J. Sylhet Agril. Univ. 8(1&2): 55-66, 2021 **ISSN:2308-1597**

SOIL NUTRIENTS STATUS AND SUSTAINABLE CLAY COLLECTION PLAN SURROUNDING LAFARGE SURMA CEMENT INDUSTRY FOR CEMENT PRODUCTION IN SYLHET REGION OF BANGLADESH

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(Available online at www.jsau.com.bd)

Abstract

This research shows that how renowned Cement producing industry could cause very minor environmental manipulation all around the factory area although they might partially using both agricultural and unproductive land. The land quality around the factory is not appreciable for farming in an extended way. The nutrients could be restored in the long term process but it will cause a lot of cash which is not feasible for poor farmers. So for rehabilitation of this area, after collecting clay in a bi-yearly rotation system the factory authority may deliver the inputs to the corresponding farmers for aquaculture and help to improve single crop growing lands by delivering natural green manure. A brief and specific sustainable clay collection plan and criteria for selecting land and subsequent activity describes in this study. This plan should be followed for ensuring long-term sustainable clay supply within minimum environmental cost.

Keywords: Sustainability, clay mineral, nutrient, Yield, Farm friendly Industrialization

Introduction

Bangladesh is the world's eighth densely populated country which is fifty times higher than that of the US and six times higher than even that of China (Ministry of Land, 2016). Its total land area is 14,570 km2 where 60% of the total land area is used as cultivated area (BBS, 2016). The population is still increasing by 1.37% every year (BBS, 2017), however, the cultivated land is decreasing simultaneously. The agricultural land is converted by uncontrolled urbanization, industrialization as well as the increasing of human activities (Ahmed, 2013).

Indigenous nutrient supplying capacity and fertilizer management may make the soil fertile for one type of crop but could be deficient for the others. So, determination of soil fertility range would be important not only for producing healthy crops economically but also for maintaining its productivity for future generations. Soils in Bangladesh are exposed to high temperatures mostly; plenty of rainfall and greater pressure from growing two or more crops in a year with or without balanced fertilizations (Biswas et. al. 2008). New nutrient deficiencies are emerging, and there might be potential hidden hunger for many others that need to be identified for efficient crop production (Saha PK et. al. 2016). Soil fertility varies among regions indicating that variable amounts of fertilizers need to be applied for different types of crop production. The inadequate dose will impair crop yield, while an overdose can cause not only economic losses but also could be responsible for environmental pollutions (Yang Y and Zhang S. 2008). So, broad knowledge on soil fertility can provide a better perception of current nutrient status, distribution patterns, and trends (Dafonte et. al. 2010), that can be obtained through geostatistical and geospatial analyses Behera et. al. 2015 and Desavathu et. al. 2018). Soil fertility in 10- 12 and 39-52% areas in Bangladesh are very low and low, respectively. Medium fertile and fertile soils are distributed in 17-41% and in about 8% areas of the country. About 55% of soils scored 70–95 (medium to high SOC) and the rest belongs to inferior quality. In some areas, P build-up has taken place (25% areas), but widespread K mining. Sulphur and Zn status in about 40% of areas are low to very low (scored <35 and <40). Soils of the major areas of the country are with low pH (5.0-6.0) (Ahmed S. 2013).

LafargeHolcim Bangladesh Ltd., a joint venture of LafargeHolcim and Cementos Molins is the only fully integrated cement company in Bangladesh producing clinker and cement of high premium quality. Since the beginning of 1997, Lafarge Surma Cement (LSC) has contributed to millions of lives by providing durable, affordable, and accessible building materials and solutions as well as by undertaking initiatives for the betterment of the economy, society, and environment.

As this company is the only one that produces clinker in home, this company is like a resource to our native country. Lafarge creates huge job markers all over the country. So, it has a huge economical influence especially in the Sylhet area as its production house.

But there are some risk factors behind his huge workstation which we cannot deny. The clinker that is produced here is basically formed from the soil they collect surrounding the nearby factory area. They mainly collect the soil deposited when flood affects this area every year on a large scale. So literally there is a cycle existing of artificial cutting and natural filling. But in the actual field, the picture is not the same. Because the rate of filling is varied year to year depending on flood volume and duration of the flood. So, this is a big issue for sustainable consumption of soil for clinker production. So, some land needs more than 2 or 3 years to become flat land as before.

Again, for some miss management the surrounding Tillas also being disturbed by local soli suppliers. So, this may be turned into a huge legal problem for environmental protection agencies.

The land Lafarge consumes is meant to be used for agricultural purposes in a traditional manner. But the farmers may be affected due to this whole process. For this factory the cropping practice may be hampered, the cropping pattern may be changed, the choice of the crop may be shrinking, the local cultural practice may be changed and all of this has some long-term consequences on both agriculture and the environment.

Again, for consuming the topsoil and exposing the sob soil, the fertility level may dramatically change. So, what is the effect of extracting topsoil on its exciting fertility level it must be evaluated for sustainable agricultural practice. There is another issue that at the extracting area there is a huge chance to building a land mafia group in local people which may economically hamper the goal of sustainable economic development of this area's people. In this situation, poor farmers may affect more as helpless. So social conflict and unrest may increase dramatically over the night.

Mbogoni et al (2011) evaluated soil fertility by using average weighted data on SOC, soil pH, total N, electrical conductivity, C/N ration, available P, exchangeable Ca, Mg and texture for rice-based system productivity improvement. Desavathu et al. (2018) used soil pH, EC, N, P, and soil fertility evaluation through inverse distance weightage interpolation. Therefore, the objective of this study was to use geo-referenced data on selected soil attributes for the preparation of soil fertility maps using average, weighted mean, geometric mean, and most minimum value techniques for Bangladesh. The primary object of this research is to study the present soil conditions of the area's from where this industry collect clay minerals and give them a plan for collecting clay in a sustainable manner for long term supply in the meantime how to rehabilitee land use for agricultural purpose in the study area for the best interest of farmers.

Materials and Methods

The study area was at Chhatak in the Sunamganj district of Bangladesh. Several lands were selected for field experimental purposes around the Cement manufacturing plant. The geo coordinate lays about 25°01'55.2"N 91°38'40.6"E to 25°02'07.3"N 91°38'25.7"E and surrounding area. Primarily Two sites were selected for data and sample soil collection (Site A consisting of 37 ha land and Site B consisting 39.3 ha land). From Site A, the sample was taken from 16 random points, and from Site B, 25 samples were taken into count for receipt of data.

A U-shaped hole was duged with the required depth and a slice of approximately 15-30 cm thick was cut out. Both sides of the slice were trimmed leaving a 5.0 cm strip, which is then put in a clean container. After that, the soil was mixed thoroughly in the container and all soil clods had broken up. From the bulked sample, about 1000 gm sample was taken as air-dried at room temperature within 16 hours of extraction. The micro and macro and other chemical properties of soil were analyzed by the standard procedure as presented in Table 1 (Nigam et al., 2014).

Table 1: Laboratory methods used for chemical analysis of soil

SN.	Particulars	Method used
1	Electrical Conductivity (mili mhos)	Solubridge conductivity meter method (Black et al., 1965)
2	pH	pH meter
3	Available N (%)	Alkaline permanganate method (Subbaiah and Asija, 1956)
4	Available K (ppm)	Flame photometric method (Jackson, 1967)
5	Available P (ppm)	Olsen's method (Olsen et al., 1954)
6	Micro component (ppm)	Atomic absorption Spectrophotometeric method
7	Organic matter (%)	Loss on ignition method

An intensive field photographic survey was done for measuring the depth of soil cut and in subsequent years for measuring the depth of filling by deposit silt from flooding. The deposition was measured by a standard scale. River stage was measured by using an automatic stage measuring device provided by Lafarge's weather recording center. A semi-structured questioner survey was done for collecting data from farmers, landowners, soil suppliers, and also Lafarge authority. This date was used for preparing a guideline for sustainable clay collection at the local level to reduce unrest at different management levels with minimum environmental loss.

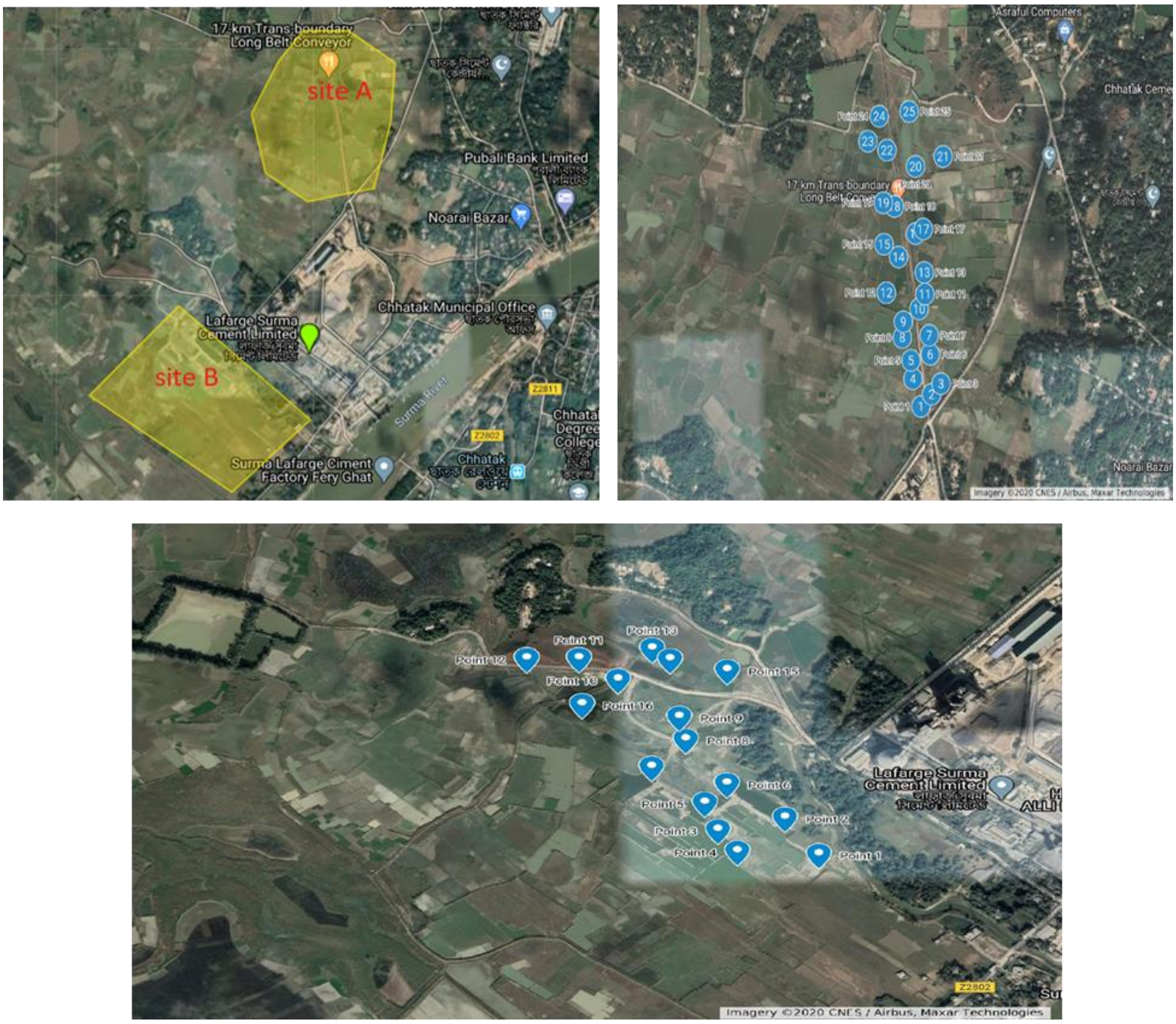

Figure 1: The study area, Sampling Stations at Site A and Site B

Result and Discussion

The elementary analysis of samples is given below. The analysis shows that the pH values of the samples are very low which indicates highly acidic soil. The overall organic matter is below the standard range which is not favorable for Rice cultivation in a profitable way. The Nitrogen deficit will be a massive constrain for crop cultivation in the study area. Without proper rehabilitation, crop cultivation is near to impossible as the Nitrogen concentration is too low. Besides, the level of calcium is moderately high as the presence of limestone all-around the field and necessary appreciable amount of potassium is missing. Magnesium is present in very high frequency but in the case of Zinc, it shows optimistic reading for crop cultivation. The study area contains a heavy amount of Iron, Copper, and Sulphur but little Boron which is also adverse for Agricultural practices. So the overall scenario is not favorable for cropping in this area in a profitable way. So this unproductive land could be used for preparing cement as parent materials without creating any adverse effect on the standing Agricultural situation.

Table 2. Elementary analysis of samples

Sl no	Soli Sample code	pH	Organic Matter	Total Nitrogen	Potassium	Calcium	Magnesium	Phosphorus	Sulphur	Boron	Copper	Iron	Manganese	Zinc
			%		µg/g (ppm)									
1	A	4.8	1.10	0.100	0.16	7.52	0.89	1.0	48.86	0.06	3.36	157.96	33.79	2.65
2	B	4.2	2.20	0.080	0.18	6.33	0.65	0.96	45.50	0.35	3.08	344.05	51.89	6.23
3	C	4.5	1.50	0.100	0.16	6.05	2.60	0.57	53.18	0.06	3.72	339.40	95.07	1.72
4	D	5.4	1.60	0.120	0.18	7.36	2.69	0.70	62.47	0.05	3.50	246.46	52.71	1.64
5	E	5.7	2.00	0.100	0.17	14.16	1.12	1.24	38.05	0.12	2.06	42.25	14.87	1.52
6	F	5.1	1.50	0.075	0.13	7.23	1.44	0.62	13.67	0.12	1.05	34.03	13.19	0.59
7	G	4.9	1.60	0.090	0.21	6.81	2.32	0.64	39.31	0.06	3.28	197.01	60.42	1.98
8	H	4.7	0.70	0.080	0.10	2.47	1.48	0.48	16.39	0.04	4.98	347.58	63.28	1.16
9	I	4.8	1.80	0.070	0.19	5.76	0.75	0.57	56.05	0.15	3.11	225.01	77.74	2.04
10	J	4.7	1.30	0.070	0.14	5.31	1.07	0.61	45.36	0.02	2.70	146.28	42.49	1.79
11	K	4.5	1.90	0.100	0.18	2.52	0.74	1.46	28.19	0.11	2.36	113.28	14.54	1.53
12	L	5.3	0.90	0.080	0.11	6.56	4.65	0.52	12.41	0.18	0.85	17.14	7.50	0.78
13	M	5.4	0.50	0.040	0.12	8.86	5.86	1.02	41.89	0.27	1.48	39.62	24.95	1.05
14	N	4.8	1.8	0.080	0.18	6.19	2.03	0.74	61.41	0.27	4.12	263.49	59.76	2.30
15	O	4	1.90	0.110	0.20	10.38	3.51	0.80	77.06	0.29	3.86	177.47	33.35	1.36
17	P	5.1	0.50	0.040	0.12	6.82	4.04	0.78	21.28	0.25	6.71	229.98	68.06	2.01

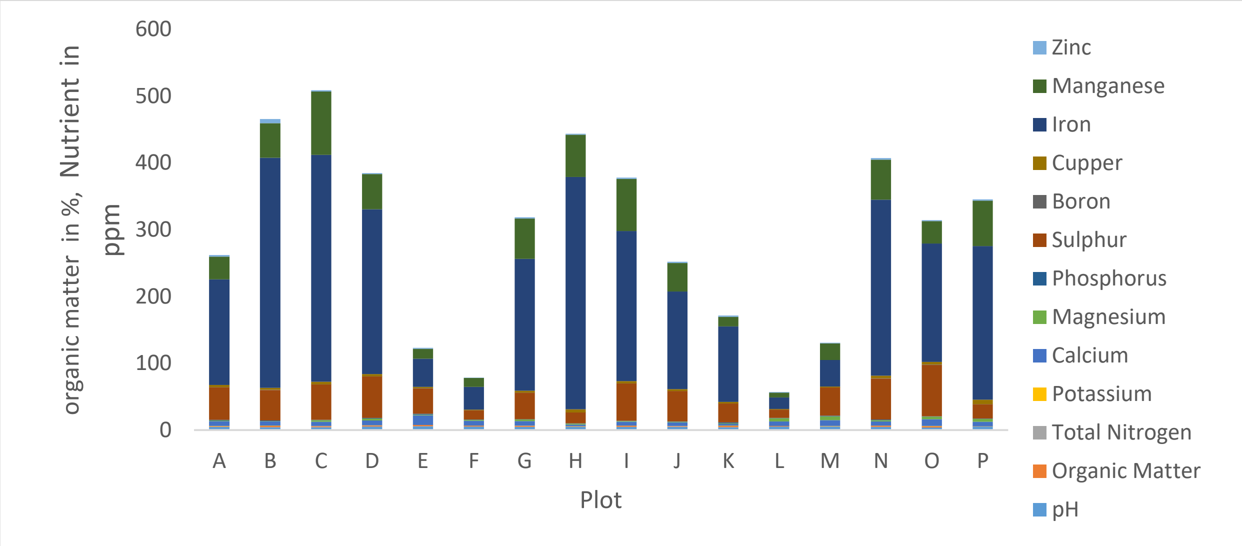

Figure 2: Comparative presence of Micro and Macro Nutrients at different samples

The table below shows the Classification of soil samples based on Texture:

Table 3. Classification of soil samples

Sl no	Soli Sample code	Textural Class	Sand	Silt	Clay
			%		
1	A	Silt Loam	23	51	26
2	B	Silt Loam	23	52	25
3	C	Silt Loam	15	60	25
4	D	Silt Loam	17	58	25
5	E	Loam	44	46	10
6	F	Silt Loam	31	53	16
7	G	Silt Loam	31	51	18
8	H	Silt Loam	21	64	15
9	I	Silt Loam	43	51	6
10	J	Sandy Loam	51	43	6
11	K	Silt Loam	26	73	1
12	L	Silt Loam	18	66	16
13	M	Silt Loam	23	64	13
14	N	Silt Loam	19	61	20
15	O	Silt Loam	15	61	24
17	P	Clay Loam	27	44	29

The table above indicates that's, most of the area contains Silt Loam soil. This is happened because of the continuous siltation from the Surma River as the area located near the Surma river bank. In this river's station, more or less every year flood pays a visit and contributes the shore area. The river stage data displayed below support this statement.

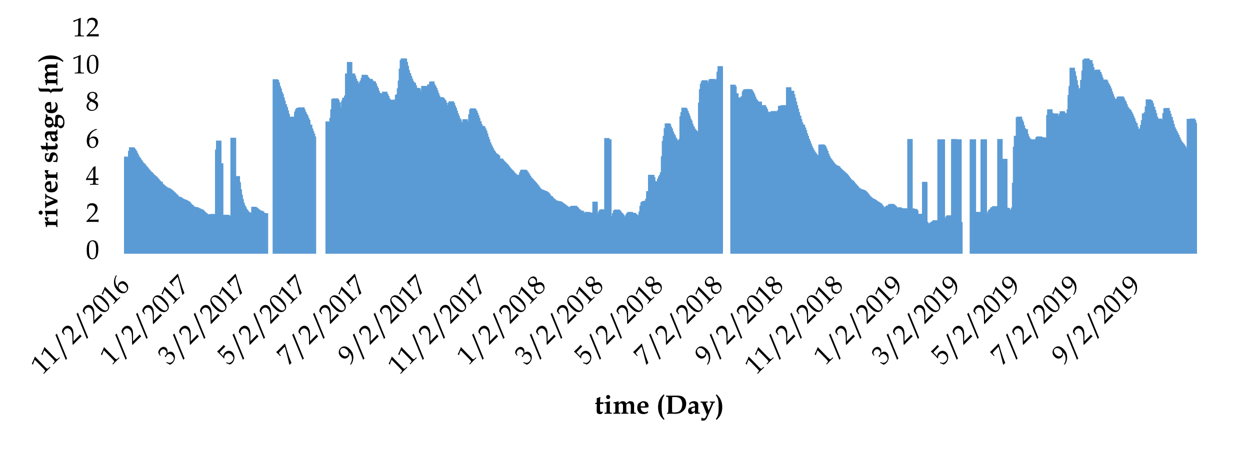

Figure 3: Surma river stage creating flood (near study area Station)

From the site survey, it is found that every year about 6 inches or half ft siltation takes place in the study area (site A and site B). So it will not be very dangerous for the environment if the industry collects soil from here in a very limited way. Soil collection may be done by Rotation System. It will be better to not collect soil more than 4 ft from an individual plot and the plots should not be disturbed until it fills up by natural siltation. So after collecting soil from a location, the plots should not be disturbed in the next 2 to 3 years. At this time others locations should be used for making it a sustainable source of clay. By this rotation system, the clay collection will be sustainable and the equal distribution of wealth also may be done among the farmers. No third-party interference is desirable between the farmer and the clay collection team. Industry authority must be aware to not cut a single plot more the once in 3 years, otherwise, it may cause adverse effects on the healing process of the pit. Again, any small or large Tilla Should not be touched for clay collection. Because it will be a devastating situation for many rare species of fodder and tree

Recommendation for Lafarge authority

Potential area for Clay collection

Table 4. Potential places for clay mineral collection in the long run

Area	Land Type	Mouja
1	FL/SC	Patibagh
2	FL/SC	Sharpin Nagar
3	FL/SC	Raj Gaon
4	FL/SC	Rajar Gaon

FL= Fellow land, SC= Single Crop

Land Selection & Clay Excavation Standards

For the collection of clay in a planned and environmentally friendly manner with minimum damage to the environment and community, the Company's plan is as follows:

- The Company shall collect clay through the independent suppliers. The Company shall make sure that the local suppliers collect the Clay in a planned and environment-friendly manner with minimum damage to the environment and community.

- The Company shall select only those lands that are less productive, fallow, and produce one crop in a year (poor boro/ aman land).
- The Company shall Identify the land and shall employ the suppliers to harvest clay from those sites under the following guidelines:

The suppliers shall produce a detailed Clay excavation plan and with the remedial measures for the necessary repair of the land;

The suppliers shall excavate clay according to the Company's guidelines regarding the depth and slope protection;

The suppliers shall not harm the neighboring land under any circumstances.

The suppliers should use the public road as minimum level and should avoid the habitation to reduce dust generation

- The Company shall only award supply agreement when the suppliers are committed to complying with all the standards and regulations set by the Company and the local authority including the rehabilitation process.
- The Company shall monitor and evaluate the Clay harvesting program intensively and take instant actions against any violations.
- The Company shall produce an advanced plan for the post-excavation scenario of the land and will work with the suppliers to improve the productivity/ use of the land.
- The suppliers shall provide a detailed plan for the post use of the land, which has to match with the LSC's guidelines and specifications. LSC Intends to restrict the post use of the excavated land to improve boro land and to some extent to AQUACULTURE and household (POND) uses.

Land Selection Guidelines

LSC intends to collect its required clay through sustainable clay mining in the future, the process of which is currently in progress. In the meanwhile, LSC aims to procure day through the local suppliers to meet its current demand. Recognizing the facts, LSC has taken several actions and Intends to sustainable clay harvesting process in the upcoming years. The following guidelines are established to reduce the impact ensuring a sustainable clay excavation program:

Selection of Potential Land

- LSC will select some potential sites. The priority would be limiting the number of the sites so that most of the clay can be collected with minimum public nuisance and road infrastructure impact;
- LSC will work only with the potential land-owners who meet the standard of the specific Land Selection Guidelines by LSC;
- Both the landowner and the supplier need to agree with the neighboring landowners regarding the excavation plan to ensure no impact on neighboring land;
- Land that has easy access to the LBC clay road would have the high priority;
- Only the fallow, rarely used, poor boro/aman land will be selected. The intended end use of the land has to match with either boro rice cultivation or preparation of pond for aquaculture or other household uses;
- Land with neighbors complaints, fertile lands, land within 1 km of the LSC Plant would be avoided.

Selection of Potential Suppliers

- Suppliers would be selected based on their willingness to comply with the excavation guidelines prepared by LSC;
- Suppliers would be selected based on their previous year's performances;

- Suppliers will be selected based on their preparedness in submitting the tender documents and required plans;
- Suppliers will be selected based on their competitive offer, their capacity to work on the potential sites selected by LSC;
- New suppliers will be prioritized based on their good reputation in the community.

Excavation Standards

Following standards have to be complied with by the suppliers

Excavation Site

Excavation Sites cannot be within 1 km of LSC Plant;

Excavation Sites cannot be double-cropped land;

Other land selection criteria set by LSC needs to be adhered to.

Excavation Depth: 2-3 ft for agricultural land

6- 8 ft for aquaculture/ household

Pond Slope: 45%

Implementation of Land Revitalization Concept

Green manuring crop cultivation after day excavation can be done. It will not only stabilize the soil but will also improve the fertility level of the soil significantly. As a result boro cultivation in the following season will be benefited greatly. Dhaincha (as a green manuring cap) can be sown in May and can be harvested in July. Moreover, this plant can survive in a flash flood and monsoon flood. LSC will work with the landowners to prepare the land after clay excavation so that the soil stabilizes. It will further provide supports to transform the excavated land to productive boro rice land. To ensure the proper implementation of the concept LSC will support the landowners in the following:

Seed & Seedlings

The seed will be purchased from the local seed dealer through the contractor. BR-29 and 8R-19 can be selected. For seedbed 7 care land (one care is equal to 33 decimal of land) will be selected and the seed will be sown In 2 batches at 7 days intervals. Seedlings will be distributed among the rehabilitated landowner without any cost.

Land Preparation

The land will be ploughed through a power tiller while labeling of land will be done through labors simultaneously. A total of 15 days will be required for land preparation at a rate of 12 care per day. The first 10% prepared land will be transplanted from the first batch of seedlings whereas the rest 90 will be transplanted from the second batch. The cost of land preparation will be complementary to the farmers.

Fertilizer

Fertilizers should be purchased ahead and should be stored in Company's Community Development Building (CDC). It will be distributed to the landowners according to the LSC's specifications through the supervisors and the contractor. Fertilizers will be distributed among the rehabilitated landowner without any cost.

Shallow Water Pump

LSC shall purchase the machine and will lend it to the farmers to take out the access water from the land. Landowners are needed to pay for the fuel. The contractor and the supervisors together will monitor the uses.

Ensuring Proper end use of the Land

Both the suppliers and the landowners are required to submit the proposal for the use of land after excavation. LSC will accept those proposals only that are complementary with the LSC's Excavation Plan. The suppliers should be responsible for preparing the land according to the proposal.

Conclusion

For the causes of hot and humid climates, the rate of organic matter depletion is high. Due to imbalanced use of chemical fertilizers, intensive agriculture, limited addition of crop residues, and limited practice of green-manure cropping, soil fertility is also declining in the country (Shelley et al., 2016). Soils of the area are deficient in some essential elements such as N, P, K, and S, which are limiting factors and N is the most limiting factor among which Mg, Zn, and B are also reported to be limiting in many areas (Jahiruddin and Satter, 2010). A monitoring cell of LSC will document all necessary steps and will monitor all essential procedures to minimize the Impact. LSC will evaluate the process for further improvement and Impact reduction. Chhatak Clay has been found to be a suitable alternative to Indian Shale, which is an essential element in the raw mix to produce clinker. As the company has planned to reduce the import of shale to save valuable foreign currency, it is essential to procure clay locally. So every environmental risk should manage properly for the sustainability of the production, without any interruptions from environmental agencies of Bangladesh. In this case, the recommended section should be strictly followed by the authority.

Acknowledgements

The authors thank to Professor Dr. Pijush Kanti Sarkar, Department of Irrigation and Water Management, Sylhet Agricultural University, Sylhet-3100 and Dr. Md. Anwar Hossen, Senior Scientific Officer, Farm Machinery and Postharvest Technology Division, Bangladesh Rice Research Institute (BRRI) Gazipur-1701, Bangladesh for their valuable assist to conduct the research.

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