Volume 1 | 2021 June

SOIL FOR LIFE

Online Magazine

Department of Soil Science
Faculty of Agriculture
University of Peradeniya

2021
Volume 01

SOIL FOR LIFE

Online Magazine

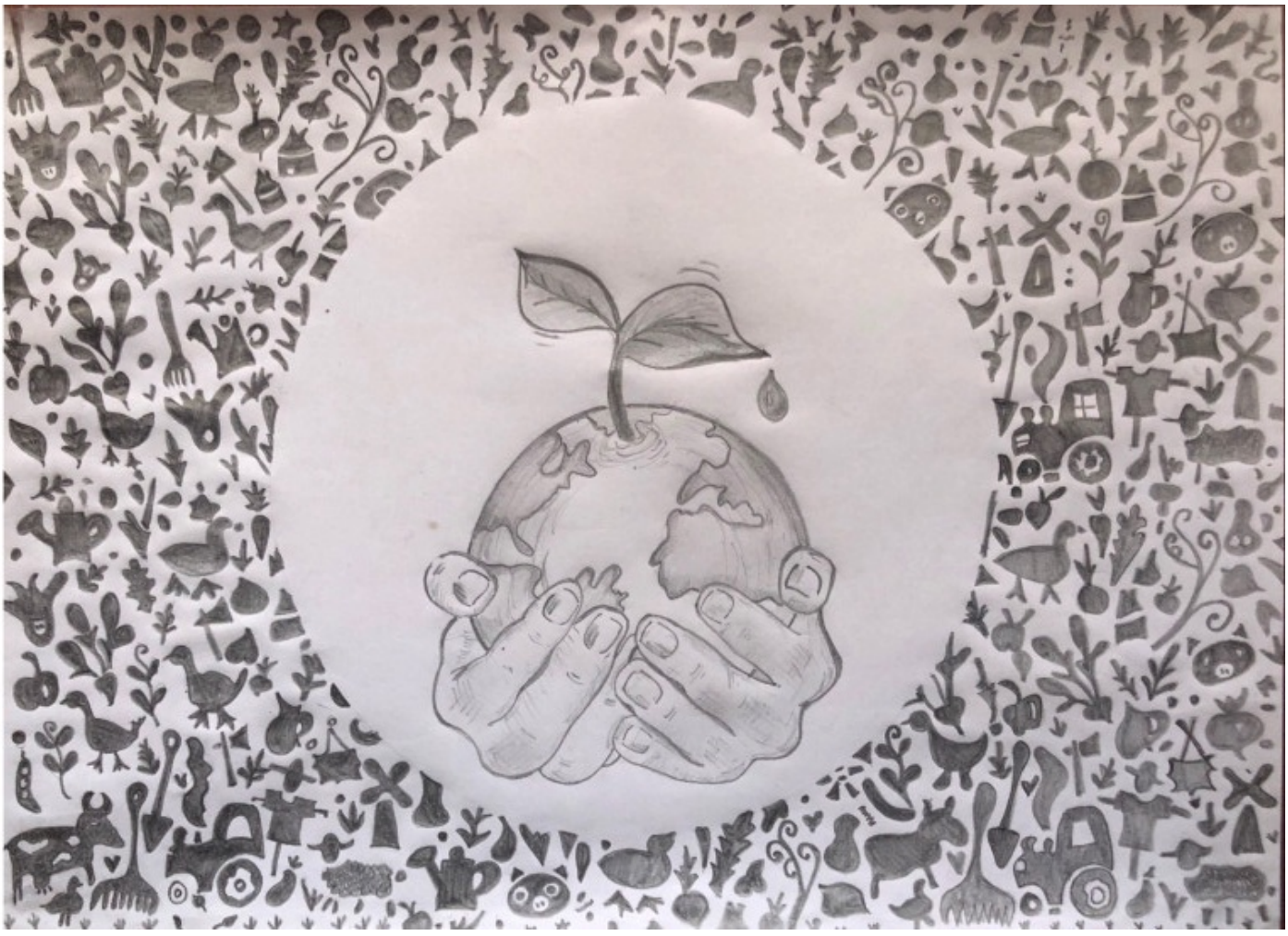
Published by

Department of Soil Science,
Faculty of Agriculture,
University of Peradeniya.

Funded by

AHEAD

ELTA-ELSE Development Project



Art by Akshila Ranabahu

Message from the Dean of the Faculty

It gives me a great pleasure to write this message to the web magazine 'Soil for Life' launched by the Department of Soil Science, Faculty of Agriculture, University of Peradeniya. This initiative aims to improve the English language competences of undergraduate students. Faculty has taken different steps to improve proficiency of English of students while they are in the University. This exercise I consider as an opportunity for them to be aware of the latest developments in the field of soil science and learn how to disseminate scientific information in a laymen language. The articles also have synthesized information so that useful for the scientific community as well. The magazine has been designed by an undergraduate student beautifully and meaningfully. While congratulating the students for improving their skills, and I thank the staff members of the Department of Soil Science for their effort in improving essential skills of undergraduates through the ELTA-ELSE development project competitively won by the Department of Soil Science.

Prof. Gamini Pushpakumara
Dean/ Faculty of Agriculture
University of Peradeniya

Message from the Head of the Department

In 2015, United Nations declared a World Soil Day (5th December) with the theme "Soil is Life". This was to generate awareness among the public and policymakers on the importance of the limited, nonrenewable and natural resource: the soil. Since then, many programs have been conducted by concerned people to create interest on soil resource which otherwise has been viewed as dirt by the general public. In this context, it is a pleasure to provide this message to the First Volume of the "Soil For Life" online magazine published by the Department of Soil Science, Faculty of Agriculture. Articles in this e-magazine has been written by undergraduates in the "Soil and Environment" majoring module at the Department of Soil Science under the activity on "Smart communication in English" in a ELTA-ELSE development project won by the Department of Soil Science. With the help of academic staff members of the Department and the ELTU of the Faculty of Agriculture, students have demonstrated their ability to present scientific information related to soil science in a way that even a layman can easily understand. These articles will not only help general public and policy makers to understand how a soil could contribute for the sustenance of life on earth, but also will help the writers to improve their English writing skills. I take this opportunity to congratulate all writers for their excellent contributions and encourage them to continue with such activities in the future as well. The commitment shown by all who supported this activity, especially Prof. W.A.U. Vitharana, the activity coordinator and Professor R.M.C.P. Rajapakse, the coordinator of the ELTA-ELSE development project, is also thankfully acknowledged. With this initiation, I wish "Soil and Environment" majoring module students can become excellent soil science communicators in time to come.

Prof. R.S. Dharmakeerthi
Head / Department of Soil Science
Faculty of Agriculture
University of Peradeniya

Message from the Activity Coordinator

Welcome to the First Volume of the “Soil For Life” online Magazine published by the Department of Soil Science, Faculty of Agriculture. The inception of this magazine roots to the activity “Smart communication in English” of the ELTA-ELSE development project won by the Department of Soil Science. The magazine intends to improve English writing skills of students who follow the “Soil and Environment” module at the Department of Soil Science. Thus, each article included in the magazine has gone through a thorough cycle of improvements by the academic staff members of the Department and also staff members of the ELTU of the Faculty of Agriculture. During this process, students received a valuable opportunity to enhance their skills in presenting scientific facts of interesting topics in a way that general public can easily understand. Thus, I consider the articles presented in this magazine are not just a set of articles, but which contributed to broaden undergraduate students’ writing skills. I take this opportunity to congratulate all writers and wish the good practice developed through this endeavor will continue for years to come while further sharpening their writing skills. I express my sincere thanks to all who supported this activity, especially ELTU members who involved in correcting the draft articles, Professor R.M.C.P. Rajapakse, the coordinator of the ELTA-ELSE development project and all staff members. I especially acknowledge K.A.I.L. Kasthuri Arachchi, undergraduate student of the Faculty of Agriculture for his commitment to develop an excellent magazine design.

Prof. W.A. Udaya Vitharana
Department of Soil Science
Faculty of Agriculture
Coordinator
Smart Communication in English (Activity 5)
ELTA-ELSE Development Project

Content

Soil Erosion – A great threat to the agriculture production

by P.G.Harshila Wickramasinghe

Only those who make a living by using soil directly care for soil. Society at large does not value soil as a resource due to their ignorance about the fact that life on earth depends on a few centimeters of surface soil layer. About thousands of years must have taken to develop a soil that enables forests, grasslands, shrubs and agricultural crops etc. to occupy that we see today. However, it takes only several minutes to remove this thin layer of fertile soil by a single rainfall event or wind, via a process called soil erosion.

Soil erosion is a serious issue that imposes a threat to sustain vegetation and food production. Practicing agriculture on eroded soils is not profitable as the quality and quantity of the crop yields are low. There are many off-site effects of soil erosion as well. Eroded soils could block irrigation channels and drainage lines leading to frequent flooding events. Moreover, erosion can carry soil particles along with contaminants such as fertilizer and pesticide residues if water flows over agricultural lands. As we often observe, garbage originated from households and industries ended up in water bodies after heavy rains. Thus, surface water becomes polluted and less suitable for the use of common purposes such as drinking and irrigation.

At present, approximately 75 billion tons of fertile soils have been removed from agricultural areas by soil erosion Therefore, soil erosion is considered as the major process of soil degradation that limits the productivity of agricultural lands. The Food and Agriculture Organization (FAO) has estimated about 50% of crop yield loss due to soil erosion. Thus, FAO of the United Nations has identified soil erosion as one of the biggest threats to global food security.

Erosion is a natural phenomenon

Erosion is a natural process that occurs in many environments. The action of wind, water, or glacier can remove the surface soil easily when it is exposed without vegetation. Rain drops could break down soil clods or aggregates into small particles on the surface soil and carry on with the surface runoff water. Wind currents can also pick up loosen soil particles on the surface soils and settle elsewhere perhaps hundreds of meters away from the origin. In glacier erosion, flowing ice erodes the land and deposits the sediments elsewhere.

Water erosion is the most important and as its damage to land resources is substantial. Soil scientists have identified five types of soil erosion as a result of water.

Types of water erosion

Sheet erosion

Rill erosion

Gully erosion

Bank erosion

source: Jim Ritter, P. (2012). Replaces OMAFRA Factsheet, Soil Erosion; Causes and Effects. (http://www.omafra.gov.on.ca/english engineer/facts/12-

Sheet erosion removes the finest soil particles containing nutrients and organic matter from the fertile surface soil layer. Rill erosion is the most common form of erosion that occurs during heavy rains. Here, soils are displaced through tiny channels called rills

which are less than 30 cm deep. If the heavy rain continues, rills become larger and lead to gully erosion which forms deep gullies. Thus, gully erosion is an advanced stage of erosion which can completely destroy agricultural lands. The bank erosion occurs when washing up of soils away from the bank of streams or rivers.

Human activities could accelerate soil erosion

Mahaweli river flow on a rainy day

You may have noticed muddy color water flow in any river on rainy days. Have you ever wondered why that has happened? Yes, it is due to soil erosion. Soil erosion is common in steep lands which are common in central highlands of Sri Lanka. Highly intensive non-sustainable agricultural practices, such as vegetable cultivation on these lands have accelerated soil erosion ending up fertile topsoils eventually in Mahaweli river. Many forest reservation lands have been encroached by farmers for vegetable cultivation. Moreover, steep slopes are being used by farmers without adopting soil conservation measures. Therefore, soil erosion is increased in the upper Mahaweli catchment area leading to inflow of eroded soil sediments to Mahaweli river and its branches. Sedimentation of soil materials in reservoirs has reduced their capacities. The most susceptible areas for erosion are Badulla, Nuwaraeliya, Kegalle, Rathnapura, and Matale. The Ministry of Mahaweli Development and Environment, Department of Agriculture, and FAO are working together simultaneously to rehabilitate the eroded lands in hilly areas.

Being the most fertile soil layer, the surface soil of the earth has the greatest importance for plant growth. Therefore, loss of topsoil via erosion should be minimized in agricultural lands. Diverse soil conservation practices have been used during the ancient time when sloppy lands in highlands were cultivated. As an example, the tank cascade system is one of the sustainable methods used to control soil erosion in the past. Sloping Agricultural Land Technology (SALT) is a popular soil conservation measure, which is suitable for hilly areas. This technique is introduced in the Philippines to sustain fertility and reduce the soil erosion in cultivated lands. In SALT, fast growing perennial nitrogen-fixing tree or shrub species are grown as bands along the contour lines. These strips or bands help to trap sediments and gradually transform the sloping land to terraced land. Growing crops on terraces minimize soil erosion in sloppy areas. Construction of earth of stone bunds along the contour lines is also a very popular soil conservation method suitable for sloppy areas. Grass waterways protect the land from rill or gully erosion.

Stop soil erosion, Save our future

Soil is a gift of mother nature and it has to be used in a sustainable manner. In the year 2019, the world soil day was celebrated under the theme “Stop soil erosion, Save our future”. Many awareness programs and activities were conducted throughout the world under this theme.

Did you know that scientists have predicted the total annual production potential will be reduced 10% by 2050 if the current trend of soil erosion continues? Therefore, soil erosion must be stopped to ensure food security and human well-being. So, there is an urgent need to fight against soil erosion and protect the soil.

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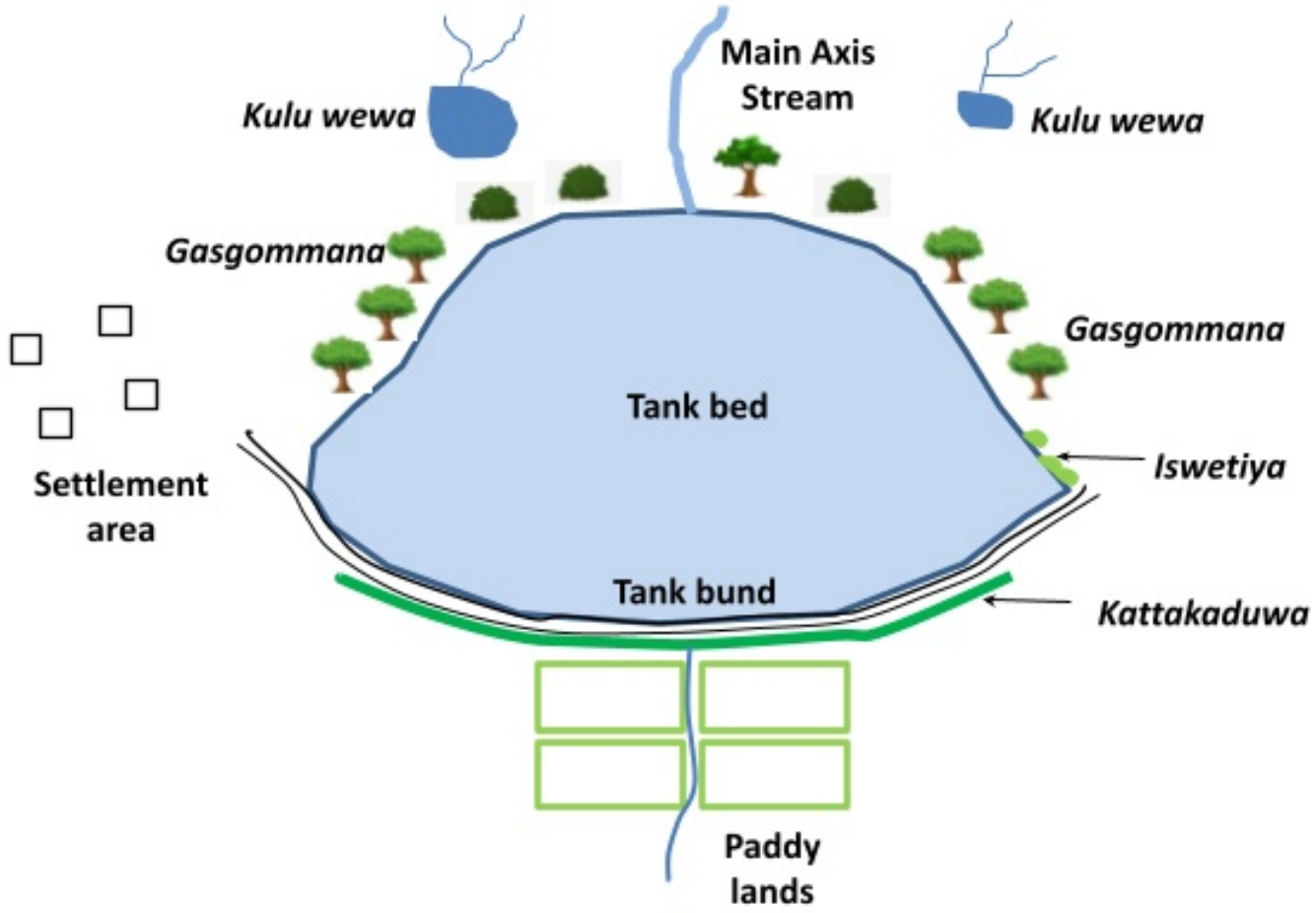
Village Tank Cascade System of the dry zone of Sri Lanka

by K.A.G.A.Lasanthika

The demand of water has been triggered as hunter-gatherers started practicing agriculture in around 8500 b.c. All ancient civilizations were established on river basins where water was ample to satisfy the needs of human life. Over the time, human settlements were extended to areas far away from river basins so that water has become scarce during the dry spells. Our ancestors used their wisdom and ingenuity to develop different technologies to store and conserve limited rainwater received by the Dry Zone and used for agriculture. The network of structures developed by our ancestors for harvesting and storing water in the low lying areas of the dry zone is named 'tank cascade system' (TCS). Advanced technologies used for the establishment of TCS about 2000 years ago are recognized across the world as unique.

Based on the landscape, rainfall and the need of the people, two forms of small irrigation systems have been evolved. They are called tanks and anicuts where the former store water and the latter connected series of tanks organized within minor or meso catchments form the cascade system. The major purpose of the TCS is recycling and reusing water through a network of small to large-scale tanks.

The TCS has several components and each of them provides a specific function to ensure a supply of good quality water throughout the year. Several components can be identified in a cascade system. Those are, tank bund and tank bed, connected irrigation channels and paddy fields, protected forest in the catchment and rainfed uplands, and high elevation household area.



Basic components of small cascade system in Sri Lanka

The TCS has several components and each of them provides a specific function to ensure a supply of good quality water throughout the year. Several components can be identified in a cascade system. Those are, tank bund and tank bed, connected irrigation channels and paddy fields, protected forest in the catchment and rainfed uplands, and high elevation household area.

Several components of the tank bund and tank bed support the sustainability of the tank cascade system. These components include sorowwa or bisokotuwa (sluice gate), which is used to release and regulate water supply to paddy fields, Ralapanawa is stone liners on the embankments which help to reduce erosion caused by water waves and Pita wana (spills), which is used to avoid any damages to the tank bund during heavy rains. Some tanks of the tank cascade system serve other purposes than the storage of water. Two small tanks namely, the kulu wewa (sieve or filter) and Godawala, are small silt trapping tanks located inside the catchment forest. Further, Kulu wewa supply water for forest vegetation and wildlife.

A grass cover, known as Perahana is located along the upper flooding line of a tank when it is full. Perahana serves as a barrier purifying runoff water flowing into the tank. Water in the tank is protected from evaporation by a tree belt called Gasgommana and it which acts as a wind barrier and minimizes the dry wind contact with the water surface. In addition, during high flood conditions, Gasgommana provides a habitat for diverse aquatic species. Iswetiya or potawetiya are earth bunds (ridges) constructed side slopes of the tank. It is known to serve as a barrier for entering eroded soil into the tank.

The Kattakaduwa or interceptor is the thick strip of vegetation located between the tank bund and the paddy fields. It is assumed that the interceptor could absorb salts and heavy metals entering along with the seepage water across the embankment. As a result, this area of the TCS is expected to be enriched with salts so that various salt tolerant plants are found in the Kattakaduwa. Also, the Yathuruwala minimizes the seepage losses from the tank by raising the downstream water table.

Kiul ela is a natural valley area and it is used to dispose of irrigation water drained out from the field and prevent salt accumulation in paddy fields. This avoids the development of salinity in paddy growing soils. Catchment

Source: https://nexttravelsrilanka.com/king-parakramabahu/ https://no.tripadvisor.com/LocationPhotoDirectLink-g304140-i395849448-Polonnaruwa_North_Central_Province.html

forest or Mukalana is another important component. The major role of the forest cover is to increase groundwater table through infiltration and gradually supply water to the tank during dry periods. Also, it serves as a source of medicine, fuel, and food for the people living around. Our ancestors have also accepted wild animals as a part of the ecosystem. Kurulu paluwa is a strip of cultivated paddy land near the tank bund which is reserved for birds. It is expected that the rest of the paddy fields will not be damaged by birds Shrublands or Landa is a large number of different shrubs grown area and it protects paddy fields, home gardens from wild animals.

The tank cascade system was the backbone of ancient agriculture. Traditional villages developed with cascade systems were in the existence until the recent past. However, human activities have disturbed many cascade systems and the sustainability of this marvel of ancient engineering is challenged. Pressure on available land resources has led to encroachments of the catchment areas reserved for forest people to destroy the catchment forest area and use it for crop cultivations and other purposes. Also, illegal exploitation of catchment forests for fuelwood and timber has limited the potential of catchment areas. Further, the lack of conservation efforts of governments and political interferences are also negatively affected by the sustainability of the cascade system. As Sri Lankans, a huge responsibility is vested on us that are to rehabilitate and preserve this wonder of the ancient ingenuity for future generations.

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“Not even a little water that comes from the rain must flow into the ocean without being made useful to man“

King Parakramabahu

Soil pullution with Cd and Pb Is it a health concern in Sri Lanka?

by K.M.P.P.Kumari

Heavy metals cause the huge problems to human beings and other animals in the environment. The most common heavy metal contaminants found in soils are Cadmium (Cd), Lead (Pb), zinc (Zn), chromium (Cr), copper (Cu), mercury (Hg) and nickel (Ni). Among them, high concentrations of Cd and Pb in soils have become a threat to the environment and living organisms worldwide.

From where heavy metals come to the environment?

Heavy metals are found naturally on the Earth's crust and some are emerged due to human activities. Naturally, volcanic activities and weathering of rocks release heavy metals to the environment. Human activities such as metal mining, waste from metal-based industries and from landfills, waste dumps and livestock manures add heavy metals to the environment. Application of metal containing fertilizers, sludge, animal manure and pesticides can lead to contamination of agricultural soils with heavy metals. For example, Cd in phosphotic fertilizers and Pb in glyphosate-based herbicides contain toxic heavy metals.

What happen when metal enters to soil?

Soil plays a major role in controlling of heavy metal entering into water and food. Soil acts as a filter and sinks for most contaminants. The main way of retaining metals in soils is by binding metallic cations such as Cd2+ and Pb2+ to the soil colloids. Soil colloids are the smallest soil particles (smaller than 1µm in diameter) which can either be mineral or organic particles. Thus, soil reduces the possibility of leaching metals into ground water.

How metal enters into human body?

Heavy metals enter to the human body by inhalation, ingestion and through skin. Lead enters to human body through the inhalation of contaminated dust particles and aerosols which are suspensions of liquid and solid particles in the atmosphere. Scientists have identified that Accidental soil ingestion is the most significant pathway of entering lead to human. In the United States, lead remains the most frequently encountered toxic metal, through the contaminated dust and aerosol outside. Cadmium enters into the body through inhalation of contaminated smoke or air, consumption of contaminated food and water.

What are the health risks?

Cadmium and lead in human body cause several health issues. Itai itai is a disease reported in Jinzu river basin in Toyama Prefecture, Japan during 1968 due to Cd poisoning. In this heavily industrialized region, the river was contaminated by slag from a mine located upstream and the soil in the surrounding rice fields become contaminated with heavy metals including Cd through sustained irrigation. Most of people have been exposed by use stream water from the Jinzu River not only for rice cultivation but also for household use and as drinking water. Accumulation of Cd in the human body can damage kidneys, liver and heart and in severe cases it may cause death. Lead poisoning also can damage kidneys, liver, heart, brain and the nervous system. Both, Cd and Pb are known as substances causing cancers (carcinogens) in human.

How serious the issue of pollution globally?

The World Health Organization (WHO) recommended safe limits of Cd in both wastewater and a soil for agriculture is 0.003 mg/L and for Pb these limits are 0.01 mg/kg and 0.1 mg/kg, respectively. Lead is more harmful to children because their brains and nervous systems are still developing. Lead poisoning can be treated but any damage caused cannot be reversed.

In Bangladesh, approximately 6.9 million

children of 5-14 years old are engaged in physical labor in different industries. Many studies have shown that considerable number of these children is exposing to Pb in hazardous environments in welding, car repair, lead melting and ship-breaking yards and all of

Source: https://images.app.goo.gl/JgBP6BhZxh5kobDY6

It is also alarmed that children live in USA approximately 4 million houses that contain lead paint are exposed lead daily. Several studies conducted in Sri Lanka have revealed low risk conditions of Cd and Pb toxicity. But in-depth studies are required to assess all possibilities and sources of Cd and Pb pollution and the status of human exposure.

How to reduce soil contamination by Cd and Pb?

Practices such as use of poor quality chemical fertilizers, misuse of pesticides and herbicides, use of poor quality water for irrigation and application of organic fertilizers such as poultry manure, sewage sludge contaminated with Cd and Pb cause the pollution of agricultural soils. Wastewater flows released by industries are often contaminated with various metalloids). Further, improper handling and dumping urban wastes are known source of metalloids including Cd and Pb.

Therefore, strict actions should be taken to stop the use of agricultural inputs contaminated with Cd and Pb. Sri Lanka Standard Institute has prepared standards to stop inflow of low quality agricultural inputs. However, stringent quality control of agro-chemicals imported to Sri Lanka is needed to be practiced. Besides, organic fertilizers produced in Sri Lanka should also be subjected to strict quality control measures. Proper garbage disposal practices and wastewater management practices help to reduce Cd and Pb contaminants in the environment.

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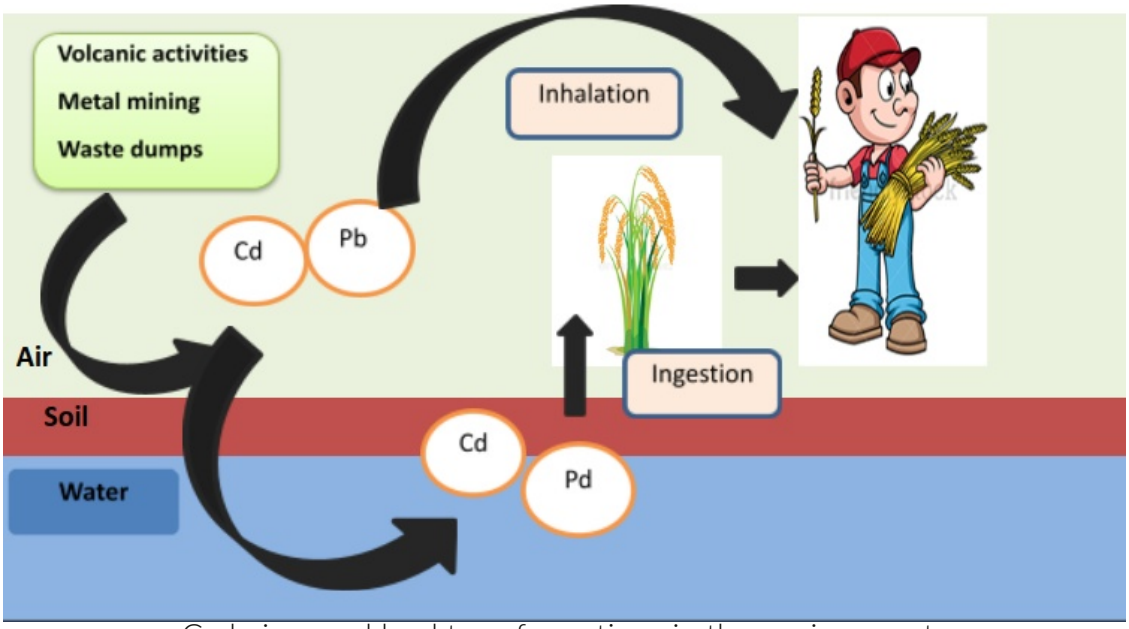


Cadmium and lead transformations in the environment

It's time to take turns from mono-cropping to crop rotation

by Akshara Samarasuriya.

source-https://images.app.goo.gl/5xNC419VXr8YjTZV7

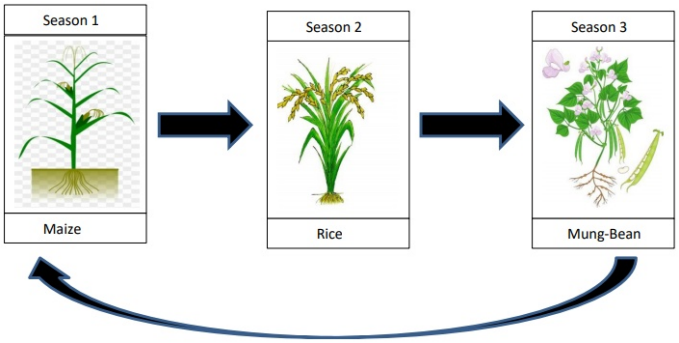
Mono-cropping is the practice of growing one type of crop continuously for a long period on the same land. This cropping pattern is practiced for many annual crops including rice, maize, and plantation crops like coconut, tea, and rubber. Mono-cropping requires the same set of management practices and machinery, year after year which makes it convenient for farmers.

However, there are a number of ecological and economical disadvantages associated with mono-cropping. Cultivation of the same crop leads to removal of some plant nutrients in high quantities as the harvest. This occurs in the same soil layer where roots occupy resulting in nutrient imbalances in the soil and gradual decline in soil fertility. Many studies have found a loss of soil carbon as a result of mono-cropping. Nutrient imbalances along with reduction in soil carbon negatively affect the diversity of soil microorganisms that is essential to maintain the fertility of the soil. Therefore, the yield of the crop is also gradually declined if mono-cropping is practiced for many years. In sloppy areas, the practice of the same land preparation method season after season leads to soil erosion. As a consequence, farmers tend to apply excessive amounts of chemical fertilizers to boost fertility, increase yields and thus the income. Growing the same crop on a land provides a favorable environment for a certain parasitic, pest and weed species and it causes crop vulnerability to such insects, plants, and microorganisms. In a situation where a pest outbreak of a crop occurs, a farmer could lose his entire harvest at once, and therefore his income for the whole season will fail, which is a quiet risk for a farmer. Thus, farmers tend to use excessive amounts of agrochemicals such as pesticides and weedicides. Therefore, mono-cropping poses a great threat to the environment.

Crop rotation is a very viable alternative for mono-cropping. In crop rotation, different types of crops are grown sequentially on the land. A farmer can achieve several benefits by practicing crop rotation. Among them, crop rotation improves soil qualities, particularly physical properties. As an example, cultivating a root crop that produces a lot of air space in the soil in one season will be beneficial for a crop that grows in the same area next season. It avoids selective removal of plant nutrients, thus a balanced state is maintained in terms of its fertility and composition. In crop rotation, a farmer can use fertilizers more smartly as there is no need to apply the same amount of fertilizer to each acre every season. If a farmer grows a legume crop in one phase of the rotation, he can improve the soil nitrogen pools. It will automatically reduce the nitrogen fertilizer requirement for the next crop. Crop

rotation changes the soil and crop environment in each season, reducing the chances of specific pests and disease outbreaks. Thus, crop rotation prevents the establishment of crop-specific pests, diseases, or weeds, which deduct the usage of chemicals. As an example, Cucurbit flies are the most common pest which attacks the Cucurbitaceae family, which includes Pumpkin, Melon, Cucumber, Snake Gourd, and Bitter Gourd. It concentrates solely on Cucurbit. The fly will be set up permanently in the same spot if the farmer leaves the Cucurbit in the same spot all year. So, rotating another crop with cucurbits will reduce the risk of a pest outbreak.

Crop rotation will enhance the efficient use of water and land. Including deep-rooting crops in the crop rotation helps to retain groundwater, which shallow-rooted crops can utilize. There are evidence for the considerable improvement of soil health thus yields by the practice of crop rotation.



A crop combination for crop rotation

Different crop rotations can be observed in different agro-ecological regions in Sri Lanka. A farmer can practice different combinations of crops in crop rotation to suit the soil, climatic condition, and economic factors. Sri Lankan farmers practice annual rotation, including maize and legume, two-year rotation with maize, potato, sugarcane, and mung bean, three-year rotation with root crops, cabbage and pumpkins, and four-year rotation with root crop, cabbage, legume, potatoes. Though crop rotation is beneficial, the majority of farmers in Sri Lanka practice mono-cropping. So, it's time to think wisely and switch from the mono-cropping system to crop rotation to achieve high productivity to cater to the increasing food requirements while sustaining the soil productivity and the environment.

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Do you know that Charcoal makes soil fertile?

by Aishika Iromi

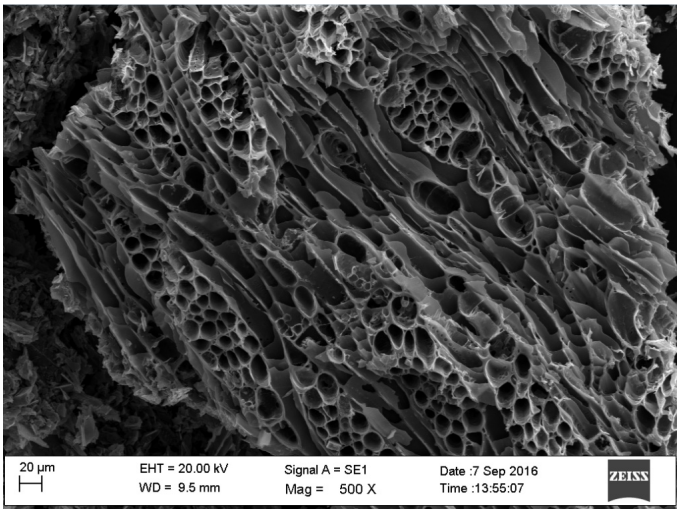
Biochar has become a famous soil amendment worldwide in agriculture during the last two decades. Biochar is similar to charcoal in appearance but in terms of chemical structure it differs from charcoal. Biochar is made by heating organic materials at a temperature nearly 300 °C in the presence of limited or no oxygen. This process is called pyrolysis. Raw materials used for biochar production are abundant and few examples for such materials are wheat straw, corn straw, wood chips, melon seed shell, peanut shell, rice husk, coconut shell, livestock and poultry manure, kitchen waste, sludge and fruit skin. Biochar can be prepared easily even in the home in a kiln, stove, pit or a heap.

Though the biochar technology seems to be new, it is not so!!! There are evidences that biochar had been used 2000 years back by Precolumbian Amazonians. They improved infertile Amazonian soils by adding a mixture of charcoal, bone, broken pottery, compost and manure. These improved fertile soils were called as Terra preta, which means the dark earth. Many archaeologists have observed Terra preta in their archeological explorations. They believe Tetra preta soils have been formed by burning forest vegetation. By using satellite images, Brazilian archaeologist Eduardo Neves was able to observe subtle differences between the canopy above Terra preta sites and the canopy outside of them in the forest. The vegetation grows better in Tetra preta soils as they are more fertile compared to neighboring areas, indicating long-lasting benefits of the incorporation of biochar to the soil.

Production of biochar by farmers of Sri Lanka

Modern science explains how biochar makes a soil more fertile than other soil amendments. Biochar has lots of tiny spaces, or microscopic pores, thus it behaves like a hard sponge when it is in the soil. Therefore, biochar can hold more water than a similar quantity of soil. Along with soil water, it also can hold nutrients and provides a safe habitat for soil organisms.

Biochar adds carbon to the soil which provides many benefits. Soil organisms could use carbon in biochar for their growth. Biochar reduces net emissions of carbon dioxide gas from soil and retains carbon in soil. Besides, emissions of nitrous oxide (N2O) and methane (CH4), two potent greenhouse gases from



Microscopic view of biochar

agricultural soils. Thus helps reduce warming of the earth's environment. Biochar improves crop productivity through enhancing physio chemical and biological properties of soils in such a manner favorable for the crop. Mainly, the water and nutrient retention in soils are improved by the incorporation of biochar. Moreover, benefits of biochar application have been found. These include, stabilizing the soil pH, reducing the availability of potentially toxic elements to plants, etc. However, biochar contains very little amounts of plant nutrients such as K, Mg, Ca, and P and thus slightly reduces the need for chemical fertilizers. If farmers can apply biochar with fertilizer it will help to reduce the fertilizer cost. Many studies have found comparatively higher yields when biochar application is practiced.

In addition, biochar application provides beneficial effects on the environment. Biochar absorbs pollutants such as pesticides and other hazardous substances added to the soil. This type of filtering effect reduces downward movement of pollutants to control groundwater pollution. Therefore, application of biochar needs to be promoted to improve soil health and crop productivity while mitigating global climate change.

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Photo credit: Professor Saman Dharmakeerthi, Department of Soil Science, Faculty of Agriculture.

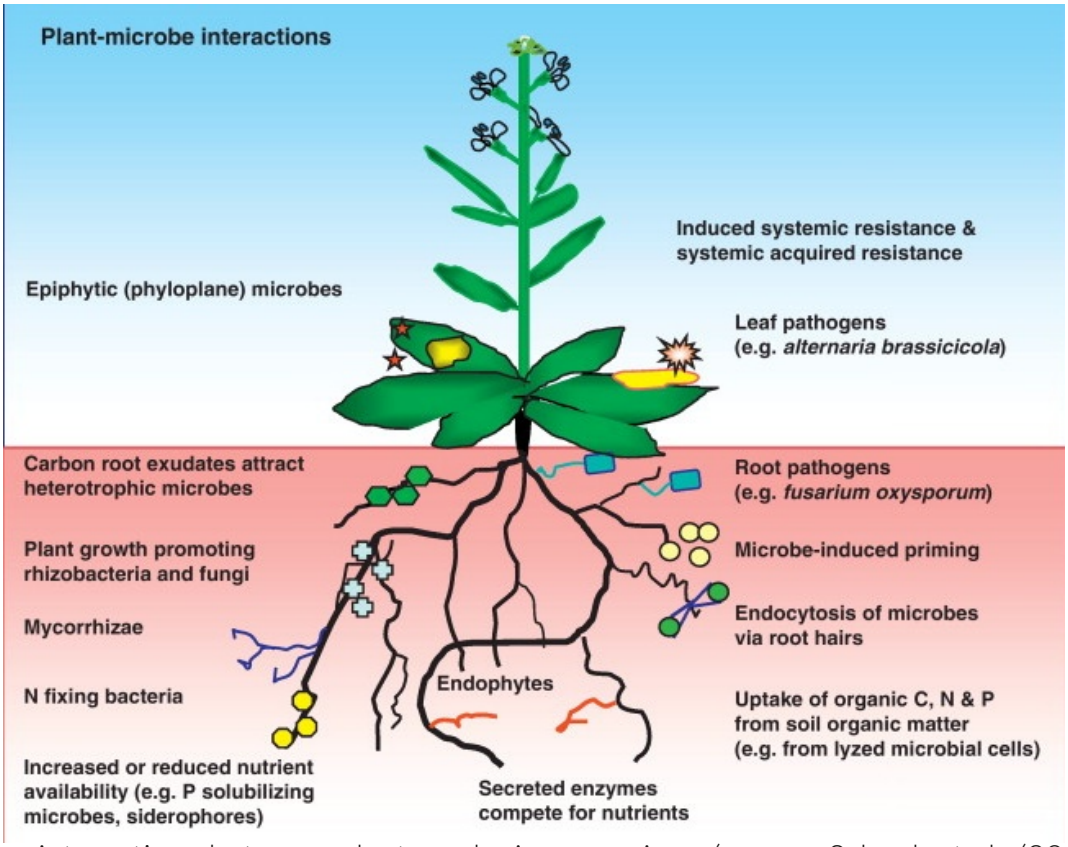
Soil microorganisms and Plants – An inseparable connection

by R.N. Baddegama

Soil microorganisms include bacteria, fungi, protozoa, and viruses. They support plant growth ensuring availability of food for all living organisms on the earth. They are also a deciding factor of maintaining various services and functions offered by any ecosystem vital for all living organisms. Such an amazing contribution of soil microorganisms is possible due to their ability to perform diverse reactions while living alone or associated with plants.

There are various interactions between plants and microorganisms which are either detrimental to plants or vital for the survival of the both partners. They live in soils surrounding roots which is known as the rhizosphere. Rhizosphere soils are generally enriched with simple carbon containing simple substances such as sugars which are released by plant roots and microorganisms thrive on them. However, these chemical substances available in the rhizosphere varied between plant species and their growth stages. Therefore, the number and the diversity of microorganisms living in the rhizosphere vary with the quality of substances available in the rhizosphere.

A vast majority of microorganisms live in the rhizosphere and promote plant growth mainly providing nutrients necessary for plant growth. A few bacterial species can fix atmospheric nitrogen and provide nitrogen directly to plants while living inside of the roots. There are many species of bacteria that live in the rhizosphere and dissolve precipitated forms of phosphates so that plant roots could take up phosphate ions. Ability of bacteria and fungi to secrete growth hormones promotes root and shoot growth. There are soil microorganisms who could suppress or kill growth of plant pathogens. Some of them improve the plant growth indirectly by providing nutrients through decomposition of organic matter. These interactions between plant root and soil microorganisms differ according to the plant variety and growth conditions.



Various interactions between plants and microorganisms (source: Schenk et al., (2012)

Soil microorganisms produce lots of substances which act as a binding agent of soil particles to form soil aggregates. Presence of stable soil aggregates help to improve the soil structure. Good soil structure is very important to retain plant nutrients and organic matter, water, and also to minimize the risk of erosion.

Soil microorganisms play a major role in nutrient cycling. Microorganisms are involved in two major processes which contribute to nutrient cycling. One is absorbing nutrients from the soil and transforming them into microbial tissues. This process known as immobilization of nutrients. The opposite process is mineralization. Mineralization happens when soil microorganisms die and release nutrients from their tissues. Further, soil microorganisms are responsible for decomposition of crop residues and release nutrients in mineral form. These processes are vital necessity in providing nutrients for plants growth.

Intensive agriculture is practiced throughout the world to cater the ever-increasing food demand through enhanced yields. This practice relies upon excessive use of fertilizers, pesticides, high yielding seeds and mechanization while over exploiting the potentials of natural resources. Excessive land preparation practices disrupt the soil structure and reduce the pore size and distribution of soil particles. Consequently, water infiltration, drainage and aeration are affected. Repeated land preparation practices cause reduction of organic matters and substantial reduction of microbial population in soil. Excessive application of agrochemicals alters the soil properties and causes accumulation of toxic substances. These changes result in many undesirable impacts on the whole ecosystem and living macro and microorganisms.

There is an urgent need of shifting towards more eco-friendly crop and soil management practices. Otherwise soil microorganisms will be unable to create a beneficial and favorable ecosystem for plant production. Minimum or zero tillage practices, crop rotation, cultivation of legumes crop, application of crop residuals, conducting integrated pest management practices and integrated plant nutrient management by combining inorganic and organic fertilizers such as organic manure and biofertilizer are some of eco friendly practices we can adopt to improve the soil biodiversity and assure optimum functioning of microorganisms. Especially, microbial inoculants can be used as bio fertilizer, bio pesticides or bio herbicides as an alternative for agrochemicals, which contain harmful compounds for living organisms. All these benefits are available if diverse microorganisms co-exist with plants or could be isolated from soils and formulate inoculants. Therefore, soils with less environmental disturbance would sustain diverse beneficial microorganisms in soils and allow ecosystems to carry out all beneficial functions.

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Nitrate pollution in groundwater of Sri Lanka

by K.M.B.M. Konara

We all know that water is one of the essential needs of living organisms. Despite the fact that world is covered with 70% water, only about 0.3% of it is fresh and available for human use. Meanwhile, groundwater accounts for 0.6% of total global water.

Use of this groundwater for irrigation is rapidly increasing in Sri Lankan agricultural sector due to the limited rainfall and poor surface water availability, especially in dry zone. Groundwater usage allows farmers to grow more crops, minimize the impact of droughts, and continue their livelihood. Besides, groundwater is the only source of drinking water for many rural communities in Sri Lanka. But unfortunately, increasing groundwater pollution induced by anthropogenic activities had led to a rapid reduction in groundwater quality of many areas.

Nitrate(NO_3^-) is one such major groundwater pollutant associated with commercial agriculture. Synthetic and organic fertilizers added to agricultural fields are the primary sources of nitrate in ground water. Although nitrate and other nitrogenous compounds support the growth of fauna and flora by providing the essential element nitrogen, nitrate is potentially hazardous for human health when present at high concentrations in drinking water. Thus, nitrate pollution in groundwater has become a matter of grave concern of groundwater consumers and health authorities.

Health issues arise due to nitrate pollution of drinking water

The World Health Organization (WHO) has recommended 50 mg/L as the maximum permissible nitrate level in drinking water. Consuming nitrate exceeding this limit can lead to low blood oxygen concentrations and cause methemoglobinemia (also known as blue baby syndrome). In addition, nitrate exposure can cause other health effects such as increased heart rate, nausea, headaches, and abdominal cramps. Some studies also suggest an increased risk of cancer, especially gastric cancer, due to excessive consumption of nitrate.

Where this issue is prominent?

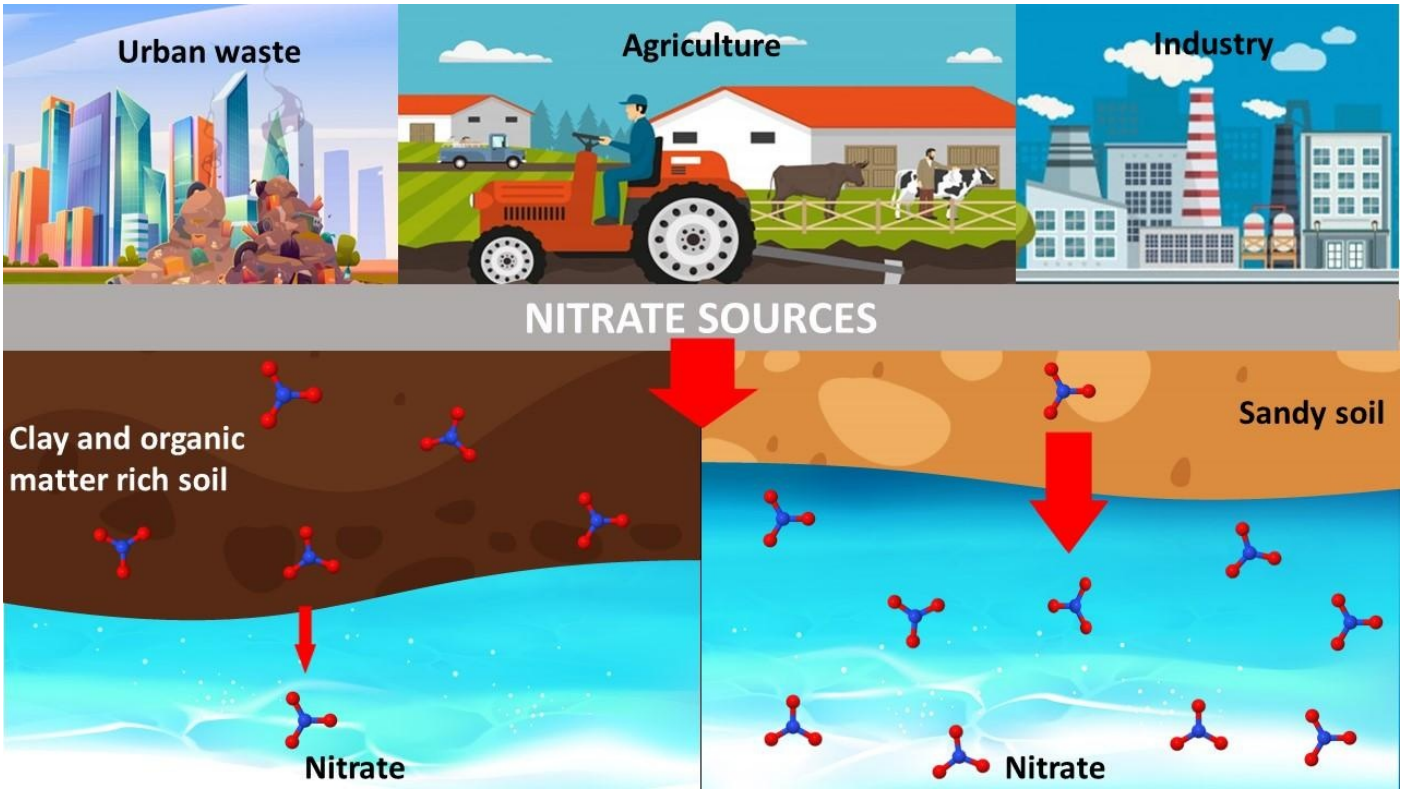
High nitrate concentrations in groundwater was first reported in Jaffna around 1984 underneath sandy regosols cultivated with annual crops in coastal areas of Jaffna. In 1990, groundwater nitrate concentrations above permissible levels were reported in Kalpitiya and Mannar. A study conducted in 2008 reported that about of 56% of 225 drinking water wells in Kalpitiya contain nitrate above WHO's maximum permissible level.

These are only few reported cases of groundwater nitrate pollution in Sri Lanka. These data suggest areas with sandy soils are more vulnerable for groundwater pollution. It is because sandy soils have less clay and organic substances, which are capable of retaining many contaminants within the soil system and purifying water before it reaches groundwater. Hence the downward movement of nitrate from soil to groundwater is faster through a sandy soil than clayey soils.

The risk of groundwater contamination in other areas of our island is not known. You must be cautious about the glass of water you drink in agricultural areas, urbanized areas, or an industrial zone. On the other hand, aquifers in Sri Lanka are situated in shallow depths, making them easily contaminated. So that water from your well or tube well may not be safe to drink if located in agricultural area!!

How to overcome this issue?

Some changes in land use management practices are essential to protect the water quality. Avoiding the excess application of



fertilizers and following the fertilizer recommendations made by the Department of Agriculture correctly are essential to reduce the risk of contamination. In addition, use of slow release nitrogen fertilizers can minimize the leaching of NO-3 to groundwater since these fertilizers release nitrates at rates compatible with the plant demand. Using nitrification inhibitors is also another approach. Nitrification inhibitors can prevent nitrate formation in the soil and retain more nitrogen in ammonium ion form which is not subjected for leaching.

So it is clear that nitrate pollution in groundwater is not a situation that could be considered lightly. Though it is a critical issue, less attention is conveyed by society. Therefore, increased social awareness and a sustainable approach to manage this situation are essential in order to overcome this issue.

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