under the quality audit activities of fertilizer, SRDI collected and determined the nutrient content only in micronutrient fertilizers like Zinc sulphate mono hydrate, Zinc sulphate heptahydrate, Chelated Zinc, Solubor Boron and Boric acid samples marketed by different fertilizers companies from the neighbouring hub areas those were applied by the farmers. The fertilizers samples were collected from Mymensingh, Thakurgaon, Gudagari and Durgapur hub areas before Rabi season in January-February 2021. On the other hand, from Dacope, Khulna and Amtali, Barguna hubs fertilizer samples were collected before Kharif season in August, 2021. Fertilizer samples were collected following the protocol of Fertilizer Inspection Manual, 2003. On the basis of availability of the micronutrient fertilizer in the local market, neighbouring the hub areas the above-mentioned fertilizer samples were collected along with trade names, address, pack size, unit price of the marketing companies. A total of different marketing company's micronutrient fertilizer samples (Zinc sulphate monohydrate-64; Zinc sulphate

heptahydrate-20; Chelated zinc- 45; Solubor-37 and Boric acid-18) were collected (Table 1). Collected micronutrient fertilizer samples will be analysed following the standard method 'Manual for Fertilizer Analysis, 2003' approved by the Government of the People's Republic of Bangladesh.

Table 1 Different micronutrient fertilizer samples collected from six hub areas of NUMAN project during 2020-2021 for quality audit

Name of Hub	**No. of fertilizers sample**					
	Zinc sulfate mono hydrate	Zinc sulfate hepta hydrate	Chelated zinc	Solubor	Boric acid	Total
Mymensingh	15	04	10	09	02	40
Thakurgaon	15	06	11	12	07	51
Durgapur	22	04	12	08	05	51
Gudagari	15	06	13	08	05	47
Dacope	13	00	09	03	05	30
Amtali	07	00	03	01	04	15
Total	**87**	**20**	**58**	**41**	**28**	**234**

Total sample collected **234**

Result and Discussion

Zinc sulfate monohydrate

It was observed that the highest amount of average zinc (Zn) in zinc sulfate monohydrate fertilizer was found at Amtali (22.86%) while the lowest quantity was observed at Thakurgaon (11.79%). On the other hand, the highest quantity of average Sulphur (S) content in zinc sulfate monohydrate fertilizer was found at Dacope10.74% while the lowest quantity of sulfur was observed at Amtali (7.92%). The minimum Zn and S content in Zinc sulfate monohydrate fertilizer was 36% and 17.5% respectively, as per Government specification. There was no consistency found in the Zn and S content in zinc sulfate monohydrate fertilizer samples. The cadmium content was found above the allowable limit at Godagari and Dacope. On the contrary, it with in the allowable limit at Mymensingh, Thakurgaon, Durgapur and Amtali. All other heavy metals like lead (Pb), Nickel (Ni) and chromium (Cr) were found below the allowable limit (Table 2). It was observed that there were 22 zinc sulfate monohydrate fertilizer marketing company involved at Durgapur hub area which was maximum while the lowest number of zinc sulfate monohydrate marketing company was observed at Amtali hub area which was 7 (Table 1). All the Zinc sulfate monohydrate fertilizer collected from different six hub areas were found non complaint or failed to meet the Government specification. The adulteration of zinc sulfate monohydrate fertilizers was found due to the absence of desirable amount of zinc and sulfur content as well as the presence of undesirable toxic heavy metal like cadmium (Cd), that exceed the allowable limit. Out of 87 zinc sulfate monohydrate fertilizer samples of different companies it was found that 42% sample contained only 0-5% Zn and 23% zinc sulfate monohydrate fertilizer samples contained 30-35% Zn (Table 3). We also determined the quality of zinc sulfate monohydrate fertilizer of two company collected from five

hub areas. Though there found a variation of Zn and S content but it was not remarkable (Fig.1 and Fig. 2). Therefore, it might be concluded that there was no quality Zn sulfate monohydrate fertilizer was found in the study. The adulteration of zinc sulfate fertilizer was found both inadequate presence of Zn and S content as well as the presence of unwanted toxic metals like Cd.

Table.2 Nutrient & heavy metal facts of zinc sulfate mono hydrate fertilizers in different hub area

Hub area	**Nutrient content (%)**		**Heavy metal content (mg/kg)**			
	Zn	S	Cd	Pb	Ni	Cr
Mymensingh	16.61±13.94	10.14±4.32	3.36±5.83	10.46±14.83	28.93±45.00	5.53±5.63
Thakurgaon	14.74±11.57	11.79±4.01	3.10±3.29	10.47±16.13	18.00±38.91	3.62±3.88
Durgapur	17.30±11.62	10.79±3.44	5.10±7.85	18.15±22.70	85.22±299.73	9.57±23.37
Gudagari	16.27±13.84	9.70±3.92	22.64±70.17	9.62±12.85	32.30±55.36	5.10±6.66
Dacope	10.74±13.53	9.68±1.45	21.00±69.35	9.31±13.19	8.93±7.91	5.40±2.98
Amtali	22.86±15.57	7.92±3.29	4.69±6.86	6.06±13.74	57.54±89.59	4.16±2.97
Govt. spec.	36.0 (min^m)	17.5 (min^m)	10 (max^m)	100 (max^m)	50 (max^m)	500 (max^m)

Table.3 Over all zinc sulfate monohydrate fertilizers quality in the study area

Zinc content (%)	No. of fertilizer	Percent of fertilizer (%)
0.0-5.0	36	42
5.1-10.0	1	1
10.1-15.0	2	2
15.1-20.0	3	4
20.1-25.0	11	13
25.1-30.0	13	15
30.1-35.0	20	23
Total	86	100

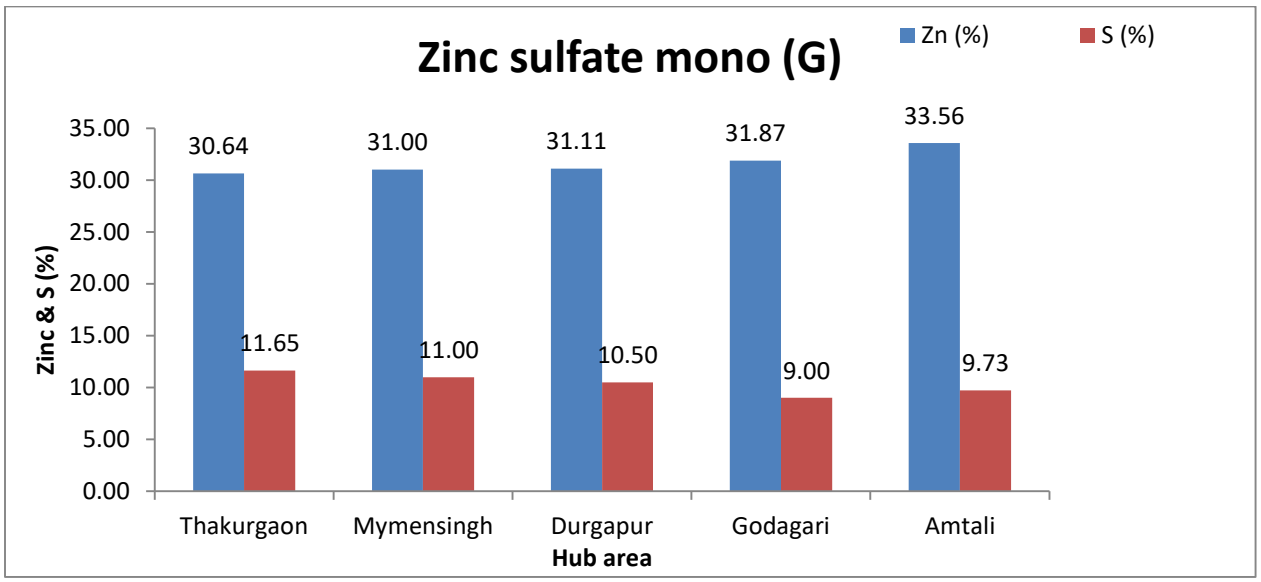

Fig.1 Nutrient content in zinc sulfate monohydrate fertilizers containing around 30% Zn of a particular company at different locations.

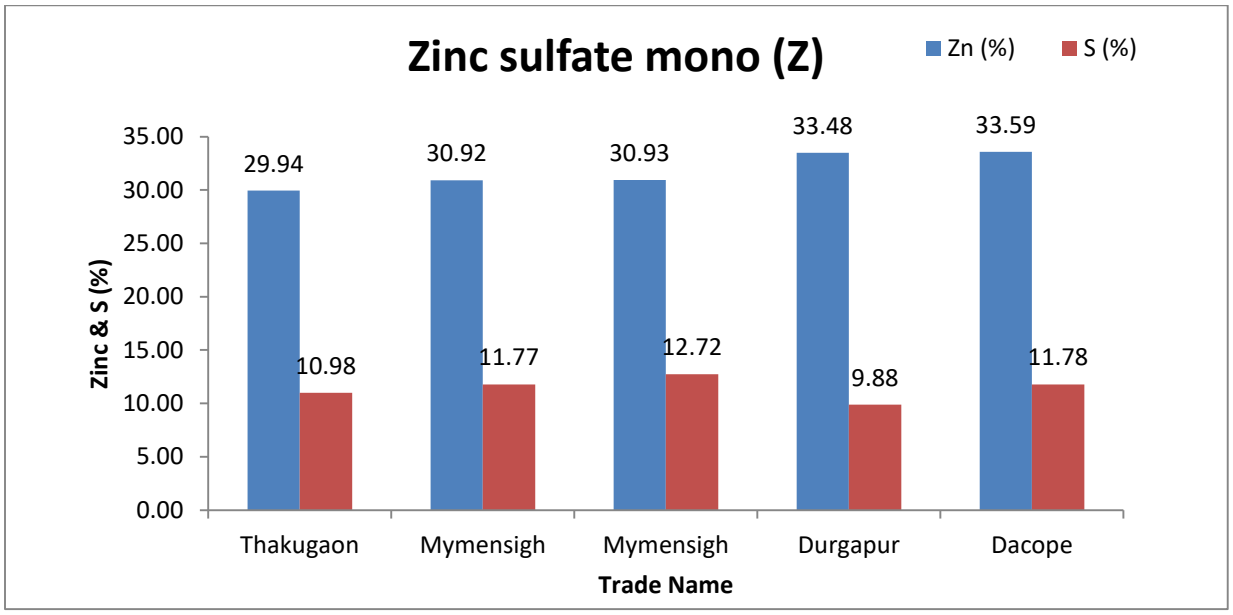

Fig.2 Nutrient content in zinc sulfate monohydrate fertilizers containing around 30% Zn of a particular company at different locations.

Zinc sulfate heptahydrate

It was observed that there was no zinc sulfate heptahydrate fertilizer found at Dacope and Amtali hub area. There were 20 different marketing companies that dealt with zinc sulphate hepta hydrate fertilizer (Table 1). The highest amount of Zn and S was found in zinc sulfate heptahydrate fertilizer at Thakurgaon16.14% and 7.36 % respectively, while the lowest quantity of Zn and S was found at Mymensingh10.01% and 7.36%) respectively. It was mentionable that as per Government specification the minimum Zn and S content in a zinc sulphate heptahydrate fertilizer

were 21% and 10.5% respectively. Zinc sulfate heptahydrate fertilizers, adulteration was found due to absence of desirable amount of zinc and sulfur content as well as the presence of undesirable toxic heavy metal like cadmium (Cd), that exceed the allowable limit at Mymensingh hub area. There was found no consistency in the Zn and S content in zinc sulfate heptahydrate fertilizer samples. The cadmium content was below the allowable limit in other three hub areas. Other heavy metals like lead (Pb), Nickel (Ni) and chromium (Cr) were found below the allowable limit (Table 4). Among the zinc sulfate heptahydrate fertilizer samples it was found that 45% were complained that contained more than 19% Zn while 35% zinc sulfate heptahydrate samples that contained only 0-5% Zn (Table 5). It was concluded that 45% zinc sulfate heptahydrate fertilizer samples were complained while the 55 % were non-complained.

Table 4 Nutrient & heavy metal facts of zinc sulfate Heptahydrate fertilizers in different hub area

Hub area	Nutrient content (%)		Heavy metal content (mg/kg)			
	Zn	S	Cd	Pb	Ni	Cr
Mymensingh	10.01±11.32	7.36±4.45	12.30±23.63	12.50±15.63	59.04±70.89	5.41±2.18
Thakurgaon	16.14±5.67	12.33±0.89	2.38±15.32	13.57±20.75	16.31±16.70	4.28±4.72
Durgapur	11.33±12.36	7.91±5.00	1.28±1.27	1.34±0.84	22.77±31.23	19.63±38.99
Gudagari	12.12±9.44	9.86±4.66	2.78±3.76	3.81±6.78	25.75±25.86	14.97±26.34
Dacope	-	-	-	-	-	-
Amtali	-	-	-	-	-	-
Govt. spec.	21.0(min^m)	10.5(min^m)	10(max^m)	100(max^m)	50(max^m)	500(max^m)

Table 5 Over all zinc sulfate heptahydrate fertilizer quality in the study area

Zinc content (%)	**Fertilizer (No.)**	**Percent of fertilizer (%)**
0.0-5.0	7	35
5.1-10.0	0	0
10.1-15.0	2	10
15.1-18.99	2	10
19-24.0	9	45
Total	20	100

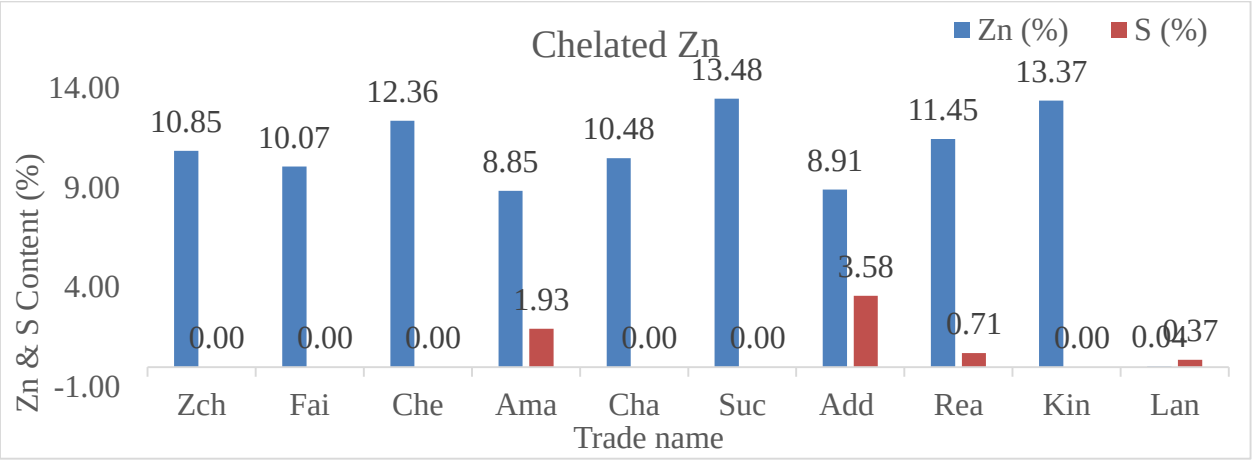

Fig.3 Quality of Chelated zinc marketed by different fertilizer companies at Mymensingh hub.

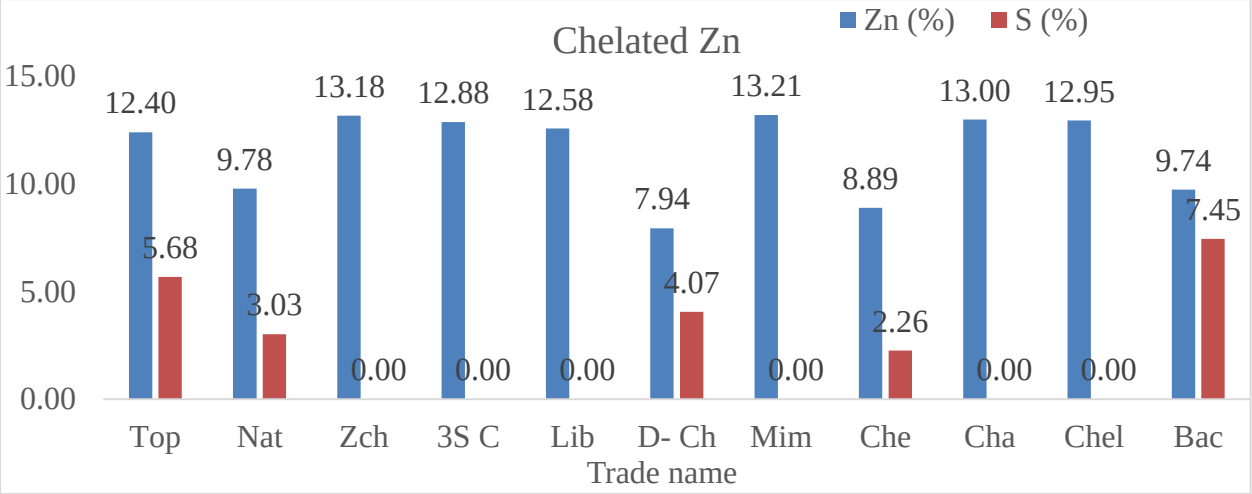

Fig.4 Quality of Chelated zinc marketed by different fertilizer companies at Thakurgaon hub.

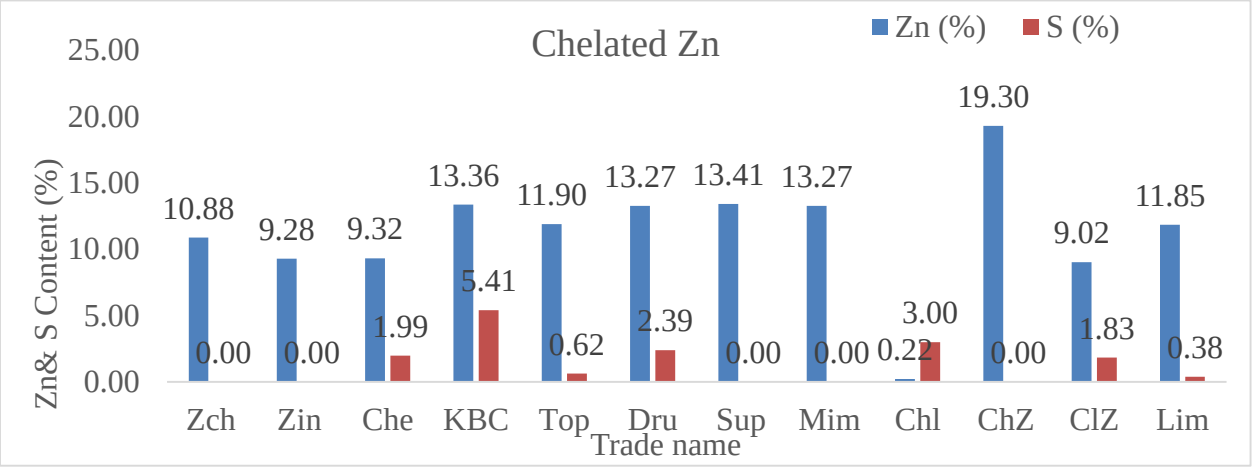

Fig.5 Quality of Chelated zinc marketed by different fertilizer company at Durgapur hub area.

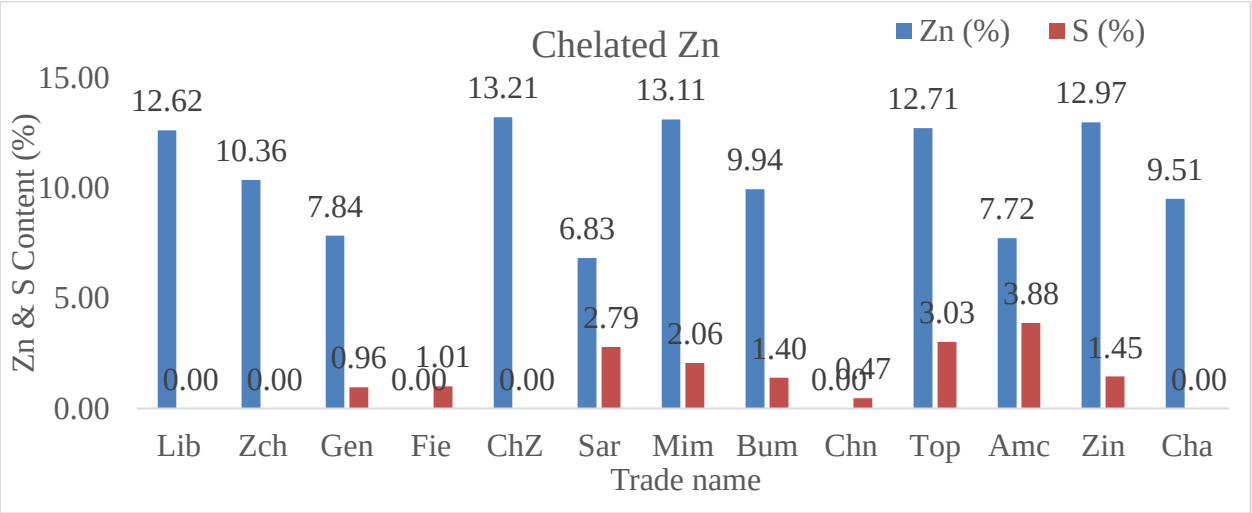

Fig.6 Quality of Chelated zinc marketed by different fertilizer company at Godagari hub area.

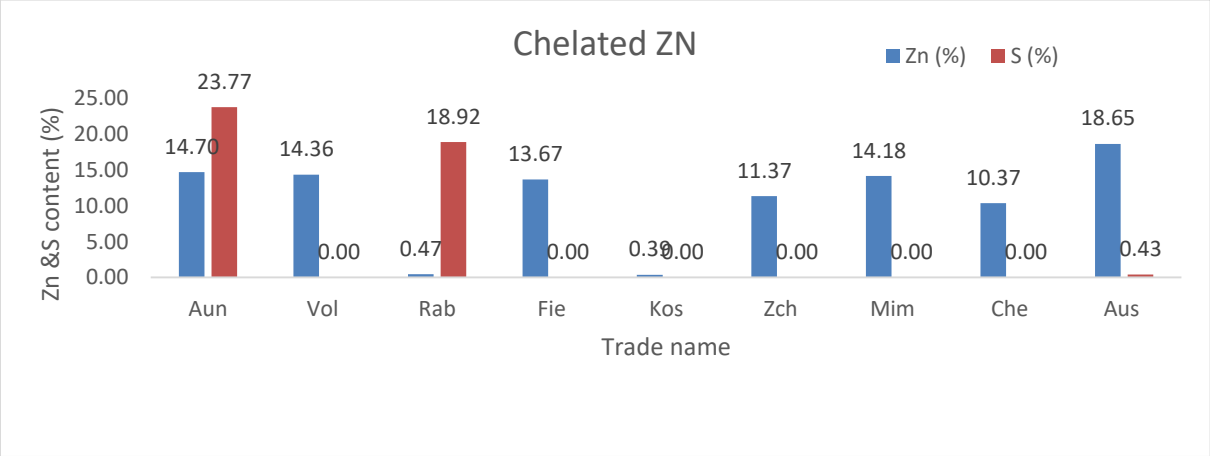

Fig.7 Quality of Chelated zinc marketed by different fertilizer company at Dacope hub area.

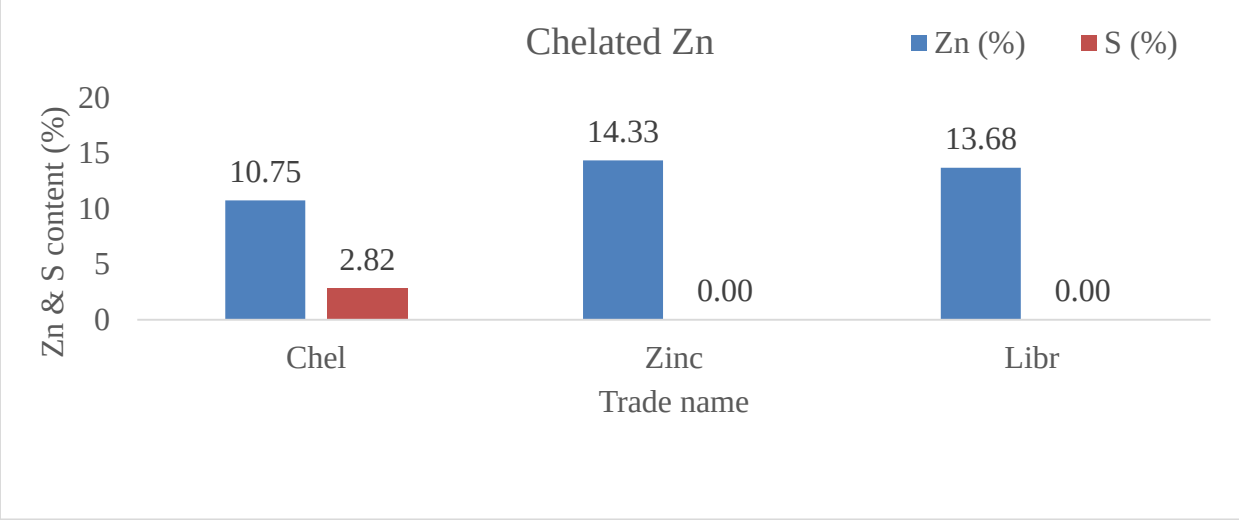

Fig.8 Quality of Chelated zinc marketed by different fertilizer company at Amtali hub area.

Chelated zinc

There were found 58 companies engaged in chelated zinc fertilizer marketing in the six hub areas. The highest number of chelated zinc fertilizer was observed at Godagari where 13 chelated zinc was found while the lowest chelated zinc was found at Amtali where 3 chelated was found (Table 1). Apparently, there were found some chelated zinc fertilizer samples that contained more than 10% Zn which was above the minimum requirement of the Government specification but the presence of undesirable S in the sample made them adulterated. At Mymensingh, there were found 10 Chelated zincs where 6 chelated zinc samples were found complaint and 4 fertilizer samples failed to comply. Among the 4 non-complaint fertilizer samples 1 sample contained undesired S and 2 samples contained less Zn as well as contained undesired S and the rest 1 contained almost no Zn (Fig. 3). At Thakurgaon, there were found 11 Chelated zincs where 6 chelated zinc samples were found complaint and 5 fertilizer samples failed to comply. Among the 5 non-complaint fertilizer samples 3 sample contained undesired S and 2 samples contained less Zn as well as contained undesired S (Fig. 4).At Durgapur, there were found 12 Chelated zincs where 5 chelated zinc samples were found complaint and 7 fertilizer samples failed to comply. Among the 7 non-complaint fertilizer samples 5 sample contained undesired S and 1 sample contained less Zn as well as contained undesired S and the rest 1 contained almost no Zn (Fig. 5). At Godagari, there were found 13 Chelated zincs where 4 chelated zinc samples were found complaint and 9 fertilizer samples failed to comply. Among the 9 non-complaint fertilizer samples 4 sample contained undesired S and 3 samples contained less Zn as well as contained undesired S and the rest 2 contained almost no Zn (Fig. 6). At Dacope, there were found 9 Chelated zincs where 5 chelated zinc samples were found complaint and 4 fertilizer samples failed to comply. Among the 4 non-complaint fertilizer samples 2 sample contained undesired S and the rest 2 contained almost no Zn and contained more S (Fig. 7). At Amtali, there were found 3 Chelated zincs where 2 chelated zinc samples were found complaint and 1 fertilizer samples failed to comply. The non-complaint sample contained undesired S (Fig. 8).

Finally, it might be concluded that 48% chelated zinc fertilizers were found complaint and rest 52% were non- complaint marked in the six-hub area (Table 6).

Table 6 Overall quality of Chelated zinc fertilizers in different hub area

Hub	Complaint	Non-complaint	Total	Complaint (%)	Non complaint (%)
Mymensingh	6	4	10	60	40
Thakurgaon	6	5	11	55	45
Durgapur	5	7	12	42	58
Godagari	4	9	13	31	69
Dacope	5	4	9	56	44
Amtali	2	1	3	67	33
Total	28	30	58	48	52

Table 7 Overall solubor boron fertilizer quality in the study area

Hub area	**Complaint sample**	**Non-complaint sample**	**Total Sample**	**Complaint (%)**	**Non-complaint (%)**
Mymensingh	8	1	9	89	11
Thakurgaon	10	2	12	83	17
Durgapur	6	2	8	75	25
Gudagari	8	0	8	100	0

Dacope	2	1	3	67	23
Amtali	1	0	1	100	0
Total	**35**	**6**	**41**	**85**	**15**

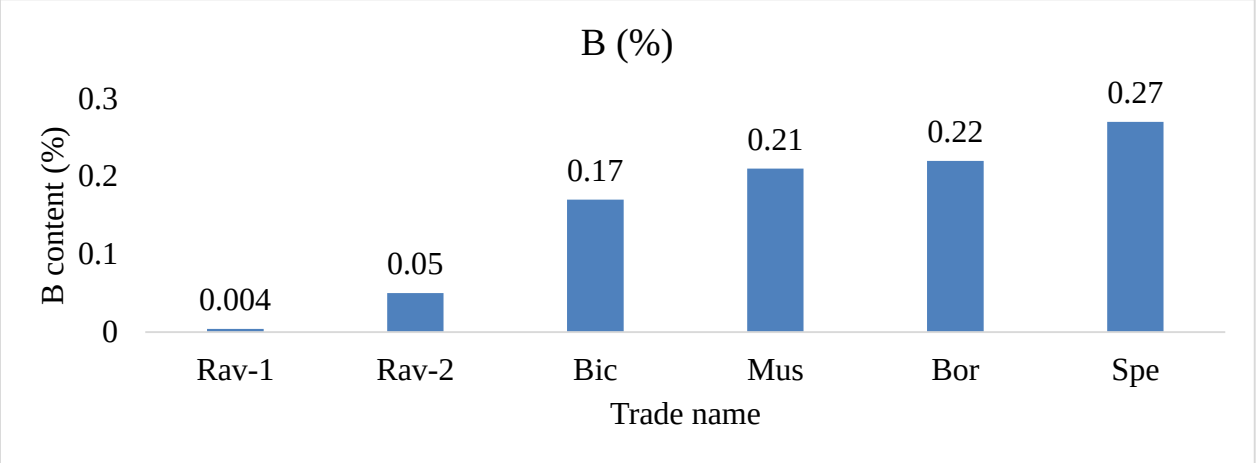

Fig. 9 Boron content of Non-complaint Solubor boron fertilizers.

Solubor boron

There were found 41 company marketed their solubor fertilizer in the six- hub area. The highest number of solubor fertilizer was found at Thakurgaon which was 12 while the lowest samples were found at Amtali which was only one (Table-1).

It was observed that 100% solubor boron fertilizers were found complaint at Godagari and Amtali hub. At Mymensingh hub, there found 89% solubor boron fertilizers were found complaint while 11% samples were found non-complaint.AtThakurgaon hub, there found 83% solubor boron fertilizers were found complaint while 17% samples were found non-complaint.At Durgapur hub, there found 75% solubor boron fertilizers were found complaint while 25% samples were found non-complaint. At Dacope hub, there found 67% solubor boron fertilizers were found complaint while 23% samples were found non-complaint. It might be concluded that 85% solubor boron was found complaint while 15% was non-complaint (Table 7). It was also observed that non-complaint solubor boron almost devoid of B (Fig. 9).

Table 8 Over all Boric acid fertilizer quality in the study area

Hub	**Complaint**	**Non-complaint**	**Total**	**Complaint (%)**	**Non complaint (%)**
Mymensingh	1	1	02	50	50
Thakurgaon	5	2	07	71	29
Durgapur	3	2	05	60	40
Godagari	1	4	05	20	80
Dacope	1	4	05	20	80
Amtali	4	0	04	100	0

Total	15	13	28	54	46

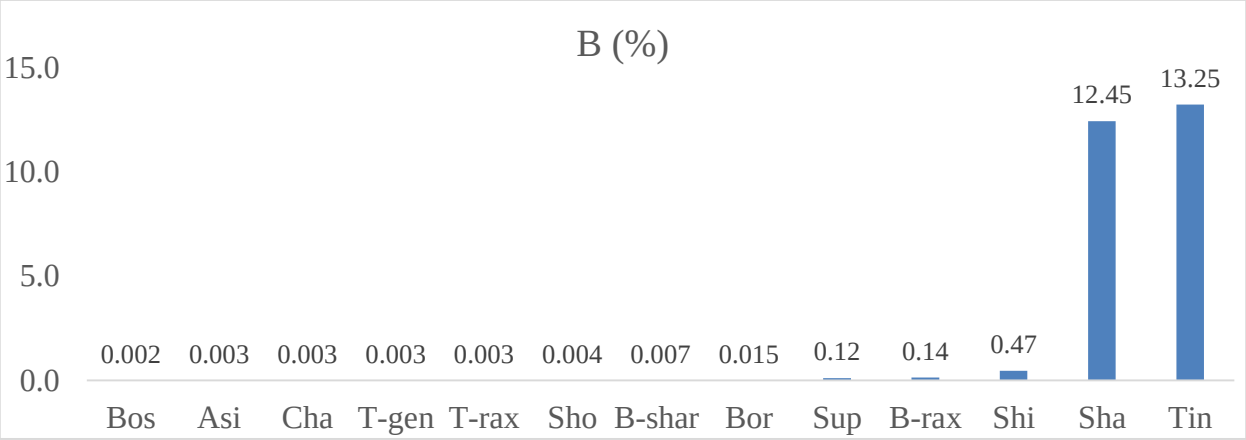

Fig. 10 Boron content of Non-complaint Boric acid fertilizers.

Boric acid

There were found 28 company marketed their boric acid fertilizer in the six- hub area. The highest number of boric acids was found at Thakurgaon which was 7 while the lowest samples were found at Amtali which was 4 (Table-1).It was observed that 100% solubor boron fertilizers were found complaint at Amtali hub. At Mymensingh hub, there found 50% boric acid fertilizers were found complaint while 50% samples were found non-complaint. At Thakurgaon hub, there found 71% boric acid fertilizers were found complaint while 29% samples were found non-complaint. At Durgapur hub, there found 60% boric acid fertilizers were found complaint while 40% samples were found non-complaint. At Godagari and Dacope hub, there found only 20% boric acid fertilizers were found complaint while 80% samples were found non-complaint. It might be concluded that 54% boric acid was found complaint while 46% was non-complaint (Table 8). It was also observed that 85% of the non-complaint boric acid almost devoid of B (Fig. 10).

Conclusion

Under the quality audit of fertilizer activity, it was observed that there were found 87 company dealt with zinc sulfate monohydrate, 20 company dealt with zinc sulfate heptahydrate, 58 company dealt with chelated zinc, 41 company dealt with solubor boron and 28 company dealt with boric acid fertilizes. It was observed that 100% zinc sulfate monohydrate fertilizers were found non-complaint; 45% zinc sulfate heptahydrate fertilizer were complaint and 55% were non-complaint; 48% chelated zinc fertilizers were found complaint and rest 52% were non- complaint. In case of solubor boron, 85% was found complaint while 15% was non-complaint and in case of boric acid 54% was found complaint while 46% was non-complaint.

Experiment-2

Sustainable soil management as keystone of nutrition sensitive agriculture in Bangladesh

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Policy Brief

In Bangladesh, more than half the population suffers from malnutrition. Severe acute malnutrition affects 450,000 children, while close to 2 million children suffering moderate acute malnutrition. Nutrient deficiencies are due to the majoritarian consumption of nutrient poor staple crops, grown on nutrient depleted soils. In particular, deficiencies of zinc and boron are widespread in Bangladesh.

Intensification of agriculture using nutrient-rich high-yielding varieties can lead to the decline of soil fertility due to mining of nutrients and soil organic matter depletion, thus jeopardizing longer term food security.

Soil health is important for a long-term nutrient supply capacity and must be considered in nutrition sensitive agriculture.

When grown on healthy soils, biofortified crop varieties can allow an increase the micronutrient content of foods in the long run and thus improve human health, with a lower dependence on inorganic fertilizers and an increased cost-efficiency.

SSM practices, including crop associations and integrated fertility strategies, increase the organic matter of the soil and ensure the addition of enough macro and micronutrients to the soil in balanced amounts.

The 'Fertilizer Recommendation Guide', published by the Government of Bangladesh, advises farmers to apply balanced micronutrient fertilization to the soil. However, micronutrient application is still low as well as organic matter use.

Background

Bangladesh is the most densely populated country in the world, with about 161 million people living in a landmass of 147,570 square kilometers, and approximately one-fourth of the population is under 18 years (UNICEF, 2019). Agriculture is the largest employment sector in the country, making up 12.92 percent of Bangladesh's GDP in 2020 and employing about 50.0 percent of the work force.

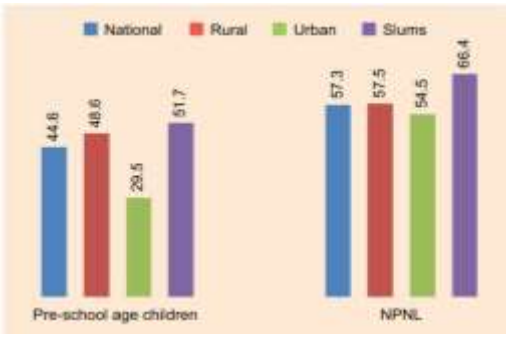
Bangladeshi agriculture has made a significant contribution to the country's food security in the last years through intensification, including the introduction of high-yield biofortified varieties that hold the potential to contribute to a nutritionally improved diet. The Bangladesh Rice Research Institute (BRRI) and the International Rice Research Institute (IRRI) have released, in collaboration with Harvest Plus, seven zinc-biofortified rice varieties. By the end of 2021, nearly

13 million farming households were growing biofortified crops and 64 million people were benefiting directly from them.

Despite significant economic progress and poverty reduction, about 35 percent of Bangladesh's population remains food insecure, with around 10 percent of ever-married women reported as moderately or severely food insecure (NIPORT, 2013). Undernutrition is exacerbated by poor dietary diversity, with 70 percent of the diet comprising cereals, and inadequate protein and micronutrient intake (Magnani et al., 2015). Most recently, the percentage of the population living in poverty has declined from 32 percent in 2010 to an estimated 23 percent in 2017 (GED, 2018). In fact, more than 54% of preschool-age children are stunted and more than 50 percent of women suffer from chronic energy deficiency. Anemia affects 52% of children under five years of age. 41% of children under five years of age are stunted. 16% of children under five years of age are wasted. 36% of children under five years of age are underweight. A quarter of women are underweight and around 15% have short stature, which increases the risk of difficult childbirth and low-birth-weight infants.

Table 1. Prevalence of Micronutrient and Nutritional Status of Bangladesh (Source: National Micronutrient Survey 2011-2012)

	Rural	Urban	Slum
	(%)		
Subclinical vitamin A deficiency			
Preschool Children	19.4	21.2	38.1
School-age children	20.2	22.1	27.1
NPNL women	5.4	4.9	6.9
Zinc deficiency			
Preschool children	48.6	29.5	51.7
NPNL women	57.5	54.5	66.4
Nutritional status of preschool children			
Stunting	31.4	31.3	51.1
Wasting	21.1	12.9	20.3
Underweight	29.6	28.1	47.4



On the other hand, agricultural intensification has put a tremendous pressure on arable land, mining soil nutrients and producing a decrease of soil organic matter, with the consequent decreased soil fertility, as well as other related degradation processes such as soil erosion, pollution, increased soil salinity, compaction and pan formation, acidification and deforestation, that impair agricultural yields and ultimately decrease the crop nutrient content.

In order to maintain soil production, increasing amounts of chemical fertilizers have been required. The Government has issued a Fertilizer Recommendation Guide (2018) that includes recommendations on the dose and time of application of fertilizers based on AEZ, and including macro and micronutrients.

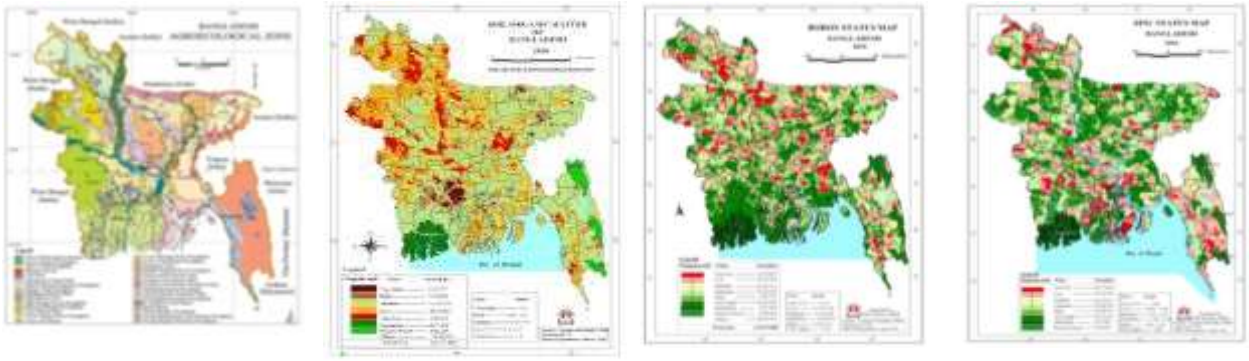


Fig. Bangladesh has been divided into 30 agro ecological zones (AEZ) that subdivided into 88 agro ecological sub-regions, which have been further subdivided into 535 agro ecological units on the basis of physiography, soils, hydrology and cropping pattern. The figure shows: (a) the agro ecological zones;(b) Geographic distribution of soil Organic Matter; (c) of Zn; and (d) of Boron.

However, farmers keep mostly relying on macronutrient fertilizers like urea, TSP, DAP, MoP and Gypsum, with very little or no use of micronutrient fertilizers like zinc (Zn) and boron (B), particularly in rice cultivation. Thus, the process of soil degradation continues, with gradual nutrient depletion and organic matter loss. For instance, a long-term study of Bangladesh soils from the Soil Resource Development Institute (Hasan *et al*., 2020) showed that the area of soils having low to very low Zn content has increased 28.71% to 78.84% of since 2010-2020, and 25.99% to 30.78% in the case of boron (B).

This means that the amount of nutrients available to plants is decreasing over time and, consequently, (biofortified) crops cannot obtain the nutrients they require. This is because, ultimately, the nutrients that the plant needs for growing come, necessarily, from the soil. If managed unsustainably, soils can pose limits to the effectivity of the biofortification approach and, conversely, improvement in soil fertility management may enable biofortified foods to be more successful.

In addition, the exclusive cultivation of biofortified seeds leads to lowly diverse diets, with negative effects on the nutritional status of the population. Monocropping of biofortified crops has also deleterious environmental effects, in particular for biodiversity.

Therefore, sustainably benefitting from biofortified crops requires a comprehensive approach, of which soil management is an important component. Through SSM, including a correct application of the micronutrient fertilizers, crop diversification and organic additions to the soil, agricultural systems including bio-fortified crop varieties, can improve nutrient content in foods while producing high yields and maintaining soil health, thus contributing to a long-term food security strategy. SSM can lead to socially supportive, commercially competitive and environmentally sound agricultural systems.

Through the project "Sustainable Soil management for nutrition sensitive agriculture" (Soils4Nutrition), the Food and Agriculture Organization of the United Nations, together with the government of Bangladesh, has tested this approach in three areas of Bangladesh, Chandina,

Chuadanga Sadar and Baliadanghi. Bio-fortified varieties have cultivated in several field trials under different management practices. The yields and nutrient content of crops have then been analyzed in order to produce recommendations of management. The objective is to provide policy makers and extension services with the knowledge for promoting an increased and longer-term nutrient supply to plants that allows a higher nutrient content in crops and contributes to a better nutrition.

Healthy crop soils: the gear for better nutrition

The soils of Bangladesh are naturally low in organic matter (OM) with organic contents for mineral soils below 2%, ranging between 0.05 and 0.9 % in most cases (Huq and Shoaib 2013). The OM supply in soil is one of the major constraints for the country's agriculture. Due to intensive agriculture, the soil organic matter has declined even further and hence soil health also deteriorated.

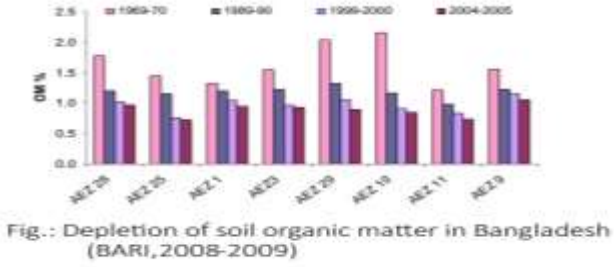


Fig.: Depletion of soil organic matter in Bangladesh (BARI, 2008-2009)

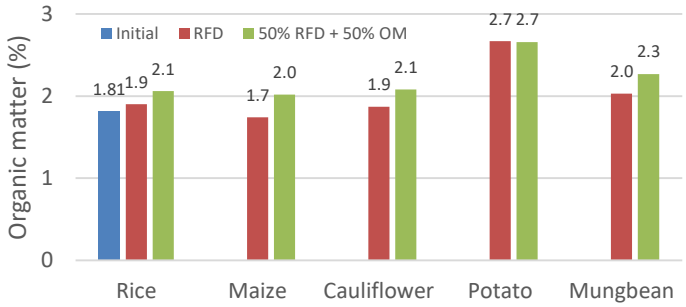
Figure 1 Depletion of soil organic matter in Bangladesh (BARI, 2008-2009)

Through soil recarbonization practices such as the application of organic manure to the soil and the inclusion of legumes to the cropping pattern, SSM can revert this declining trend, thus improving soil health, while providing higher yields of nutrient rich crops and farm profits.

This has been proved in the field trials of the Soils4Nutrition project. Additions of OM have allowed to increase the soil organic matter and the crop yields while reducing the chemical fertilizer needs in a 50% compared to RFD[1].

When used together with a cover crop (mungbean), the SOM increase was optimized. Added benefits of N fixation, diversifying diets, increasing biodiversity and increasing resilience to unpredictable climate.

The benefits of OM application are consistently observed as an increase of ca. 20 % in the medium and long term, independently from the soil pH. Fertilizer management has shown no significant



[1]**RFD: Recommended Fertilizer Dose**

effect on soil pH. So, acidity amendments may be required for optimized soil fertility and reduced toxicity effects in acid soils as frequent in Bangladesh.

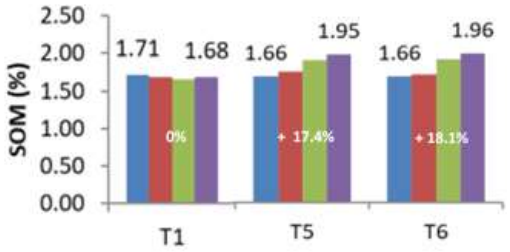


Figure 3Medium and long term SOM status with different treatments

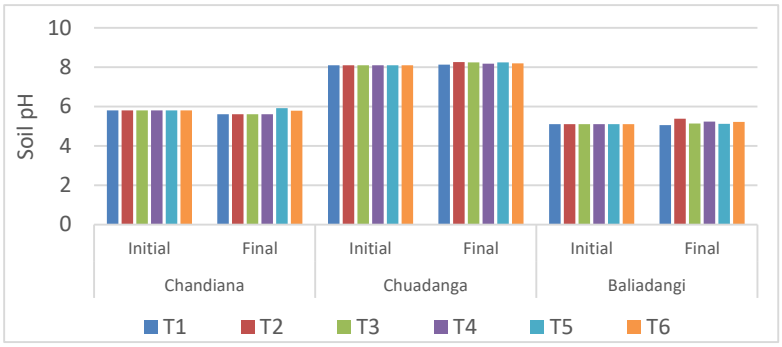


Figure 4Soil pH has remained stable under different fertilizer treatments at the three demonstration sites

The right rate, time, place, and source for micronutrient fertilizers

Basal application of zinc is recommended in Bangladesh by 'Fertilizer Recommendation Guide'. The results of the field tests carried out under the S4N project have shown that basal applications of micronutrients together with organic additions can increase the zinc content of soil pool. On the

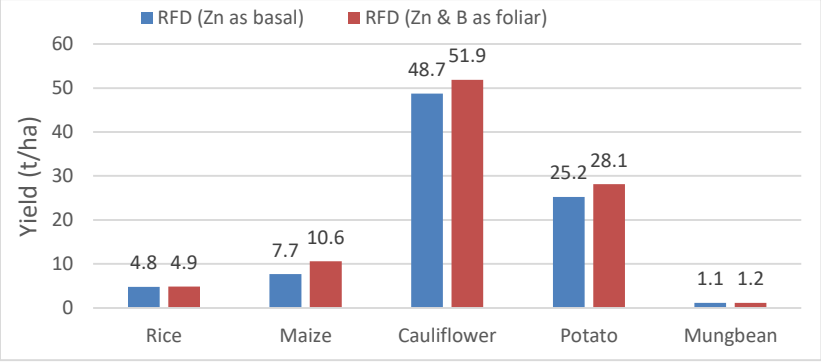


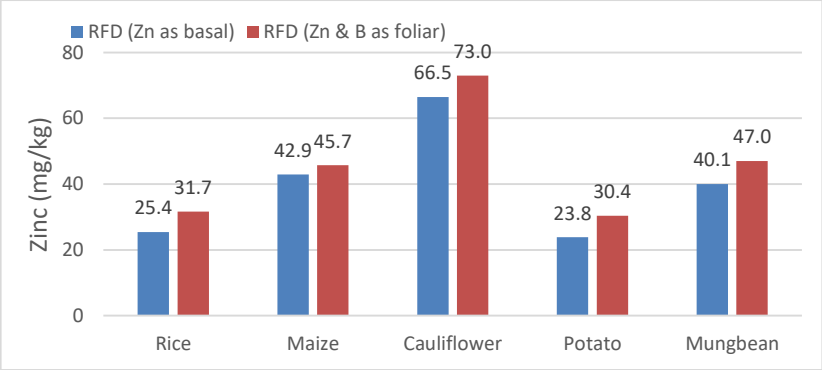
Figure 5Higher yield for foliar application of Zn & B than basal application of Zn

Figure 6Foliar application of Zn and B increased grain/edible parts zinc content of different crops

other hand, applying Zn and B as foliar spray during the flowering period of crops optimizes both yield and the amount of Zn in crops in comparison with the application of basal fertilizer only.

This indicates that strategies combining both basal and foliar applications provide the best outcome from a twofold point of view: while basal fertilization improves soil nutritional status, thus enhancing the system's long-term capacity for an improved plant nutrition, foliar applications provide immediate increases in both yields and nutrients in the edible parts of crops.

Importantly, for an adequate management of fertility for an optimal plant growth and nutrient content in crops, both plants growing cycle and soil characteristics must be considered when planning fertilization strategies. The characterization of the soil nutrient pool and the nutrient



cycling through periodic soil and monitoring will allow to use the adequate fertilizers efficiently. Conversely, predictions from soil science of nutrient deficiencies and nutrient interactions may help in the identification of target areas for comprehensive interventions in nutrition management, rather than focus on single-nutrient strategies. This has to be accompanied also by an exact knowledge on the composition of fertilizers, in order to avoid toxicity issues and to achieve the maximum cost-efficiency.

Technology dissemination and capacity development.

Farmer-to-farmer extension initiatives such as the 'Global Soil Doctors Programmeme' (GSDP), have demonstrated to be very efficient in order to foster adoption of SSM linked to better nutrition. In Bangladesh, the GSDP has provided training to 450 farmers on the basic concepts of soil, soil sampling, soil pH, soil nutrients etc. in a pilot site. Fifteen farmers were then selected as 'Soil Doctors' that explained and disseminated knowledge on sustainable soil management and soil health to end beneficiaries. Upscaling of such activities to the country scale can potentially help farmer communities to know their soil, its maintenance and relationship with human nutrition, thus empowering them for achieving an improved food security.

Figure 7Soil Doctor Training Group

Recommendations and way forward

Through an in-depth review of the scientific literature on nutrition sensitive agriculture (FAO, 2022) and based on the results of the Soils4Nutrition project in Bangladesh, the followed recommendations arise:

(i) Soil health must be considered and regularly monitored within any nutrition sensitive agriculture intervention.
(ii) The use of biofortified varieties has to be embedded in a Sustainable Soil Management strategy, in order to ensure that soils are capable of a long term supply of nutrients while maintaining a healthy status.
(iii) The incorporation of a legume cover crop to the existing cropping pattern through intercropping or crop rotation is advised in order to improve soil health, through OM increase and N fixation, and to foster biodiversity and diversify diets.
(iv) The mainstreaming of integrated soil fertility management (ISFM) including the combined use of organic and mineral fertilizers and of foliar and basal applications. The convenience of pH correction through liming must be also considered within ISFM.
(v) The application of organic manure to the soil in order to improve its physical and chemical properties, to increase yields and to reduce the expenses in mineral fertilizers.

(vi) To include foliar application of a balanced dressing of micronutrients during flowering period to increase the micronutrient content of grain/edible parts.
(vii) The countrywide implementation of 'Global Soil Doctor Programmeme" to improve technical knowhow of farmers on soil health and human nutrition.

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Future Research Programmes (2022-2023)

i. Study on sludge management produced from Pagla Sewerage Treatment Plant of Dhaka WASA through composting process.
ii. Nutrient Management for Diversified Cropping in Bangladesh.
iii. Acidic soil management through poultry waste- based compost.
iv. Heavy metal content in soils and edible parts of the crops grown in different location of Bangladesh.
v. Effect of DAP fertilizer on soil reaction in northern part of Bangladesh.
vi. Determination of Molybdenum in soils of southern part of Bangladesh.
vii. Quality control programme on inter laboratory analysis of soil and fertilizer samples.

Chapter 5: Achievement of Projects & Programmeme

Achievement of SRSRF Project in 2021-2022

Type of activities	Achievement
Research on soil conservation & watershed management	Basic Research-6 Adaptive Research-9
Research on soil salinity management	Basic Research-8 Adaptive research-12
Research on acid soil management	Field Research-32
Technology transfer	Adaptive Research trial-24 Field day-24
One day training on soil sample collection technique and use of balanced fertilizer	3420 farmers, entrepreneurs & others (76 batches)
One day training on identification of adulterated fertilizer	240 farmers, fertilizer dealers, extension workers & others (8 batches)
6-day TOT training on the use of Upazila Nirdeshika & Union Shahayika	12o officers, teachers, researchers & others (4 batches)
3-day training on the use of Upazila Nirdeshika & Union Shahayika	60 officers, teachers, researchers & others (2 batches)
SAAO training on the use of Upazila Nirdeshika	1050 (21 batches)
Skill development training of officers	60 (2 batches)
Priniting of Union Shahayika	100
Preparing festoon for local level fertilizer recommendation	100
Organizing group discussion	4
Transformation of SRDI's central laboratory into accredited laboratory	Provided spare parts for two AAS and one fume hood
Supply of chemicals for SRDI laboratories	Supplied as per demand
Purchase of laboratory and field equipment	Supplied as per demand
Establishment of web base virtual soil museum	Implementation process ongoing

Achievement of GKBSP Project in 2021-2022

Type of activities	Achievement
Research/ adaptive trial	Rabi-140 Kharif-1:150 Kharif-2:150 Total:440
2-days officers' training	No. of batch-1
2-days SAAO's training on problem soil management	No. of batch-2
One day's farmers training on soil sample collection technique & identification of adulterated fertilizer	No. of batch-120
Survey	Union survey-18 Upazila surface water-6
Printing	Union shahayika-28 Display board-60
Publication	Leaflet-10,000

Type of activities	Achievement
Procurement	Lab Equipment-231
	Computer and Accessories-5
	Office Equipment-2

Achievement of CCBS Project in 2021-2022

SRDI Head Office Dhaka: Old office building broken down and removed. New building preparation work going on. Shore pile driven is completed. Tie beam rod binding going on.

Rajshahi: Second Roof casting going on.

Khulna: Pile driven completed.

Cumilla: Great beam casting completed. Column casting going on for first roof casting.

SMRC, Batiaghata, Khulna: Electrical work, internal road and boundary wall completed.

SCWMC, Bandarban: Electrical work completed, Internal Road and boundary wall work order is given.

Achievement of"Acidic soil management and sustainable crop production & improvement of soil fertility by practicing climate smart agricultre in Barind area" Programmeme in 2021-2022

Activities	Achievement
Conducting field trial	Adaptive Trial: 15 Nos.
	Research Trial: 10 Nos.
3-days SAAO training on acid soil management and sustainable crop production	SAAO-30 (1 batch)
One day training on balanced fertilizer utilization, soil sample collection and Identification of Adulterated fertilizers	Farmers-50

Achievement of "Assessment of Cultivated Land Area for Different Crops Using Remote Sensing and Upazila Nirdeshika"

Activities	Achievement
One day training of officers on map preparation using GIS and Remote sensing software.	No. of officer: 30 (2 batches)
One day training on how to collect crop's signature data using survey 123 apps.	SRDI officers-2 baches. SAAO-23 batches
Collection of signature data	Upazila: 138 upazila Collected signature: 8600 polygon and 1100-point data of different crops Season: Rabi and kharif1

Achievement of "Strengthening of Three Newly Created Laboratories" Programme (STNCLP)

Activities	**Achievement**
Seminar/Conference	Organized
Printing & Publishing	Purchased
Training: a) Farmers' b) Lab Attendant	 a) 10 batches (250 beneficiaries) b) 01 batch (25 lab attendants)
Lab. Chemicals	Procurement completed and distributed to concerned laboratories as per demand.
Uniform/Apron	Purchased and distributed to laboratories as per demand.
Electric materials (AC, Freeze & Photocopier)	Purchased and distributed to laboratories as per demand.
Laboratory Equipment (Instruments, Glassware & Safety Materials)	Procurement completed and distributed to concerned laboratories as per demand.
Furniture (Table, Computer Table, Visitor Chair, Book self)	Purchased and distributed to laboratories as per demand.

Chapter 6: Activities of Research Centers

6.1 Soil Conservation and Watershed Management Center (SCWMC), Bandarban

EXPT. No. 1

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

Md. Mahbubul Islam

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. It was observed that the average highest soil loss was 14.0 ton/ha in line to line distance 2 meter managed plot (18.65, 14.64 ,11.66 & 10.98 ton/ha/yr.) in the year of 2018-19 to2021-22 and Average lowest soil loss was 11.0 ton/ha in line to line distance 1 meter managed plot (14.43, 11.33, 9.17 & 9.05 ton/ha/yr.) in the year of 2018-19 to 2021-22. On the other hand, the highest average return (1,94,000 BDT) was obtained from line to line distance 2-meter managed plot (ha/yr.) and the lowest average return (1,68,000 BDT) was obtained from line to line distance 1 meter managed plot (ha/yr) in the year of 2018-19 to2021-22. 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.

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 is 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 pressure 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-renewable 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 there 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 programme 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 Sadarupazila, 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 m^2 (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-1. 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-3 & 4 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-6). Yield defers from row-to-row distance (shown in Table-7). 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/-per hectare per year during FY 2018-19, 2019-20, 2020-21 & 2021-22 and average return was 1,94,000/- for four years. while those were Tk. 90,000/-, Tk. 1,83,000/- Tk. 1,92,000/- and Tk 2,07,000/- during FY. 2018-19, 2019-20, 2020-21 & 2021-22 and average return was 1,68,000/- for four 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-1: Initial fertility status and fertility status after broom cultivation

Parameter	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	4.24H	0.212M	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	4.64H	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-2: 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-3: Soil loss under the cultivation of broom grass hill different treatments-2018-22 (t/h/y).

Particulars	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total S0il loss (T/ha)	Average S0il loss (T/ha)
Broom-1 Meter	2018-19	_	_	_	_	_	3.24	3.97	2.90	1.98	2.34	_	_	14.43	**11.00**
	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**	
Broom- 2 Meter	2018-19	_	_	_	_	_	4.16	4.78	3.56	2.47	3.68	_	_	18.65	**14.00**
	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	
	2021-2022	-	-	-	-	0.32	2.86	1.54	3.45	1.61	1.20	-	-	10.98	
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	

Table-4: Run off (%) under the cultivation of broom grass hill different treatments-2018-22 (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**		
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**		

Table 5. Nutrient loss (tha^{-1}) from plots under different treatments- (2019-20).

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: 6. 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) programme and means were separated by critical difference (CD) values at 5% level of significance.

Table-7: 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/-		
2019-	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/-	**1,68,000/-**	**1,94,000/-**
2021-22	2064	138	2070/-	2278	152	2280/-	2,07,000/-	2,28,000/-		

Conclusions

The planting of broom grass has a direct impact on preventing surface soil erosion on steep hillsides. Broom grass grows in clumps and has many tangled-up roots that grow to about one meter below the ground. This makes it highly effective in preventing soil erosion on hillsides as the grass is less likely to fall compared to other plants. The roots and leaves of the plant slow down water drops and the flow of water after heavy rain by absorbing the water in the soil. It also increases the local biodiversity in the communities. Various journals prove that 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. The grass also possesses numerous medicinal properties that are essential in subsistence communities. 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.

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EXPT. No. 2

EFFECT OF PLANTATION OF BAMBOO FOR EROSION CONTROL AND ITS ECONOMICAL PURPOSES. MULI/PAIYA: *GIGANTOCHLOA ROBUSTA* AND ORA: *FARGESIA ROBUSTA.*

Md. Mahbubul Islam

Abstract

The potential of bamboo in erosion control and slope stabilization has been proven worldwide. Bamboos are being used as living plants as well as construction material in different soil bioengineering techniques in many countries. Bamboo shoots are crisp, tender, and have a mild, corn-like taste. Two indigenous types of bamboo were selected so that those can be surviving with the local climatic condition. Between two, one is locally called Paiya/Muli bamboo and another is called Ora bamboo. Locally fabricated multi-slot devisor was installed at each plot for estimating Soil Loss and Runoff from those plots. It was recorded that the highest soil loss was recorded on Paiya bamboo and lowest soil loss was recorded on 0ra bamboo plot. Bamboo has evergreen leaves, dense canopy and numeral culms which can help to intercept considerable amount of rainfall. Falling raindrops change their direction and ways and reduce velocity, and therefore decrease soil erosion. Bamboo leaves can filter air pollutants, recycle CO_2 and replenish the atmosphere with Oxygen. Bamboo is also helpful against landslides and soil loss by preventing erosion.

Introduction

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)*. Due to different type of land degradation, Bangladesh lost a substantial amount of production which in terms of money may be thousands of billion takas in every year (BARC, 1999). The potential of bamboo in erosion control and slope stabilization has been proven worldwide.

Bamboos are being used as living plants as well as construction material in different soil bioengineering techniques in many countries. The soil and water bioengineering approach are combined with bamboo traits and mechanical properties. The existing accumulated experiences of using bamboo in soil and water bioengineering works, along with the existing standards and design guidelines, make bamboo species an essential and cost-effective material for erosion control and slope stabilization works.

Bamboo is a globally distributed group of plants with more than 1400 species distributed worldwide in tropical, equatorial and semitropical biomes. It builds important and diversified habitats with different specificities, according to the nature of the species and the general ecological conditions. Most bamboo species show a very strong development and colonization ability, determining that in some temperate habitats, they can assume an invasive character. Soil bioengineering comprises a diversified group of techniques and land management systems developed by mankind throughout the millennia to use natural systems and elements in order to ensure the safety and functionality of land uses in a context of restricted availability of materials and, particularly, energy. Soil bioengineering techniques have been used throughout the world with the available plants and construction systems, many times replicated in different continents due to its efficiency and easy construction. Only in the first decades of the twentieth century, this set of building and land management techniques has been recognized as an integrated engineering approach to many soil stabilization problems, and they started to be systematized, studied and developed.

The strength of bamboo culms and roots and their straightness, lightness combined with hardness, range and size of hollowness make them potentially suitable for a variety of both structural and nonstructural applications. With good physical and mechanical properties, low shrinkage and good average density, bamboo is well suited to replace wood/timber in soil bioengineering applications but also to act on its own as a living material providing rapid ground coverage and sediment trapping, increasing surface roughness, increasing soil strength and decreasing pore-water pressures in the soil by evapotranspiration. The use of bamboo to make retaining structures for soil mass or for stream bank erosion control has been practiced in traditional way in various places around the world for long time. Live bamboo stakes, wattle fence, hedge brush layering techniques and bamboo crib walls are most commonly used bioengineering techniques. A live bamboo crib wall is a three-dimensional structure created from untreated bamboos, fill material and live cuttings. Morgan and Rickson [5] described the crib wall as ‘a specialized form of gravity-retaining structure using on-site fill material, held within a constructed framework, to provide most of the necessary mass to resist overturning by the weight of both the slope and the materials.

Bamboo belongs to the grass family and has an aerial part characterized by a jointed stem called a culm. The culms are typically hollow with the exception of certain bamboo species which have solid culms. The underground part of the plant is built from rhizomes growing normally at a shallow depth (up to a maximum of 150 mm) from where the roots develop. These roots can grow deep into the soil up to 500 mm. The rhizomes are the main form of spreading of the plant by growing horizontally away from the plant and, because they have a similar structure as the culm with vegetative nodes developing either roots or buds, originate new shoots and new individuals.

Bamboo is the fastest growing perennial, evergreen, arbores cent plant with a resulting high productivity: the dry weight yield per hectare could total as much as 32–38 or even 47 tons of biomass per hectare per year but averaging 8–18 tons per ha per year in normal conditions according to the different species and locations. This productivity, expressed both for the aerial

and the root parts of the plant, illustrates the ability of bamboo to cover the terrain very rapidly, to develop a dense network of sub superficial rhizome and root system which would structure and consolidate the upper soil layer.

Bamboo is globally distributed between 51°N and 47°S, particularly in subtropical, tropical and equatorial regions. It also covers a high-altitude range, reaching up to 4000 m above sea level and thriving at temperatures as low as −20°C. The main area of occurrence is Asia where the largest number of species can be found. There is also a growing interest for bamboo as an ornamental plant, which brought the spread of several species to areas outside their natural ecological areas. This also raised some problems such as turning into invasive species and threatening natural habitats. The reinforcement effect ensured by bamboo roots can be expressed in engineering terms as an 'additional cohesion' added to the strength of the non-rooted soil Eq. Therefore, the total cohesion of a rooted soil will be the sum of the uprooted soil cohesion plus the cohesion increase due to the presence of roots in the soil. The rooted soil strength value is then used in traditional slope stability analysis methods (e.g., limit equilibrium methods) to determine the overall slope stability:

Bamboo shoots are crisp, tender, and have a mild, corn-like taste. They're low in fat and high in fiber and potassium. The shoots of most temperate bamboos are edible, but some are naturally sweeter (and larger) than others, and therefore need less processing. Below is a list of bamboos particularly well suited for shoot production? Bamboo shoots are best when cooked to remove trace amounts of cyanogens (as in cyanide) and other bitter compounds which make them hard to digest. As an aside, bamboo foliage is good fodder for some types of animals. We supplement our rabbit food with bamboo leaves, which they seem to love. Some farmers are feeding bamboo to their goats, sheep, cows and even llamas. The animals receive fodder and provide a useful service by eating the leaves and branches off poles which can then be used for numerous building projects or for market.

A case study conducted under a research project from the University of Natural Resources and Life Sciences Vienna (BOKU) and the Tribhuvan University Kathmandu, Nepal [44]. Bamboo made crib walls are comparatively cheaper than gabion or stone masonry wall (construction costs only ¼ of gabion and 1/5 of masonry wall) but provide the same technical stability. Experiences of using bamboo in soil and water bioengineering works, together with the existing standards and design guidelines, make specific bamboo species an essential and cost-effective material for erosion control and slope stabilization works where these species are native.

Objectives

I. Reclamation of gullied land by minimizing erosion hazard.
II. For Landscape, aesthetic and economic purposes,
III. For environmental and ecological conservation,
IV. To mitigate the demand of food and fodder,
V. To introduce handy craft as a part off-farm activities for livelihood.

Materials and Methods

Two indigenous types of bamboo were selected so that those can be surviving with the local climatic condition. Between two, one is locally called Paiya/Muli bamboo and another is called Ora bamboo whose scientific names are *Gigantochloarobusta* and *Fargesiarobusta.* The

experiment was carried out non replicable condition. Two experimental plots having area of 100 sq.m (5m x 20m) each on a degraded land (very steep to extreme steep slope) were selected in the SCWMC's Research area at Bandardarban Sadar upazila, Bandarban. Bamboo seedlings were collected from the culms situated in the nearby areas and planted in the month of July- 2018 following contour lines maintaining row to row distance 2.0 m and plant to plant distance 1.0 m. Before plantation, jungles were cleaned and composite Top soil samples were taken for nutrient studying. Locally fabricated multi-slot devisor was installed at each plot for estimating Soil Loss and Runoff from those plots. The seedlings were planted by dibbling method. Only one seedling was planted in each pit. After plantation of the seedlings, intercultural operation has been done when necessary. No fertilizer and manure were applied to the seedlings.

Soil loss and run-off from each 100 sq.m (20 m. x 5 m.) experimental plot were measured after each shower throughout the rainy season. Daily and eventually monthly soil loss and run-off were estimated from each plot by processing aliquot of sample every day. Every morning (if rains previous day) amount of run-off water has been measured in multi-slot divisors and aliquot of about 2 litre of homogeneous sample has been collected from each tank. Suspended sediment in the sampled aliquot has been measured by simple lab. filtering and oven drying. Corresponding rainfall was recorded by manual type and ordinary rain gauge installed in SCWMC meteorological station where climatic data like rainfall, temperature, humidity, evaporation etc. are being recorded regularly.

Results and Discussion

Table 8. Initial soil fertility status and fertility status after crop harvest.

Parameter	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		
Payia Bamboo	2017	5.4	2.76 M	0.138 L	2.65 VL	0.41 H	66.69 VH	2.50 VH	0.56 O	7.72 VH	1.53 H	0.97 VH	97.80 VH	24.54 VH
	2018	4.1	5.5 H	0.275 O	1.03 VL	0.51 VH	26.01 O	6.99 VH	0.40 M	8.93 VH	2.81 VH	3.23 VH	77.68 VH	21.39 VH
Ora Bamboo	2017	4.8	3.09 M	0.155 L	2.05 VL	0.33 O	0.001 VL	2.03 H	0.29 L	5.26 O	1.04 M	0.92 VH	92.45 VH	17.68 VH
	2018	4.1	5.8 VH	0.290 O	0.96 VL	0.47 VH	36.08 H	7.05 VH	0.16 L	7.44 H	2.00 VH	4.25 VH	66.03 VH	20.71 VH

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

Table-9: Soil Texture

Particulars	Soil Textural Class	Sand	Slit	Clay
		%		
Payia Bamboo	Silt Loam	23	62	15

Ora Bamboo	Silt Loam	28	54	18

Table 10: Soil loss under Paiya/Muli bamboo and Ora bamboo *Gigantochloa robusta* and Fargesia robusta during 2018-2019 to2021-22 (t/h/y).

Particulars	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Average
Payia Bamboo	2018-19	-	-	-	-	-	2.35	6.93	6.97	2.81	4.22	-	-	23.28	
	2019-20	-	-	-	-	-	1.97	6.78	4.53	3.32	1.87	-	-	18.47	**17.85**
	2020-21	-	-	-	-	1.24	1.86	2.59	3.22	2.38	3.08			14.37	
	2021-22					0.25	2.25	4.65	3.74	2.52	1.87			15.28	
Ora Bamboo	2018-19	-	-	-	-	-	1.91	6.13	6.20	1.66	1.83	-	-	16.07	
	2019-20	-	-	-	-	-	0.91	5.20	3.86	2.75	1.14	-	-	13.86	**12.65**
	2020-21	-	-	-	-	082	1.24	1.69	2.72	1.44	2.38			10.29	
	2021-22					0.16	1.56	2.78	3.08	1.65	1.15			10.38	

Soil loss under different bamboo species on degraded and gullied plots during 2018-2019 to 2021-22sessions are being presented in table 10. Which was recorded throughout the rainy season. It was recorded that the average highest soil loss was 17.85 t/ha (23.28, 18.47, 14.37 & 15.28 $tonh^{-1}y^{-1}$ in 2018-19 to 2021-22) on Payia bamboo and lowest average soil loss was 12.65 t/ha on Ora Bamboo plot (16.07, 13.86, 10.29 & 10.38 ton $h^{-1}y^{-1}$ in 2018-19 to 2021-22). Run-off percentage under different bamboo species on degraded and gullied plots during 2018-2019 to 2021-22 sessions are being presented in table 11. Which was recorded throughout the rainy season.

Table 11 : Run-off under Paiya/Muli bamboo and Ora bamboo *Gigantochloa robusta* and *Fargesia robusta during* 2018-2019 to 2021-2022.

Particulars	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Paiya Bamboo	2018-19	-	-	-	-	-	21.53	36.03	50.76	53.07	45.13	-	-	-
	2019-20	-	-	-	-	-	21.35	54.18	41.85	42.42	33.36	-	-	-
	2020-21	-	-	-	-	20.21	23.62	35.72	55.78	52.19	55.64	-	-	
	2021-22					9.58	20.60.	33.48	39.36	25.45	32.12			

Particulars	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Ora Bamboo	2018-19	-	-	-	-	-	21.47	33.86	58.84	50.27	38.27	-	-	-
	2019-20	-	-	-	-	-	22.64	50.83	39.73	41.92	32.08	-	-	-
	2020-21	-	-	-	-	23.50	25.68	40.18	65.23	60.82	58.70	-	-	
	2021-22					7.2	19.47	29.70	31.53	22.45	24.36			
Rain fall	2018-19	3	0	0	67	207	607	691	256	249	266	0	14	2360
	2019-20	0	57	9	72	234	244	1024	398	411	141	43	9	2642
	2020-21	40	0	0	133	217	297	380	410	361	405	23.	0	2266
	2021-22	-	-	-	-	108	545	531	585	376	203	-	-	2348

Table 12. Nutrient loss (tha^{-1}) from plots under different land use (2018).+

Particulars	N	P	K	S	Zn	B	Ca	Mg	Cu	Mn
Payia Bamboo	5.2	0.00266	0.71944	0.00604	0.00088	0.0005	2.716	0.7776	0.00042	0.02118
Ora Bamboo	4.9	0.00208	0.30498	0.014	0.00058	0.00036	1.912	0.6	0.00034	0.01974

Table-13: Yield and Return (BDT) of the Bamboos (Payia & Ora Bamboo).

Financial year	**Stage and Yield**		**Economical return**		**Remarks**
	Payia Bamboo	Ora Bamboo	Payia Bamboo	Ora Bamboo	
2018-2019	Seedling stage	Seedling stage	Seedling stage	Seedling stage	**Payia bamboo takes more time for sprouting & harvesting as compared to Ora bamboo.**
2019-2020	Growing stage	Growing stage	Growing stage	Growing stage	
2020-2021	Selection harvesting Stage	Selection harvesting Stage	Tk. 2,250/- (150 Nos. @ Tk. 15/- each)	Tk. 4,000/- (200 Nos. @ Tk. 20/- each)	
2021-2022	Harvesting Stage, 180 nos.	Harvesting Stage, 250 nos.	180 nos. x 15/- =2,700/- per plot (100m2) =2,700/- x100 =**2,70,000/-per ha**	250 nos. x 20/- =5,000/- per plot (100m2) =5,000/- x100 =**5,00,000/-per ha**	

Conclusions

Bamboo has evergreen leaves, dense canopy and numeral culms which can help to intercept considerable amount of rainfall. Falling raindrops change their direction and ways and reduce velocity, and therefore decrease soil erosion. Bamboo leaves can filter air pollutants, recycle CO_2 and replenish the atmosphere with Oxygen. Bamboo is also helpful against landslides and soil loss by preventing erosion. The soil and water bioengineering approach are combined with bamboo traits and mechanical properties. The existing accumulated experiences of using bamboo in soil and water bioengineering works, along with the existing standards and design guidelines, make bamboo species an essential and cost-effective material for erosion control and slope stabilization works.

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EXPT. No. 3

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

Md. Mahbubul Islam

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 three years indicates that the gully bed was filled with eroded soil from its catchment area of 0.12hac is 0.628 m which is equivalent to 138.188 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.

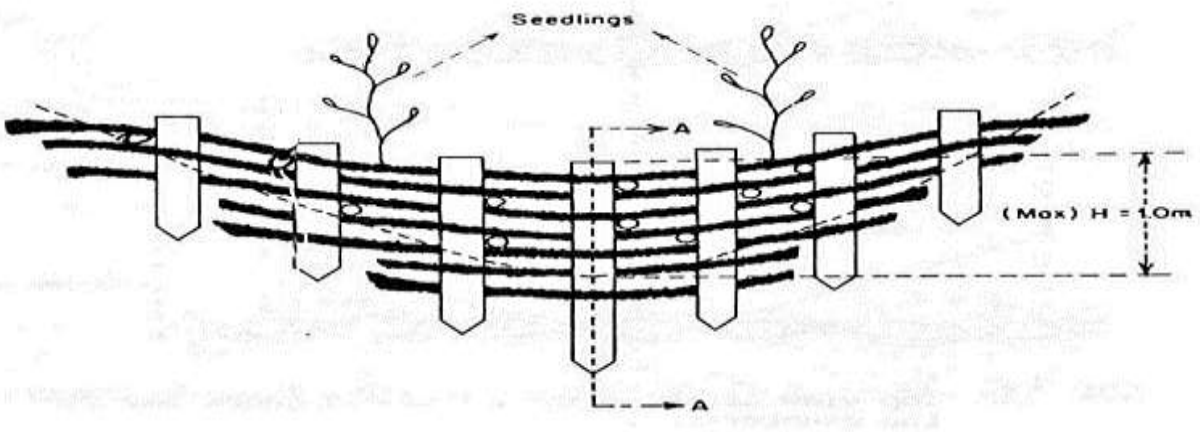
Materials and Methods

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 were 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 $tonh^{-1}y^{-1}$. Finally, 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 $tonh^{-1}y^{-1}$. After Four years total deposition depth of eroded soil is 138.188 ton/ha. Amount of deposited soil is shown in Table-14. Weight of deposited soil was assumed to be on average 1400 kg per cubic meter.

Table-14: Amount of soil deposited by Brush wood Check Dam.

Location	Cross Sectional Area of the Gully bed (m^2.)	Catchment area of the gully (check dam) in hac.	RL of gully bed(m) June-18	RL of gully bed(m) March-19	RL of gully bed(m) April-20	RL of gully bed(m) April-21	RL of gully bed(m) April-22	Depth of deposition (m)	Amount of deposited soil (m^3)	Deposited amount from the catchment each year (ton)	Deposited amount $tonh^{-1}y^{-1}$	Total Depo- sition (ton/ha)
Upper check dam	8.20x2.30 = 18.86	0.12	94.102 (Initial)	94.418	94.54	94.62.	94.73	0.316 (2019)	5.96 (2019)	8.344 (2019)	69.533 (2019)	**138.188**
								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)	

Note: Weight of 1.0 m^3 soil = 1.3 to 1.7 ton. Here considered 1.4 ton per m^3 of soil.

Conclusions

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.

As the Research Within three years, the gully bed has been raised up 0.628 m which proves that the check dam is capable to check 138.188 ton/hac sedimentation carried from the upper catchment area. Not only that, as the check dam interrupt surface run-off velocity, it also increase 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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EXPT. No. 4

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

Md. Mahbubul Islam

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. The lowest soil loss recorded in practicing zero tillage cultivation method across the hill slope and the highest soil loss recorded in digging up along the slopes. This research improves soil healthy by reducing soil erosion hazard, enhances crop production and encourages the hill dwellers to adopt the cultivation system to losing zero tillage across the hill slope in contour.

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 associated 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 phenomenon (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 15. Initial soil fertility status and fertility status after crop harvest.

Parameter	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-16: 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 ton/ha/yr. in the year of 2018-19,2019-20 ,2020-21 & 2021-22 respectively and finally the average highest soil loss was 55.38 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 ton /ha/yr. in the year of 2018-19, 2019-20 ,2020-21 & respectively and finally the average lowest soil loss was7.20 ton/ha/yr. On the other hand, soil loss recorded in digging-up across the slope were 52.04, 49.91, 43.35 & 34.12ton/ha/yr. in the year of 2018-19, 2019-20, 2020-21 & 2021-22 respectively and average was 45.0 ton/ha and zero tillage cultivation method along the hill slope were 14.48, 13.19 ,12.41 & 11.38 ton/ha/yr in the year of 2018-19, 2019-20, 2020-21 & 2021-22 respectively and average was 12.86 ton/ha.

Table 17. Total Soil Loss (ton/ha/yr) under indigenous & Zero Tillage cultivation methods of Pineapple for 2018-19, 2019-2020, 2020-21 and 2021-2022.

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	**45.00**
	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	
	2021-22					1.544	6.85	7.69	8.08	5.76	4.24			34.12	
Digging up Along	2018-19	-	-	-	-	-	7.71	19.83	16.25	14.83	9.97	-	-	68.59	**55.38**
	2019-20	-	-	-	-	-	4.84	27.69	9.52	11.91	6.23	-	-	60.19	
	2020-	-	-	-	-	4.23	7.68	8.04	11.50	10.05	11.03	-	-	52.55	
	2021-					2.899	8.79	8.23	9.49	6.65	4.25			40.21	
Zero tillage Across	2018-19	-	-	-	-	-	0.96	3.49	2.29	0.72	1.23	-	-	8.69	**7.20**
	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	
Zero tillage Along	2018-19	-	-	-	-	-	1.4	6.22	3.57	1.76	1.53	-	-	14.48	**12.86**
	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	
	2021-22					0.35	2.64	2.39	3.11	1.70	1.24			11.38	
Rainfall (m/m)	2018-19	3	0	0	67	207	607	691	256	249	266	0.0	14	2360	
	2019-20	-	57	9	72	234	244	1024	398	411	141	43	9	2642	
	2020-21	40	-	-	133	217	297	380	410	361	405	23	-	2266	

	2021-22	-	-	-	-	108	545	531	585	376	203			2348	

Table-18: Run off (%) under the cultivation indigenous & Zero Tillage cultivation methods of Pineapple.

2018-19, 2019-2020, 2020-2021 and. 2021-22.

Particulars	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Rain fall (m/m)
Digging up Across	2018-19	_	_	_	_	_	29.48	61.10	61.12	63.39	63.36	_	_	_
	2019-20	_	_	_	_	-	40.78	51.99	50.26	44.28	34.37	_	_	_
	2020-21	_	_	_	_	26.49	42.45	46.54	45.65	30.56	68.95		_	_
	2021-22					11.35	23.56	21.45	24.75	22.45	20.12			
Digging up Along	2018-19	_	_	_	_	_	27.26	59.24	68.66	65.75	57.15	_	_	_
	2019-20	_	_	_	_	-	45.01	53.75	53.50	47.42	38.03	_	_	_
	2020-21	_	_	_	_	28.42	45.25	49.37	46.10	33.82	70.38	_	_	_
	2021-22					12.4	30.25	28.70	31.32	27.85	23.54			
Zero Tillage Across	2018-19	_	_	_	_	_	25.78	56.77	65.75	53.93	54.05		_	_
	2019-20	_	_	_	_	-	33.39	49.72	46.38	38.64	30.72		_	_
	2020-21	_	_	_	_	19.43	23.90	37.03	39.99	26.23	57.62		_	_
	2021-22					9.4	22.70	20.45	23.20	19.80	18.50			
Zero Tillage Along	2018-19	_	_	_	_	_	26.52	55.53	57.15	58.66	50.94	_	_	_
	2019-20	_	_	_	_	_	36.56	51.24	50.91	41.15	32.55	_	_	_
	2020-21	_	_	_	_	23.36	39.76	41.11	43.76	29.14	60.16	_	_	_
	2021-22					10.5	24.30	22.8	26.80	21.64	19.60			
Rain Fall(m/m)	2018-19	3	0	0	67	207	607	691	256	249	266	0.0	14	2360.00
	2019-20	_	57	9	72	234	244	1024	398	411	141	43	9	2642.00

	2020-21	40	-	-	133	217	297	380	410	361	405	23	-	2266
	2021-22	-	-	-	-	108	545	531	585	376	203	-	-	2348

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 & 2348 mm in the year of 2018-19, 2019-20 ,2020-21 & 2021-22 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.19. Nutrient loss (tha^{-1}) from plots under different land use (2019)

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.20. Yield Study of Pineapple under different Cultivation Practices:

Cultivation practices	Yield per Plot (Nos)				Fruit Size	Sale Value per plot				Average Earning for 4 yrs.(tha^{-1})
						Total Earning (tha^{-1})				
	2018	2019	2020	2021		2018 19	2019-20	2020-21	2021-22	
Digging up Across	12	187	214	225	**Standard size**	216/-	3366/-	3,852/-	4050/-	**2,87,100/-**
						21,600/-	3,36,600	3,85,200	4,05,000/-	
Digging up Along	10	190	196	200	Comparatively smaller	150/-	2850/-	2,940/-	3000/-	**2,23,500/-**
						15,000/-	2,85,000/-	2,94,000/-	3,00,000/-	
Zero tillage Across	15	255	270	280	Comparatively bigger	300/-	5,100/-	5,400/-	5,600/-	**4,10,000/-**
						30,000/-	5,10,000/-	5,40,000/-	5,60,000/-	
Zero tillage Along	13	205	212	228	Standard size	234/-	3690/-	3,816/-	4104/-	**2,96,100/-**
						23,400/-	3,69,000/-	3,81,600/-	4,10,400/-	

For judging economic viability, the input & output cost of pineapple cultivation in different practices are also being studied. It was observed that the height average return comes from Zero tillage Across the slope 4,10,000/- and the lowest average return comes from Digging up Along the slope 2,23,500/- for four years. On the other hand, average return comes from Zero tillage Along the slope was **2,96,100/-** and digging-up across the slope was **2,87,100/-** for four years.

Conclusions

The conservation of soil and water is essential for sustainable production, environment preservation and balanced eco system. Loss of soil by water erosion on slopping lands adversely affects the physical, chemical and biological properties of soils, leading to low crop productivity, use of indigenous methods of pineapple cultivation has created negative effect on soil erosion. This research improves soil healthy by reducing soil erosion hazard, enhances crop production and encourages the hill dwellers to adopt the cultivation system to losing zero tillage across the hill slope in contour.

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EXPT. No. 05

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

Md. Mahbubul Islam

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 on its own research area. 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. Maximum soil loss 20.734 ton/ha.y^{-1} was recorded at controlled plot on steep slope where as minimum soil loss was 8.834 ton/ha.y^{-1} at pineapple hedge plot on gentle slope. Maximum yield was12.844 ton/hac.y^{-1} at pineapple hedge plot on gentle slope and minimum yield was 8.505 ton/hac.y^{-1} at controlled plot on steep slope .

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 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 intensity 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.

Objective:

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 m^2 (5m x 20 m) ^{for} each plot. Total area of each slopping land was 300 m^2. 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 m^2 (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 bamboos 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} was recorded at controlled plot on steep slope where as minimum soil loss was 8.834 ton/ha.y^{-1} at pineapple hedge plot on gentle slope. On field yield data was recorded. Only the ripen watermelon those were collected from field was included in yield data. Maximum number of fruits (76 nos.) with maximum weight (Average 1.69 Kg) was recorded on pineapple hedge plot on gentle slope. On the other hand, minimum number of fruits (63 nos.) with average minimum weight (1.35 kg) was recorded at controlled plot on steep slope. Maximum yield was 128.44 kg/plot *i.e.*12.844 ton/hac.y^{-1} at pineapple hedge plot on gentle slope and minimum yield was 85.05 kg/plot *i.e.* 8.505 ton/hac.y^{-1} at controlled plot on steep slope for the year 2021-22.

Table-44: 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 hedge	74	1.64	121.36	12.136
		Vetiver Hedge	72	1.62	116.64	11.664
		Controlled	70	1.56	109.20	10.920
3	Steep	Pineapple hedge	74	1.50	111.00	11.100
		Vetiver Hedge	73	1.45	105.85	10.585
		Controlled	63	1.35	85.05	8.505

Table-45: 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

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		
		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 Hedge	1.190	1.243	1.32	1.251	17.514
		Controlled	1.410	1.470	1.563	1.481	20.734

Conclusion

The research is going on from one-year past as the research is in the primary stage. 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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TRANSFERABLE TECHNOLOGY / ADAPTIVE RESEARCH

PROGRAMMEE-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.

PROGRAMMEE-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.

PROGRAMMEE-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.

PROGRAMMEE-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.
3) 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.

PROGRAMMEE-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.

PROGRAMMEE- 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), Batiaghata, Khulna

Experiment No. 1:

EFFECT OF DIFFERENT STRENGTH OF SALINE WATER ON EMERGENCE AND GROWTH OF COUNTRY BEAN

A Biswas

Abstract

Soil salinity is a major agricultural constraint in many countries. Plants' response to salinity depends on the salt concentration. The objective of this study was to test the effect of different strength of saline water on emergence and growth of country bean. This study was carried out under controlled conditions with five water salt concentrations (2, 4, 6, 8, and 10 dS/m) added to potting soil. A completely randomized design was used. Seedlings grown under saline conditions were investigated for emergence, root length, shoot length, fresh root weight, fresh shoot weight

and normal seedling%. The results revealed that root length, shoot length, fresh root weight, fresh shoot weight and normal seedling% tend to decrease when the electrical conductivity of the solution is increased.

Introduction

Salinity affects agricultural yield and quality in arid and semi-arid regions. Soil is said to have become salinized when the salt concentration in the root zone reaches a level too high for optimum plant growth and production. More than 20% of total cultivated lands in the world contain salt levels high enough to cause salt stress in cultivated plants. Salinity is becoming a serious agricultural problem, especially in irrigated lands located in semi-arid areas. High salt concentrations in the soil reduce the production of various plants around the world. Salts dissolved in soil water can reduce crop growth in two ways: by osmotic influences and by specific-ion toxicities. Crop plants differ a great deal in their ability to survive and yield satisfactorily when grown in saline soils. Some plants evolved strategies to survive and reproduce under highly saline conditions, where most plants cannot. These plants are named 'halophytes,' and they represent only 1% of all plant species. However, halophytes are defined as having the ability "to complete the life cycle in a salt concentration of at least 200 mm NaCl under conditions similar to those that might be encountered in the natural environment". The salt tolerance of halophytes varies among species and among different stages of a plant's life cycle, and the seed germination stage is generally considered more sensitive to salt than the mature plant growth stage for a crop. It is important to determine the limit of salinity that crops can tolerate and determine whether they can uptake and accumulate salts to use them for soil desalination. This may encourage and motivate farmers to introduce these plants into their cropping system. The goal of this study was to test the tolerance of country bean at different water salinity level.

Materials and Methods

The experiments were carried salinity management and research center, soil resource development institute, Batiaghata, Khulna to test the effect of different strength of saline water on emergence and growth of country bean. Plastic pots were used in conducting the experiment. The plastic pots were firstly washed by washing powder and followed by rinsing with distilled water. Then these were dried in air. After drying the plastic pots were ready for the experiment. Finely prepared soil was used as a matrix for seed emergence. Up to 4.5 cm of the pot was filled up by soil. Necessary amount of salt treatment was given to create saline environment by saturating the soil before placing the sweet gourd seed.

Preparation of Salt Solution

In order to develop the desired water salinity of 2 to 10 dS/m EC, saline water was collected from river and then it was mixed with non saline water. After that different treatment solution was prepared. Different concentrations (2, 4, 6, 8 and 10 ds/m) was applied to the sown seed on plastic pot. The salinity level was maintained by assessing the salt level, using EC meter. The experiment was laid out in the Completely Randomized Design (CRD) with three replications. The following treatments were 2, 4, 6, 8 and 10 dS/m. The seeds were transferred to the planting medium. Five disinfected seeds were placed in plastic pots. Each Plastic pot was prepared by moistened 2, 4, 6, 8 and 10 dS/m saline water. Emergence was monitored from the days of seed sowing till 5th days. Seeds were considered germinated when the radical was at least 2 mm long. The number of

germinated seeds was recorded daily and the final emergence percentage was determined after 5th days of. When emergence started after seed sowing, the daily data of emerged seedlings were recorded carefully.

The shoot lengths of germinated seeds were recorded after 30th DAS. One seedling was randomly taken from each plastic pot. Then they were divided into two parts viz. shoot and root. For shoot length and shoot lengths were recorded. The root length was taken in cm (centimeter). The root length of germinated seeds was recorded at 30th DAS. From each of the plastic pot five seedlings were taken randomly and averaged. Centimeter (cm) scale was used for measuring root length. The fresh weight of shoots was recorded at 30th days of seed sowing. The roots and shoots were separated and weighed. Then fresh weights of the shoot were taken with the help of electric balance in gram (g) and averaged. The fresh weights of the root were taken with the help of electric balance in gram (g). For this, after 30th days of seed sowing five samples were randomly taken from every plastic pot. Before weighting the root and shoot were separated and washed carefully to remove sand particle. After that fresh root weight were taken from individual plant and averaged.

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

Soil salinity (EC: dS/m) of Experimental pot

Initial Salinity of pot soil was 1.74 dS/m. After applying different strength of saline water soil salinity of different pot was increased.

Table 1: Soil salinity of different pot after applying different strength of saline water.

Treatment	Soil Salinity (EC*: dS/m) of pot			
	5 DAS**	10 DAS	20 DAS	30 DAS
T_1 (2dS/m)	1.79	1.85	1.96	2.13
T_2 (4dS/m)	1.85	1.91	2.96	3.87
T_3 (6dS/m)	1.92	2.14	3.41	5.12
T_4 (8dS/m)	2.05	2.85	4.25	6.42
T_5 (10dS/m)	2.56	3.21	5.34	7.36

*EC determined by 1: 1 extraction Method

** DAS- Days after sowing

Effect of water Salinity on emergence and growth

Emergence (%): 100% seeds were germinated for all treatment. Since all soil's salinity of all pots were more or less non saline after 5 days of seed sowing.

Root length: Root length of sweet gourd at 30 days of seed sowing ranged from 6.5 to 26.7 cm (Table 2). While the lowest root length (6.5 cm) was recorded for the treatment of 8 dS/m and the highest root length (26.7 cm) was obtained from 2 dS/m.

Shoot length: Shoot length of sweet gourd at 30 days of seed sowing ranged from 22.4 to 105.5 cm (Table 2). While the lowest root length (22.4 cm) was recorded for the treatment of 8 dS/m and the highest root length (105.5 cm) was obtained from 2 dS/m.

Table 2: Effect of water Salinity on emergence and growth of country bean

Treatment	Emer-gence (%)	At 30 days after Seed sowing				
		Root length (cm)	shoot length (cm)	Fresh root weight (g)	Fresh shoot weight (g)	Normal Seedling (%)
T_1 (2dS/m)	100.0	**26.7 a**	**105.5 a**	**8.4 a**	**44.8 a**	**100.0 a**
T_2 (4dS/m)	100.0	23.7 b	92.0 b	7.5 b	39.8 b	95.0 a
T_3 (6dS/m)	100.0	13.8 c	72.4 c	4.2 c	25.0 c	55.0 b
T_4 (8dS/m)	100.0	6.5 d	22.4 d	1.9 d	9.8 d	0.0 c
T_5 (10dS/m)	100.0	0.0 e	0.0 e	0.0 e	0.0 e	0.0 c
CV (%)	0.00	4.74	3.96	5.50	7.72	9.98

Fresh root weight: From the data, it was found that highest (8.4 g) fresh root weight was found from the treatment 1 (2 dS/m) and lowest (1.9 g) fresh root weight was found from treatment 4 (8 dS/m). (Table 2).

Fresh shoot weight: From the data it was found that highest (44.8 g) fresh shoot weight was found from the treatment 1 (2 dS/m) and lowest (9.8 g) fresh shoot weight was found from treatment 4 (8 dS/m). (Table 2).

Normal Seedling %: From the data it was found that highest (100%) normal seedling % was found from the treatment 1 (2 dS/m) and lowest (55%) normal seedling % was found from treatment 3 (6 dS/m). (Table 2).

Conclusion

This is first year experiment. It should be carried out for next 2 years

Experiment No. 2

EFFECT OF DIFFERENT STRENGTH OF SALINE WATER ON EMERGENCE AND GROWTH OF SWEET GOURD

A Biswas

Abstract

In this study, the effects of different water salinity levels (2, 4, 6, 8 and 10 dS/m) on emergence and seedling growth of sweet gourd. Seedlings grown under saline conditions were investigated for emergence, root length, shoot length, fresh root weight, fresh shoot weight and normal seedling%. The results revealed that root length, shoot length, fresh root weight, fresh shoot weight

and normal seedling% tend to decrease when the electrical conductivity of the solution is increased.

Introduction

Salinity stress is one of the most important abiotic stress factors that limits crop production in arid and semi-arid regions. Salinity negatively affects plant growth when salts accumulate in the root zone. High levels of salinity affect seed germination and plant growth by water deficit (osmotic stress), ion toxicity and ion imbalance (ionic stress) or a combination of these factors. The osmotic effect initially reduces the ability of the plant to absorb water. Several minutes after the initial decrease in leaf growth, a gradual growth recovery takes place until a new steady state is reached, depending on the salt concentration outside the root. The ions effect is the result of salt accumulation in leaves, leading to salt toxicity in the plant, primarily in the older leaves (i.e., salt-specific effect). Salt toxicity may result with the death of leaves and therefore reduce the total photosynthetic leaf area. As a result, a reduction occure in the supply of photosynthate to the plant, affecting the overall carbon balance necessary to sustain the growth. Salt toxicity primarily occurs in the older leaves where Na and Cl build up in the transpiring leaves over a long period of time. Leaf injury and death are probably due to the high salt load in the leaf that exceeds the capacity of salt compartmentation in the vacuoles, causing salt to build up in the cytoplasm to toxic levels. Salinity is an important constraint to crop production in the world. Because of salinity problems, researchers are trying to get the salt resistant vegetables to meet the need of mankind. One of the most effective way to overcome salinity problems is the introduction of salt tolerance to crops. Most of the literature indicates that vegetable crops are particularly susceptible to salinity during the seedling and early vegetative growth stages as compared to germination. The present study was therefore initiated to investigate the effects of different salt concentrations on plant growth of sweet gourd.

Materials and Methods

The experiments were carried salinity management and research center, soil resource development institute, Batiaghata, Khulna to test the effect of different strength of saline water on emergence and growth of sweet gourd. Plastic pots were used in conducting the experiment. The plastic pots were firstly washed by washing powder and followed by rinsing with distilled water. Then these were dried in air. After drying the plastic pots were ready for the experiment. Finely prepared soil was used as a matrix for seed emergence. Up to 4.5 cm of the pot was filled up by soil. Necessary amount of salt treatment was given to create saline environment by saturating the soil before placing the sweet gourd seed.

Preparation of Salt Solution

In order to develop the desired water salinity of 2 to 10 dS/m EC, saline water was collected from river and then it was mixed with non-saline water. After that different treatment solution was prepared. Different concentrations (2, 4, 6, 8 and 10 ds/m) was applied to the sown seed on plastic pot. The salinity level was maintained by assessing the salt level, using EC meter. The experiment

was laid out in the Completely Randomized Design (CRD) with three replications. The following treatments were 2, 4, 6, 8 and 10 dS/m. The seeds were transferred to the planting medium. Five disinfected seeds were placed in plastic pots. Each Plastic pot was prepared by moistened 2, 4, 6, 8 and 10 dS/m saline water. Emergence was monitored from the days of seed sowing till 5th days. Seeds were considered germinated when the radical was at least 2 mm long. The number of germinated seeds was recorded daily and the final emergence percentage was determined after 30th days of. When emergence started after seed sowing, the daily data of emerged seedlings were recorded carefully. The emerged seeds were recorded daily. At 5th DAS emergence percentages were found out.

The shoot lengths of germinated seeds were recorded after 30th DAS. One seedling was randomly taken from each plastic pot. Then they were divided into two parts viz. shoot and root. For shoot length and shoot lengths were recorded. The root length was taken in cm (centimeter). The root length of germinated seeds was recorded 30th DAS. From each of the plastic pot five seedlings were taken randomly and averaged. Centimeter (cm) scale was used for measuring root length. The fresh weight of shoots was recorded at 30th days of seed sowing. The roots and shoots were separated and weighed. Then fresh weights of the shoot were taken with the help of electric balance in gram (g) and averaged. The fresh weights of the root were taken with the help of electric balance in gram (g). For this, after 30th days of seed sowing five samples were randomly taken from every plastic pot. Before weighting the root and shoot were separated and washed carefully to remove sand particle. After that fresh root weight were taken from individual plant and averaged.

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

Soil salinity (EC: dS/m) of Experimental pot

Initial Soil Salinity of pot soil was 1.74 dS/m. After applying different strength of saline water soil salinity of different pot was increased.

Table 1: Soil salinity of different pot after applying different strength of saline water.

Treatment	Soil Salinity (EC*: dS/m) of pot

	5 DAS**	10 DAS	20 DAS	30 DAS
T_1 (2dS/m)	1.77	1.83	1.91	2.17
T_2 (4dS/m)	1.87	1.90	2.89	3.91
T_3 (6dS/m)	1.90	2.12	3.45	5.19
T_4 (8dS/m)	2.04	2.78	4.21	6.48
T_5 (10dS/m)	2.55	3.19	5.30	7.42

*EC determined by 1: 1 extraction Method

** DAS- Days after sowing

Effect of water Salinity on emergence and growth

Emergence (%): 100% seeds were germinated for all treatment. Since all soil's salinity of all pot's were more or less non saline after 5 days of seed sowing.

Root length: Root length of sweet gourd at 30 days of seed sowing ranged from 9.2 to 28.1 cm (Table 2). While the lowest root length (9.2 cm) was recorded for the treatment of 8 dS/m and the highest root length (28.1 cm) was obtained from 2 dS/m.

Shoot length: Shoot length of sweet gourd at 30 days of seed sowing ranged from 18.7 to 87.2 cm (Table 2). While the lowest root length (18.7 cm) was recorded for the treatment of 8 dS/m and the highest root length (87.2 cm) was obtained from 2 dS/m.

Table 2: Effect of water Salinity on emergence and growth of country bean

Treatment	Emer-gence (%)	At 30 days after Seed sowing				
		Root length (cm)	shoot length (cm)	Fresh root weight (g)	Fresh shoot weight (g)	Normal Seedling (%)
T_1 (2dS/m)	100.0	**28.1 a**	**87.2 a**	**8.8 a**	**61.4 a**	**100.0 a**
T_2 (4dS/m)	100.0	24.9 b	76.1 b	8.0 a	52.1 b	80.0 b
T_3 (6dS/m)	100.0	14.5 c	71.6 c	4.5 b	27.6 c	60.0 c
T_4 (8dS/m)	100.0	9.2 d	18.7 d	3.4 b	6.3 d	0.0 d
T_5 (10dS/m)	100.0	0.0 e	0.0 e	0.0 c	0.0 e	0.0 d
CV (%)	0.00	4.7	3.9	5.5	7.7	9.9

Fresh root weight: From the data it was found that highest (8.8 g) fresh root weight was found from the treatment 1 (2 dS/m) and lowest (6.3 g) fresh root weight was found from treatment 4 (8 dS/m) (Table 2).

Fresh shoot weight: From the data it was found that highest (61.4 g) fresh shoot weight was found from the treatment 1 (2 dS/m) and lowest (44.8 g) fresh shoot weight was found from treatment 4 (8 dS/m) (Table 2).

Normal Seedling %: From the data it was found that highest (100%) normal seedling % was found from the treatment 1 (2 dS/m) and lowest (60%) normal seedling % was found from treatment 3 (6 dS/m) (Table 2).

Conclusion

This is first year experiment. It should be carried out for next 2 years

Experiment No. 3

EFFECT OF DIFFERENT TYPES OF MULCH ON SOIL SALINITY AND YIELD OF SWEET GOURD

A Biswas

Abstract

In reducing soil salinity, a low-cost and farmer's friendly method is required. Accordingly, a field experiment was carried out in Salinity Management and Research Center, Soil Resource Development Institute, Batiaghata, Khulna during kharif-1 season of 2022 to investigate the effect of different types of mulch on soil salinity and yield of sweet gourd (Pumpkin). The experiment includes three treatments viz. no mulch (control), straw mulch and mulching paper. Soil salinity was recorded at 30 days interval. After one months of seed sowing highest soil salinity (9.69 dS/m) and lowest soil salinity (5.48 dS/m) was found at no mulch (control) and mulching paper respectively in the month of April. Besides, highest value of three yield parameters i.e., fruit length (22.82 cm), fruit diameter (84.96 cm) and fruit weight (3.50 kg) were found at mulching paper as compared to control. Highest yield (29.74 t/ha) was also found at mulching paper treatment and lowest yield (19.62 t/ha) was found at no mulch (control). The results revealed that use of mulching paper decreased salinity and also increased yield of sweet gourd in saline soil. These findings suggest that the application of mulching paper not only reduce soil salinity but also increase the yield of sweet gourd.

Introduction

Agriculture is the backbone of the economy of Bangladesh. The development of Bangladesh depends largely on the development of agriculture sector which contributes 12.65 percent of the GDP (BBS, 2020). Most of the agricultural production in Bangladesh is strenuous in rice, occupying about 75 percent of total cropped areas, whereas only 7 percent of the total cropped land is used for horticultural crops, including vegetables (BARI, 2017). The area under vegetable cultivation accounts for only 2.56 percent of the total cropped areas. In Bangladesh, a good number of vegetables are grown throughout the year both in winter and summer seasons. Climatic condition of Bangladesh is congenial for cultivating a wide variety of vegetables. Among different types of vegetables, sweet gourd is appreciated by consumers as because of its fruits, tender stems, leaves and even flowers could be used as vegetables both at green and ripe stages.

The coastal area accounts for more than 30% of the cultivable land in Bangladesh. Out of 2.86 million hectares of coastal and off-shore lands about 1.056 million ha of arable lands are affected

by varying degrees of salinity. Farmers mostly cultivate low yielding, traditional rice varieties during wet season. Most of the land remains fallow in the dry season (January – May) because of soil salinity, lack of good quality irrigation water and late draining condition. By using management technologies of soil salinity (EC) can be reduced and the yield of cultivated crops can be increased.

Therefore, mulching could be an effective choice for reducing soil salinity along with increasing production in coastal areas. Mulching is the exercise of protective covering of the soil surface around the plants with a living or non-living mulch to make promising conditions for the plant growth and efficient crop production. Organic mulches can reduce the effect of salt toxicity on plant growth or actively accelerate soil desalinization. Considering the above fact, applying mulch material is one of the suitable technologies for reducing soil salinity. Since mulch protects the soil from direct sun light and reduces evapotranspiration and thus soil salinity remains lower in the soil. This experiment is designed to find out the effect of different mulching on soil salinity yield performance of sweet gourd.

Objectives:

- To find out effect of different types of mulch on soil salinity and yield of sweet gourd in coastal saline soil.

Materials and Methods

An experiment was conducted at Salinity Management and Research Centre, Soil Resource Development Institute, Batiaghata, Khulna during Kharif-1 season of 2022. The experiment was carried out in Randomized Complete Block Design with three replications. Sweet gourd (variety-Bengal Sweet-2) was taken as experimental crop. Three experimental treatments were considered viz. (a) control (no mulch) (b) straw mulch (c) mulching paper. The land was prepared by three ploughing by power tiller. Manure and basal dose of fertilizer was applied during land preparation. Germinated seeds were sown and necessary intercultural operations were done as when it necessary. The seeds were sowed at 15-03-2022. Data was recorded as per requirement. Soil salinity was measured by using EC Meter at 30 days interval. Three yield parameters such as fruit length (cm), fruit diameter (cm) and fruit weight (kg) were taken under consideration to analyze the effect on yield of sweet gourd. Total yield was calculated by measuring total fruit weight of a plot. The data were subjected to statistical analysis of variance (ANOVA) using statistix 10 software and the means were tested using Duncan's Multiple Range Test (DMRT).

Chemical properties of experimental plot's soil

pH	OM (%)	K meq/100 gm soil	Total N (%)	P	S	Zn	B
				µg/g			
7.6	2.98	0.37	0.173	10.72	14.98	2.96	0.52

Results and Discussions

An upward trend of soil salinity at all treatments was observed from February to May (Table 1). In the month of March, the lowest soil salinity was found at mulching paper (4.28 dS/m) while the highest soil salinity was observed at control (5.67 dS/m) where no mulch was used. In the month of April, the lowest soil salinity was found at mulching paper (5.48 dS/m) in comparison with the the highest soil salinity was found at control (9.69 dS/m) (Table 1). Thus, it revealed that soil salinity can be reduced by using different mulches in which mulching paper has significant effect on reducing soil salinity.

Table 1: Month wise soil salinity of experimental plot during cultivation period

Treatment	Month wise Soil salinity (EC: dS/m)			
	Mar	April	May	June
Control	5.67	9.69	8.25	8.64
Straw Mulch	5.14	6.43	6.27	7.35
Mulching Paper	4.28	5.48	5.98	6.14

EC determined by 1: 1 extraction Method

The treatments show significant effect on different yield parameters and yield of sweet gourd in saline soils (Table 2). The highest fruit length (22.82 cm) was found at mulching paper while the lowest (14.48 cm) was found at control. The highest fruit diameter (84.96 cm) and fruit weight (3.50 kg) were observed at mulching paper in comparison with the control where lowest fruit diameter (59.36 cm) and fruit weight (2.12 kg) were found. The highest yield (29.74 t/ha) was found at mulching paper and the lowest (19.62 t/ha) was found at control. Thus, it revealed that significant difference was found between straw mulch and mulching paper on yield of sweet gourd. But it had a very significant effect from no mulch and mulching paper (Table 2).

Table 2: Yield data of sweet gourd at different mulches in saline soil

Treatment	Fruit Length (cm)	Fruit diameter (cm)	Fruit weight (kg)	Yield (t/ha)
Control	14.48 c	59.36 c	2.12 c	19.62 c
Straw Mulch	19.70 b	74.90 b	2.98 b	26.26 b
Mulching Paper	**22.82 a**	**84.96 a**	**3.50 a**	**29.74 a**
CV (%)	6.58	4.97	8.65	6.26

Conclusion

This is second year experiment. It should be carried out for next year.

Experiment No. 4

EFFECT OF DIFFERENT TYPES OF ORGANIC MANURE ON SOIL SALINITY AND YIELD OF SWEET GOURD

Abstract

Salinity is a major threat for growing cucurbit vegetables in the coastal zone of Bangladesh. An experiment was conducted during Kharif-1 season of 2022 at Salinity Management and Research Centre, Batiaghata, Khulna to find out the effect of different types of organic manure on soil salinity and increase sweet gourd yield in coastal region of Bangladesh. There were four treatments having control (no organic manure), cow dung, poultry manure and vermicompost. 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 text crop was sweet gourd. The highest yield (29.62 t/ha) was recorded from vermi compost followed poultry manure (28.25 t/ha), cow dung (22.07 t/ha), while without organic manure gave the lowest yield (16.90 t/ha). In the month of April, lowest soil salinity (6.24 dS/m) was found from vermicompost. Highest salinity (9.80 dS/m) at control. Vermi-compost is therefore recommended for sustainable yield of sweet gourd in saline soil, and reduces salinity related land degradation in coastal region of Bangladesh.

Introduction

Soil salinity is a major concern to agriculture because it affects almost all plant functions. Usually 30-50% yield losses occur depending on the level of soil salinity. Over 30% of the cultivable area of Bangladesh lies in the coastal and offshore zones. Out of 2.86 million hectares of coastal and offshore lands, about 1.056 million hectares are affected by varying degrees of salinity. Batiaghata Upazila is situated in the eastern side of Khulna District in the Division of Khulna, Bangladesh. The areas of the Upazila are seasonally flooded with saline water of the Kazibacha river which causes various degrees of soil salinity. In this area farmers grow mostly low-yielding, traditional rice varieties during the wet season. Most of the lands remain fallow in the Kharif-1season (January–May) because of increasing soil salinity and the lack of good-quality irrigation water. Both organic and inorganic amendments are found to be effective in the amelioration of saline soils. Organic matter decomposition and plant root action also help dissolve the calcium compounds found in most soils, thus promoting reclamation of saline soil. Various organic amendments such as cowdung, poultry manure and Vermi compost can be used for the amelioration of saline soils. Organic amendments improve physical, chemical and biological properties of soils under saline conditions. Leithy et al. (2010) conducted an experiment on study the effect of saline water addition to bio and organic fertilization treatment on plant growth, mineral and chemical constituents. Salinity affected most of the morphological parameters and decreased the growth performance. Well drained fertile sandy loam or loamy soil is the best for sweet gourd. However, it can be grown in clay soil with adequate drainage facilities. It can therefore be grown throughout the year in the sub-tropical climate of Bangladesh. If proper amendments can be introduced, the farmers can be benefited by introducing a new crop in fallow agricultural field during the Kharif 1 season. Due to this reason, a scientific study was undertaken to determine the effect of different types of organic manure on Soil Salinity and Yield of Sweet Gourd in coastal area.

Material and Methods

An experiment was conducted during Kharif-1 season of 2022 at Salinity Management and Research Centre, Batiaghata, Khulna to find out whether organic manure amendment can reduce soil salinity and increase sweet gourd yield in coastal region of Bangladesh. There were four treatments having cow dung, poultry manure, vermicompost and control (without organic manure). 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 text crop was sweet gourd (variety- Bengal Sweet-2). Seeds were sowed on 17-03-2022. Weeding was also done when necessary. Irrigation was done one day internal. Insects and pests were controlled by using insecticides and pesticides when necessary. Fruits were collected after fruits ripened. In this experiment, data on yield contributing characters were recorded from randomly from selected pits and plants. Soil salinity was measured by using EC Meter at 30 days interval. Three yield parameters such as fruit length (cm), fruit diameter (cm) and fruit weight (kg) were taken under consideration to analyze the effect on yield of sweet gourd. Total yield (t/ha) was calculated by measuring total fruit weight of a plot. The data were subjected to statistical analysis of variance (ANOVA) using statistix 10 software and the means were tested using Duncan's Multiple Range Test (DMRT).

Chemical properties of experimental plot's soil

pH	OM (%)	K meq/100 gm soil	Total N (%)	P	S	Zn	B
				µg/g			
7.4	1.86	0.31	0.14	11.31	21.56	1.86	0.46

Results and Discussions

It was observed that the soil salinity increases from March to April (Table 1). The highest salinity (9.82 dS/m) was found in the month of April whereas the lowest (4.26 dS/m) was recorded in the month of March. In the month of April, the lowest soil salinity (6.24 dS/m) was recorded from vermi-compost pit while the highest soil salinity (9.82 dS/m) was found at control (Table 1). Vermi-compost has a significant effect in reducing soil salinity over control. A gradual reduction in soil salinity was noticed with the increase of the doses.

Table 1: Month wise soil salinity of the experimental plot

Treatment	Month wise Soil salinity (EC: dS/m)			
	Mar	April	May	June
Control	5.74	9.82	10.50	9.52
Cow dung	5.10	7.45	8.64	6.23
Poultry manure	4.35	6.89	6.87	6.64
Vermi-compost	**4.26**	**6.24**	**7.24**	**7.14**

EC determined by 1: 1 extraction Method

The yield and yield attributes of sweet gourd was significantly influenced by different types of organic manure (Table 2). The highest fruit length (23.82 cm), fruit diameter (79.47 cm) and fruit weight (3.39 kg) were found from vermi-compost where the lowest fruit length (15.12 cm), fruit diameter (60.87 cm) and fruit weight (2.47 kg) were found at control. The yield of sweet gourd was also significantly influenced by different types of organic manure. The highest fruit yield (29.62 t/ha) was recorded from vermi-compost plot followed by poultry manure (28.25 t/ha) and cow dung (22.07 t/ha) whereas the lowest fruit yield (16.90 t/ha) was found at control.

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	15.12 c	60.87 c	2.47 c	16.90 c
Cow dung	17.92 b	68.35 b	2.74 b	22.07 b
Poultry manure	**22.92 a**	**77.10 a**	**3.17 a**	**28.25 a**
Vermi-compost	**23.82 a**	**79.47 a**	**3.39 a**	**29.62 a**
CV (%)	7.17	7.32	6.85	6.68

Conclusion

This is first year experiment. It should be carried out for next 2 years.

Experiment No. 5

REDUCING SOIL SALINITY THROUGH SHADE AND MULCH TECHNOLOGY

A Biswas

Abstract

An experiment was conducted at Salinity Management and Research Centre, Batiaghata, Khulna during kharif-1 season of 2022 to estimate the contribution of mulch and shade in reducing soil salinity effect on sweet gourd. The experiment was laid out in Randomized Complete Block Design with three replications. Four treatments were used i.e., control, only shade, only mulch and shade + mulch technology. In reducing soil salinity shade and mulch technology performed better over only shade and only mulch technology. The lowest (6.25 dS/m) soil salinity was recorded at shade and mulch technology followed by only mulch technology (7.12 dS/m), only shade technology (9.52 dS/m), while the highest soil salinity (10.32 dS/m) was found at control in the month of April. The highest yield (27.27 t/ha) was recorded from shade and mulch technology followed by only mulch technology (23.90 t/ha), only shade technology (20.20 t/ha), while the lowest yield (17.00 t/ha) was found at control. Thus, the soil salinity was significantly reduced by using shade and mulch technology.

Introduction

The coastal region of Bangladesh is under the constant threat of soil and water salinization (MoA and FAO, 2013). Both magnitude and extent of soil salinity have been increasing with time. These changes created negative impact on soil fertility and crop productivity which underpins the rural economy of coastal Bangladesh. The average cropping intensity (%) in the coastal areas has not been increased keeping pace with that of floodplain agriculture. About 30-50% of net cropped area remains fallow in Rabi and Kharif-1 seasons in the coastal region. Intensive irrigation with light saline surface water in such areas further complicated the problem, leaving behind huge salt deposits after evaporation, leading to secondary salinization and alkalinization (Choudhury and Chakraborty, 2013). The salinity increases in dry months showing a peak in March-April and decreases in wet months with the minimum in July-August (Haque et al., 2014). The prevailing salinity intrusion has severely affected the crop productivity in the saline regions of Bangladesh. The situation calls an urgent need to improve crop productivity. Introduction of new crops and/or crop varieties in the fallow lands of the coastal regions might be the scholastic technique for improvement of system productivity. It is high time to find an alternative way to mitigate this problem. Use of shade and mulch might potentially reduce the capillary rise and evaporation loss of water from the soil, the salinization of surface soil by underground water. Moreover, straw mulch is reported to be an effective strategy for promoting crop emergence by modifying the soil microclimate through increasing the soil temperature. The experiment was therefore conducted to estimate the contribution of straw mulch and shade for the mitigation of salinity effect on sweet gourd cultivation in the saline area of Bangladesh.

The proposed study will help in possible soil and water management with using mulch, shade in coastal saline areas of Bangladesh for the betterment of the country.

Objectives:

a) To find out effect of shade and mulch on soil salinity and yield of sweet gourd in coastal saline soil.

Materials and Methods

An experiment was conducted during Kharif-1 season of 2022 at Salinity Management and Research Centre, Batiaghata, Khulna to estimate the contribution of mulch and shade in reducing soil salinity on sweet gourd. The experiment was laid out in Randomized Complete Block Design with three replications. Four treatments were used i.e., control, only shade, only mulch and shade + mulch technology. The crop was sweet gourd (variety- Sweety). The seeds were sowed at 11-03-2022. Weeding was also done when necessary. Irrigation was done one day internal. Insects and pests were controlled by using insecticides and pesticides when necessary. Fruits were collected after fruits ripened. In this experiment, data on yield contributing characters were recorded from randomly from pits and plants. Yield data was taken from whole plot. Collected data were analyzed statistically.

Chemical properties of experimental plot's soil

pH	OM	K		P	S	Zn	B

	(%)	meq/100 gm soil	Total N (%)	µg/g			
7.5	1.92	0.39	0.17	10.62	23.85	1.58	0.51

Results and Discussions

There was a significant effect of shade and mulch technology on reducing soil salinity in sweet gourd production (Table 1). It was observed that salinity generally increases from March to April. Among different technology mulch and shade technology performed better over control and other treatments. In April, the lowest soil salinity (6.25 dS/m) was found at shade and much technology while the highest salinity (10.36 dS/m) was recorded at control (Table 1).

Table 1: Month wise soil salinity of pit soil

Treatment	Month wise Soil salinity (EC: dS/m)			
	Mar	April	May	June
Control	6.24	10.36	9.54	9.42
Only Shade	5.84	9.52	8.85	8.46
Only Mulch	5.13	7.12	7.26	7.14
Shade+ Mulch	**4.67**	**6.25**	**6.13**	**5.86**

EC determined by 1: 1 extraction Method

Yield and yield attributes of sweet gourd were significantly influenced by shade and mulch technology (Table 2). Among the four treatments the highest fruit length (24.85 cm) was found from shade and mulch technology and the lowest (14.47 cm) from control (Table 2). The highest fruit diameter (81.42 cm) was found from shade and mulch and the lowest (71.32 cm) was found from control.

Table 2: Yield data of sweet gourd in saline soil

Treatment	Fruit Length (cm)	Fruit diameter (cm)	Fruit weight (kg)	Yield (t/ha)
Control	14.47 d	71.32 c	2.35 d	17.00 d
Only shade	18.62 c	77.80 b	2.81 c	20.20 c
Only mulch	22.25 b	79.80 ab	3.30 b	23.90b
Shade + mulch	**24.85** a	**81.42** a	**3.56** a	**27.67**a
CV (%)	5.43	6.32	7.15	8.46

The highest fruit weight (3.56 kg) was found from shade and mulch and the lowest (2.35 kg) was found from control. Yield of sweet gourd was significantly influenced by mulch and shade technology. The highest yield (27.67 t/ha) was found at shade + mulch technology which is followed by only mulch technology (23.90 t/ha) and only shade technology (20.20 t/ha), while control gave the lowest yield (17.00 t/ha).

Conclusion

Shade + mulch give better result. Thus, we can use shade+ Mulch technology.

Chapter 7: Research Activities done by Head Quarter & Field Offices

Land Degradation in Bangladesh 2020

Ameer Md. Zahid*, Md. Altaf Hossain*** & Neelima Akter Kohinoor***

The research work was done under the project "Establishing National Land Use and Land Degradation Profile toward Mainstreaming SLM Practices in Sector Policies (ENALULDEP/SLM)" implemented by SRDI during 2019-2021. Land degradation is defined as the lowering of the productive capacity of land. Land degradation is classified and measured through this work in a way that can be monitored in the future. An extensive literature review of existing information and data was made. Aerial photographs (2000-2012), toposheets (2000-2012), Soil and landform maps of SRDI (2003-2019), and Historic Google Earth Pro imagery (up to 2020) are used as important tools. Surveys were also done in limited scopes. Research findings were validated through group discussions and workshops. The final product was made in a GIS environment. The outcome maps and generated data/ information can be used as an important tool for taking sustainable land management decisions.

1. Introduction

Land degradation can be defined as a change in one or more land/soil properties that result in a decline in land/soil quality. The extent to which land degradation affects agricultural productivity and poses a threat to food security is fundamentally influenced by economic, environmental, and institutional factors. Recent estimates suggest that 5 – 6 million hectares of arable land worldwide are irreversibly lost each year as a result of soil erosion, salinization, and other degradation processes (Hamdy & Adil., 2014). Land degradation is always with us, but its causes, extent, and severity are contested. Land degradation can be defined as a decline in productivity and ecosystem function. It may be assessed by the use of periodically determined different fertility index data. Deviation from the normal or standard may serve as an assessment of land degradation and improvement. In earlier years, a group of SRDI scientists conducted a baseline study for the base year 2000 under DS-SLM Project in cooperation with FAO and DoE researchers and estimated the area under different types of land degradation (Zahid et al., 2020). Thus, the objective of the present study under ENALULDEP/SLM project was:

Objectives of the study

a) To establish a knowledge base and increased understanding of the state of land degradation in the country.
b) To investigate major land degradation processes, their causes, distribution, and intensities throughout the country.
c) To update the national land degradation map for meeting the needs of policy adoption and national development plan.

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2. Methodology

Data and information contained in the book "Land Degradation in Bangladesh: Baseline Study of Land Degradation Processes 1985-2000" were used as benchmark information for preparing the present manuscript. Extensive Investigations were made to find out contemporary information on land degradation process, types, severity and trends described and mapped in other reports, monographs, and research papers including web pages. Some important data sources and tools used for land degradation in 2020 are listed below.

- Upazila Land and Soil Resources Utilization Guides, 450 volumes (SRDI 2003-2019)
- Aerial photographs (2000-2012), Survey of Bangladesh (SOB)
- Toposheets (2000-2012), SOB
- ArcGIS 10.5
- Microsoft Excel spreadsheet
- Historic Google Earth Pro imagery (up to 2020)
- Books extensively consulted are:

  - Agroecological Regions of Bangladesh (FAO, 1988)
  - Collection and Analysis of Land Degradation Data (RAPA-FAO, 1994)
  - Problem Soils of Asia and the Pacific (RAPA-FAO, 1990)
  - Land Degradation in Bangladesh: Baseline Study of Land Degradation Processes 1985-2000 (Zahid, et al. 2020)
  - Impact of Land Degradation in Bangladesh: Changing Scenario in Agricultural Land Use (Karim and Iqbal, 2001)
  - Geography of Bangladesh (Haroun Er Rashid, 1991)
  - The Geography of the Soils of Bangladesh (Hugh Brammer, 1996)
  - Problem Soils of Bangladesh (Khan, et. al., 2008)

- Other maps and documents from SRDI, BARC, DoE, WDB, Forest Department, BMD, FAO, USAID, etc
- Surveys (in limited numbers)
- Group discussions
- Workshops

Land degradation class or the degree of degradation was estimated in relation to

- declined productivity,
- changes in agricultural suitability,
  - biodiversity loss,
- also, in some cases in relation to social conditions that affect people, and
- declined safe food production.

Four degradation classes recognized were defined as following.

a) Very severe: The land parcel is difficult to reclaim at farm level. Major engineering works are required for land restoration. Original biotic functions are largely destroyed. Production loss is between 50-75%

b) Severe: The land parcel is greatly reduced agricultural productivity, but is still suitable for use in local farming systems. Major improvements are required to restore productivity. Original biotic functions are partially destroyed. Production loss is between 25-50%

c) Moderate: The land parcel has considerably reduced agricultural productivity, but is still suitable for use in local farming systems. Restoration to full productivity is possible by

modifications of the management system. Original biotic functions are mostly intact. Production loss is between 10-25%.

d) Light: The land has somewhat reduced agricultural suitability, but is suitable for use in local farming systems. Restoration to full productivity is possible by modifications of the management system. Original biotic functions are still largely intact. Production loss is between 0-10%.

None: The land parcel has not gone under any type of degradation is designated as "none". Its productivity is fully intact. Land gone under "improvement" or area of "bright spot" is also included in this nomenclature.

It is worthy of notice that in case of nutrient depletion, degraded land can be restored simply by applying recommended doses of fertilizers into the soil. Therefore, in case of such types of degradation, major engineering works are not required for restoration.

Table 1: Relative productivity loss according to degradation class

Degradation class	Very severe	Severe	Moderate	Light
Relative productivity loss	50-75%	25-50%	10-25%	<10%

[Modified from FRG, 2018]

3. Results and Discussion

Class-wise areas (million ha, mha) of different land degradation types and their percentage against the country area found in the study are given in the following table.

Types of Land Degradation	Degradation class (mha)				Total area (mha)	% of country area
	Very severe	Severe	Moderate	Light		
Soil Fertility Decline:						
1. Soil nutrient depletion	1.47	2.78	3.27	3.55	11.07	75.0
- P depletion	2.45	3.43	1.30	0.66	7.83	53.1
- K depletion	0.30	3.03	2.13	1.22	6.68	45.3
- S depletion	1.32	3.95	1.62	0.75	7.64	51.8
- Zn depletion	1.14	4.02	2.13	0.75	8.04	54.5
- B depletion	0.76	3.07	2.55	0.98	7.36	49.9
2. Soil organic matter depletion	0.46	3.94	5.66	1.55	11.62	78.7
Water erosion:						
3. Soil erosion [Hilly areas]	-	1.28	0.33	0.09	1.70	11.5
4. Riverbank erosion	-	0.65	0.08	0.02	0.75	5.1
5. Sandy overwash	-	-	0.27	0.16	0.42	2.9
6. Acidification	0.38	2.28	3.30	2.12	8.08	54.8

Types of Land Degradation	Degradation class (mha)				Total area (mha)	% of country area
	Very severe	Severe	Moderate	Light		
7. Salinization	0.20	0.42	0.25	0.19	1.06	7.2
8. Drought	0.29	0.44	0.61	0.18	1.54	10.4
9. Waterlogging	-	0.10	-	-	0.10	0.7
10. Soil pollution [Arsenic contamination]	0.21	0.78	2.13	1.37	4.49	30.5
11. Ecosystem degradation	-	0.04	0.09	0.42	0.55	3.7
12. Soil sealing	0.05	0.09	0.37	0.12	0.63	4.3

Note: The percentages of land degradation are shown against the total country area (14.757 mha).

3. 1 Soil nutrient depletion: Degraded land with respect to soil nutrient depletion is around 11.07 million ha which amounts to 75% of the country area.

3.2 Soil organic matter depletion: Degraded land with respect to soil organic matter depletion in 2020 is around 11.62 million ha which amounts to 78.7% of the country area.

3.3 Acidification: Degraded land with respect to acidification is around 8.08 million ha which amounts to 54.8% of the geographical area of the country.

3.4 Salinization: Degraded land with respect to salinization is around 1.056 million ha which amounts to 7.2% of the geographical area of the country

3.5 Soil Pollution: Soil pollution has become a major issue for the people of Bangladesh in recent years. This is associated mainly with industrialization, urbanization, and mining. Dense river systems allow the contaminants to be dispersed more easily. Industrial wastes and effluents are being discharged randomly on soils, into canals, rivers, along the roadsides, or in the vicinity of industrial areas without any treatment. Lead, cadmium, arsenic, chromium, mercury, and nickel are significant contaminants (FRG, 2012). Irrigation with contaminated groundwater and river water is also responsible for soil contamination. Soil can be polluted through the excessive application of chemical fertilizers like phosphate and zinc fertilizers, and herbicides. Bangladesh has the highest percentage of As-contaminated STWs, and yearly increases of up to 0.1 mg of As per kg of soil can occur as a result of irrigation, especially in paddy fields. Irrigation with As-contaminated groundwater is the primary cause of vegetable and rice As contamination in Bangladesh. Degraded land with respect to groundwater arsenic contamination is around 4.49 million ha which amounts to 30.5% of the geographical area of the country.

3.6 Soil erosion in hilly areas: Degraded land in respect to soil erosion (hilly areas) is around 1.7 million ha which amounts to 11.5% of the country area.

3.7 Riverbank erosion: Riverbank erosion is rampant in areas along the active river channels of the Ganges (the Padma & the Meghna), the Brahmaputra-Jamuna, the Tista, the Dharla, the Garai-Madhumati, the Arial Khan and in the coastal and off-shore areas of Bangladesh. In Bangladesh, river bank erosion is caused mainly due to strong river currents, enhanced by mechanized river traffic, channel diversion during the rainy season, and siltation of riverbeds.

Degraded land in respect to riverbank erosion is around 0.75 million ha which amounts to 5.1% of the geographical area of the country.

3.8 Sandy overwash: The soils, gravel, and sandy coarse materials eroded from hills are usually deposited in the downstream areas. Before deposition in the downstream or basins, eroded material runs down the slope with a greater velocity along with run-off water, destroying standing crops on foothills or adjoining piedmont areas, breaches roads and houses. This is more common in the northern piedmont areas of the country. Degraded land with respect to sandy overwash is around 0.42 million ha which amounts to 2.9% of the geographical area of the country.

3.9 Drought: Degraded land with respect to drought is around 1.54 million ha which amounts to 10.4% of the geographical area of the country.

3.10 Waterlogging: Degraded land in respect to waterlogging is around 0.10 million ha which amounts to 0.7% of the geographical area of the country. The waterlogged area in the southwest region comprises Sadar, Sarsha, Jhikargacha, Abhaynagar, Bagarpara, Monirampur, Keshabpur, Chougachha of Jashore, Rupsa, Batiagata, Dumuria, Dacope and Paikgacha of Khulna and Tala, Kalaroa, and Sadar of Satkhira and Sadar, Mullahat, Rampal, Fakirhat, Morelganj, Sharankhola, Mongla, Chitalmari and Kachua of Bagerhat district. Noakhali district, in the southwest region, faces waterlogging during the rainy season.

3.11 Soil sealing: Soil sealing is defined as the permanent covering of the soil surface with impervious materials such as concrete or asphalt, tar seal, and buildings and other structures that cannot be easily removed. Locally, cities have a considerable impact on the environment: they create microclimates (such as the urban heat island effect), pollute water and air, destruct natural habitats with a consequent loss of biodiversity and degrade soil. Degraded land in respect to soil sealing is around 0.63 million ha which amounts to 4.3% of the geographical area of the country.

3.12 Ecosystem degradation: One of the main causes that contribute to the country's degradation of ecosystems is deforestation due to the advance of the agriculture frontier and inappropriate forest exploitation. Mining and the extraction of construction materials without taking measures to cushion the impact cause drastic changes in the natural landscape while degrading its valuable ecosystems. The construction of roads without proper drainage measures or in territories subject to penetration and settlement are high-stress factors for ecosystems, especially those which are highly fragile as a result of their weather conditions and the nature of their soil and water. Wetlands are very fragile ecosystems that are being severely affected, causing a reduction in the number and diversity of the species of terrestrial flora, birds, reptiles, mammals, fish, and crustaceans. Ecosystem degradation in haor areas of Sylhet basin and some parts of Eastern Surma-Kushiyara Floodplains were investigated. Degraded land with respect to ecosystem degradation is around 0.55 million ha which amounts to 3.7% of the geographical area of the country.

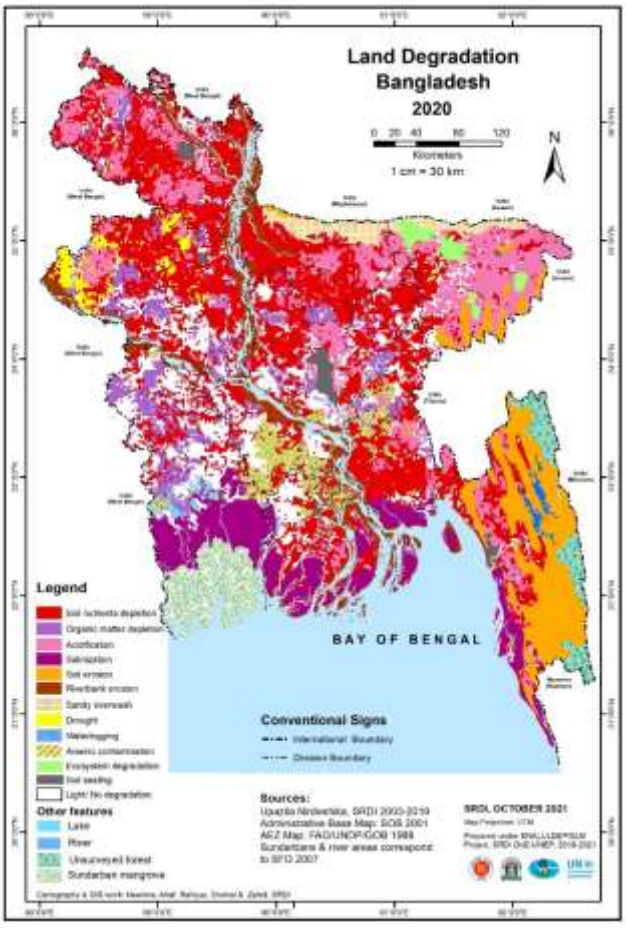
3.13 Land Degradation in Bangladesh 2020

The Land Degradation Map of Bangladesh 2020 was developed by combining the above 12 individual land degradation type maps, where the nutrient depletion map itself is a combined map from 5 separate nutrient maps (P, K, S, Zn & B depletion map). The sequence (lowermost to

uppermost) of all 12 map layers placed one after another and land degradation classes considered for each individual map layer are as follows.

Sequence	Types of Land Degradation	Degradation class considered (area in mha)					Contribution to National degradation mapping (%)
		Very severe + Severe	Very severe +Severe +moderate	Severe	Severe+ moderate	Moderate	
1	Soil organic matter depletion	4.4					29.82
2	Drought	0.73					4.95
3	Soil pollution (As)	0.99					6.71
4	Soil nutrient depletion		7.52				50.96
5	Acidification	2.66					18.03
6	Sandy overwash	-	-			0.27	1.83
7	Soil erosion	-			1.61		10.91
8	Salinization		0.87				5.90
9	Waterlogging			0.1			0.68
10	Ecosystem degradation	-			0.13		0.88
11	Soil sealing	0.14					0.95
12	Riverbank erosion	-			0.73		4.95

It was estimated that moderate to very severe classes of land degradation took place in 11.24 million ha area of the country in 2020. It was about 76.2% of the country area. The degraded land is 0.54 million ha higher than the previous estimation of 10.70 million ha (72.5%) in 2000. The results showed that each year around 27,000 ha of land has been degraded (moderate to very severe degradation) since 2000.



Conclusion & Recommendations:

Land degradation is the greatest challenge to feed the nation's upcoming millions of new mouths. The different land degradation processes, their areas, extent, and severity have been clearly identified. The urgent need is to adopt a comprehensive national land use policy and sustainable land management practices. This is badly necessary for reversing, restoring, or, at

least, halting land degradation in order to achieve the land degradation neutrality target of the nation in near future.

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Effects of Organic Matter and Various Doses of Liming on Soil Properties, Growth Traits and Yield of Wheat Grown in Amnura Soil Series of High Barind Tract

Dr. M. N. Islam*

Abstract

A field experiment was conducted during 2020-2021 to evaluate the effects of liming and organic matter on soil properties, growth traits and yield of wheat grown in Amnura soil series of High Barind Tract (AEZ-26), The experimental location was in Gomastapur Upazila under Chapainawabganj district. There were five treatments of liming material applied as dolomite (CaCO3.MgCO3) along with 4 kg decimel^{-1} Organic Matter (OM) as vermicompost incorporated in soil in each treatments plot. Yield and yield components data of crop were recorded during growth stage and harvesting time. The post-harvest soils were analyzed for pH, OM, N, available P, K, S, Zn, B, Ca and Mg. The application of different doses of lime along with OM to soil progressively increased 0.8-2.0 units of soil pH and increased availability of nutrients i.e., P, Ca, Mg & others in soils. The grain yields of wheat (BARI Gom-33) were positively correlated with soil pH, available P contents of post-harvest soils. Plant height (cm), effective tiller number hill^{-1},

spike length plant^{-1}, grains spike^{-1}, 1000-grains weight (g), grain yields (t ha^{-1}) were significantly influeced by liming. The treatment T_3 (2.0 t lime ha^{-1}) produced grain yield of 5.6-ton ha^{-1} which was statistically higher to those in T_1, T_2, T_4, T5 & T_6 treatments. Total uptake of P, K, S was increased due to application of lime along with OM which was mainly associated with increased wheat yields. The findings demonstrated that OM and liming are not only essential for wheat cultivation but also congenial for microbial growth in Amnura soil. The application of 2.0 t lime ha^{-1} found to be optimum for desired soil pH (pH 6.5-7.0) in case of wheat. Higher yield with increased nutrient availability was obtained through this application which is a prerequisite for sustainable crop production.

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Introduction

Soil organic matter (OM) is a key factor in maintaining long-term soil fertility since it is the reservoir of metabolic energy, which drives soil biological processes involved in nutrient availability. A good soil should have at least 2.5% organic matter, but in Bangladesh most of the soils have less than 1.5%, and some soils contain even less than 1% organic matter (FRG, BARC, 2012). Organic nutrient sources improve physical, chemical and biological properties of soil. Organic matter (OM) improves the soil structure through aggregation, which favourably influences tillage preoperative crusting, water infiltration, moisture retention, aeration, temperature and root penetration (Mandal*et al.*, 2003, De Datta and Hundal, 1984). Organic matter supplies plant nutrients, increases water holding capacity of soil, reduce residual negative effect of fertilizers and pesticides (Padre *et al.*, 2007 and Tinglu*et al.*, 2007). It makes the crops more tolerant to diseases, insects and also prevents soil erosion (Dreyfus*et. al.*, 1985; Evans and Rotar, 1986). It increases the capacity of the soil to buffer changes in pH, increases the cation retention capacity, reduces phosphate fixation. Organic matter is the energy source for soil microorganisms, which are the primary agents that enhance the decomposition and release of minerals in soil system.

OM also creates a positive soil environment from which plants can uptake nutrients from applied chemical fertilizers. Organic matter increases uptake of applied chemical fertilizers by the plants; thereby increases crop productivity and reduces toxic flow of active chemical fertilizers to the environment.

Soil environment is very important for plant growth and soil pH is the most important indicator of soil environment. Soil pH indicates whether the media for plant growth is favorable or not. Soil pH indicates whether the soil acidic, alkaline or neutral. Acid soils are a major agricultural constraint for crop production due to its adverse effect on soil fertility and productivity. In Bangladesh, soil acidification problem is becoming more acute than the previous time due to the removal of base material from top soil.

In acid soil, low phosphorus (P), (Ca), (Mg) and iron (Fe) toxicity are considered as two major yield limiting factors on crop production of Barind soils of Bangladesh. Soils in the study area of Bangladesh are becoming acidic (strongly acidic) day by day. As soil pH indicates the soil environment as well as soil quality which regulate the availability of plant nutrients and crop yield and also crop quality.

Most of the soils of Bangladesh are low to medium acid in reaction, due to the predominance of high rainfall areas and leaching. There are mainly three groups of acid soils found in Bangladesh, such as: acid basin clay, acid sulphate soil and brown hill soil (Alam, 2006). The soils of northwest part of Bangladesh are light textured, low in organic matter and strongly acidic to moderately acidic in nature, pH ranges from 4.5 to 6.5. The status of available P, Ca and Mg of these soils are low. Aluminum toxicity is responsible for poor yields in acid soils. Liming on acid soil increases the pH level, decrease Fe, Al and Mn toxicity, increase the availability of N, P, Ca and Mg and microbial activities. In acid soils, application of lime significantly increased water-soluble nitrogen and fixed ammonium. Therefore, a study was undertaken in a highly acidic soil of Gomastapur Upazila under Chapainawabganj district, to demonstrate the changes of soil properties due to liming along with OM in wheat field and to evaluate the effects of lime and OM on yield and yield contributing traits of wheat.

Major Objectives

i. To determine the appropriate lime rate at different pH level & crops.

ii. To study the effect of liming on soil nutrient availability.

iii. To evaluate the effect of lime on crop yield and yield contributing characters at different lime rate.

Material and Methods

The experiment was conducted at farmer's field of Gomastapur Upazila under Chapainawabganj District from November 2020 to March 2021. The experimental field was located at 24°50'54.0" latitudeand E- 88°26'35.6" longitude at a height of 22 m above the mean sea level. It belongs to the Agro Ecological Region 26 (High Barind Tract). The soil was clay loam having pH 5.4, Organic matter 1.34%, total N 0.08%, available P 6.3 μg g^{-1}, K 0.12 meq 100 g $soil^{-1}$, available Ca 6.7 meq 100 g $soil^{-1}$, Mg 2.37 meq 100 g $soil^{-1,}$ S 4.09 μg $g^{-1,}$ B 0.55 μg g^{-1}, Zn 0.39 μg g^{-1} and Mn 8.2 μg g^{-1}. The test crop was wheat *Triticumaestivum cv.* BARI Gom-33 for the study. Certified seeds were collected from the Bangladesh Wheat and Maize Research Centre, Nashipur, Dinajpur. There were six different doses of lime application along with 4 kg $decimel^{-1}$ Organic Matter (OM) in the form of vermicompost incorporated in soil in each treatment plot in wheat experiments field as follows T_1 (Control); T_2 (1.0 t ha^{-1} lime); T_3 (2.0 t ha^{-1} lime); T_4 (3.0 t ha^{-1} lime); T_5 (4.0 t ha^{-1} lime). The liming material had 20% Ca and 10% Mg. The liming material was applied to the soil on 21 November 2019 and mixed well with soil by repeated ploughing by power tiller and country plough. Final land preparation was done on 29 November, 2020.

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. There were altogether 18(6×3) unit plots (5m ×4 m). Inter-block and Inter-plot spacing were 1m and 0.7m, respectively. Fertilization was as N @ 1240 g $decimel^{-1}$ from urea, P @ 425 g $decimel^{-1}$ from TSP, K @ 615 g $decimel^{-1}$ from MoP, S @ 455 g $decimel^{-1}$ from gypsum, Zn @ 15 g $decimel^{-1}$ from zinc sulphate (heptahydrate) and B @ 8g $decimel^{-1}$ from boric acid. Three irrigations were applied, the first irrigation after 18 days of sowing, second irrigation after 55 days of sowing at crown root initiation stage and the third after 75 days of sowing at heading stage. Weeding and pest control programme were done when necessary. The crop was harvested at maturity after about three months of sowing (March 28, 2021). Ten plants from each plot were

sampled randomly recording for yield parameters. Then plot- wise weights of grain and straw were recorded.

Analysis of soil samples

Soil samples were collected randomly from 10 different spots of the field from a depth of 0-15cm. After harvest of wheat, the soil samples from each plot were collected at a depth of 0-15 cm. The initial soil samples were analyzed as per standard methods for soil texture, pH, organic matter, total N and available P, K, S, Ca, Mg, Zn, B and Mn contents. The post-harvest soils were also analyzed for soil pH, available P, K, S, Ca, Mg, Zn, B and Mn contents.

The data were analyzed statistically by F-test to examine whether the treatment effects were significant or not. The mean comparisons of the treatments were evaluated by LSD (Least significant Difference Test) if the treatments were significant. The analysis of variance (ANOVA) for different parameters was done by computer using "Statistix-10" software programme.

Results and Discussion

OM and liming effects on changes of Soil properties of post-harvest soils:

The changes in pH, P, Ca and Mg content in soil markedly varied after the harvest of wheat. The pH values, P, Ca and Mg availability of the post-harvest soils in different treatments of wheat increased steadily with increasing rates of lime application (Table 1). The pH of the initial soil was 5.4 which increased to 6.2, 7.0, 7.0, 7.3, 7.3 and 7.4 T1, T_2, T_3, T_4, T_5 andT_6 respectively. The increased in soil pH was due to available of Ca and Mg in soils. The initial value of available phosphorus in the soil was 6.3µg g^{-1} soil and the post-harvest soils had the values 24.63, 36.20, 92.06, 26.63, 57.70 and 25.73 µg g^{-1} soils in T_1, T_2, T_3, T_4, T_5 and T_6 respectively. Lime application increased the soil pH which helped the release of fixed P from the oxides and hydroxides of Fe and Al thus increased the P availability in soils. The available Ca of the initial soil was 6.7 meq100 g $soil^{-1}$ which increased to 7.99, 7.85, 8.29, 8.58, 3.20 and 3.20 meq100 g $soil^{-1}$ in T_1, T_2, T_3, T_4, T_5 and T_6 respectively. The liming material used as dolomite (CaCO3.MgCO3), which on dissolution released a large amount of Ca& Mg and thus the available of Ca increased in post-harvest soils. The available Mg of the initial soil was 2.37 meq 100g $soil^{-1}$ which decreased to 2.79, 3.55, 3.62, 3.44, 3.71 and 3.73 meq100 g soil-1 in T_1, T_2, T_3, T_4, T_5 and T_6 respectively.

Table 1: Interaction effects of OM and liming on soil properties of post-harvest soils of Wheat field

Treatments	pH	Organic Matter (%)	TN (%)	K (meq 100g^{-1}soil)	Ca (meq 100g^{-1}soil)	Mg (meq 100g^{-1}soil)	P (µg g^{-1}soil)	S (µg g^{-1}soil)	Zn (µg g^{-1}soil)	B (µg g soil$^{-1)}$	Mn (µg g soil$^{-1)}$
Initial soil Values	5.4	1.34	0.08	0.12	6.7	2.37	6.3	4.09	0.39	0.55	8.2
Analytical Values after 2nd Year Experiment											
T_1: Control + OM	6.0-6.2	1.51 ^{ab}	0.09^{a}	0.12^{a}	7.99^{a}	2.79^{c}	24.63^{d}	5.0^{c}	0.23^{a}	1.10^{b}	17.1^{a}
T_2: 1.0 t ha^{-1} + OM	6.6-7.0	1.60 ^{a}	0.09^{a}	0.12^{a}	7.85^{a}	3.55^{a}	36.20^{c}	10.33^{b}	0.21^{a}	1.20^{b}	18.2^{a}
T_3 : 2.0 t ha^{-1}+ OM	6.5-7.0	1.39 ^{bc}	0.09^{a}	0.17^{a}	8.29^{a}	3.62^{a}	92.06^{a}	14.94^{a}	0.33^{a}	1.50^{a}	20.7^{a}
T_4: 3.0 t ha^{-1} + OM	6.9-7.3	1.50 ^{ab}	0.09^{a}	0.11^{a}	8.58^{a}	3.44^{a}	26.63^{d}	10.06^{a}	0.41^{a}	1.06^{b}	18.3^{a}

T_5 : 4.0 t ha^{-1} + OM	6.8-7.3	1.36 ^{c}	0.09^{a}	0.08^{a}	3.20^{a}	3.71^{a}	57.70^{b}	5.80^{a}	0.30^{a}	1.16^{b}	17.5^{a}
T_6 : 5.0 t ha^{-1} + OM	6.7-7.4	1.59^{a}	0.09^{a}	0.07^{a}	3.20^{a}	3.73^{a}	25.73^{d}	6.47^{c}	0.30^{a}	1.23^{ab}	17.5^{a}
F-test		*	NS	*	NS	NS	*	*	NS	NS	NS
$LSD_{0.05}$		0.127	0.017	0.028	1.437	0.348	6.237	2.263	0.409	0.296	6.198
CV (%)		4.70	10.93	11.45	9.45	5.52	7.82	14.19	13.71	13.46	17.91

OM= Organic Matter, equally incorporated in soil in every treatment plot
*= Significant at 0.05% level of probability
The Figures having common letter in a column are not significantly different by F-test at 5%level.
LSD= Least Significant Difference, CV= Co-efficient of Variation

OM and liming effects on changes of growth and yield components of wheat:

Table 2: Interaction effects of OM and lime on growth and yield components of wheat

Treatments	Plant Height (cm)	Tillers $hill^{-1}$ (no.)	Spike Length (cm)	Grains $Spike^{-1}$	1000-grains weight (g)	Grain yield (t ha^{-1})
T_1: Control + OM	81.10 ^{a}	12.60 ^{a}	13.23 ^{b}	26.67 ^{b}	23.34 ^{a}	4.3 ^{c}
T_2: 1.0 t ha^{-1} + OM	83.73 ^{a}	13.00 ^{a}	14.50 ^{ab}	37.67 ^{a}	33.34 ^{a}	5.3 ^{b}
T_3 : 2.0 t ha^{-1}+ OM	85.33 ^{a}	11.47 ^{a}	15.13 ^{a}	35.00 ^{ab}	32.00 ^{a}	5.6 ^{a}
T_4: 3.0 t ha^{-1} + OM	84.67 ^{a}	12.06 ^{a}	15.03 ^{a}	34.00 ^{ab}	23.34 ^{a}	5.5 ^{ab}
T_5 : 4.0 t ha^{-1} + OM	84.00 ^{a}	12.53 ^{a}	13.23 ^{b}	34.00 ^{ab}	26.66 ^{b}	5.4 ^{ab}
T_6 : 5.0 t ha^{-1} + OM	81.70 ^{a}	12.53 ^{a}	13.13 ^{b}	34.33 ^{ab}	30.00 ^{a}	4.5 ^{c}
F-test	*	*	*	*	*	*
LSD value	353.35	3.312	1.753	9.203	11.247	0.483
CV	149.30	14.72	6.86	15.05	21.99	4.44

OM= Organic Matter, equally incorporated in soil in every treatment plot
*= Significant at 0.05% level of probability
The Figures having common letter in a column are not significantly different by F-test at 5%level.
LSD= Least Significant Difference, CV= Co-efficient of Variation

Yield Components:

The application of different doses of lime significantly increased the plant height, the effective number of tillers $hill^{-1}$, spike length $plant^{-1}$, the number grain $spike^{-1,}$ 1000 grain weights (g) and Grain yield (t ha^{-1}) are presented in Table 2.

Plant height of wheat progressively increased with increase in lime doses. The plant height ranged from 81.10 cm in T_1 (control) treatment to 85.33 cm in T_3 treatment. The tallest plant recorded in T_3 was significantly comparable to those obtained in T_4 treatments. All the treatments of T_1, T_2, T_5 and T_6 differed statistically from each other in plant height.

The **Tillers** hill^{-1} by different treatments varied from 11.47 to 13.00. The highest number of tillers was obtained in the treatment T_2, which was significantly comparable to those obtained in T_1 treatment.

Spike length of wheat ranged from 13.13 to 15.13 cm, the tallest spike was found in T_3. The treatmentT_3 and T_4 treatment which values are same and statistically similar. The treatments of T_1 differed statistically from each other in Spike length.

The number of **grains spike^{-1}** of wheat ranged from 23.34 to 33.34. The highest number of grains was found in T_2 treatment which was significantly comparable to those obtained in all treatments. The treatment T_2 recorded higher number of grains spike^{-1} over T_1 treatment and statistically superior to T_1 treatment.

The **1000- grains weight** of wheat ranged from 23.34 to 33.34g. The highest 1000 grains weight was found in T_2 which was significantly comparable to those obtained in all treatments. The treatments of T_2 recorded highest1000- grain weight and T_3, T_4 and T_5 statistically similar.

Grain yield of wheat (var. BARI Gom33) was significantly responded due to application of different doses of lime along with OM (Table 2). The highest grain yield was found in T_3 (5.6 t ha^{-1}) while the lowest in T_1 (4.3 t ha^{-1}) treatment. All the treatments of T_1, T_2, T_4 T_5 and T_6 differed statistically from each other in grain yields of wheat. Application of lime combined with OM increased grain yield of wheat to a considerable extent but application of lime at the doses of 2.0 t ha^{-1} was enough for desired yield of wheat.

Conclusion

It may be concluded that OM and lime application in High Barind Tract (AEZ-26) in the Amnura soil series increased soil pH at desired level (pH 6.5) along with increased microbial population and yield of wheat. Based on the present findings, it is suggested that the amount of lime **2.0 t ha^{-1} along with OM** may be optimum for wheat cultivation in the Amnura soil series in AEZ 26. It may be varied due to different pH range & OM contents in soil. However, it was the only one-year research findings. For making viable recommendation, it is necessary to continue this research for at least two more years.

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