Vetiver Grass Planting in Ropes System by Comparing the Bio-mass and Unit Cost to Other Systems for Developing into Industrial System and Reducing the Operation Cost

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Abstract

This research was conducted on the slope area. In order to conserve the soil from erosion and degradation, In addition, it is to study the growth of bio- mass; such as, roots, stems and leaves, and the production cost. The vetiver grass, planted by randomized complete block designed in four planting bed (4- replications), was grown along the geographical aspect in four directions towards the north, south, east and west. The 12 treatments were arranged into 12 rows/bed with spacing 0.1 X 1 m. by 3 months old using the at 20 cm height of vetiver grass seedlings, Each treatment consisted of 200 plants, which made the total 2,400 plants. The 5 plants from each side of the plot were alternately cut every 2 months. The plants were uprooted without leaf cutting when they were 12 months old in order to examine the bio-mass weight. The length of root were grouped into 0-10, 10-20, 20-30, 30-40 and 40-50 cm, and leaves and stems were cut at the height 0-10, 10-20, 20-30, 30-40 and 40-50 cm. The study was carried out during 1 July 1997 - 30 June 1998.

It was found that vetiver grass from 12 treatments could entirely survive 100%. At six and eight months after planting, fresh and dry weight of bio- mass of all entire treatments were very low due to short daylenght. period and plants being dormant in December, which was the sixth month of the experiment. In February, the eighth month, the weather is cold and dry, thus most of plants stopped growing. The bio- mass weight increases when plants are older because, long daylenght condition, especially for monocotyledon, and starting of rainy season, The 12 treatments were shown the different bio- mass of fresh and dry weight after planting for 2 months. However, when the plants were 12 months old, the different planting method provided the different bio- mass. The 11^{th} treatment presented the highest bio- mass but it was not significant when compared with 7^{th}, 8^{th}, 9^{th}, and 12^{th} treatments. The similar amount of bio-mass which was satisfactory, could be found in the rope planting system namely the 11^{th} treatment (with watering and fertilizing) and the 9^{th} treatment (with out watering and fertilizing) However, the 11^{th} treatment's production cost was the highest at B73.20/m, whilst the 9^{th} was only 19.05/m. Moreover, there was not different reaction in terms of spacing on the plots, depth of roots, and the height of stems and leaves from the soil surface. When the grass was 4,6,8 and 10 months old, the fresh and dry weight was not different.

For leaf cutting plants with watering and fertilizing, the normal planting system provided the highest fresh weight of roots, while the rope system supplied the highest dry weight. On the contrary, without watering and fertilizing, the ninety -degree planting gave the highest stems and leaves fresh weight, whereas, the highest dry weight was found in the rope system.

Non leaf-cutting plants with watering and fertilizing, the planting system gave the highest root weight, yet, the rope system provided the highest weight from stems and leaves. Root depth, and, stem and leave height at 0-10 cm from soil surface, could supply the highest bio- mass weight for both fresh and dry.

The data in this report is presented the variation, however it could be concluded and would be useful for future study.

INTRODUCTION

Doitung Development Project has conducted the activities on the vetiver grass planting for conserveing soil and water based upon The Queen Mom's idea given by His Majesty the King for solving the soil erosion in the Project area. The Vetival Grass Study and Multiplication Center was set up in 1992, the center had got honorable chance to be the study tour area for the World vetiver grass first meeting in 4th – 8th February 1996 at Dusit Island Resort, Chiang Rai province.

The research for developing multiple usage of vetiver grass began from the varieties selecting for adaptability, multiplying, planting, watering, packaging as well as using all parts of grass in multi-purposes. It is very important to develop the planting system for an industrial system with efficiency, convenience, low operation costs and time. The research will be useful for mankind in the future for conserving soil from erosion by vetiver grass planting.

OBJECTIVES

1. to experiment the ROPES system on vetiver grass in order to compare with the other systems in terms of growth and the bio-mass of leaves and roots
2. to study the unit cost in order to compare with 12 treatments

RESEARCH DURATION
From June 1997 – July 1998

RESEARCH WORKING GROUP

1. Samart Sumanochitraporn — Head of the research
2. Montira Salaxana — Co-researcher
3. Surasak Honghom — Co-researcher
4. Surachai Manopeow — Co-researcher

TOOLS AND METHODOLOGIES

A. Comparative study on the growth and survival rate of the vetiver grass planted in different 12 treatments.

1. Study area: Selecting the geographic aspects with 45 degree slope in 4 directions towards north, south, east and west.

2. Planning: Designing plots of vetiver grass and planting in the right angle to the slope; in each plot consisted of 12 rows with 5 meters in length and 10 cms of plants distance and 1 meter of row distance. There were 4 replications based on the slope of each direction.

3. The experimental plants: Selecting 2,400 plants of 3-month old vetiver grass with similar height and strength, then separated them into 12 groups (200 plants per group), and the 12 treatments as follows:

1st treatment: *A normal planting system with watering*: to plant the vetiver grass in the right angle with 10 cms distance and 50 seedlings per row. The water system set in the plot every 20 cms distance by using a 750 ml bottle (contained 2/3 of water) with water wire. In one row, 20 water bottles were used to watering seedling.

2nd treatment: *A normal planting system with watering and fertilizing*: used the similar method as in the 1st treatment but adds chemical fertilizer (Formula 15-15-15) in every water bottle which contains 1% chemical fertilizer.

3rd treatment: *A normal planting system*: to use the similar method as the 1st and 2nd treatments without watering and fertilizing.

4th treatment: *30 degree slope planting system without watering and fertilizing*: planted 10 cms distance with 30 degree slope from soil surface. There were 50 seedling per row.

5th treatment: *60 degree slope planting system without watering and fertilizing*: to use the similar method as the 4th treatment.

6th treatment: *90 degreeat the right angle with surface planting system without watering and fertilizing*: to use the similar method as the 4th and 5th treatments.

7th treatment*: A rope by braiding system with watering*: to grow the vetiver grass with 10 cms distance. Each grass rope is consisted of 50 plants with 5 meter long. Each of them covered the roots with soil and leave the braiding part on the surface. The water system is similar as the 1st treatment.

8th treatment: *A Rope by braiding system with watering and fertilizing*: used the similar method as in the 7th treatment and add 1% chemical fertilizer (Formula15-15-15) in the water.

9th treatment: *A Rope by braiding system without watering and fertilizing*: used the similar method as the 7th and 8th treatments.

10th treatment: *Rope system with watering*: to plant the vetiver grass by roping with the 10 cms distance. Each grass rope is consisted of 50 plants with 5 meter long. The water system is similar as the 7st treatment that use a bottle to drop water by air pressure in the different temperature of the daylight.

11th treatment: *Rope system with watering and fertilizing*: to plant the vetiver as in the 10th treatment but adds 1% chemical fertilizer (Formula 15-15-15) with water in the bottles.

12th treatment: *Rope system without watering and fertilizing:* to plant the vetiver as in the 10th and 11th treatments.

4. Data collection: Collecting the data about the fresh and dry grass weight of stems and roots as well as the survival rate.

4.1) To collect the data of survival rate in every 20 days after planting.

4.2) To cut leaves of 10 plants by 5 of the beginning and 5 of the end of each row in every 2 months. It is about 40 plants with leaf-cutting of each treatment in order to calculate the fresh and dry weight (in gram) of roots and stems at 2, 4, 6, 8, 10 and 12 months old after planting.

4.3) At 12 months after planting, the vetiver grass were gathered for measuring the fresh and dry weight (in gram) of roots and stems at 5 different levels of the depth and height from the surface : 0-4, 10-20, 20-30, 30-40 and 40-50 cms and to find out the bio-mass of all plants and the bio-mass of plants with the non leaf-cutting.

B. Comparing operation costs of each treatment.

The research collected the productive cost of vetiver grass in 12 treatments including: preparing cost, labor cost, transportation cost, and planting operational cost to find out the unit cost per meter.

RESULTS OF THE RESEARCH

A. The comparative study on the growth and survival rate of the vetiver grass planted in different 12 treatments

1. The survival rate: to plant vetiver grass in 12 treatments with leaf-cutting and non leaf-

cutting. It found that vetiver grass from 12 treatments could entirely survive without replanting.

2. Leaf-cutting in every 2 months. For the fresh and dry weight of leaves among at 2, 4, 6, 8, 10 and 12 months after planted, it was found that the 6 and 8 month old grass produced the lowest fresh and dry weight. It can assume that the plants were in dormancy period and the 6th month (December) is the cold season (short day light). Moreover a cotyledon plant like vetiver grass is usually in a stage of dormancy during cold and dry season. However, the plants increased the fresh and dry weight of leaves in the long day light and the humidity in the rainy season (Figure 1: Shows the comparison between the bio-mass of fresh weight and dry weight of the vetiver leaves at the different age)

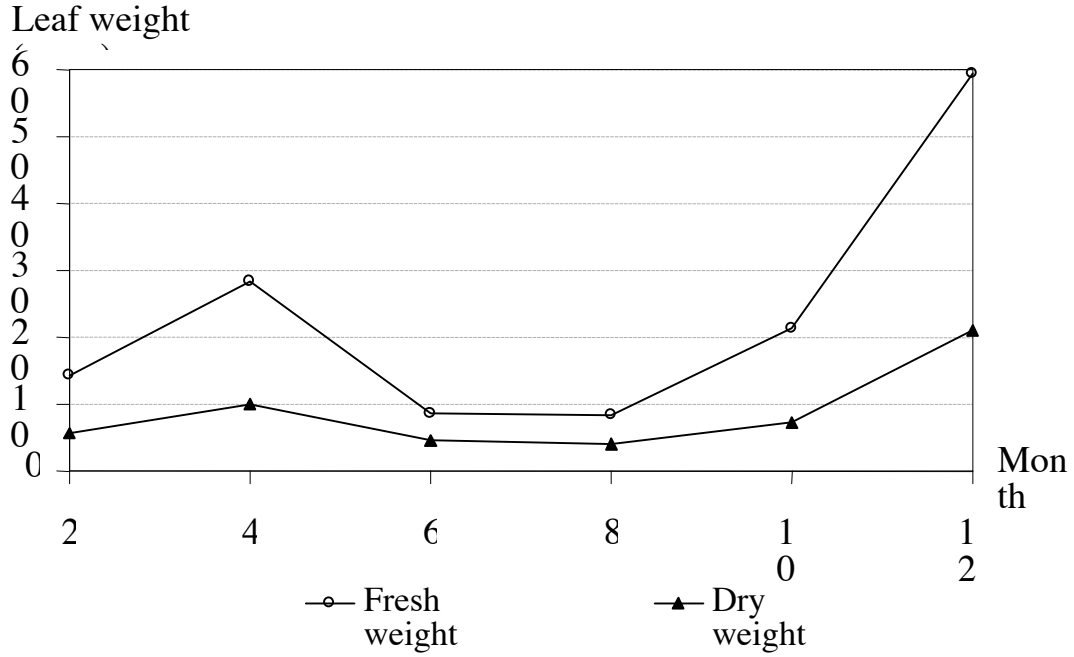


Figure 1 The comparison between the bio-mass of fresh weight and dry weight of the vetiver leaves at the different age

From the statistic analysis, it was found that the rope system with watering and fertilizing could produced the highest fresh and dry weight of leaves 12 months after planting at 116.7 and 42.0 grams, respectively. For leaf-cutting at 2 and 12 months after planting, it produced the fresh and dry weight of leaf different from other months. In the 2nd month after planting, the vetiver, planted in normal system with watering and fertilizing, produced the highest fresh and dry weight of leaves at 31.0 and 12.3 grams, respectively. For leaf-cutting in the 12th month after planting, rope system with watering and fertilizing could produce the highest fresh and dry weight of leaves at 116.7 and 42.0 grams, respectively, while there was no difference with the other rope by braiding system with or without watering and fertilizing as well as the rope system without watering and fertilizing. When cutting the leaves at 4, 6, 8 and 10 months after planting, there was no significantly different in the fresh and dry weight of leaves compared with every treatment. (Table 1 and 2)

Table 1 Fresh weight (gram) of the vetiver grass planted in different treatments at 2, 4, 6, 8, 10 and 12 months after planting.

Treatments	Age (month) after planting					
	2	4	6	8	10	12
1	17.8	26.8	6.3	6.2	9.4	24.2
2	31.0	29.8	5.9	5.9	19.0	48.7
3	20.3	38.2	8.2	7.4	14.3	23.0
4	19.8	38.2	9.5	9.5	19.8	29.5
5	13.4	21.4	8.0	7.9	13.9	35.4
6	16.8	23.0	6.7	6.3	13.6	19.0
7	8.3	21.1	8.0	7.9	22.3	69.1
8	7.0	23.7	9.4	9.3	25.8	81.5
9	10.2	34.3	9.3	9.1	29.2	103.0
10	9.6	28.1	9.0	9.0	26.6	76.2
11	9.7	32.6	15.0	14.6	36.0	116.7
12	8.3	23.5	8.2	8.5	25.2	88.1
$LSD_{0.05}$	10.3	ns	ns	ns	ns	55.0
% C.V.	64.6	43.5	51.9	49.2	78.1	79.9

Table 2 Dry weight (gram) of the vetiver leaves planted in different treatments at 2, 4, 6, 8, 10 and 12 months after planting.

Treatments	Age (month) of vetiver grass after planting					
	2	4	6	8	10	12
1	8.3	10.0	3.5	3.2	3.6	7.8
2	12.3	10.9	3.1	2.7	5.2	17.0
3	8.2	12.2	4.7	4.6	5.2	7.5
4	8.1	14.2	4.8	4.9	6.3	10.4
5	5.5	8.6	3.3	3.7	4.7	12.0
6	6.9	8.9	3.6	2.8	5.0	7.0
7	3.6	7.6	3.8	2.5	7.4	23.6
8	3.2	8.0	5.2	4.1	8.7	31.2
9	4.5	10.5	5.2	4.3	9.8	33.2
10	4.0	9.6	5.3	4.1	9.2	27.0
11	2.8	11.3	6.8	7.1	12.9	42.0
12	2.3	9.5	4.7	4.7	7.8	35.0
$LSD_{0.05}$	4.0	ns	ns	ns	ns	19.3
% C.V.	65.3	40.9	48.3	51.9	78.3	79.6

3. Bio-mass. At 12 month after planted, gathered all plants to separate roots and stems in order to find out the fresh and dry weight, the data as follows.

3.1 Bio-mass of roots and stems with leaf-cutting: The roots and stems with leaf-cutting at 2, 4, 6, 8, 10 and 12 months after planting were divided into 5 parts: at different depth and height from the surface at 0-1, 10-20, 20-30, 30-40 and 40-50 cms and find out the fresh and dry weight. It was found that the depth or height of roots and stems from the soil surface at 5 levels did not have reaction with 12 treatments. But it reacted with the bio-mass of the fresh and dry weight of roots and stems as follows:

For root, it was found that normal planting with watering and with watering and fertilizing could produce the highest fresh roots weight at 11.9 and 12.4 grams, respectively. The rope system with watering and fertilizing could produce the highest dry weight at 4.5 grams (Table 3), while the root at 0-10 cms depth from surface produced the highest the bio-mass fresh and dry weight at 24.4 and 8.3 grams, respectively. (Table 4)

It found that leaves and stems at ninety-degree planting without watering and fertilizing produced the highest stems and leaves fresh weight at 21.3 grams, whereas the rope system without watering and fertilizing produced the highest stems and leaves dry weight at 12.1 grams. It was not significant when compared with other systems (Table 3). The leaves and stems at the height 0-10 cms produced the fresh and dry weight of bio-mass at 33.0 and 11.4 respectively. It was not significant when compared with other systems (Table 4).

Table 3 The bio-mass of fresh and dry weight of vetiver roots, stems, and leaves with leaf-cutting at 12 months after planting in different systems.

Planting Treatments	Roots		Stems/Leaves	
	Fresh weight (g.)	Dry weight (g.)	Fresh weight (g.)	Dry weight (g.)
1	11.9	4.0	20.1	6.8
2	12.4	4.2	19.1	6.0
3	5.7	1.8	16.1	5.5
4	5.4	2.0	8.4	2.7
5	10.0	3.3	14.5	4.9
6	9.7	3.2	21.3	7.1
7	7.9	2.6	13.7	4.3
8	9.9	3.3	13.4	4.4
9	11.2	3.9	15.8	5.3
10	9.2	3.2	12.7	4.3
11	11.2	4.5	12.9	4.6
12	8.0	2.9	17.1	12.1
$LSD_{0.05}$	3.7	1.3	5.7	3.0

Table 4 The bio-mass of fresh and dry weight of vetiver roots, stems, and leaves at different depth and height after planting 1 year in leaf-cutting plants.

Depth and Height from the soil surface (cms.)	Roots		Stems/Leaves	
	Fresh weight (g.)	Dry weight (g.)	Fresh weight (g.)	Dry weight (g.)
0-10	24.4 a	8.3 a	33.0 a	11.4 a
10-20	11.5 b	4.0 b	18.7 b	6.6 b
20-30	6.0 c	2.2 c	11.9 c	4.7 bc
30-40	3.2 d	1.1 d	8.2 d	3.4 cd
40-50	1.7 d	0.6 d	5.2 d	2.3 d
$LSD_{0.05}$	2.4	8.2	3.7	1.9

3.2 The bio-mass of roots and stems of Non leaf-cutting plants The vetiver grass from 12 treatments with non leaf-cutting, at 12 months after planting, were cut at the height 0-10, 10-20, 20-30, 30-40 and 40-50 cms. from soil surface. It found that the 12 treatments did not react with the 5 different depth and height from soil surface. The treatment presented the fresh and dry weight of different bio-mass of roots and stems, as follows:

For roots with watering and fertilizing using the rope by braiding system supplied the highest fresh and dry weight at 24.2 and 8.3 grams respectively (Table 5). The roots at 0-10 cms from soil surface produced the highest fresh and dry weight of bio-mass at 36.4 and 12.1 grams respectively. It was not significant with harvesting at different depth from soil surface (Table 6).

For stems and leaves without watering and fertilizing, the rope by braiding system supplied the highest fresh and dry weight at 46.3 and 14.6 grams respectively (Table 5). The stems and leaves were cut at the height 1-10 cms from soil surface produced the highest fresh and dry weight of bio-mass at 48.4 and 15.8 gram respectively. It was not significant with other height levels (Table 6).

Table 5 The bio-mass of fresh and dry weight of vetiver roots, stems and leaves in different treatments after planting for 12 months in non leaf-cutting plants.

Planting Treatments	Roots		Stems/Leaves	
	Fresh weight (g.)	Dry weight (g.)	Fresh weight (g.)	Dry weight (g.)
1	15.2	5.4	38.4	12.3
2	19.0	6.7	40.1	13.7
3	9.7	3.2	34.9	11.6
4	10.4	3.6	37.6	12.6
5	14.1	4.7	33.5	11.0
6	13.8	4.6	39.1	13.1
7	11.2	3.6	24.7	8.1
8	24.2	8.3	40.1	13.6
9	17.3	5.4	28.5	9.5
10	12.5	4.4	28.4	9.4
11	18.6	5.8	46.3	14.6
12	18.0	6.4	33.8	13.1
$LSD_{0.05}$	5.7	1.8	8.5	2.9

Table 6 The bio-mass of fresh and dry weight of vetiver roots, stems, and leaves at different depth and height at the 12 months old in non leaf-cutting plants.

Depth and Height from the soil surface (cms.)	Roots		Stems/Leaves	
	Fresh weight (g.)	Dry weight (g.)	Fresh weight (g.)	Dry weight (g.)
0-10	36.4 a	12.1 a	48.4 a	15.8 a
10-20	19.7 b	6.8 b	37.8 b	12.7 b
20-30	11.2 c	3.8 c	33.2 b	11.4 bc
30-40	6.1 d	2.0 d	30.4 cd	10.3 cd
40-50	3.2 d	1.1 d	30.4 cd	9.3 d
$LSD_{0.05}$	3.7	1.2	5.5	1.9

The bio-mass of fresh and dry weight of roots and stems in roots and stems in the less leaf-cutting plants are higher than the non leaf-cutting plants after planting for 12 months. For 12 treatments in both non leaf-cutting plants and leaf-cutting plants after planting 12 months found that the normal planting system with watering and fertilizing produced highest fresh and dry weight of roots and stems. While the leaf-cutting plants with the rope system and the

rope by braiding system with watering and fertilizing supplied the highest fresh and dry weight of roots and stems. The non leaf-cutting plants with the rope by braiding system without watering and fertilizing produced the highest fresh and dry weight of roots and stems (Table 3 and 5). Moreover, the depth and height from soil surface produced the fresh and dry weight of roots and stems higher than the level of the depth and height from soil surface (Table 4 and 6)

B. Comparing operation costs of each treatment.

Table 7 The operation costs of different 12 vetiver grass treatments (unit=Baht/Meter/10 vetiver grass seedling)

Treatments	Seedling costs	Transportation costs	The rope by braiding system costs	The rope system costs	Land preparation costs	Planting costs	Water system costs	Fertilizers costs	Total	Remarks
1	16.90	0.40	-	-	0.75	1.00	50.00	-	69.05	
2	16.90	0.40	-	-	0.75	1.00	50.00	4.00	73.05	
3	16.90	0.40	-	-	0.75	1.00	-	-	19.05	
4	16.90	0.40	-	-	0.75	1.00	-	-	19.05	
5	16.90	0.40	-	-	0.75	1.00	-	-	19.05	
6	16.90	0.40	-	-	0.75	1.00	-	-	19.05	
7	16.90	0.20	1.00	-	0.75	0.20	50.00	-	69.05	
8	16.90	0.20	1.00	-	0.75	0.20	50.00	4.00	73.05	
9	16.90	0.20	1.00	-	0.75	0.20	-	-	19.05	
10	16.90	0.20	-	1.15	0.75	0.20	50.00	-	69.20	
11	16.90	0.20	-	1.15	0.75	0.20	50.00	4.00	73.20	
12	16.90	0.20	-	1.15	0.75	0.20	-		19.20	

The operation costs of 12 treatments as follows:

1. The prices of vetiver grass's seedlings at 1.69 Baht/seedling, according to received budget.

2. The transportation of vetiver grass seedlings average from the 10 kilometers transportation of a truck (1 ton of weight) that carried 600 seedlings, and average from the labor costs per hour including carrying seedling to and off the truck. The seedlings packed in

bags were transported 2 rounds of rented truck with gasoline and a driver. The driver was paid 280 Baht (140 Baht per round), using 2 labors (100 Baht per day) for carrying seedling bags. For the transportation of the vetiver grass with rope system, the truck transported 1 round with 2 haft day-labors (After finished work, labors did other works). So it cost about 240 Baht (100 Baht of labors and 140 Baht of truck rent). Thus, the transportation of 2 types of vetiver seedlings for research plots cost 720 Baht, averaged 0.40 Baht for seedling in bags and 0.20 Baht for seedlings with the rope by braiding and rope systems.

3. For the costs of rope by braiding and roping vetiver grass, calculated by from daily labor. The labor payment calculated from the length of vetiver grass rope that the labors can do per day. Averaged by 5 labors, they got 1.00 Baht per mater from the braiding vetiver grass and got 1.15 Baht per mater from rope vetiver grass.

4. The land preparation calculated from labor costs. The labors got about 880 Baht from planting 1 rai or 1,600 square meters. In the research, there were 4 research plots or about 240 square meters and had the 5 meters wide-fire buffers around the plots. Each plot was about 330 square meters per 1 meter long vetiver grass planting. It cost about 0.75 Baht from 2400 seedlings.

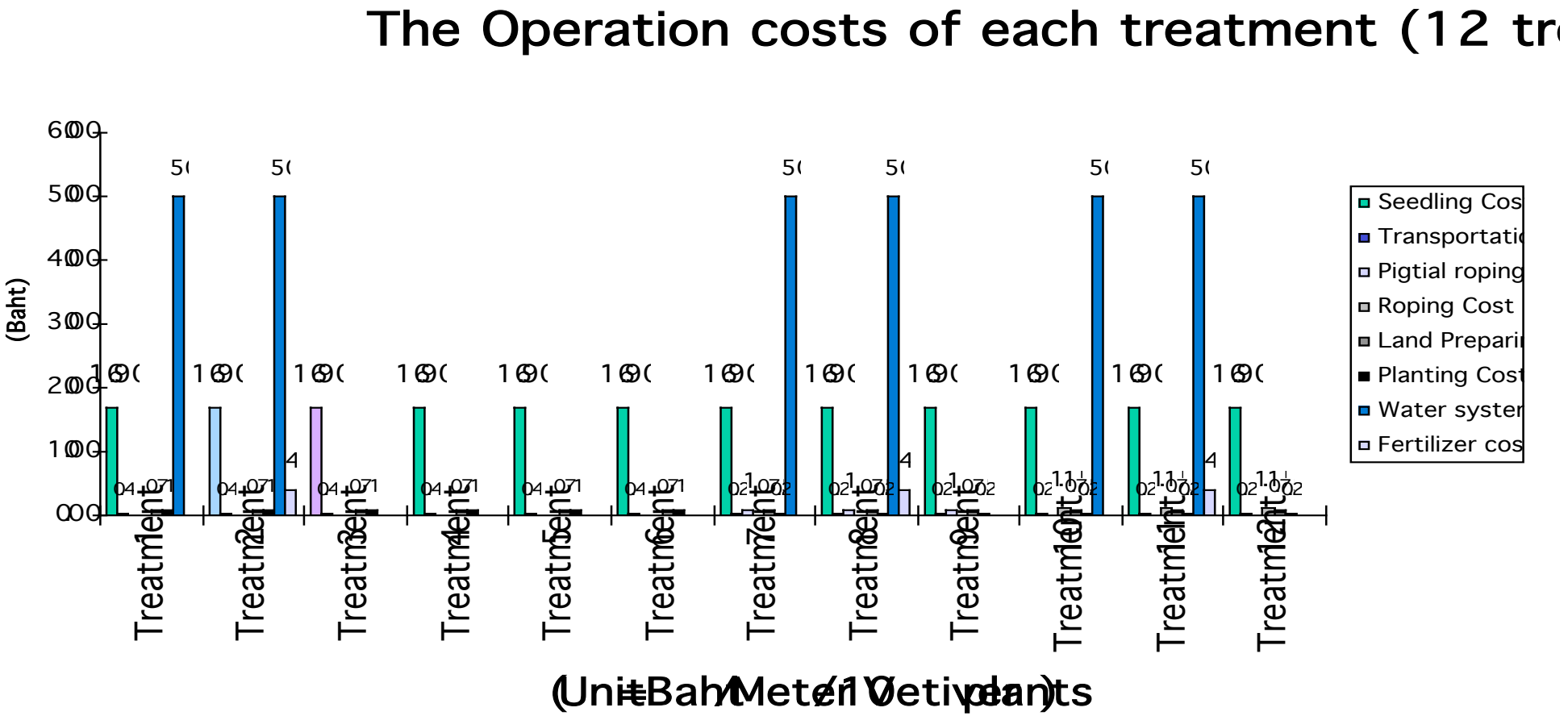
5. The costs of planting in plastic bags, the research calculated by based on the information from labors that carried and planted. They planted 10 bags of vetiver grass in 1 meter long and it cost 1 Baht. Planting vetiver grass by using ropes system both the rope by braiding and rope treatments can be more efficiency about 0.20 Baht per meter than the plastic bags.

6. For plastic bottle-water system by using Thermo energy, this system dropped water in every 20 cms. The researchers set 25 bottles of water per 5 meters long and it cost about 50.00 Baht. 1 set of bottle of water is about 2 Baht.

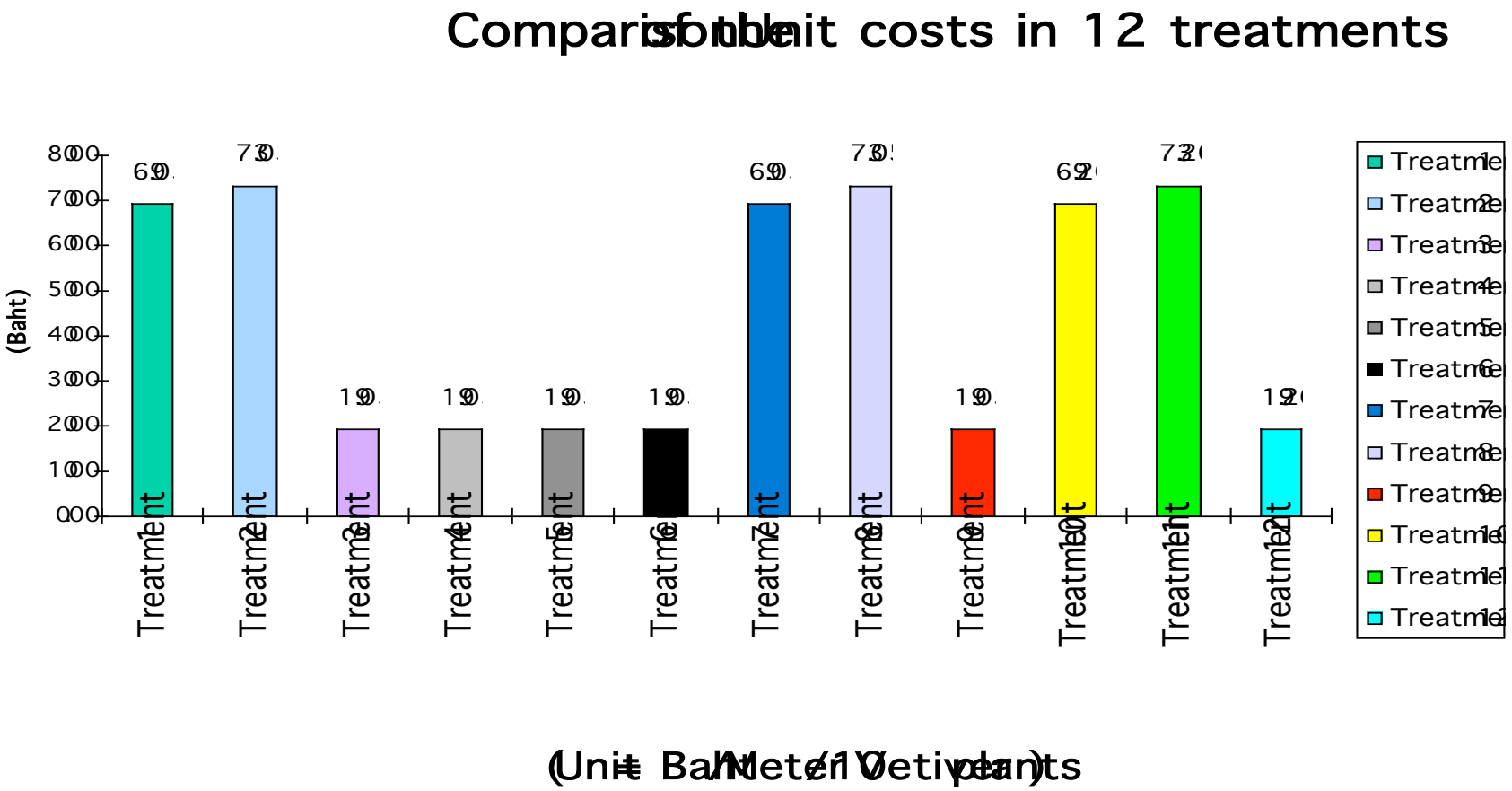
7. In practice, fertilizers were used 4 times per month by mixing when watering. About 1 decigram per 1 Baht per time, the total was 4 Baht per fertilizing.

*** The water system by using Thermo energy is new innovation. This innovation used the theory of heat, it mentions about the different temperature of daylight conditions can produce air pressure in water bottle. The bottle divided into 3 parts and 1 of its contains by air. The upper part from the bottom of water bottle has a small hole connected by water wire. Then the air in the bottle expands when heated, the low temperature of water was pushed through the wire. The water will stop when the temperature is low. Regarding to Dr. ZVIENOCH, he suggested this method for watering the vetiver grass in dry season.

It was found that vetiver grass from 12 treatments could entirely survive 100% because the vetiver grass was planted on July and it is the beginning of raining season. Comparing the operating costs of 12 treatments, it found that the operation costs of treatments without watering and fertilizing per 1 meter long were almost the same amount at 19.05-19.20 Baht per meter. The 3rd, 4th, 5th, 6th, and 9th treatments had lowest operation costs at 19.05 Baht per meter. But it would have more costs between 69.05-73.20 Baht per meter with watering and fertilizing. The 11th treatment had highest operating costs at 73.20 Baht per meter, but this treatments produced the highest fresh and dry weight of bio-mass of roots, stems and leaves at 12 months after planting. It means that this treatment is economical effective because the planting factors are depending on transportation, water system and land quality. It is very significant for further study.



Graph 1 The Operation Costs of each treatment (12 Treatment)



Graph 2 Comparison of the Unit Cost in 12 treatments

CONCLUSION

A. Comparing the vetiver bio-mass of every treatments and its survival rate.

1. Vetiver grass planting from 12 treatments could entirely survive 100% because the vetiver grass was planted on July which is the beginning of raining season.

2. At 6 and 8 months after planting, fresh and dry weight of bio-mass of all entire treatments were very low due to being dormant but the weight increased more when the plants are older and in maturing stage.

3. The bio-mass of 12 months old in non leaf-cutting and leaf-cutting, it did not have reaction between periods and planting of 12 treatments and the depth and height from soil surface of leaves and stems.

4. The vetiver grass was planted by normal system with leaf-cutting, watering and fertilizing at 12 months old produced the bio-mass of highest fresh weight in roots. For the rope system with watering and fertilizing produced the bio-mass of highest dry weight of roots. Moreover, ninety-degree planting without watering and fertilizing produced the highest stems fresh weight. The highest stems dry weight was found in the rope system without watering and fertilizing.

5. For non leaf-cutting plants with watering and fertilizing, the rope by braiding system provided the highest bio-mass of roots, while the rope system with watering and fertilizing supplied the highest bio-mass of stems.

6. The stems and roots at the height 0-10 cms produced the bio-mass of fresh and dry weight.

B. Comparing operation costs of 12 treatments with the vetiver growth of bio-mass and survival rate.

1. For collecting data on the operation costs of planting and bio-mass in 12 treatments in four planting bed (4- replications), it found that the bio-mass of the 9^{th} treatment with rope by braiding system was not different from the 11^{th} treatment which presented highest bio-mass. If the vetiver plants in a large area, it will reduce the transportation and labor costs. Compared with the 3^{rd}, 4^{th}, 5^{th} and 6^{th} treatments had the same amount of operation costs, but planted in small scale area.

In addition, labors have more skills on roping; it will reduce more operation costs. However, it should have enough water and fertile soil for plants. If the plants are lack of water, it will have very high survival rate.

2. The 11^{th} treatment presented the highest bio-mass of roots and leaves. This treatment is good for drought area such as rain shadow area and less fertile soil, but the expenses of this treatment are very high at 73.20 Baht per meters. The advantage of this treatment is low transportation and labor costs and it is better than planting in bags.

3. The 3^{rd}, 4^{th}, 5^{th} and 6^{th} treatments had the same amount expenses with the 9^{th} treatment which planted vetiver in bags at 30, 60 and 90 degree from soil surface without watering and fertilizing. It found that the bio-mass was not different from the 11^{th} treatment. In the large scale of operation, the other treatments have high transportation and labor costs than the 9^{th} and 11^{th} treatments. However the roots were not damaged in other treatments with plants in bags, comparing with the 9^{th} and 11^{th} treatment with rope system. In conclusion, The above treatments (3^{rd}, 4^{th}, 5^{th} and 6^{th} treatments) can plant in diverse area compared with the 9^{th} and 11^{th} treatments.

PROBLEMS, OBSTACLES AND SOLUTIONS

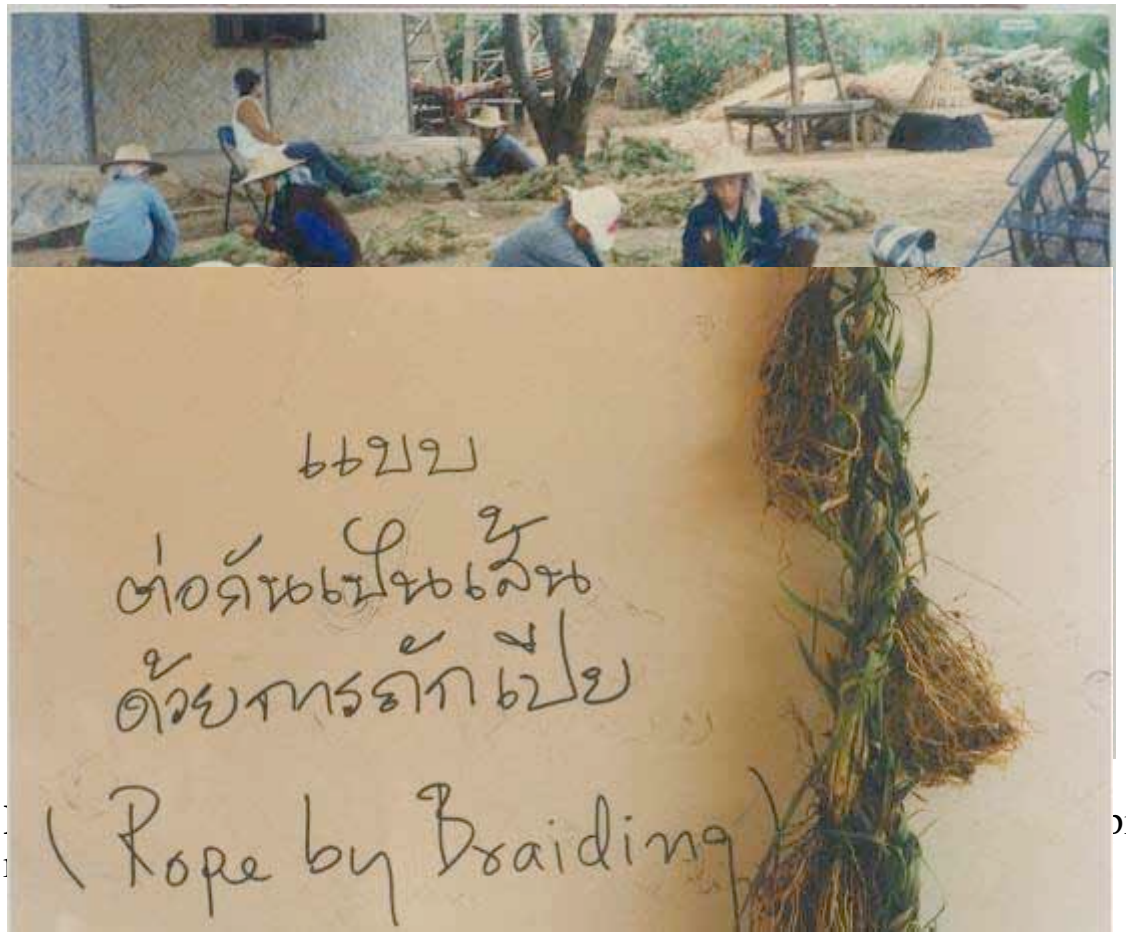
1. This research is a continue work from plant multiplication, seedling nursery and planting by both in bags and rope system. There were many problems in this research because

many people in working team accidentally went back to work with their headquarters, especially the one who mainly researched in the fields. The research team solved this problem by trained the head of workers to collect data in the field. It needs to form and train the staffs on research skills and those staffs should be willing to do research for more efficiency work.

2. The research on vetiver grass needs further study because each parts of plant can be used. It needs more intensive study and also more on varieties selection and breeding new varieties which are adapted in drought and cold conditions.

However the research, Vetiver Grass Planting in Ropes System by Somparing the Bio-mass and Unit cost to Other Systems for Developing into Industrial System and Reducing the Operation Cost, is very significant for developing and promoting knowledge on conserving soil and water for farm

Figure 2 Vetiver grass *(Vetiveria zizaniodes)* at 3 months



bing and

Figure 6 Transferring vetiver *(Vetiveria zizaniodes)*seedling to research plots

plots

Figure 9 Planting Vetiver grass *(Vetiveria zizaniodes)* in the plots

Figure 10 1. A normal system without watering and fertilizing.
2. A normal system with watering and fertilizing.

Figure 12 7. A rope by braiding pattern without watering and fertilizing
8. A rope by braiding pattern with watering and fertilizing

Figure 13 10. A roping pattern without watering and fertilizing
11. A roping pattern with watering and

Dr. ZVI ENOCH

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Finally, I hope to in collaborate other research projects on soil and water conservation in the future. Thanks again for the cooperation.

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Staff Leader

Appendix