

# **VETIVER FOR REHABILITATION OF PADAENG ZINC MINE, MAE SOT DISTRICT, TAK PROVINCE, THAILAND**

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## **Abstract**

Padaeng Industry Public Company Limited (PDI) was established in 1981 to mine and refine zinc metal and zinc alloys. The mine is located in Mae Sot District and its refinery is in Muang District of Tak Province; the roaster plant is in Rayong Province and the head office is in Bangkok.

The company's intention since establishment 34 years ago has been to take care of the environment for balancing of nature, optimizing of natural resources usage and conservation, and to follow His Majesty King Bhumibol Adulyadej's guidance on conservation and rehabilitation of the post mining area to restore it as a forest area.

The mining leases and related activity areas cover about 332 hectares (ha). The original source of zinc ore deposit was on the top of the hill. Some parts of the leases and permits have not been used and they are left as natural forest and to be a buffer zone to the surrounding areas. Therefore, only the mined area of about 167 ha needs rehabilitation. Rehabilitation was done as soon as possible when each part of the mining and related activities were finished.

PDI started growing vetiver for conserving soil and water on 15 August 2003. Thirty nine cultivars of vetiver were trialed on site. This revealed that cultivar Kamphaengphet No. 2 was the most appropriate for the climate and the soil of the PDI mine. The mine has grown vetiver for rehabilitation in the last 12 years concurrent with mining operation. A total of 19.17 million vetiver slips were planted. Therefore, PDI mine is one of the biggest mines in Thailand where vetiver has been grown to protect the environment. PDI mine is growing 1-2 million vetiver slips every year, and planting trees at the same time.

Bare soil is planted with vetiver first for soil rehabilitation, adding more organic matter into the soil, preventing soil erosion, reducing velocity of runoff water and protecting moisture in the soil. Then local tree species, such as teak, iron wood, Siamese sal, local cork tree, orchid tree, etc. were planted. In addition, fast growing trees, such as Eucalyptus, Royal Poinciana and Leucaena are also planted. Altogether about 97,600 trees were planted.

From 1993 to 2014, an area of 166 ha (or 62% of leases) was rehabilitated at the cost of 63 million Thai Baht, from the total 114 million Thai Baht of PDI Mine Rehabilitation Fund. When the mining leases terminate in 2023, the company will return the whole area with plantation forest to the Royal Forest Department. The company hopes that all stakeholders including the surrounding communities will protect the plantation forest area after post mining for their own benefit forever.

As a result of PDI's strong intention to rehabilitate the mined land with the vetiver growing project and to continue post mine rehabilitation, PDI was awarded the Green Mining Award for 3 years between 2010 and 2012. In addition, PDI mine also received

the CSR Award for 4 years (2011 to 2014) from the Department of Primary Industries and Mines, Ministry of Industry. All employees of the company are proud of these awards; they want to protect the environment surrounding them for sustainable nature.

**Keywords:** Mine rehabilitation, zinc mine, vetiver, forestry plantation

## **1. Introduction**

### **1.1 Location of the project**

The project area is located at 13 Moo 4, Phratad Padaeng Sub-district, Mae Sot District, Tak Province. It is approx. 17 km SE of Mae Sot Town. We can drive from the roundabout along Road No. 1090 (Mae Sod to Um Pang) for about 6.5 km, then turn left another 7 km to the Padaeng mine.

### **1.2 Details of the project**

#### **1.2.1 General information**



**Figure 1.** Padaeng mine pit, looking NW

Padaeng Industry Public Company Limited (PDI) was established on 10 April 1981 by Thai public (Ministry of Finance) and private investors and a private company from Belgium (Vieille Montagne). The Company engaged in mining and refining business with the objective to produce zinc metal and zinc alloys to serve its customers. The company's mine is located in the Mae Sot District and its refinery is in Muang District of Tak Province, while the roaster plant is in Rayong province and the head office is in Bangkok.

The company's intention since establishment 34 years ago has been to take care of the environment for balancing of nature, optimizing of natural resources usage and conservation. The company was granted the first mining lease in 1982. Mining operation started in 1984 after mining preparation and finishing of the refinery plant construction. The mining leases and related activity areas cover about 332 hectares (ha). The original surface of zinc ore deposit was on the top of the hill and the hill slope was without soil cover. Some parts of the leases and permits have not been used. They are left as natural forest and to be a buffer zone to the surrounding areas. Therefore, only the mined area of about 167 ha needs rehabilitation. Rehabilitation has been done as soon as possible when each part of mining and related activities were finished.

### 1.2.2 Background of the project

*To adopt our King's remark in conservation and rehabilitation of the post mining area to return it as a forest area once again*

In 2003, Mr. Arsa Sarasin was His Majesty's Principal Private Secretary and the chairman of PDI. His Majesty gave him a speech to consider conserving and rehabilitating of the post mining area to return it to forestry area once again. Then, it could be a tourist site and continue providing jobs to communities. It would also be a centre of local natural learning.

Since then, PDI has strongly adopted the royal guidance by coordinating with the Office of the Royal Development Project Board and Huay Sai Royal Development Study Centre in Phetchaburi Province to introduce vetiver for growing on bare soil surface to prevent erosion and conserve soil moisture. It will be the pioneer plantation before planting other trees; then the bare land will become real forest according to the royal speech.



**Figure 2.**

### 2. Implementation - Purchase of Topsoil for Improvement of Soil Suitable for Tree Planting

Rehabilitation started in places where mining and related activities were completed, namely, mine pit edges, waste collecting areas, and others. The steps of land preparation are as follows:

1. Buying fertile topsoil from outside the mine to cover bare soil up to at least 30 cm thick before planting. The company provides a budget of 50 million Thai Baht for fertile topsoil due to unsuitable soil within the project area.
2. Bare soil is covered mostly with vetiver and some ruzi grass. It is aiming at soil rehabilitation, adding more organic matter into the soil, preventing soil erosion, reducing velocity of runoff water and conserving moisture in the soil as long as possible.
3. Local trees species, such as, teak, iron wood, Siamese sal, local cork tree, orchid tree, etc. are planted. In addition fast growing trees, such as Eucalyptus, Royal Poinciana and Leucaena are also planted. Altogether about 97,600 trees have been planted. Tree planting was done shortly before and at the start of the rainy season, so that the rain water will help them survive and grow sufficiently before the dry season.



**Figure 3.** More than 60% of the rehabilitation plan has been achieved.

From 1993 to 2014, a total area of 166 ha (or 62% of leases) was rehabilitated at the cost of 63 million Thai Baht, from the total of 114 million Thai Baht of PDI Mine Rehabilitation Fund.

### **3. Achievement of the Project**

#### **3.1 Vetiver growing for soil and water conservation for 12 years**

The company started growing vetiver for soil and water conservation on 15 August 2003 and continued every year for the last 12 years. Thirty nine cultivars of vetiver were trialed. It reveals that cultivar Kamphaengphet No. 2 is the most appropriate for the climate and the soil of PDI mine.



**Figure 4.**

#### **3.2 Success in using vetiver for mine rehabilitation in Thailand**

PDI mine has grown vetiver for rehabilitation in the last 12 years concurrent with mining operation. A total of 19.17 million vetiver slips have been planted. Therefore, Padaeng mine is one of the big mines in Thailand where vetiver has been grown on a large scale covering the whole mountain.





**Figure 5.**

### 3.3 Community participation

The company is growing 1-2 million vetiver slips every year, and planting trees at the same time. The mined bare land is going to be reforested after mining. The company also invites any government agency and community, especially groups of teachers and students from local schools, colleges and universities to join in the activity. They learn how good vetiver is for soil and water conservation with full community participation. There have been almost 1,000 people that join in the activity each year.



**Figure 6.** Pictures showing activity of annual vetiver planting for soil and water conservation

#### **5.4 A decade of progressive and successful rehabilitation turns bare overburdened dumps into green hills**

The year 2014 marks a full decade of progressive and successful rehabilitation of Padaeng mine; its bare overburdened dumps have become green hills with dense plantation trees. It is an outstanding evidence to show its strong intention in rehabilitating the mined areas.

This was a hill used as an overburden collecting area. It was piled as steps of benches according to engineering design, 15 m in height and 8 m in width for each bench. The slope of each bench is 35 degree whereas the overall slope is 27 degree. Materials of hard limestone rocks are piled at the outmost shell for slope strength and erosion prevention. The rock surface was capped by the fertile soil to a thickness of at least 30 cm. After that, the vetiver was grown as underground walls to cover the bare soil to prevent topsoil erosion, and trees of local species were planted. As the overburden was piled from the ground level to the top of the hill, the rehabilitation could be made consequently from the lower level to the top, respectively. There was no need to wait to finish the whole overburden piling in each place.



**Figure 7.**



### 3.5 Expected final picture of post mine rehabilitation in 2023

To demonstrate that corporate business should do with social responsibility, PDI undertakes rehabilitation subsequent to mining and related activities. Eventually, the mining operation is going to terminate in 2018, but the post mine rehabilitation is going to continue for another 5 years until 2023. The mining operation consists of cutting step benches first, then fertile topsoil from outside is brought in to cap the surface of the final open pit at a thickness of at least 30 cm before growing grasses to cover the bare surface and planting trees. The same practices are used for overburden dumps.

Floating platforms of vetiver plant were used in sedimentation ponds in Padaeng mine as shown in pictures below:



Year 2003

Year 2013

**Figure 8.**

For rehabilitation of the tailing storage facilities (TSF), water level was reduced by not adding water and evaporation, and was filled with rocks and capped with fertile topsoil. Then vetiver and trees with shallow roots are planted. For other areas of housing, offices, crushing plant and floatation plant, the buildings will be demolished then rehabilitated with vetiver and trees until 2023.

Below are the models of the rehabilitated areas between 2018 and 2023.

**3.6 Her Royal Highness Princess Maha Chakri Sirindhorn planting Vetiver at Padaeng Mine:** On 28 December 2009, Her Royal Highness Princess Maha Chakri Sirindhorn visited the vetiver plantation for conserving soil and water at PDI, as instructed by HM King Bhumibol Adulyadej. The princess planted vetiver and also a local cork tree. She then visited the exhibition of vetiver on the top of the overburden collecting area.



**Figure 9.**



Year 2018



Year 2020



Year 2023

**Figure 10.**



**Figure 11.** The local cork tree which was planted by the Princess in the overburden collecting area in 2009



### 3.7 The Princess visited the rehabilitation project and planted vetiver for soil and water conservation.

On 23 December 2013, Her Royal Highness Princess Maha Chakri Sirindhorn visited one of the post mining areas and vetiver planning area for soil and water conservation on the overburden dump. The PDI Management, employees and the Committee of Padaeng Rehabilitation Fund proudly welcomed and reported to the Princess the progress of the vetiver growing project. The Princess also planted an iron wood tree which is the tree symbol of Tak Province on the overburden area while the Princess was undertaking various jobs for people in Tak province.



Figure 12.

### 3.8 Padaeng mine rehabilitation fund of 114 million Thai Baht

The company has established the Padaeng Mine Rehabilitation Fund valued at 114 million Thai Baht for use until the end of the mining leases in 2023, to ensure adequate funds for rehabilitation and environmental protection of the whole mining area. It includes environmental monitoring, establishing a tourist site and a center of nature learning and career training. The most important goal is to motivate the community to look after the forest for sustainability. From 2003 to the end of 2014, the funding committee had approved 62 million Thai Baht for rehabilitation.

### 3.9 The annual meeting of the committee of the Padaeng Mine Rehabilitation Fund

The annual meeting of the committee of the Padaeng Mine Rehabilitation Fund is held every year according to its regulations of the year 2003. The main agenda is to report annual progress and to approve the plan and budget for the next year. In 2014, the committee held a meeting on December 2<sup>nd</sup> to acknowledge and approve the progress of the 2014 projects with a budget of about 10 million Thai Baht, as well as to approve the plan and budget for 2015. Note, in addition to PDI members, the committee also included officials from various government agencies and communities.



**Figure 13.** *Left:* The meeting on December 2<sup>nd</sup> 2014; *Right:* The committee visited the area for 2015 projects.

### 3.10 Participation convincing and sustainable management

When the mining leases terminate in 2023, the company has to return the whole area with forest plantation to the Royal Forest Department. The company hopes that all stakeholders including the surrounding communities will protect the plantation forestry area after post mining for their own benefits that will last forever.

### 3.11 Ways of site management for sustainability

The communities and all stakeholders in the local area should have a brainstorm meeting to determine how to manage the forest area for their own benefits. There are a lot of ways of sustainable land management such as a Zinc Mine Museum, a Centre for training and seminars, an Elderly Health Care place, resorts, a National Park, a community forest, or a combination of these.



**Figure 14.** An example of Zinc Mine Museum/Vetiver Learning Centre





**Figure 15.** An example of a combination of resort/national park/community forest

### **3.12 Self-sufficient economics in rehabilitation**

The company has been adopting the royal philosophy of self-sufficient economics to adapt in mine rehabilitation. Water-biological fermentation and manure of the earthworms have been made in PDI rehabilitation nursery for organic fertilizer, thus saving the cost. Manure of earthworms has a good quality of accelerated blooming and plant growing. The urine of the earthworms mixed with water could be absorbed into plant leaves. It can also deter insects and pests.



**Figure 16.** *Left:* Earthworms in the rehabilitation nursery; *Right:* Watering from the reused containers.

### **3.13 Padaeng Mine received the Green Mining awards**

As a result of PDI's strong intention to rehabilitate the mined land with a vetiver growing project and to continue post mine rehabilitation, PDI was awarded the Green Mining Award for three years between 2010 and 2012. In addition, PDI mine also received the CSR Award for 4 years (2011 to 2014) from the Department of Primary Industries and Mines, Ministry of Industry. All employees of the company are proud of these awards; they want to protect the environment surrounding them for sustainable nature.

#### **3.14 Following supporting document is one of necessary awards' criteria**

*Supporting Document No. 1:* Areas and patterns of vetiver growing in the project

*Supporting Document No. 2:* Annual promoting activity of vetiver growing for conserving soil and water between 2003 and 2014

*Supporting Document No. 3:* A series of pictures before and after growing vetiver for comparison