SHEPROS®

Safety, Heath & Environment Product Solutions

The Best Solution for Sustainable Agriculture Practice in Peat Soils.

SOILPRO – Solution for Peat Soils

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Peat Soils

Definitions of Peat

- Peat is accumulation of purely 100 % organic material (Andriesse,1992).

- USDA defined peat as organic soils (Histosols) if more than half of the upper 100 cm is organic. Loss of ignition >65% (Soil Survey Staff, 1998).

- Wosten, 2001 defined peat as a soil that contains at least 65 % organic material (<35% mineral material), is at least 50 cm in depth, cover an area of at least 1 ha and acidic with pH of 3-4.

Characteristics of Peat Soil in Malaysia and Indonesia

Peat soils are organic soils, defined as containing more than 65% organic matter. Peat is developed in large water-logged basin from dead natural vegetation under anaerobic condition where the rate of organic matter (OM) buildup is faster than the breakdown. The mineral substratum is usually clay and can be potentially acid sulfate.

Peats in South-east Asia often contain more than 90% organic matter. They are acidic with pH levels as low as 3.5. They generally have a low nutrient content, except when flooded by rivers, with a high Carbon/Nitrogen ratio. The concentration of substances such as phenols and aluminum are sometimes high and may cause toxicity in plants. Water, air, mineral content and organic carbon content are the four main components of peat which are inter-linked and dependent on each other.

Water is a vital component but the volume of water varies – when fully saturated, peat lands may be composed of more than 90% water by volume.

Irreversible drying of peat is one of the characteristics of peat soil and may occur after prolonged and intensive periods of drying. Peat lands that are drained for land use changes but abandoned for prolonged periods will exhibit this phenomenon. It may cause severe drought stress in shallow rooting crops. This may be due to the hydrophobic nature of dried peat due to the presence of resinous coating which presumably forms upon drying (Coulter 1957). Such properties of resistance in re-absorption of water could also be attributed to adsorbed air films and iron coating around the peat material.

Bulk density of peat material depends on the amount of compaction, the botanical composition of the materials, the degree of decomposition and the mineral and moisture content.

Typical Properties of Peat Soils

Most peat soils are categorized as Tropofibrists and Tropohemist in the USDA soil order of Histosol which are contrast with mineral soils. Below are some typical properties of peat soils:

- Very large in water holding capacity
- Up to 98% of organic matter
- pH of 2.8 to 4.5
- Poor capacity in nutrients retention especially for potassium
- Low nutrients content except for nitrogen
- Rapid fixation of water soluble copper and zinc compounds by humic and fulvic acids and polyphenolic compounds
- Very low bulk density of 100 to 200 kg/m^3 compared to mineral soils which are 1,400 to 1,800 kg/m^3

Classification of Peat

Criteria used include depth of organic layer, ash content, nature of subsoil, salinity of ground water and stage of decomposition.

For tree crops like oil palm, depth of the organic layer is the most important factor.

Classification	**Depth (m)**
Shallow Peat	< 1
Moderately Deep Peat	1-3
Deep Peat	> 3

Mixed Peat Soils which are suitable for oil palm cultivation.

Sapric: Highly Decomposed Peat

Fibric: Poorly Decomposed Peat

Peat material is either fibric, hemic, or sapric. Fibric peats are the least decomposed, and comprise intact fiber. Hemic peats are somewhat decomposed, and sapric are the most decomposed.

Carbon Emissions from Peat Lands

Burnt peat swamp soil

Degraded peat lands

Fern covered degraded peat swamp *Fire for agriculture*

Peat lands are a major storage of carbon in the world. They account for 550 giga tons worldwide. The majority of the carbon stored in peat lands is in the saturated peat soil that has been sequestered over millennia. In the sub (polar) zone, peat lands contain on average 3.5 times more carbon per hectare than the above-ground ecosystems on mineral soil; in the boreal zone they contain 7 times more and in the humid tropics over 10 times more carbon.

Growing Source of Greenhouse Gas (GHG) Emissions

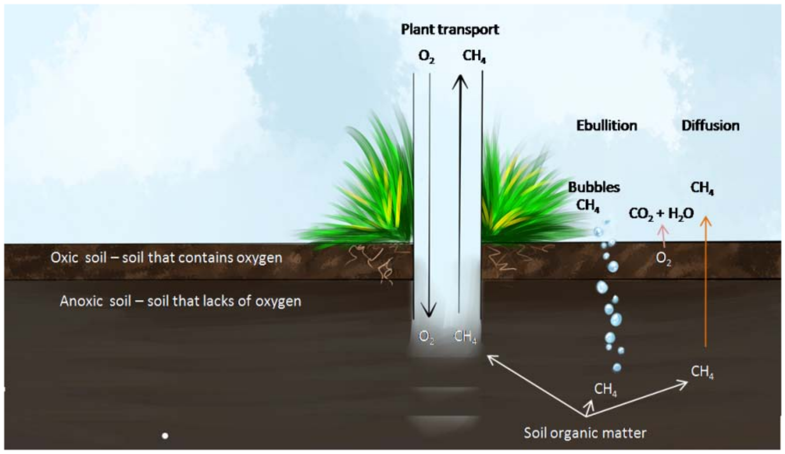
The main threat for release of carbon from peat lands arises from the drainage of the large areas of organic wetland (peat) soils for agriculture, forestry and peat extraction all over the world. As a result, the organic carbon that is normally underwater is suddenly exposed to the air, where it decomposes and emits carbon dioxide (CO_2). Additionally, increased temperature, from removal of vegetation cover such as forest cover, enhances the rate of CO_2 emissions from peat. Also the use of fertilizers, such as used in oil palm plantations, has an accelerating effect on the decomposition rate of peat soils.

Peat Fires

Fires resulting from peat are known as peat fires. What makes them different from forest fires is their low temperature, spread slowly and flameless like a smoldering coal, as they are always burning. When the right situation presents itself, peat catches fire. Peat fires can go into the soil and travel underground. Factors responsible are lightning, forest fires, arson and mining activities. Peat fires can burn as deep as 5 meters and spread very slowly. Peat fires not only destroy thousands of acres of forest lands but also cause destruction of the peat wetland habitats in which many plants and animals thrive. Peat fires in Southeast Asia and in Russia, release huge amounts of CO_2 every year. Altogether global CO_2 emissions amount to at least 2,000 million tons annually, equivalent to 5% of the global fossil fuel emissions.

Methane

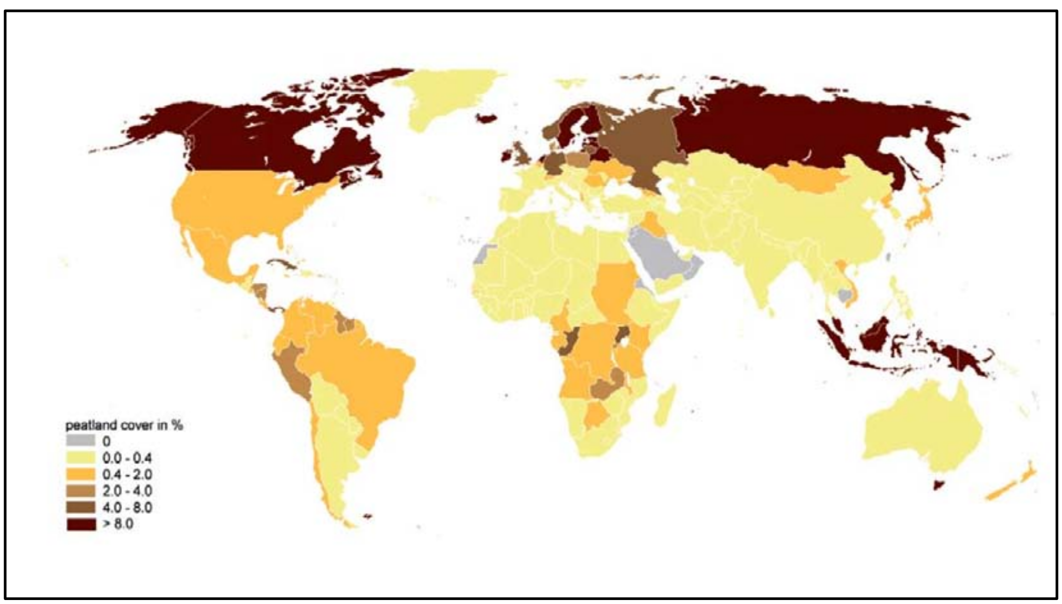
Once anaerobic conditions are given to methane (CH_4) producing micro-organism Archaea, the quality and supply of the organic material is the major factor in methane production. Substantial amounts of methane are only produced when fresh plant material is amply available. Old (recalcitrant) peat plays only a subordinate role. Methane is emitted via three main pathways: diffusion, ebullition and plant mediated transport.



Production, re-oxidation and emission of CH_4 from vegetated peat land site.

Global Problem

In Indonesia, emissions from peat soils due to logging and drainage contribute 60% to the total Indonesian CO_2 emissions (~900 million tons per year). While Indonesia currently has the highest CO_2 emission from peat lands, the degradation of peat lands is a global problem.



The Global Peat land status and CO_2 *emissions in all countries of the world.*

Impact of Climate Change on Peat Lands

Another cause for concern is that climate change poses an enormous challenge to peat lands and CO_2 emissions. For instance, warmer summer weather threatens to thaw the large peat land (permafrost) areas of Canada and Russia, causing them to decompose. There is also a risk that fossilized methane, stored under the permafrost areas, could be released.

Greenhouse Gases – Why Does It Matter?

As greenhouse gas emissions from human activities increase, they build up in the atmosphere and warm the climate, leading to many other changes around the world—in the atmosphere, on land, and in the oceans. These changes have both positive and negative effects on people, society, and the environment—including plants and animals. Because many of the major greenhouse gases stay in the atmosphere for tens to hundreds of years after being released, their warming effects on the climate persist over a long time and can therefore affect both present and future generations.

Many of the major greenhouse gases can remain in the atmosphere for tens to hundreds of years after being released. They become globally mixed in the lower atmosphere, reflecting contributions from emissions sources worldwide.

Several factors determine how strongly a particular greenhouse gas will affect the Earth's climate. One factor is the length of time that the gas remains in the atmosphere. A second factor is each gas's unique ability to absorb energy. By considering both of these factors, scientists calculate a gas's global warming potential, as compared to an equivalent mass of carbon dioxide (which is defined by a global warming potential equal to 1).

Keys Points Greenhouse Gas Emissions

- **Global Greenhouse Gas Emissions.** Worldwide, net emissions of greenhouse gases from human activities increased by 35 percent from 1990 to 2010. Emissions of carbon dioxide, which account for about three-fourths of total emissions, increased by 42 percent over this period. The majority of the world's emissions result from electricity generation, transportation, and other forms of energy production and use.

- **Atmospheric Concentrations of Greenhouse Gases.** Concentrations of carbon dioxide and other greenhouse gases in the atmosphere have increased since the beginning of the industrial era. Almost all of this increase is attributable to human activities. Historical measurements show that current levels of many greenhouse gases are higher than any levels recorded for hundreds of thousands of years, even after accounting for natural fluctuations.

- **Climate Forcing.** Climate forcing refers to a change in the Earth's energy balance, leading to either a warming or cooling effect. An increase in the atmospheric concentrations of greenhouse gases produces a positive climate forcing, or warming effect. From 1990 to 2013, the total warming effect from greenhouse gases added by humans to the Earth's atmosphere increased by 34 percent. The warming effect associated with carbon dioxide alone increased by 27 percent.

Major Long-Lived Greenhouse Gases and Global-warming Potential (GWP)

This table shows types of greenhouse gas, how it is produced, life time in the atmosphere and the 100-year global warming potentials.

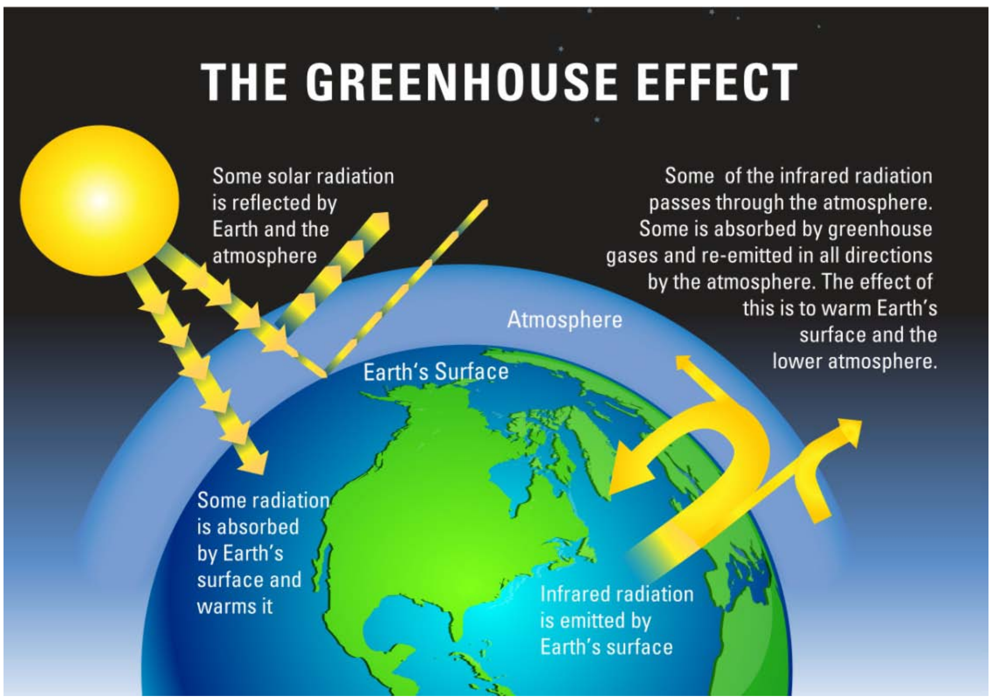
Global-warming potential (GWP) is a relative measure of how much heat a greenhouse gas traps in the atmosphere. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide. A GWP is calculated herein over a specific time interval of 100 years. GWP is expressed as a factor of carbon dioxide (whose GWP is standardized to 1). **Example**, methane's lifetime in the atmosphere is much shorter than carbon dioxide (CO_2), but CH_4 is more efficient at trapping radiation than CO_2. Pound for pound, the comparative impact of CH_4 on climate change is over 28 times greater than CO_2 over a 100-year period.

Greenhouse gas	How it is produced	Average life time in the atmosphere	100-year global warming potential
Carbon dioxide	Emitted primarily through the burning of fossil fuels (oil, natural gas, and coal), solid waste, and trees and wood products. Changes in land use also play a role. Deforestation and soil degradation add carbon dioxide to the atmosphere, while forest re-growth takes it out of the atmosphere.	see below*	1
Methane	Emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and agricultural practices and from the anaerobic decay of organic waste in municipal solid waste landfills.	12 years	28
Nitrous oxide	Emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.	121 years	265
Fluorinated gases	A group of gases that contain fluorine, including hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride, among other chemicals. These gases are emitted from a variety of industrial processes and commercial and household uses, and do not occur naturally. Sometimes used as substitutes for ozone-depleting substances such as chlorofluorocarbons (CFCs).	A few weeks to thousands of years	Varies (the highest is sulfur hexafluoride at 23,500)

Global warming potentials and lifetimes come from the Intergovernmental Panel on Climate Change's Fifth Assessment Report.

** Carbon dioxide's lifetime is poorly defined because the gas is not destroyed over time, but instead moves among different parts of the ocean–atmosphere–land system. Some of the excess carbon dioxide will be absorbed quickly (for example, by the ocean surface), but some will remain in the atmosphere for thousands of years, due in part to the very slow process by which carbon is transferred to ocean sediments.*

Greenhouse Effect on Climate Change



Life on earth depends on energy from the sun. About 30 percent of the sunlight that beams toward Earth is deflected by the outer atmosphere and scattered back into space. The rest reaches the planet's surface and is reflected upward again as a type of slow-moving energy called infrared radiation.

The heat caused by infrared radiation is absorbed by "greenhouse gases" such as water vapor, carbon dioxide, ozone and methane, which slows its escape from the atmosphere.

Although greenhouse gases make up only about 1 percent of the Earth's atmosphere, they regulate our climate by trapping heat and holding it in a kind of warm-air blanket that surrounds the planet.

This phenomenon is what scientists call the "greenhouse effect." Without it, scientists estimate that the average temperature on Earth would be colder by approximately 30 degrees Celsius (54 degrees Fahrenheit), far too cold to sustain our current ecosystem.

Health Impacts Associated with Climate Change

The Intergovernmental Panel on Climate Change has concluded that humans are impacted by climate change directly through changing weather patterns and indirectly through changes in water, air, food quality and quantity, ecosystems, agriculture and economy.

Potential effects of climate change on public health include:

- **Direct Temperature Effects**: Climate change may directly affect human health through increases in average temperatures, which are predicted to increase the incidence of heat waves and hot extremes.

- **Extreme Events**: Climate change may affect the frequency and severity of extreme weather events, such as hurricanes and extreme heat and floods, which can be destructive to human health and well-being.

- **Climate–Sensitive Diseases**: Climate change may increase the risk of some infectious diseases, particularly those diseases that appear in warm areas and are spread by mosquitoes and other insects, such as malaria, dengue fever, yellow fever, and encephalitis.

- **Air Quality**: Respiratory disorders may be exacerbated by warming-induced increases in the frequency of smog (ground-level ozone) events and particulate air pollution.

Peat Lands and Agriculture as Partner for Growth

The significant challenges facing agriculture are well known. Simply put, the world will need to produce more food and reduce the external impacts of food production systems on the environment. In developing countries, peat lands for agriculture represent a major way out of poverty for rural populations, and are well placed for significant gains in productivity and economical success. For example, well managed oil palm plantation systems produce not only palm oil but also co-benefits such as job opportunities for surrounding population.

The history of peat lands and agriculture provide us with good insight into both the mistakes of the past and solutions for the future. Only a sustainable good agriculture practice and a good ecosystem will offer the solution to simultaneously achieving food and nutrition security, poverty reduction and environmental sustainability.

Nutritional Requirements of Oil Palm Trees in Peat Soil

Nitrogen

There is an 8-15% response to N in the early years, but with increased mineralization of the organic matter the need for external N tends to decline with age. Generally, a 0.5-1.5 kg of urea/palm/year is recommended.

Phosphate

For optimum growth and production phosphate is essential. A 20-40% response to P has been obtained in peat. Rock phosphate is applied in and around the planting hole at planting. Generally, further annual dressings at 1.0-1.5 kg/palm will be applied. Higher rates of phosphate can reduce Cu uptake.

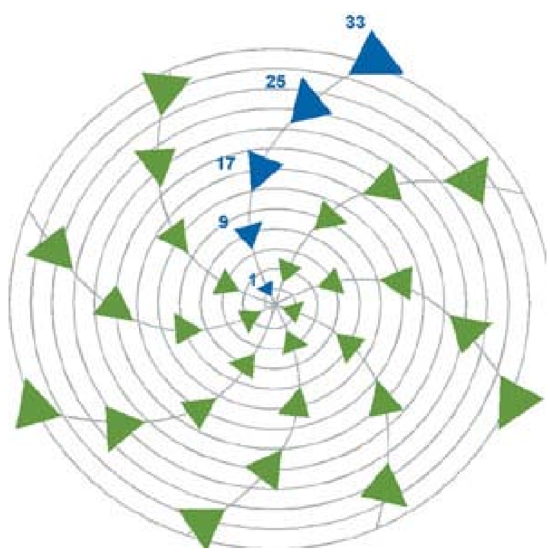
Potassium

Peat is very deficient in K and large doses of potash are required for optimum production. Usually 3-6 kg of MOP or its equivalent is required for mature palms. Where bunch ash (40% K_2O) is available, half the K is applied as MOP and the other as bunch ash.

Copper

Cu is fundamental to the growth of oil palm on peat. Deficiency leads to the condition known as mid-crown chlorosis. For proper establishment, early application is essential. It is applied to the soil at planting – with further dressing at the end of the 1st and 2nd year. Thereafter, application is based on leaf levels –which should be maintained between 3 to 5 ppm in frond 17.

Frond arrangement on a palm showing how to identify Frond #17:



Zinc

Deficiency of zinc leads to the condition known as peat yellows. Early application is recommended. The method and rate being the same as Cu. Leaf levels in frond 17 should be maintained between 12 to 15 ppm.

Before

After

Other nutrients

Magnesium	-	No response obtained
	-	Not commercially applied except in cases of imbalance due to very high K application
Boron	-	Requirements similar to mineral soils
Manganese	-	No response obtained
Iron	-	No response obtained

Peat Acidity and Liming

Generally, the pH is about 3.5 for peat in Malaysia and Indonesia. Liming is done in the first 2-3 years to correct acidity and to promote better rooting. Thereafter, applications are made according to requirements. Over liming can affect K uptake and micronutrient availability. Where bunch ash is used routinely, lime application can be reduced or eliminated.

Distribution of Peat Lands in Malaysia and Indonesia

- Estimated 18.48 million hectares of tropical peat lands in Indonesia and 2.46 million hectares in Malaysia.

- MPOB (2009) reported 666,038 hectares peat land in Malaysia (Sarawak- 437,174 ha, Peninsular Malaysia -207,458 ha and Sabah-21,406 ha) had been cultivated with oil palm.

- In Indonesia (after Soekardi and Hidayat, 1988) estimated there are 1.77 million hectares of logged –over peat forest have been developed for oil palm cultivation, mainly in Sumatra (1.40 million ha) and Kalimantan (0.37 million ha).

Distribution of Peat in Malaysia and Indonesia

The area (ha) of peat lands in Malaysia:

REGION	Area (Ha)	Percentage (%)
Peninsular Malaysia	642,918	26.16
Sabah	116,965	4.76
Sarawak	1,697,847	69.08
TOTAL	**2,457,730**	

The area (ha) of peat soil in Indonesia:

REGION	Area (Ha)	Percentage (%)
Kalimantan	9,313,920	50.4
Papua	4,601,520	24.9
Sumatra	4,490,640	24.3
TOTAL	**18,480,000**	

Constraints to Oil Palm Cultivation on Deep Peat

1. Low Bulk Density

   - Subsidence & shrinkage of the peat
   - Root exposure
   - Leaning and lodging of palms

2. Movements and access to palms difficult

3. High Amounts of Un-decomposed Timber and Air-pockets in Profile

4. Low Nutrient Content

5. High Acidity

6. High Infrastructure Cost

   - Drainage and Water management
   - Good network of drains to remove excess water
   - Water table management

7. Pest and Disease Problems

   - Termites and ganoderma are major problems

8. Irreversible Drying of Peat

The condition of oil palm trees in peat soil.

SOILPRO

Farmers in many areas of the country can take good soil for granted, but farmers in peat lands have to work for it. The loose and non-sticky peat soil needs soil conditioners, and lots of it, to become good agriculture soil.

Generally, the top 8-12" of soil, where plants' roots live, determines the success of the farming efforts. Plants need oxygen, nutrients and certain degree of soil compaction in order to grow in peat soil. Most of the peat soils are too loose to allow roots to grow. SOILPRO is a suitable soil conditioner that can improves the binding of loose peat soil, water infiltration into soil, root holding and penetration, and crop nutrients and water uptake.

Adding SOILPRO as peat soil amendment improves soil texture, reduces loose soil, improve nutrients uptake, improves drainage and aeration, moderates soil temperature, and reduces pore space, which are essential to plant growth.

SOILPRO – An Environmentally Friendly Inorganic Peat Soil Binder

SOILPRO is an environmentally safe, specifically formulated of highly effective inorganic peat soil binder. It is applied into peat soils and once it is mixed with water will serve as a binding agent. SOILPRO is a tackifier and soil binder that can sustain the plants to the soil ground. It is also the most reliable and effective procedure for growing trees for a multitude of soil stabilization, erosion control and re-vegetation peat soil projects. The soaring popularity of using SOILPRO lies in the fact that it creates a revolution in peat soil agriculture.

Results of SOILPRO can be seen with just one application

The exceptional results achieved with the use of SOILPRO are reached in one application. The improving results of soil structures can be seen in just a few hours. Apart from the absence of any biological content, SOILPRO are perfectly safe to vegetation and wildlife. With SOILPRO, you are assured of uniform coverage, faster and simpler loading procedures and reduced water and fertilizer demand.

Advantages of SOILPRO as a Peat Soil Binder

The various binding forces in peats soils by SOILPRO will cause it to become closer together without reducing into smaller volume. As peat soils are bound together, the space between pore spaces is reduced, thereby reducing the large space available in the peat soil for root holding. The binding forces will change the loosing of peat soil aggregates into a positive effect on peat soil aggregate structure.

The application of SOILPRO can have a large number of advantages on peat soil quality and crop production as the followings:

- causes soil pore spaces to become smaller
- increases the cation exchange capacity (CEC)

- generates swelling power
- prevents the leaching of fertilizers
- increases the strength of soil aggregate structure of peat soils to prevent trees from falling down
- reduces the acidity of peat soils
- reduces the emission of carbon dioxide and methane
- uses the formulation inorganic materials for lasting performance
- reduces water infiltration rate into peat soils
- decreases the rate of water penetrating into the soil root zone and subsoil
- improves the potential for water holding, excess water runoff, surface soil waterlogging and soil erosion
- increases the ability of peat soils to hold water and nutrients, which are necessary for plant root growth and function
- improves crop emergence as a result of soil crusting
- promotes root growth and opening the volume of peat soils explored by roots
- encourages soil exploration by roots and increases the ability of crops to take up nutrients and water efficiently from peat soils
- increases crop yield potential
- gives beneficial microbes a place to live (bacteria, fungus, protozoa, nematodes, etc.)
- has no offensive odors

During dry season, SOILPRO will keep the peat soils moist and not restrict root growth and penetration into subsoil. This situation can reduce the lead to stunted, drought-stressed plants as a result of restricted water and nutrient uptake, which results in reduced crop yields.

In wetter season, SOILPRO can improve soil aeration and lead to the decreased loss of nitrate nitrogen by denitrification, which is the conversion of plant available nitrate-nitrogen into gaseous nitrogen forms that are lost to the atmosphere. This process occurs when soils are in an anaerobic condition and soil pores are mostly filled with water. Reduced soil aeration can affect root growth and function, and lead to increased risk of crop disease.

All these factors without proper soil amendment can increase crop stress and yield loss.

A Simple Visual Demonstration of SOILPRO in Peat Soil

A Water Retention Test is used to prove the water holding capacity of SOILPRO when mixed with peat soil sample. The samples were prepared and labeled as below:

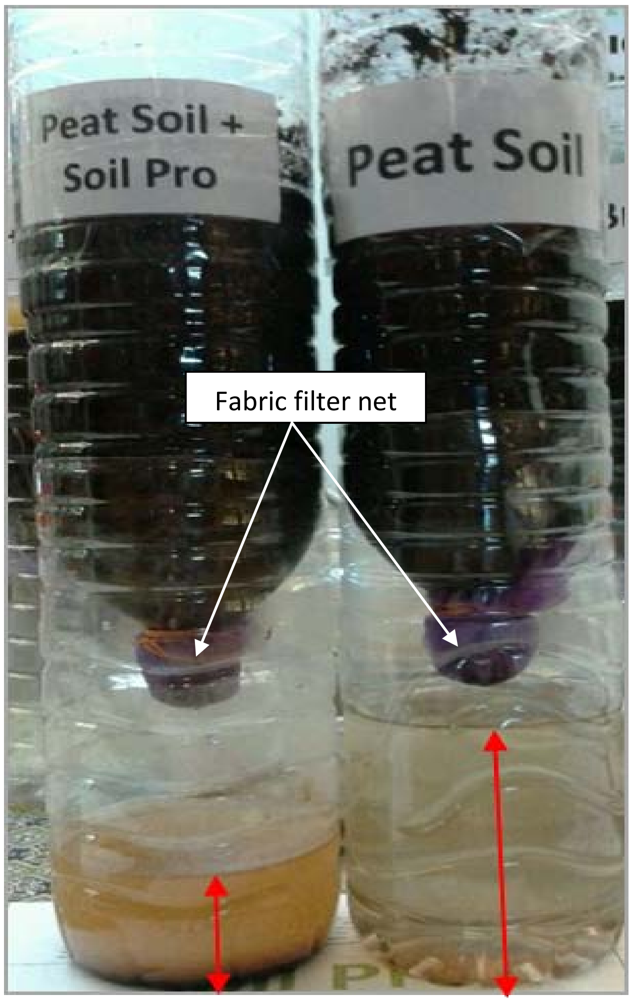
"Peat soil + SOILPRO"

- Mixing ratio of peat soil to SOILPRO = 20:1
- Total weight = weight of peat soil + weight of SOILPRO = 800g + 40g = 840g

“Peat soil”

- 100% of peat soil
- Total weight = 800g

Both test samples were poured with 800g of water simultaneously. The results were observed after 1 minute.



Conclusion:

The **“Peat soil + SOILPRO”** sample retained at least twice the amount of water as compared to that of **“Peat soil”** sample.

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