INDIAN SOCIETY OF SOIL SCIENCE
KOLKATA CHAPTER

Newsletter

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Chief Editor's Desk

The Indian Society of Soil Science (ISSS) started its journey from Kolkata (the then Calcutta) in the year 1934 with Professor J. N. Mukherjee (the then Palit Professor of Chemistry at the University of Calcutta) as its Founder-Secretary. The Headquarter of ISSS was shifted to the then Imperial (now Indian) Agricultural Research Institute (IARI), New Delhi when Professor Mukherjee joined the Institute as its Director in the year 1944. Since then the Society has expanded its activities manifolds and presently it is one of the Premiere Learned Societies in India. The Society is also affiliated to the International Union of Soil science (IUSS).

The Society holds Annual Convention and National Symposium every year. In West Bengal, the Society held its Annual Convention since 1960 thrice; in 1974. 1997 (62nd) and 2017 (82nd), all under the aegis of the Kolkata Chapter of ISSS.

Among the multifarious activities of the Kolkata Chapter of ISSS, one is to bring out Newsletter. This activity was discontinued in the past for several reasons. The Chapter is resuming its Newsletter with the present Number. I congratulate all the Contributors to this Number and sincerely hope that this Newsletter will be appreciated by the Members of ISSS, in general, and by the Members of the Chapter, in particular. In this task, I have been constantly helped by the former and the present Secretaries of the Chapter, namely Dr. Krishnendu Das and Dr. Feroze Rahman, as well as other Members of the Editorial Board. The encouragement and help received from all the Members of the Chapter and those of the Parent Society is gratefully acknowledged.

Prof. S. K. Sanyal

Message from President's Desk

An increasing population, increased food, feed, and fodder needs, natural resource degradation, climate change, new parasites, slow growth in farm income, and new global trade opportunities all necessitate a paradigm shift in soil research. In recent years, a declining trend of total factor productivity with low nutrient use efficiency has been observed, primarily due to the deterioration of soil health. The primary causes of soil health deterioration are: a large nutrient gap between demand and supply; high nutrient turnover in the soil-plant system coupled with low and imbalanced fertiliser use; decline in organic matter status; emerging deficiencies of secondary and micronutrients; nutrient leaching and nutrient fixation problems; impeded drainage; soil pollution; soil acidity, salinization, sodification and so on. Further, in the eastern part of India, soils broadly fall into four main groups, viz., red soils, laterite soils, alluvium soils, saline soils, and soils of the Himalayan region. These soils differ in their productivity and need different management practices depending on soil physical and chemical properties and biological conditions, rainfall or availability of water for irrigation, crops and cropping systems.

I am humbled to get the opportunity to serve as President of the Kolkata Chapter of the Indian Society of Soil Science, one of the most vibrant and also oldest Chapters. We are blessed with many dedicated scientists and teachers who care deeply about the discipline, its standing, and their contributions to research for the development of soil science in a fast-changing environment. I hope the chapter will make all possible efforts to solve the diverse problems of the soils of the region.

Dr. Gouranga Kar

From Secretary's Desk

The endevour of Indian Society of Soil Science Kolkata Chapter is to serve the cause of Soil Science since last several years. The erstwhile Calcutta Chapter of ISSS was constituted in early 1970's as an informal group of soil scientists meeting at regular intervals to exchange and discuss ideas and views related to Soil Science Research. Since the publication of the last issue of the Newsletter, one of the its important activities was the organizing of 82nd Annual Convention and National Seminar on Developments in Soil Science at Amity University Kolkata during December 11-14, 2017. In collaboration with IPNI South Asia Programme and NABARD Kolkata, the Kolkata Chapter of ISSS organized a National Seminar on '*Soil Health Management and Food Security: role of Soil Science Research and Education*' during Oct 8-10, 2015. The series of P. K. Dey Memorial Lectures from 6th to 9th were organized by the Chapter at ICAR-

NBSS&LUP, Regional Centre Kolkata which were delivered by the different eminent Scientists of Soil Science Research of the Country. The 10th P. K. Dey Memorial Lecture was recently organized by the Chapter at ICAR-CRIJAF Barrackpore and was delivered by Dr. T. J. Purakayastha, Principal Scientist, ICAR-Indian Agricultural Research Institute, New Delhi 110012 on '*Carbon carrying capacity of soil: Role of clay, substrate quality, and microbes at the interface of climate change*' on August 6, 2022.

To perpetuate the memory of Late Prof. Shyamal Kumar Gupta, the Professor S. K. Gupta Memorial Lecture was initiated by ISSS Kolkata Chapter. The First Professor S. K. Gupta Memorial Lecture on *'Zinc-The Indispensable Micronutrient'* was delivered by Dr Pradip Sen, MD, WBSSS, Govt of WB on Nov 4, 2019. The Second Prof. S. K. Gupta Memorial Lecture was delivered by Prof. S K Sanyal, Former Vice-Chancellor, BCKV, Mohanpur on *'Arsenic Contamination in Groundwater: Effect on Water-Soil-Crop-Human Continuum'* on April 23, 2022 on hybrid mode.

There is a need for upsurge in membership of the Chapter and initiative has been undertaken to increase the number of members from different organizations located in Kolkata or nearby. The chapter is striving to achieve further excellence and reach out to different stakeholders of agriculture in wider scale with the message of need for natural resource management, especially soil, through organizing symposia, conferences, interaction, special lectures, interface meet etc.

Dr. F. H. Rahman

Research Articles

Article 1: Arsenic Contamination of Groundwater: Build-up in Soil-Crop-Human Continuum & Mitigation

Groundwater pollution with arsenic in the affected belt of West Bengal and Bangladesh showed elevated arsenic in soil, groundwater, paddy, and other plants, thereby causing hazardous effect for human consumption. Early symptoms of arsenic poisoning are skin disorder, weakness, languor, anorexia, nausea, etc. Long-term exposure causes diarrhoea, edema, skin pigmentation, melanosis, hyperkeratosis, enlargement of liver, respiratory disease and skin cancer.

Solubility, bioavailability and toxicity of arsenic depend on its oxidation state and form. Arsenite is more toxic than arsenate, monomethyl arsonous acid and dimethyl arsenic acid. Proportion of soluble arsenite in soil increases with diminishing E_h and increasing pH when OH^- ion causes displacement of arsenite and arsenate from common binding sites *via* ligand exchange

Remedial Options at a Glance

- Optimum conjunctive use of ground and surface water (e.g. harvested rainwater) and recharge of groundwater resource with harvested rainwater, free of arsenic.
- Development/identification of suitable low arsenic-accumulating high yielding crops/varieties, and preferring low-water requiring, farmer-attractive cropping sequences (especially for the lean period of January to May), suitable for the arsenic-contaminated areas.
- Irrigation with pond-stored groundwater in which partial arsenic-decontamination is facilitated by sedimentation-cum-dilution with rain water.
- Enhancing the water use efficiency (through optimum water management) for groundwater irrigation, especially for summer (*boro*) paddy.
- Increased use of FYM and other manures, inclusion of green manure crops in the cropping systems,, as well as application of appropriate inorganic amendments (zinc/iron/silicon salts as and wherever applicable).
- Identification/development of varieties /crops which accumulate less arsenic in the consumable parts and where the ratio of inorganic to organic forms of arsenic is low.
- Developing cost-effective phyto- and bio-remediation options (especially rhizo-exclusion).
- Creation of general awareness by arranging mass campaigning, holding of farmers' day, field demonstrations, while taking due cognizance of the socioeconomic factors (Sanyal et al., 2015; Sanyal, 2017).

Policy Interventions

The issue of arsenic contamination in groundwater in parts of the country and its adverse effect on human health has been agitating the scientists, physicians, community workers, lawmakers and the general public at large, especially those who are suffering from its toxic effect. The primary attention, however, is directed towards solving the problem of such contaminated resource-based drinking water supplies to mostly the rural population. This is mentioned at the beginning of this article but is reiterated here to emphasize that the issue of addressing the drinking water sector itself is a huge challenge. The options have been mostly confined to the use of the relatively safe surface water, adequately clarified of its pathogen load, or tap the relatively deep aquifer layer (at a depth more than 150–200 m below the ground level) which is essentially free of the toxin in the affected belt. Periodic monitoring of the quality of such drinking water sources is also ensured quite satisfactorily.

However, what remains to be addressed is the food-chain issue which gets contaminated due to the entry of arsenic in it through the contaminated groundwater sources being pressed to irrigate the agricultural crops. This is not to undermine the existence of quite a vast amount of experimental data already generated by not only the agricultural scientists, but also the geologists, hydrogeologists, environmental experts and, most of all, the medical professionals (the latter till date in a moderate scale though) working in a consortium mode. It is quite reasonably well-established now that the food-chain contamination provides *yet another potential pathway of arsenic exposure* of the population in rural areas. Hence it is imperative that any comprehensive mitigating intervention of chronic arsenic toxicity in people requires integrated approaches toward reducing arsenic entry into the food chain, on one hand, while reducing arsenic in the drinking water below the safe limits, on the other. Unless this is attempted and accomplished, the food bio-safety concern, in its totality, is unlikely to go hand-in-hand with the food and nutritional security concerns of the country, not only for the domestic population but also for the export market. It appears that despite such realization at the level of scientists, it is yet to translate itself in terms of a concrete action plan, perhaps as a pilot programme initially, and finally as a large-scale initiative, to be implemented covering the entire affected belt. ***To ensure the latter, the concerned planners and the policy-makers need to be adequately sensitized***.

The success of such an integrated approach would essentially depend on its multi-level stakeholder nature,

involving researchers, technologists as well as the planners with a focus on the real beneficiaries. The beneficiaries ought to be empowered through awareness and training to understand and participate actively in such mitigation programmes. A major shift from a purely technical to a holistic approach is needed to ensure a *technically feasible, socially acceptable, economically viable and environment-friendly sound action plan*.

Conclusions

Generating awareness and motivating people to test the quality of their drinking water for arsenic remains a key factor to contain the exposure to arsenic. In view of the unprecedented health hazard and misery among the affected people with severe skin lesion, the supply of arsenic-free drinking water, coupled with the arrangement of free treatment of these patients in the state referral hospital, could help considerably in alleviating the disease burden. This is all the more important keeping in view the fact that the majority of the affected people are very poor and live in remote villages.

Arsenic-contaminated groundwater has been the main source of irrigation, drinking and allied activities in the affected areas of rural Bengal and elsewhere. Excessive use of arsenic contaminated groundwater resulted in an elevated level of arsenic in soil and food-chain. Thus, it is indeed high time that appropriate mass awareness is generated among the farming communities towards the judicious use of groundwater, coupled with appropriate remedial measures to minimize the hazards of the toxin affecting the human food-web. Furthermore an integrated approach should bring together not only the agricultural scientists but also the physicians, social scientists as well as the planners at the local level.

There is also a need to improve the field and laboratory protocols for large-scale and fairly rapid measurement of geogenic arsenic contamination, with its speciation in groundwater and soil for ascertaining the ***net*** toxicity of arsenic in soil-crop-animal-human continuum. Evidently, all these issues may best be addressed through a multi-level stakeholder approach, involving researchers, technocrats, policy-makers, planners with a focus on the real beneficiaries. These beneficiaries ought to be empowered through education and training, thereby enabling them to understand and participate actively in arsenic mitigation programmes.

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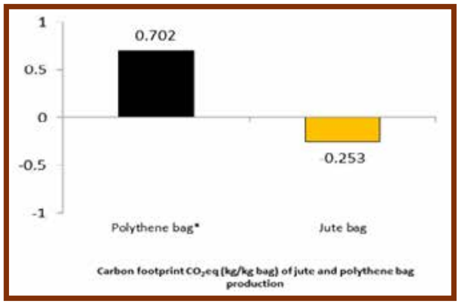
Article 2: Low carbon footprint jute product: an eco-friendly substitute for plastic

The production, usage, and consumption of any product pose a threat to the carbon footprint. There are different types of packaging materials available to cater to the needs of people. A variety of raw materials and technologies are employed to manufacture them. The most popular of those are plastic, paper, non-woven and woven bags. Plastic bags are made from non-renewable resources, where the key ingredients are petroleum and natural gas. Polyethylene-high density (HDPE), low density (LDPE), and linear low-density polyethylene (LLDPE) are the raw materials widely used for the manufacture of plastic bags. Among the alternatives that offer both sustainable and economic appeal, there is a group of fibres known as bast fibers. Among bast fibers, jute takes up the highest percentage in the textile market. All products have an environmental impact on the planet, and its quantification is crucial to reducing it.

Jute *(Corchorus capsularis & Corchorus olitorius)* is a lingo-cellulosic, bast fibre plant next to cotton in importance. It is grown under a wide variation of climatic conditions, mainly in developing countries. Bangladesh and India account for over 90 percent of the world's production. Natural fibres are eco-compatible by nature from cradle-to-grave. Diversified uses of jute as a natural fibre composite are enormous. Approximately 3.80 MT of carbon dioxide gets sequestered per hectare of raw jute fibre production, which is much higher than many tree species (Singh et al. 2019). The carbon dioxide emission from jute is carbon-neutral in nature since the product is from a plant-source and can be considered as a bio-mass. The Life Cycle Assessment (LCA) study on Jute and its products by Price Waterhouse Coopers Ltd. for the National Jute Board (NJB) of India reveals that the most significant impact is carbon sequestration by green jute plants during the growth stage. It was estimated that, on an average, as much as 1.8–2.0 tonnes per hectare of the left-over aboveground biomass of jute (leaves, tops, and branches) is added annually to the soils under jute cultivation (Singh et al. 2017). The carbon build-up rate was 0.11 to 0.25 tonne carbon per hectare per year under the jute-rice-wheat cropping system (Mandal et al. 2007). The roots of jute plants can penetrate up to 60 cm of soil depth or more, with lateral roots that may act as potential carbon sequesters and restorers of soil fertility. Pathak et al. (2011) also reported the carbon sequestration potential (CSP) of field crops including jute under various cropping systems. India could save approximately 10.5 million tonnes of CO_2 from the atmosphere each year by cultivating jute on a 0.70 million hectare area, which is worth approximately 13 crore US dollars. The CER revenue per hectare out of jute cultivation can go to the jute growers or may be shared proportionately with jute industries and farmers.

Increasing demand for packaging materials has given rise to various issues relating to its disposal as well as to the overall environmental footprint and sustainability of the packaging materials. A Life Cycle Assessment (LCA) study was conducted of all inputs and outputs, aggregated in the form of resources used and environmental emissions, extending from the production of raw materials to the final disposal of the product. The system boundary chosen in this LCA study was cradle-to-grave, i.e., from jute cultivation to the disposal of jute bags (Singh et al. 2018). The global warming potential (GWP) for the production of one kg of jute bag is approximately -0.253 kg CO_2eq(Singh et al. 2022). The negative sign indicates a net sequestration of the CO_2 in the soil by the cultivation of jute crops in 120-125 days(Fig. 1). Approximately 1.26 kg CO_2eq is assimilated at the agricultural stage, with the release of 1.00 kg/CO_2eq for the production of 1 kg of raw fibre at the agricultural farm stage. Jute sticks and jute caddy are locally used as fuel, which further helps mitigate GHG emissions in terms of replacement of equivalent fossil fuel and fuelwood in the local area and jute mills. A jute bag can be reused more than 30 times as its primary use for packaging. The frequency of reuse depends on conditions, such as handling, material weight, place, etc. The jute bag degrades within 100 days if mixed with soil under normal environmental conditions. The overall climate change impact of jute bags from agriculture farm to the usage and disposal phase is net carbon sequestration, i.e., sequestering more CO_2, than is emitted in the entire life cycle stages. The excess sequestered carbon is left in the form of fixed carbon in organic matter, and this increases the soil fertility. Thus, the jute bag is an environmentally friendly material from a climate change perspective. The uses of bast fibres products can play an important role in reducing plastic usage. Popularizing the usage of low carbon footprint yielding jute products may yield benefits for improving environmental quality.



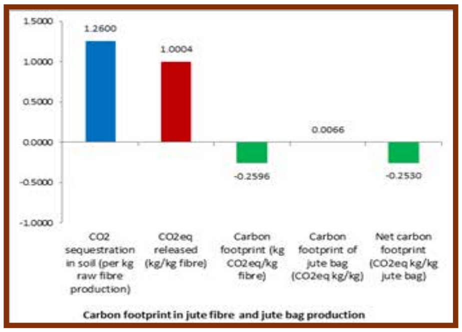


Fig. 1 Carbon footprint in jute fibre and plastic bag production in India
(*CPCB)

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Article 3: Soil Organic Matter Management in Agriculture: Sequestering Carbon to Keep Lands Alive (7TH Dr. P. K. Dey Memorial Lecture)

During the 20th century, the low-yield indigenous nature-based agriculture transformed progressively into new high-intensity, energy-demanding, and productivity-led agriculture called industrial farming to cater food demands of a burgeoning population. Without protecting the soil on our 4 billion acres of cultivated farmland, 8 billion acres of pastureland, and 10 billion acres of forest land, it will be impossible to feed the world, keep global warming below 2 degrees Celsius, or halt the loss of biodiversity. The causes of soil degradation are both natural and human-induced. Over and misuse of *soils lead* to the loss of a significant amount of plant nutrients and *soil* carbon from agricultural *soils* due to human-induced soil degradation resulting from land clearing and deforestation, inappropriate agricultural practices, improper management of industrial effluents and wastes, over-grazing, careless management of forests, surface mining, urban sprawl, and commercial/industrial development. Inappropriate agricultural practices include excessive tillage and use of heavy machinery, excessive and unbalanced use of inorganic fertilizers, poor irrigation and water management techniques, pesticide overuse, inadequate crop residue and/ or organic carbon inputs, and poor crop cycle planning. The loss of the world's fertile soil and biodiversity, along with the loss of indigenous seeds and knowledge, poses a mortal threat to our future survival. Thus, a comprehensive system of farming practices needs to be focussed on topsoil to restore degraded soil biodiversity and rebuild soil organic matter, and reverse climate change while allowing farmers to maintain productivity, growth, and ensure carbon sequestration and farm income. It helps in climate mitigation by removing carbon dioxide from the air by fixing it in aboveground crop biomass and depositing it in the soil organic carbon (SOC) pool.

The perception that soil is a "living" system results from the observation that the number of living organisms in fertile soil (10 g) can exceed nine billion, which is one and one-half times the human population of the earth. Thus, the physical and chemical attributes of soil regulate biological activity and interchanges of molecules/ ions between the solid, liquid, and gaseous phases, which influence nutrient cycling, plant growth, and organic matter decomposition.The continued addition of decaying plant residues to the soil surface contributes to the biological activity and the carbon cycling process in the soil. Carbon cycling is the transformation of organic and inorganic carbon compounds by flora and fauna in the soil-plants-atmosphere continuum. The decomposition of organic matter is largely a biological process that occurs naturally. Its speed is determined by three major factors: soil organisms, the physical environment, and the quality of the organic matter. However, it is generally agreed that the composition of the community can vary. In fact, SOM and soil organisms are so interdependent that it is difficult to discuss one without the other. In addition, SOM associated with different soil textures (sand, silt, and clay), will differ in susceptibility to decomposition. Many studies have shown that SOM associated with the sand size fraction is more susceptible to decomposition, and thus a higher turnover, than the silt- or clay-size fractions.

A wide variety of bacterial species, archaea, and protists, have metabolically important enzymes in polyhedral micro-compartments and are bound by three to seven highly conserved proteins. This micro-compartmentalization enhances the catalytic efficacy of the enzyme(s) and sequesters atmospheric carbon inside by providing metabolic channeling through enzyme co-localization and by reducing the effects of product/ substrate diffusion. In the different forms of RubiscCOs are thought to predominate in sols and rebound in plants, algae, and cyanobacteria and autotrophic, chemo-litho-trophic, and lithotrophic bacteria. It significantly varied due to crop management, forestry, and forage cultivation under different soil types. The maximum Rubisco-enzymes were observed in forage crops and natural weed fields and substantially improved with soil organic carbon. The glomalin content varied from 112 to 255 g/kg. The maximum plant phytolith carbon was observed in grassland and natural weeds. The particulate organic carbon in forest land was followed by forage land and the least was observed in cultivated lands. During the 20th century, the low-yield indigenous nature-based agriculture transformed progressively into new high-intensity, energy-demanding, and productivity-led agriculture called industrial farming to cater food demands of a ever-increasing population. Without protecting and regenerating the soil on our 4 billion acres of cultivated farmland, 8 billion acres of pastureland, and 10 billion acres of forest land, it will be impossible to feed the world, keep global warming below 2 degrees Celsius, or halt the loss of biodiversity. Therefore, more attention is required to establish relationships among biodiversity, C-sequestration, productivity, and livelihood security under regenerative agriculture.

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Article 4: Carbon carrying capacity of soil: Role of clay, substrate quality, and microbes at the interface of climate change (10TH Dr. P. K. Dey Memorial Lecture)

Abstract

Future scenario of climate change would be having significant impact on carbon carrying capacity of soil which is largely influenced by the complex interactions of climate, clay mineralogical makeup, substrate quality and microbial community composition of soil (Mao *et al.*, 2022). Smectitic clay minerals are more efficient in stabilization of soil organic carbon than the kaolinitic minerals (Singh *et al.*, 2017) though the amorphous and poorly crystalline mineral components have a high chemical capacity to protect organic carbon (Mikutta *et al.*, 2005).The reduction in C storage with temperature was more than three times greater in coarse-textured soils, with limited capacities for stabilising organic matter, than in fine textured soils with greater stabilisation capacities (Hartley *et al.*, 2021). Carbon retained by the reactive minerals was found to contribute between 3 and 72% of organic carbon found in mineral soil, depending

on mean annual precipitation and potential evapotranspiration (Kramer and Chadwick, 2018).Climate warming may ultimately lead to an increase in the decay of more stable SOM compounds, resulting in a positive feedback to climate that is, however, lessened with time by the shift towards a more efficient microbial community in the longer term (Frey *et al*., 2013). The litter chemistry will change due to elevated level of CO_2 and decrease the decomposability of litter (Purakayastha *et al*., 2019; Viswanath *et al*.,2010). Litter type exerted little control over the total C mineralization in soils enriched with short-range order (SRO) minerals, whereas C mineralization varied substantially with litter type in soils lacking these minerals. However, the decomposition of decadally cycling SOC is highly sensitive to temperature change, which will likely make this large SOC stock vulnerable to loss by global warming in the 21st century and beyond (Lin et al., 2015).The labile C appeared to trigger catabolic responses of the resident microbial community that shifted the SOM mining to N-rich components; an effect that increased with higher fungal dominance (Rousk et al., 2016).The microbes utilizing soil-C in the litter treatments had higher CUE, suggesting the longer-term stability of soil-C may be increased at higher temperature with litter addition. Even the growth of distinct microbial communities can alter the turnover and fate of SOM and, in the context of global change, its response to temperature (Creamer *et al*., 2015). Slow turn-over litter with low clay content will prime more soil carbon and thus provide lower protection of soil native carbon than fast turn-over litter to add in soil with high clay content (Sulman *et al*., 2014). Under future climate change projection scenario, Indian soils especially the hill soils and soils of north eastern part will become vulnerable to loss of carbon but if both temperature (result of elevated CO_2) and rainfall increase, then how loss of carbon is balanced by increase in net productivity is questionable.

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Article 5: Managing Natural Resources in the Face of Climate Change *vis-à-vis* Technology Extension

Introduction:

Notwithstanding what was being ‘Trumpeted’ by some self-proclaimed global leaders, climate change is not a ‘Myth’, rather a stark reality that humankind has to confront with in order to sustain and survive on the face of this planet. Our climate is CHANGING and changing at a rate faster than we are changing ourselves to adapt to these changes. Going by the consensus of the scientific community, we have two alternatives – either we ‘Live with it’ (Adaptation) or we ‘Deal with it’ (Mitigation). Admittedly, mitigation cost is far too high and we cannot possibly revert to holistic mitigation. Similarly, sole adaptation may also not be suitable alternative as our climate will continue to change owing to the large amount of toxic Green House gases that we have already loaded our environment with. So, suitable location-specific perspicacious and percipientcombination of the two (Adaptation and mitigation) is our best bet *per se*. But then, we have only ourselves to blame for this unwarranted situation. Climate change is almost entirely caused by anthropogenic undoing’s – our ardent yearning for development, however, ill considerate that be, our fierce voracity to win over natural resources, our unbridled predisposition to dominate over others. Given the trend continues for another two centuries, we may well jeopardize our *very existence* on this planet for want of natural resources necessary for growing food for our survival.

Agriculture is primarily an anthropogenic modification of natural ecosystem that is essentially dependent on natural resources, namely soil and water, and is a function of climate. On one hand, shifting global climate is affecting natural resources - mostly in an undesirable manner than otherwise, while on the other, indiscreet anthropogenic management of natural resources is exacerbating climate shift through augmented emission of greenhouse gases (GHGs) to the atmosphere. It is basically a two-way interaction which needs to be understood for formulation of improved adaptation and mitigation strategies, as well as manage natural resources.

Future projection of climate change and its implications for natural resources:

IPCC 6th assessment report has indicated that despite several mitigation and adaptation strategies adopted globally in varying scale, our climate has continued to change and this change is unequivocally attributed to anthropogenic activities. Our atmosphere now contains 410 ppm carbon dioxide, 1866 ppb methane and 332 ppb nitrous oxide (as in 2019). These continued increases in GHGs have resulted in successive warmer decades. Global surface temperature during the first two decades is 1^0C higher than the average during 1850 - 1910 with increase in land temperature being more than ocean surface temperature (IPCC, 2021).

The frequency and intensity of heavy precipitation events have increased since 1950s over most land areas. Droughts have also been more frequent in some region due to exacerbated evapotranspiration. According to the report (IPCC, 2021), global proportion of major tropical cyclones (category 3 to 5) have arguably increased during the last four decades. Monsoon precipitation in South and South East Asia has been projected to intensify.

There is general consensus that climate change will pressurize dryland areas and actually is going to facilitate several desertification processes despite increase in vegetation productivity of drylands due to increased CO_2 concentration in atmosphere. Decreases in water availability have a larger effect than CO_2 fertilisation in many dryland areas. It is conjectured with high confidence that aridity will increase in some places as well as certain areas are at risk of salinisation (IPCC, 2021). There is possibility that future climate change will increase the potential for water-driven soil erosion in many dryland areas leading to soil organic carbon decline in some dryland areas (IPCC, 2019).

Climate change-driven land degradation will be intensified due to increased frequency, intensity and/ or amount of heavy precipitation, increasing floods, drought frequency and severity, intensified cyclones, sea level rise and increased heat stress. Some areas will be affected by coastal erosion as a result of sea level rise. IPCC (IPCC, 2022) has indicated with very high degree of confidence that in cyclone-prone areas, the combination of sea level rise and more intense cyclones will cause land degradation with serious consequences for people and their livelihoods.

Extreme rainfall and flooding limits oxygen in soil which may suppress the activities of soil microbes and plant roots and lower soil respiration, thereby lowering carbon cycling (Knapp *et al.* 2008). In agricultural systems, heavy precipitation and inundation can delay planting, increase soil compaction and cause crop losses through anoxia and root diseases (Posthumus *et al.* 2009). In tropical regions, flooding associated with tropical cyclones can lead to crop failure from both rainfall and storm surge. In some cases, flooding can affect yield more than drought, particularly in tropical regions (e.g., India) and in some mid/high latitude regions such as China and central and northern Europe (Zampieri *et al.* 2017).

Warmer atmosphere will increase water vapour concentrations as a result of climate change and as such will alter the hydrological cycle and therefore regional freshwater resources. IPCC predicts that in general, wet regions will get wetter and dry regions drier with some exceptions. As such many arid and subtropical regions will face water scarcity to a great extent. Consequently, in these regions increased temperatures and decreased rainfall will reduce surface and groundwater resources, increase plant evapotranspiration and increase evaporation rates from open water bodies. However, in many high latitude regions and wet tropics, increased rainfall can be expected to benefit freshwater and terrestrial ecosystems. However, an increase in extreme rainfall events is also expected which will lead to increases in surface runoff, regional flooding and nutrient removal as well as a reduction in soil water and groundwater recharge in many places. IN summary, a warming climate is projected to exacerbate the existing pressures on renewable freshwater resources in water-stressed regions of the World, and result in increased competition for water between human and natural systems (IPCC, 2022).

Projected impacts on agriculture in India:

Despite increase in overall agriculture productivity, climate change has slowed down the growth rate over the last 5 decades (IPCC, 2022). Asian continent is kingpin in so far as global agricultural production is concerned for it alone accounts for 67% of global agricultural production (Mendelsohn, 2014). Hence, it is imperative that Asian agriculture has to be managed scrupulously in order for the wellbeing of mankind. It has been hypothesized that Asian agriculture will face climate-related risk in an exacerbated manner as time will progress. Near to not-so-distant future (2030 to 2080) will see decline in crop production and aquaculture, particularly in South and South East Asia, and future food security will be negatively impacted for changes in crop and cropping systems and crop areas in almost all the regions (IPCC, 2022). In India, overall rice production may decrease by 10 to 30% and maize production may decrease by 20 to 70% under temperature increments between 1^{0}C and 4^{0}C. Quite alarmingly, IPCC (2022) has indicated that OUR COUNTRY WOULD BE MOST VULNERABLE nation in future despite observed increases in food production from 1990 to 2014. In terms of total crop production, rice production in our country may be severely affected due to emergence of pest like golden apple snail (*Pomacea canaliculated)* by 2080 along with other Asian countries like China, Indonesia, Bangladesh, Vietnam, Thailand, Myanmar, Philippines and Japan (IPCC, 2022). The said Report has also indicated that climate related risks to agriculture and food security will be more acute as time progresses and as global warming reaches 1.5^{0}C (IPCC, 2018b).

Technology extension as an adaptation and mitigation tool for sustainable livelihood in the face of climate change:

Land degradation in agriculture systems can be addressed through sustainable land management, with an ecological and socioeconomic focus, with co-benefits for climate change adaptation. Near-term capacity-building, technology transfer and deployment, and enabling financial mechanisms can strengthen adaptation and mitigation in the land sector. IPCC postulated with medium degree of confidence that knowledge and technology transfer could help enhance the

sustainable use of natural resources for food security under a changing climate. Raising awareness, capacity building and education about sustainable land management practices, agricultural extension and advisory services, and expansion

of access to agricultural services to producers and land users can effectively address land degradation (IPCC, 2019). Site and regionally-specific technological solutions, both based on new scientific innovations and indigenous and local knowledge (ILK), can reverse desertification, thereby contributing to climate change mitigation and adaptation.

Women empowerment and gender mainstreaming can boost interactions among household food security and sustainable land management. The overwhelming presence of women in many land-based activities including agriculture, in countries like India, provides opportunities to mainstream gender policies, overcome gender barriers, enhance gender equality, and improve sustainable land management and food security (IPCC, 2019).

National Innovations in Climate Resilient Agriculture (NICRA), was launched in 2011 in India to address the challenges of climate variability and climate change along with farmers need to adapt quickly to increasing frequency of drought, flood and other extreme events by application of science and technology. Technology Demonstration Component (TDC) of NICRA offers great opportunity to work with farmers and apply such technology under field conditions with the background of current climate hostility. The emphasis has been capturing and improving the understanding on performance of technologies in different agro-ecologies and farming systems. This also facilitates quantification of various components of climate resilience in different biophysical and socio-economic context. The overall focus of technology demonstrations under NICRA is to enhance resilience of farms and the farming community to climate risks so as to ensure sustainability over a period of time. Thus, the emphasis is on adaption to climate variability which entails appropriate response to contingency situations. Sustainability is the immediate goal in highly intensive production systems facing natural resource degradation. Therefore, the central objective of technology demonstrations in such regions is not on enhancing productivity but on interventions related to coping with vulnerability as well as improvement in natural resource use efficiency for sustaining the productivity gains. This initiative has reaped great dividends in so far as natural resource management is concerned. A couple of examples of such endeavours with their impacts are cited below,

A. Impact of land shaping and rainwater harvesting

In this technology, 1/5th portion of the flat low land is dug up to make a pond up to 8-9 feet depth. The excavated earth is utilized for raising the rest of the low land up to 1.5 feet height. The land embankment around the entire land is strengthened to 3 feet height and 5 feet wide. With the rest of the soil, a 5-feet wide and 4-feet high pond embankment is created. This has facilitated cultivation of short-duration HYV paddy and vegetables which earlier was beyond option. At the same time, pisciculture with duck rearing is taken up in the pond. This has increased return six-fold from a meagre Rs. 6500/- per 0.27 ha of land. Apart from that, it has put a check on migration of womenfolk as these womenfolk could now get engaged in their own farm in various agricultural activities, besides leisure hour.

B. Community afforestation with mangroves

Rising sea level with increasing occurrence of coastal hazards is endangering the mangrove ecosystem, which are extremely valuable in terms of their services for human and other biotic communities, of the world.

Haq (2010) estimated that one single cyclone *Sidr* has destroyed nearly one-third of the mangrove population in the Bangladesh part of Sundarbans. One of the major interventions taken up under NICRA was creation of awareness among the community in villages of the Indian part of Sundarbans about the benefits of

having mangrove vegetation along the river embankment which could absorb the brunt of cyclonic storms and high tides thereby sparing the village from mass destruction. Saplings of sundari, *Heritierafoames* and other mangrove species were multiplied by rural youths in the villages, and within a span of almost 2½ years of the project, approximately 20,000 mangrove plants were transplanted which is slowly expanding the green belt along the coastal border of the villages.

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Proceedings of the Annual General Body Meeting of the ISSS Kolkata Chapter held on August 6, 2022 at ICAR-CRIJAF, Barrackpore in hybrid mode

The following members of ISSS, Kolkata Chapter attended the meeting (offline and online)-

Prof. Saroj Kumar Sanyal, Patron, ISSS Kolkata Chapter

Prof. Kunal Ghosh, Patron, ISSS Kolkata Chapter

Dr. Gouranga Kar, Director, ICAR-CRIJAF, Barrackpore

Dr. D.C. Nayak, President, ISSS Kolkata Chapter

Dr. Krishnendu Das, Secretary, ISSS Kolkata Chapter

Dr. F. H. Rahman, Pr. Scientist, ICAR-ATARI Kolkata

Dr. Samar Gangopadhyay, Ex- Pr. Scientist, ICAR-NBSS & LUP, RC, Kolkata

Dr. Amit Saha, Head, Crop Production, ICAR-CRIJAF, Barrackpore

Dr. B. Majumdar, Pr. Scientist, ICAR-CRIJAF, Barrackpore

Dr. Ritesh Saha, Pr. Scientist, ICAR-CRIJAF, Barrackpore

Dr. S. K. Ray, Head, ICAR-NBSS & LUP, RC, Kolkata

Dr. S. K. Das, Pr. Scientist, ICAR-CIFRI, Barrackpore

Dr. Dhiman Burman, Head, ICAR-CSSRI, RS, Canning Town

Dr. D. K. Kundu, Ex Head, Crop Prodn, ICAR-CRIJAF, Barrackpore

Dr. S. K. Reza, Sr. Scientist, ICAR-NBSS&LUP, RC, Kolkata

Dr. Siladitya Bandyopadhyay, Scientist, ICAR-NBSS&LUP, RC, Kolkata

Dr. Sonali Paul Majumdar, Sr. Scientist, ICAR-CRIJAF, Barrackpore

Dr. Shreyosi Gupta Chowdhury, Scientist, ICAR-NBSS&LUP, RC, Kolkata

Dr. Ruma Das, Scientist, ICAR-NBSS&LUP, RC, Kolkata

Dr Mrinmoy Dutta, Ex- Pr. Scientist, ICAR-RC for NEH, Tripura

Dr Tashi Dorjee Lama, Pr. Scioentist, ICAR-CSSRI, RS, Canning Town

Dr. B. N. Ghosh, Pr. Scientist, ICAR-NBSS&LUP, RC, Kolkata

Dr S Mukhopadhyay, Pr.Scientist, ICAR-NBSS&LUP, RC, Kolkata

Dr. Debarati Datta, Scientist, ICAR-CRIJAF, Barrackpore

Dr. S. Ghosh, ICAR-ATARI Kolkata

Smt. R. Bhattacharya, ICAR-ATARI Kolkata

Invitee Guest:

Dr. J. C. Tarafdar. Emeritus Scientist & Former National Fellow, ICAR-CAZRI, Jodhpur & Chief Guest, 10th P. K. De Memorial Lecture.

Dr. T. J. Purokayastha, Principal Scientist, IARI, New Delhi, & Speaker, 10th P. K. De Memorial Lecture.

Dr. Krishnendu Das, Secretary, ISSS Kolkata Chapter welcomed the members of the Chapter present (both offline and online) in the Annual General Meeting. He requested Dr. D. C. Nayak, President, ISSS Kolkata Chapter to preside over the meeting. Dr. Nayak also welcomed all members and informed that the Chapter had lost three members on their death namely Dr. Dipak Sarkar, Ex-President and Patron of the Chapter & Ex-Director, ICAR-NBSS & LUP; Dr. Kalyan Chakrabarty, Ex-Treasurer of the Chapter & Ex-Associate Professor, Institute of Agricultural Science, Calcutta University and Dr. Sudipta Mukherjee, Member of the Executive Committee of the Chapter & Advisor, National Tea Research Foundation, Tea Board, Kolkata. One minute silence was observed in the memory of the departed souls. The President then moved on to the listed agenda for the meeting.

Agenda I: Confirmation of the minutes of the last Annual General meeting.

Dr. Krishnendu Das, Secretary, read out the salient points of the proceedings of the last AGM. The house approved the same after discussion.

Agenda II: Presentation of Annual Report of the Chapter by the Secretary

Dr. Krishnendu Das, Secretary, informed the house that the regular general meeting was not held after 2019 due to pandemic COVID-19 situation. He reported the consolidated activities for the period 2019 to 2022.

Secretary's Report during the period from 2019 to 2022

The new office bearers of the Kolkata Chapter took over the charge after the last AGM held on March 1, 2019 at ICAR-NBSS & LUP, Kolkata. During this period the Chapter organized a few important programmes which are highlighted below.

Five E.C meetings were held on 25.05.2019, 27.06.2019, 18.09.2019, 12.02.2022 and 17.07.2022 to discuss various activities of the Chapter.

The Chapter member strength now stands at 54 (Life Member 17, Ordinary Member 22 and Annual Student Member 15). Some Ordinary Members in view of their transfer to ICAR Institutes/Regional centres around Kolkata have enrolled themselves as Chapter members.

The 9th P.K. Dey Memorial lecture was organized by the Chapter, at ICAR-NBSS&LUP, Regional Centre Kolkata on July 19, 2019. Dr. M. C. Manna, Principal Scientist & Head, Division of Soil Biology, ICAR-IISS, Bhopal delivered the lecture on *'Soil Organic Matter Management in Agriculture: Sequestering Carbon to Keep Lands Alive'.*

The prestigious 30th Dr S.P. Raychaudhuri Memorial Lecture was organised by ISSS, Kolkata Chapter on September 27, 2019. Dr Ashish Kumar Biswas, Principal Scientist and Head, Division of Soil chemistry and Fertility, ICAR- Indian Institute of Soil Science, Bhopal delivered this lecture on the topic *'Carbon Sequestration and its Implication in Agricultural Soils: Issues and Perspectives'.*

To perpetuate the memory of Late Prof. Shyamal Kumar Gupta, the Professor S. K. Gupta Memorial Lecture was initiated by ISSS Kolkata Chapter. A corpus fund was raised for this purpose with contributions from all the admirers and students of Prof Gupta. Dr Sanjay Gupta, his elder son, donated a sum of Rs. 1,00,000/- for this purpose. The 'First Professor S. K. Gupta Memorial Lecture' was delivered by Dr Pradip Sen, Ex Additional Director of Agriculture (Research), Government of West Bengal, on November 4, 2019 on the topic *'Zinc-The Indispensable Micronutrient'.*

Due to the Covid 19 pandemic which swept the entire world, no significant activity could be undertaken by the Chapter in 2020 and 2021. However, during the current year, when the situation has somewhat improved, a special lecture was organised by the Chapter in hybrid mode. Dr D K Pal, a distinguished Pedologist and Former Head, Soil Resource Studies Division, ICAR-NBSS & LUP, Nagpur & Honorary Member, ISSS, New Delhi delivered a talk at ICAR-NBSS & LUP, Reginal Centre, Kolkata on April 7, 2022 on the topic *'Carbon Sequestration Strategies in Indian Tropical Soils: Factors and Enhancement Strategies'.*

The 'Second Professor S. K. Gupta Memorial Lecture' was delivered by Prof. S K Sanyal, Former Vice-Chancellor, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur & Honorary Member, ISSS, New Delhi on the topic *"Arsenic Contamination in Groundwater: Effect on Water-Soil-Crop-Human Continuum"* on April 23, 2022 in hybrid mode.

Agenda III: Presentation of Audited Report for 2019 to 2022 by Treasurer.

Dr. Siladitya Bandyopadhyay, Treasurer presented the audited report of accounts for the period 2019 to 2022. He mentioned the details of Receipts & Payments; Expenditure & Income and Liabilities & Assets for the period. It was mentioned that the Chapter got back Rs. 1,45,000/- (Rupees one lakh forty-five thousand) against the advance of Rs. 3,80,000/- (Rupees three lakh eighty thousand only) given to the Organizing Committee of 82nd Annual Convention of ISSS, held at Kolkata during 11-14th December, 2017. It indicated that the Chapter had incurred a net loss of Rs. 2,35,000/- for organizing the 82nd Annual Convention of ISSS, held at Kolkata. The matter was also discussed in an EC meeting earlier. The house approved the report after these discussions.

Agenda IV: Presentation of Auditor Report

Dr. S. K. Reza, the Auditor presented his report and informed that he had gone through the financial records during the period from 1st April, 2019 to 31st March, 2022 of ISSS, Kolkata Chapter. He observed that the records in respect of vouchers, bills, FDs and bank account statements were maintained properly. No irregularity was observed but some overwriting in bills/ vouchers should be avoided.

Agenda V: Formation of New Executive Committee of ISSS Kolkata Chapter for 2022 and 2023

The following Executive Committee for the period 2022 and 2023 was constituted by the house.

Chief Patron - To be kept in abeyance.

Patrons -

Prof. K. Ghosh, Ex-Head, Deptt. of ACSS, Inst. of Agril. Science, CU.

Prof. S.K. Sanyal, Ex Vice-Chancellor, BCKV, Mohanpur, Nadia.

Dr. H.S. Sen, Ex-Director, ICAR-CRIJAF, Barrackpore.

Dr. Pradip Sen, Ex-Managing Director, WB State Seed Corporation, Kolkata.

Dr. D. C. Nayak, Ex-PS & Head, ICAR-NBSS & LUP, RC, Salt Lake, Kolkata.

President - Dr. Gouranga Kar, Director, ICAR- CRIJAF, Barrackpore.

Vice Presidents -

Dr. K. Das, Ex-Principal Scientist, ICAR-NBSS & LUP, RC, Kolkata.

Dr. Dhiman Burman, Head, CSSRI, Regional Station, Canning Town.

Dr. B N. Ghosh, Principal Scientist, ICAR-NBSS & LUP, RC, Kolkata.

Secretary - Dr. F. H. Rahman, Principal Scientist, ICAR-ATARI, Kolkata.

Joint Secretaries -

Dr. Bijan Majumdar, Principal Scientist, ICAR-CRIJAF, Barrackpore.

Dr. S. K. Das, Principal Scientist, CIFRI, Barrackpore.

Dr. N. C. Sahu, Head, Sasya Shyamala KVK, RKMVU, Narendrapur.

Treasurer - Dr. S. Bandyopadhyay, Sr. Scientist, ICAR-NBSS&LUP, RC, Kolkata.

Auditor - Dr. S. K. Reza, Sr. Scientist, ICAR-NBSS&LUP, RC, Kolkata

The Members of the Executive Committee will be selected in the next EC meeting.

Agenda VI: Any other matter with the permission of the Chair

Prof. S. K. Sanyal informed that a meeting of Newsletter committee should be arranged as early as possible for the publication of ensuing issue. Dr. K. Das assured him that the meeting will be arranged shortly. Dr. K. Das, Secretary, ISSS Kolkata chapter requested the house to propose the candidate for the contest in Councillors of ISSS, New Delhi from the Kolkata Chapter, ISSS. The House unanimously proposed the name of Dr. Ritesh Saha, Principal Scientist, CRIJAF, Barrackpore for Councillor contest of ISSS, New Delhi. It is also requested to increase the membership of the Chapter.

The meeting ended with the vote of thanks by Dr. Gouranga Kar, Director, ICAR-CRIJAF, Barrackpore.

News and Snippets

The 82nd Annual Convention of the Indian Society of Soil Science was held at Kolkata during December 11 – 14, 2017. It was held at Amity University with principal partnership with Indian Council of Agricultural Research. The Convention drew large number of members to the tune of 350 with a galaxy of luminaries of Soil Science as well as from other fields.

Awards and Recognitions

Dr. F. H. Rahman was awarded Fellow of **Himalayan Scientific Society for Fundamental and Agricultural Research 2022** during 6th International Conference on 'Current Issues In Agricultural,Biological & Applied Sciences for Sustainable Development' (CIABASSD-2022) at Kalimpong Science Centre, Deolo, Kalimpong, during June 11-13, 2022.

Professor S. K. Sanyal was conferred the Honorary Membership of the Indian Society of Soil Science, New Delhi at BHU, Varanasi in 2019

Professor S. K. Sanyal was conferred the Honorary Membership of the Clay Minerals Society of India, New Delhi at IARI New Delhi in 2021

Dr. Tanmoy Karak was awarded Fellow of The Royal Society of Chemistry, London in 2022

Dr. S. K. Gangopadhyay was awarded Fellow of Clay Mineral Society of India, New Delhi during the Annual Convention at New Delhi in 2021

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