SOUL OF THE THAI PEOPLE:

THE GREAT PHILOSOPHER IN SOIL

HIS MAJESTY THE LATE KING BHUMIBOL ADULYADEJ

His Majesty will Live in our Hearts Eternally
Prostrate at His Footstep in
Forever Gratefulness for His Majesty the late King

RL 0005.2/5806

Bureau of the Royal Household
Grand Palace, BKK 10200

21 September 2017

Subject: Requesting Royal Permission.

To: The Permanent Secretary of the Ministry of Agriculture and Cooperatives.

Reference: Official letter of the Ministry of Agriculture and Cooperatives KS 0822/6082 on 19 September 2017

With reference to official letter of the Ministry of Agriculture and Cooperatives KS 0822/6082 on 19 September 2017, the Land Development Department is requesting to include copies of selected photographs of royal activities, royal teachings and royal speeches, and the presented awards to His Majesty the late King Bhumibol Adulyadej, as well as the postcard given at the royal cremation ceremony in the book entitled "Soul of the Thai People: The Great Philosopher in Soils, His Majesty the late King Bhumibol Adulyadej". The total amount of this book to be printed is 11,000, which will be distributed to the Thai people.

The Department of Private Secretary recognizes the loyalty of the Land Development Department, Ministry of Agriculture and Cooperatives and believe that such activity is for remembrance of His Majesty the late King Bhumibol Adulyadej.

Please be informed accordingly.

Sincerely Yours

(Mr.Krit Garnjana-Goonchorn)

Director General, Department

of the Private Secretary

Department of the Private Secretary

Forward

This book entitled “Soul of the Thai People: The Great Philosopher in Soils, His Majesty the late King Bhumibol Adulyadej” is published by the Land Development Department, Ministry of Agriculture and Cooperatives for the remembrance of His Majesty the late King who had done great work on soil resources management especially in alleviating the problem soils. His royal initiatives on such subjects have been implemented in many areas including the implementation of the “Klaeng Din” project as conducted in the swampy area of Pikun Thong Royal Development Study Centre, Narathiwat Province; the vetiver growing project for soil erosion control; and the project of planting the forest without growing any trees on the lateritic soil or gravelly soil at Khao Cha-ngum Land Rehabilitation Project as well as the Royal Initiatives regarding the improvement of the sandy soils for agricultural uses and for reforestation at the Khao Hin Sorn Royal Development Study Centre, Chachoengsao Province. All of the aforesaid projects have led to the rehabilitation of degraded land to restore soil fertility. As a result, the land can yield sustainable productivity, and at the same time, the soil resources of the country can be conserved and the environmental balance can be restored.

We are forever grateful for His Majesty the late King for recommending the Royal Initiatives aiming at properly managing the soil resources of the country. The Land Development Department is very honored to work in accordance with His Royal Initiatives and vow to follow on his footsteps eternally.

We, the land developers, are forever grateful for His Majesty the late King Bhumibol Adulyadej.

Mr.Suradesh Tiewtrakool
Director General
Land Development Department

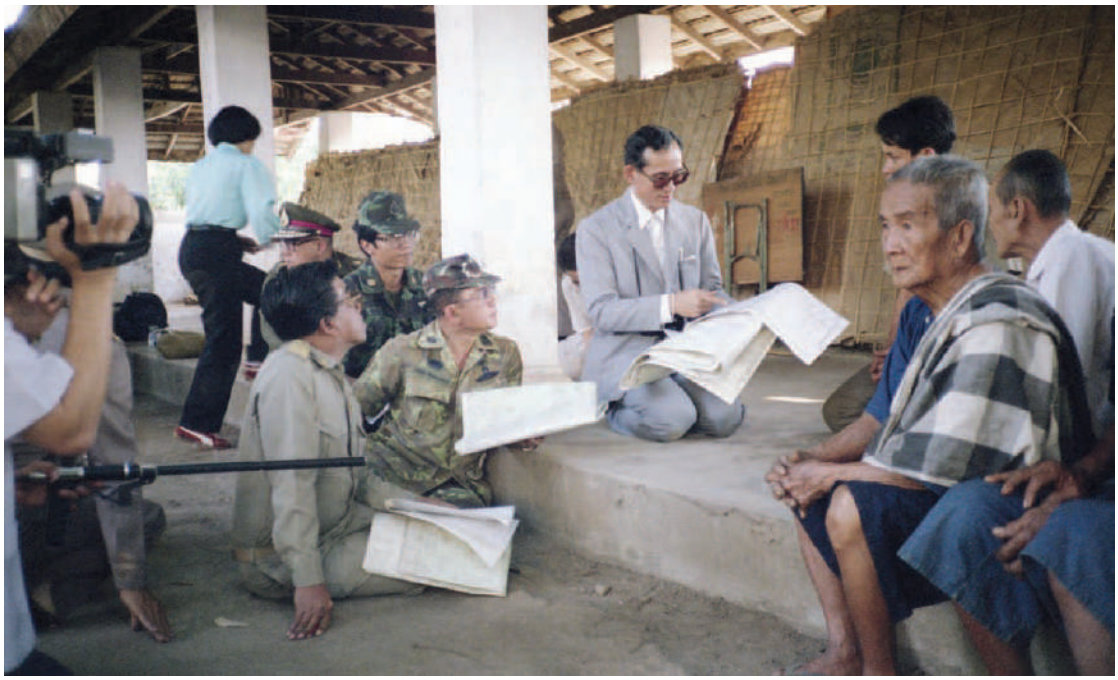
Contents

Chapter 1
Introduction

Chapter 1
Introduction

With the goal to alleviate the hardships and to ensure better quality of life for His subjects, His Majesty the late King Bhumibol Adulyadej had worked tirelessly for 70 years since his succession to the throne. His Majesty the late King had initiated up to 4,687 development projects throughout Thailand promoting sustainable development and ecological conservation at the same time. His Majesty the late King Bhumibol Adulyadej's kindness and great effort in His endeavor to develop the nation, until this day, inspired the whole nation to follow in His footsteps.

One of the essential factors related to the physical development to which His Majesty paid most attention was the soil which is considered an integral fundamental element of development projects. This is because the soil plays an important role in agricultural production as well as in a quest to conserve the natural balance. Moreover, misuse or mismanagement of soil can lead to deterioration of the environment.



Based on the most recent data as investigated by the Land Development Department, Ministry of Agriculture and Cooperatives, no less than 150 million rai (1 ha equals to 6.25 rai) of the land in the nation have been used to exclusively cultivate various crops during the past two decades. Although the production of economic crops, namely paddy rice, maize, sugarcane and cassava, seem to be high enough not only for domestic consumption but also for exporting to other countries, the average national yield per rai is relatively low and lower when compared to those

of some other producing countries such as China, Australia, Malaysia, Korea and Japan. At the same time, the majority of Thai soil resources, to date, have deteriorated to certain extent and are in need of appropriate remediation. The common problems found are acid sulfate soil, low fertility soil, low organic matter content in soil, soil compaction, occurrence of hardpan in soil and soil prone to erosion.

His Majesty the late King Bhumibol Adulyadej were well aware of and observed the afore-mentioned problems during 50 years of His Royal visits to various parts of the country. His Majesty the late King had also realized that one of the key factors that reduced crop production from year to year was the deterioration of the soil itself. This led to his keen interest and as a result, various projects initiated to solve the problems of soil and to increase soil productivity. His Royal initiatives in various forms of soil management are exemplars of projects that offer both educational value and historical value, and should be implemented in order to ensure high soil fertility which can then serve as the key resource for sustainable agriculture for the nation.

Chapter 2
To be as Humble as the Soil


NO TURN ON RED
P ARKING
King Bhumibol Adulyadej of Thailand Square


MOUNT AUBURN HOSPITAL
300 & 330 Mount Auburn Street
Main Entrance
West Garage
Needhar
Medical
ENTER
HERE

Chapter 2

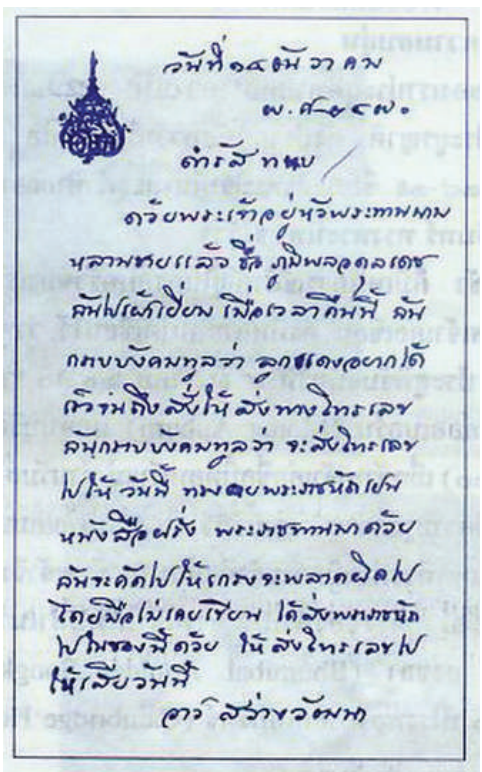
To be as Humble as the Soil

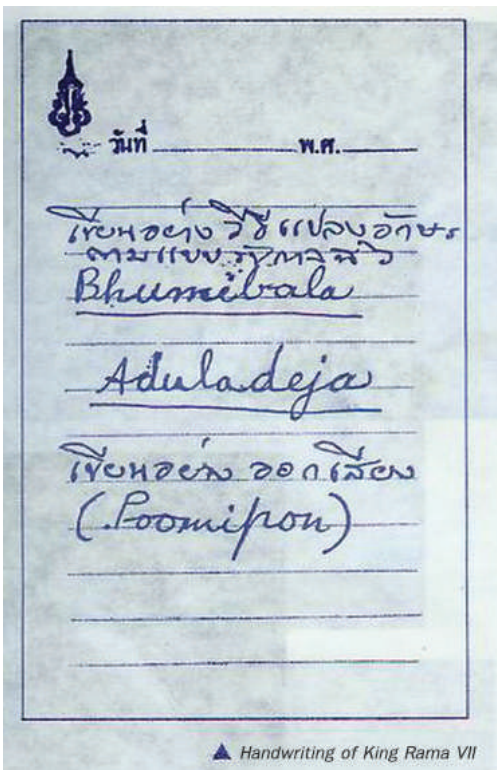
08:45 hr. of Monday the 5th of December 1927 at Mount Auburn Hospital, Massachusetts in the United State of America, an auspicious time for Thailand even though the nation was facing an economic hardship.

During that period, His Majesty King Prajadhipok (King Rama VII) was faced with an economic crisis in the country and was tasked with initiating policies that had to sustain economic stability during the time of great economic depression after the World War I. Thai people in those days were in search of some hope for the nation. Furthermore, the conflicts among various groups of Thai people had worsened the political situation. His Majesty King Prajadhipok had to find the way to stabilize the weak economy and to ensure political stability. However, His Majesty's approach did not satisfy the needs of a group of intellectuals who in turn, in the year of 1932, established a political group under the name "Kanaraj" which eventually transformed the nation's regime.

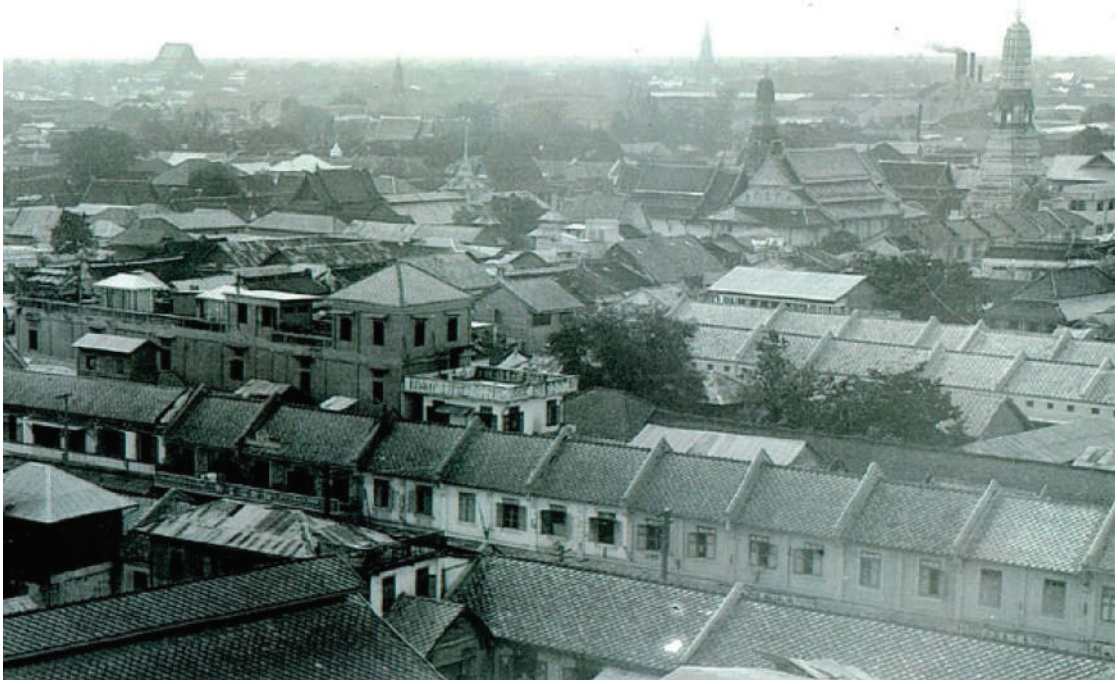
During that time, Princess Srinagarindra sent a telegram to Queen Sri Savarindira to inform Her Majesty of the birth of the youngest son of His Royal Highness Prince Mahidol of Songkhla. Informed of the news by Queen Sri Savarindira, His Majesty King Prajadhipok bestowed upon the newborn the name “Bhumibol Adulyadej”. Princess Galyani Vadhana, told the story of the naming of her youngest brother in a book entitled “The Small King” explaining that Queen Sri Savarindira wrote on 14 December 1927 that “Your son’s name is Bhumibala Aduladeja” and included His Majesty King Prajadhipok’s handwriting in her reply.

The word “Bhumibol Adulyadej” means “Strength of the Land, Incomparable and Unparalleled Power” In addition, as recorded by Princess Galyani Vadhana in the book entitled “The Small King”, Her Royal Highness said that the Princess Mother said to His Majesty King Bhumibol Adulyadej, “In fact, your name Bhumibol means the Strength of the Land as I want you to be on the ground of soil.” His Majesty the late King Bhumibol Adulyadej later explained that what his Queen Mother meant was that she wished for His Majesty the late King to be humble and work for His Thai subjects. From then onwards, the future of Thailand had been in His Majesty’s Royal hands since that day.





▲ Handwriting of King Rama VII



The Arosa Mountain Range, Grisona State, Switzerland

Chapter 3

The Light that Sparked His Majesty the late King's Interest in the Field of Soil and Environment

Chapter 3

The Light that Sparked His Majesty the late King's Interest in the Field of Soil and Environment

His Majesty the late King Bhumibol Adulyadej's interest in the field of soil and envinonment started naturally when he was young. Since his childhood, he realized the importance of the natural balance and the interaction among the forests, water, soil and organisms. An excerpt from His Majesty's Royal speech granted to the International Lion Society on 25 September 1969 at Chitralada Villa, Dusit Palace can demonstrate His Majesty's keen interest.

"...Someone may question why I have become interested in irrigation or forestry. As I can recall, at the age of 10, at the school there was a teacher who now has already passed away. He taught about natural science and soil conservation and stressed the importance of having forests covering the mountain areas. Without this, when it rained, runoff water would carry soil down the slope. The soil would be damaged and could be lost from the mountain surfaces. This is the basic principle of forestry, soil conservation and irrigation. If we do not take care of the forest on the mountains, damage would occur from the mountains and would then affect the reservoir due to sedimentation, and the rivers would be filled with the sediment causing flooding. All that was just said was taught when I was 10 years old..."

Professor Dr. Santhad Rojanasoonthon (a Royal Scholar) said that the first spark of interest in soil of His Majesty the late King Bhumibol Adulyadej began when His Majesty visited the area of Khao Tao Mountain, Hua Hin District, Prachuap Khiri Khan Province, in 1963. There, Dr. F.R. Moorman, the FAO expert in soil who worked in Thailand showed him the soil in the lagoon and explained to him that such soil was problematic for agricultural uses. His Majesty the late King mentioned that this soil was the worst soil in the world as it contained an extremely high level of acidity and at the same, high level of salinity. Therefore, His Majesty the late King initiated that this place should be converted to a reservoir instead of being used for agricultural land. This reservoir was the first one which His Majesty the late King constructed and which His Majesty used His personal fund of 60,000 Baht to construct.

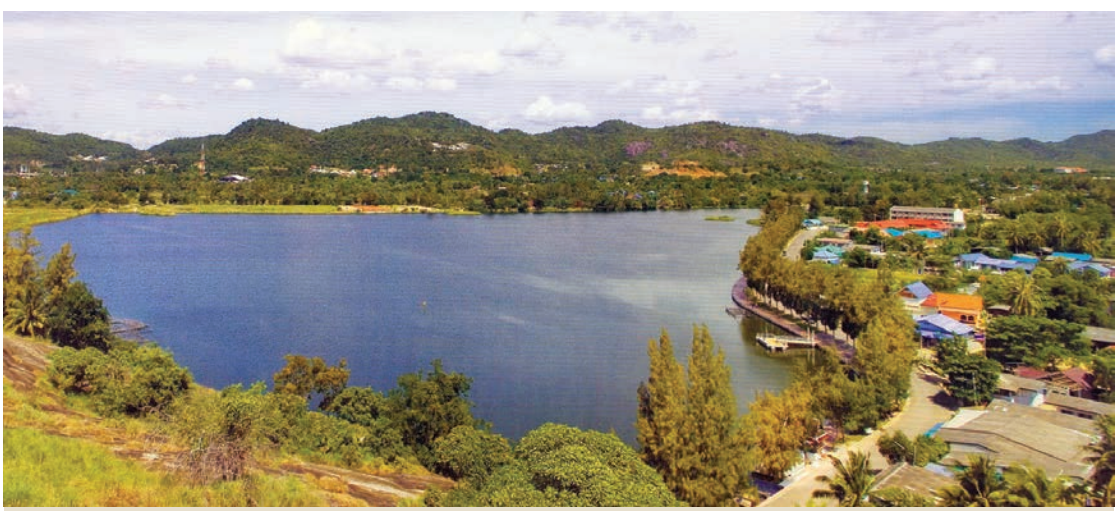
The incident had brought about his interest in soil and more specifically in

problems with soil that could negatively affect agricultural production in Thailand. His first intiative related to land development was established in 1968 in the area of Hupkapong Village, Cha-am District, Phetchaburi Province. This royal initative project was to provide to the local farmers a suitable area for crop production. His Majesty the late King suggested that the project should be well prepared with appropriate soil conservation practice as quoted in the Royal speech:

Dr. F.R. Moormann explained about the distribution of the vetiver roots in soil peds.

"...Soil improvement should begin with surface soil conservation. Its fertility should be maintained and the surface soil should not be plowed away or removed. The natural trees should be kept on the ground to store the moisture in the soil..."

His Royal Interest in soil management had continued and resulted in the Royal Highland Development Project which began in 1969. The purpose of this project was to stop the growing of the opium by the hill tribe people who lived on the highland in the North. Such cultivation not only had brought about various social problems but had also damaged the environment of the highland. His Majesty conveyed this message in the Royal speech as follows:



Khao Tao Reservoir constructed in 1963 was the first irrigation project initiated by His Majesty the late King.

"...The first thing that we need to do is that the soil and water resources have to be investigated. In terms of soil, we should know exactly where the shallow soil on the marginal land in the area of steep slopes occurs so that restriction of uses for forestry can be enforced. Such areas should be delineated clearly on the map and should not overlap with the areas suitable for farming. Then, reforestation should be conducted in the areas where the forests have been destroyed. For areas which are still suitable for cropping, we should do so in a proper way because the slopes can be rather steep, not flat. If we plow the land improperly, soil could be washed downhill. So we have to conserve the soil with terracing, contour diversion or planting vetiver grass along the countour line..."

The above quote illustrates very clearly His Majesty's Interest in soil management in various forms, especially for soil-related problems, an issue of which His Majesty the late King had always instructed relevant units to closely monitor.

Chapter 4

The Timeline of the Royal Initiative Projects in Relation to Land Development

Chapter 4

The Timeline of the Royal Initiative Projects in Relation to Land Development

During the seven decades which His Majesty the late King Bhumibol Adulyadej reigned the country, His Majesty visited different regions including the most remote areas of the country. In doing so, he learned about the living conditions and problems of the people that needed to be solved. Wishing to improve the standard of living of His subjects, His Majesty the late King initiated various development projects totaling 4,685. Those development projects have followed the Royal Philosophy of Sufficiency Economy in harmony with the sustainable management of the natural resources and natural balance. His Royal Initiative Projects have covered various disciplines including agriculture, cooperatives, land development, water resource development, irrigation, forest management and conservation, environmental management and protection, media communication, artificial rain making projects as well as medical cares and public sanitation.

With HIs ingenuity and kindness, His Majesty had initiated various royal projects, some of which have focused on land development or management of the soil resources for the farmers to earn their living and to sustainably support their families. Soils with various problems have been remedied and can yield economically feasible production. Moreover, His Majesty's projects have promoted specific ways to sustainably use soil and to lessen environmental impacts. In accordance with the reference published by the office of the Royal Development Projects Board (ORDPB), the Royal Initiative projects on land development and soil resource management are illustrated in a timeline. These projects have been conducted successfully, and some projects have continued to the present days.

Dr. Buncherd Balangkula reported to His Majesty the late King about the Hubkrapong Land Development Project, Cha-am District, Phetchaburi Province on 20 May 1966.

1. The First Decade (1958 - 1967)

1.1 In 1963

The Khao Tao Reservoir Project was established in Hua Hin District, Prachuap Khiri Khan Province. His Majesty the late King visited a local lagoon which later on was turned into a reservoir. At this location, Dr. F.R. Moorman, a FAO expert on soil, explained to His Majesty that the soil in this area was extremely high in acidity and in salinity. His Majesty the late King described the soil in the Khao Tao area as the worst soil in the world. Because of this, instead of using the land for agricultural development, His Majesty advised that the soil be used for water storage and instructed the relevant units to construct a reservoir.

1.2 In 1966

The Land Development Project in Accordance with the Royal Initiative was established in Hupkapong, Cha-am District, Phetchaburi Province. This project focuses on land allocation for the farmers. The family of each farmer was initially given 25 rai (4 ha) for accommodation and farming in which soil conversation practices, soil improvement, control of soil erosion in accordance with the Royal Initiatives are promoted and implemented.

His Majesty paid a royal visit at the vegetable growing plot at the Huai Luk Royal Project, Chiang Dao District, Chiang Mai Province on 13 February 1984.

2. The Second Decade (1968 - 1977)

2.1 In 1969

The Royal Development Project on the highland development was established. This project focuses on the highland development for the hill tribe people in order to eradicate opium growing and shifting cultivation on the northern highlands.

2.2 In 1971

The Don Khun Huai Royal Initiative Project was established in Cha-am District, Phetchaburi Province. This Royal Initiative focuses on land allocation for the farmers and the improvement of land using various appropriate farming systems.

2.3 In 1972

The Land Development Project as initiated by His Majesty the late King was established in Nongplub-Kladluang Village, Hua Hin District, Prachuap Khiri Khan and Phetchaburi Province. This project focuses on land settlement together with land development activities for landless farmers so that they can earn their living mainly on agriculture and can earn sufficient income for their families.

His Majesty visited Don Khun Huai, Cha-am District, Phetchaburi Province
on 20 May 1993.

3. The Third Decade (1978 - 1987)

This decade was the period of the establishment of the six Royal Development Study Centres in accordance with His Majesty's Initatives. The Royal Speech in relation to the establishment of those Royal Development Study Centres is as follows:

> **"...The purpose of the Royal Development Study Centres is to improve fertility of the farm lands of the farmers by means of land and water development as well as reforestation in addition to application of cultivation techniques for various cropping system and livestock raising. The budgets allocated for the project development are from the donation of the people. These Royal Development Study Centres will serve as the demonstration farms that farmers and officials can visit and learn about various agricultural activities. At the same time, these Centres can serve as a model for the surrounding communities. When the livelihood of the people around the Centres improves, rice mills and rice banks for each community can be established. Finally, the farmers can train themselves to be self-sufficient ..."**

3.1 In 1979

The Khao Hin Sorn Royal Development Study Centre in accordance with His Majesty's Initiative was established in Khao Hin Sorn Subdistrict, Phanom Sarakham District, Chachoengsao Province. The main purposes are to rehabilitate and improve the project area which had originally degraded, to develop water resources and to properly utilize the land.

His Majesty visited
the Pikun Thong Royal Development
Centre, Mueang District,
Narathiwat Province.

The area of the Khung Kraben Bay Royal Development Centre,
Tha Mai District, Chanthaburi Province

3.2 In 1981

The Pikun Thong Royal Development Centre was established in Galuwor Nua Subdistrict, Mueang District, Narathiwat Province. The center focused on the solutions to the acid-sulfate soil amelioration and on proper utilization of soil. At the same time, swamp forests can be conserved and rehabilitate to keep balance of the environment in the swamp or in the wet land of Narathiwat Province.

3.3 In 1981

The Kung Krabaen Bay Royal Development Study Centre was established in Tha Mai District, Chanthaburi Province. The main objective of this center is to utilize the land along the coastal zone for environmentally-friendly aqua-culture development. As the same token, the mangrove forests along the tidal flat is protected by the project to ensure natural balance. The results of those studies generated by the project can be applicable to other areas with the same surroundings.

His Majesty visited the area of the Puparn Royal Development Study Centre, Mueang District, Sakon Nakhon Province.

3.4 In 1982

The Puparn Royal Study Centre was established in Na Nok Khao Subdistrict, Mueang District, Sakon Nakhon Province in accordance with His Majesty's Initiatives. The main purpose of this centre focuses on water resource development, reforestation and rehabilitation of the degraded land. At the same time, the centre educates the local community about proper ways of utilizing the land resource and the other natural resources. Furthermore, the centre can be used as the demonstration model to develop other areas that are similar in geo-social pattern.

3.5 In 1982

The Huai Hong Khrai Royal Development Study Centre was established in the vicinity of Doi Saket District, Chiang Mai Province. The objective of the centre is to develop a model for watershed management in the hilly areas where the land covers are deteriorated. The model watershed management includes various forms of water resource development such as construction of reservoirs or check dams along the natural streams. In addition, the degraded forests have been replanted in various patterns to revive the natural habitats. At the same time, studies on appropriate environmentally-friendly land utilization have also been conducted.

His Majesty visited the area of dipterocrap forest in the Huai Hong Khrai Royal Development Study Centre, Doi Saket District, Chiang Mai Province.

The area of the Huai Hong Khrai Royal Development Study Centre,
Doi Saket District, Chiang Mai Province

His Majesty visited the Huai Sai Royal Development Study Centre,
Cha-am District, Phetchaburi Province on 17 May 1985.

3.6 In 1983

The Huai Sai Royal Development Centre, located in Sam Phraya Subdistrict, Cha-am District. Phetchaburi Province, was established in accordance with the Royal Initiatives. The main initial objective of this centre was to rehabilitate the degraded land that had earlier been exclusively used for continuous cropping over a long period of time. The project focuses on water resource management, reforestation, and appropriate land utilization specifically for the land capability, local topography and social conditions. The expected final outcome is the maintenance of the way of living which follows the concept of self-sufficiency and conservation of the natural resources.

The area of the Huai Sai Royal Development
Study Centre before development efforts

Soil and water conservation system installment at
the Huai Sai Royal Development Study Centre

His Majesty visited the Munoh Livestock – Agriculture Project, Tak Bai District, Narathiwat Province on 8 September 1982.

3.7 In 1983

The Munoh Livestock – Agriculture Project in accordance with His Majesty's Royal Initiative was established in Kosit Subdistrict, Tak Bai District, Narathiwat Province. This project is an irrigation project which uses the water from the Munoh Irrigation Project to wash away the extremely acidic substances from the acid-sulfate soil in the wet-land and thus improve the quality of soil so that it can be utilized for paddy rice cultivation and other suitable cropping systems.

His Majesty visited the “Klaeng Din Project” at the Pikun Thong Royal Development Study Centre, Mueang District, Narathiwat Province on 7 October 1990.

3.8 In 1984

The “Klaeng Din Project” was established. This project is one of the Royal Initiatives that was set up to conduct studies to find ways to eliminate the acid sulfate soil in the area monitored by the Pikun Thong Royal Development Study Centre, Narathiwat Province. The study involves drainage of the wet land where the content of sulfur in the lower layers of subsoil is high. Once, this sulfidic layer of the soil is drained, the oxidation process occurs. Then, the sulfuric acid can be induced, and this makes the soil extremely acidic, so much so that no economic crops can be grown. The process of wetting and drying the soil to increase the soil acidity was termed by His Majesty the late King as “Klaeng Din” in Thai. After the process of “Klaeng Din”, various methods to improve the quality of the soil will be conducted so that the soil can be used for cultivation for satisfactory yields. This project follows the objective of the Pikun Thong Royal Development Study Centre and the project has continued to the present days.

The “Klaeng Din” experimental plots

The area of the Pikun Thong Royal Development Study Centre

His Majesty visited the Khao Cha-ngum Land Rehabililation Project, Photharam District, Ratchaburi Province on 15 July 1993.

3.9 In 1985

Khao Cha-ngum Land Rehabilitation Project in accordance with the Royal Initiative was established in Khao Cha-ngum Subdistrict, Photharam District, Ratchaburi Province. The purpose of this project is to find ways to rehabilitate the areas with shallow soil such as lateritic soil and shallow soil layer containing gravels, rock fragments or bed rock. Common practices for land rehabilitation include water resource development, reforestation to reach the climax forest capacity as well as appropriate land utilization to suit the soil condition and topography.

3.10 In 1986

A land development project was established in Ban Khok Yang Village, Pron Subdistrict, Tak Bai District, Narathiwat Province. This is one of the subprojects of the Munoh Irrigation Project under the Royal Initiative. The project aims at making use of the irrigation water from the Munoh Irrigation project to improve the condition of soil with contains high sulfate content so that the soil can be used for cultivation of paddy rice.

The water reservoir in the Khao Cha-ngum Land Rehabilitation Project

4. The Fourth Decade (1988 - 1997)

4.1 In 1988

Pak Phanang Watershed Development Project under the Royal Initiative was established in Pak Phanang District, Nakhon Si Thammarat Province.

This project initially involved the construction of the water regulator near the mouth of the Pak Phanang River. The purpose of this project is to store the water in the Pak Phanang River, to prevent intrusion of the sea water to the river and to drain the flooding water to the sea. The storage water in the river can be utilized for agricultural development, especially for improvement of the acid sulfate soil within the project area covering approximately 100,000 rais along the coastal lowland.

4.2 In 1990

Acid Sulfate Soil Development Project, Khok It – Khok Ni Village, Pron Subdistrict, Tak Bai District, Narathiwat Province.

This project was a project of transferring the result of the "Klaeng Din Project" to improve the acid sulfate soil for rice production to the area that was not successful in growing rice. After improvement, rice production was satisfactory and the farmers had enough rice for consumption.

His Majesty planted vetiver at Huai Hong Khrai Royal Development Study Centre, Doi Saket District, Chiang Mai Province on 24 February 1992.

4.3 In 1990

The Khok Kuwae Development Project under the Royal Initiative was established in Pron Subdistrict and Bang Khun Thong Subdistrict, Tak Bai District, Narathiwat Province. This project has been developed to use the fresh water from the Munoh irrigation canal to wash the acid from the acid sulfate soil and to make the soil suitable for cultivation.

4.4 In 1991

The promotion and campaign of vetiver growing under the Royal Initiative was introduced. This Royal Initiative involves the cultivation of vetiver on the sloping land that is susceptible to soil erosion in order to prevent soil erosion. All Royal Development Study Centres have been assigned to study various aspects of vetiver growing, namely propagation of vetiver, cultivation practices and proper utilization of vetivers. Transferring of the vetivers from the centres to the farmers' fields is also one of the essential elements to introduce the vetiver to the farmland by the farmers so that soil erosion can be prevented.

His Majesty visited the area for construction of the Mae Aow Noi reservoir in the Mae Aow Watershed Development project, Pa Sang District, Lamphun Province on 31 March 1992.

4.5 In 1992

The Doi Tung Development Project (Highland Development) under the Royal Initiative was established in Mae Fah Luang District, Chiang Rai Province. This project was established by the Royal Initiative of His Majesty the late King's Mother. In accordance with His Majesty the late King Initiative on vetiver growing, His Majesty's Mother advised her staff together with the farmers on the highlands to grow vetivers to cover the areas of steep slopes. Such measure could prevent soil erosion and make soil and water conservation feasible.

4.6 In 1992

The Mae Aow Watershed Development Project under the Royal Initiative was established in Pa Sang District, Lamphun Province.

Part of this project focuses on the activities of land development namely land classification, land use planning, soil improvement and prevention of soil erosion.

Growing vetiver on the highlands

His Majesty planted vetiver at the Mae La Noi Royal Project, Mae La Noi District, Mae Hong Son Province on 14 March 1992.

4.7 In 1992

The Mae La Noi Royal Project was established in Ban Dong Village, Huai Hom Subdistrict, Mae La Noi District, Mae Hong Son Province.

His Majesty instructed relevant units to use vetiver growing in this area because His Majesty saw that the mountainous areas were highly susceptible to erosion. Community participation in vetiver growing was introduced to ensure the success of the project. The cultivation period is before the rainy season, and additional water is also provided.

His Majesty visited the Pang Tong Royal Highland Development Project, Mueang District, Mae Hong Son Province on 19 March 1992.

4.8 In 1992

The Pang Tong Service Centre and Highland Development under the Royal Initiative was established in Mog Jumpae Subdistrict, Mueang District, Mae Hong Son Province.

In some areas of the project, the soil started to erode away, especial in the sloping areas and along the banks of water reservoirs. Thus, His Majesty the late King recommended vetiver growing on those areas. One month prior to the rainy season with such cultivation method, vetivers grew very well and the organic matter together with plant residue were trapped in front of each row of the vetiver. Moreover, reforestation and a botanical garden together with soil and water conservation measures were also introduced.

4.9 In 1992

The Chaipattana–Mae Fah Luang Reforestation Project under the Royal Initiative was established in Nong Plub Subdistrict, Hua Hin District, Prachuap Khiri Khan Province and Raimai Pattana Subdistrict, Cha-am District, Phetchaburi Province.

This project focuses on forest rehabilitation and environmental conservation to recover the fertility of the land, to develop water resource as well as to improve the soil quality. Soil erosion control by using the vetiver grass was also introduced to the land prone to erosion.

The degraded land caused by continuous cropping of pineapples over 20 years before the establishment of the Chaipattana – Mae Fa Luang Reforestation Project

The Chaipattana – Mae Fa Luang Reforestation Project in Prachuap Khiri Khan and Phetchaburi Provinces in 2004.

His Majesty the late King Bhumibol Adulyadej planted vetiver
at the Pa Tong Service and Development Project of the highlands,
Mueang District, Mae Hong Son Province on 19 March 1992.

His Majesty visited the Phru Kaekae Development Project, Sai Buri District, Pattani Province on 7 October 1993.

4.10 In 1992

The Phru Kaekae Development under the Royal Initiatives was established in Ban Kao Subdistrict and Pasaeyawor Subdistrict, Sai Buri District, Pattani Province.

This project aims to improve the degraded swampy land. The original soil was high in acid sulfate with prolonged water – logging. After development, the problems of sulfate acid soil and flooding have been alleviated, and the land could be used to cultivate crops, especially rice. The local farmers could own their farmland and earn a living following the concept of the sufficiency economy philosophy.

The Phru Kaekae Development Project before development efforts.

Phru Kaekae Development Project after project establishment.

4.11 In 1996

The Ban Khok Krathom Acid Sulfate Soil Development Project was developed in Khok Krathom village, Tak Bai District, Narathiwat Province.

This project aimed at implementing the measures for alleviating the problem of the acid sulfate soil for rice production. The local farmers could utilize their farmland and could produce enough rice yields for their own consumption.

His Majesty visited Yuyo Development Project, Tak Bai District, Narathiwat Province on 4 October 1996.

4.12 In 1996

The Yuyo Land Development Project under the Royal Initiative was introduced in Bang Khun Thong Subdistrict, Tak Bai District, Narathiwat Province.

This project aimed to use the fresh water from the Su-ngai Padi reservoir through the concrete flume crossing over part of the Phru To Dang swamp to provide irrigation to the project area at Ban Yuyo. Such irrigation water was used alleviate the problem of the acid sulfate soil within the project area which was used for growing paddy rice. The expected outcome was an increase in crop production for the local farmers and to upgrade the standard of their livelihoods.

4.13 In 1997

The Acid Sulfate Soil Improvement Project under the Royal Initiative was established in the area under Chaipattana Foundation in Ban Na District, Nakhon Nayok Province.

This project was established in order to conduct various research studies solutions to the acid sulfate soil in Nakhon Nayok Province. The project is expected to be used as a model project providing solutions to the acid sulfate soil in the Central Plain. The solutions include using rain water to wash away the acidity from the soil, the method of which was called “the Pre-theory” by His Majesty; using raised bedding without covering the surface of the ridge with the adverse condition acidic subsoil; liming and demonstration of the farming system following the “New Theory” after the quality of soil and water has been improved.

Her Royal Highness Princess Maha Chakri Sirindhorn visited the Acid Sulfate Soil Improvement Project, Ban Na District, Nakhon Nayok Province on 20 November 1997.

Experimental plots in the Acid Sulfate Soil Improvement Project, Ban Na District, Nakhon Nayok Province

Chapter 5

Royal Messages on Soil Development

Chapter 5

Royal Messages on Soil Development

His Majesty the late King Bhumibol Adulyadej had always stressed the importance of soil development as His Majesty had realized that soil was the key factor for agricultural production. If the soil is utilized, an acceptable level of fertility must be maintained through proper management. If soil is problematic, it can lead to lower productivity which is economically unfeasible, and can be the loss of balance of nature.

His Royal Initiatives concerning soil development were based on fundamental soil science even though His Majesty was not a soil scientist.

The following is the content of the report that was written by His Majesty the late King Bhumibol Adulyadej and was sent directly to the office of Royal Development Projects Board (ORDPB). This report was originally in Thai, and it can be translated in English as follows:

Soil Dev.

Soil Development

Soil suitable for agricultural production must have the following properties:

- Containing plant nutrients so called “fertilizers” which consist of the following major elements

1) N (nitrogen) in the form of nitrate

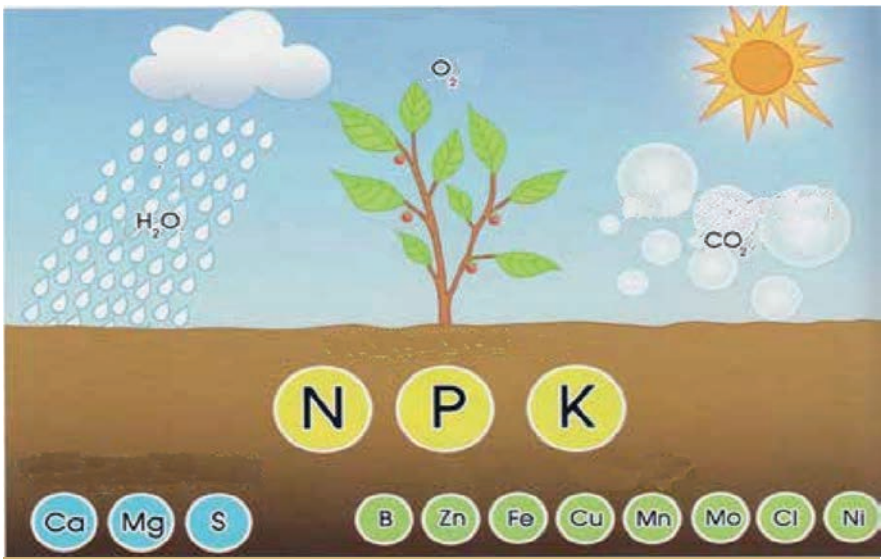
2) P (phosphorus) in the form of phosphate

3) K (potassium)

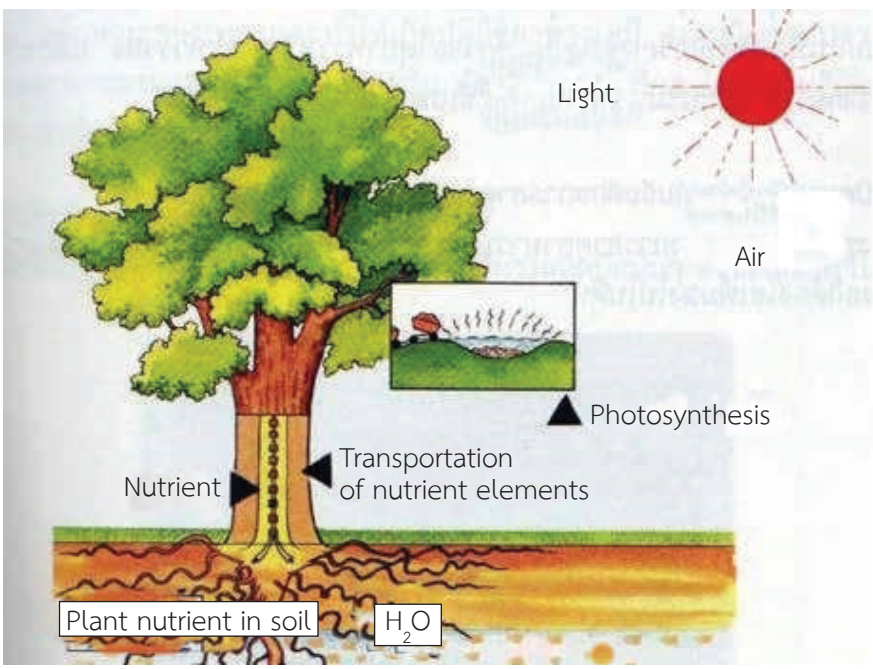
- Other elements namely O H Mg Fe
- Level of acidity and alkalinity close to neutral (pH 7)
- Low salinity
- Containing soil microorganism
- Having optimum soil moisture (not dry, not wet)
- Having suitable porosity (not hard)

To elaborate further from the above Royal message, the soil suitable for agriculture or the good soil should have four characteristics as follows:

1) It must contain plant nutrients so called fertilizers in the optimum amount and sufficient for crop growth. These nutrients include nitrogen (N), phosphorus (P), potassium (K), oxygen (O), hydrogen (H), magnesium (Mg), iron (Fe), and others.



The plant nutrients in the soil and in the air, termed "the fertilizer" by His Majesty the late King



2) It must have proper chemical conditions such as neutral acidity and alkalinity (pH around 7.0) and low salinity.

3) It must contain the optimum amount of soil microorganisms such as various bacteria's and soil fauna that can help decompose plant residues on the ground surface and convert them into soil organic matter or humus. The organic matter in soil can make soil porous, increase water holding capacity of the soil, and facilitate absorbing and increasing availability of the plant nutrients.

Generally, the essential soil microorganisms can be classified into two groups. The first group consists of the microorganism capable of transferring nitrogen in the atmosphere into fixed nitrogen in the root nodules of the legumes. Within these nodules, the host plant can utilize nitrogen for its growth. Thus, these microorganisms are called the symbiotic nitrogen fixing bacteria, one example of which is the Rhizobium species. The other ones are the non – nitrogen fixing microorganisms. This latter type can transfer the atmospheric nitrogen for their own growth. Once they die, nitrogen will be released and accumulated in the soils as the nitrogen source. Some species of soil microorganisms can also produce certain acids that can dissolve phosphorous to increase the phosphate availability for the plant. However, it can be stated that those plant nutrients derived from soil microorganisms are not sufficient for growth of various food crops growing on all kinds of the soils.

4) It must constitute favorable physical soil conditions suitable for plant growth. For example, the soil must be porous, friable and not compact or should not contain hardpan. These physical soil conditions can facilitate moisture and nutrient availability in the soil needed by the plant. The major factors that introduce favorable physical soil conditions include soil organic matter, cultivation practices, soil texture and the existing topographic conditions. For example, flooding cannot occur in the upland areas. On the other hand, in the lowland areas, with high ground water table, water – logging can be problematic for cultivation of the crops like upland crops or fruit trees. If it is so, certain measures should be put in place for instance reshaping of the soil with raised – bedding and construction of the dike around the farming area, which in turn can be very costly. Thus, to reduce cost of cultivation, the paddy rice farming would be more appropriate which also reduce the investment in reconditioning the soil.

Apart from the royal message on characterizing the properties of the soils suitable for agricultural production, His Majesty the late King also described problem soils for agricultural uses in several projects that had been initiated by Himself. In addition, His Majesty the late King also noted the cause of the problem soils and how to solve these problems for some projects, which can be highlighted as follows:.

Problem soils

1. The Khao Hin Sorn Royal Development Study Centre:
   Sandy soils, low plant nutrients.
2. The Huai Hong Khrai Royal Development Study Centre:
   Rocky, gravelly, droughtiness.
3. The Pikun Thong Royal Development Study Centre:
   Acid sulfate soil.
4. The Huai Sai Royal Development Study Centre:
   Sandy soils, low plant nutrient.
5. The Puparn Royal Development Study Centre:
   Sandy soils, salt–affected soil, water deficiency.
6. The Kung Krabean Bay Royal Development Study Centre:
   Saline soils.
7. The Khao Cha - ngum Project: Compacted soil, soil with rock fragments and lateritic gravels.
8. The Wat Mongkol Chaipattana Project: Water deficiency.
9. The Pak Panang Project: Saline water, saline soil and acid sulfate soil.
10. The Land Development Project at Ban Prik Subdistrict, Ban Na District:
    Acid sulfate soil, flooding and water deficiency.
11. The Nong Plub–Kladluang Project: Lateritic soil, soil with hard pan.
12. The Hup Kapong–Don Khun Huai Project: Sandy soil, low plant nutrients, soil with hardpan, water deficiency.
13. The San Kamphaeng Cooperatives Project: Lateritic soil, water deficiency.

Causes of soil problems

1. The RDSC Khao Hin Sorn, Phanom Sarakham District, Chachoengsao Province: after forest encroachment, the farmers cultivate the land for upland crops such as maize and cassava long enough to make soil infertile and sandy. In the dry season, wind erosion commonly occurs. In the rainy season, on the other hand, soil is eroded away by water run-off.

2. The RDSC Huai Hong Khrai, Doi Saket District, Chiang Mai Province: forest encroachment is common. Thus, in the rainy season, the soil is washed away and only rocks and gravels are left on the earth surface.

3. The RDSC Pikun Thong, Mueang District, Narathiwat Province: originally, the land was an old swamp. The soil in the swamp consists of various plant residues that have accumulated on the surface for a long time. The substratum composed of the mud clay forms under the marine facies, which in turn, results in the accumulation of the sulfur compound. When this layer is exposed to the air, the oxidation process occurs giving rise to the occurrence of sulfuric acid in the soil.

4. The RDSC Huai Sai, Cha-am District, Phetchaburi Province: originally, the whole project area was covered with the forest. Later on, the villagers cleared the forest for fire wood and charcoal. After forest encroachment, the land was cultivated for upland crops such as pineapple until the soil became infertile and sandy. Afterwards, the surface soil is eroded away by water and wind, exposing the hardpan layer. This soil does not contain any available plant nutrients.

5. The RDSC Puparn, Mueang District, Sakon Nakhon Province: originally, the project area was covered with the native forest. Later on, the forest was cut down for fire wood, and the land was cleared for agriculture. Due to the high rate of forest destruction, the water storage reduces in the dry season, but in the rainy season, run-off water passing on the ground surface is very powerful. Therefore, widespread soil erosion occurs, and the top soil becomes thinner. Moreover, salt from the underground layer patchily appears on the ground surface.

6. The RDSC Kung Krabaen Bay, Tha Mai District, Chanthaburi Province: soil turns saline due to intrusion of the sea water.

7. The Khao Cha-ngum Project, Photharam District, Ratchaburi Province: in the past, extreme forest destruction occurred. The soil that consists mostly of lateritic gravels has also been excavated for road construction. The areas occupied with the native grasses have been over grazing by the livestock. Moreover, the native trees have also been cut down for fire-wood beyond the rate of regrowth. Therefore, with the combination of the aforesaid factors, extreme soil erosion occurs, and the lateritic soil is the result in most parts of the areas. Although the lateritic soil contains some plant nutrients and soil microorganisms but it is not enough for plant growth.

8. Wat Mongkol Chaipattana Project, Mueang District, Sara Buri Province: similar to that of item No. 5.

9. Pak Panang Project, Pak Panang Distrct, Nakhon Si Thammarat Province: southern part of the project area has a similar problem like that of item No. 6 and in the northern part of the project areas has problems similar to those in item No. 3.

10. Land Development Project, Ban Prik Subdistrict, Ban Na District, Nakhon Nayok Province: the problems are similar to those in item No. 8.

11. The Nong Plub-Kladluang Project, Prachuap Khiri Khan Province and Phetchaburi Province: during the early stage of the project development, forest covers were destructed. Once the areas started to develop, the land was cleared, and all the trees were cut down. Since there are no conservation practices, the lateritic soil is eroded away and is carried downslope to the streams. As a result, the areas look similar to that mentioned in item No. 4.

12. Hupkapong-Don Khun Huai Project, Phetchaburi Province: originally, there were occurrences of forest destruction. Once the development of the project began, the condition of the area has become similar to that mentioned in item No. 4.

13. San Kamphaeng Cooperatives Project, San Kamphaeng District, Chiang Mai Province: forest destruction was common in the area prior to the development of the project. Once the project started to develop, the soil surface was completely cleared and all covering trees were taken away. There were no measures to protect the lateritic soil from wind and water erosion. Also, the soil in the area is relatively warm as there is a hot spring near the project area.

Khao Hin Sorn Royal Development Study Centre
Phanom Sarakham District, Chachoengsao Province.

Problems:

Sandy soil, low plant nutrients.

Solutions

1. Reservoir construction
2. In the lower part along the stream, making demonstration farm of "New Theory"
3. Growing vetiver on uplands
4. Growing fruit trees and annual crops with using organic fertilizer

Huai Hong Khrai Royal Development Study Centre
Doi Saket District, Chiang Mai Province.

Problems : Rocky, gravelly, doughtiness

Solutions :
1. Construction of reservoir and check dam.
2. When the area becoming moist, forest was recovered but additional reforesting was made as necessary.
3. In the gently sloping area, improving the soils with suitable crops and pasture together with organic fertilizer and growing vetiver.

Pikun Thong Royal Development Study Centre
Mueang District, Narathiwat Province.

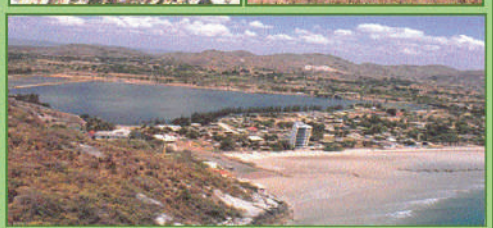


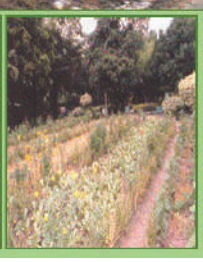



Problems : Acid sulfate soil
Solution : “Klaeng Din Project”

Huai Sai Royal Development Study Centre
Cha-am District, Phetchaburi Province






Problems : Sandy soil, low plant nutrients, hard pan soil.

Solution :
1. Construction of reservoir.
2. Plant forest without forest replanting.
3. Growing vetiver along creeks and planting fast growing trees.
4. Soil improvement by application of organic fertilizer, crop rotation and green manure.

Puparn Royal Development Study Centre
Mueang District, Sakon Nakhon Province





Problems :

Sandy soil, salt-affected soil water deficiency

Solutions :

1. Construction of reservoir and check dams.
2. Reforestation.
3. Improving soils with organic matter and crop rotation.
4. Breaking the lateritic crust and mix subsoil with lateritic gravels and plowing.

Kung Krabaen Bay Royal Development Study Centre
Tha Mai District, Chanthaburi Province

Problems :

Saline soils

1. Conservation of mangrove forest.
2. Conducting aquaculture by means of closing system with environmental friendly.





How to solve the problems

In general:

a) Searching for or improving the water resource

b) Ameliorating the soil

c) Selecting proper farming systems (crop growing or livestock raising)

Problem No. 1 Khao Hin Sorn Royal Development Study Centre: 1979

The forest in the project area was encroached and was cultivated for crops such as maize and cassava, in turn causing low soil fertility and sandy soil. In the dry season, soil is blown away by wind erosion. On the other hand, in the rainy season, the soil is washed away by water run-off, the phenomenon of which is called water erosion.

Background: At first, an area of 264 rai (42.24 ha) was given by the head of the village for construction of the palace in the year of 1977. The area was shown in the topographic map at the scale of 1: 50,000 (adjoining sheet 5236II, 5336III, IV). With the agreement of the head of the village, the land would be used for conducting research on agriculture and for establishing a learning centre. Later on, an area of 1,000 rai (160 ha) belonging to Phanom Sarakham Boy Scout Camp was added to the project area. Together with the land given by the company and private sector, the total area of the project is roughly 2,000 rai (320 ha).

a) Firstly, Huai Jek dam (map coordinate QR 715208) was constructed. After surveying the area and locating the area for dam construction, the construction started at the time of the opening ceremony of the Royal Statue of King Pin Khlao at Wat Khao Hin Sorn (Khao Hin Sorn Temple) (on 8 August 1979). After that, the constructions of Huai Samrong Nua and Huai Samrong Tai reservoirs to serve as additional water resources outside the project area started.

b) The soil along the stream is of moderate quality and does not present a lot of problems. Thus, ordinary fertilizer application can be used. On the contrary, the soil in the upland areas consists of sandy soils, soil with hardpan and rock fragments. The common recommended measure is to grow grasses along the countour line so that they can hold the soil and can produce more organic matter. The sandy soil without growing grasses will be eroded away when it rains. In addition, growing of various trees can help hold the water in the soil.

c) When the water resource has been developed, the upland areas can be cultivated for upland crops and fish can be farmed in the lowland. Furthermore, the upland areas can be also used for livestock raising. Various grasses, fruit trees and woods can also be grown. Livestock farming, grass growing, and tree planting can improve the quality of the soil, and can make the whole area arable. With the aforementioned measures, it may require a long period of time for the soil to recover and become fertile again.

Soil Dev.

Problem No. 2 Huai Hong Krai Royal Development Study Centre: 1982

The forest in the project area was encroached prior to the establishment of the project. In the rainy season, soil erosion occurs due to water run-off and left over rock fragments and gravels on the surface.

Background: On 22 February 1982, we visited the lower Huai Hong Krai dam which had been constructed to reserve the water for the people who were the members of San Kamphaeng Cooperatives. According to Mr. Tinnakorn Komgris, a livestock specialist in milk cow raising in the areas above the dam, those areas were rocky and only a few cows could be raised. At that time, if we had obtained that land for development, we could have made it happen, and the people would now be jealous of our success within 5 years.

On 11 December 1982, permission was finally given to establish the Royal Development Study Centre in the area of the whole Huai Hong Krai watershed. The total area of the centre was about 8,500 rai (1,360 ha), including all the degraded forest due to forest encroachment and forest fire. The soil also had been eroded away by water erosion and had left behind the rock fragments, laterites and gravels on the surface layer.

a) In the lower part of the project area lies the Huai Hong Krai reservoir.

All the streams passing by were all dry, so a number of reservoirs and check dams had to be constructed in order to conserve the humidity or the moisture in the areas and improve the soil quality.

b) To increase water quantity in the reservoir of Huai Hong Krai Royal Development Study Centre, water from Huai Mae Lai was converted to the reservoir in Huai Hong Krai Centre and draining down to Huai Hong Krai reservoir. Moreover, check dams were also constructed on the small natural streams in the project area. When the water system started to work, the forest trees that had been degraded would be recovered and could develope into the climax forest. Gently sloping areas located near Huai Hong Krai can then be cultivated for various upland crops. In the reservoir, fish farming can be introduced as well. The construction of the water system in the project should run from 1984 to 1989.

c) When the water system in the centre is in place, the whole project areas should be divided into the following zones:

1. In the highland areas which used to be the climax forest, reforestation activities should be conducted following the zoning below:

1) areas with water resources (near check dams and dams with surplus supply of water)

2) areas with intermittent streams and temporary water supply (check dams in rain-fed areas or with temporary water supply)

3) areas with frequently dry streams (check dams in rain-fed areas)

4) areas with the water in the stream commonly dry (no check dam, only rainfed area) Within those four zones, afforestation would be conducted in some areas.

2. In addition to the aforementioned zonation, soil improvement on the stony area, gravelly areas, areas with sandy soils and lateritic soils should be encouraged. After that, these areas can be used for pasture development for livestock or for growing upland crops and fruit trees.

3. In the area near Huai Hong Krai, cultivation of paddy rice should be made.

4. In the Huai Hong Krai reservoir, fish culture can be introduced by the members of fishery cooperatives. The success of this activity can be expected within 5 years, and higher efficiency should be expected over time. Soil conservation practices by using water resources and vetiver can be conducted so that the soil reaches the full stage of high fertility.

Problem No. 3 Pikun Thong Royal Development Study Centre Mueang District, Narathiwat Province: 1982

Some project areas consist of old swamps. Soil in the swamp mostly contains plant residues that have accumulated for a long time, and by mixing with sea water, soil with sulfur compound has developed. Once the soil is exposed to the air, oxidation of the sulfur compound will occur giving rise to sulfuric acid.

a) Searching for water resources or improving water quality

Background: on 29 September 1979, a Royal Initiative was granted for the construction of a reservoir, locating at the coordinate of RH 173064 in the map at a scale of 1 : 50,000, adjoining sheet 5321I, sheet name Ban Yang Daeng (coordinate of RH 167056), Kaluwor Subdistrict, Mueang District, Narathiwat Province. Such assignment was given to the survey soldiers for field investigation.

In September 1981, the construction of Klai Ban reservoir started in a hurry.

In January 1982, the Pikun Thong Royal Development Centre was established, and in 1983, the construction of the Klai Ban reservoir was completed (with the capacity standing at 2,850,000 m^3).

On 16 August 1983, a Royal initiative was granted for the construction of the Khao Samnak reservoir.

On 18 September 1983, the construction of the Khao Samnak reservoir started at Khao Samnak village, Kaluwor Subdistrict together with a check dam to increase the quantity of water and forest covers. In 1984, the construction of the Khao Samnak reservoir was finished (with the capacity standing at 140,000 cubic metres).

On 16 September 1984, a rice-growing trial was conducted on the area nearby the Klai Ban reservoir and the "Klaeng Din" experimental project started (Klaeng Din Project was the project on accelerating of soil acidity and amelioration of the acid sulfate soils).

On 1 October 1988, the soil from the bottom floor of the reservoir was removed to increase the height of the edge of the reservoir. After that, the areas were planted with para-rubber and other crops.

On 5 October 1992, the know-how from the Kleang Din Project was transferred to other areas with acid sulfate soil. In addition, the water from the Bang Nara river was pumped into the Klai Ban reservoir through a pipe (construction finished by 1997).

b) Soil amelioration

In the area of Pikun Thong Royal Development Study Centre, 3 main types of soil can be observed namely, soil in the swamp, lateritic soil and the "the Ban Thon series" soil.

1) Soil in the swamp (wet land) is characterized by the peat soil in the top layer and the pyritic mud clay in the lower layer. The pyritic compound contains iron and sulfur compound which, upon oxidation, can change into an oxide, and after mixing with water, it can give rise to sulfuric acid.

2) Most lateritic soil occur on hilly terrains. The surface soil that contains organic matter is rather thin (only 5 cm in thickness). This in turn, overlies a layer of lateritic soil which contains mostly iron compound. If water and wind erosion on this soil are prevented, soil fertility can be improved.

3) The surface horizon of the Ban Thon soil series contains little organic matter over a layer of white sand, which is in turn, underlain by a very hardpan layer caused by cementation of Fe-humus complexes.

If the peat soil (1) from the swamp mixes with the surface layer of the Ban Thon soil series, the Ban Thon soil series can be cultivated for various crops.

For the lateritic soil (2), if there is insufficient organic matter content, growing grasses is recommended to increase the quantity of soil microorganisms so that the organic matter and nitrogen can be accumulated.

For the soil in the swamp (1) which is mostly composed of acid sulfate soil, the results from the "The Klaeng Din" project can be applicable, especially when using fresh water to wash away the soil acidity. Mixing the soil with limestone dust is also recommended.

c) Selection of appropriate farming systems (cropping or livestock raising)

When the acid water and the acid from the soil are washed away, the soil can be cultivated for paddy rice, legumes and various fruit trees, and the pond can be used for fish farming.

The swampy area before development efforts

The Klai Ban reservoir

The Klaeng Din experimental plots

The control plot of the Klaeng Din Project

Raise bedding for cultivation of coconuts

Peat soil in the swamp

Sandy soil with organic hard pan (spodic horizon)

Problem No. 10. Land Improvement Project, Ban Prik Subdistrict Ban Na District, Nakhon Nayok Province: 1997

Problems are similar to those mentioned in No. 3 (extremely acidic) and in No. 8 (dry)

(3) Pikun Thong Royal Development Study Centre, Mueang District, Narathiwat Province:

The centre situated on an old swampy area. Soil consists of plant residues that has been deposited and decomposed over a long period of time. Mixed with the sea-water, sulfur compound has accumulated in the soil. When the soil oxidizes and mixes with water, sulfuric acid forms in the soil.

(8) Wat Chai Mongkol Pattana Project, Mueang District, Saraburi Province.The condition of the project area is similar to those mentioned in No. 5 (dry)

Background: Thanphuying Yossawadee Amporn Paisan was given an audience to receive the holy water from His Majesty the late King for the occasion of her turning 84 years old, on 19 March 1997. At the same time, she offered a land of 50 rai (8 ha) to His Majesty the late King, and he accepted it. Later on, His Majesty the late King asked the Chaipattana Foundation to be the care-taker of this piece of land. This land was barren, and the soil was low in fertility (yielding only 100 kg/rai of rice). This was because this area used to be a swamp and thus was similar to that of Pikun Thong Centre, except that it was drier.

Soil improvement methods: As a common practice, water should be provided for a year-round cultivation, which in turn will reduce the soil acidity. However, due to low capability potential for cultivation of the soil, it is expected to require a long period of time for improvement, and the expenses can be high. Moreover, the improvement practices may impact on the people nearby. For progressive practice, pond excavation in the proportion of 1 to 5 of the total area should be made.

a) Searching for the water resource or improvement of the water quality

Firstly, 2 ponds should be excavated for the total area of 15 rai and each pond is 4 m deep (pond capacity standing at 96,000 cubic metres). However, the size of the ponds could be reduced to 10 rai (64,000 m^3) for collection of the rain water (the amount of the annual rain fall totals 1,300 mm, and if the total project area is 50 rai, the water supply for the whole project area should equal 104,000 m^3) However, in the rainy season, the flooding water could be as high as 50 cm above the ground surface. Thus, the flood water can be drained to the ponds by pipe installation if it becomes necessary.

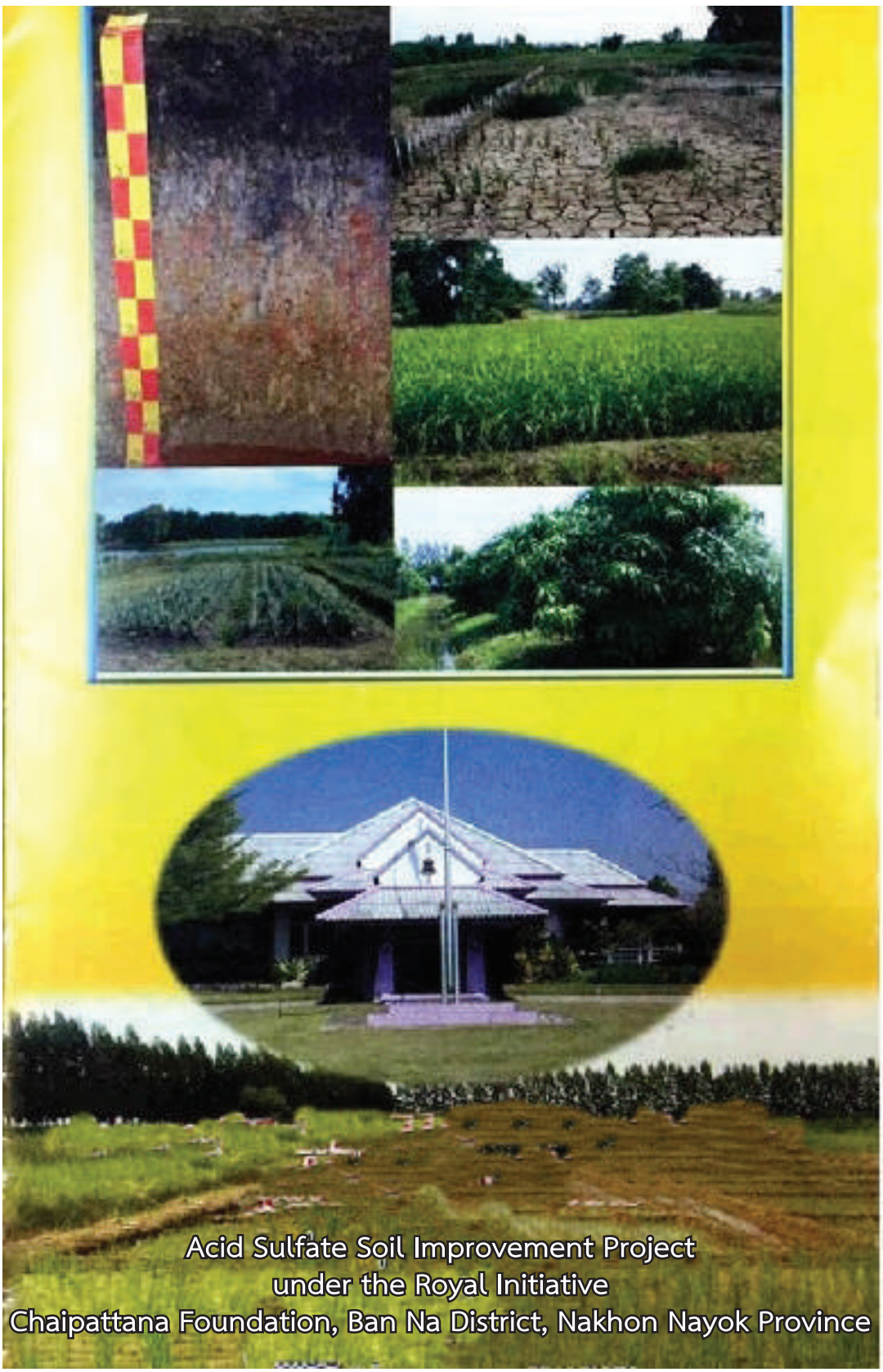
Soil from the excavated ponds could be used for filling the areas around the ponds to make the area higher to avoid flooding. In the future, these ponds could be used as a storage for the collection of water from Pasak dam or from other sources.

b) Soil amelioration

Because the surface soil excavated from the ponds has a thickness of about 50 cm and the soil quality is quite favorable, so they should be removed and kept in another place. Also, the surface soil in the area around the pond needs to be removed. After that, the subsoil from the ponds will be used to fill the area in which the surface soil has been taken away. Later on, all surface soil will be used to cover the whole area. This will make the whole areas covered with the surface soil and can be used for cultivation because the quality of the surface soil is relatively suitable for cultivation.

c) Selection of the farming system (cropping or livestock raising)

Cultivation can start with grasses, paddy rice, upland crops and trees. In the ponds, fishes can be raised. Above the pond, livestock such as pig, duck and chicken can also be raised.



Acid Sulfate Soil Improvement Project
under the Royal Initiative
Chaipattana Foundation, Ban Na District, Nakhon Nayok Province

Chapter 6

Management of the Problem Soils in Accordance with the Royal Initiatives

Chapter 6

Management of the Problem Soils in Accordance with the Royal Initiatives

Throughout His Majesty the late King Bhumibol Adulyadej's lifetime, He had always paid great attention on agricultural development for better livelihood of the Thai farmers who had been recognized as the backbone of the country. As part of the fundamental factor for agricultural production, soil plays an important role. In Thailand, soil consists of various kinds, some of which are suitable for production and some are problematic in terms of their quality, physical condition and chemical characteristics. Those problem soils always impact on crop growth, resulting in low production, crop failure and uneconomic return. The result of a soil survey which was conducted by the. Land Development Department showed that the problem soils in Thailand account for more than 100 million rai (16 million ha).

Amelioration of those problem soils caused by inappropriate land utilization or naturally occurrences include various types of practices. However, solving these problems is not easy, and many factors must be taken into consideration. However, the task of solving these problems seemed easier when His Majesty the late King Bhumibol Adulyadej considered soil-related problems in all physiographic regions of the country. Throughout a long period of tireless efforts, His Majesty had paid great attention on finding solutions to the problems of soils which affected agricultural production. In accordance with the Royal Remark that was given to the officers at an exhibition before the time of the opening ceremony of the Agricultural Museum at Khlong Luang District, Pathum Thani Province on 21 May 2002, His Majesty stated that

> **"...Her Royal Highness Princess Maha Chakri Sirindhorn used to ask me why I always work with the problem soils. I explained that nobody would like to work with the problem soils because it is a very difficult task. If I can solve the problem, it will be very useful. Before that Her Royal Highness did not quite understand, but now she understands. I will not work with the good soils..."**

The solutions to the problem soils that His Majesty initiated are very comprehensive and systematic. It often begins with research to understand the causes of a problem followed by more formal studies which would focus on how to solve the problem. Moreover, His Majesty stressed that the solutions should not be too complicated so that farmers can easily follow and practice them.

The followings are examples of the management practices initiated by His Majesty the late King Bhumibol Adulyadej that have helped farmers across the country to solve the soil problems. They can be listed and described by problem type as follows:

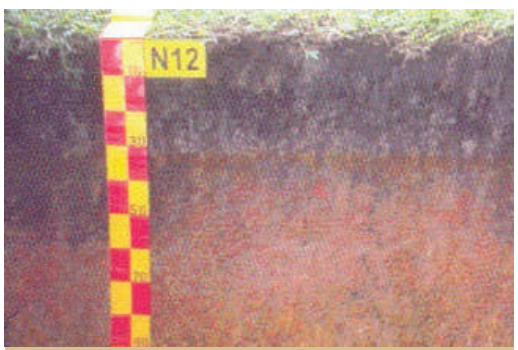
6.1 Amelioration of the Acid Sulfate Soil

The acid sulfate soil is one type of acid soils that has extremely high acidity that various cultivated crops cannot be grown or may result in low yields. This acid sulfate soil commonly occurs on the coastal low land of Thailand. The aerial distribution of this soil comprises about 6 million rai (1 million ha), mostly occurring in the central plain and along the coastal zone of the Thai peninsula. The acidity of this soil is due to contamination of the sulfuric acid in the soil. The formation of sulfuric acid is caused by oxidation of the sulfur compound (pyrite) that naturally occurs in muddy subsoil. The oxidation process can occur when the soil is dry long enough either by naturally occurrences or by man-made incidents.

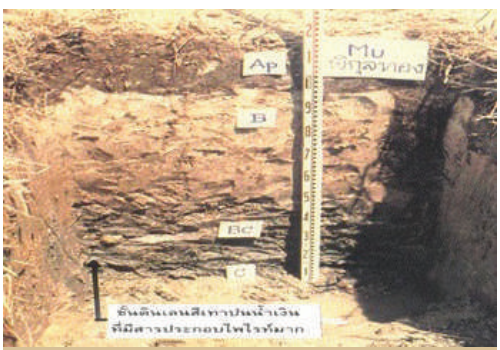
This extremely acid soil is called the “acid sulfate soil”. In Thai, it is also known as the “sulfuric acid soil”.

The acid sulfate soil reduces the capability for crop production. The crop selection to be grown on this soil is very limited, and the production is relatively low.

If the soil is excavated to make a fish pond, the water in the pond will be extremely acidic and not suitable for fish raising. Crop failure on this soil is commonly caused by high acidity, containing high quality of Fe and Al compounds that are toxic to plants and also by phosphorus compound in the soil becoming less available to crops.



Soil profiles of the acid sulfate soil in central plain.

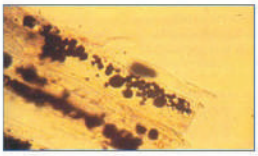


Acid sulfate soil in the south.

pH value of less than 4.5

Rice growing failure on acid sulfate soil

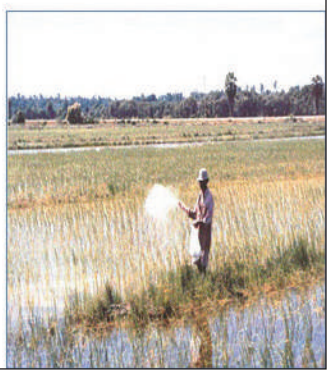
Chemistry of the acid sulfate soil



Oxidation Process

$$FeS_2 + 7/2O_2 + H_2O \longrightarrow Fe^{+2} + 2SO_4^{-2} + 2H^+$$

$$Fe^{+2} + SO_4^{-2} + 1/4O_2 + 3/2H_2O + \longrightarrow 1/3K^+1/3KFe_3(SO_4)_2(OH)_6 + H^+ + 1/3SO_4^{-2}$$



Chemical equation of liming

$$CaCO_3 + H_2SO_4 \longrightarrow CaSO_4 + CO_2 + H_2O$$

His Majesty the late King became interested in this soil problem when He visited Narathiwat Province and stayed at Thaksin Ratchaniwet Palace, beginning in the year of 1974. While he paid the visits the farm of the farmers overthere, His Majesty was informed by the farmers about the problem of the acid sulfate soil in Narathiwat Province. Therefore, His Majesty the late King initiated the establishment of the Pikun Thong Royal Development Study Centre on 18 August 1981. During the Royal Speech at Thaksin Rachaniwet Palace on that day, His Majesty stated,

> **"...Because most areas in Narathiwat Province consist of swamps, water-logging is common. Also, soils are also low in quality. These areas cover the total of 300,000 rai (48,000 ha). Many farmers do not own land to make a living. Even when the swampy land is drained to solve the problem of water logging, it is still very hard to utilize. This is because the soil contains pyritic compounds which can form the acid sulfate soil as the soil becomes dry or oxidized. Therefore, it needs soil amelioration, and the personnel from concerned government agencies have to work together by means of multi-disciplinary research so that these swampy areas in Narathiwat Province can be developed. The successful results of the studies can be later used as a technical model for sustainable development in other swampy areas..."**

Acid sulfate soils in Narathiwat Province, mostly found in swampy areas with an aerial extent of about 100,000 rai which was unproductive

After establishment of the Pikun Thong Royal Development Study Centre, His Majesty the late King paid a number of visits in many areas of Narathiwat Province and gave the Royal speeches regarding the development of land which was plagued by the acid sulfate soils, the timeline of which can be illustrated as follows:

On 11 September 1983

Given at Pikun Thong Royal Development Study Centre.

> **"...The Royal Development Study in Narathiwat Province should focus on research and services for the livelihood of the Thai people in the South. Research on problem soils in swamps should be the focus. The personnel from different government agencies that do not have common understanding about this topic can have a chance to work together and create better understanding among each other..."**

His Majesty visited the “Klaeng Din Project” at the Pikun Thong Royal Development Study Centre, Mueang District, Narathiwat Province on 7 October 1990.

His Majesty granted the Royal Initiative to conduct the Klaeng Din Project at the Pikun Thong Royal Development Study Centre on 16 September 1984.

On 27 June 1984

Given at Pikun Thong Royal Development Study Centre.

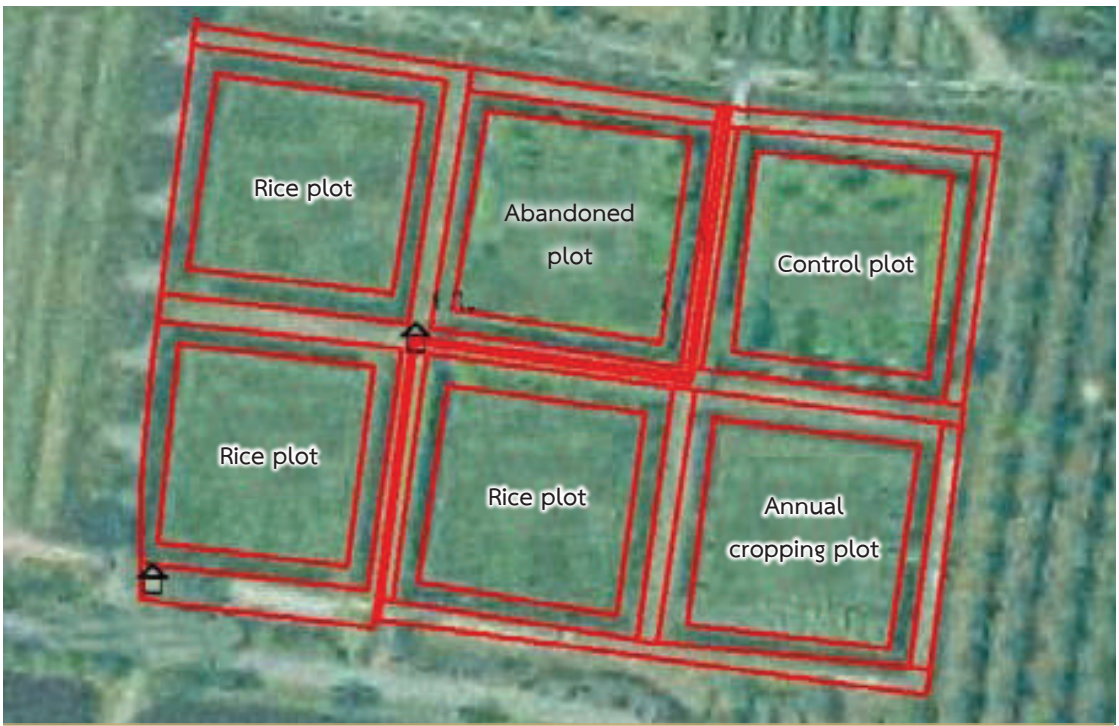
“...Carry on the soil amelioration by using rock phosphate to compare with lime dust to alleviate the problem of the acid sulfate soil. Rock phosphate can be obtained from Nakhon Si Thammarat Province or nearby areas. The director of Pikun Thong Royal Development Study Centre should take the responsibility for this task...”

On 12 September 1984
Given at Khok Chumboke Village, Ban Khunthong Subdistrict, Tak Bai District, Narathiwat Province.

"...Extend the Munoh Irrigation Project as a second phase for solving the acid sulfate soil problem at Khok Chumboke village. The improvement of irrigation scheme can be made by digging a canal from Khok Yang to connect with Khlong Bang Tuay canal. After that, secondary channels are dug to cover the whole project areas so that the water will be stored, which, in turn, can reduce soil acidity. The estimation of the cost for the additional irrigation system will be made by the staff of the Royal Irrigation Department. The personnel from Tak Bai District will help in surveying the lines for this irrigation system as well as purchasing land from the farmers to construct the irrigation canals...".

On 16 September 1984
Given at the Pikun Thong Royal Development Study Centre.

"...It is well aware that the duty of the Royal Development Study Centre is to study the development methods for the local community and for solving the problems for the farmers. To date, the farmers are facing the problems of alteration of their farm land to various kinds of acid sulfate soils which are not suitable for cultivation. Therefore, the Royal Development Study Centre should create the land use zoning similar to that of the problem areas outside the centre. With an aid of technology, the study can reveal the sequences of such land degradation and how much time is needed until the soil shows such degradation. After that, a study on soil amelioration should be conducted in order to make soil as fertile as possible. Then, the results of the studies should be reported to the farmers for further application..."



The "Klaeng Din Project", a royal initiative on 16 September 1984

"...Must conduct experiments to increase soil acidity. This can be done by draining water from the soils to make the soil dry so that the pyritic compounds in the soil can be oxidized and thus can create high acidity. After that, a study on the acid sulfate soil alleviation should be conducted so that this soil can be cultivated. The method for solving this problem can be transferred to the farmers who have the same soil problem. The duration of the study should be 2 years, and the experimental crop should be paddy rice..."

On 26 September 1986
Given at the Pikun Thong Royal Development Study Centre.

"...The study should be continued so that it can be used as the guide line for developing acid sulfate soil...".

Rice experimental plots

A plot that was left abandoned after rice cultivation

A Royal Initiative was made on 3 September 1990 to improve the acid sulfate soil for rice cultivation at the Khok It-Khok Nai Village, Tak Bai District, Narathiwat Province.

On 1 October 1987

Given at the Pikun Thong Royal Development Study Centre.

"...Change the period of water draining from the experimental plots so that the times of drying and rewetting of each plot are different from each other..."

On 3 September 1990

Given at Khok It-Khok Nai Village, Pron District, Tak Bai District, Narathiwat Province.

"...The farmers who live at Khok It - Khok Nai Village want to grow rice on their farm land that consists mainly of acid sulfate soil. To do this, the Royal Irrigation Development should provide water for on-farm irrigation. After that, soil amelioration should be conducted to the extent that the soil can be used for cultivation of paddy rice. Cooperation for practice can be made with the consultancy with the Royal Irrigation Development to control the ground water level in the project area ..."

Control plot

Annual cropping trial

On 7 October 1990

Given at the Pikun Thong Royal Development Study Centre.

"...In order to improve and solve the problem of acid sulfate soil for production of the economic crops, one should consider various methods including selecting the liming material that can be efficiently used, using water to wash away acidity from soil, using suitable cultivation practices, and using crop varieties that are acid tolerant. The experimental trial should be designed to involve a landscape similar to that of the farm land at Khok It - Khok Nai Village. A study of soil improvement should be accomplished within one year. After that, the resulting technology of soil improvement can then be transferred to Khok It - Khok Nai Village...".

"...To make the raised-bedding for cultivation of tree crops in the area with acid sulfate soil, one should first remove the surface soil and replace it with the subsoil from the ditch. Then, the original surface soil should be placed on the top layer again. This method can make the raise-bedding becoming higher, and the surface soil is still on the top...".

"...Carry on the study of using lime and other soil amendment materials for improving the organic soil in the swamp. This can facilitate the crops to utilize more nitrogen and other plant nutrients..."

"...Plot 1 to Plot 5 are designated as the experimental plots to monitor change of acidity in the acid sulfate soil using methods proposed by the Land Development Department..."

On 5 October 1992

Given at the Pikun Thong Royal Development Study Centre.

"...The "Klaeng Din Project" has its own reasons like I said 3 or 4 years ago. Water is needed to make the soil work. When the soil works, it will not get angry. At first, nobody believed in this method, but the experiment conducted here has shown that this method works. Therefore, the results of our research here are one of the most important issues. Foreigners who have come to visit seem to be satisfied. They have the same problems which cannot be solved and cannot find any textbooks about how to solve the problems...".

"...The "Klaeng Din Project" should carry on and focus on the research as well as extension of the research to see how the acidity changes after the plot has been left abandoned for one year. This is because that soil horizon contains sulfur compound. If we add water and air to the soil, such chemical reaction can give rise to sulfur oxide and sulfuric acid. If we stop the oxidation of those sulfur compound, the sulfuric acid cannot be produced. Therefore, if some experimental plots remain unused, the monitoring of the soil acidity should be conducted to see if it returns to the original condition. If it does, we should see if we can improve it again. This process of study may require some time, for instance about a year. If we do not use the land for cultivation, the study should be conducted to see how much the soil condition has deteriorated and how long it would take to bring back the favorable condition...".

"...After those acid sulfate soils have improved, water can be used to reduce soil acidity to the stage that the soil can be cultivated. These soils should be left idling so that the study can be conducted to see if the sulfur compound in the soil is oxidized or not. If it is, it must be solved again, and we should monitor the period of time until the soil it can be utilized again...".

"...This study should be turned into a textbook that can be distributed to other areas. Other potential experimental areas may now need to be subdivided into small plots like those in Pikun Thong Center. The dikes around the project area can be replaced by canals, and roads or bridges can be constructed as well...".

"...Observation should be made to see how long the effect of liming material on the soil lasts. However, liming alone may not be very effective, so water application in the field should be made in addition. Liming material alone may not be expensive; however, the cost of transportation to the field can be very high. So the farmers have high investment costs. If the water supply is available, the farmers can cultivate various crops all year round. However, the farmers are always facing a lack of the labor to help put liming material in their field ..."

On 9 October 1992

Given at Khok It - Khok Nai Village, Pron District, Tak Bai District, Narathiwat Province.

"...I used to come to Khok It - Khok Nai Village, the farmers said that they grew rice on their farmland but the yield was only 50 to 100 kg/rai per rai. Now, after soil improvement, the rice yield has increased by upto 400 – 450 kg/rai which is fairly good. From now on, the soil will not be acidic any more, and this is because the soil has been treated so it has become extremely acidic. Then, the water is used to wash away the acidity from the soil. Since this method of soil improvement was first used here, the soil quality has improved. This is a victory in that we have succeeded in improving the soil, and in helping the farmers improve their livelihood. In the past, the farmers had to buy rice for their own consumption, but at present, the farmers can produce enough rice to sell..."

On 28 September 1993

Given at Khok It - Khok Nai Village, Pron District, Tak Bai District, Narathiwat Province.

"...For the topic of development research, let the Pikun Thong Royal Development Study Centre make the demonstration plots to showcase how to solve the problems of acid sulfate soil in the areas of Yuyo village and their surrounding villages. The purpose of this demonstration is to let the farmers see the system of acid sulfate soil improvement appropriate for crop production..."

His Majesty paid a visit at a profile pit to observe the soil at the Klaeng Din Project, the Pikun Thong Royal Development Study Centre, Mueang District, Narathiwat Province on 14 October 1993.

On 14 October 1993

Given at the Pikun Thong Royal Development Study Centre.

"...There was a need to conduct a study of the soil profile focusing on the engineering properties in the swampy area of the Pikun Thong Royal Development Study Centre. However, because the soil in the swamp is very soft and has low bearing capacity, It any construction would require a number of the deep piles in the layer of bed rock that may be as deep as 40 m or more. Therefore, more information about this issue should be sought via research in order to learn about the characteristics of the soil horizon and the depth of the bed rock. This study can be used as an important soil database for any construction work which needs to be done in swampy areas..."

"...Continue to study the temporal change of the soil acidity of the acid sulfate soil for the Klaeng Din Project. The period of study should be long enough to see how long the acidity lasts..."

On 4 October 1996.

Given at the Bang Toei water regulator, Bang Khun Thong Subdistrict, Tak Bai District, Narathiwat Province.

"...The acid sulfate soil development project at Khok Krathom Village, Pron District, Narathiwat Province is already well irrigated. However, the farm lands of the farmers consist mostly of acid sulfate soil which cannot be utilized. Therefore, the Pikun Thong Royal Development Study Centre should proceed by implementing the same methods done at Khok It – Khok Nai Project..."

On 6 October 1996
Given at the Narathiwat airport, Narathiwat Province.

"...Try to introduce the results and the research on the improvement of the acid sulfate soil of the Pikun Thong Centre to apply at Yuyo Village..."

6.1.1 Amelioration of the Acid Sulfate Soil as Initiated by His Majesty the late King

In accordance with the Royal Initiative Given on 16 September 1984, the Pikun Thong Royal Development Study Centre was assigned to conduct a study in relation to the amelioration of the acid sulfate soil called "the Klaeng Din Project". The results of the study can be summarized as follows:

The soil in the swamp located as a representative soil for the study. Initially, the soil as deep as 2 m was examined in detailed by means of sampling and analyzing the properties. In general, the soil has a texture of silt loam to silty clay loam down to a depth of 1 m from the soil surface. Below this, the soil is underlain with a bluish grey muddy layer. This muddy layer contain an appreciable amount of pyrite compound (FeS_2), which with oxidation, can produce sulfuric acid and make the soil extremely acidic. No sulfuric acid would be produced if the soil is saturated with water. Therefore, the process of "Klaeng Din" as so called by His Majesty the late King means to make the soil wet and dry at different times of the year within the designated intervals so that oxidation of pyrite compound can occur, and the level of acidity of the sulfuric acid in the soil reaches its maximum 3 years after this experiment took place, the soil became extremely acidic and had a pH value of about 3.8 – 4.0. After that, this soil was cultivated for a number of economic crops which died after a short period of germination. Therefore, His Majesty the late King instructed relevant parties to continue the study to solve the problem of extremely acidic soils so that various economic crops especially paddy rice could be grown, and appreciate amounts of yields could be produced. The results of the study can be concluded thereinafter.

There are four important factors to solve the problem of acid sulfate soil for cultivation.

1) The ground water table should be maintained as high as 1 m below the soil surface. This will prevent oxidation of the pyritic compound that occurs in such a deep subsoil. Therefore, if needs supplementary water from the irrigation system.

2) The soil acidity and toxic substance can be washed away from the acid sulfate soil by using the irrigation water. Optimum time for washing is about 2-4 weeks per one wash.

3) Application of liming materials can help neutralize the acid from the soil and water. Liming materials can be various kinds of carbonate compounds such as quick lime, marl, dolomite or limestone dust. The rate of application depends upon the types of crops grown; however, the average rate equals 1-3 ton/rai. If liming material is applied together with the acidity wash, the amount of liming material can be reduced by half compared to the normal rate.

4) Planting of the crops that are tolerant to the acidity.

Some examples of acid tolerant rice varieties are Hom Dok Mali 105, Pathum Thani 1, RD 31, 41, 47 and 48 and Luk Daeng.

Some examples of acid tolerant fruit trees are mango, jackfruit, santol, native olive, tamarind, guava and bamboos.

Some examples of acid tolerant fast growing trees (without the need of soil improvement) are Casuarina spp., Eucalyptus spp., Acacia mangium, neem tree, Eugenia sp., Mahogany, and Melaleuca spp.

It should be noted that if the improvement of the acid sulfate soils is implemented, paddy rice can be cultivated at a low cost. On the other hand, if there is a need to grow upland crops, vegetables, or fruit trees, ponding systems and raised – bedding for crop growing need to be put in place. However, to make the raised – bedding, the high acidic subsoil should not be placed on the top of the surface on the ridge. Moreover, there should be a pumping system to drain excessive water out from the farm in the rainy season to avoid floods. In addition, the new theory of the farming system as initiated by His Majesty the late King can be implemented once the areas with acid sulfate soil have been improved.

Moreover, after soil improvement is completed, and the water – logging problem is solved, grasses for feeding various kinds of livestocks can be grown with high productivity. In order to dig a pond for fish farming where soil has high acidity, improvement of the qualities of water and soil will be necessary. After that, they can be used for raising various kinds of fish namely, catfish, tilapia, common carp and white ribbon.

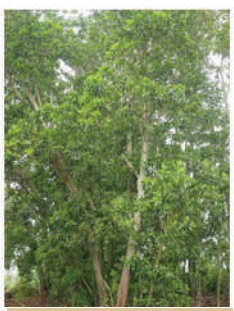
Acid-tolerant fast-growing trees


Melaleuca


Neem tree


Mahogany


Eugenia


Acacia


Eucalyptus


Casuarina


Reed

6.1.2 Technology Transfers of the Klaeng Din Project

The results of the study on Klaeng Din Project have been applied to improve the quality of the acid sulfate soil in many places. The first pilot project which was initiated by His Majesty the late King to implement the results of the Klaeng Din Project was the improvement of the acid sulfate soil at Khok It-Khok Nai Village, Tak Bai District, Narathiwat Province. This project started in 1990.

The implementation of the such project seemed to be very successful, and this was confirmed with the statement of His Majesty the late King who paid a visit to the project site on 9 October 1992. Part of the royal statement can be quoted as follows:

> **"...I used to come to Khok It-Khok Nai Village, the farmers said that they grew rice on their farmland but the yield was only 50 to 100 kg per rai. Now, after soil improvement, the rice yield has increased by upto 400-450 kg/rai which is fairly good. From now on, the soil will not be acidic any more, and this is because the soil has been treated so it has become extremely acidic. Then, the water is used to wash away the acidity from the soil. Since this method of soil improvement was first used here, the soil quality has improved. This is a victory in that we have succeeded in improving the soil, and in helping the farmers improve their livelihood. In the past, the farmers had to buy rice for their own consumption, but at present, the farmers can produce enough rice to sell..."**

The paddy field at Ban Khok It-Khok Nai before soil improvement

The paddy field at Ban Khok It-Khok Nai after soil improvement

At present, the results of the "Klaeng Din Project" have been implemented and the technology from the project has been transferred to the farmers and to other projects including the acid sulfate soil development program of the Pak Panang basin development project in Nakhon Si Thammarat Province, and the irrigation project of Khun Dan Prakarnchol Dam, Nakhon Nayok Province. In relation to the acid sulfate soil development project in Nakhon Nayok province, His Majesty the late King Bhumibol Adulyadej gave the royal speech on 4 December 1997, an excerpt of which can be quoted as follows:

> **"...The location that contains the acid sulfate soil is Ban Na District, Nakhon Nayok province. The provinces' name is Nakhon Nayok. (In Thai, Nakhon means a city and Nayok means the prime minister, so people may assume that the word means the city of the prime minister). Actually, originally, the word "nayok" had a full name of "Nayok pasee" which means the land tax for paddy field which has now been waived as yearly rice yields on those lands were not successful compared to the old days. Therefore, if we can improve those soils or can find the way to utilize those soils for successful cultivation, the name of this province may change to something like "nasomboon". ("na" means the paddy field, "somboon" means fertile, so the whole word can mean the fertile paddy field or the city of fertile paddy field). Nakhon Nayok Province consists of a hundred thousand rai of which have all been waived from the land tax. If the study can be made with success, I believe that the farmers' income will be increased..."**

Therefore, to demonstrate how to improve the acid sulfate soil in the central plain of the country, His Majesty the late King initiated the establishment of a project as so called "Study on the Acid Sulfate Soil Improvement Project under the Royal Initiative in the year of 1997." This project is located on the land belonging to Chaipattana Foundation, Ban Na District, Nakhon Nayok Province. So far this project is relatively successful.

6.2 The Measures for Solving the Problem on Soil Erosion

Soil erosion here refers to the loss of soil due to runoff water moving down slope when it rains. Mostly, the surface soil is removed or occurrences of rills or gullies on the ground surface can be observed.

Factors that are important to the intensity of soil erosion vary from place to place. Some common factors include the amount of rainfalls and the nature of raindrops, the slope length and the slope degree, vegetation covers and land management. In general, if the soil has been used for continuous cropping for some time with improper cultivation, extreme soil erosion can occur when compared with areas with forest covers where soil erosion rarely takes. When the surface soils are eroded away, the fertility of the soil will be lost. Mass of soil losses will be transported to the natural water resources, and the sedimentation can be seen as demonstrated by the high level of turbidity and the shallowness. Any streams or rivers that show a high level of turbidity of the sediment, which indicates that the upstream often has the problem of soil erosion, which requires proper soil conservation practices. Even though the evidence of soil erosion can be observed in most natural streams or rivers in various parts of the country, there is still a lack of community awareness of the problem or long-term solutions.

To solve the problem of soil erosion, there are two broad types of soil conservation practices namely, the mechanical method and the vegetative method. They can be summarized as follows:

1.The mechanical method is dealing with construction of various structures on the landscape so that the velocity of runoff water can be reduced. This, in turn, results in less degree of soil erosion. Some examples of the mechanical method to prevent and control soil erosion are contour tillage, diversion terrace and bench terrace. However, control of soil erosion by various mechanical methods are still not popular among farmers. Even though the contour tillage is one of the most simple and easy soil conservation practices, it is still not widely practiced. This is due to that fact farmers prefer to hire tractors which prefer to plow the land up and down the slope, which is an easier and faster task.

2.The vegetative method is the practice of using vegetation to prevent soil erosion. This method needs less investment, and the farmer can easily use it. Some examples of the vegetative method are mulching, contour cropping or strip cropping which requires planting of strips conservation vegetation in between strips of the economic crops. The conservation vegetation can include grasses and legumes.

His Majesty the late King was truly interested in the vegetation method used to solve soil erosion. His Majesty initiated the idea of using vetiver to the concerned agencies as a method to control soil erosion.

Patterns of soil erosion

Sheet erosion

Rill erosion

Gully erosion

Badland

Up and down hill plowing which can induce soil erosion

Terracing without a proper structure which can induce soil erosion

Mechanical measures for soil erosion control

Contour plowing

Diversion

Terracing

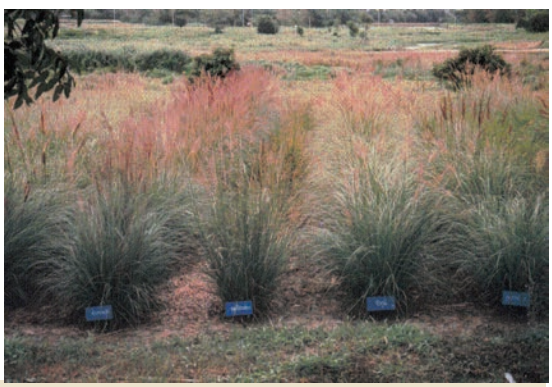
Hill side ditch

Vegetative measures for soil erosion control

Cover-crop planting

Mulching with crop residues

The Royal Initiative in vetiver planting of different means as examples of vegetative measures for soil erosion control



Plant propagation plots of vetiver

Deep root system of vetiver

Upland vetiver

Lowland vetiver

6.2.1 Collection of the royal statements related to the development and campaign for using the vetiver for soil erosion prevention.

The following are the royal statements of His Majesty the late King in relation to the projects on the development and campaign for using the vetiver, compiled by the Office of the Royal Development Projects Broad (ORDPB) from 22 July 1991 to 25 July 2011, totaling altogether 30 events.

1) On 22 July and 29 July 1991

The first statement on vetiver growing was given by His Majesty the late King to Dr. Sumet Thantivejkul, the Secretary of ORDPB at Chitralada Villa and Klai Kangwon Villa, Hua Hin District, Prachuap Khiri Khan Province, parts of which can be concluded as follows:

1.1) Try to conduct the study of using vetiver to control soil erosion at all Royal Development Study Centres and other appropriate areas. Huai Sai Royal Development Centre and Khao Hin Sorn Royal Development Study Centre should be used as the main study areas.

1.2) Research on vetiver growing should consider the following 2 appropriate landscapes,

1.2.1) On the hilly terrain, growing of vetiver should be done in horizontal rows following the contour of the terrain and also along the creeks, which can prevent soil erosion and preserve soil moisture.

1.2.2) Growing vetiver on the flat terrain, the cultivation methods should be

- planting around the farm land
- planting in the cropping area, 1-2 rows are needed
- planting in the furrow on the cropping area

1.3) The results of the study should show the growth rates of both the stem and root of the vetiver, capability of the vetiver to conserve soil fertility, moisture retention in the soil and the varieties of the vetiver as well.

2) On 5 July 1991

The royal statement was given to Mr. Pramote Maiklad, the director of the Office of Special Task, Royal Irrigation Department, and Police Colonel Theeradej Rodphothong, the director of the Huai Sai Royal Development Study Centre at Klai Kangwon Villa, Hua Hin District, Prachuap Khiri Khan Province. Parts of the royal statement can be summarized as follows:

2.1) His Majesty studied the natural methods of the soil conservation for a long time and found that to start using a new piece of land for farming, the surface soil was always removed. For instance, conventional tillage is often practiced, and His Majesty recognized that this could bring about problems in the future. So His Majesty stressed that the Huai Sai Royal Development Centre not cultivate in such a way that the soil would be destroyed. For example, the surface soil should not be removed or plowed to explore subsoil. His Majesty instructed all agricultural projects of Huai Sai Centre to follow His recommendation and become a model for local farmers.

2.2) His Majesty studied documents related to soil conservation by growing vetiver published by the World Bank. So His Majesty instructed the Huai Sai Royal Development Study Centre to conduct a study on using the vetiver to prevent soil erosion. Also, vetiver should be grown in different types of land such as along the natural water channels, in cashew nut farms, in sloping areas and along natural creeks. For natural creeks, simple check dams made from rocks should be constructed and vetiver should be planted in front of the dams. In addition, vetiver can be grown in agricultural areas such as land for cultivation of maize. Photographic recording should be made both before operation and after operation. The study should be conducted by Huai Sai Royal Development Study Centre in and should be made a model for vetiver growing.

3) On 7 July 1991

The royal statement was given by His Majesty the late King during His Royal visit at Suan Huad Sai Yai Project, Pranburi District, Prachuap Khiri Khan Province. Parts of the royal statement can be quoted as follows:

> **"...Vetiver should be grown here because this grass is very useful in preventing soil erosion and can hold the surface soil together since the project area contains a great deal of sloping land. Moreover, the vetiver can also conserve the organic matter in the soil. Young leaves of vetiver can be used as livestock feed as well..."**

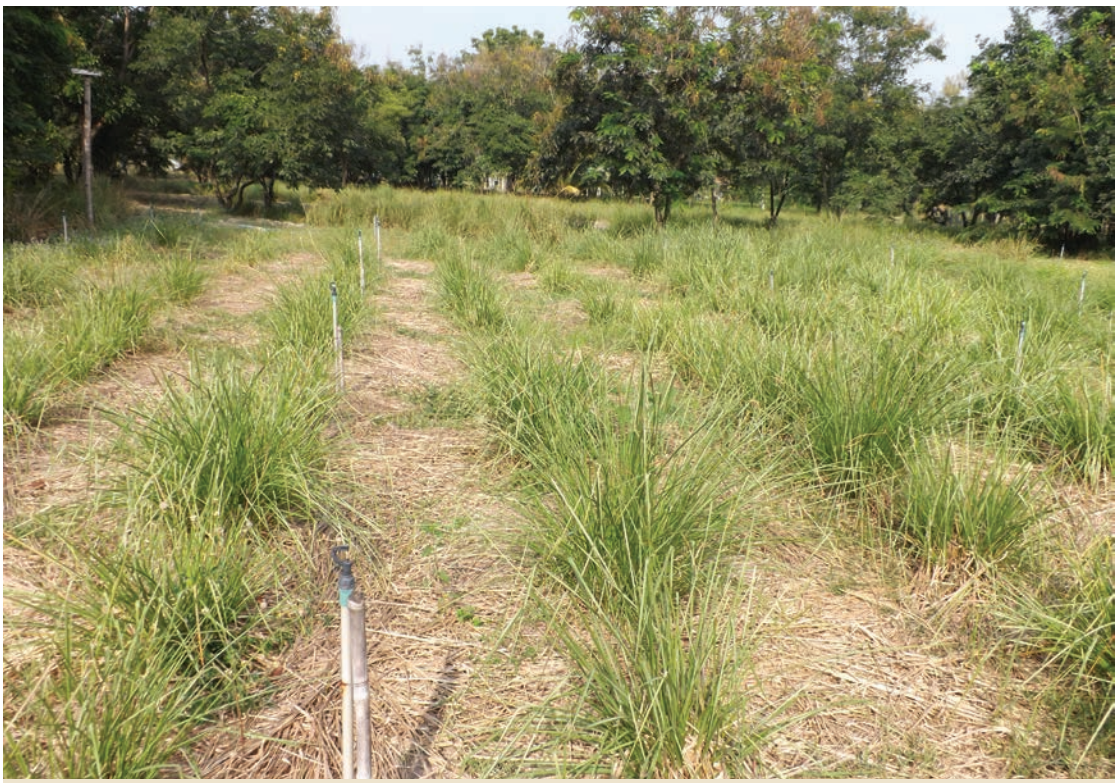
4) On 19 February 1992

During the royal dinner at Bhubing Rajanives Palace, Mueang District, Chiang Mai Province, His Majesty the late King recommended the officers from the Police Border Patrol Department to grow vetiver in the areas of Police Border Patrol Camps and nearby villages all over the country. This is because vetiver consists of the common characteristics for the soil conservation especially to grow as the fence along the contour lines, a method of which has been proven successful in many Asian countries. Furthermore, growing vetiver can also increase the production of the upland crops that are grown between vetiver rows.

5) On 20 February 1992

His Majesty the late King Bhumibol Adulyadej, Her Majesty Queen Sirikit and Her Royal Highness Princess Maha Chakri Sirindhorn paid a visit the Royal Highland Development Project at Huai Kaew Subdistrict, Mueang District, Chiang Mai Province and observed the plots of vetiver varieties from Thailand and foreign countries. In addition, they also visited the experimental plots in which vetiver was planted vertically across the natural channel to reduce the flow of the water discharge in the water channels and to allow accumulation of the soil organic matter in front of the vetiver rows.

After that, Their Majesties visited the vetiver plots for propagation at the sixth Regional Office of the Land Development Department, Chiang Mai Province. At the site, His Majesty the late King gave a royal speech that can be concluded as follows:



Collection plots of vetiver varieties

5.1) Vetiver is the plant that has a long root system. All roots vertically penetrate to the deep soil and function as a living wall to filter sediment and to prevent soil surface wash-off. Therefore, vetiver cultivation should be studied and experimented.

5.2) To grow vetiver, it is recommended that it is planted in single rows with approximately 10-15 cm gap between plants. This growing method does not require a lot of space, and vetiver can be taken care of very easily. Moreover, vetiver should also be grown in water channels and on sloping land to control the rate of soil erosion.

5.3) Growing vetiver as a method for soil conservation is a new approach. Although many do not expect great results, the results seem to surpass their expectation. Moreover, there is no need to grow vetiver on the farmers' land, but they should be grown in the areas of the Land Development Stations for demonstration. The varieties which do not reproduce via flowering, and which can withstand drought and can still stay green during the dry season should be used. Planting time of vetiver should be right before the rainy season. This will allow the local farmers to easily see the results.

6) On 24 February 1992

His Majesty the late King Bhumibol Adulyadej and Her Royal Highness Princess Maha Chakri Sirindhorn paid a visit to Huai Hong Krai Royal Development Study Centre where Dr. Sumet Tantivejkul the Secretary of ORDPB, Mr. Pramote Maiklad, water management specialist, Royal Irrigation Department, and Mr.Pimolsak Suwannathat Deputy Secretary of ORDPB received a royal audience.

His Majesty visited the areas of vetiver plots at the Chiang Mai Land Development Station, Chiang Mai Province on 20 February 1988.

During their royal visit, His Majesty the late King and Her Royal Highness Princess planted vetiver and gave royal speeches that can be concluded as follows:

6.1) Vetiver growing should be continued because not only does vetiver conserve soil and water, but also its root can hold the soil water, which allows soil to retain enough moisture that is useful for the growth of the cultivated upland crops or tree crops. Another advantage of vetiver is that it can store nitrogen for the soil and can prevent toxic substances and some chemical compounds from percolating through to the ground water which, in turn, prevents pollutants from those substance from entering canals or rivers.

6.2) A study should be conducted on the selection of vetiver varieties that are suitable for each physiographic region. Those selective varieties should promoted and distributed to other regions especially those with sloping areas prone to erosion such as the areas of Khao Cha-ngum Land Rehabilitation Project and the Wat Yannasungworn Project. The planting period should be before the rainy season for 3 months so that the vetiver will become strong enough to resist the runoff water in the rainy season. Furthermore, a study should be conducted on vetiver growing in water channels to serve as a check dam. In addition, vetiver should be planted on the steep side slope of highways as well.

7) On 19 March 1992

His Majesty the late King Bhumibol Adulyadej and Her Majesty Queen Sirikit visited the Pang Thong Highland Development Project, Mok Jampae Subdistrict, Mueang District, Mae Hong Son Province, during which His Majesty recommended that vetiver be planted 3 months before the rainy season especially in the area that does not have enough water. This is because after 3 months of growing, vetiver would be strong enough to resist the high velocity of the runoff water in the rainy season

8) On 14 May 1992

His Majesty the late King Bhumibol Adulyadej gave royal statements to the minister of Ministry of Agriculture and Cooperatives at Chitralada Royal Villa. Parts of the royal statements can be concluded as follows:

8.1) Vetiver growing projects should be implemented all over Thailand within two years even though the cost may be relatively high.

8.2) Vetiver varieties selected should be ones that cannot be reproduced by seed propagation.

8.3) The root length of the tiller should be about 15 cm. If the tiller is planted in a plastic bag, the whole bag can be placed directly in the planting hole without the need to cut the bag off in order to allow the root to penetrate the soil directly.

8.4) Vetiver growing can be implemented in most areas of the agricultural land, around the ponds or water sources, and in forest areas. Also, it can be implemented in water channels to prevent deposits of soil particles in the water. Moreover, the dense vetiver roots can help retain moisture in soil.

8.5) At the Huai Sai Royal Development Study Centre, vetiver growing is recommended for the Muslim village there to increase the accumulation of soil surface. On the other hand, at the Khao Cha-ngum Land Rehabilitation Project, vetiver growing should be done in a continuous single row in the upper part of Khao Khiew Mountain. In the early stage of planting, soil would be added in front of the vetiver row to accelerate the growth of the vetiver. When the vetiver is fully developed, it can increase the quantity of the soil surface.

9) On 8 June 1992

His Majesty the late King Bhumibol Adulyadej paid a visit to the Khao Cha-ngum Land Rehabilitation Project, Photaram District, Ratchaburi Province. During the royal visit, His Majesty made the statements, parts of which can be expressed as follows:

9.1) It is important to select the vetiver varieties that do not reproduce through the seeds. Otherwise, it will be dangerous.

9.2) It is recommended to grow vetiver around the reservoir bank in 3 rows as follows:

- row 1, growing vetiver at the maximum water level
- row 2, growing vetiver about 20 cm above row 1
- row 3, growing vetiver about 20 cm below row 1

(This is because the water level always reaches its maximum)

Growing vetiver around the reservoir bank can offer two advantages namely,

9.2.1 It can prevent erosion of soil into the reservoir, which in turn, can reduce sediments which make the reservoir shallow. If there is a need to use the soil from the reservoir for some purposes, a backhoe can run across the vetiver rows to get the soil from the reservoir, and the vetiver will not die.

9.2.2 Planting rows of vetiver on the bank around the reservoir can help maintain the surface soil on the bank. It can also make the soil more fertile and can increase the growth of the forest in the watershed area above the reservoir.

9.3) Vetiver should be grown on the soil with a shallow hardpan and should be allowed 2-3 years to grow before a study is conducted to determine how well the roots penetrate the shallow hardpan.

9.4) When growing vetiver in water channels to prevent water erosion, one should consider the following issues:

9.4.1 If the water channel is wide and deep, vetiver should be grown in the form of an upside-down letter V across the channel in a number of the rows, but the apex of rows should be pointed upstream. The rows of the vetiver should resemble the fish skeleton. The distance between the vetiver rows is about 1 m. This planting method can reduce water erosion, and the water can easily infiltrate the soil in front of the vetiver rows.

9.4.2 Vetiver growing should be made in the row across the water channel. This will help trap the sediments in the water channels, which will eventually be completely filled up.

9.5) A study should be conducted to investigate whether vetiver growing can control the growth of lalang grasses (Imperata cylindrica). The method should involve planting vetiver around an area of lalang grasses. Once the vetiver reaches the maximum growth stage, set a fire in the area of lalang grass and observe how well the vetiver can stop the widespread of the fire.

9.6) Vetiver should be grown around fruit trees. This can protect the soil around the trees from eroding in the form of scattering holes. At the same time, vetiver leaves can be cut off and used as mulches around the fruit trees to conserve the soil moisture.

9.7) In the cropping areas, vetiver can be grown using different methods namely,

- planting around the cropping area,
- planning 1-2 rows in the cropping area, and
- planting in between the strips of crops.

9.8) For the mountainous areas, it is recommended that vetiver be grown along the contour of the terrain and across the water channel to prevent erosion of the surface soil and to retain moisture in the soil.

10) On 6 July 1992

His Majesty the late King Bhumibol Adulyadej and Queen Sirikit paid a royal visit to the Suan Haad Sai Yai Project. Their Majesties observed the vetiver propagating plots on the mountainous area and presented the royal initiatives that can be concluded as follows:

10.1) The vetiver should be planted closer together because the vetiver variety used here or its characteristics have not been identified. After that, His Majesty the late King planted the vetiver in the experimental plot by using the vetiver variety collected from Khao Tao.

10.2) After 5 days of the royal visit, His Majesty the late King ordered a specialist on vetiver growing to check the vetiver grown in the project area. The results of this investigation indicated that the vetiver variety in the project area were growing very well. His Majesty instructed expansion of the project and promotion of the in other areas.

11) On 22 July 1992

His Majesty the late King Bhumibol Adulyadej had paid a visit to Huai Sai Royal Development Study Centre, Cha-am District, Phetchaburi Province. Over there, he planted the vetiver grass on the vetiver experimental plots located south of a reservoir and gave the royal statement to the officers that can be concluded as follows:

11.1) More vetiver should be grown because it consist of very special characteristics which can conserve the soils, especially for the soils with hardpan in the Centre. Also, vetiver can act as a living dam to retain soil moisture and to increase the fertility in soil.

11.2) For growing vetiver on the sloping land, the vetiver rows should be around 1-2 m vertically apart in order to use the vetiver tillers as economically as possible. However, the vetiver tillers should be planted close together to allow faster growth. If the vetiver is grown around the fruit tree, it should be planted in a half circle similar to the structure of Chinese cemeteries.

3) Vetiver should be grown above the reservoir as a barrier to block the sediment and to absorb the toxic chemicals as well as the liquid waste that can be transported to the reservoir. The vetiver is capable of absorbing the toxic substance in its roots and stem, and later on, they will be decomposed to form the fertilizer for the crops.

12) On 28 August 1993

His Majesty the late King Bhumibol Adulyadej gave the Royal Initiatives to Dr. Sumet Tantivejkul at Chitralada Royal Villa, an excerpt of the Royal speech can be quoted as follows:

> **"...To grow the vetiver in the form of big tillers, the distance between the tillers should be around 15 cm. However, the small tillers can be planted about 2-3 cm apart. This will help the tillers grow better and will require the least number of tillers. With this method, within 2 months, vetiver can develop successfully. On the contrary, if big tillers are planted, the maximum growth requires about 2 years, which is too slow. At Doi Tung,**

big vetiver tillers were used and the distance between tillers was rather small, so it required a lot of vetiver tillers. It was an experiment that expected quick results. We can conclude then that one should use small tillers and the distance between the tillers should be very small. For the distance between vetiver rows, it is suggested that it should be about 2 m. However, because the human height is around 2 m, to make it easier to work in the field, 1.5 m would be more convenient...”

13) On 15 July 1996

His Majesty the late King Bhumibol Adulyadej and Her Royal Highness Princess Maha Chakri Sirindhorn visited the Khao Cha-ngum Land Rehabililation Project, Photharam District, Ratchaburi Province. Over there, His Majesty the late King gave the royal initiative on vetiver growing to Dr. Sumet Tantivejkul, Mr. Jari Tulyanon, Mr. Sawat Watanayakorn, Mr. Rungruang Julacharti, Mr. Pramote Maikla, Mr. Sittilarp Vasuvat, Mr. Sima Molakul, Mr. Payung Nopsuwan and other government officials. This royal initiative can be concluded as follows:

13.1) The distance between vetiver tillers to be grown should be about 5 cm.

13.2) Planting vetiver around fruit trees and other trees in circular rows to conserve soil moisture may cause the problem of competition for plant nutrients between the trees and the vetiver. Since the vetiver has a dense root system, they may absorb more plant nutrients and thus, this can hurt the tree growth. Therefore, one should plant vetiver in the form of a half circle downslope around the trees. This can solve the problem, and the vetiver rows can help conserve the soil moisture.

13.3) To protect gully erosion in the channel, it is recommended to grow vetiver in a row across the water channel in the form of upside down V (^) with the apex pointing upstream. When the water in the stream flows downslope, the vetiver row can reduce the water discharge and can prevent gully erosion in the channel. Moreover, the vetiver row can trap the sediment to allow them to deposit in the channel.

13.4) For planting vetiver on the lateritic soil, an auger should be used. The planting holes should be filled with good soil before planting the vetiver. The root of the vetiver can develop very well and can penetrate deeper into the lateritic soil.

13.5) Vetiver growing all over the project area of the Khao Cha-ngum should be encouraged.

14) On 6 August 1996

His Majesty the late King Bhumibol Adulyadej, Her Majesty Queen Sirikit and Her Royal Highness Princess Maha Chakri Sirindhorn paid a royal visit to the Huai Sai Royal Development Study Centre, Phetchaburi Province. There, His Majesty gave the royal initiative on vetiver growing to Dr. Sumet Tantivejkul, Mr. Pramote Maikla, Mr. Chaicharn Chalothon and other officers. The royal statement can be summarized as follows:

14.1) The vetiver should be planted in a circular row around fruit trees with a narrow distance between the tillers. If the vetiver circle is planted close to the tree, the tree will have a moisture stress because vetiver will absorb a great deal of water and reduce

the water supply to tree roots. Therefore, the vetiver should be planted around the tree in the form of a half circle and with narrow distances between the tillers.

14.2) Regarding reforestation in the area of Khao Thong (the name of a hill), it is recommended that all plants covering the soil surface should not be cleared. This is because all surface soil, water and natural fertilizers will be washed downslope. Longer vetiver rows should be planted in ^ shape which, in turn, will eventually fill the water channel with the sediment. If the channel is rather deep, check dams should be made before planting the vetiver in front of the check dams.

In the area where vetiver is planted in the planting hole made by augering, some areas can be dug to form a furrow so that the vetiver root can better penetrate the soil.

- In the area of hardpan soil, vetiver can be grown in between the rows of the vetiver fence. An auger can be used to make the furrow with compost in the furrow.

- The height of the vetiver tillers should be about 30 cm. Moreover, the soil between the vetiver rows is relatively fertile, so it can be used for growing annual crops or intercropping with fruit trees.

14.3) For planting vetiver to fill the gaps between the tillers of a vetiver row, it is recommended to dig the soil at the gaps and fill them with compost, and then to plant the vetiver tillers less than 5 cm apart. The leaves of the already planted vetiver near the gaps need to be trimmed off, so that the sun light can reach the newly-planted tillers. After that, regular watering is required to allow the new tillers to grow. The soil that is trapped in front of the vetiver rows is very fertile and can be as much as 35 cm thick. The method of planting more vetiver tillers to fill gaps in existing vetiver fences has proven effective in improving soil quality, and should thus be promoted.

15) On 3 April 1997

His Majesty the late King Bhumibol Adulyadej paid a visit to the Huai Sai Royal Development Study Centre. The itinerary of the royal visit can be summarized as follows:

15.1) The first stop: the experiment trial on making use of the vetiver on the hard pan soil. At the site, the royal initiatives can be concluded as follows:

- His Majesty instructed relevant parties to make a planting hole on the hard pan soil and then fill it with the friable soil. Later on, the relevant units were instructed to plant the vetiver in the hole so that the root of the vetiver could penetrate through the hard pan. Consequently, the vetiver root would introduce moisture to break the hard pan layer.

- His Majesty instructed relevant units to conduct an experiment trial to grow vetiver in the row along the contour line with the 5 cm distance between the tillers in the row. The row of vetiver can prevent soil erosion and can trap the soil sediment in front. In addition, this sediment can be collected and used for growing various crops.

- His Majesty instructed relevant units to plant a vetiver row around a tree like the boundary of the Chinese cemetery (half circle) in order to conserve the soil moisture for the tree.

15.2) The second stop: the soil and water conservation project at the Khao Borking watershed area. At this stop, he initiated the following suggestions.

- To plant the forest trees and vetiver in rows along the contour line. When rain comes, runoff water will carry the leaves of the trees which will then be trapped by the vetiver row. This in turn can improve soil fertility. Reforestation can be conducted by the Royal Forestry Department, but growing of vetiver should be the responsibility of the Land Development Department. The Huai Sai Royal Development Study Centre should act as the coordinator between those two Departments.

16) On 23 April 1997

His Majesty the late King Bhumibol Adulyadej visited the Khao Hin Sorn Royal Department Study Centre. At the center, he gave the royal initiatives which can be concluded as follows:

16.1) The first stop: the dam site at the Huai Jek Reservoir.

- To plant the vetiver around the forest boundary to prevent soil erosion. The leaves of the trees on the ground are completely decomposed, and such decomposition will improve soil quality. The vetiver that were planted between the rows of the trees will survive, but their growth rate may be stalled for a period of time. Once the trees are cut down, the vetiver will grow again. In the areas with hard pan soil, vetiver can be planted in planting holes that need to be dug. After that, the roots of the vetiver will penetrate and break the hard pan. In addition, in front of the vetiver, the sediments and the falling leaves can be trapped, which in turn allows new soil to develop.

16.2) The second stop: the Uttayarn Muscha Villa. His Majesty the late King gave royal initiatives to the director of the Khao Hin Sorn Royal Development Study Centre as follows:

- To conduct a study on growing the vetiver on the hard pan soils similar to those at the Khao Cha-ngum Land Rehabilitation Project at Photaram District in Ratchaburi Province, and at the Huai Sai Royal Development Study Centre.

17) 9 May 1997

His Majesty the late King Bhumibol Adulyadej and Her Royal Highness Princess Maha Chakri Sirindhorn paid a visit to the demonstration plot for paddy rice growing at the Chitralada Villa. His Majesty the late King gave royal initiatives on soil conservation to Mr.Chucheep Harnsawat, the Minister of Agriculture and Cooperatives and relevant officers. They can be concluded as follows:

- Soil conservation practices should be conducted along with the reforestation program. Apart from the project on acid sulfate soil improvement which had previously been given, soil conservation by growing vetiver should also be conducted at a large scale in order to protect the soil surface and prevent the loss of it. This project was firstly practiced at the Huai Sai Royal Development Study Centre and at the Khao Cha-ngum Land Rehabilitation Project. Moreover, other royal development study centres should establish the same trials of vetiver growing. Therefore, the Ministry of Agriculture and Cooperatives should extend vetiver growing in other areas that need to improve and conserve soil and water that have already degraded.

18) On 24 July 1997

His Majesty the late King Bhumibol Adulyadej and Her Royal Highness Princess Maha Chakri Sirindhorn paid a visit to Kasetsart University for the commencement ceremony. A part of the royal speech given to the graduates can be quoted as follows:

> **"...Everybody should carefully pay attention to the stories, people and things around them and related to them. Do not ignore even little things such as grass. If we consider them very seriously, they can bring about appropriate knowledge. Grass may be a kind of noxious weed or can be very useful, for the purpose of soil and water conservation. This is because the root can penetrate vertically deep into the soil, and they can hold water and the soil particles tightly. Also, the dense tillers in the form of a row can help trap soil sediment and can preserve the surface soil..."**

19) On 25 July 1997

His Majesty the late King Bhumibol Adulyadej and Her Royal Highness Princess Maha Chakri Sirindhorn presided over the commencement ceremony at Kasetsart University. Some parts of the royal speech can be quoted as follows.

> **"...Today, I would like to add something more. Good and useful things should be implemented theoretically, correctly and appropriately in order to achieve good results. For instance, to grow vetiver, we must make sure that the vetiver is planted in continuous rows and in accordance with the landscape. As an example, on the upland, one should plant it across the slopes and the channel. On the contrary, on the flat land, the vetiver should be grown around the farm land or plant between the strips of crops. For the reservoir areas, vetiver should be planted around the banks of the reservoirs above the water level. The vetiver that is grown using the aforementioned methods can help prevent soil erosion, can conserve soil moisture, and can trap the sediment as well as toxic substances so that such will not flow into the reservoirs or the farm ponds, the condition of which is very beneficial for soil and water conservation, land rehabilitation and reforestation. Graduates who are about to start their work-life should carefully study for appropriate implementation..."**

20) On 23 June 1998

His Majesty the late King Bhumibol Adulyadej visited the Huai Sai Royal Study Development Centre, Cha-am district, Phetchaburi Province and Mrigadayavan Palace, Cha-am District, Phetchaburi Province. There, he gave the royal speech, some parts of which can be quoted as follows:

> **"...People may not understand how soil can turn more fertile. A brief explanation is that the mountains above the soil are covered with forests, and when leaves fall to the ground, they are carried down slope by the rain water. If we do not grow vetiver or do not prevent falling leaves or other materials to flow into the channel, the soils cannot improve. On the other hand, if we plant the vetiver and construct a diversion bund, they can prevent those materials from flowing into the channel, and the soils**

condition can be recovered and can be used for cultivation. If we do nothing, the surface soil will be washed away, and what is left will be the hard pan and sandy material. Moreover, the fertile sediment will be washed downslope and accumulate making the channels shallower. When the channels become shallow, the water from the mountain can overflow to the low land. Furthermore, the run-off from the mountain will be rapid, potentially causing flash floods ...”

21) On 14 July 1998

His Majesty the late King Bhumibol Adulyadej had paid a royal visit at the Huai Sai Royal Development Study Centre, Cha-am District, Phetchaburi Province. Parts of the royal speech can be presented as follows:

“...It is important to understand that arable land in Thailand has become scarce. Therefore, we need to find marginal land and try to develop such land for utilization as well as pay attention to various usages. Moreover, to make the project successful, it is necessary to have cooperation among the government agencies including the Land Development Department and the Royal Forestry Development to study the issue together. If we can do this, Thailand will not face further problems...”

“...The planted vetiver rows can trap the water and fertilizers traveling down from the mountain. The mountain acts like the water supplying machine. The fertilizers form naturally. This will make land development possible. In addition, irrigation can be established together with forest development...”

“...If we are to create good soil on bad soil, do not use this hard pan layer because it contains no plant nutrients, and it is too hard. We need to form a new soil surface with the help of vetiver growing. Before planting vetiver, we must conduct soil boring for each tiller and then put the fertile soil in each planting hole. The vetiver roots can penetrate through this hole to allow better growth. Furthermore, the rain water moving down from the mountains will carry the leaves which will be trapped in front of the vetiver rows. As a result, the soil can be developed little by little to increase the soil volume...”

22) On 20 April 2000

His Majesty the late King Bhumibol Adulyadej gave a royal speech to the officers at Khao Borking, the Huai Sai Royal Development Centre at Cha-am District in Phetchaburi Province. Parts of the royal initiatives can be concluded as follows:

22.1) To experiment with growing trees and vetiver grass together, and to study suitable varieties of trees for the hard pan soil.

22.2) To conduct the trial for marginal-soil improvement by means of natural methods as follows:

- Growing vetiver on the hard pan soil to break the hard pan layer and to allow water to percolate through the soil.

- Planting forest trees together with the vetiver. The trees can be grown on the hard pan soil with the help of the vetiver which will supply water and nitrogen.

23) On 12 April 2001

His Majesty the late King Bhumibol Adulyadej gave an audience to Mom Rajawong Sam Chamcharus Rushnee and the personnel from the Royal Project at Chitralada Royal Villa who reported the progress of the project. The followings are the conclusions of His Majesty's royal initiatives in relation to vetiver growing:

23.1) To introduce the method of using vetiver and clay to construct economical storage houses on farms for the local people up-country. Once constructed, the storage houses should be used to store paddy and should be monitored to investigate how to control the high temperature in the storage houses. If the roof has a similar design as the same as Igloo, the temperature and moisture inside the house can be controlled. Furthermore, a study of how to prevent damages on the exterior wall of the storage houses caused by the moisture should also be conducted.

23.2) A study on termite control for vetiver should be conducted. A study on vetiver tissue in relation to damage from termites should also be conducted. The study should first focus on how to reduce substances that attract termites so that further problems can be eliminated when vetiver is used as industrialized material.

23.3) A study on the durability of plywood made from vetiver to use in the manufacturing of furniture and in interior design. One of the main focuses of such study should be on how to prevent damage from termites on vetiver plywood. Moreover, a study should be carried out to find a local alternative adhesive agent used in manufacturing vetiver plywood in order to replace the imported one commonly used.

23.4) Using vetiver as construction material should be promoted as it is economical, pollution-free, and energy-efficient. Such material can be handmade by the local people using vetiver ash as a substitution material for cement. The aim is to obtain a product that is durable and long-lasting. Also, vetiver tissue can be used as reinforcement. The proportion of vetiver ash in manufacturing such material should be studied in order to improve the quality so that it can replace synthetic material.

23.5) To demonstrate a model of changes in hydraulics of the fluid flow, erosion characteristics and the sedimentation observed with vetiver strips, His Majesty suggested the followings:

- Extend the model from a concept model to a model that can collect accurate data and is acceptable in the Engineering fields. Also, a test should be conducted to confirm geographical information.
- Data collected from the model should be applied in the field to reduce flood damage in agricultural areas.
- A study should be conducted on how vetiver and other vegetation can reduce or prevent nitrate pollution as a result of agricultural activities which percolate and contaminate the ground water below the soil surface.
- The use of moisture from the vetiver rows to reduce or prevent the damage from forest fire should be promoted.
- Vetiver growing operated by groups of farmers should be promoted as a means for additional income. This will help them control the quantity, quality and variety of the vetiver which should clearly be distinguished from vetiver growing on farms for preventing loss of the soil surface. Research should be conducted on how to reduce cost of production if vetiver is to be grown for additional income using separate tillers.

23.6) In order to make use of vetiver tissues for the melamine kitchenware industry, one should produce the suitable melamine kitchenware that match the natural vetiver color. Also, the legal patent should be obtained.

23.7) Approaches to the protection of the right of patent for vetiver products of the royal project are as follows:

- The working group on research and technology development of the vetiver should implement the initiatives because they are very useful for the public.
- A patent should be promptly filed for the outcome of the work so that they will become the national intellectual properties in the future.

24) On 13 September 2002

His Majesty the late King Bhumibol Adulyadej gave his royal speech at the Klai Kangwon Palace, Hua Hin District, Prachuap Khiri Khan Province as quoted below.

> **"...In cases of huge construction work, vast areas of land, especially in the area of foothill slopes, need to be opened and cleared. Vetiver growing can serve as as the pioneer plants for the land to be rehabilitated, for the landscape to be protected and for the natural fertility to be maintained..."**

25) On 16 November 2002

His Majesty the late King Bhumibol Adulyadej gave a royal speech at the Permanent Reforestation Project devoted for the Royal Recognition of PTT Company at Pranburi District, Prachuap Khiri Khan Province as follows:

25.1) Vetiver should be planted before or at the time of forest replanting. Proper methods of vetiver planting, which is planting along the contour line, should be ensured. From a map showing a reforesting project of the PTT Company, it can be seen that forest trees were planted downslope in the same way that the hill tribe people plant their cabbages, which is considered an improper way for forest replanting. The evidence can be observed by a large quanity of accumulated sediments at the foothills.

25.2) Vetiver should be planted as a strip to prevent forest fires in the reforested areas. To inspect the area, the forest workers always use motorcycles to travel along the vetiver strips. Moreover, the vetiver strip is different from lalang grass (Imperata cylendrica) because in the dry season, the lalang grass can catch fire very easily, while vetiver remains green as the root of the vetiver can absorb soil moisture which will keep the surface soil moist and can act as the natural breaker for the forest fire.

26) On 22 November 2002

His Majesty the late King Bhumibol Adulyadej gave the royal speech to Mr. Amphol Senanarong, the privy councilor, the National Research Council, and a group of researchers at the Salaruang Pavillion, Klai Kangwon Palace, Hua Hin District, Prachuap Khiri Khan Province which can be concluded as follows:

26.1) Vetiver is a kind of grass that can be utilized for several purposes. The major benefits of vetiver planting are preventing soil erosion and improving soil fertility. Moreover, the root of vetiver can penetrate deep into the ground and can absorb toxic substances that are often carried down by runoff water. Also, when vetiver is planted around the farm, it can also prevent termites and rats which are the main pests that damage crops. In addition, the vetiver strip can prevent snakes as well.

26.2) There are many kinds of termite. Some can damage the houses, while others can help improve soil conditions. However, termites that eat vetiver do not die immediately, but their digestive system may be affected.

26.3) Vetiver can serve the function of a firebreak as it can reduce damage of forest fires in the areas of reforestation or in natural forests.

26.4) Vetiver should be planted together with the forest trees especially on the mountainous areas. This can prevent soil erosion and forest fires since vetiver can be somewhat fire-resistant as the leaves are always green all year round. Furthermore, vetiver roots can absorb soil moisture. Thus, planting vetiver as firebreaks can prevent forest fires in the dry season.

26.5) Growing eucalyptus and pine trees on the mountains have been shown to induce forest fires. Therefore, vetiver should be grown along side these trees.

26.6) Using vetiver leaves to manufacture alternatives for plywood instead of using wood material can reduce the import of wood products and can decrease the rate of deforestation. However, the production process of vetiver plywood alternatives requires the import of expensive glue from foreign countries. Therefore, a study that can give rise to the local manufacturing of such glue should be conducted. This glue should be high quality and inexpensive to reduce the potentail national expenses.

26.7) A specific study should be conducted on how to extract and produce essential oil from vetiver roots, although this can be expensive. Vetiver should be grown for this purpose and no digging up of vetiver tillers in the reforesting projects should be done for this purpose.

26.8) An investigation should be conducted to see the feasibility of promoting and using vetiver leaves as the raw material for home products. Such investigation should look into whether there will be enough supply of vetiver for the industrial manufacturing of vetiver-based home products as this would potential require a large quantity of vetiver. The study should focus on, among other issues, the optimum use of vetiver in such a way that it will not affect the main objective of vetiver growing, which aims at soil erosion control. Therefore, a separate cultivation area for vetiver which will be used for purposes other than reforesting should be prepared. In addition, research on other possible raw materials for the manufacturing of the alternative synthetic plywood should be conducted as well.

27) On 22 February 2003

His Majesty the late King Bhumibol Adulyadej gave the royal initiatives to Mom Rachawong Sam Chamcharus Rushchanee and the working group of Vetiver Development for Economic Crop, a Highland Royal Project at the Ruang Pavilla, Klai Kangwon Palace, Hua Hin District, Prachuap Khiri Khan Province. The royal initiatives can be concluded as follows:

27.1) The vetiver varieties in Thailand should be registered to obtain the legal patent as soon as possible. The process to obtain the patent should be carried out even with some vetiver varieties which may not be appropriate for the current purposes in order to prevent misuse of the plant.

27.2) The Land Development Department is responsible for soil amelioration and improvement to ensure high fertility. One method to ensure high soil fertility is growing vetiver. Also, the department should prepare a sufficient quantity of vetiver for those who wish to grow vetiver.

27.3) Understanding of farmers in vetiver growing and a sufficient quantity of vetiver supply should be ensured. To date, the supply of vetiver is insufficient. While the supply is being increased, vetiver growing can initially cover 10, 50 or 100 m, and this can later be extended to cover the entire area.

27.4) His Majesty the late King also conveyed a message to the Prime Minister who serves as the representative of the government that the government should assist and support vetiver growing throughout the country. This can be very beneficial to the country in the future.

27.5) Planting of the vetiver requires proper methods. The distance between vetiver tillers should not be too wide as it cannot intercept the runoff water, the sediments and the humus. If the vetiver is grown in contour intervals, it can serve as a wall to reduce downslope water runoff. The suitable interval between tillers should be 5 cm. When the vetiver has fully grown, it will become very dense and highly effective for soil erosion control.

27.6) Vetiver can help absorb nitrogen. If nitrogen percolates down to the ground water, it can be accumulated in the water resource and become a toxic substance in the water which is hard to eliminate. Therefore, vetiver can be used to absorb toxic substances and can protect the environment.

28) On 4 August 2005

His Majesty the late King Bhumibol Adulyadej gave a royal speech to Kunying Sudarat Keyuraphun and the high-ranking officers of the Ministry of Agriculture and Cooperatives at the Piemsuk Villa, Klai Kangwon Palace, Hua Hin District, Prachuap Khiri Khan Province which can be quoted as follows:

> **"...Vetiver has to be planted across the slope so that it can help trap runoff water. If planting downslope, soil will be washed away. Vetiver consists of many kinds. Unlike lalang grass, the good varieties will not have flowers. Roofs that are made from the vetiver leaves have high endurance. Vetiver also has dense leaves that do not easily catch fire. On the contrary, the leaves of lalang grass easily catch fire in the dry season. If vetiver is planted under trees, they can help absorb water in the soil. Vetiver can obstruct the growth of lalang grass nearby. Therefore, vetiver can provide benefits both in the rainy season and in the dry season..."**

29) On 31 August 2009

His Majesty the late King Bhumibol Adulyadej gave the royal speech to Mr. Ampol Senanarong, the privy councilor and the personnel who worked with the Project on Development and Campaign of Vetiver Growing under the Royal Initiatives, at the Piemsuk Villa, Klai Kangwon Palace, Hua Hin District. Prachuap Khiri Khan Province which can be quoted as follows:

> **"...I have studied vetiver for about seventeen years as the Privy Councilor has said already. Even though it has taken me a long time to study it, it has also been very useful and fruitful. It is amazing that a grass has been given 17 years of research. However, one must understand that there are many varieties of vetiver and if we had not started studying them, the usefulness would have never been revealed.**
>
> **The past seventeen years has been very beneficial because the study has shown that vetiver or the grasses similar to vetiver are**

miraculously useful in various aspects. Some grasses may be useful in some places. The vetiver grass, on the contrary, is very useful in different landscapes not only on flat land or but also in mountainous areas. Vetiver can grow on both deep soils and shallow soils. Vetiver roots can penetrate upto five or six meters which was never expected in grasses before. More importantly, vetiver roots only grow vertically upto five meters without spreading horizontally. Therefore, it will not disturb the roots of the crops cultivated nearby.

I paid a visit to my mother at the Sra Pathum Palace, and at the time she was not very well and she seemed to have been suffering from boredom. The word "boredom" was not beyond her condition at that time. So I told her that I would like to ask her to help me to grow a plant, and if we became successful in doing that it would be very beneficial for the whole country. Upon hearing the request, she, all of a sudden, became very enthusiastic and asked me if there was such a plant, and she thought that I had done a lot of research already. So I told her about the miracles of the vetiver grass telling her that although vetiver was a kind of common grass but it can make the crops cultivated nearby grow very well. I had never thought of this before. She asked me where I would grow vetiver, and I told her that it was the place that she used to work, which was on the mountainous area called "Doi Tung" that she liked. If we did not grow vetiver on those areas, it would not make the areas developed. Those areas were not developed because they were only covered with grasses or other plants. If we planted vetiver, the usefulness of vetiver could make those areas more developed and more fertile. In addition, I told her about the fact that vetiver could grow magically and how we could plant and how to select the vetiver varieties to grow.

She was excited but doubted if she could be of any help. I said if she was ready, we could go to work now. She called upon her people and said that she was strong enough now and could do some work right now. so it can also be said that vetiver was a miracle grass that could make my mother become strong immediately. Finally, she went to Doi Tung a few days later and asked her people to plant vetiver in various places as an experiment. I could say that she was very happy to have something to do even though her doctor did not allow her to do so. Surprisingly, she was able to walk and plant vetiver herself. Within a few days, vetiver grew very well which was an amazing thing.

Some kinds of vetiver can penetrate their roots very deep, like I said it is about four or five meters. Some roots are as deep as six meters. For the other grasses, their roots can go deep in the soil but just only three meters. The long root system of vetiver offers coverage on the ground surface which can prevent soil erosion. The soil under the covering vetiver will also be strong and can be used for anything. For example, the soils along the road bank will be protected and will not slide downs the slopes

of the hills. This can be seen on the road to Doi Tung. Vetiver growing on the bank of the road makes the road safe and stable. It is the miracle of the vetiver grass. Moreover, it will make the tree planting along the road side feasible. In addition, the soils along the roadsides have stopped eroding which had damaged the cropland below in the past.

Therefore, it can be seen within a few days that the recommendation to grow vetiver was the right thing to do. It is important that research be conducted to indicate areas suitable for certain kinds of vetiver, and the selected vetiver should not damage the soil. Sometimes, growing vetiver may require areas with enough land-width. And the distance between vetiver rows should be suitable. It may be one meter or more depending upon the slope degree of the land. Before I left for Chiang Mai, I had received a design for vetiver growing. It appeared that the interval between vetiver rows varied greatly. Some were only few meters and some were several meters. However, it did not affect the growth of vetiver. The vetiver grew very well within a few months. On the other hand, cultivation of crops normally takes more time, and it is normally more difficult to obtain results. Vetiver can benefit the soil within a short period of time after planting and experimenting.

Therefore, the results of the vetiver trial are very useful and have made the researchers excited. Although it was initially believed that vetiver is useful, we didn't know that it would offer so many benefits. Within a few months, large areas of land have become useful. So this has made the officers involved very glad to be part of this. Those involved are not only knowledgeable about soil improvement, but they can also plant one plant species and experiment with another effectively. The next step is to identify the various varieties of vetiver in Thailand, including the varieties that grow on mountains, on flat land, and areas close to the ocean. This means there is a lot more to research more so than the past seventeen years.

I would like to thank all of you for offering great benefits to agriculture and cultivation, especially to make Thailand more developed in an amazing way. Many people did not believe that vetiver, a common grass, would make the country free from several dangers. Some people said that vetiver is a kind of weed. But some have studied and confirmed that vetiver is not a weed, but a miracle grass that helps the country. Therefore, your work related to vetiver is very useful and can save the nation from a number of dangers. I would like to thank you for all your effort even though it is hard work for you to go everywhere to collect vetiver in the fields when there are a number of grasses. It is hard work because you need to find the most practical way of planting. I witnessed this in some places I visited. The officials are doing their best to plant vetiver, and the results have been very satisfactory.

Therefore, I need to tell you that your work is a tough one, but it offers great benefit. It is very tiring to have to go places and keep trying to find the right locations for vetiver growing and to study it to your best ability. But at the end, the outcome of this work has produced beneficial and exciting results. Just like when my mother was very excited with vetiver growing. Although it is just a grass, growing it can enhance agriculture and advance knowledge in agriculture and development including road development which allows successful farming.

Thank you for the works that you have done and I must say that it is very tiring but it is very useful. At present, the results of this work are very satisfactory, and more satisfactory results will follow. Thanks for your great efforts...”

30. On 25 July 2011

His Majesty the late King Bhumibol Adulyadej gave the royal initiative to Mr. Sumet Tantivejkul, the secretary to the Chaipattana Foundation, and the Committee on Broadcasting, Television and Telecommunication, and concerned officers at the Somdej Prapeenangther Chaophakulayaniwattana Kommaluangnarathiwatratchanakarin Hall, 14th Floor, Chalermprakiat Building, Siriraj Hospital. The royal initiatives can be concluded as follows:

There was a great landslide at Kratun Subdistrict, Phipun District, Nakhon Si Thammarat Province on 22 November 1988. This was because there was a huge tropical depression 3-4 days before that incident occurred. The terrestrial rain storm hit that area on 22 November, especially on the foothill slope that cultivated pararubber. The soil could no longer absorb more water from the storm. Thus, the enormous landslide occurred. The sediment and rock debris from the landslide damaged large areas of the foothill slope and the valley below.

Normally, caution should be taken during operation. Even though vetiver can prevent soil erosion, it can principally be the cause of soil erotion as well as its roots penetrate deep into the soil which can easily create cracks in the soil and allow water into the soil causing soil erosion. Also, it is a common practice to plant fast-growing trees which do not have taproots. Thus, these trees cannot hold the soil together. Therefore, one should conduct a study to investigate the kind of soil structure and the types of plants that can effectively solve this issue. At the same time, we should also be careful about using the plastic bags with wings as this may be suitable for certain areas, but not others.

His Majesty the late King was worried about agricultural uses of the land on the mountainous areas and in the reserved forests. At the time, when His Majesty returned to Thailand in 1961, the population in Thailand was only about 18 million, and it (at the time of the speech) increased to almost 70 million. Therefore, the need for land for cultivation increased. However, the arable land on the flat topography was already occupied and the those who invaded these lands did so illegally. So when pressured by the authority, they had to move farming to the mountains and to the forests for cultivation of para-rubber, oil palm and fast growing trees. These events occurred widespread in the north-east and the north, and the severe landslides constantly took place. Landslides also caused severe damage and it would take several years to bring back the surface soil that could

be used for cultivation. When exploring new land into the mountainous areas, road construction followed. Some of these roads blocked the natural water way causing flooding damage and landslides. Such incident could be seen in Rayong, Chanthaburi and Chumphon Provinces. Not only in the north, landslides also occurred at Khao Phanom Mountain, Krabi Province and in Nobphitum District, Nakhon Si Thammarat Province in the south this past March. Broken bridges and damaged roads could be seen everywhere. Bridges made from ropes were temporarily used. Furthermore, repairing houses and improving farmlands would require a long period of time. Meanwhile, it would be necessary to seek methodology to prevent the damage and educate the villagers on how they could protect themselves and permanently solve the landslide issue which resulted from land encroachment.

His Majesty the late King also talked about his experience with flooding damage caused by road construction and how to solve those problems. He said that after completion of the construction of the four-lane road in front of Klai Kangwon Palace, Hua Hin District, Prachuap Khiri Khan Province, there was a heavy rain and water flew along the road causing flooding in the western part of the palace area since it was located in the lower part. It became more serious because the street island obstructed the water flow. Therefore, His Majesty gave an order to remove the street island so that water could easily flow pass the palace into the sea, and the flooding problem could be solved. Later on, cement pipes were installed to drain the water, but there was still flooding especially around the electricity distributing station. The officers had to use a pump to take the water out, but it was not successful. His Majesty thus told the officers to stop pumping the water and tried to make the drainage way to drain the water into the sea. As can be noted here, pumping of water might not be an appropriate way to solve the flooding problem. Management methods to store the surplus water or to drain the water would be more appropriate.

Another royal initiative indicated that the way to solve the problem should begin with the root cause of the problem that is proper use of land for farming and appropriate approach to urbanization. This may take 10 – 20 years which may not be fast enough to correct those serious damages that are occurring widespread throughout many regions. Therefore, research is needed to investigate how to plant vegetative covers and trees with taproot in combination with vetiver or other plants that are suitable for the areas. For example, in shady areas, the Krainam Tree should be grown. Moreover, gully control or suitable management should be conducted in order to prevent water erosion. If water begins to seep through the soil, soil, roads or bridges will be damaged. The slope degree of land should be another factor to consider. It must be determined whether or not there would be a need of slope gradient adjusting or structure to support the slope. If road construction is required, it is important to know how to ensure that the road will be strong enough and that water erosion can be prevented causing harm to people. All of those aforesaid issues are the questions that need to be answered. The Foundation of Water Management should promote and support problem-solving efforts, and conduct research to find the solutions. If the solutions are effective, transferring of these practices to the people should be made. Even though some of these people have been committing illegal actions, they should be properly guided and educated. However, to solve those problems, it may require high monetary input. Therefore, demonstration of the problem-solving approaches should be conducted so that different communities can follow.

6.2.2 Conclusion of the characteristics of vetiver which can prevent soil erosion

Vetiver can grow everywhere in Thailand. This grass was introduced by His Majesty the late King as the plant to be grown as the strip along the contour line for prevention of soil erosion if the cultivation is made on the sloping land. The followings are the characteristics of vetiver that can prevent soil erosion:

1) Vetiver has a long root system that can hold the soil particles tightly.

2) Vetiver can grow in various places of Thailand.

3) Vetiver does not behave like weeds because it grows in the form of the tiller and the root does not produce the new seeding. Moreover, the flower of vetiver cannot produce fertile seeds to germinate in the soil. Therefore, the seeds of vetiver are difficult to germinate which are not the same as the seeds of some weeds like lalang grass or bermuda grass.

However, there are proper ways to grow vetiver. For example, vetiver should be planted in open areas during the rainy season. In general, planting using the method of tiller growing in a bag will be better than planting using the tillers alone. The interval between tillers should be 5-10 cm so that at the full stage of growth, the vetiver will be like a hedge row which His Majesty the late King Bhumibol Adulyadej called “the living wall”. These vetiver hedges can reduce the velocity of water runoff which, in turn, can prevent soil erosion. After planting the vetiver, one should take regular care of them and should try to get rid of any weeds that grow competitively with the vetiver. Examples of these weeds are lalang grass (Imperata cyclindrica) and siam weed (Epatorium odoratum) which can damage the vetiver hedge rows. If some parts of the vetiver rows are affected by weed invasion (a condition His Majesty the late King called the “lost teeth” in the mouth), erosion prevention will become ineffective. It is thus suggested that vetiver be planted across the slope or along the contour line. The interval between the vetiver rows is dependent upon the degree and the length of the slope. In general, vetiver can effectively prevent soil erosion when they are planted on the areas with a slope of less than 50 percent (25 degrees). However, the best practice for vetiver growing is planting it on the land with a slope of less than 35 percent. In areas with steep or very steep slopes, vetiver should be grown in combination with other measures such as terracing or hill slide ditching.

Other uses of vetiver beside soil erosion prevention are that they can be used for making handicraft or roofing material. Vetiver leaves generally should be trimmed in the rainy season at the height about 30 cm above the ground surface. This method of cutting leaves can make the vetiver grow well in the dry season. Even if wildfire occurs, the roots of vetiver will survive and can produce new leaves when rain comes. Another agricultural use of vetiver leaves is the raw materials for mulching to keep the surface soil moist.

Several patterns of vetiver growing for soil erosion control

Other uses of vetiver

For making compost

For mulching

Vetiver leaves used for many purposes

For thatching

For making handicrafts

6.2.3 Research on vetiver cultivation and transferring of technology on vetiver growing

The Royal Development Study Centres that His Majesty the late King established in different physiographic regions of the country are aimed at demonstrating the outcomes of integrated development for farmers and the general public who wish to learn about vetiver cultivation and use it to make a living.

Therefore, the centres have become the core platform for research on vetiver cultivation. These activities include selection or collection of various vetiver varieties, propagation of vetiver, research on utilization of vetiver and technology transfer to the local farmers. Moreover, training courses on vetiver growing as well as vetiver growing plots for demonstration are offered to farmers and the general public to learn about the approach and collect vetiver tillers. Furthermore, the Land Development Department has also played an important role in supporting these royal initiatives related to vetiver cultivation by conducting research on erosion control by means of vetiver growing, production of vetiver tillers of various varieties fsor distribution and propagation to the farmers, government officials and the general public.

6.3 Approaches to Solve Sandy Soil Problems

Sandy soil means the soil with sandy texture that naturally covers the total area of 9 million rai throughout Thailand. Sandy soil has similar quality to sand that is used for mixing cement for general construction work. Sandy soil if used for agriculture, often presents problems of low fertility or low nutrient content, and low water holding capacity. Plants growing on sandy soil in the dry season often exhibit problems of moisture stress. Moreover, if sandy soil occurs on sloping land, when rain comes, the soil is normally prone to erosion. Continued use of such soil for cropping without proper fertilization always brings about low production or zero production.

The Khao Hinsorn Royal Development Study Centre is an exemplary centre which has shown great success in solving the sandy soil problem caused by deforestation and continuous cropping of maize and cassava. Such activities rapidly turn soil infertile, and in the rainy season, the surface soil is normally washed away by runoff water, making the area desert-like.

His Majesty the late King Bhumibol Adulyadej established the Khao Hin Sorn Royal Development Study Centre on 8 August 1979 when His Majesty visited the area for the royal opening ceremony of the Phra Bat Somdet Phra Pin Klao Chao Yu Hua Statue at Phanom Sarakham District, Chachoengsao Province. There, 7 villagers presented His Majesty with a piece of land located in Village No. 2, Khao Hin Sorn Subdistrict, Phanom Sarakham District, Chachoengsao Province as a location for His Majesty to construct a royal pavilion.

Before His Majesty accepted this piece of land, he asked those villagers whether it would be alright if the land would not be used for a pavilion but for a study centre that focused on various aspects of agriculture. Gladly, the villagers welcomed His Majesty's request. So His Majesty responded:

"...If the soil is not good, and we do not help or do something, eventually, Thailand will become a desert..."

As a result, the Khao Hin Sorn Royal Development Study Centre was established under an objective of solving sandy soil problems and recovering the soil condition so that the land would become fertile, would be considered a green area and would be utilized appropriately.

In the document given to the Office of the Royal Development Projects Board (ORDPB), His Majesty the late King, as if an academic, included notes and comprehensive analyses, so that the document would be used as a guideline for developing the area of the Khao Hin Sorn Royal Development Centre. The royal messages can be quoted:

"...Sandy Soil offers low plant nutrients..."

"...The soil along the stream if it is moderate in quality and does not present a lot of problems, the ordinary fertilization can be used. On the contrary, the soil on the upland areas commonly consists of sandy soil, soil with hard pan and rock fragments. The common recommended measure is to grow grasses along the contour line so that they can hold the soil together and can produce more organic matter. Sandy soil without grasses grown will be eroded away when it rains. In addition, growing various trees can help holding the water in the soil..."

Soil characteristics and the landscape in the area of the Khao Hin Sorn Centre before 1979, which was so degraded and was desert-like with eroded surface soils

Before soil improvement, His Majesty the late King initiated that water sources should be developed so that supply of water can be used. He stated that:

> **"...Firstly, the Huai Jek dam (map coordinate QR715208) was constructed because there was a great deal of seepage water. After surveying the area and locating the area for dam construction, the construction started at the time of the opening ceremony of the Royal Statue of King Pin Klao at Wat Khao Hin Sorn (Khao Hin Sorn Temple) (on 8 August 1979). After that, the construction of the Huai Samrong Nua and the Huai Samrong Tai reservoirs to serve as additional water sources outside the project area started..."**

When the water sources were developed, soil development measures started in accordance with the royal initiative quoted as follows:

> **"...When the water sources have been developed, the upland area can be cultivated for upland crops, and fish can be farmed in the lowland. Furthermore, the upland areas can also be used for livestock raising. Various grasses, fruit trees and woods can also be grown. Livestock farming, grass growing, and tree planting can improve the quality of soil, and can make the whole area arable. With the aforementioned measures, it may require a long period of time for the soil to recover and become fertile again..."**

Due to the royal initiatives given by His Majesty the late King to develop Khao Hin Sorn Royal Development Study Centre, the project area of more than 1,500 rai has been rehabilitated and improved. The whole area has become greenish and now consists of reforested areas, areas of upland crops, fruit trees, vegetables and a demonstration farm

A Royal visit to Khao Hin Sorn Royal Development Study Centre

His Majesty paid a visit to Khao Hin Sorn Royal Development Study Centre on 23 April 1997.

His Majesty paid a visit to Khao Hin Sorn Royal Development Study Centre on 23 April 1997.

Demonstration plots of the “New Theory” in the Khao Hin Sorn Royal Development Study Centre

under the concept of "the new theory". Moreover, nine new reservoirs in the centre and nearby areas have been constructed. In addition, vetiver growing has been practiced around the reservoirs and on the sloping areas prone to erosion.

In conclusion, to solve the problem sandy soil, the followings are His Majesty's recommendations:

6.3.1) To develop water sources for the project, especially construction of reservoirs in the main watershed of the centre like Nam Jone watershed and others. The total of 18 reservoirs located in the centre and nearby areas are very useful for agricultural development. At the same time, those reservoirs can slow down the rate of runoff, can keep the soil moist and can make the replanted forest become fertile.

6.3.2) To practice mixed farming including herbs, livestock, and organic fruit trees and biennial plants. Organic fertilizers or compost should be used to plant fruit trees and biennial plants in order to continuously increase the amount of soil organic matter. Water from the reservoirs can be distributed to the nearby farms via small irrigation canals.

6.3.3) To practice reforestation in areas of degraded forests. After 20 years of reforestation, the forest has become completely recovered, and now various crops can be grown. Soil erosion problems have been minimized. The entire area can be used as a model for demonstration of land rehabilitation.

Officers involved were honored when His Majesty the late King Bhumibol Adulyadej and Her Royal Highness Princess Maha Chakri Sirindhorn visited the centre on 23 April 1997 and, upon seeing the outcome of the development project, said that

> **"...At Khao Hin Sorn, many officers have been working together for 15 years. Therefore, this centre can be used as a model to help the villagers and can make similar tasks in the other areas easier. Those officers have to work with persistence and finally what they did is now very useful. The villagers are happy, so am I. These areas in the past, could not even be used to grow cassava, but now the condition has improved. The weather is also comfortable, there has been a big change..."**

The Khao Hin Sorn Royal Development Study Center after development efforts

6.4 Approaches to Solve Shallow Soil Problems

Shallow soil refers to soil which contains rock fragments, gravels on laterites at the quantity of more than 35 percent by volume at the depth of less than 50 cm from the surface. Those coarse fragments or layers of consolidated material can affect the ability of the surrounding tree roots to penetrate the soil. Also, soil loses the capacity to absorb plant nutrients, and water seeps through the soil very easily as the soil cannot effectively absorb water which in turn can lead to the risk of moisture stress. Generally, these conditions often limit plant growth and cause low productivity of the economic crops. Moreover, it will be more restricted to plant growth if the soil is underlain by bedrock or laterite crust at the shallow depth.

According to the faxed documents sent by His Majesty the late King to the Office of the Royal Development Projects Board, this soil is consolidated, containing rock fragments and lateritic gravels. The soil is often found in many places including the Huai Hong Khrai Royal Development Study Centre, the Khao Cha-ngum Land Rehabilitaion Project, the Nong Phlap-Klat Laung Land Settlement Project and the San Kamphaeng Cooperative Project.

The measurements for improving shallow soil in accordance with the Royal Initiatives can be summarized as follows:

6.4.1) How to improve the condition of soil containing rock fragments, gravels and layers of shallow bedrock

The methods for soil improvement can be obtained from the result of the study conducted in the Huai Hong Khrai Royal Development Study Centre, Doi Saket District, Chiang Mai Province. Located in Khunmaekuang Forest, this centre is the best model for watershed protection, development and appropriate utilization. It was established on 11 December 1982 under the royal initiative. The aerial extent of the centre is about 8,500 rai. Before the centre establishment, the area consisted of degraded forests and was used for shifting cultivation. To describe the characteristics of the area, His Majesty the late King noted in the faxed document given to ORDPB as follows:

> **"...The Huai Hong Khrai Royal Development Study Centre: Rocky, gravelly and droughty..."**

His Majesty described the causes of such conditions as follows.

> **"...Forest encroachment is common. Thus, in the rainy season, the soil is washed away, and only rocks and gravels are left on the earth surface..."**

During the early work of the development, His Majesty granted the following royal initiatives:

- In the lower part of the project area lies the Huai Hong Khrai reservoir. All the streams passing by were all dry. As a result, a number of reservoirs and check dams had to be constructed in order to conserve the moisture in the area and to improve the soil quality.

- To increase water quantity in the reservoir of the Huai Hong Khrai Royal Development Study Centre, water from Huai Mae Lai was diverted to small reservoirs in the Huai Hong Krai Centre and then down to the Huai Hong Krai reservoir. Moreover, check dams were also constructed in small natural streams in the project area. When the water system started to work, the degraded forest would be recovered and could develop into a climax

The area of Huai Hong Khrai Royal Development Study Centre which His Majesty the late King noted as rocky, gravelly and droughty.

Royal Visits to the Huai Hong Khrai Royal Development Study Centre

His Majesty visited the Huai Hong Khrai Royal Development Study Centre on 8 February 1987.

His Majesty visited th Huai Hong Khrai Royal Development Study Centre on 3 February 1974.

forest. Gently sloping areas located near the Huai Hong Krai Centre can then be used cultivate various upland crops. Fish farming could be carried out in the reservoir as well. The construction of the water system in the project was planned for the period between 1984 and 1989.

- When the water system in the centre was in place, the whole project areas should then be divided into the following zones:

a. In the highland areas which used to be climax forests, reforestation activities should be conducted following the zoning below:

- areas with continuous supply of water from the system (near check dams and dams with surplus supply of water)
- areas with intermittent streams and temporary water supply (check dams in rain-fed areas or with temporary water supply)
- areas with frequently dry streams (check dams in rain-fed areas)
- areas with the water in the stream commonly dry (no check dam, only rain-fed area)

Within those four zones, afforestation would be conducted in some areas.

b. In addition to the afore-mentioned zonation, soil improvement on stony areas, gravelly areas, areas with sandy soil and lateritic soil should be restored. After that, these areas could be used as pasture for livestock raising, or for growing upland crops and fruit trees.

c. Near the area of the Huai Hong Khrai reservoir, paddy rice was recommended.

d. In the Huai Hong Khrai reservoir, fish culture should be conducted and the activity should be done by group of fishermen or members of fishery cooperatives.

After 5 years of the development activities in the centre, results could be seen. Moreover, after 10 years of the development effort, the results became even more noticeable. Soil conservation by using water and vetiver made the area more fertile. Because of His Majesty's royal initiatives, the whole areas have become fully developed and mostly covered with climax forests and several water resources.

In the valley bottom with the land having slope of less than 10 degrees or 20 percent, agricultural activities in various patterns have been conducted namely agro – forestry, vegetables, forage crops and medical herbs. The cultivation methods have included both intensive farming and conventional farming. However, the soil in the area is relatively shallow and susceptible to erosion. Therefore, many measures of soil amendments have been practiced, such as application of organic fertilizer, intercropping with the legumes between strips of economic crops, rotation cropping, as well as growing of vetiver for soil erosion control.

In conclusion, the approaches to the solution to shallow soil which can be commonly found in the mountainous areas of the watershed should focus on water resource development, maintaining of forest areas, and reforestation so that the surface soil and the environment can be protected. On the other hand, in areas with gentle slopes, suitable crops should be cultivated for example growing forage crops for livestock, application of organic fertilizers and vetiver growing as the strip along the contour line.

The successful outcome of the development project at the Huai Hong Khrai Royal Development Study Centre in an area with rocky soil, gravelly soil (shallow soils), and doughtiness

It is worth mentioning here that after 35 years of development work, the degraded forests within the royal project areas have recovered, watershed areas are now protected, and soil erosion problems have been eliminated. Moreover, in the valley bottoms with gentle slopes, agricultural practices have been conducted in harmony with forest conservation and environmental protection. This pattern of development is a model for the general public and units related to forestation to follow and apply in other areas.

6.4.2 Approaches to lateritic soil problems

Lateritic soil refers to soil that contains a large quantity of lateritic gravels in the form of loose lateritic or a consolidated lateritic layer at the depth no deeper than 50 cm from the soil surface. In Thai, the loose lateritic gravel is called "Luk Rung" in which Luk means son. Thus, His Majesty called the laterite layer that is consolidated in Thai as Mae Rung and "Mae" means mother. This kind of soil is very problematic because not only its surface layer is very thin, but also laterite gravels often restrict growth of crops growing on it. Moreover, this soil has a low capacity of water holding, which can cause moisture stress. In areas with sloping land, such soil is very susceptible to erosion.

The royal initiative project which focuses on shallow lateritic soil is called the Khao Cha-ngum Land Rehabilitation Project in Khao Cha-ngum Subdistrict, Photaram District, Ratchaburi Province. This land was presented to His Majesty the King by Police General Srituuk Patamasingh Na Ayudhaya, and His Majesty the King told Phra Chao Worawong Ther Phra Ong Chao Chakkapan Pensiri on 4 January 1985 to use the land for a royal initiated project. His Majesty initiated the guideline for the project which can be chronologically concluded as follows.

On 26 November 1986

"...Carry on the study to improve this degraded soil until it can be used for agriculture. Experimental designs and testing of cropping patterns on this soil should be appropriate for the landscape..."

On 4 December 1994

"...Regarding naturally growing trees, there is a place that you should go and it is very easy to go, and that is the Khao Cha-ngum Project in Ratchaburi Province. There, the project is located near the mountains where most forests were previously degraded. This is because there were no trees, nothing at all. We had started to work on that area 7 years ago, but we left the area abandoned for about 5 years later on. I paid a visit there again two years ago, I found that the forests have regenerated and reached the full stage of forest cover even though we did not plant any trees. The important thing to make forests recover is not to disturb them, just protect them, the forest can grow naturally...."

And on 15 July 1996

"...The forests should be taken care of, and we should not try to damage them. If we leave them alone and do not disturb them, within 30 – 40 years, they will recover naturally, probably from dipterocarp forests to mixed deciduous forests ..."

Moreover, His Majesty the late King gave a clear analysis of the soil problems taking place in the Khao Cha-ngum project area as shown in His Majesty's faxed document excerpted below.

The Khao Cha-ngum Project, Photaram district, Ratchaburi Province: In the past, extreme forest destruction occurred. The soil consisting mostly of lateritic gravels was also excavated for road construction. The areas covered with the native grasses were overgrazed by the livestock. Moreover, the native trees were cut down for firewood beyond the rate of regrowth. Therefore, with the combination of the aforesaid factors, extreme soil erosion has occurred, and lateritic soil is the result in most parts of the area. Although lateritic soil contains some plant nutrients and soil microorganisms, but it is not enough for plant growth.

The research in the Khao Cha-ngum Land Rehabilitation Project has led to the following general guidelines for improving lateritic soil and stony soil.

1) Construction of reservoirs along the major streams, not only for waterstorage but also for water usage as necessary.

2) Soil improvement by applying compose, green manure and growing legumes. Also, growing vetiver along each contour line should be made in order to control soil erosion, reduce the rate of runoff water and maintain moisture in soil.

3) Growing of the fast-growing trees such as neem trees, but for soil that has a thick surface, some fruit trees which can withstand drought conditions such as mangos and tamarinds can be grown.

4) On the mountain where the forest is totally degraded, let the forest trees grow naturally and do not damage or burn them.

The above-mentioned represents only a small part of the activities related to soil resource management for agriculture and for environmental balance that were given by His Majesty the late King Bhumibol Adulyadej over a period of no less than half a century. His royal initiatives have been technically proven to be successful and applicable to every part of Thailand. The outcomes of His Majesty's work related to land development, soil conservation, soil improvement and soil resource management can optimize soil productivity, and at the same time, the environmental balance can also be maintained.

His Majesty visited the Khao Cha-ngum Land Rehabilitation Project on 8 July 1992.

Soils in the project area

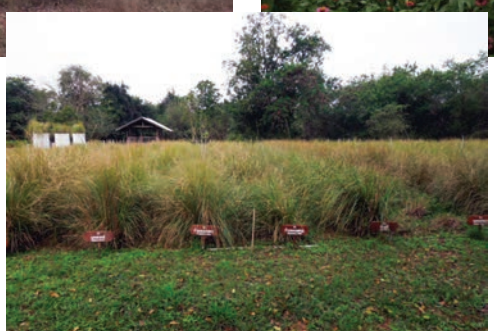
Soil condition that His Majesty labeled as compacted with lateritic and gravelly soil

The Khao Cha-ngum Land Rehabilitation Project

Photo of the Landscape in 1986
(prior to development efforts)

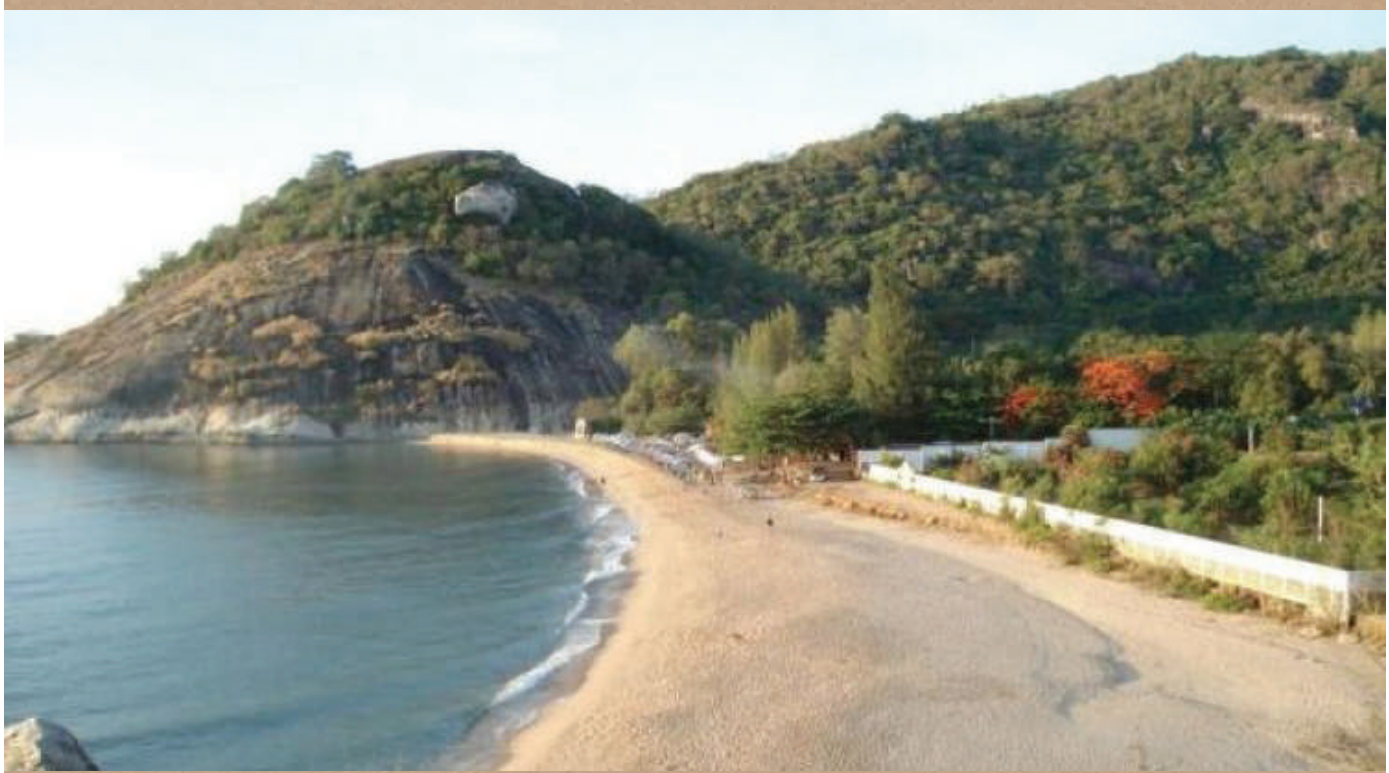
Photo of the Landscape in 2017
(after development efforts)

The overview of the Khao Cha-ngum Land Rehabilitation Project (after development efforts)



Chapter 7

His Majesty the late King Bhumibol Adulyadej Taught Some Students Issues Concerning Soil



Chapter 7
His Majesty the late King Bhumibol Adulyadej Taught Some Students Issues Concerning Soil

In order to illustrate His Majesty's knowledge on soil, this chapter presents the time when His Majesty granted an audience to a group of the students from Klai Kangwon School and allowed them to learn about soil from Him. The event can be concluded as follows:

On Saturday, 6 October 2001 at 16.49 hrs., His Majesty the late King Bhumibol Adulyadej and Her Royal Highness Princess Maha Chakri Sirindhorn paid a visit to the Khao Tao reservoir project at the Khao Tao Village in Hua Hin District, Prachuap Khiri Khan Province together with a group of the students and local officers. There, His Majesty taught the group of students the subject of soils to, the summary of which is presented below.

7.1 Observation of the soil in front of the Khao Tao School, near the Khao Tao reservoir

His Majesty explained that at the Khao Tao School 30 years ago, the area was a low coastal plain, usually referred to as “the lagoon”. A lagoon is a low coastal plain which has an opening that allows sea water to enter. General Director of the Royal Irrigation Department, Momluang Chucharti Kumpoo, informed His Majesty that the area should be used for cultivation of paddy, and a reservoir should be constructed on the area of high elevation above. Meanwhile, Dr. F.R. Moormann, an FAO expert on soil, showed His Majesty the late King the soil in the area and Dr. F.R. Moormann stated that this soil was not favorable for cultivation because it had high acidity and high salinity at the same time. Therefore, His Majesty the late King initiated the construction of a reservoir instead of using the area for paddy cultivation. After the construction of the reservoir, the quality

of water has improved. Moreover, the villagers can now use the water in the reservoir for their own consumption. This reservoir is the first reservoir that His Majesty the late King constructed, and only 60,000 Baht was spent from his own expense for the construction.

To explain about the soil in the school area, His Majesty the late King allowed Dr. Pisoot Vijarnsorn, a senior specialist and a staff member of the Land Development Department to conduct deep soil boring of about 3 m below the soil surface and to illustrate to the students. His Majesty the late King explain to the students that this soil at the surface was the buried soil which consisted of a layer of lateritic soil on the top with a sandy layer in the lower part. At the depth below 150 cm from the soil surface lay the original soil which was normally considered the most unfavorable soil because such soil was not only extremely acidic but also very saline. The soil that was observed was the same as the soil that was bored by Dr. F.R. Moormann, an FAO expert on soil, 30 years ago.

In addition, His Majesty the late King explained further that even though the soil was not considered good soil but it could be improved via practical methods. Thus, His Majesty instructed relevant officers to take sandy soil from the beach to cover the original soil surface and to increase the thickness. Then, lateritic gravels that were used for the road construction around the reservoir were then used to cover the sandy layer. After grass growing, the surface layer improved because of the high level of microorganism and in turn the level of soil organic matter increased. With time, the quality of the soil continued to improve to the extent that it could be used for growing various plants. His Majesty explained further that this practice was in line with that of the Khao Cha-ngum Land Rehabilitation Project, Ratchaburi Province, where the soil was lateritic and unusable for agriculture. To solve the problem, His Majesty explained that He recommended

constructing a reservoir, and growing vetiver and soil building plants. When the areas contained enough water and vegetation, the surface soil would have plenty of supply of organic matter and nutrients, which in turn, could make the plants grow very well, and such area would not be barren land anymore.

In addition, His Majesty the late King also explained about the formation of the acid sulfate soil in the south. This soil contains jarosite mottles in subsoil. Originally, this soil consists of pyrite compound within the soil matrix. If it is wet, no reaction would occur. If the soil is dry, sulfur would react with oxygen, giving rise to sulfur dioxide (SO_3) which in combination with water (H_2O), could form sulfuric acid (H_2SO_4). The soil will become extremely acidic, and no crop could be grown if there is no soil amelioration. In fact, the soil in Khao Tao School was formerly highly acidic but later on, sea water intruded to cover that area and left the salt accumulated on the soil surface. Therefore, the soil in the area was both extremely acidic and high in salinity, the condition of which made the soil unfavorable for agriculture.

Regarding improvement of the acid sulfate soil, His Majesty also told the students about the "Klaeng Din Project" (The project of accelerating the soil acidity and its amelioration) at the Pikun Thong Royal Development Study Centre, Narathiwat Province. After conducting the project, the soil has improved. The method involved using water to leach the acid and applying liming materials to neutralize the acidity.

In conclusion, at this station, His Majesty the late King explained to the students about the background of the Khao Tao reservoir construction and the original soil in that area which used to be a lagoon. His Majesty said that even though the soil was high in both acidity and salinity, we could make use of them if we were clever and smart enough.

7.2 Observation of the soil in the northern part of the Khao Tao reservoir

The second stop is about 1 km to the north from the first stop. At this stop His Majesty the late King Bhumibol Adulyadej explained to the students that He used to pass this area which was a foothill slope. At that time, the farmers cultivated the pineapple but faced various problems resulting from soil erosion. The surface soil was totally eroded away, and was washed downslope and finally deposited in the reservoir. His Majesty took the students to the location where the problem occurred to observe if any trace of such problems was still observable.

He mentioned that vetiver should be planted along the contour line to prevent soil erosion. In many areas, vetiver growing was proven to be a successful approach to soil erosion control because it could hold the soil particles tightly. Unfortunately, as most of the land in the area had been urbanized and used for accommodation, and more perennial plants were being grown, vetiver growing became less and less common in the area.

By conducting soil boring as deep as 2 m the officials from the Land Development Department showed His Majesty and the students the soil pH and the electrical conductivity. From the test, the soil was high in alkalinity and contained some carbonate concretions. His Majesty then explained that the value of electrical conductivity correlated with the level of the salt content in soil. If the soil contained a large amount of salt, the electrical conductivity value would be very high. Soil in this area was not the same as that found at Khao Tao School, even though the two areas were not too far from each other. If the soil in this area contained a large amount of calcium carbonate,

it could be readily used to neutralize the soil acidity in the Khao Tao School area. Before His Majesty left for the Klai Kangwon Palace, He added further that construction of a reservoir should be done in an upland area which would then allow water to travel down for local utilization. However, the Khao Tao reservoir was constructed on the lower part, but it may not be a problem because we could pump water up to the upland area and release the water down slope for utilization, which represented a solution that was based on academic principles.

His Majesty further stated that this was similar to the process of artificial rain making which required knowledge of physics. Nonetheless His Majesty stressed that there were difficulties and complications in the process of artificial rain making, and promised the students a tour of the artificial rain making project. By the same token, studying soil science required some background knowledge of chemistry and physics. Otherwise, it would be difficult to understand. His Majesty the late King finally thanked the officers from various departments and from the local agencies who arranged this trip for the students so that the students could learn about the actual fieldwork. In addition, His Majesty finally said that the students should memorize what was observed, not only taking notes of it. At 19.30 hrs., His Majesty the late King returned to the Klai Kangwon Palace, Hua Hin District, Prachuap Khiri Khan Province.

Chapter 8
Highland Development in Accordance with the Royal Initiatives: The Royal Project

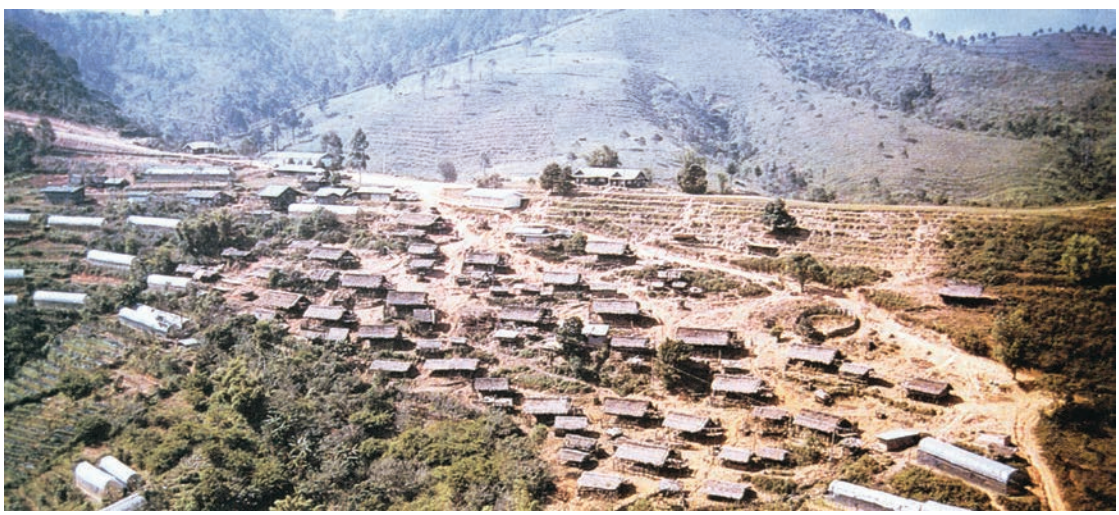
Chapter 8

Highland Development in Accordance with the Royal Initiatives: The Royal Project

In the early stage of the Highland Development Project during 1967 – 1969, the project area was completely covered with the primary forest. There were no roads that would allow easy access, and there were only narrow tracks along the mountains. Most people who wandered around in the area were groups of hill tribes who carried opium for trading and were always armed with machine guns. Other groups in the area was the soldiers of No. 93 Battalion that were forced down from China, troops of Karen and the Communist Wa. These troops were periodically attacked by Myanmar troops, but they still roamed the area. These troops fought to stay in the area in order to ensure that the hill tribe people could freely grow opium for living which led to deforestation, soil erosion and landslide on the cultivation areas of the mountains. Therefore, most mountains in the areas did not have forest cover.

[1/]Copy from the book entitled "To be Humble as the Soil" (in Thai only)

To stop opium growing on these highlands, His Majesty the late King Bhumibol Adulyadej established a Royal Project. Initially, this projected was called "The Project under the Royal Patronage for the Hill Tribes" but had been renamed several times. Finally, in 1992, it was named the Royal Project, and later, the Foundation of the Royal Project was also established. During that period, Queen Sirikit, Her Royal Highness Princess Maha Chakri Sirindhorn and Her Royal Highness Princess Chulabhorn paid a visit at the project site many times to monitor the progress of the project. The Royal Project also sent the staff to work in several branches in different regions on the highlands of the north. The royal visits to these project sites always provided moral support to the staff. Moreover, all of the hill tribe people were always happy to greet the Royal Family.



Before 1956, the forest on the highlands deforested by the hill tribe people for cultivation of opium.

His Majesty visited the Development Unit for the Hill Tribe People at Ban Khun Wang, San Pa Thong District, Chiang Mai Province on 16 February 1985.

The most distinct outcome of the Royal Project is that His Majesty the late King Bhumibol Adulyadej basically placed the people at the core of the development, holistically seeing the area as an ecosystem. His Majesty made sure that the hill tribe people have real occupations, and the royal project would act as the distributor of their products from which they could earn a living. This allowed the officers at the Royal Project to earn trust from the hill tribe people. Once trust had been earned, the officers could then educate the hill tribe people on how to properly protect the natural resources such as forest and soil. In addition, the hill tribe people could also be made aware that since they lived in the watershed area of the highland, they should conserve the environment appropriately so that it would not impact on the people in the lower parts of the watershed.

With such an integrative approach, the hill tribe people stopped growing opium and forest encroachment. They stopped the

His Majesty visited Ban Nong Hoy Kao Mai within the Nong Hoy Royal Project, Mae Rim District, Chiang Mai Province on 18 February 1985.

practice of shifting cultivation. With the more permanent land occupation, the government thus provided roads and utilities to the hill tribe people. As a result, their living improved tremendously. This development approach required time and careful analysis. The model was carefully tested by using simulation. Three factors were observed in this sustainable development approach, namely the occupation of the hill tribe people, natural resources conservation and community resilience. Nonetheless, the challenge remained in that the factors affecting the development approach varied in different areas.

The most important issue for His Majesty's initiated approach in solving the problem of opium growing in reserved forest areas was to sympathize with the hill tribe people and understand their ways of living. His Majesty never considered them encroachers. Rather, His Majesty considered them citizens who needed help in finding solutions to their problems. This is in accordance with His Royal Speech on 17 June 1973 at Chitralada Royal Villa which can be quoted as follows:

His Majesty visited the Doi Ang Khang Royal Project, Fang district, Chiang Mai Province on 11 March 1989.

"...The reserved forest areas are labeled on the map by the relevant government agency. However, for me, I label them as areas with people. So it is not fair to issue a reserved forest law on the people who had been living in the area prior to the issuing of the law. It is rather strange to label this area as the reserved forest. This is because once the area has been labed as such, the people who have lived in that area become law-breakers. By law, these people may be law-breakers, but in fact, the persons who labeled the area as the reserved forest have committed an illegal act. The local people have been living there prior to the mapping, and thus they should have the human rights. So, this means that the government has invaded the territory of the people, not that the people did something against the law..."

His Majesty's work on the highlands which later led to the birth of the Royal Project started with his royal visits to the various hill tribe groups in different locations. While visiting the areas and the people, His Majesty collected field data by himself. The book entitled the Royal Journey on the Highland by Mom Chao Bhisadej Rajani summarizes the work of His Majesty the late King as follows.

8.1 The procedure to integrate the collected data

His Majesty the late King Bhumibol Adulyadej integrated all data to develop a project which nobody had done before and which was very crucial. They were four issues that motivated His Majesty the late King to start the project.

8.1.1 His Majesty found that the hill tribe people were earning an equal amount of money from opium selling as from selling local peaches.

8.1.2 His Majesty found that Kasetsart University was doing research on peach grafting and the results were promising showing higher yields. The yields could then be traded in town.

8.1.3 If peach growing could be promoted among the hill tribes, they would not need to move from one place to another and in the process deforest more land as they could have yields of peaches every year. This would not damage the soils or the forests. In addition, the hill tribe people would have a permanent occupation. The problem of soil erosion would not be solved if the hill tribe people still practiced shifting cultivation.

8.1.4 The establishment of the Royal Projects in remote areas with permanent staff members who provided help and suggestions to the hill tribe people was an important innovation that could help improve the living of the hill tribes whose security problems were still prevalent.

After 48 years since the first Royal Project was established in 1969, all the projects initiated

by His Majesty were headed by Mom Chao Bhisadej Rajani. In 1992, the name was changed to the Royal Project Foundation. At present, there are 39 branches in the Northern provinces namely Chiang Mai, Chiang Rai, Phayao, Lamphun, Mae Hong Son and Tak Provinces.

8.2 The Royal Initiatives on Land Development in the Royal Project Areas

His Majesty the late King once gave a Royal Initiative regarding land development as quoted here:

> **"...The land should be developed and allocated to the villagers and the hill tribes for permanent cultivation and better living..."**

To accomplish these activities, His Majesty the late King suggested that the concerned government agencies including the Royal Forestry Department, Land Development Department, Department of Agriculture Extension, Royal Irrigation Department as well as Department of Agriculture should work together to achieve the same objectives.

His Majesty the late King also stressed the importance of setting up the land use zoning in accordance with the land capacity so that the land could be utilized appropriately. For instance, some areas of land should be used for residential purposes, while others should be used for agriculture or forestation. His Majesty the late King also noted that in the agricultural areas, soil and water conservation practices should be implemented especially in areas with steep slopes.

His Majesty the late King emphasized vetiver growing for soil and water conservation and for rehabilitation of the degraded areas caused by soil erosion on steep slopes. Therefore, on 20 February 1992, His Majesty the late King Bhumibol Adulyadej, Her Majesty Queen Sirikit, and Her Royal Highness Princess Maha Chakri Sirindhorn personally visited the vetiver propagating plots at the Royal Project. There, His Majesty gave the royal suggestion to grow vetiver in order to demonstrate the practice to the farmers and the general people. Also, on 14 March 1992, His Majesty the late King, Her Majesty Queen Sirikit and Her Royal Highness Princess Maha Chakri Sirindhorn visited the people and observed the vetiver plot for the purpose of soil and water conservation at Mae La Noi Royal Development Centre, Mae La Noi District, Mae Hong Son Province. There, His Majesty planted vetiver so that the concerned officers could further distribute to the local farmers.

8.3 Implementing the Royal Initiatives on Land Development

The Land Development Department started its crucial role in the Royal Project in 1976. The tasks for the Land Development Department includes land clearing, land allocation to the farmers, construction of soil and water conservation structures and soil amendment. The work budget is provided by Land Development Department and the Royal Project.

In 2003, the Land Development Project was renamed as "The Centre for the Royal Project of the North". The project focused on the land development activities on the highlands within the project areas.

Then, on 10 September 2004, the working group of this project agreed to change the project name to "the Centre of Land Development for the Royal Project". However, the tasks remain the same.

At present, the centre is the representative of the Land Development Department for the Royal Project. The centre's activities aim to support the Royal Project on land use planning, and soil and water conservation including construction of soil conservation structures and promotion of vetiver growing for soil erosion control. In addition, the designs of certain farming structures such as the irrigation systems and feeder roads were the tasks of this project. Moreover, the activities related to soil improvement to recover soil fertility are also conducted by the project. Methods of soil improvement include the use of green manure, soil acidity correction and application of biological techniques. All of the applied technologies target an increase in crop production and a decrease in production cost, but at the same time remain environmentally friendly.

8.4 The Outcomes of the Royal Project

The Royal initiatives in the Royal Project are new concepts. This project has totally changed the quality of life of the hill tribe people on the highlands in the north. The outcomes can be concluded as follows:

1) Several hundreds of new crops have been introduced and grown in the project area. These crops include fruit trees, flowers and herbal plants. In addition, livestock raising and fish culture with new species such as trout, red pawn and sturgeon have also been introduced.

2) Opium growing on the highland has been completely eradicated. The hill tribes have started cultivating other crops in accordance with the recommendation of the project officers. Moreover, the project also takes care of the marketing for the growers which in turn has benefited the Royal Project as well.

3) One important outcome has been that the local people's conscience has been created through trust in the Royal Project. They can now take care of themselves and improve their quality of life.

4) Due to the royal initiative as quoted below:

"...We must sell the agricultural products for the hill tribes and give the money to them..."

the Royal Project has created the framework that encompasses all aspects of cultivation such as teaching growing methods, conducting soil conservation practices, harvesting, logistics and marketing. At the beginning, these activities were difficult to do but later on, with the help of the research department, testing, logistics and marketing became standardized and widely accepted.

5) The Royal Project allows the local people to live and use the land to make a living . As a result, the hill tribes have started to appreciate and value their land and do their best to conserve soil, water and forest trees.

6) The hill tribe people have stopped practicing shifting cultivation resulting in positive impacts on and natural resources and environment conservation.

7) The Project peacefully has secured the living of the hill tribe people who live on the highland. Also, the project has allowed the people of different tribes to live together in harmony and believe in each other.

8) The Royal Project is a rural development project that has been proven to be successful and sustainable and that should be implanted in other highland areas both within the country and outside the country.

9) His Majesty the late King Bhumibol Adulyadej saw “human beings” as the core. The activities were conducted “holistically” in combination with the “ecosystem” by means of a multidisciplinary approach. Also, in order for the project to accomplish its goals, cooperation between different agencies from government offices, private sectors and international organization in the field of soil, water, forestry, communication, sanitation, education and local cultures is necessary.

10) The main activities for the project focus on three values as follows:

10.1) Ability to produce high quality products that can compete with others,

10.2) Protection and reviving of the natural resources with conscience, and

10.3) Seeing of “human beings” as the core of the framework in order to strengthen the community.

When reviewing the work that followed the Royal Initiatives given in 1974, it appears that the royal project has successfully fulfilled the objectives set by His Majesty. The outcomes have been very distinct and can be applicable to other areas. In fact, the royal project covers only 10 to 15 percent of the total area of the highlands in the country. Therefore, there is still a great deal more to do in order to cover the whole highland area in the north. Also, this model can be transferred to the highland in the Mekong River region. This model, now known as the “Royal Project Foundation Sustainable Development” should be applied in other areas in order to promote the royal activities following the footprint of His Majesty the late King Bhumibol Adulyadej.

Chapter 9
Worldwide Recognition


05 December
World Soil Day

Chapter 9
Worldwide Recognition

The activities on land development are just a small part of all the royal efforts of His Majesty the late King Bhumibol Adulyadej. More than half a century, His Royal Initiatives has been proven to be technically sound and applicable to various parts of the country in solving and managing soil problems. Soil and water conservation as well as soil improvement are the basic tool for sustainable uses of the land by the farmers. The cultivated crops under such method always produce satisfactory yields with good economic returns, which, in turn, can uplift the living standard of the farmers. The outcome will be even more beneficial if once their living standard has improved and the farmers follow the concept of self-sufficiency of His Majesty the late King Bhumibol Adulyadej as a way of living.

All of His Initiatives has been recognized and accepted not only throughout the country but also in the international community. His great efforts have earned him 32 international accolades and more than 20 honorable degrees from the universities worldwide.

The followings are examples of honorable awards given to His Majesty the late King in relation to his work on soil resource development from different agencies all over the world.

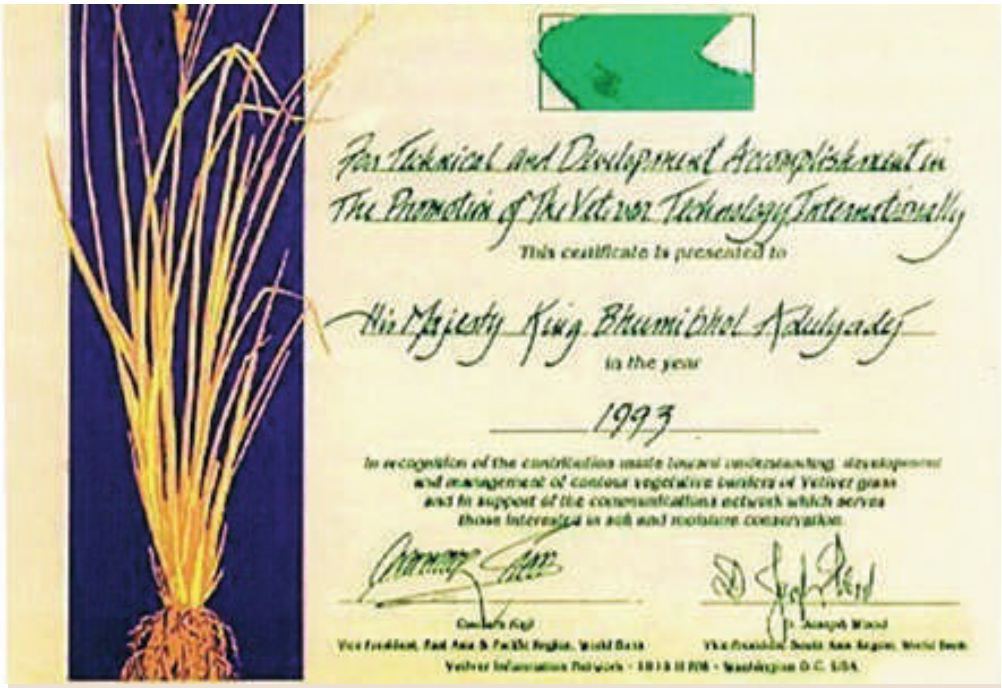
1) The Tele Food Medal presented by FAO for outstanding work in agricultural development and promotion of international food security on 8 December 1999.

2) The International Merit Award presented by The International Erosion Control to honor His Majesty's excellence in soil and water conservation and natural resources protection on 25 February 1993.

3) The Bronze Vetiver Sculpture Award of Recognition presented by the World Bank to recognize His Majesty's accomplishment in promoting vetiver growing nationally and internationally on 30 October 1993.

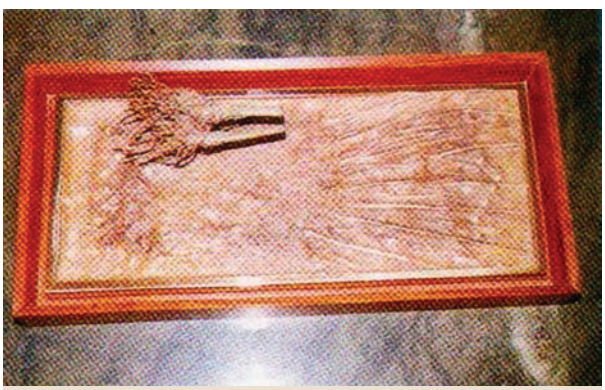
4) Patent Number 22637 issued by the Department of Intellectual Property to His Majesty the late King for an invention on the process of acid sulfate soil improvement for cultivation (The Klaeng Din Project) on 5 October 2007.

5) The Award of Honor "The Humanitarian Soil Scientist" presented by the International Union of Soil Sciences on 16 April 2012 and requested to use his birthday, 5 December, as the World Soil Day.



Certificate of international Merit Award presented by The International Erosion Control on 25 February 1993.

The Tele Food Medal presented by FAO on 8 December 1999.



The Bronze Vetiver Sculpture Award presented by the World Bank on 30 October 1993.

The board members of the International Union of Soil Science and the Soil and Fertilizer Association of Thailand presented an award of the Humanitarian Soil Scientist to His Majesty the late King at Siriraj Hospital on 16 April 2012.

During the period of 3 to 5 December 2012, the Land Development Department was assigned by Ministry of Agriculture and Cooperatives to arrange an event entitled **"To Honor His Majesty the King for the Recognition of the Humanitarian Soil Scientist and for cerebration the World Soil Day, 5 December.**" This event aimed to express gratitude to His Majesty the late King on his royal initiatives on land development, to celebrate his receiving of the Humanitarian Soil Scientist Honorable Award from the International Union of Soil Science and to celebrate the World Soil Day, 5 December. This event also took place at FAO office in Rome the same day. During this period, the exhibition of all the work conducted by His Majesty the late King was also displayed at Siam Paragon, Bangkok.

The board member and former Secretary-General of the International Union of Soil Science presented an award of the Humanitarian Soil Scientist.

The personnel who organized the event felt that it was their highest honor when Her Royal Highness Princess Maha Chakri Sirindhorn precided over the royal opening ceremony of the event on 3 December 2012. Moreover, Her Royal Highness Princess Maha Chakri Sirindhorn signed her name on a clay plate to celebrate the 5 December as the World Soil Day. Her kindness touched everyone who attended the event.

An important issue concerning the World Soil Day is that at the General Assembly of the United Nation, in New York, USA on 20 December 2013, the members of the Assembly voted to make an international announcement that the 5 December would henceforth be the World Soil Day and requested all member nations to annually celebrate the day. The reason for designating the 5 December which was the birthday of His Majesty the late King as the World Soil Day was to honor to him for the continued dedication of his great efforts on sustainable uses of soil for agricultural production and for His Majesty's initiation of a number of the soil improvement measures as solutions to the problem soils such as acid sulfate soil, lateritic soil, sandy soil and soils prone to erosion. In addition to the announcement of the World Soil Day, the Assembly also declared 5 December 2015 as the International Year of Soil. The theme of that event in 2015 was "Healthy Soils for a Healthy Life".

Her Royal Highness Princess Maha Chakri Sirindhorn presided over the World Soil Day event on 3 December 2012.

The World Soil Day exhibition on 3-5 December 2012

Her Royal Highness Princess Maha Chakri Sirindhorn signed a clay plate to recognize the World Soil Day, 5 December.

Her Royal Highness observed the exhibition to celebrate the World Soil Day.

On 20 December 2013, The General Assembly of the United Nation declared 5 December as the World Soil Day.

On 5 December 2014, His Majesty the late King Bhumibol Adulyadej, as the official request from FAO, sent Her Royal Highness Princess Bajrakitiyabha to grant a royal speech on His behalf at the United Nations Headquarter, New York, USA in the cerebration of the International Year of Soil 2015 and to honor the great effort of His Majesty on soil conservation and amelioration. Below is the full royal speech of Her Royal Highness Princess Bajrakitiyabha.

Royal Message of His Majesty the King of Thailand Delivered by Her Royal Highness Princess Bajrakitiyabha on the Occasion of the Celebration of the 1st World Soil Day and Launch of the International Year of Soils at the United Nations Headquarters, New York City, the United States of America on Friday, 5th of December, B.E.2557 (2014)

Distinguished participants,

In compliance with the thoughtful request of the Food and Agriculture Organization of the United Nations, I am pleased to share a few thoughts with the present assembly who are here gathered to celebrate the World Soil Day and to launch the International Year of Soils.

It would not be incorrect to say that soil lies at the heart of human survival a vital endowment given by mother nature from which we derive the essentials of life itself, be they food, medicine, clothing, shelter or energy. Soils and human life are inseparably intertwined: if soil are allowed to retain their quality and fertility, so will they sustain for us a better quality of life.

Today, however, the world is confronted, generally, by two sets of challenges. First, there is the degradation of the once fertile soils through wasteful use and mismanagement. This condition is brought about, notably, by farming without replenishing soil nutrients, slash and burn agriculture following heavy deforestation, post-harvest stubble burning, and, not least, the prolonged unrelenting use of chemical fertilizers. These malpractices exact heavy costs, most prominent among which are the steep fall in agricultural productivity in terms of both quality and quantity, ecological imbalances, environmental pollutions and hydro-geological devastation such as landslides and floodings. Secondly, there is the problem of infertility in the types of soil which are in themselves unfit for cultivation.

These challenges, so outlined, have direct repercussions on food security of the world population as the amount of arable land is outstripped by the sheer pace of population growth. In order to ensure a viable, long-term food security and a sustainable ecosystem, these issues must be addressed as an urgent priority with the commitment to adopt the best practices in soil conservation, soil reconditioning and enrichment to make soils fit and ready for cultivation.

The adoption by the United Nations General Assembly of the landmark Resolution to declare the 5th December of every year the World Soil Day and to launch 2015 as the International Year of Soils, is a highly propitious occasion to raise the awareness of the international community on the central role of soils in our lives. I truly wish to commend the Food and Agriculture Organization of the United Nations and all of you for your dedication to our common cause. I much hope that such resolve and the close cooperation displayed will be the key to achieving an appropriate way to conserve, enrich and manage soil resources leading to a better life for all.

Again, I applaud you all for your most admirable contributions and I wish to extend my best wishes for every success in this important undertaking.

Thank you.

In 2016, The World Soil Day was celebrated at the United Nation Headquarter in New York, USA and also at the FAO Headquarter in Rome, Italy. The event was entitled “Soils and Pulses, a Symbiosis for Life”. This event was also celebrated in many countries around the world, including Thailand. During this auspicious occasion, the organizing committee in Rome made a request to Her Royal Highness Princess Maha Chakri Sirindhorn to grant a Royal Speech via a video message both at the United Headquarter in New York and at FAO Headquarter in Rome. Her full royal speech is presented below.

Video message addressed by
Her Royal Highness Princess Maha Chakri Sirindhorn
for the World Soil Day 2016
"Soils and pulses, a symbiosis for life and for halting soil degradation"
Friday 2 December 2016, 09.30 - 12.30 hrs.
Conference Room 12, Conference Building,
United Nations Headquarters

Ladies and Gentlemen,

The Issues of environment and natural resources related to sustainable development are variable and diverse from region to region. Among these issues, soil or land resource plays great important role not only for food product to provide nutrition and income, but also for other products such as medicine, cloths, shelters and other ecosystem services.

It is worth mentioning that the global food security requires healthy soils to provide sufficient food for growing population estimated by the FAO to increase from current 7 billions up to 9 billions in 2050. But the amount of arable land is limited. Approximately 33% of the earth services of the degraded soils and unfortunately about 40% of this infertile soil is in the poor and underdeveloped countries.

Soil degradation is the direct cause of decline in food productivity. The degradation factors are mainly erosion by water and wind, lost of wetlands, deforestation and loss of biodiversity. This damaging factors are also found connected with climate changes the scarcity of arable land has also in the encroachment of marginal lands such as hilly or steep slopes for slash and burn cultivation. The practice produces less, but damages more. It deteriorates soil and the environment extensively causing landslide, severe soil erosion, fertility lost flood and drought.

The issue aforementioned are therefore, of very serious consequences and have direct impact on economic growth and poverty alleviation. To solve these problems we need all the concerned sectors in society to make a joint effort. The sound and appropriate land use policies, national regional and international, should be laid down with solid information and knowledge scientifically, acquired followed by well planed programs and activities and implemented with well trained personnel. To raise the awareness of soil resource the 68th session of the United Nation General Assembly on the 20th of December 2013 has declared the 5th of December, H.M King Bhumibol's birthday, to be the world soil day in recognition to His Majesties untirely efforts in researching and conducting essential projects on sustainable use of soils, soil improvement and conservation for more than 40 years.

I do believe that the celebration of the World Soil Day will be a significant platform in promoting a platform and education on soils in all regions and nations. I do think that all of us has an obligation drive together utilizing this valuable resource wisely and therefore conserving it for the future generations.

Finally, I would like to express my sincere thanks to all who have been working deligently in making the world Soil Day an important event in our life.

Thank you.

Most importantly, on 28 October 2016, the United Nations General Assembly Plenary Meeting paid tribute to the memory for His Majesty the late King Bhumibol Adulyadej of Thailand at the United Nations Headquarter in New York, USA. The speeches given by the President of the 71st Session on the UN General Assembly, the UN Secretary-General and the U.S. Permanent Representative to the UN are included below.

H.E. Mr. Peter Thomson, President of the 71st Session of the UN

Secretary-General,

Excellencies,

Ladies and Gentlemen,

This morning, we meet to pay tribute to His Majesty King Bhumibol Adulyadej of Thailand, who passed away on 13 October 2016

His late Majesty King Bhumibol reigned for 70 years, making him one of the longest serving Monarchs in human history.

He was revered by his people, and admired throughout the world, for his grace, dignity and humility and steadfast dedication to his country and people.

At his Coronation, he declared "We shall reign with righteousness for the benefits and happiness of the Siamese people" – it was a commitment he worked tirelessly to fulfil throughout his life.

King Bhumibol was beloved as the "People's King", and through the thousands of development projects that he initiated over his lifetime, he oversaw a period of profound social, economic and development transformation across the country, significantly improving the livelihoods and wellbeing of the Thai people.

King Bhumibol was also a force for peace and unity within Thailand and the broader region, and was a strong supporter of the multilateral system. His achievements throughout his life led to numerous awards from the United Nations and beyond, including the UN Development Programme's first Human Development Lifetime Achievement Award, in 2006

King Bhumibol was also a committed environmentalist. He played a leading role in the promotion of soil science and conservation, and was a leader in sustainable land resource management.

Under King Bhumibol's leadership, Thailand raised global awareness of the importance of soil as a resource for poverty reduction, climate change adaptation, sustainable development, and security.

In 2013, the General Assembly recognised these efforts by designating 5 December – the same date as the King's birthday – as World Soil Day, as well as 2015 on the International Year of Soils.

King Bhumibol was one of the most venerated global leaders of our time. His profound legacy to people and nation of Thailand, and the world at large, will always be remembered.

On behalf of the General Assembly I extend our most sincere condolences to the Government, the Royal Family, and the people of Thailand, as we mourn His Majesty the King's passing.

Our hearts and thoughts are with the Thai people at this time.

I now request the General Assembly to rise to observe a minute of silence in memory of His Majesty King Bhumibol Adulyadej.

H.E. Mr. Ban Ki Moon
UN Secretary-General

Your Excellency Mr. Peter Thomson, President of the General Assembly,

Excellencies,

Distinguished guests,

Ladies and gentlemen,

We come together to pay tribute to the life and legacy of His Majesty King Bhumibol Adulyadej, Rama IX, of Thailand – the world's longest-reigning monarch.

On behalf of the United Nations, I once again express most profound condolences to Her Majesty Queen Sirikit, the Royal Family, the Government of Thailand and the Thai people. A visionary and a humanitarian, King Bhumibol was loved and revered by the people of Thailand and respected around the world.

I had the honour of meeting King Bhumibol during a visit to Thailand in 2007, and long admired his dedication to improving his country and the lives of its people, particularly the most vulnerable.

Throughout seven decades, King Bhumibol served as a stabilising force in Thailand, notably during times of political turmoil and tensions.

The outpouring of grief from the Thai people on his passing is testimony to the King's tremendous influence across the country and recognition of his life-long work to better the lives of his people.

King Bhumibol's commitment to sustainable development and national resilience helped move the country through its various development phases and towards becoming a vibrant economy.

In recognition of his work, King Bhumibol was awarded the first United Nations Human Development Lifetime Achievement Award in 2006.

The United Nations recognises and pays tribute to the remarkable life that His Majesty King Bhumibol led and joins all those who loved the revered King in offering heart-felt condolences.

In the spirit of the late King, the United Nations looks forward to further strengthening the partnership with the Royal Thai Government and the people of Thailand to advance democracy, development, peace and human rights for all.

Thank you.

H.E. Samantha Power, U.S. Permanent Representative to the United Nations

Good morning, everybody. This is one of the many days that I feel very privileged to represent the host country of the United Nations so as to have the chance to address you on such an important occasion.

On behalf of the United States, I wish to convey our deepest condolences and most heart-felt condolences to Her Majesty Queen Sirikit, her children and grandchildren, and to the people of Thailand on the passing of His Majesty King Bhumibol Adulyadej. His Majesty was not only a lifelong friend and partner to the United States, but he also had deep personal ties to our nation.

The King's parents met in Cambridge, Massachusetts, where both were studying medicine – his father at Harvard, and his mother at Simmons College. His Majesty only lived there as an infant, but his presence is still very much felt in Cambridge.

I can speak with a bit of authority on this subject because, before I had the privilege of serving in the Obama Administration, I was a professor in Cambridge at Harvard's Kennedy School of Government. And my walk to and from campus often took me through King Bhumibol Square, which sits adjacent to the Kennedy School, and was named in honor of his birth.

Walking through King Bhumibol Square, it is not uncommon to see Thai people who had come to pay homage to His Majesty, taking photographs next to the plaque bearing his name in the square. There are several places like that in Cambridge. In the nearby Brigham and Women's Hospital, where His Majesty's mother once worked, hardly a day goes by when Thai visitors do not come by bearing gifts, flowers, or small, handwritten notes. That is the kind of devotion His Majesty inspired in the Thai people.

Nearly two decades ago, a journalist asked the King how he wanted to be remembered. He replied that he cared very little about how history remembered him. He said, "If they want to write about me in a good way, they should write how I do things that are useful."

In the eyes of His Majesty, doing things that were useful meant finding a way to solve the problems that affected real people – most importantly, the vulnerable and marginalized people. And, as the King saw it, the only way to know what was useful – and to understand the problems people were facing – was to get out into the field, into the places where people lived. So the King traveled constantly within his country, in particular to the poor and rural parts, where – over the course of his tenure – he would develop thousands of development projects.

But it wasn't just that His Majesty went to these places – we see leaders do that a fair amount – it was also how he went. He made a point of meeting directly with locals – be

they fishermen, rubber or rice farmers, or primary school students. When he met with officials, he would choose those working at the very grassroots – agronomists, schoolteachers, policemen.

And His Majesty was more than just a keen observer. Being useful meant helping fix the problems that he encountered, and empowering the Thai people to do the same. He had a mind that was at once kinetic and deliberate, creative – as we have heard – and scientific. Over the course of his life, he registered nearly 40 patents and trademarks – often for inventions that he built, tested, and modified himself – and most of which aimed at tackling everyday problems faced by the poor. This is completely extraordinary.

Take the invention nicknamed the "monkey's cheeks," which he designed to address the perennial floods that Thailand experiences. His Majesty remembered seeing as a child the way that monkeys would store chewed bananas in their cheeks so that they could eat them late, and built a system of small reservoirs that worked using a similar principle – storing excess water during heavy rains that could be used later for irrigation. The system of the "monkey's cheeks" is still being used across Thailand today. Many of the King's inventions fit this pattern – merging conservation with human development. He was decades ahead of the curve in recognizing that what was environmentally sustainable was crucial to the long term health of communities.

Let me conclude. In June 1960, His Majesty returned to the United States at the invitation of then-President Dwight Eisenhower. He was asked to address a joint session of the U.S. Congress. He was just 32 years old.

Speaking to Congress, His Majesty said that he had accepted the invitation in part because of what he called "the natural human desire to see my birthplace" – Cambridge – which he returned to on that trip. But he also came, he said, to affirm our two nations' unique friendship and shared values. As he put it, "Friendship of one government for another is an important thing. But it is friendship of one people for another that assuredly guarantees peace and progress."

His Majesty told members of the U.S. Congress that there was one tradition valued above all others for the Thai people – the commitment to family. He said, "The members of a family are expected to help one another whenever there is a need for assistance. The giving of aid is a merit in itself. The giver does not expect to hear others sing his praises every day; nor does he expect any return. The receiver is nevertheless grateful. He too, in his turn, will carry out his obligations.

Now the King was speaking about the bonds and generosity among members of Thai families. But in retrospect, his words can just as easily be applied to the way that he lived his life. A life of always looking for ways to be useful to those in need. A life of giving, and of serving, every single day. Not to earn praise, not to get something in return, but rather because that is what one does for family. And His Majesty considered all the people of Thailand to be his family. How fortunate the Thai people were to have had His Majesty as a member of their family. And how fortunate we are to be able to learn from the way that this remarkable king chose to live his life.

Thank you.

References

กรมพัฒนาที่ดิน. ๒๕๕๐. ด้วยพระบารมี ฟื้นฟูปฐพีไทย. บริษัทประชุมช่าง จำกัด. ๑๘๕ หน้า

_____. ๒๕๕๑. รวมใจภักดิ์ รักษ์ดินรักษ์น้ำ เทิดไท้องค์ราชัน. ที่ระลึกครบรอบ ๔๕ ปี กรมพัฒนาที่ดิน กระทรวงเกษตรและสหกรณ์. ๘๐ หน้า

_____. ๒๕๕๔. ๘๔ พรรษามหาราชา ตามรอยพระบาท ศาสตร์แห่งดิน. โรงพิมพ์ชุมนุมสหกรณ์การเกษตรแห่งประเทศไทย จำกัด. ๒๓๙ หน้า

_____. ๒๕๕๕. แม่อยากให้เธออยู่กับดิน. โรงพิมพ์ชุมนุมสหกรณ์การเกษตรแห่งประเทศไทย จำกัด.

_____. ๒๕๕๕. ตามรอยพระบาท จอมปราชญ์แห่งการพัฒนาที่ดิน ครบรอบ ๔๙ ปี. ที่ระลึกครบรอบ ๔๙ ปี กรมพัฒนาที่ดิน กระทรวงเกษตรและสหกรณ์. ๑๖๘ หน้า

_____. ๒๕๕๗. ๕๑ ปี พัฒนาที่ดิน สู่เกษตรสีเขียว. ที่ระลึกครบรอบ ๕๑ ปี กรมพัฒนาที่ดิน กระทรวงเกษตรและสหกรณ์. ๑๗๕ หน้า

_____. ๒๕๕๘. คู่มือการพัฒนาที่ดิน สำหรับหมอดินอาสาและเกษตรกร. กระทรวงเกษตรและสหกรณ์. ๒๔๒ หน้า

_____. ๒๕๕๘. พระราชกรณียกิจ จากฟากฟ้าสู่แดนดิน. กระทรวงเกษตรและสหกรณ์. ๑๐๘ หน้า

_____. ๒๕๕๘. วันดินโลก ๕ ธันวาคม : World Soil Day. กระทรวงเกษตรและสหกรณ์. ๑๕ หน้า

กระทรวงพาณิชย์. ๒๕๕๔. อัจฉริยราชา ผู้สร้างสรรค์ภูมิปัญญาแห่งแผ่นดิน. สายธุรกิจโรงพิมพ์. ๑๖๗ หน้า

โครงการศึกษาทดลองการแก้ไขปัญหาดินเปรี้ยวอันเนื่องมาจากพระราชดำริ. มปป. คู่มือการทำการเกษตรตามแนวทฤษฎีใหม่บนพื้นที่ดินเปรี้ยว. มูลนิธิชัยพัฒนา. ๑๔ หน้า

_____. มปป. โครงการศึกษาทดลองการแก้ไขปัญหาดินเปรี้ยวอันเนื่องมาจากพระราชดำริในที่ดินมูลนิธิชัยพัฒนา. ๑๖ หน้า

โครงการศูนย์ศึกษาการพัฒนาพิกุลทองอันเนื่องมาจากพระราชดำริ. ๒๕๓๖. คู่มือการปรับปรุงดินเปรี้ยวจัดเพื่อการเกษตร. ๗๔ หน้า

มูลนิธิเสริมสร้างเอกลักษณ์ของชาติ. ๒๕๕๘. พระเมตตาใต้ฟ้าเดียวกัน. บริษัทรุ่งศิลป์การพิมพ์ (๑๙๗๗) จำกัด.

ศูนย์ศึกษาการพัฒนาพิกุลทองอันเนื่องมาจากพระราชดำริ. ๒๕๕๐. อันนี้สิเป็นชัยชนะ... ๘๐ พรรษา พิกุลทองเทิดไท้. โรงพิมพ์สุไหงโก-ลก. ๒๐๓ หน้า

ศูนย์ศึกษาการพัฒนาพิกุลทองอันเนื่องมาจากพระราชดำริ. ๒๕๕๓. คู่มือการปรับปรุงดินเปรี้ยวจัดเพื่อการเกษตร. ๗๖ หน้า

สมาคมดินและปุ๋ยแห่งประเทศไทย. ๒๕๕๖. ด้วยพระบารมี ปฐพีพัฒนา ๕ ธันวา วันดินโลก : เรื่องที่ ๓ รางวัลนักวิทยาศาสตร์ดินเพื่อมนุษยธรรม ใน วารสารดินและปุ๋ย ๕ ธันวาคม ๒๕๕๖ ฉบับพิเศษ จดหมายเหตุวันดินโลก. หน้า ๔๑-๔๔

สำนักงานคณะกรรมการพิเศษเพื่อประสานงานโครงการอันเนื่องมาจากพระราชดำริ. ๒๕๔๒. ประวัติศาสตร์ศูนย์ศึกษาการพัฒนาอันเนื่องมาจากพระราชดำริ. บริษัทอมรินทร์พริ้นติ้งแอนด์พับลิชชิ่ง จำกัด (มหาชน). ๑๗๖ หน้า

_____. ๒๕๔๗. อันเนื่องมาจากพระราชดำริ. บริษัทรุ่งศิลป์การพิมพ์ (๑๙๗๗) จำกัด. ๒๑๗ หน้า

_____. ๒๕๕๕. ประมวลพระราชดำริในพระบาทสมเด็จพระเจ้าอยู่หัว. บริษัทจุดทองจำกัด. ๓๙๗ หน้า

_____. ๒๕๕๕. ผลสำเร็จโครงการอันเนื่องมาจากพระราชดำริ ๘๔ พรรษา ประโยชน์สุขสู่ปวงประชา. บริษัทอมรินทร์พริ้นติ้งแอนด์พับลิชชิ่ง จำกัด (มหาชน). ๒๔๗ หน้า

_____. ๒๕๕๖. ๔๓๕๐ การทรงงาน เพื่อประโยชน์สุขแห่งมหาชน. บจก. สุขุมวิทมีเดีย มาร์เก็ตติ้ง. ๑๗๙ หน้า

_____. ๒๕๕๗. ร้อยเรื่องราว : เกร็ดการทรงงาน. บจก.สุขุมวิทมีเดีย มาร์เก็ตติ้ง. ๑๘๘ หน้า

สำนักงานจังหวัดนราธิวาส. ๒๕๔๓. ๗๒ พรรษา นราฯ ราษฎร์ รวมใจเทิด ในหลวง. โรงพิมพ์อาสารักษาดินแดน.

สำนักงานส่งเสริมวิสาหกิจขนาดกลางและขนาดย่อม (สสว.). ๒๕๕๐. เจ้านายเล็ก ๆ ยุวกษัตริย์ เล่ม ๑. โครงการตู้หนังสือเฉลิมพระเกียรติ พระบาทสมเด็จพระปรมินทรมหาภูมิพลอดุลยเดช บรมนาถบพิตร เนื่องในโอกาสมหามงคลเฉลิมพระชนมพรรษา ๘๐ พรรษา ๕ ธันวาคม ๒๕๕๐. ๑๗๓ หน้า

_____. ๒๕๕๐. เจ้านายเล็ก ๆ ยุวกษัตริย์ เล่ม ๒. โครงการตู้หนังสือเฉลิมพระเกียรติ พระบาทสมเด็จพระปรมินทรมหาภูมิพลอดุลยเดช บรมนาถบพิตร เนื่องในโอกาสมหามงคลเฉลิมพระชนมพรรษา ๘๐ พรรษา ๕ ธันวาคม ๒๕๕๐. ๑๘๕ หน้า

สำนักราชเลขาธิการ. ๒๕๓๗. ประมวลพระราชดำรัสและพระบรมราโชวาทที่พระราชทานในโอกาสต่าง ๆ ปี พุทธศักราช ๒๕๓๗. สำนักราชเลขาธิการ กรมราชเลขานุการในพระองค์

_____. ๒๕๔๐. ประมวลพระราชดำรัสและพระบรมราโชวาทที่พระราชทานในโอกาสต่าง ๆ พุทธศักราช ๒๕๔๐. สำนักราชเลขาธิการ กรมราชเลขานุการในพระองค์

_____. ๒๕๔๑. ประมวลพระราชดำรัสและพระบรมราโชวาทที่พระราชทานในโอกาสต่าง ๆ พุทธศักราช ๒๕๔๑. สำนักราชเลขาธิการ กรมราชเลขานุการในพระองค์

_____. ๒๕๕๒. ประมวลพระราชดำรัสและพระบรมราโชวาทที่พระราชทานในโอกาสต่าง ๆ พุทธศักราช ๒๕๕๒. สำนักราชเลขาธิการ กรมราชเลขานุการในพระองค์

สำนักสำรวจดินและวางแผนการใช้ที่ดิน. ๒๕๕๓. การพัฒนาระบบสารสนเทศโครงการจัดพัฒนาที่ดินตามพระราชประสงค์หนองพลับ-กลัดหลวง. กรมพัฒนาที่ดินกระทรวงเกษตรและสหกรณ์

Websites

http://www.siamrath.co.th/n/2264

http://www.tsdf.or.th/en/seminar-event/10631/tribute-to-the-king

https://www.flickr.com/photos/faolony/albums/72157649615811162

http://ag.alltech.com/crop/en/news/soil-%E2%80%93-our-silent-ally-feeding-world

https://www.technologychaoban.com/news-slide/article_5094

http://www.ldd.go.th/museum/image/musuem/13.jpg

http://cdn.images.express.co.uk/img/dynamic/133/590x/ski-travel-activity-Arosa-Switzerland-UploadExpress-James-Rampton-62687

http://teakdoor.com/Gallery/albums/userpics/58147/1927bangkokskylineBB.jpg

http://www.thebostoncalendar.com/system/events/photos/000/066/431/original/Mt_Auburn_Hospital_Ext_opt.jpeg?1463422266

https://www.fluenta.com/wp-content/uploads/2016/12/Soil.jpg

https://pxhere.com/th/photo/848859

http://www.xn--b3czk4afcy3gxah5a1g4e.com/wp-content/uploads/2013/01/ IMG_5360_1ed_resize_resize2.jpg

The editing committee in Thai version for publication of the book entitled

"Soul of the Thai People: The Great Philosopher in Soil, His Majesty the late King Bhumibol Adulyadej"

First edition in October 2017, 11,000 books.

Advisory committee

Prof. Santhad Rojanasoonthon	the Royal Scholar
Mr. Danucha Sindhavananda	the Secretary-General of the Office of the Royal Development Projects Board (ORDPB)
Mr. Suradesh Tiewtrakool	Director General of Land Development Department (LDD)
Mr. Kemkaeng Yutidhammadamrong	Deputy Director General of LDD

Working Group

Mr. Pisoot Vijarnsorn	Land Development Department (LDD)
Ms. Srinit Boonthong	ORDPB
Ms. Jinjana Keawsaiyaem	ORDPB
Ms. Matira Puktivadee	ORDPB
Mr. Sathaporn Jaiarree	LDD
Mr. Somsod Dumnoenngam	LDD
Mr. Anuwat Pothinam	LDD
Mrs. Saiyud Phetsuk	LDD
Mrs. Nootsuporn Krisadatarn	LDD
Mrs. Kittima Sivaarthitkul	LDD
Ms. Sumitra Watana	LDD
Ms. Naruekamon Janjirawuttikul	LDD
Ms. Raviya Thongyon	LDD
Ms. Duangsamorn Dendung	LDD

English translation editors

M.L. Thanisa Choombala	Senior Language Lecturer The Language Center The Asian Institute of Technology (AIT)
Mr. Pisoot Vijarnsorn	Land Development Department
Ms. Saranya Norkaew	LDD
Ms. Naruekamon Janjirawuttikul	LDD