SHEPROS®

Safety, Heath & Environment Product Solutions

MACROGEL for

Submerged Soil in Paddy Field

SHEPROS AGRICULTURE SDN. BHD.

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Submerged Soils

The chemical and biological aspects of submerged soils are subjects of scientific and ecological interest. Its scientific interest springs from its applications in geochemistry, pedology, agriculture, limnology, oceanography and pollution control. 72% of the earth's land is covered with submerged soil or sediment. The chemical and biological changes in these submerged materials influence the followings:

- the character of the sediment or soil that forms
- the suitability of wet soils for crops
- the distribution of plant species around lakes, streams, estuaries, deltas and marine flood plains
- the capacity of lakes and seas to serve as sinks for terrestrial wastes

Typical Types of Submerged Soils

1. Waterlogged soils

Waterlogged soils are soils that are saturated with water for a sufficiently long time annually to give the soil the distinctive gley horizons resulting from oxidation-reduction processes. Saturation with water may be due to impermeability of the soil material, the presence of an impervious layer, or a high water table.

2. Marsh Soils

Marsh soils may be defined as soils that are more or less permanently saturated or submerged. Freshwater marshes are classified according to their origin into upland, lowland, and transitional. Upland marshes receive mainly rainwater and are therefore poor in bases and have pH values of 3.5-4.5. Lowland marshes are saturated or submerged with water-carrying bases and have pH values of 5.0-6.0.

3. Paddy Soils

Paddy soils are soils that are managed in a special way for the wet cultivation of rice. The management practices include:

- leveling of the land and construction of levees to impound water
- puddling (plowing and harrowing the water-saturated soil)
- maintenance of 5-10 cm of standing water during the 4-5 months the crop is on the land
- draining and drying the fields at harvest
- reflooding after an interval which varies from a few weeks to as long as 8 months

These operations and oxygen secretion by rice roots lead to the development of certain features peculiar to paddy soils.

During the period of submergence, the soil undergoes reduction and turns dark gray. Iron, manganese, silica and phosphate become more soluble and diffuse to the surface and move by diffusion and mass flow to the roots and to the subsoil. The cations displaced from exchange sites particularly by iron migrate out of the reduced zone and are lost. When the soil is drained and dried, the reduced iron is reoxidized and precipitated, leaving H^+ ions as the only major cation. The soil is acidified and the clay disintegrates.

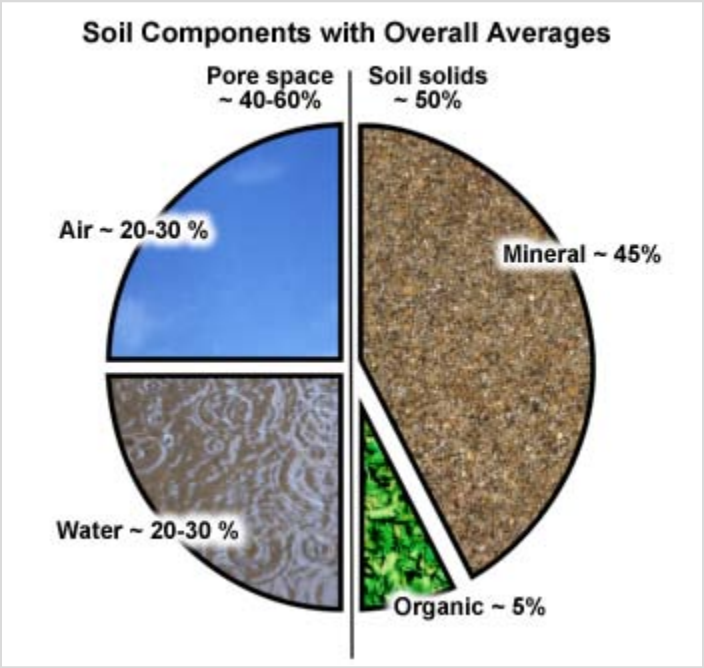
4. Subaqueous Soils

These soils are formed from river, lake, and ocean sediments under continuous water columns.

Effects of Submergence on Soil Properties

Soil is teaming with life and it is the primary medium for growing plants. Most soil is exposed to the air. However, much of the world's population depends on a crop grown in soil submerged by a layer of water. The practice of submerging soil for rice production has been going on for centuries, even millennia.

Soil is composed of mineral particles, organic matter, and pore space, which is the void or empty space between soil particles.



When soils are submerged with water, the soil properties will go through many changes such as below:

- **Change of gas exchange in pore space**

  When soil is submerged, the ratio of the air and water in the pore space will change. It will affect gases like oxygen and carbon dioxide pass through air-filled pore space providing gas exchange that plants and soil organisms need for respiration.

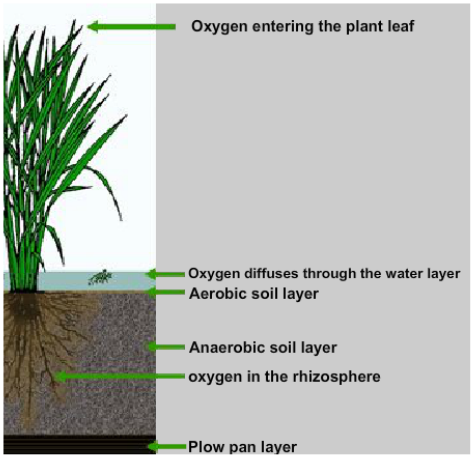
- **Slow diffusion of oxygen through water layer**

  Oxygen in the atmosphere dissolves in the water covering the submerged soil. The dissolved oxygen moves slowly through the water layer. If it reaches the soil surface, it is consumed rapidly by soil substrates and microorganisms. Only a thin layer of soil (typically not more than a millimeter in thickness) is penetrated by oxygen because of slow diffusion through the water and rapid consumption in the soil. This soil layer has aerobic properties and is sometimes referred to as a thin aerobic surface layer.

  The water level covering the soil creates a barrier between the atmosphere and soil. Oxygen from the atmosphere travels through the water layer at a much slower rate than air. The soil below the aerobic layer is without oxygen and can be called anaerobic.

- **Soil depends oxygen from plants**

  Some plants like rice are adapted to submerged soil and have porous structures in the stem and root called aerenchyma tissues. These tissues provide a passage for gas to flow into the plant through the leaves and then down to the roots. Rice roots respire using oxygen supplied through aerenchyma tissue. A small amount of oxygen moves out of the roots and into the surrounding soil called the rhizosphere. As a result, this soil also has properties of aerobic soil.



- **Change in soil biology**

  Soil is home to a vast diversity of organisms. Aerated soil contains tremendous diversity and quantity of organisms and microorganisms. Submergence starts a biological transition. When oxygen in the soil is depleted, aerobic organisms die or become dormant. They are replaced by two types of organisms surviving without oxygen called facultative and obligate anaerobes. The transition from aerobic to anaerobic organisms takes from a few hours to a few days. The majority of facultative and obligate anaerobes are specific types of bacteria. They use chemical compounds and other soil substrates rather than oxygen for respiration Some types of protozoa and nematodes may also be present.

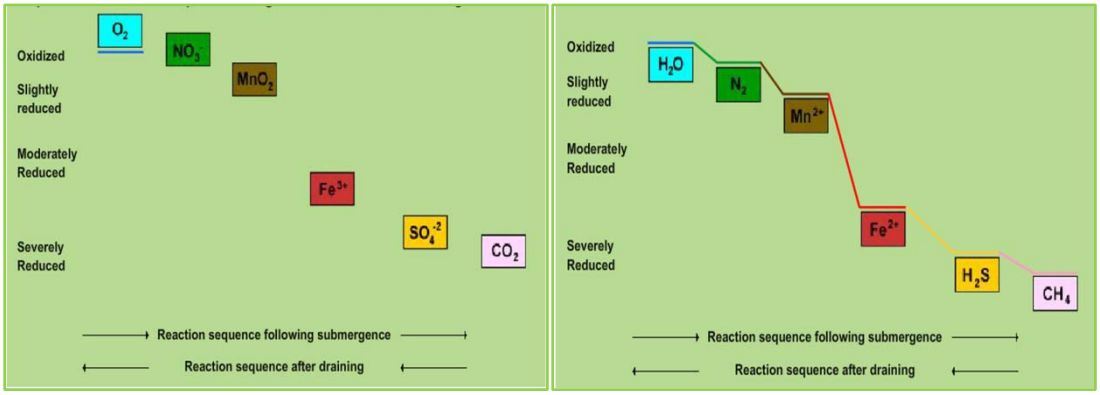
- **Change in soil chemistry**

  When organisms respire, they convert carbon compounds like glucose and fats into usable energy. During respiration, electrons are released by the carbon compounds. If these electrons are absorbed by oxygen molecules, the process is aerobic respiration. When they are absorbed by something other than oxygen, the process is anaerobic respiration. Anaerobic respiration happens where oxygen is lacking or absent such as submerged soils.

  Compounds that gain or lose electrons during respiration become new compounds with new properties. A compound losing an electron(s) during respiration is oxidized while a compound gaining an electron(s) is reduced. Both types of reactions happen simultaneously.

  When soil is submerged, organic matter in the soil is oxidized and soil components such as iron, manganese, and sulfur are reduced. These reactions happen in a predictable sequence. Compounds requiring the least energy for reduction are reduced first. Those requiring more energy will be reduced when reduction of the first compound is mostly complete. The reduction process will stop if there is not enough energy or electron acceptors to continue.

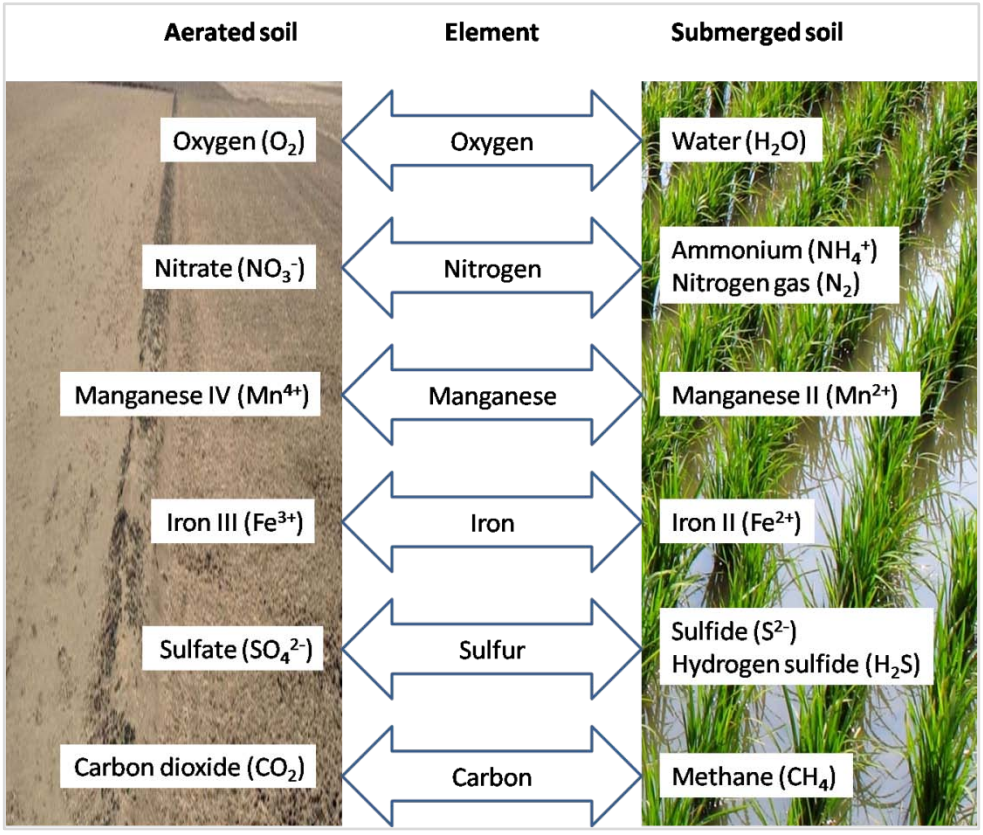
  The compounds appearing in the box below are common to aerated soil. The compounds in the soil change following submergence**.**



The sequence of the compounds from left to right is the order in which they will be reduced starting with oxygen and ending with carbon dioxide. When soil is drained, oxygen begins to penetrate the soil and react with the reduced compounds. The reduced compounds are then oxidized in the reverse sequence starting on the right side and moving left.

- **Other features change with soil chemistry**

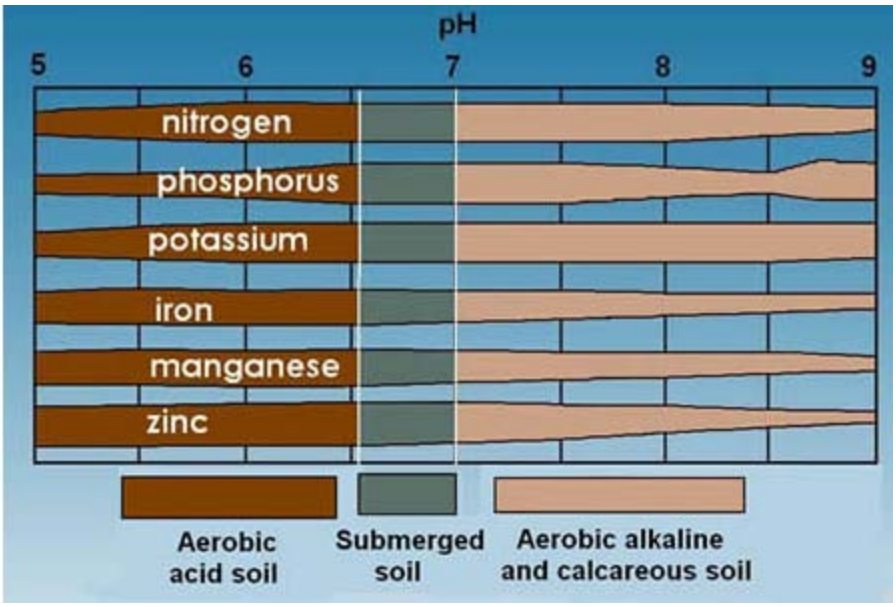
  - Dominant form of elements in aerated versus submerged soil.



  - Changes in chemical forms result in soil color changes. While light colors indicate a well-drained soil, submerged soils are grey or blue-green color.

  - Soil pH is another characteristic that changes because of the changes in soil chemistry. Aerated soils that are acidic or alkaline typically shift towards a more neutral pH after they are submerged.

    In the chart below, the width of each bar represents the availability of the identified nutrient from a pH of 5 to 9. In the pH range typical of many submerged soils (6.5 to 7), these six important crop nutrients are collectively more available then at other pH values.



Some elements can become toxic to plants if they are available in excess amounts. Aluminum and iron are examples of nutrients that become toxic to rice when the pH value becomes too low (acidic).

- **Effects of physical change**

  - Saturation of soil following submergence causes swelling of soil aggregates in formation of a watertight layer. As the aggregate size increases, the pore space decreases.

  - Submergence means the plants have greater access to water. For example, rice is particularly sensitive to water shortage during flowering. Increasing water retention in soil helps reduce the risk of stress due to insufficient supply of water for rice.

  - Soil and water respond differently to changes in air temperature. Submerging the lower portion of rice plants helps reduce low temperature injury in cooler climates. It also keeps soils cooler where high temperature injury may be a problem.

  - An agronomic and economic benefit of submergence is less weed competition. The seeds of many weed species will not germinate or their germination rate will be decreased when they are submerged.

Submerged Soils in Malaysia's Paddy Fields

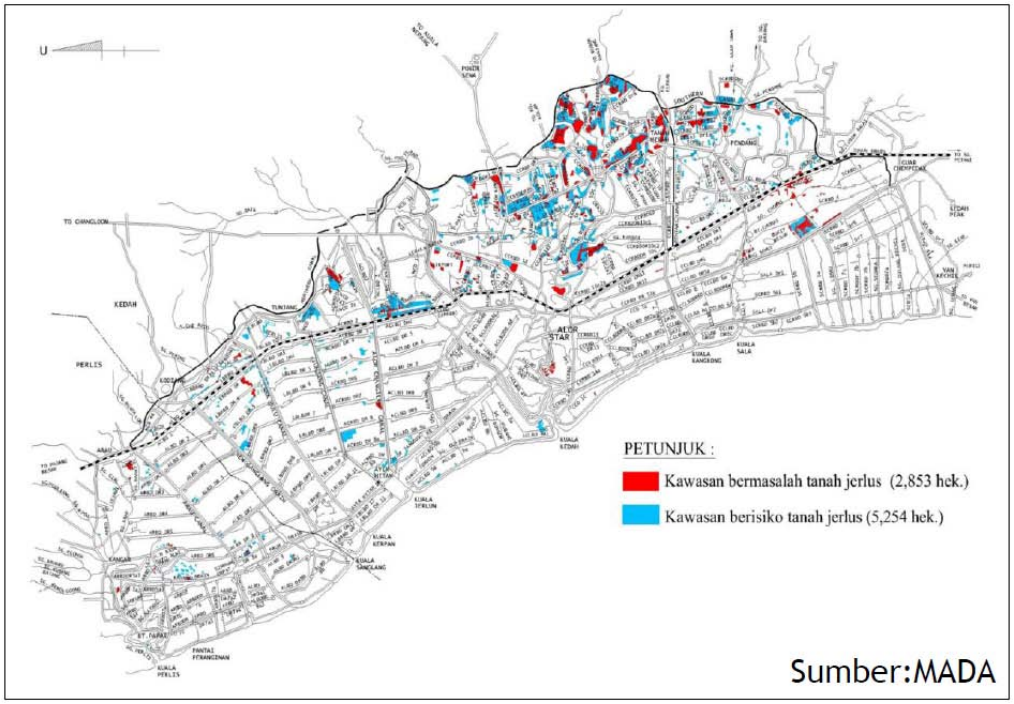
In Malaysia, submerged soil in paddy field of 156 hectares was first discovered in Kampung Kubang Nipah, Lokaliti F-II, Wilayah II, Kedah by Lembaga Kemajuan Pertanian Muda (MADA) in 1999. The areas of submerged soils in paddy fields under MADA are as below:

Year	Area (Hectare)		
	Submerged soil	Potential Submerged soil	Total
2012	860	5270	6230
2013	2853	5254	8107

Territory of MADA	Area (Hectare)		
	Submerged soil	Potential Submerged soil	Total
I – Kangar	131	790	921
II – Jitra	1064	1509	2573
III – Pendang	1434	2541	3975
IV – Kota Sarang Semut	224	414	638

Source: MADA

The distribution map of problematic submerged soils in MADA's territory



The red areas in the map indicate problematic submerged soil areas of 2,853 hectares. The blue areas in the map indicate potential submerged soil areas of 5,254 hectares. Source:MADA

The Causes of Submerged Soils in Paddy Fields

Various factors contribute to the causes of submerged soil in the paddy fields in Malaysia. The main factors are as below:

- Insufficient of drainage canals in which leaves the fields waterlogged.
- Fields waterlogged due to disturbed and obstructed drainage canals.
- While paddy grows in wet conditions, there has to be a layer of hardened soil (what farmers call “hardpan”) about half a meter deep to support the seedlings and farming machinery. When the fields are constantly soaked, the hardpan does not form.
- Change of weather pattern in the northern region of Peninsular Malaysia is unpredictable and the dry season for paddy planting is no longer regular.
- The dry season is short nowadays, rice fields become waterlogged.
- Rice fields that are constantly saturated have a destructive rippling impact in land preparation from seeding and harvesting heavy machineries.
- Farmers do not follow proper planting schedule.
- No proper treatment of submerged soils.

Using tracked heavy machinery to plough rice fields might ease the burden of farmers, but it damages the soil.

Typical Effects and Problems of Submerged Soils in Malaysia's Paddy Fields

The effects and problems of submerged soils in paddy fields are as below:

- Soil is acidified and the clay disintegrates into soft soil.
- Soils change in chemical, biological and physical properties.
- Soil is soft and sinkable.
- It creates sinkholes in paddy fields.
- Soil in paddy fields is saturated with water even after draining.
- It is easily exposed to flooding.
- Soil doesn't have the holding and loading capacity.
- It gives low rice production.
- The distribution of rice growth is uneven.
- Tires of heavy machineries often sink into the soil and badly reduce work efficiency.
- Soil structure loss its tendency to form hardpan.

Submerged soils in paddy fields

Heavy machineries sink in submerged soil

Soil is saturated with water even after draining

Low rice production

Number of Stages in Problematic Submerged Soils

Here is a brief summary of what the stages mean for problematic submerged soils in paddy field.

Stage 1: Initial Stage

- The plowing of the soil cannot be done smoothly.
- The soils easily stick onto machineries.
- The distribution of rice planting is uneven.
- It can withstand a four-tire machinery with a weight of more than 5.5 metric tons or a harvester with a weight of 5 - 7 metric tons.

Soil is soft and sticky.

Distribution of rice growth is uneven.

Stage 2: Middle Stage

- The puddling of the soil cannot be done smoothly.
- The soil easily sticks onto machinery.
- The distribution of rice planting is uneven.
- Rice cannot be planted in soft submerged soil.
- It can withstand a two-tire machinery with a weight of less than 5.5 metric tons.
- The rice cannot be harvested with harvester due to the soft submerged soil.

Rice cannot be planted in soft submerged soil

Harvesters trapped in submerged soil

Stage 3: Severe Stage

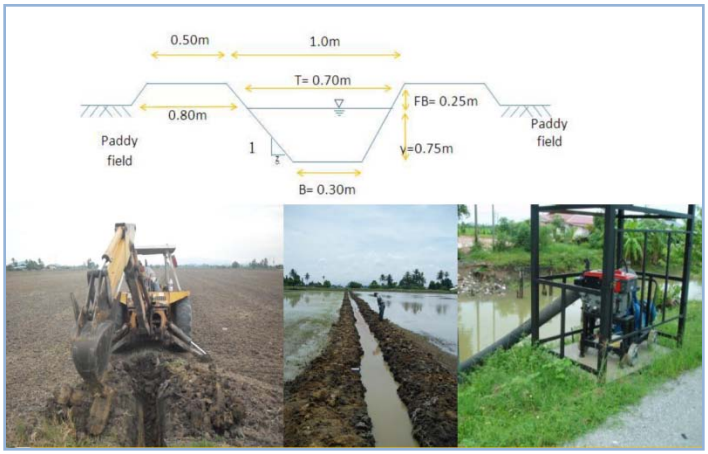
- Soil preparation cannot be done with machinery due to the soft submerged soil.
- All works are done manually.

Paddy fields end up as wasteland

The Current Practice in Solving Submerged Soils in Paddy Fields

Currently, both of the Malaysian Government Agriculture Agencies, namely Institut Penyelidikan Dan Kemajuan Pertanian Malaysia (MARDI) and Lembaga Kemajuan Pertanian Muda (MADA) are proposing the following approaches:

1. **Improvement of the drainage and the road system in the paddy fields**
   - clean and deepen the existing drainage
   - building small sub-drains in paddy fields connecting to main drains
   - building more water gates
   - supply of portable pumps to drain excess water in the paddy fields
   - building a network of roads in the paddy fields



Drainage systems

Disadvantages:

- The cost is too high.
- It is time consuming.
- It depends on of intensive use of the labors and machineries.
- Not all areas in paddy fields are suitable.
- It is not sustainable.

2. Physical treatment of problematic submerged soil

- Replace the problematic submerged soil with suitable soils. Compact it and top up with the original topsoil.

Replacement of submerged soil

Disadvantages:

- Replacement of submerged soil with topsoil from inland areas.
- Logistic problems in rural areas.
- The cost is too high.
- It is time consuming.
- It depends on of intensive use of the labors and machineries.
- Not all areas in paddy fields are suitable.
- It is not sustainable.

3. Alternative treatment materials for soil replacement

- Gypsum
- Charcoal
- Rice husk
- Effective Microorganism (EM) –"Ibu Tanah" brand

Disadvantages:

- Replacement of submerged soil with topsoil from inland areas.
- Replacement of submerged soil with expensive treatment materials.
- Logistic problems in rural areas.
- The cost is too high.
- It is time consuming.
- It depends on of intensive use of the labors and machineries.

- Not all areas in paddy fields are suitable.
- It is not sustainable.

4. Modify or using the right machineries in the submerged soils in the paddy fields

Wooden sticks on four wheel tractor

Floats for two wheel tractor

Flippers for four wheel tractor

Cage wheels for four wheel tractor

Full track type tractor

4-half track type tractor

Disadvantages:

- Additional cost of machinery modification.
- Not all areas in paddy fields are suitable.
- It further damages the submerged soils.
- It is not sustainable.

5. Stop planting paddy for a few seasons

- Drying and draining off excess water in paddy fields.

Disadvantages:

- Paddy fields are left unattended for a few seasons.
- Farmers lose their income.
- Government has to compensate farmers due to loss of income.
- Unattended land will be the breeding ground for diseases and pests.
- Building extra drainage to drain excess water from paddy fields.
- Potential of ending up as wasteland.
- The cost is too high.
- It is time consuming.
- It depends on of intensive use of the labors and machineries.
- Not all areas in paddy fields are suitable.
- It is not sustainable.

Macrogel – The Solution to Submerged Soils

Macrogel is a highly effective soil conditioner for activation of the agrophysical and agrochemical processes in the submerged soils. It contains highly effective nanogel and inorganic minerals that bind and improve the ion exchange in the submerged soils. It activates agrophysical and agrochemical processes in the submerged soil in an environmentally safe manner.

Advantages of Macrogel:

- It significantly increases the holding capability of submerged soils with growing media to retain the plant growth.
- It improves the loading capacity of the submerged soils to sustain heavy machinery particularly in paddy field.
- It is easy to apply and cost effective.
- It improves the efficiency and value of chemical fertilizer up to 50%.
- It stimulates plant growth and extends their life spans.
- It improves the soil fertility and its microbiological activity.
- It reduces soil salinization and migratory mobility of contaminants in the ionic form and their movement to ground water.
- It does not contain pathogenic micro-flora, seeds of weeds, microbes and genetically modified organisms.
- It can be combined with all types of organic and chemical fertilizers.
- It is safe for animals, fish and aqua plants.
- It has a high cation exchange capacity (CEC).
- It improves long term soil quality.
- It increases soil aggregate stability.
- It is resistance to soil erosion.
- It reduces the emission of greenhouse gases.

Lower Costs & Environmental Benefits

The 'nano-size' increased the surface coverage and improved the performance of **Macrogel** in submerged soils. Thus, it will require less application, resulting in lower cost.

Macrogel Toxicity Tests (48 hours direct exposure)

Harmless to frogs

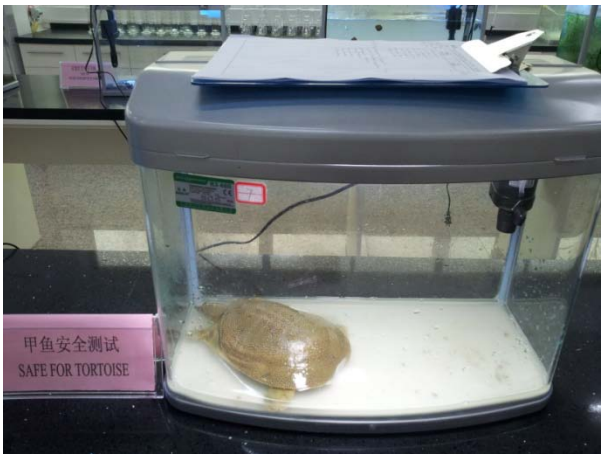
Harmless to earthworms

Harmless to aquarium fish

Harmless to rats

Harmless to tadpoles and aquatic plants

Harmless to hardy aquarium fish



Harmless to tortoise

Harmless to mudfish

How does Macrogel function in Submerged Soils?

Macrogel acts with water and forms a network of nanogel webs to bind with the loose aggregates of the submerged soils.

Macrogel in dry powder form

Macrogel in gel form

Macrogel forms a network of nanogel webs

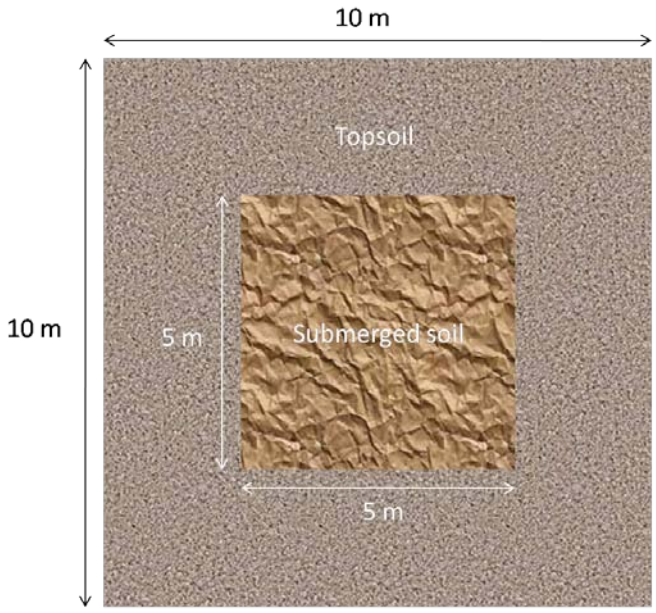
Creation of Macrogel bound hardpan

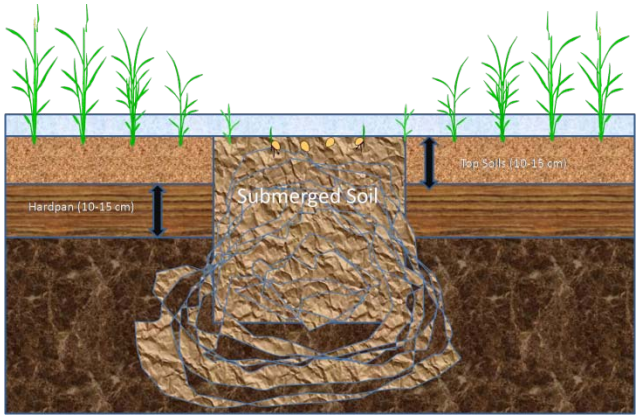
Classification of Submerged Soils

Classification of Submerged Soil	Measuring Index	Condition of Submerged Soil	Note
Class 1	≥ 0.3 MPa	Can withstand four tire machinery with a weight of > 5.5 mt or a harvester with weight of 5-7 mt.	Strong hardpan soil
Class 2	0.2 - 0.29 MPa	Can withstand two tire machinery with a weight of < 5.5 mt.	Potential spoilage of hardpan soil
Class 3	≤ 0.19 MPa	No machinery and only manual work.	No hardpan soil

Application Methods

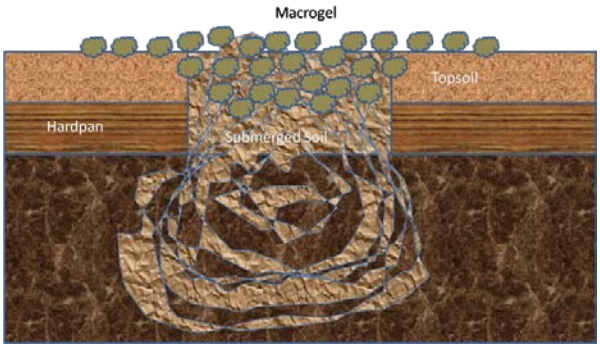
Example: A 5m x 5m area of submerged soil requires an application of 1 kg Macrogel onto surrounding area of 10m x 10m.



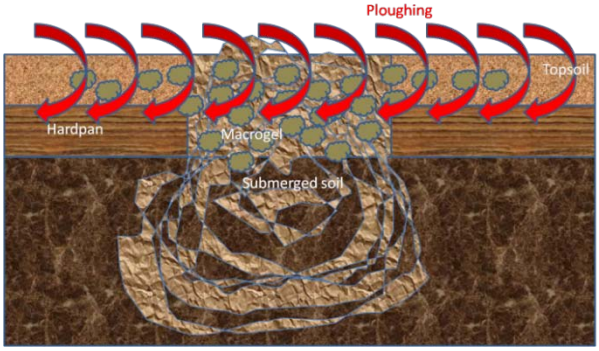


Submerged soil before treatment

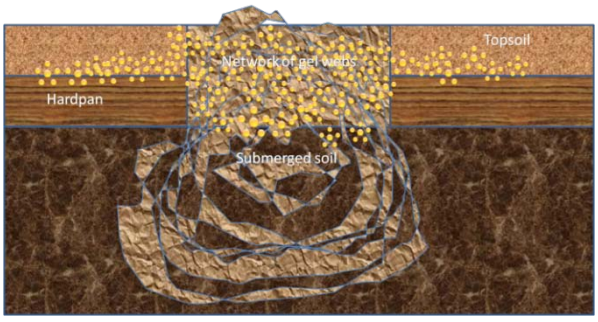
1. Sprinkle Macrogel on submerged soil. (100kg/ha)



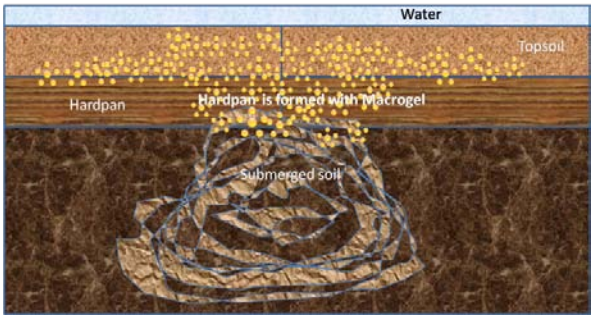
2. Plough Macrogel into submerged soil and its surrounding topsoil with an in-depth of 10 – 15 cm. (rate: 100kg/ha)

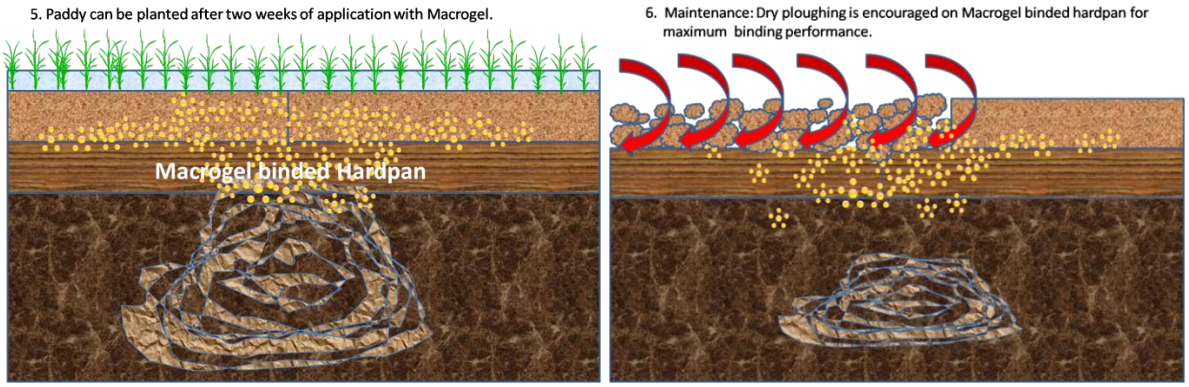


3. Macrogel will reacts with water and forms a network of gel webs to bind with the loose aggregates of the submerged soils.



4. A new hardpan is formed through the network of gel webs on top of the submerged soil. The new hardpan can't be easily destroyed by water.





Application of Macrogel on initial and middle stages of problematic "Class 2" submerged soils:

- Carry out the first plow following normal practice.
- Apply 1 kg Macrogel per $10m^2$ onto the problematic submerged soil after the first plow.
- Follow with the current farming practices of second plow and third plow.

Application of Macrogel on Severe Stage of Problematic "Class 3" Submerged Soils:

- Slash and burn all the old paddy straws.
- Apply 1 kg Macrogel per $10m^2$ onto the problematic submerged soil.
- Plow the area 1-2 weeks after the Macrogel application (Macrogel will settle down and will allow small machinery to carry out plowing activities).
- Follow with the current farming practices of second plow and third plow.

Application of Macrogel onto the problematic submerged soils

Hardpan soil maintenance after Macrogel application:

- Expose plowed soil to sunlight for drying.
- Proper draining to make sure the paddy field is dried in between paddy planting seasons.

Macrogel Field Tests and Testimonials

There had been numerous trials on submerged soils in MADA's territory since 2013. The trials are meant to recover the damaged hardpan paddy field into a usable and functional paddy field which has the loading capacity to withstand the weight of heavy machineries.

1. Wilayah 1, Pulai Lincau, Arau

Farmer's Name:	Abdul Ramli bin Abu Seman
Phone No.:	012 478 0884
Area:	1 Ha
Condition:	More than 50% of Class 3 Submerged soil
Macrogel Application:	100 kg/Ha
Date of Application:	23rd Sep 2013
Officer-in-charge:	Puan Shakina and Encik Mustafar (MADA's Officers)
Cooperators:	En. Mohammad Zuhdi bin Yusof (Penolong Pegawai Pertanian), En. Mohd Husni bin Ibrahim (Pembantu Pertanian)

Farmer's comments: Stopped planting paddy for 2 seasons to dry the land. The next 2 seasons, planting and harvesting were done manually. After one treatment with Macrogel, this season the planting and harvesting can be done with machineries.

The trial was monitored by Puan Shakina, the Head of Agronomist of MADA (HP: +6019 5598593).

Before *After*

Havesting with machinery after one season of treatment with Macrogel

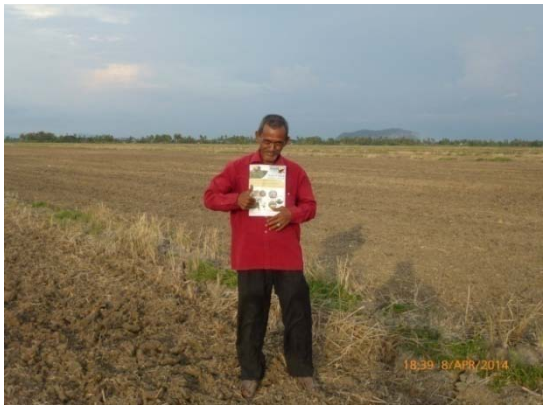
2. Wilayah 2, Kampung Nipah, Jerlun

Famer's Name:	Saad Zakaria
Phone No:	019 463 4015
Area:	2 Ha
Condition:	More than 50% of Class 3 Submerged soil
Macrogel Application:	200 kg/Ha
Date of Application:	8th Oct 2013
Officer-in-Charge:	En. Zuhdi , En. Hassan , En. Husni (MADA) and Jabatan Pertanian Teluk Chengai soil division monitoring soil compaction.
Cooperators:	En. Mohammad Zuhdi bin Yusof (Penolong Pegawai Pertanian) and En. Mohd Husni bin Ibrahim (Pembantu Pertanian)

Farmer's comments: Have been harvesting manually for 2 seasons. After application of Macrogel, paddy can be harvested with harvester.

Before

Department of Agriculture data collection



After

3. Wilayah 3 , Kampung Bukit Seni, Kobah

Trial Plot 1:

Farmer's Name:	Abdul Azmi Hashim
I.C.No:	620609025257
Phone No:	0194975248
Area:	5.5 relung
Condition:	More than 50% of Class 3 Submerged soil
Macrogel Application:	300 kg
Date of Application:	24th Nov 2013
Officer-in-Charge:	Encik Zuhdi, Encik Husni and Encik Fidaus (MADA) and Jabatan Pertanian Teluk Chengai Soil Division monitoring soil compaction.
Cooperators:	En. Mohammad Zuhdi bin Yusof (Penolong pegawai pertanian), En. Mohd Husni bin and Ibrahim (Pembantu Pertanian).

Farmer's comments: For 2 seasons, he could not fully work on the land. Now he is happy that he can use machineries on his paddy field.

Before

After

Trial Plot 2:

Farmer's Name:	Badri
Phone No:	019 5442848
Area:	2 relung
Condition:	More than 50% of Class 3 Submerged soil
Macrogel Application:	50 kg
Date of Application:	21st Jan 2014
Officer-in-Charge:	Encik Zuhdi and Encik Husni (MADA's officers)
Cooperators:	En. Mohammad Zuhdi bin Yusof (Penolong Pegawai Pertanian) and En. Mohd Husni bin Ibrahim (Pembantu Pertanian).

Farmer's comments: The paddy field has been abandoned for 2 years due to its unworkable condition. After treatment of Macrogel, the tractor can be used in the paddy field.


Before


After

4. Kampung Alor Gunung, Alor Star, Kedah

Farmer's Name:	Jabib Bin Hamid
I.C. No.:	550215025317
Phone No:	012 4892904
Area:	1 Ha
Condition:	More than 50% of Class 3 Submerged soil
Macrogel Application:	100 kg/Ha
Date of Application:	24th Aug 2013
Officer-in-Charge :	Encik Nasri, SPPK Kepala Batas (NKEA division)
Cooperators:	En. Mohammad Zuhdi bin Yusof (Penolong Pegawai Pertanian) and En. Mohd Husni bin Ibrahim (Pembantu Pertanian).

Farmer's comments: For two seasons, the paddy was planted with full track tractors and harvested manually. After the application of Macrogel, the half track tractor can be used to plow the area and harvesting was done with the harvester.

Before application of Macrogel

After application of Macrogel

After harvesting

5. FELCRA Seberang Perak

Officer's Name: Encik Zainal (Seed Center)
Phone No: 019 6684996
Area: 1 Ha
Macrogel Application: 100 kg/Ha
Date of Application: 3rd Sept 2013

Officer's comments: After treatment with Macrogel, the transplanter machine can work without being caught in soft soil.

Application of the Macrogel *After treatment*

6. Tokai, Sarang Semut

Farmer's Name: Chan Boon Hua
Phone No: 017 496 3810

Farmer's comments: After treatment with Macrogel, soil becomes compact and easier to work with.

7. Sungai Petani

Farmer's Name: Khoo Hock Guan
Phone No: 012 529 3512
Condition: More than 50% of Class 3 Submerged soil

Farmer's comments: Machineries couldn't go in the paddy field for seasons before treatment with Macrogel.

List of Agriculture Agencies and Officers involved in the Trials of Macrogel Hardpan Rehabilitation

Muda Agricultural Development Authority (MADA)
Lembaga Kemajuan Pertanian Muda (MADA),
Ibu Pejabat MADA, Jalan Ampang Jajar,
05990 Alor Star, Kedah Darul Aman.
Tel : 04 7728255

- Tuan Haji Kamaruddin bin Dahuli
  Pengarah Bahagian Industri Padi

- Puan Sakinah binti Ahmad Tarmizi (HP : 019 5598593)
  Ketua Seksyen Kesuburan Tanah dan Tanaman

- Encik Mohammad Zuhdi bin Yusof
  Penolong Pegawai Pertanian

- Mohd Husni bin Ibrahim
  Pembantu Pertanian

Institut Penyelidikan Dan Kemajuan Pertanian Malaysia (MARDI)
Pusat Penyelidikan Mekanisasi & Automasi,
MARDI Seberang Perai,
Peti Surat 203,
13200 Kepala Batas, Pulau Pinang.
Tel : 04 575 1195

- Tuan Hj Ayob bin Abdul Hamid (HP : 012 4570493)
  Timbalan Pengarah Program Mekanisasi Pengeluaran Padi

- Dr. Chan Chee Sheng (HP : 012 4891171)
  Pegawai Penyelidik Mekanisasi & Automasi

Jabatan Pertanian Negeri Kedah Darul Aman
Unit Pengurusan Tanah dan Pemuliharaan Sumber Tanah,
Teluk Cengai, 06600 Alor Star, Kedah Darul Aman.
Tel : 04 7775000

- Mohd Hatta bin Harun (HP : 019 4092491)
  Pegawai Pertanian G 41, Unit Pengurusan Tanah dan Pemuliharaan Sumber Tanah.

Submerged Soil Testing Guidelines:

Classification of Submerged Soil	Measuring Index	Condition of Submerged Soil	Note
Class 1	≥ 0.3 MPa	Can withstand a four tire machinery with a weight of > 5.5 mt or a harvester with a weight of 5 - 7 mt.	Strong hardpan soil
Class 2	0.2 - 0.29 MPa	Can withstand a two tire machinery with a weight of < 5.5 mt.	Potential spoilage of hardpan soil
Class 3	≤ 0.19 MPa	No machinery and only manual work	No hardpan soil

TRIAL PLOT 1

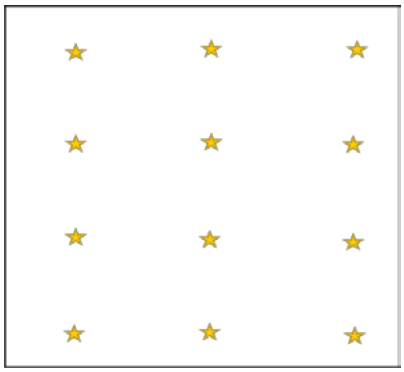
PPK: F-II Jerlun, Kubang Nipah
Season: Season 1 2013/2014
Farmer Name: Mohd Hadrin Faizal Marzuki
Location: Kubang Nipah
Assessment 1 (Before): 6th Oct 2013
Assessment 2 (After): 9th Jul 2104
Assessment Point: 12 points
Area Treated: 1.0 Ha

Methodology:

100 kg/Ha of Macrogel was manually applied 1 week before the first plow in the submerged area. Land preparation started one week after treatment as of the current farming practice.

Plotting:

Plotting in 3 rows with 4 points per row was measured before and after the Macrogel treatment (Before and after paddy planting).



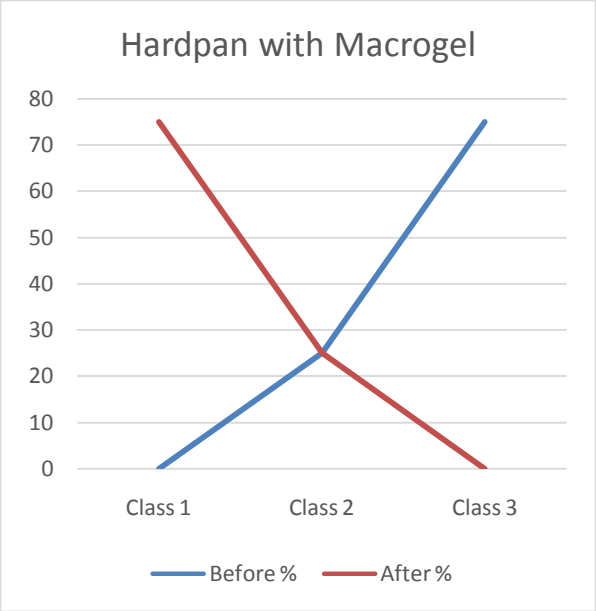
Results:

The assessment was carried out with a "Penetrometer" by the Department of Agriculture before and after planting season in the area that was treated with Macrogel at the rate of 1 kg per $10m^2$.

Point Number	Classification of Submerged Soil (Before)	Classification of Submerged Soil (After)
1	2	1
2	3	2
3	3	1
4	2	1
5	3	2
6	3	1
7	3	1
8	3	1
9	2	1
10	3	1
11	2	1
12	3	2

Classification of Submerged Soil	Before		After	
	No. of Point	% of Class	No. of Point	% of Class
Class 1	0	0	9	75
Class 2	3	25	3	25
Class 3	9	75	0	0
Total	12		12	

Classification of Submerged Soil	% of Classification (Before)	% of Classification (After)
Class 1	0	75
Class 2	25	25
Class 3	75	0



Before treatment

After treatment

Conclusion:

After treatment with Macrogel, 25% of Class 2 and 75% of Class 3 submerged soils improved to 75% Class 1 and 25% Class 2 submerged soil. A total of 75% of the paddy field has hardpan soil.

TRIAL PLOT 2

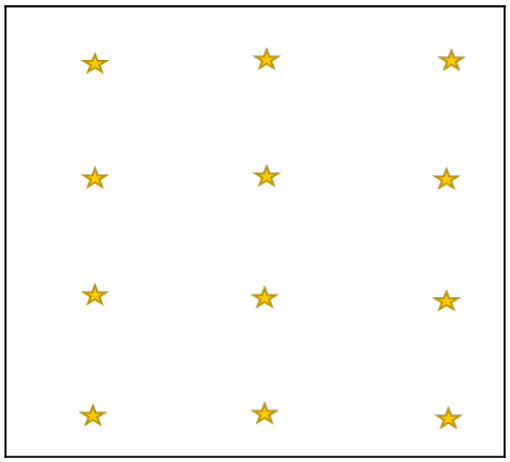
PPK: C IV Kangkong, Wilayah 4
Season: Season 1 2013/2014
Farmer's Name: Mohd Asri Mustapa
Location: Banggol Wan Awang
Lot: 1318
Assessment 1 (Before): 7th Oct 2013
Assessment 2 (After): 9th Jul 2014
Assessment Point: 12 points
Area Treated: 1Ha

Methodology:

100 kg/Ha of Macrogel was manually applied 1 week before the first plow in the submerged area. Land preparation started one week after treatment as the current farming practice.

Plotting:

Plotting in 3 rows with 4 points per row was measured before and after the Macrogel treatment (Before and after paddy planting).



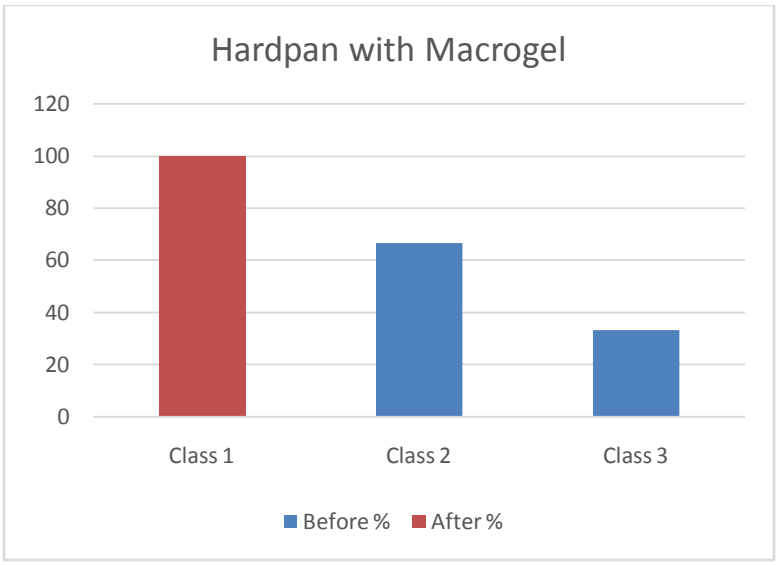
Results:

The assessment was carried out with a "Penetrometer" by the Department of Agriculture before and after planting season in the area that was treated with Macrogel at the rate of 1 kg per $10m^2$.

Point Number	Classification of Submerged Soil (Before)	Classification of Submerged Soil (After)
1	3	1
2	2	1
3	2	1
4	2	1
5	2	1
6	2	1
7	3	1
8	2	1
9	2	1
10	3	1
11	2	1
12	3	1

Classification of Submerged Soil	Before		After	
	No. of Point	% of Class	No. of Point	% of Class
Class 1	0	0	12	100
Class 2	8	66.7	0	0
Class 3	4	33.3	0	0
Total	12		12	

Classification of Submerged Soil	% of Classification (Before)	% of Classification (After)
Class 1	0	100
Class 2	66.7	0
Class 3	33.3	0



Before *After*

Department of Agriculture data collection

TRIAL PLOT 3

Wilayah 2, Alor Mardi, Kepala Batas

Methodology:

1. Two 'relong Kedah' area are selected for trials. One 'relong' is used for treatment with Macrogel and the other 'relong' is used as a control area.
2. Each area consisted of 4 plots of $3m^2$.
3. Estimated Macrogel application on the plotted paddy field is $100g/m^2$ after the first plow, and followed by current farming practices.
4. The assessments of the depth of the submerged soils are randomly measured on each plot with 3 points known as R1, R2 and R3. Data will be collected based on pre-treatment (land preparation) and after harvest.
5. Trials are done in the end of the year which is usually rainy season and submerged soil is in serious condition.

** "Relong" is the definition of an area of a plot by local farmers in Kedah.*

Assessment Data:

Pre Treatment Assessment: 20th Nov 2012

Macrogel Treated Area

Before Planting		Depth (m)			
No	Treatment	R1	R2	R3	AVE
1	PLOT 1	0.55	0.76	0.57	0.63
2	PLOT 2	1.20	1.26	1.15	1.20
3	PLOT 3	0.46	0.48	0.39	0.44
4	PLOT 4	0.54	0.45	0.58	0.52

Untreated Area

Before Planting/Treatment		Depth (m)			
No	Treatment	R1	R2	R3	AVE
1	PLOT UT1	0.55	0.58	0.60	0.58
2	PLOT UT2	1.00	1.12	1.23	1.12
3	PLOT UT3	0.46	0.49	0.46	0.47
4	PLOT UT4	0.44	0.45	0.48	0.46

After Harvesting Assessment: 23rd June 2013

Macrogel Treated Area

After Planting		Depth (m)			
No	Treatment	R1	R2	R3	AVE
1	PLOT 1	0.15	0.17	0.13	0.15
2	PLOT 2	0.22	0.32	0.24	0.26
3	PLOT 3	0.12	0.10	0.12	0.11
4	PLOT 4	0.13	0.14	0.13	0.13

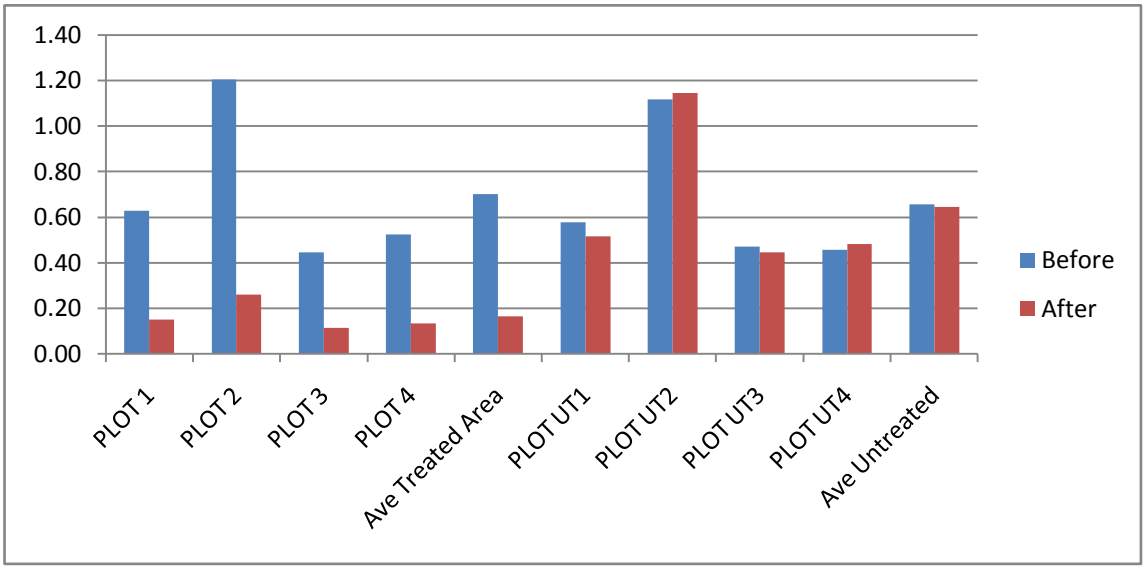
Untreated Area

After Planting/Treatment		Depth (m)			
No	Treatment	R1	R2	R3	AVE
1	PLOT UT1	0.43	0.57	0.54	0.51
2	PLOT UT2	1.24	1.05	1.14	1.14
3	PLOT UT3	0.42	0.45	0.46	0.44
4	PLOT UT4	0.52	0.49	0.43	0.48

Results:

Based on the summary below, area treated with Macrogel shown significant improvement. Almost all of the treated problematic submerged soils recovered as hardpan soil.

Before Planting		Depth AVE (m)	
No	Treatment	Before	After
1	PLOT 1	0.63	0.15
2	PLOT 2	1.20	0.26
3	PLOT 3	0.44	0.11
4	PLOT 4	0.52	0.13
	Ave Treated Area	0.70	0.16
5	PLOT UT1	0.58	0.51
6	PLOT UT2	1.12	1.14
7	PLOT UT3	0.47	0.44
8	PLOT UT4	0.46	0.48
	Ave Untreated	0.66	0.65



Treated areas with Macrogel showed significance improvement (left); and Untreated areas still facing the same submerged soil problem (right)

Photos shown below are the actual condition of submerged soils before and after the treatment with Macrogel.

Before Treatment. (20th Nov 2012)

After treatment, there are significant improvements with hardpan buildup. (23rd June 2013)

Hardpan recovered after treated with Macrogel

Conclusion:

Based on the above results, Macrogel can turn problematic submerged soils into hardpan soil even in extreme conditions such as the monsoon season. The problematic submerged soil with an average depth of 0.7m before treatment improved to 0.16m after the treatment with Macrogel. There is no improvement with the untreated control area.

Potential Market Size of Macrogel

No.	Area	Total Area (Ha)	Percentage of estimated area with problematic submerged soil (%)	Estimated area with problematic submerged soil (Ha)	Potential Market of Macrogel per Season	
					Quantity (kg)	Value (RM)
1.	MADA	84,000	9.7	8,148	814,800	20,370,000.00
2.	IADA Penang	3,000	10.0	300	30,000	750,000.00
3.	IADA Perak	36,000	10.0	3,600	360,000	9,000,000.00
4.	Other Areas	326,000	5.0	16,300	1,630,000	40,750,000.00
	Total	**449,000**		**28,348**	**2,834,800**	**70,870,000.00**

Usage of Macrogel: 100 kg/ha.
Price of Macrogel: RM 25.00/kg.
Other Areas: KADA, KETARA, IADA Kemasin Semerak and IADA Pekan Rompin.
IADA = Intergated Agricultural Developmet Area.

Price Competitiveness

Macrogel Solution vs. Current Practice (Replacement of problematic submerged soil)

Application	Cost / 10 m^2 (RM)	Cost/Hectare (RM/Ha)
Macrogel Solution	2.50	2,500.00
Current Practice (Replacement of problematic submerged soil)	300.00	300,000.00

Macrogel Solution:
1 Hectare (Ha) = 10,000 m^2
Usage of Macrogel: 100 kg/ha.
Price of Macrogel: RM 25.00/kg.

Current Practice (Replacement of problematic submerged soil for 10 m^2):

a. Back hoe: RM200.00
b. Top Soils: RM 50.00
c. Labor: RM 50.00
Total: RM300.00

Saving Ratio of Macrogel Solution vs Current Practice = 2.50:300.00 = **1:120**

Macrogel Cost vs. Loss of Paddy Yield due to Problematic Submerged Soil per Season

Macrogel application/hectare : RM2,500.00/Ha

Average paddy yield/hectare (mt/Ha) : 6.0 mt/Ha
Paddy price (RM/mt) : RM 1,100.00/mt
Loss of paddy yield (RM/Ha) : RM 6,600.00/Ha

Saving Ratio of Macrogel Solution vs. Loss of Paddy Yield =2,500.00:6,600.00 =**1:2.64**

Therefore, the saving from Macrogel Solution vs. Loss of Paddy Yield = RM 4,100.00/Ha

Based on the estimated problematic submerged soil of 28,348 Ha;
Total savings = 28,348 Ha x RM 4,100.00/Ha = **RM 116,226,800.00**